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PYTHAGORAS
and the Early Pythagoreans

LEONID ZHMUD

Translated from Russian by
Kevin Windle and Rosh Ireland

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For M.M.S.

Preface

The first version of this book, the result of my research into early Pythagoreanism, was written in 1990–2, when I spent two years at the University of Konstanz as a Fellow of the Alexander von Humboldt Foundation. The Russian version was published in St Petersburg in 1994, and a German translation, made on the initiative of Wolfgang Schuller (Konstanz), appeared in Berlin in 1997. For some time I felt that I could hardly add anything substantially new to what I had already written about Pythagoras and the early Pythagoreans. My work on a book about the Peripatetic Eudemus of Rhodes, the author of the first works on the history of science, led me to look at the discoveries of Pythagoras and the Pythagoreans in the exact sciences from a slightly different point of view and alter my perceptions. The direct cause of my return to work on Pythagorean material was a kind suggestion from Helmut Flashar (Munich) that I should write the chapters on Pythagoras and the most important Pythagoreans for a new edition of the Ueberweg-Praechter *Grundriss der Geschichte der Philosophie*. When one considers each representative of the Pythagorean school individually, one is reminded how unique they all were and how different their views are from the number philosophy which Aristotle attributed to the Pythagoreans in general and to no single individual. This is one of the many reasons why we ought to be very cautious about the Pythagoreans as a collective identity, for this is the very area of classical tradition where we can expect to encounter the grossest distortions.

I am much indebted to Hilary O'Shea at Oxford University Press for her support of my project and patience in waiting for it to reach completion. When I began reworking my book in 2006 I little thought that it would take almost five years, or that the revision would be so extensive. While the basic structure is unchanged, the text has been rewritten and several new sections and whole chapters added. In particular, I have achieved substantial progress on the question of why the number philosophy that Aristotle ascribes to the Pythagoreans is so similar to Plato's unwritten doctrine. This required a special chapter. I have now resolved in different ways many of the particular questions which I considered in the first edition, partly thanks to new

publications which have appeared in the interval. The first and most complex part of the work was done while I was a Fellow at the Netherlands Institute for Advanced Study in Wassenaar (NIAS) (2006–07). To live and work in Wassenaar was a great pleasure, and I would like to express my most sincere gratitude to the NIAS for that very fruitful year. I owe the same debt of gratitude to the Maison des Sciences de l'Homme (Paris), and especially the Alexander von Humboldt Foundation, whose support I enjoyed during the concluding stage of the project, in spring 2009 and summer 2010. For this I would like to thank André Laks (Sorbonne) and Gereon Wolters (University of Konstanz), who unfailingly supported my scholarly endeavours.

Andrew Barker (Birmingham), Paul Keyser (New York), and Jens Høyrup (Roskilde, Denmark) read individual chapters of this book, and Constantin Macris (Paris) and Bruno Centrone (Pisa) read it in its entirety. Their numerous corrections and valuable comments have greatly improved it. They have my sincere gratitude. I am particularly grateful to the English translators of my book, Kevin Windle and Rosh Ireland (Canberra). My collaboration with them has been very close and friendly, in spite of the distance separating us.

Leonid Zhmud

St Petersburg, June 2011

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Abbreviations

Sources

Achil. *Isag.*	Achilles, *Isagoge*
Ael.	Aelian
De nat. an.	*De natura animalium*
VH	*Varia historia*
Aesch. fr.	Aeschylus, *Tragicorum Graecorum fragmenta*, vol. 3, ed. S. Radt (Göttingen, 1985).
Aët.	Aëtius, *Doxographi Graeci*, ed. H. Diels (Berlin, 1879), 267–444.
Alcidam.	Alcidamas
Alex. *In Met.*	Alexander Aphrodisiensis, *In Aristotelis Metaphysica commentaria*, ed. M. Hayduck (Berlin 1891).
Alex. Polyh.	Alexander Polyhistor, *FGrHist* 273
Alexis, fr.	*Poetae Comici Graeci*, edd. R. Kassel, C. Austin (Berlin 1983–).
Amips. fr.	Amipsias, *Poetae Comici Graeci*, edd. R. Kassel, C. Austin (Berlin 1983–).
Ammon. *In Porph.*	Ammonius, *In Porphyrii isagogen*, ed. A. Busse (Berlin, 1891).
Anat. *De decad.*	Anatolius, *De decade*
Anaxag.	Anaxagoras
Anon. Lond.	*Anonymi Londinensis ex Aristotelis Iatricis Menoniis et aliis medicis eclogae*, ed. H. Diels (Berlin, 1893).
Anon. in Pl. *Tht.*	*Anonymi Commentarius in Platonis Theaetetum*, edd. J. L. Heiberg, H. Diels (Berlin, 1905).
Anon. Phot.	Anonymus Photii, Phot. Cod. 249, 438b–441b = H. Thesleff, *The Pythagorean Texts of the Hellenistic Period* (Åbo, 1965), 237–43.
Antiphanes fr.	*Poetae Comici Graeci*, edd. R. Kassel, C. Austin (Berlin, 1983–).
Antisthenes fr.	*Antisthenis Fragmenta*, ed. F. Decleva Caizzi (Milan, 1965).
A. P.	*Anthologia Palatina*
Apoll.	Apollonius, *FGrHist* 1064

Apul.	Apuleius
Apol.	*Apologia*
Flor.	*Florida*
Ar.	Aristophanes
Av.	*Aves*
Lys.	*Lysistrata*
Nub.	*Nubes*
Pl.	*Plutus*
Ran.	*Ranae*
Archestratus	*Parodorum epicorum Graecorum et Archestrati reliquiae*, ed. T. Brandt (Leipzig, 1888); *Archestratos of Gela*, ed. S. D. Olson and A. Sens (Oxford, 2000).
Archyt.	Archytas
Arist.	Aristotle
APost	*Analytica Posteriora*
APr	*Analytica Priora*
De audib.	*De audibilibus*
Cael.	*De caelo*
De an.	*De anima*
De iuvent.	*De iuventute et senectute*
De poet.	*De poetis*
De gen. et corr.	*De generatione et corruptione*
De phil.	*De philosophia*
De resp.	*De respiratione*
EE	*Ethica Eudemia*
EN	*Ethica Nicomachea*
fr.	*Aristotelis qui ferebantur librorum fragmenta*, ed. V. Rose, 3rd edn. (Leipzig, 1886); *Aristotelis fragmenta selecta*, ed. W. D. Ross (Oxford, 1955); *Aristotelis opera. Librorum deperditorum fragmenta*, ed. O. Gigon (Berlin, 1987).
GA	*De generatione animalium*
HA	*Historia animalium*
Met.	*Metaphysica*
Mete.	*Meteorologica*
MM	*Magna Moralia*
PA	*De partibus animalium*
Phys.	*Physica*
Poet.	*Poetica*
Pol.	*Politica*
Probl.	*Problemata*
Protr.	*Protrepticus*: I. Düring, *Aristotle's Protrepticus: An Attempt at Reconstruction* (Göteborg, 1961).

Rhet.	*Rhetorica*
Soph. el.	*Sophistici elenchi*
Top.	*Topica*
Aristid. Quint.	Aristides Quintilianus
Aristobulus fr.	*Fragmenta pseudepigraphorum quae supersunt Graeca*, ed. M. Denis (Leiden, 1970).
Aristocl.	Aristocles of Messene. *Testimonia and Fragments*, ed. M. L. Chiesara (Oxford, 2001).
Aristophon fr.	*Poetae Comici Graeci*, ed. R. Kassel, C. Austin (Berlin, 1983–).
Aristox. fr.	Aristoxenus, ed. Wehrli
Harm.	*Elementa harmonica*, ed. R. da Rios (Rome, 1954).
Asclep. *In Met.*	Asclepius, *In Aristotelis metaphysicorum libros A–Z commentaria*, ed. M. Hayduck (Berlin, 1888).
Athen.	Athenaeus
Aul. Gell.	Aulus Gellius
Biton	Biton: *Poliorcétique des Grecs: traités théoriques*, ed. C. Wescher (Paris, 1867).
Boeth. *Inst. mus.*	Boethius, *De institutione musica*
Cael. Aurel. *De morb. acut.*	Caelius Aurelianus, *De morbis acutis*
Callim. fr.	Callimachus. *Fragmenta*, ed. R. Pfeiffer (Oxford, 1949).
Cassiodorus	
Var.	*Variae*
Cels. *De med.*	Celsus, *De medicina*
Cens.	Censorinus, *De die natali*
Chalcidius. *In Tim.*	*Timaeus a Calcidio translatus commentarioque instructus*, ed. J. H. Waszink (London, 1962).
Cic.	Cicero
De finib.	*De finibus*
De inv.	*De inventione*
De orat.	*De oratore*
De rep.	*De re publica*
ND	*De natura deorum*
Tusc.	*Tusculanae disputationes*
Clearch.	Clearchus, ed. Wehrli
Clem. *Strom.*	Clemens Alexandrinus, *Stromata*
Cyril. *Adv. Julian.*	Cyrillus Alexandrinus, *Adversus Julianum Imperatorem libri decem*
D. L.	Diogenes Laertius

Damasc. *Princ.* — Damascius, *De primis principiis in Platonis Parmenidem*, vols. I–II, ed. C. A. Ruelle (Paris, 1889).
Dem. Phal. — Demetrius Phalereus, ed. Wehrli
Democr. — Democritus, ed. H. Diels; ed. S. Luria, *Democritea* (Leningrad, 1970).
Dic. — Dicaearchus, ed. Wehrli; ed. D. C. Mirhady, in W. W. Fortenbaugh and E. Schütrumpf (eds.), *Dicaearchus of Messana* (New Brunswick, 2001), 1–142.
Diod. — Diodorus Siculus
Dion. Halic. — Dionysius Halicarnassensis, *Antiquitates Romanae*
DK — *Die Fragmente der Vorsokratiker*, ed. H. Diels, W. Kranz, 6th edn., vols. I–III (Berlin, 1952).
Dox. — *Doxographi Graeci*, ed. H. Diels (Berlin, 1879).
Elias
  In Arist. Cat. — *Eliae in Porphyrii Isagogen et Aristotelis Categorias*
  In Porph. — *commentaria*, ed. A. Busse (Berlin, 1900).
Emped. — Empedocles
Epistol. gr. — *Epistolographi graeci*, ed. R. Hercher (Paris, 1873).
Etym. Gudian. — *Etymologicum Gudianum*, ed. A. de Stefani, vol. 1–2 (Leipzig, 1909–1920).
Euc. — Euclid
Eud. — Eudemus Rhodius, ed. Wehrli
Eudox. — Eudoxus: Lasserre, F. *Die Fragmente des Eudoxos von Knidos* (Berlin, 1966).
Eur. — Euripides
  Hec. — *Hecuba*
  Hipp. — *Hippolytus*
  Or. — *Orestes*
  Phoen. — *Phoenissae*
  Rhes. — *Rhesus*
Euseb. *Prep. Ev.* — Eusebius, *Praeparatio evangelica*, ed. K. Mras, vols. 1–2 (Berlin 1954–6).
Favorin. fr. — Favorinus: Mensching, E. *Favorinos von Arelate* (Berlin, 1963).
FGrHist — *Die Fragmente der griechischen Historiker*, ed. F. Jacoby, vols. I–III (Berlin, 1929–58). *Die Fragmente der griechischen Historiker Continued.* Pt. 4. *Biography and Antiquarian Literature*, ed. G. Schepens. Fasc. 1: *The Pre-Hellenistic Period*, ed. J. Bollansée et al. (Leiden, 1998). Fasc. 3: *Hermippos of Smyrna*, ed. J. Bollansée (Leiden,

	1999). Fasc. 7: *Imperial and Undated Authors*, ed. J. Radicke (Leiden, 1999).
FHSG	*Theophrastus of Eresus: Sources for His Life, Writings, Thought, and Influence*, ed. W. W. Fortenbaugh, P. M. Huby, R. W. Sharples, D. Gutas, Pt. 1–2 (Leiden, 1992).
Galen	
De Hipp. et Plat.	*De placitis Hippocratis et Platonis*
De meth. med.	*De methodo medendi*
In Hipp. de nat. hom.	*In Hippocratis De natura hominis commentaria*
G.-P.	*Poetarum elegiacorum testimonia et fragmenta*, edd. B. Gentili, C. Prato, vols. 1–2 (Leipzig, 1979–1985).
Gaud. *Harm.*	Gaudentius, *Harmonica introductio*
Hdt.	Herodotus
Heracl.	Heraclitus
Hermipp. fr.	Hermippus, ed. Wehrli; ed. Bollansée, *FGrHist* 1026
Hermodor. fr.	Hermodorus: M. Isnardi Parente, *Senocrate-Ermodoro: Frammenti* (Naples, 1982).
Her. Pont. fr.	Heraclides Ponticus, ed. Wehrli
Hes. *Op.*	Hesiod, *Opera et dies*
Th.	*Theogonia*
Hesych.	Hesychius
Hierocl. *In Carm. aur.*	Hierocles, *In Carmen aureum*
Hieron. *Adv. Rufin.*	Hieronymus, *Epistula adversus Rufinum*
Hipp.	Hippocrates
Aer.	*De aere, aquis et locis*
Affect.	*De affectionibus*
De articul.	*De articulis*
De carn.	*De carnibus*
De flat.	*De flatibus*
De gen.	*De genere*
De haemor.	*De haemorrhoidibus*
De loc. in hom.	*De locis in homine*
De morb.	*De morbis*
De morb. sacr.	*De morbo sacro*
De oss.	*De ossium natura*
De semin.	*De semine*
De sept. partu.	*De septimestri partu*
De superf.	*De superfoetatione*
De victu acut.	*De victu in morbis acutis*
Epid.	*Epidemiae*

Mul.	*De mulierum affectibus*
Nat. hom.	*De natura hominis*
Nat. mul.	*De natura muliebri*
Oct.	*De octimestri partu*
Progn.	*Prognosticon*
Prorrhet.	*Prorrheticus*
VM	*De vetere medicina*
Hippob. fr.	Hippobotus: *Frammenti di Ippoboto*, ed. M. Gigante, in A. Mastrocinque (ed.), *Omaggio a Piero Treves* (Padua, 1984), 151–93.
Hippol.	Hippolytus
Ref.	*Refutatio omnium heresium*
Iamb.	Iamblichus
Comm. Math.	*De communi mathematica scientia liber*, ed. N. Festa, corr. U. Klein (Stuttgart, 1975).
De myst.	*De mysteriis*
In Nic.	*In Nicomachi arithmeticam introductionem*, ed. E. Pistelli (Leipzig, 1894).
Protr.	*Protrepticus*, ed. E. Pistelli (Stuttgart, 1888).
VP	*De vita Pythagorica liber*, ed. L. Deubner, corr. U. Klein (Stuttgart, 1975).
Iren.	Irenaeus
Adv. haeres.	*Adversus haereses*
Isoc.	Isocrates
Antid.	*Antidosis*
Bus.	*Busiris*
Iust.	Iustinus, *Epitome historiarum Philippicarum Pompei Trogi*
K-A	*Poetae Comici Graeci*, edd. R. Kassel, C. Austin (Berlin, 1983–).
Luc.	Lucian
Gall.	*Gallus*
Hist. conscr.	*Quomodo historia conscribenda sit*
Ver. hist.	*Vera historia*
Vit. auct.	*Vitarum auctio*
Lys.	Lysias
Macr. *Somn. Sc.*	Macrobius, *Commentarius in Somnium Scipionis*
Neanth. fr.	Neanthes, *FGrHist* 84
Nicom.	Nicomachus
Ar.	*Introductionis arithmeticae libri II*, ed. R. Hoche (Leipzig, 1866).
fr.	*Life of Pythagoras*, *FGrHist* 1063

Harm.	*Harmonicum enchiridion*, ed. K. Jan, *Musici scriptores Graeci* (Leipzig, 1895) 236–65.
Numenius, fr.	Numenius, *Fragments*, ed. É. des Places (Paris, 1974).
OF	*Orphicorum fragmenta*, ed. O. Kern (Berlin, 1922).
Olymp. *In Phaed.*	Olympiodorus, *In Platonis Phaedonem commentaria*
Oribas. *Coll. med.*	Oribasius, *Collectiones medicae*
Papp.	Pappus
Coll.	*Pappi Alexandrini collectionis quae supersunt*, ed. F. Hultsch, vols. 1–3 (Berlin, 1876–1878).
Comm.	*The Commentary on Book X of Euclid's Elements*, tr. G. Junge and W. Thomson (London, 1930).
Paus.	Pausanias
Philo	Philo of Alexandria
De opif.	*De opificio mundi*
De plant.	*De plantatione Noë*
Prob. lib.	*Quod omnis probus liber sit*
Philodemus	
De piet.	*De pietate*
Hist. Acad.	*Historia Academicorum*
Philol.	Philolaus
Philop.	Philoponus
In de An.	*In Aristotelis libros de anima commentaria*, ed. M. Hayduck (Berlin, 1897).
In Phys.	*In Aristotelis Physicorum libros commentaria*, ed. H. Vitelli, vols. 1–2 (Berlin, 1887–8).
Philostr. *VA*	Philostratus, *Vita Apollonii Tyanensis*
Phylarch.	Phylarchus, *FGrHist* 81
Pind.	Pindar
Ist.	*Isthmian Odes*
Pyth.	*Pythian Odes*
Pl.	Plato
Charm.	*Charmides*
Crat.	*Cratylus*
Epin.	*Epinomis*
Euthyd.	*Euthydemus*
Euthyphr.	*Euthyphro*
Gorg.	*Gorgias*
Hipp. mai.	*Hippias maior*
Hipp. min.	*Hippias minor*
Lach.	*Laches*
Leg.	*Leges*

Men.	*Menexenus*
Parm.	*Parmenides*
Phaed.	*Phaedo*
Phdr.	*Phaedrus*
Phil.	*Philebus*
Prot.	*Protagoras*
Res.	*Respublica*
Soph.	*Sophista*
Tht.	*Theaetetus*
Tim.	*Timaeus*
Plin. *NH*	Pliny (the Elder), *Naturalis historia*
Plut.	Plutarch
De an. procr.	*De anima procreatione in Timaeo*
De E	*De E apud Delphos*
De gen. Socr.	*De genio Socratis*
De Isid.	*De Iside et Osiride*
De lib. educ.	*De liberis educandis*
De mus.	*De musica*
Quaest. conv.	*Quaestiones convivales*
Quaest. Rom.	*Quaestiones Romanae*
Polyaen. *Strateg.*	Polyaenus, *Stratagems*
Polyb.	Polybius
Porph.	Porphyry
De abst.	*De abstinentia*
In Ptol. Harm.	*Kommentar zur Harmonielehre des Ptolemaios*, ed. Düring (Göteborg, 1932).
Quaest. Hom.	*Quaestiones Homericae*
VP	*Vita Pythagorae*
Posid. fr.	Posidonius, *Fragments*, ed. L. Edelstein and I. G. Kidd, vols. i–iii (Cambridge, 1972–88); W. Theiler, *Poseidonios. Die Fragmente*, vols. 1–2 (Berlin, 1982).
Procl.	Proclus
In Crat.	*In Platonis Cratylum commentaria*, ed. G. Pasquali (Leipzig, 1908).
In Euc.	*In primum Euclidis elementorum librum commentarii*, ed. G. Friedlein (Leipzig, 1873).
In Parm.	*In Platonis Parmenidem commentarii*, ed. G. Stallbaum (Leipzig, 1839).
In Rem Publ.	*In Platonis Rem publicam commentarii*, ed. W. Kroll, vols. 1–2 (Leipzig, 1899–1901).
In Tim.	*In Platonis Timaeum commentaria*, ed. E. Diehl, vols. i–iii (Leipzig, 1903–6).

Ps.-Alex. *In Met.*	Alexander Aphrodisiensis, *In Aristotelis Metaphysica commentaria*, books VI–XIV.
Ps.-Scymn.	Pseudo-Scymnus, ed. K. Müller, *Geographi Graeci minores*, vol. i.
Ps.-Plut. *Strom.*	Pseudo-Plutarch, *Stromata*, ed. H. Diels, *Dox.*, 579–583.
Ptolemy	Ptolemy
Alm.	*Almagest*
Harm.	*Harmonica*
Quint. *Inst. or.*	Quintilianus, *Institutio oratoria*
ROT	Aristotle, Revised Oxford Translation
Schol. Euc.	*Scholia in Euclidis elementa*, ed. J. L. Heiberg and E. S. Stamatis, *Euclidis opera omnia*, vol. 5.1–2 (Leipzig, 1977).
Schol. Iamb. VP	*Scholia in Iamblichi De Vita pythagorica*, ed. Deubner, pp.148–50.
Schol. Plat. Alc.	*Scholia in Platonis Alcibiadem primum*, ed. W. C. Greene, *Scholia Platonica* (Haverford, Penn. 1938).
Schol. Plat. Res.	*Scholia in Platonis Rem publicam*, ed. W. C. Greene, Scholia Platonica (Haverford, Penn. 1938).
Schol. Theocr.	*Scholia in Theocritum vetera*, ed. K. Wendel (Leipzig, 1914).
Sext. Emp.	Sextus Empiricus
Adv. log.	*Adversus logicos*
Adv. math.	*Adversus mathematicos*
Simpl.	Simplicius
In Cael.	*In Aristotelis De caelo commentaria*, ed. J. L. Heiberg (Berlin, 1894).
In Cat.	*In Aristotelis categorias commentarium*, ed. K. Kalbfleisch (Berlin, 1907).
In de An.	*In Aristotelis libros de anima commentaria*, ed. M. Hayduck (Berlin, 1882).
In Epict.	*Commentarius in Epicteti enchiridion*, ed. F. Dübner (Paris, 1842).
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SSR	*Socratis et socraticorum reliquiae*, ed. G. Giannantoni, vols. 1–5 (Naples, 1990).
Speus. fr.	Speusippus: Tarán, L. *Speusippus of Athens* (Leiden, 1981).
Stob.	Joannes Stobaeus
Ecl.	*Eclogae physicae et ethicae*
Strab.	Strabo

Suda	*Suidae lexicon*, ed. A. Adler, vols. 1–5 (Leipzig, 1928–38).
Syrian. *In Met.*	Syrianus, *In Aristotelis Metaphysica commentaria*, ed. W. Kroll (Berlin, 1902).
Tertul. *De an.*	Tertullian, *De anima*
Theodor.	Theodorus
Theodoret.	Theodoretus
Graec. affect. cur.	*Graecarum affectionum curatio*
Theol. ar.	*Iamblichi Theologoumena arithmeticae*, ed. V. De Falco (Leipzig, 1922).
Theon. *Exp.*	Theon Smyrnaeus, *Expositio rerum mathematicarum ad legendum Platonem utilium*, ed. E. Hiller (Leipzig, 1878).
Theophr.	Theophrastus
CP	*De causis plantarum*
DS	*De sensibus*, ed. H. Diels, *Dox.*, 497–527.
HP	*Historia plantarum*
Met.	*Metaphysica*
Theopomp.	Theopompus
Thuc.	Thucydides
Tim.	Timaeus, *FGrHist* 566
Val. Max.	Valerius Maximus
Vett. Val.	Vettius Valens
Vitr.	Vitruvius
Xen.	Xenophon
Mem.	*Memorabilia*
Symp.	*Symposium*
Xenocr. fr.	Xenocrates: M. Isnardi Parente, *Senocrate-Ermodoro: Frammenti* (Naples, 1982).
Xenoph.	Xenophanes

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Guthrie	W. K. Ch. Guthrie, *A History of Greek Philosophy*, i–ii (Cambridge, 1962–5).
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Kahn	Ch. H. Kahn, *Pythagoras and the Pythagoreans. A Brief History* (Indianapolis, 2001).
KRS	G. S. Kirk, J. Raven, M. Schofield, *The Presocratic Philosophers* (Cambridge, 1980).
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Journals and Encyclopaedia

AAWM	*Abhandlungen der Akademie der Wissenschaften in Mainz, Geistes- und Sozialwissenschaftliche Klasse*
A&A	*Antike und Abendland*
A&R	*Atene e Roma*
AAP	*Atti della Accademia Pontaniana*
AAW	*Abhandlungen der Akademie der Wissenschaften zu Berlin*
AClass	*Acta Classica*
ACSMG	*Atti del Convegno di studi sulla Magna Grecia*
AGPh	*Archiv für Geschichte der Philosophie*
AHES	*Archive for History of Exact Sciences*
AION	*Annali del'Istituto Universitario Orientale di Napoli*
AJP	*American Journal of Philology*

AKSGW	*Abhandlungen der Königlich Sächsischen Gesellschaft der Wissenschaften*
AncPhil	*Ancient Philosophy*
ANRW	*Aufstieg und Niedergang der römischen Welt*
BAGB	*Bulletin de l'Association Guillaume Budé*
BICS	*Bulletin of the Institute of Classical Studies*
BJHS	*British Journal for the History of Science*
BSA	*Annals of the British School at Athens*
BSHM	*British Society for the History of Mathematics*
CB	*The Classical Bulletin*
CeM	*Classica et mediaevalia*
CPh	*Classical Philology*
CQ	*Classical Quarterly*
CR	*Classical Review*
DPhA	*Dictionnaire des philosophes antiques*
G&R	*Greece and Rome*
GRBS	*Greek, Roman and Byzantine Studies*
HM	*Historia Mathematica*
HR	*History of Religions*
HS	*History of Science*
HSCP	*Harvard Studies in Classical Philology*
HThR	*Harvard Theological Review*
JEA	*Journal of Egyptian Archaeology*
JHA	*Journal for the History of Astronomy*
JHI	*Journal of the History of Ideas*
JHS	*Journal of Hellenic Studies*
JMT	*Journal of Music Theory*
LEC	*Les études classiques*
LF	*Listy filologické*
MAL	*Memorie della Accademia Nazionale dei Lincei*
MStudStor	*Miscellanea di studi storici*
Mus. Helv.	*Museum Helveticum*
NC	*Numismatic Chronicle*
PBA	*Proceedings of the British Academy*
PCPhS	*Proceedings of the Cambridge Philological Society*
PdP	*Parola del Passato*
PhilosAnt	*Philosophie antique*
Q&St	*Quellen und Studien zur Geschichte der Mathematik, Astronomie und Physik*
QUCC	*Quaderni urbinati di cultura classica*
RAC	*Reallexikon für Antike und Christentum*
RCCM	*Rivista di cultura classica e medioevale*

RE	*Paulys Realencyclopädie der classischen Altertumswissenschaft*
REA	*Revue des études anciennes*
REG	*Revue des études grecques*
RFIC	*Rivista di filologia e di istruzione classica*
RhM	*Rheinisches Museum für Philologie*
RHR	*Revue de l'histoire des religions*
RPhilos	*Revue philosophique de la France et de l'étranger*
RSA	*Rivista storica dell'Antichità*
SPAW	*Sitzungsberichte der Preußischen Akademie der Wissenschaften zu Berlin*
SSCA	*Stockholm Studies in Classical Archeology*
TAPA	*Transactions of the American Philological Association*
Vig. Chr.	*Vigiliae Christianae*
WS	*Wiener Studien*
ZPE	*Zeitschrift für Papyrologie und Epigraphik*

Introduction

The Pythagorean Question: Problems, Methods, and Sources

The modern history of the study of Pythagoreanism, which began with August Böckh's book on Philolaus,[1] now reaches back almost two centuries. In that time hundreds if not thousands of books and articles have been written about Pythagoras and the Pythagoreans,[2] yet the body of facts on which all scholars would agree is far from large, and widely differing and often mutually exclusive interpretations are legion. The Pythagorean question remains one of the most intricate in the history of early Greek science, philosophy and religion and has every chance of being consigned to the category of insoluble problems.

This is not because every generation takes a new view of the personality and teaching of Pythagoras: this is common to all Greek thinkers who, like Socrates, Plato and Aristotle, retain their intellectual appeal in the modern world. It is not even because of the existence of almost insurmountable differences of opinion within each generation of scholars, all divided into their own disciplines (philology, the histories of science, of medicine, philosophy, religion, etc.) and national schools of thought, each resting primarily on its own tradition. The problem as I see it lies in the fact that within the scholarly community no consensus has yet been reached on the most

[1] A. Böckh, *Philolaos des Pythagoreers Lehren nebst den Bruchstücken seines Werkes* (Berlin, 1819).

[2] See the general and specialized bibliographies: L. Paquet et al., *Les Présocratiques: Bibliographie analytique (1879–1980)*, 2 vols. (Paris, 1988–9); L. E. Navia, *Pythagoras: An Annotated Bibliography* (New York, 1990); id., *The Presocratic Philosophers: An Annotated Bibliography* (New York, 1993); B. Šijakovič, *Bibliographia Praesocratica* (Paris, 2001).

fundamental facts and the separation on the basis of these of soluble problems from fundamentally insoluble. Although no 'definitive' interpretation of Plato's philosophy is possible, there is general agreement that Plato was a pupil of Socrates, the teacher of Aristotle, and the author of philosophical dialogues. But as to whether Pythagoras was taught by Egyptian priests or by Pherecydes of Syros, whether he studied philosophy and science, whether there were any texts that he himself wrote, whether his students included mathematicians and philosophers – all this remains the subject of debate.

To hope for a solution to the Pythagorean question in these circumstances would be an unforgivable illusion. Having spent many years in the study of Pythagoreanism, I have no such illusions. If I am returning to this problem it is only because I remain convinced that, like any other complex scientific problem, it can be broken down into a number of smaller, particular ones, which may prove amenable to solution. There are many facts on which agreement may be reached; there is also an undoubted hierarchy of interpretations, ranging from those admittedly impossible or unverifiable to those which are more probable and internally consistent. The fact that the situation is not hopeless, given – naturally – a willingness to accept the facts and take account of the achievements and errors of our predecessors, is indicated by the resolution of one particular question of great importance, that of the authenticity of the fragments of the Pythagorean Philolaus (*c.*470–*c.*400).[3]

It is hardly a matter of chance that Böckh was the one who posed this question, given that he understood classical philology as *Altertumswissenschaft*, whose task was to investigate the ancient world in its entirety. Pythagoreanism sets before us precisely the kind of problem in which politics and religion, philosophy and science are closely intertwined. Before all else it was necessary to demarcate the range of most reliable sources, and Böckh's choice proved to be completely correct: the fragments of Philolaus are 'ein lichter Punkt' in the 'labyrinthischen Gewirre der Überlieferungen über die Pythagoreische Weisheit und Pythagoreische Gesellschaft, welche großentheils durch späte und urtheilslose Schriftsteller . . . zu uns herübergekommen sind'.[4] If these fragments are spurious it is extremely difficult to assert that a scientific and philosophical school existed

[3] This and all other ancient dates are BC unless otherwise indicated.
[4] Böckh, *Philolaos*, 3.

within the framework of early Pythagoreanism, that is, from Pythagoras to Philolaus. The question posed but not resolved by Böckh was discussed for almost a century and a half, during which time some scholars leaned towards accepting the authenticity of *all* the fragments of Philolaus and others doggedly rejected them. A solution was found by Walter Burkert in his epoch-making book. Burkert was the first to divide the fragments of Philolaus into two unequal parts and demonstrate convincingly that the smaller part (B 1–7, 13, 16–17) was authentic, while the others bore the stamp of later ideas and terminology that was alien to the Presocratics.[5]

Burkert, who did much to revolutionize the study of Pythagoreanism, demonstrated yet again that success in this field, even partial success, can be achieved only by examining the sources thoroughly and sifting out those which can provide a basis for our reconstructions. Most of the information from the classical period about Pythagoras and early Pythagoreanism has been preserved in the work of later writers; separating it from the accretions of the Hellenistic and Imperial eras is extraordinarily difficult. The results of nineteenth-century research in this field were summed up by Eduard Zeller, who noted that the further we get from the time of Pythagoras, the greater the quantity of sources, while the reliability of these declines.[6] Zeller's attempt to rely on sources from the fifth and fourth centuries and that part of the later tradition which concurs with them on important details appears fully justified to this day. Burkert made important corrections to Zeller's approach, showing that it is a necessary but not a sufficient condition, since the early sources are also problematic and contradictory. In part this is due to their fragmentary nature, but the main difficulty is that they not only relate to *various* aspects of ancient Pythagoreanism in its almost 200-year history – from the rise of the Pythagorean community in Croton in *c.*530 to the disappearance of the school after 350 – but they also give varying *interpretations* of those aspects. Burkert distinguished two basic lines of interpretation, the Platonic and the Aristotelian, giving clear preference to the latter.[7] One of the aims of the present study is to show that the Aristotelian interpretation of Pythagoreanism, which most scholars are inclined to

[5] Burkert, 218 ff. One of his predecessors was R. Mondolfo, 'Sui frammenti di Filolao', *RFIC* 15 (1937), 225–45. See also Zeller i. 371 n. 3.

[6] Zeller i. 364. For a review of sources, see Zeller and Mondolfo i. 313–85.

[7] Burkert, 53 ff., esp. 79 f.

accept, does not really deserve credit, whereas the very existence of the Platonic interpretation, as defined by Burkert, is open to question.

Burkert's conclusion on the authenticity of some of Philolaus' fragments was accepted surprisingly quickly by the great majority of students of Presocratic philosophy. However, as usually happens in science, the solution of one particular problem immediately gives rise to new ones. Burkert 'rescued' some of the fragments of Philolaus, but not Philolaus as a philosopher and scientist himself. Burkert regarded Philolaus as a figure representing the transition from the religious-mythological lore and number symbolism of the time of Pythagoras to Pythagorean science represented by the generation of Archytas. Carl Huffman, who relied heavily on Burkert's analysis, tried to move further forward and reconstruct as fully as possible the philosophical and scientific teaching of Philolaus, which survived in the authentic fragments and *testimonia*.[8] In the attempt to 'rescue' Philolaus, as a philosopher and scientist, Huffman considered it possible to sacrifice both Pythagoras and practically all Pythagoreans before Philolaus. None of them, in his view, were scientists or philosophers, or if they were, they failed to set down their ideas in writing. Naturally, Huffman came up against a serious problem in making Philolaus a bearer of the Pythagorean tradition. He resolved it by presenting a Philolaus who, while never completely ceasing to be a Pythagorean, becomes increasingly 'Presocratic'.[9]

The same approach may be seen in Huffman's fundamental new work on Archytas, based on a detailed analysis of all available sources.[10] Huffman is the first scholar to present such a full picture of this outstanding Pythagorean scientist, philosopher and politician, who exerted considerable influence on Plato. However, the Pythagoreanism of Archytas explains hardly anything in his science and philosophy; moreover, he himself needs to be explained, since it emerges that he did less to continue Pythagoras' line than to break with it. Why did the contemporaries of Philolaus and Archytas consider them Pythagoreans, and what did it mean to be a Pythagorean in the

[8] C. A. Huffman, *Philolaus of Croton: Pythagorean and Presocratic* (Cambridge, 1993). According to Huffman's analysis, *testimonia* A 7a, 9–10, 16–24, 27–9 are authentic.

[9] Cf. L. Zhmud, 'Some Notes on Philolaus and the Pythagoreans', *Hyperboreus* 4 (1998), 243–70.

[10] C. A. Huffman, *Archytas of Tarentum: Pythagorean, Philosopher and Mathematician King* (Cambridge, 2005).

fifth century? Is Pythagoreanism possible without Pythagoras, like Orphism without Orpheus, of whose personality we have absolutely no need; or is Pythagoreanism possible in spite of Pythagoras, like some intellectual and spiritual movements which have evolved in directions opposite to the designs of their founders? I do not believe that much can be achieved by taking this path. While acknowledging that Pythagoras is the most complex component of the Pythagorean question, we should aim not to cast him aside, but to try and find the links connecting him with the Pythagoreans of the sixth to fourth centuries, and through them with the larger phenomenon of ancient Greek Pythagoreanism. To divide the larger problem into a number of smaller ones – Pythagoras, the Pythagorean school, the Pythagoreans, Pythagoreanism – seems to me if not a guarantee of success at least a step in the right direction.

What are the connections between these related but not fully overlapping concepts? The Pythagorean school includes only those Pythagoreans who left their mark in philosophy, science, and medicine. 'The Pythagoreans' is a more general term, which also embraces those who were members of the Pythagorean political societies (*hetairiai*) and/or representatives of the Pythagorean way of life. Both these groups ceased to exist in the middle of the fourth century, and with them went ancient Pythagoreanism. But Pythagoreanism as a whole, as the totality of what was conveyed in antiquity (and often later) by the name of Pythagoras, lived on after that, and with time assumed new forms. Among its filiations were 'Pythagorizing' philosophers, for example, Diodorus of Aspendus (second half of the fourth century), who had nothing to do with the politics, philosophy, or science of the Pythagoreans but merely led an ascetic way of life which had become popular. Their reflection in Middle Comedy, the so-called Pythagorists, often appeared on the Athenian stage after the mid-fourth century as indigent preachers of metempsychosis and vegetarianism (*DK* 58 E).

Even clearer evidence of the end of ancient Pythagoreanism is provided by the pseudo-Pythagorean writings which appeared at the turn of the third century, signed with the names of Pythagoras and historical or invented Pythagoreans.[11] These texts, whose authors

[11] For discussion of the date and place of the creation of the pseudo-Pythagorean literature, see W. Burkert, 'Hellenistische Pseudopythagorica', *Philologus* 105 (1961), 16–43, 226–46; id., 'Zur geistesgeschichtlichen Einordnung einiger Pseudopythagorica',

are still unknown, were fabricated throughout the Hellenistic period and the early Roman Empire without any discernible link with the original writings of the Pythagoreans of the fifth and fourth centuries.[12] The 'Pythagoreanism' of pseudo-Pythagorean writing comes down to a small number of very general notions which had a well-known connection with Pythagoras and his school: arithmology, cosmic and musical harmony, etc. As a rule the authors of these works relied on Academic and Peripatetic interpretations of Pythagoreanism, or directly on the theories of Plato and Aristotle. Published under the name of Pythagoras and his disciples, these writings were evidently intended to demonstrate precisely whom Greek philosophy had to thank for all that was best in it. The abundance of this material stands in contrast to its almost complete uselessness for any historical reconstruction of the teachings of Pythagoras and the Pythagoreans.

The growing body of pseudo-Pythagorean literature, the revival of dogmatic Platonism, and the undying fame of Pythagoras laid the ground in the first century for the birth of Neo-Pythagoreanism. Along with the pseudonymous tracts appeared the writings of those who saw themselves as followers of the Platonized Pythagoras, but wrote in their own names. With few exceptions, all known neo-Pythagoreans of whom written works or fragments are preserved were Platonists: Eudorus of Alexandria (second half of the first century), Moderatus of Gades and Apollonius of Tyana (second half of the first century AD), Nicomachus of Gerasa and Numenius of Apameia (second century AD), and others.[13] The final synthesis of Neoplatonism and neo-Pythagoreanism was achieved by such

in K. von Fritz (ed.), *Pseudepigrapha I* (Geneva, 1971), 25–55; H. Thesleff, *An Introduction to the Pythagorean Writings of the Hellenistic Period* (Åbo, 1961); id., 'On the problem of the Doric pseudo-Pythagorica', *Pseudepigrapha I*, 57–102; A. Städele, *Die Briefe des Pythagoras und der Pythagoreer* (Meisenheim am Glan, 1980); B. Centrone, 'La letteratura pseudopitagorica: origine, diffusione e finalità', in G. Cerri (ed.), *La letteratura pseudepigrafa nella cultura greca e romana* (Naples, 2000), 429–52.

12 H. Dörrie, 'Der nachklassische Pythagoreismus', *RE* 24 (1963), 271.

13 See J. Dillon, *The Middle Platonists*, 2nd edn. (London, 1996). 'To propound Pythagorean views, or adopt Pythagorean practices, was not an alternative to being Platonist: depending on one's position in a long-running debate, Pythagoreanism was Platonism properly interpreted or Platonism with optional extras', G. Clark, 'Philosophic Lives and the Philosophic Life: Porphyry and Iamblichus', in T. Hägg and P. Rousseau (eds.), *Greek Biography and Panegyric in Late Antiquity* (Berkeley, 2000), 36.

important figures for the Pythagorean tradition as Porphyry of Tyre (*c.* AD 235–*c.*305), the pupil of Plotinus, and especially Iamblichus of Chalcis in Syria (*c.* AD 245–*c.*325), the pupil of Anatolius and later Porphyry. Porphyry's *Life of Pythagoras* and Iamblichus' *On the Pythagorean Life*, with Nicomachus' popular introductions to mathematics, became canonical texts which defined the picture of Pythagoras and his school right down to the nineteenth century.

Thanks to the collective efforts of many generations of admirers and interpreters, Pythagoreanism was the only strain of Presocratic thought to survive, albeit in much-modified form, until the end of antiquity, and Pythagoras vied with Socrates and Plato (far outstripping their predecessors) in influence on thinkers of later eras.[14] Here, however, it would be more fitting to speak of 'Pythagoras', the author of the pseudepigrapha, the hero of aretalogical biographies and fantastic novels, than of the real historical figure of interest to us. These two hypostases of Pythagoras bear roughly the same relationship to each other as Alexander the Great and the protagonist of *A Novel about Alexander*, except that Pythagoras did not have any Ptolemy or even any Callisthenes of his own. This being so, any interpretation of him as a person, of his teaching and his work, is far more problematic than is the case with Philolaus, Archytas, and many other Pythagoreans. Although the central figure in pseudo-Pythagorean literature is not Pythagoras but Archytas, and for every authentic fragment of Philolaus and Archytas there are several (sometimes several dozen) that are spurious, it remains possible to set against these late forgeries some quite tangible evidence. In the case of Pythagoras' teaching, the basis of our reconstructions is much less sure. For this reason, even if we confine ourselves to establishing the vast but elusive influence of Pythagoras on Archaic and Classical culture, historians inevitably draw on something which lies outside the limits of the sources: their own general views on the rise of Greek philosophy and science, and on the influence exerted on these by Greek religion and Oriental knowledge. By superimposing on this historical background what is known of Pythagorean religion, philosophy, and science in the sixth to fourth centuries, they then try to determine the contribution of

[14] On Pythagoreanism in the Middle Ages and the modern age, see Kahn, 157 ff.; Ch. Riedweg, *Pythagoras: His Life, Teaching, and Influence* (Ithaca and London, 2005), 169 f.; Ch. Celenza, *Piety and Pythagoras in Renaissance Florence: The Symbolum Nesianum* (Leiden, 2001).

Pythagoras himself. Given the varied nature of the initial premises, it is clear that the results will rarely be conclusive.

If we turn to the sources, the difficulties are not limited to the usual ones faced in studying the Presocratics, like interpreting philosophical and scientific views which are to be reconstructed on the basis of a small number of fragments and indirect evidence. From Pythagoras himself not so much as one line has reached us. Apparently he really did not write anything.[15] All that remains is the deep mark he left in the ancient tradition, a mark which is very difficult to interpret. In the literature of the fifth and fourth centuries Pythagoras already emerges as an outstanding thinker and mathematician, a religious and ethical reformer, a wise teacher, an influential politician, a demigod to his disciples and a charlatan to some of his contemporaries, and the founder of a scientific school that was at the same time a religious brotherhood. These contradictory views, both ancient and modern, may largely be attributable to his unique personality. In him, it seems, are found almost all those departures from the 'normal' Presocratic as an author of a philosophical work, which characterized other thinkers of his era – Thales, Empedocles, Archytas.

Thales, an older contemporary of Pythagoras, also wrote nothing, but here we are dealing with a problem of a quite different order. The philosophy of Thales remains his alone, provided, of course, that we overlook the fact that it was the first in Greece. No arguments developed about him in the schools of Plato and Aristotle; we know of no 'Thalesians' or 'neo-Thalesians', whereas the Pythagoreans and neo-Pythagoreans are well known. Pythagoras had more followers and disciples than any of the Presocratics even in his lifetime (and many more after his death). By analysing various aspects of ancient Pythagoreanism, we can establish the areas in which the influence of Pythagoras was most enduring. At the same time, the wide variety of individuals and forms which we see in Pythagoreanism inevitably raises the question: do all elements of ancient Pythagoreanism owe their existence to its founder? Some general considerations and historical parallels suggest they do not, and there are still fewer grounds

[15] Although the established view that Pythagoras wrote nothing developed only in the age of Hellenism, it does not follow from this that he actually did set anything down. Cf. Ch. Riedweg, '"Pythagoras hinterliess keine einzige Schrift" – ein Irrtum?', *Mus. Helv.* 54 (1997), 65–92.

to argue for direct continuity with regard to Pythagoreanism after the mid-fourth century.

As often happens, the decline of the Pythagorean school after 350 coincides with a veritable boom in philosophical and historical literature about Pythagoras and the Pythagoreans, first in the Academy and the Lyceum, and later outside these. Even the Stoic Zeno wrote his *Πυθαγορικά* (D.L. VII, 4). In the last third of the fourth century at least four biographies of Pythagoras were written, and with each century that passed their number increased, while pseudo-Pythagorean writings multiplied at an even greater rate.[16] The neo-Pythagorean biographers Nicomachus and Apollonius selected from this large body of literature the material that best suited their tastes and views, and combined it with Platonism and the popular religious notions of their time. This trend was continued by their Neoplatonic successors Porphyry and Iamblichus, who created the image of Pythagoras the 'divine sage' at a time when the influence of Christianity was already rapidly increasing. The biography found in the collection of Diogenes Laertius is more sober, but like all the other biographies of Pythagoras which have come down to us it is the product of literary invention and of use only on those rare occasions when it relies directly or indirectly on the scant trustworthy evidence to be found in the fourth-century writers – Aristoxenus, Dicaearchus, Neanthes of Cyzicus, Timaeus of Tauromenium, and others.

The critical investigations into the late tradition begun by Zeller were carried further by Erwin Rohde, Armand Delatte, Isidore Lévy, André-Jean Festugière, Kurt von Fritz, Walter Burkert, and others.[17] Their research showed that material on ancient Pythagoreanism dating back to fourth-century authors survived in texts from the Hellenistic and Roman periods only in the form of occasional brief passages. Unlike the search for secondary sources, attempts to

[16] In all, six biographies of Pythagoras have come down to us. They range from a few pages in the *Suda* to a whole treatise by Iamblichus. In this Pythagoras outstripped even Plato and Aristotle.

[17] Rohde, 102 ff.; J. Mewaldt, *De Aristoxeni Pythagoricis sententiis et Vita Pythagorica* (diss. Berlin, 1904); W. Bertermann, *De Iamblichi vitae Pythagoricae fontibus* (diss. Königsberg, 1913); Delatte, *Lit.*; id., *Pol.*; id., *Vie*; H. Jäger, *Die Quellen des Porphyrios in seiner Pythagoras-Biographie* (diss.; Zurich, 1919); Lévy; A.-J. Festugière, 'Sur la "Vita Pythagorica" de Jamblique' (1937), in his *Études de philosophie grecque* (Paris, 1971), 437–62; von Fritz, *Pol.*; id., 'Pythagoras', *RE* 47 (1963), 171–203; Burkert.

reconstruct authentic Pythagorean texts from the fifth and fourth centuries brought no result. The idea that the *Pythagorean Memoirs* transmitted by Alexander Polyhistor are a fourth-century source was rebutted by Willy Theiler, and later by Festugière.[18] Theiler showed that the greater part of the Pythagorean texts examined by Delatte (including the famous Ἱερὸς λόγος) were late forgeries.[19] The interpretation of Pythagoras' speeches, found in Iamblichus, as a fifth-century source has also been rejected,[20] as has Corssen's theory that Androcydes' book *On Pythagorean Symbols* was written by a fourth-century doctor.[21] Perhaps because of the absence of palpable success in this area of *Quellenforschung*, in recent decades very few scholars have ventured far into it. Most such attempts have proved to be only one more rehearsal of previously rejected ideas,[22] or an unwarranted revision of well-established opinions.[23] A tendency now widespread in classical philology to suppose that many late authors who were previously regarded as compilers were in fact not compilers[24] has also

[18] See M. Wellmann, 'Eine pythagoreische Urkunde des 4. Jh. v.Chr.', *Hermes* 54 (1919), 225–45; Delatte, *Vie*, 197 ff.; W. Wiersma, 'Das Referat des Alexandros Polyhistor über die Pythagoreische Philosophie', *Mnemosyne* 10 (1941), 97–112. Cf. W. Theiler, Review, *Gnomon* 2 (1926), 147–56; Lévy, 74 f.; A.-J. Festugière, 'Les "Mémoires pythagoriques" cités par Alexandre Polyhistor', *REG* 58 (1945), 1–65. Zeller, iii. 2, 103 ff., 108, dated the *Memoirs* in the late 2nd – early 1st cents.

[19] See also K. von Fritz, 'Pythagoreer', *RE* 47 (1963), 239 ff.

[20] See A. Rostagni, 'Pitagora e i Pitagorici in Timeo' (1914), in his *Scritti minori*, ii/1 (Turin, 1956), 3–50; id., 'Un nuovo capitolo nella storia della retorica e della sofistica' (1922), in *Scritti minori*, i (Turin, 1955), 3–59; Delatte, *Lit.*, 85 f; id., *Pol.*, 39 f.; cf. Burkert, 104 n. 37.

[21] See P. Corssen, 'Die Schrift des Arztes Androkydes Περὶ πυθαγορικῶν συμβόλων', *RhM* 67 (1912), 240–62. Cf. Burkert, 167 n. 9. On Androcydes see below, 171, 192.

[22] De Vogel, 70 ff., argued that the speeches of Pythagoras reported by Iamblichus are an early source. Cf. Burkert, 104 n. 37; id., Review, *Gymnasium* 74 (1967), 458–60; M. Zucconi, 'La tradizione dei discorsi di Pitagora in Giamblico', *Vita Pythagorica*, 37–57, *RFIC* 98 (1970), 491–501. The suggestion of J. C. Thom, *The Pythagorean Golden Verses* (Leiden, 1995), that the pseudo-Pythagorean *Golden Verses* date from the 4th century, is even less convincing.

[23] J. Philip, 'The Biographical Tradition – Pythagoras', *TAPA* 90 (1959), 185 and P. Gorman, 'The "Apollonios" of the Neoplatonic Biographies of Pythagoras', *Mnemosyne* 38 (1985), 130–44, rejected the idea that Nicomachus and Apollonius wrote biographies of Pythagoras.

[24] This tendency has shown itself e.g. in many recent works on Iamblichus: D. O'Meara, *Pythagoras Revived: Mathematics and Philosophy in Late Antiquity* (Oxford, 1989); G. Staab, *Pythagoras in der Spätantike: Studien zu De Vita Pythagorica des Iamblichos von Chalkis* (Munich, 2002); M. Lurje, 'Die *Vita Pythagorica* als Manifest der neuplatonischen Paideia', in M. von Albrecht et al. (eds.), *Jamblich.*

done nothing to foster the development of *Quellenforschung*, which is increasingly associated with something hopelessly outmoded.[25] Nevertheless, whatever the extent of originality of the late antique writers and of our faith in nineteenth-century philology, it seems obvious that we have not yet exhausted our chances of finding in the ancient tradition evidence of the classical period on the Pythagoreans, even if our searches are not always successful.[26]

An uncritical adherence to the late tradition – still quite often met with – poses artificial barriers along the path of research. Is it possible to reconstruct the philosophy and science of the early Pythagoreans if their community was dominated by the absolute authority of the Master and all doubts were swept aside with 'Ipse dixit', if the teaching before the time of Philolaus was oral and secret, and all achievements were attributed to Pythagoras?[27] But even if we cast aside these and similar late legends, it is possible to come to a dead end by placing excessive faith in the authorities of the classical era. By restricting our research into early Pythagoreanism to the evidence of writers before 300, we are taking only the first step in our search for reliable sources. The legendary tradition about Pythagoras, which reaches back to his lifetime, evolved in accordance with the laws of this genre of folklore, constantly incorporating similar elements (miracles, prophecies and the like), and sometimes losing any tangible connection with the person who gave birth to it. In any case, there are no grounds whatever for giving the legendary tradition privileged status because of its supposed 'archaic' character: virtually every source of a legend about Pythagoras has introduced something new. In a similar way a legendary tradition developed about the Pythagoreans, which is reflected in a book by the Milesian Sophist Anaximander the Younger, the *Interpretation of Pythagorean Symbols*, as well as in Aristotle, and later in a long series of new interpretations of 'Pythagorean symbols' (58 C 1–6).

Pythagoras: Legende – Lehre – Lebensgestaltung (Darmstadt, 2002), 221–52. It is revealing that neither O'Meara nor Staab (*Pythagoras*, 222) analyse Iamblichus' sources.

[25] J. Mansfeld, *Studies in the Historiography of Greek Philosophy* (Assen, 1990), 345.

[26] Burkert, who had asserted earlier that the story of the *mathematici* and *acusmatici*, found in Iamblichus, derives from Aristotle (192 ff.), was forced to admit that this cannot be proved: id., 'Pythagoreische Retraktationen', in W. Burkert et al. (eds.), *Fragmentsammlungen philosophischer Texte der Antike* (Göttingen, 1998), 314 f.

[27] D.L. VIII, 15, 42, 46; Porph. *VP* 57–8; Iamb. *VP* 158, 198, 199, 226–7, 246–7.

Like no one else among the Presocratics, Pythagoras very soon became the subject of constant disputes. Beginning with Xenophanes and Heraclitus, almost all of the early tradition is polemical. That is why it has far more to say about Pythagoras than about any other thinker of his day. The first book about the Greek philosopher was Democritus' *Pythagoras* (A 33,1). When in the Academy the earliest genre of philosophical historiography arose – a monograph devoted to an individual thinker or school of thought – among the very first specimens were *Πυθαγόρεια* by Xenocrates (fr. 2) and *On the Pythagoreans* by Heraclides of Pontus (fr. 22, 40–1). In addition, Pythagoras became the hero of Heraclides' fantastic dialogues *Abaris* (fr. 73–5, cf. fr. 90) and *On the Woman who Stopped Breathing* (fr. 87–9), which drew on the legends and elaborated on them. Speusippus wrote a book which was to become highly influential, *On Pythagorean Numbers* (fr. 28). It is commonly accepted now that the Platonists presented Pythagoras and the Pythagoreans as the precursors of Plato and ascribed Academic notions to them. Whether this is the case will be examined later (§12.1). At any rate, the Platonists were sympathetic towards Pythagoras and the Pythagoreans. In contrast to them Isocrates, the rival of the Academy, was rather ironic about Pythagoras' *φιλοσοφία* (*Bus.* 28), and his student, the historian Theopompus, expressed great hostility to Pythagoras' philosophy (*FGrHist* 115 F 72).

Discussing the theories of the Presocratics in *De caelo*, Aristotle makes an interesting psychological remark: 'It is what we are all inclined to do, to direct our enquiry not to the matter itself, but to the views of our opponents' (294b5). Besides his works on individual Pythagoreans or against them (*On Archytas' Philosophy*, *Against Alcmaeon*), Aristotle wrote two special monographs: *On the Pythagoreans* (fr. 191–6), containing a collection of mostly legendary material, and *Against the Pythagoreans* (fr. 198–205), in which he criticized their philosophical and scientific theories.[28] He took issue with the Pythagoreans in his *Physics*, *De caelo*, *Metaphysics*, and other

[28] In the catalogue of Aristotle's writings (D.L. V, 22–7), dating back to the 3rd cent., both works are listed (nos. 97, 101), each one being the size of a book. In about the 2nd cent. the two books were combined into a single book, which later writers cited using different titles. See P. Moraux, *Les Listes anciennes des ouvrages d'Aristote* (Louvain, 1951), 107; J. Philip, 'Aristotle's Monograph on the Pythagoreans', *TAPA* 94 (1963), 185 ff.; Burkert, 29; O. Gigon (ed.), *Aristotelis opera*, iii. *Librorum deperditorum fragmenta* (Berlin, 1987), 408 f.

works, but quite often his true opponents were not so much the actual representatives of that school as his colleagues at the Academy. This factor left a deep imprint on his interpretation of Pythagoreanism and doomed to failure any attempt to view Aristotle uncritically as the most reliable source on Pythagorean views.[29] The famous 'number doctrine',[30] passed on by Aristotle, still considered to be the quintessence of Pythagorean philosophy, cannot be found in the early Pythagoreans or in Philolaus, and it has proved impossible to trace it back to Pythagoras. Aristotle's interpretation of Pythagorean number philosophy can be understood only in the context of Plato's unwritten doctrine and the theories of the Academics that were built on it. And while Charles Kahn, the author of a recent monograph on Pythagoras and the Pythagoreans, believes that 'Aristotle was the last author to draw a clear distinction between the two schools',[31] there are good grounds to wonder whether Aristotle really made a strict distinction between Pythagoreanism and Platonism, and whether he did not ascribe to the Pythagoreans ideas which were alien to them.

In the next generation, Theophrastus at least once (*Met.* 11a27–b10) linked 'the Pythagoreans' with the principles of Plato's unwritten doctrine (in late Hellenism, this became a defining characteristic of a pseudo- and neo-Pythagorean tradition). Fortunately this tendency does not affect the individual Pythagoreans who figure in his doxographical compendium the *Opinions of the Physicists.* Pythagoras and anonymous Pythagoreans, the bearers of the number doctrine, are not included there. The writings about Pythagoras and his followers by the Peripatetic Aristoxenus, who in his youth studied under the last of the Pythagoreans, paint an idealized portrait of philosophers, scientists, and politicians living in harmony with their ethical principles. This picture differs from the one found in his biographies of Socrates and Plato, which abound in the most varied and scandalous accusations. In spite of the unconcealed personal sympathies and antipathies of Aristoxenus, the teachings which he

[29] One such attempt was by Philip, 5 f. Cherniss's criticism of Aristotle is generally excessive, but mostly accurate with regard to the Pythagorean material (Cherniss, *Criticism*); cf. below, §§11.2, 12.2.

[30] Hereafter I will apply the name 'number doctrine' (number philosophy) to that form of the philosophy of number according to which the world arose out of numbers and consists of numbers, i.e., number is an ontological principle.

[31] Kahn, 65. Cf. Zhmud, 'Some Notes', 259 ff.

passed on in his *Pythagorean Precepts* are suspiciously like those of the Academy. Dicaearchus, his less biased colleague from the Lyceum, also makes Pythagoras, Plato, and Socrates the heroes of his philosophical biographies. In the works of the Peripatetic Eudemus on the history of mathematics and astronomy we find a picture which is rather different from Dicaearchus', although it does not contradict it.

Thus, if we confine ourselves to sources from before 300, we find in them the same basic hypostases of Pythagoras as are discussed in contemporary scholarship: a religious teacher, a politician, a philosopher, and a scientist. Although the proportions of these different aspects vary in the works of modern scholars, and depend on their personal tastes, as a rough approximation the differing views may be reduced to two main trends (within which, however, there are substantial variations). The first accepts in essence the ancient tradition of the philosophical and scientific work of Pythagoras and his immediate students.[32] The second trend, much more critical of Pythagoras, emerges in the early twentieth century,[33] and is most marked in Burkert, whose book gave it broad currency.[34] In that view, the early (pre-Platonic) tradition contains no evidence of the scientific or philosophical work of Pythagoras and his closest followers, and the evidence which appeared later is merely a projection of the work of the later Pythagoreans – Philolaus, Archytas, and their students – into the past. Thus Pythagoras appears principally as a religious teacher (a 'shaman' to Burkert, a 'guru' to Riedweg), preaching a doctrine close to Orphism, on the transmigration of souls, and founding a secret sect in which his followers led a life ruled by stringent and absurd taboos.

[32] Guthrie, i. 146–359; K. von Fritz, 'Pythagoras', *RE* 47 (1963), 171–203; id., 'Pythagoreer'; de Vogel; van der Waerden; Kahn.

[33] See e.g. H. Vogt, 'Die Geometrie des Pythagoras', *Bibl. Mathematica* 9 (1909), 15–54; K. Reinhardt, *Parmenides und die Geschichte der griechischen Philosophie* (Bonn, 1916), 231 f.; E. Sachs, *Die fünf platonischen Körper* (Berlin, 1917); Frank; Lévy, 6; W. Rathmann, *Quaestiones Pythagoreae Orphicae Empedocleae* (diss.; Halle, 1933), 23 ff.; W. A. Heidel, 'The Pythagoreans and Greek Mathematics', *AJP* 61 (1940), 1–33; O. Gigon, *Der Ursprung der griechischen Philosophie* (Basel, 1945), 142 ff.

[34] See e.g. Knorr, 5 ff.; J. Barnes, *The Presocratic Philosophers*, 2nd edn. (New York, 1982), 78 ff.; Huffman, *Philolaus*; P. Kingsley, *Ancient Philosophy, Mystery, and Magic: Empedocles and Pythagorean Tradition* (Oxford, 1995); M. Giangiulio, *Pitagora: le opere e le testimonianze*, i–ii (Milan, 2000); Riedweg, *Pythagoras.*

It is hardly possible to unite harmoniously all versions of the classical sources, because the reality was no less contradictory than the tradition. Should we therefore sacrifice one of the aspects of early Pythagoreanism – the scientific, the philosophical, the political, or the religious – as the price of greater inner unity in our reconstruction? 'A minimalism that eliminates every aspect of tradition which seems in any respect questionable cannot help giving a false picture.'[35] Burkert in his book twice demonstrated the justice of this assertion: first, by rehabilitating a somewhat questionable tradition about Philolaus, and then by trying to eliminate all evidence of scientific and philosophical work by Pythagoras, as well as his closeness to the Ionian *ἱστορία*.

It is quite natural that science should usually be the first casualty of a selective approach, especially when we consider how eagerly many twentieth-century scholars tried to cast aside the heritage of 'positivism' (variously understood) and the 'modernization' of Archaic Greece.[36] Unfortunately, what took the place of 'modernization' was frequently not an unbiased approach, but artificial archaizing of the Presocratics: contrary to Aristotle's judgement, they were brought together with the theologians and wonder-workers of the Archaic period;[37] the sources of their thinking were sought in Oriental mythology and theogony, or even in the religion of hunting tribes (shamanism) and the like. Paradoxical though it may seem, this archaizing tendency is to a large extent linked with the fact that attempts were made to judge the Presocratics by the standards of the age of positivism and, if the material did not match the accepted image of a rationalist and scientist, the scientific component of the Archaic culture was rejected outright. In the meantime, what in the sixth and fifth centuries was coming to be science was not yet science in full measure, and the image of a scientist as we know it was only beginning to take shape from the variety of human material. Not only do Thales the politician, Xenophanes the poet, Pythagoras the

[35] Burkert, 10.

[36] While Rohde (103 f.) regarded Pythagoras not as a philosopher but as a religious reformer *and* a scientist, in Frank's view (67) 'old Pythagoras' could in a certain sense be termed a philosopher, but he had very little to do with science. Philip (24 ff., 200 ff.) likewise allows that the early Pythagoreans were philosophers, while rejecting their claim to science.

[37] On Aristotle's distinctions between 'physicists' and 'theologians', see L. Zhmud, *The Origin of the History of Science in Classical Antiquity* (Berlin, 2006), 130 f.

religious teacher, and Archytas the army commander not resemble university professors, they do not resemble specialized Hellenistic scientists either. However, the variety of human individuality, formed in a particular cultural situation, and the uniqueness of the very period of the 'Greek miracle',[38] should not discourage those who see that the methods by which Thales, Pythagoras, and Archytas solved scientific problems are the same as those of mature science.

The real alternative to modernization and archaization lies in acknowledging that *each* sphere of activity of Pythagoras and the Pythagoreans – politics, religion, philosophy, and science – has its own internal logic and independent history, and each must therefore receive its own specific explanation. Each explanation must be compatible with all the others, but not reducible to a single unified all-embracing construction, such as that offered by F.M. Cornford and J. Burnet – Pythagorean science as 'purification of the soul'.[39] The Platonic origin of this notion prevented it from taking hold as a convincing explanation for Pythagoreanism. Another construction, which arose in late Antiquity, proved to be far more enduring. To resolve the contradictions in the tradition surrounding Pythagoras and his disciples, two different trends, or degrees of initiation, which supposedly existed among the early Pythagoreans, were invented: the scientific *mathematici*, and the religious *acusmatici*, who engaged in political life. The dispute between them, described by Iamblichus (*Comm. Math.* 76.16 ff.), in some ways recalls the dispute between modern scholars about science and religion in the Pythagorean school. While the *acusmatici* refused to recognize the *mathematici* as fellow Pythagoreans, the *mathematici* did not deny the Pythagoreanism of the *acusmatici*, but claimed to be following Pythagoras even more closely.

Many modern studies add to this construction the thesis of a gradual rationalization of Pythagoreanism, which would explain the development of myth and number symbolism into philosophy and

[38] For the first attempt at a systematic study of the 'Greek miracle', applying sociological and socio-psychological methods, see Zaicev. Unfortunately, responses to this book have been few, partly because the 'Greek miracle' itself is losing its erstwhile appeal.

[39] F. M. Cornford, 'Mysticism and Science in the Pythagorean Tradition', CQ 16 (1922), 137–50; 17 (1923), 1–12; Burnet, 97 f.; cf. the critique by Burkert, 211 f.

science. Leaving aside the fact that this development is itself extremely questionable, the thesis of rationalization as a form of linear evolutionary progression 'from myth to reason'[40] runs counter both to the steady increase in mythical elements in the tradition about Pythagoras and the Pythagoreans, and to the real history of the Pythagorean society. Rationalization does nothing to explain Pythagoras himself, or such figures in his entourage as the athlete and army commander Milon, the mathematician Hippasus, the doctor Democedes, and the natural philosopher Alcmaeon. Since the political dominance of the Pythagoreans, first in Croton, then in other cities, is an indisputable fact of the history of Magna Graecia in the years *c.*510–450, the Pythagorean society should be regarded above all within the context of that history.[41] Those who suppose that it was originally a sect of superstitious ritualists[42] need to explain how this sect came to lead the southern Italian aristocracy and hold on to power for more than half a century, making Croton famous for its unprecedented number of victors at the Olympic Games and other sporting competitions.[43]

It is revealing that the rationalization of Pythagoreanism is dated in widely varying periods. To Erich Frank, Aristotle's 'so-called Pythagoreans', whom he identified with Archytas and his pupils, were responsible for all the achievements attributed to the early school.[44] Burkert, who accepted Frank's idea that early Pythagorean science and philosophy were a retrospective Academic projection, took him to task for exaggeration and dated the beginning of the Pythagoreans' philosophical and scientific work to the mid-fifth century. The well-known historian of science B. L. van der Waerden was prepared to go

[40] R. Buxton (ed.), *From Myth to Reason? Studies in the Development of Greek Thought* (Oxford, 2001).

[41] See the classical studies of Pythagorean politics: Delatte, *Pol.*; von Fritz, *Pol.*; Minar; Dunbabin, and the following more recent works: M. Giangiulio, *Ricerche su Crotone arcaica* (Pisa, 1989); M. Bugno, *Da Sibari a Thurii: La fine di un impero* (Naples, 1999).

[42] W. Burkert, 'Craft Versus Sect: The Problem of Orphics and Pythagoreans', in B. F. Meyer (ed.), *Jewish and Christian Self-Definition*, iii (London, 1983), 1–22.

[43] On the Pythagorean athletes, see Giangiulio, *Ricerche* 102 f., 291 f.; C. Mann, *Athlet und Polis im archaischen und frühklassischen Griechenland* (Göttingen, 2001), 164 ff.

[44] Relying on Aristotle's phrase *οἱ καλούμενοι Πυθαγόρειοι*, Frank, 69, argued that these Pythagoreans were not true followers of Pythagoras. Cf. Cherniss, *Criticism*, 348; Guthrie, i. 155; J. Philip, 'Aristotle's sources for Pythagorean doctrine', *Phoenix* 17 (1963), 252 f.; Burkert, 29 ff.; Huffman, *Philolaus*, 31 f.

even further in the rehabilitation of the early school. He recognized its great successes in mathematics, astronomy, and physics, but refused to attribute them to Pythagoras himself, whom he depicted as merely an apt pupil of the Egyptians and Babylonians, who related to his followers the essence of the knowledge he had received.[45] Finally Riedweg, who generally shared Burkert's approach, acknowledges such an important element of the tradition as the coining by Pythagoras of the word φιλόσοφος,[46] and even Pythagorean science: though 'a speculative theory of numbers with certain mythical traits', it is nevertheless a science, at least in the sense of Lévi-Strauss's *pensée sauvage.*[47]

Unlike *pensée sauvage* and other twentieth-century anthropological constructs, such as 'Greek shamanism' or 'mythical thinking',[48] the science and philosophy of the sixth century, represented by the likes of Thales, Anaximander, Anaximenes, and Xenophanes, are absolutely real. Our task is to determine to what extent Pythagoras and his earlier followers were mediators between the sixth-century Ionians, on the one hand, and the science and philosophy of the second half of the fifth century (Pythagorean or not), on the other. On the whole we have to admit that Pythagoras' contribution to philosophy and science may be reconstructed with varying degrees of accuracy. His students did not set down his views, unlike those of Socrates, for example. The Pythagorean sources make no mention of Pythagoras at all. The early tradition presents him as a 'wise man', but how his wisdom showed itself we learn principally from the evidence of the post-Platonic time. As a result, we have no direct, reliable access to his philosophical teachings. In order to achieve even a relative degree of reliability, it is necessary to compare the ideas of the early Pythagoreans, from whom we have some fragments and *testimonia*, with those fifth- and fourth-century sources on Pythagoras which have withstood a preliminary historico-philological scrutiny. The ideas, which do not fundamentally contradict attested early Pythagorean views, define the limits of the possible. In order to

[45] Van der Waerden, 14 f.

[46] Ch. Riedweg, 'Zum Ursprung des Wortes "Philosophie"', in A. Bierl et al. (eds.), *Antike Literatur in neuerer Deutung* (Munich, 2004), 147–81. Cf. W. Burkert, 'Platon oder Pythagoras? Zum Ursprung des Wortes "Philosophie"', *Hermes* 88 (1960), 159–77.

[47] Riedweg, *Pythagoras*, 90. Cf. L. Zhmud, Review, *AncPhil* 23 (2003), 416–20.

[48] L. Zhmud, 'On the Notion of "Mythical Thinking"', *Hyperboreus* 1 (1994/5), 155–69.

establish what within those limits is most reliable, we need to apply additional criteria, for example, the fact that Pythagoras' philosophy should be post-Milesian and pre-Eleatic.

The path proposed here is far from straightforward. The teachings of the early Pythagoreans which have come down to us – of Alcmaeon, Hippasus, Menestor, Hippon, and others – are too highly individual to be seen as a reflection of Pythagoras' own system. In fact, there is no certainty at all that such a system actually existed. Furthermore, the search for traces of influence of Pythagoras' philosophy on his younger coutemporaries Parmenides and Heraclitus, and later on Anaxagoras, Empedocles, and Zeno has so far yielded few decisive results. Yet it is difficult to see any serious alternative to this approach. Any reconstruction of the philosophical views of Pythagoras must be founded primarily on the views of his students and followers, and use the teachings of the philosophers of the sixth century and early fifth century for purposes of verification.

The most important premise for such an approach is continuity in the evolution of Pythagorean theories. Since continuity is most plainly visible in the exact sciences, by virtue of their cumulative development, the reconstruction of Pythagoras' achievements here, or at least of the range of problems he dealt with, will be most reliable. Here it is possible to establish the individual links in the chain of scientific discoveries linking Pythagoras with Ionian geometry and astronomy (Thales, Anaximander) on the one hand, and on the other with Pythagorean mathematics (Hippasus, Theodorus, Archytas). We may note that such a reconstruction is not only possible, but essential. While the Eleatics, Heraclitus and Empedocles may be described – if with some reservations – as thinkers who owe little or nothing to the influence of Pythagoras the philosopher, or, in the case of Empedocles, owe only part of their religious teaching to him, the geometry, astronomy, and especially arithmetic and harmonics of the mid-fifth century are left hanging in the air if we exclude Pythagoras and the early Pythagoreans from the ranks of those who contributed to their development. The question of their mathematical work is thus inseparable from another question of equal importance: who created the Greek geometry and astronomy which was taken up and developed by Oenopides and Hippocrates of Chios? A comprehensive picture of the development of *mathēmata* will never be achieved, but even a partial reconstruction is unquestionably preferable to simply renouncing this line of investigation.[49]

Strange as it may seem, the thesis of the continuity of Pythagoreanism from the sixth to the fifth and fourth centuries applies least in the area of religion.[50] The tradition contains no evidence of any religious teaching or practice by the Pythagoreans known to us. We simply know next to nothing about what Milon, Brontinus, Democedes, Alcmaeon, Hippasus, Iccus, Menestor, Hippon, Theodorus, Philolaus, Lysis, Eurytus, Echecrates, Xenophilus, Archytas, Hicetas, Ecphantus, and other historically attested Pythagoreans believed in, what they worshipped, or how. In particular, we do not know whether any of them shared even Pythagoras' best-known and reliably attested religious doctrine, metempsychosis, or practised the vegetarianism which was associated with it.[51] The dearth of information here is largely due to the fragmentary and selective nature of our sources. By itself, however, this cannot account for the fact that in the area of religion we are compelled to rely almost exclusively on sources outside the Pythagorean school which deal with either Pythagoras or anonymous Pythagoreans, *οἱ Πυθαγόρειοι*. It must be admitted that, with regard to religious matters, neither the writings of the Pythagoreans known to us by name nor their way of life offered anything of interest to the ancient doxographical and biographical traditions.

The dual nature of the figure of Pythagoras himself was noted by his contemporaries (see Heraclitus' *ἱστορία* and *κακοτεχνία*, B 129) and attested by Aristotle: 'Pythagoras, the son of Mnesarchus, first dedicated himself to the study of mathematical sciences, especially numbers, but later could not refrain from the wonder-working of Pherecydes' (fr. 191). This combination of the rational and the

[49] Cf. 'In the absence of earlier documentation, the history of Pythagoreanism before Philolaus, like the history of Greek mathematics before Hippocrates of Chios, must remain an area for informed speculation' (Kahn, p. ix).

[50] Continuity of the Pythagoreans' oligarchic policies in Magna Graecia was interrupted by the anti-Pythagorean uprising in the mid-5th century, when, according to Polybius (II,39,1; from Timaeus), 'the best men in every polis' perished. Later the Pythagoreans managed not only to adapt to democracy, but to produce a political leader ~~as~~ outstanding as Archytas.

[51] Huffman's point of departure is the premise that metempsychosis was 'tacitly' shared by all Pythagorean philosophers: C. A. Huffman, 'The Pythagorean Conception of the Soul from Pythagoras to Philolaus', in D. Frede and B. Reis (eds.), *Body and Soul in Ancient Philosophy* (Berlin, 2009), 21–44. There is, however, no evidence for this.

religious is not unique among the Presocratics: the natural philosopher Empedocles pretended to be a wonder-worker and was a proponent of metempsychosis. The modern age affords numerous examples of successful combinations of scientific thought and an interest in astrology, alchemy, hermetism, magic, Cabbalism, and other occult and mystic trends.[52] Pythagoras claimed to possess supernatural powers and was the kind of personality who attracted legends, even legends which had originally referred to other, less famous wonder-workers. But, unlike Pythagoras, none of the ancient Pythagoreans known to us is linked – in the reliable part of the tradition – with anything remotely supernatural or miraculous. This is one of our most serious problems. The difference between the Pythagoreans and Pythagoras is striking, and gives rise to some obvious questions: were they really his disciples and followers, and why do we not find among them a single religious figure with even a distant resemblance to Pythagoras? If these people were Pythagoreans and no others can be found, this should tell us much about Pythagoras himself and the society he founded. In this case, Pythagoras, by combining too much variety within himself, may turn out to be an exception among the Pythagoreans, who adopted only that part of his legacy which corresponded to their own inclinations and interests. Later this happened with Aristotle and the Peripatetics.

Not even the names of the individuals who followed Pythagoras' religious teaching and the prescriptions and taboos associated with it are known to us. The superstitious ritualists who avoided walking along main roads, bathing in public baths, talking in the dark, stepping over yokes, and using knives to stoke fires, always turn out to be anonymous figures from the legendary, not the historical tradition – unlike the Pythagorean politicians, athletes, doctors, philosophers, and mathematicians. Whatever the case, that anonymity, which is also a feature of Orphism, does not give cause to doubt that Pythagoras had followers who valued his religious teaching above all. The aim here is not to reduce the religious aspect of Pythagoreanism to a minimum, but rather to establish its real dimensions, with a historically viable way of life and a belief system for its followers.

[52] C. Webster, *From Paracelsus to Newton: Magic and the Making of Modern Science* (Cambridge, 1982); B. Vickers (ed.), *Occult and Scientific Mentalities in the Renaissance* (Cambridge, 1986); J.-F. Bergier (ed.), *Zwischen Wahn, Glaube und Wissenschaft: Magie, Astrologie, Alchemie und Wissenschaftsgeschichte* (Zurich, 1988).

In appealing to the legendary tradition, we must recognize clearly that we are dealing with religious folklore, not with the realities of the Pythagorean way of life which Plato mentioned with such respect (*Res.* 600a–b).

The intention here, then, is to build up an individual portrait of Pythagoras against the background of a collective portrait of the Pythagoreans, allowing the two portraits to complement and correct each other. The collective portrait itself should consist of individual portraits of particular historical figures, and not be a collage of assorted features allegedly common to the Pythagoreans 'as a whole'. This approach has its problems, not least because scholarship has not yet established who is to be deemed a Pythagorean or by what criteria. In spite of some disagreements though, the individual Pythagoreans known to us by name constitute a fully tangible group, as distinct from the anonymous Pythagoreans seen as standardized bearers of a generalized 'school doctrine'. The collective portrait of the anonymous Pythagoreans, such as is found, for example, in Aristotle's writings, or in modern works on the history of philosophy,[53] is inevitably anachronistic. Unlike the Academy, Garden, and Stoa, which were institutionalized philosophical schools with a range of well-defined doctrines, varied though these were at different times, the Pythagorean school arose not as a philosophical school, but as a political society, a *hetairia*. The teachings of its founder were not set down in writing, and the school itself, widely scattered in many cities, evolved in the course of almost two centuries. It is no surprise that in reliable sources we can find nothing resembling a Pythagorean orthodoxy. All Pythagoreans were different, although all shared common features with other Pythagoreans. Orthodoxy appears only in the late pseudo-Pythagorean literature, but this is founded not on the authentic Pythagorean tradition, but on Platonism and/or Aristotelism.

In the modern world, as in antiquity, the stories which are passed down of certain social, ethnic or religious minorities often differ from those told about the individuals who make up those minorities. While the former are by no means bound to be unreliable, or the latter truthful, the two should be carefully distinguished. If we were to collect all the information on individual Pythagoreans and compare it with what the fifth- to fourth-century writers tell us about the

[53] See e.g. Guthrie i., 146 f.

Πυθαγόρειοι as a kind of collective entity, these portraits would be substantially different. Sometimes they differ even within the work of a single author: the teachings of individual Pythagoreans, conveyed by Aristotle, do not remotely resemble the number doctrine which he attributes to the Pythagoreans as a group. Of course, *Πυθαγόρειοι* is often no more than a *façon de parler*, concealing real and identifiable people, like Archytas, for example, who is present behind the Pythagoreans in Plato's *Republic* (530a–531c), or Philolaus, whose astronomical theory Aristotle ascribes to some anonymous Pythagoreans (*Cael.* 293a18 ff.). But frequently it is impossible to identify the collective Pythagoreans with any of the historical figures or groups of Pythagoreans that we know. If the doctrines or actions attributed to the collective Pythagoreans are not confirmed at the level of individuals, and especially if they run directly counter to that part of the tradition, such evidence needs to be regarded with a high degree of scepticism.

Notwithstanding the indisputable service rendered by Aristotle in creating the history of philosophy,[54] it must be admitted that the history of Pythagorean philosophy proved to be beyond his capabilities. If we follow in his footsteps and deduce the philosophy of the Pythagoreans from their work in mathematics,[55] we risk overlooking clear evidence that the source of the philosophical views of the early Pythagoreans lay not so much in mathematics as in natural sciences and medicine, which were closely interconnected. The first Pythagorean whose philosophy shows traces of the influence of mathematics is Philolaus. Before him, the influence of Pythagorean mathematics was visible in the teachings of the Eleatics and Heraclitus,[56] although this fact is the subject of constant dispute, like almost everything else that may serve to confirm Pythagoras' role as a mediator between Ionian and Italian science and philosophy.

Here we cannot fail to perceive one of the paradoxes of Pythagorean studies: those who deny that Pythagoras was one of the mediators between the thought of the *Greek* East and West are apt to see him

[54] L. Zhmud, 'Doxographische Tradition', in H. Flashar and G. Rechenauer (eds.), *Grundriss der Geschichte der Philosophie. Philosophie der Antike*, i. *Vorsokratiker* (Basel, 2012), 150–74.

[55] 'The Pythagoreans, as they are called, devoted themselves to mathematics; they were the first to advance this study, and having been brought up in it they thought its principles were the principles of all things' (Arist. *Met.* 985b23 f.).

[56] On Parmenides see below, 251 ff.; on Heraclitus, see below, 35 n. 29.

rather as a mediator between Orient and Occident as a whole, as a cultural hero who united Egyptian and Babylonian mathematics with Indian metempsychosis and Scythian shamanistic rites.[57] The ancient image of him as the interlocutor of Zarathustra and pupil of the Chaldeans, Brahmans and Druids seems to be self-reproducing and therefore ineradicable. Remaining a riddle in his own right, Pythagoras has served for two and half millennia as the key to everything that those who write about him would like to resolve and explain. If this study can do anything to supplant this image with the real historical (and therefore contradictory) figure, it may be deemed to have succeeded.

[57] W. Burkert, *Greek Religion* (Cambridge, Mass., 1985), 445.

1

The Early Tradition on Pythagoras and Its Development

1.1 FEATURES OF THE PRE-PLATONIC TRADITION

Some fifteen references to Pythagoras between the end of the sixth and the beginning of the fourth century have been preserved, together with several references to Pythagoreans. This is much more than of any other thinker contemporary with him; Anaximander and Parmenides, for example, are not mentioned in any fifth-century text which has come down to us. It would appear that, in the sixth to fourth centuries, the author of a significant philosophical or scientific work could be confident of consistent attention on the part of some educated Greeks, but certainly not of general recognition. If Pythagoras, who left no writings, proves to be a better known figure than any other Presocratic, the question arises: did he really achieve fame as a philosopher and scientist? Before, however, we seek in the evidence of the early tradition what it was that brought fame to Pythagoras, we should elucidate what we *expect to* and what we *can* discover there.

Since we lack Pythagoras' works and references to him in the Pythagorean writings, the testimonies of the early tradition are particularly valuable. An analysis of what his contemporaries and several succeeding generations knew and thought about Pythagoras became long ago the most important tool in a critical examination of the fourth-century tradition and the sources dependent on it.[1] That such

[1] E. Zeller, 'Über die ältesten Zeugnisse zur Geschichte des Pythagoras' (1889), in *Kleine Schriften* (Berlin, 1910), 458–72; for a comprehensive survey of early sources, see Zeller and Mondolfo i. 313 ff. Rathmann, *Quaestiones*, 37 ff. is hypercritical. See also Burkert, 208 ff., 277 ff.

an examination is necessary is self-evident; it takes on even greater importance as we recognize the obvious tendentiousness of many Academic and Peripatetic interpretations of Pythagoreanism. A reaction to it is the tendency, reinforced in recent decades, to deny any contribution to the development of philosophy and science by Pythagoras and his immediate followers. Yet is the image of Pythagoras as a philosopher and scientist an invention of the Academy?[2] There are many grounds for thinking that the Academy and the Lyceum based their interpretations, not on a blank space, but on a tradition which preceded them, and which did contain reliable facts. Proceeding from this assumption, we have first to establish what degree of coincidence between pre- and post-Platonic tradition would be sufficient to discard the theory of the purely religious nature of early Pythagoreanism. Should one expect a *detailed* congruence of these stages of tradition (for example, to find in early testimonies specific facts about Pythagoras' scientific discoveries, etc.), or would a similarity of their *general outlines* be sufficient?

There is much to indicate that this last suggestion is much more realistic. If one looks at early evidence concerning Thales, it becomes obvious how similar are the traditions about these two sages, neither of whom left behind any written works. Thales was widely known as one of the Seven Sages, as a politician and even as an engineer (Hdt. I, 75, 170). The legendary tradition connected him with events in which he could not have participated and with sayings which could not have been his.[3] The first specific evidence about Thales' philosophical views and geometrical discoveries we find in Aristotle, Theophrastus, and Eudemus. Apart from two short remarks in Aristophanes' comedies which link Thales' name with the study of geometry (*Nub.* 180; *Av.* 1009), the only evidence of his philosophical and scientific activity to appear before the middle of the fourth century was his prediction of a solar eclipse,[4] of which many scholars

[2] See e.g. Frank, 356 n. 156; Rathmann, *Quaestiones*, 37 ff.; Burkert, 208 ff., 277 ff.

[3] For analysis of the tradition of the Seven Sages, see B. Snell, *Leben und Meinungen der Sieben Weisen*, 4th edn. (Munich, 1971). An attempt to cast doubt on its antiquity by D. Fehling, *Die sieben Weisen und die frühgriechische Chronologie* (Bern, 1985), was unsuccessful: J. Bollansée, 'Fact and Fiction, Falsehood and Truth: D. Fehling and Ancient Legendry about the Seven Sages', *Mus. Helv.* 56 (1999), 65–75.

[4] It is mentioned by Xenophanes, Heraclitus, Herodotus, and Democritus (D.L. I, 23). The anecdote reported by Plato (*Tht.* 174a) that Thales, observing the stars, fell down a well is connected with it.

are doubtful.[5] This does not mean that Thales as a progenitor of natural philosophy and science is a Peripatetic construction which there is no reason to trust. In the case of Thales, as with Pythagoras, Aristotle and his pupils made use of (and interpreted) sources unavailable to us which, through intermediaries, go back to the Archaic period.[6] That Aristotle and Theophrastus trace the history of 'physics' from Thales, and Eudemus also traces the history of geometry and astronomy from him, was the result of their deliberate and generally correct choice.[7]

Just how wrong a pedantic application of *argumentum ex silentio* to the early tradition is can be seen in effectively total silence regarding the political activity of Pythagoras and his followers. Amongst all the evidence of the time, only the words of Antisthenes imply Pythagoras' participation in political life, and only indirectly. Three references to the Pythagoreans (Hdt. II, 81; *DK* 90, 6; 58 C 6) contain not a single word about it. Nevertheless, no one now doubts the significant role of Pythagoras and the Pythagoreans in the turbulent events at Croton in the last third of the sixth century, reported by Aristoxenus, Dicaearchus, and Timaeus (below §2.4). Tendentious as Aristoxenus' story may seem to us, there is no reason to suppose that all the facts he reports are his own invention or that of someone before him. Their substance derives from the oral tradition of the sixth century, and, possibly, from some works of the fifth and the first half of the fourth century which have not survived.

Praise, ridicule, criticism, admiration, echoes of legend, and individual guesses are what we find in the early tradition as it responds in the first place to the personality of Pythagoras and to that part of his teaching which was best known. The authors of surviving accounts

[5] Neugebauer, *ES*, 148 f.; D. R. Dicks, 'Thales', *CQ* 53 (1959), 294–309; A. C. Bowen, 'Eudemus' History of Early Greek Astronomy: Two Hypotheses' in I. Bodnár and W. W. Fortenbaugh (eds.), *Eudemus of Rhodes* (New Brunswick, 2002), 307–22.

[6] Aristotle's information about Thales' philosophy derives from Hippias' of Elis *Synagogē*: B. Snell, 'Die Nachrichten über Lehre des Thales und die Anfänge der griechischen Philosophie- und Literaturgeschichte', *Philologus* 96 (1944), 170–82; C. J. Classen, 'Bemerkungen zu zwei griechischen "Philosophiehistorikern"', *Philologus* 109 (1965), 175–8; A. Patzer, *Der Sophist Hippias als Philosophiehistoriker* (Freiburg, 1986); J. Mansfeld, 'Aristotle, Plato, and the Preplatonic Doxography and Chronography', in his *Studies*, 22–83. Note that Aristotle (*Met.* 983b22–26) dealt with Thales' first principle, water, in the spirit of the natural philosophy of the 5th cent. and attributed Hippon's arguments to him (*KRS*, 91 n. 1).

[7] Zhmud, *Origin*, 131, 191 f., 238 f.

very rarely report historical details. None of them aimed to provide anything like a full portrait of Pythagoras, except, perhaps, Democritus, of whose book, sadly, we know nothing beyond that it was full of admiration for Pythagoras (68 A 1.38). The selectivity and partiality of the early tradition are evident; if we do not recognize that, we shall not be able to interpret it correctly.

It is no less important to realize the selectivity, not only of Preplatonic tradition, but of Plato as well. What would the Presocratics' world look like on his evidence alone? Thales is one of the Seven Sages; the tale of his gazing at the stars is not the most reliable evidence of his discoveries in astronomy. Anaximander and Anaximenes do not exist. Xenophanes is named once, as the first of the 'Eleatic tribe' (*Soph.* 242d), but remains just a name. Pythagoras is also mentioned once, as educator and as the founder of the 'Pythagorean way of life' (*Res.* 600a–b). The Pythagoreans Hippasus, Alcmaeon, Menestor, and Hippon do not exist. Philolaus figures in the *Phaedo* only as the mentor of the tyros at philosophy Simmias, Cebes, and Echecrates;[8] his sole doctrine is a rejection of suicide. Archytas is mentioned in the *Seventh Letter* as a politician who helped Plato return from Syracuse, where he had been detained by the tyrant Dionysius the Younger (47 A 5). No one would recognize in him the original thinker and brilliant mathematician. Central figures like Parmenides, his pupils Zeno and Melissus, with Heraclitus, Anaxagoras, and Empedocles, are represented to different degrees in Plato's dialogues, but Ion of Chios, Archelaus, Leucippus, Democritus, and Diogenes of Apollonia are absent.[9] Of the mathematicians and astronomers, only Theodorus and Theaetetus appear in Plato, while Oenopides and Hippocrates of Chios and even the Athenians Meton and Euctemon are not mentioned.

In Aristotle we find not simply many more names of philosophers and scientists, but more detailed information about them, more direct quotations, a more accurate and consistent chronology, etc. In regard to the Presocratics, of whom Aristotle saw himself as a direct successor, the differences between him and Plato are qualitative; they are even more substantial between the Academy and the Lyceum.

[8] D. Sedley, 'The Dramatis Personae of Plato's Phaedo', in T. Smiley (ed.), *Philosophical Dialogues* (Oxford, 1995), 3–26.

[9] Metrodorus of Lampsacus (*DK* 61) is mentioned once as interpreter of Homer (*Ion* 530c), the Pythagorean Iccus as athlete and trainer (*Prot.* 316d, *Leg.* 839e–840a).

Speusippus, Xenocrates, and Heraclides wrote on a number of famous philosophers (those, as a rule, in whom Plato was interested)[10] but virtually nothing has remained of these works. Aristotle and the Lyceum are the basis of our knowledge of the Presocratics. Almost all the figures represented in the collection of Diels-Kranz are also mentioned in the works and fragments of the head of the Lyceum and his pupils – Theophrastus, Aristoxenus, Dicaearchus, Eudemus, and Menon. And the reverse applies: those not named by them were consigned to oblivion or survive only as names, like the Pythagorean Ameinias, the teacher of Parmenides.[11] It is quite natural that most information about Pythagoras, both historical and legendary, has come to us through Aristotle and the Peripatetics, the founders of such historiographical genres as biography, doxography, and the history of science and medicine. The question is merely whether confirmation can be found for a radical shift during the Academic stage of the tradition preceding Aristotle, which changed Pythagoras from a religious teacher and wonder-worker into a philosopher and scientist unknown to the authors of the fifth century.

If one considers the evidence of the pre-Platonic tradition, it is clear that its development does not fit the familiar pattern 'from myth to logos'. The testimonies of the fifth century are notable for an almost total absence of the supernatural element which abounds both in many fourth-century writers and in Pythagoras' later biographers. The stuff of legend, fantasy, and fable so beloved of the neo-Pythagoreans stems largely from the works of Anaximander the Younger, Andron of Ephesus, Aristotle, Heraclides, and Neanthes.[12] Of course, when Aristotle related the legends about Pythagoras, unlike Iamblichus and Porphyry he disbelieved them and made no attempt to persuade his readers. The same, however, cannot be said of all of his contemporaries. The authors of the fourth century had access to both the historical and legendary tradition about

[10] Xenocrates: *On the Teachings of Parmenides* (fr. 2), Heraclides: *Against Zeno, Against Democritus, Interpretation of Heraclitus* (fr. 22, 39). See also *Πυθαγόρεια* by Xenocrates (fr. 2), *On the Pythagoreans* by Heraclides of Pontus (fr. 22), and *On Pythagorean Numbers* by Speusippus (fr. 28).

[11] First mentioned by the Hellenistic biographer Sotion (D.L. IX, 21 = 28 A 1), see below, 71.

[12] Anaximander the Younger (58 C 6), Andron of Ephesus (*FGrHist* 1005 F 3–4), Aristotle (fr. 191–6), Heraclides (fr. 40–1, 89–90); Neanthes (*FGrHist* 84 F 29, 31, 33).

Pythagoras, which they set down in proportion to their interests and the nature of their works.

Certainly, the writers of the fifth century could not but be familiar with the oral tradition about Pythagoras, which contained legends of his wonders and reincarnations, fantastic inventions, etc. If all these stories are not in fact represented in the early tradition, this is not because there were many more of them current in the fourth century than before, although the constant growth of the legendary tradition is undoubted. From some stage onwards the oral legendary tradition lived and developed independently of the personality of Pythagoras himself, largely independently even of Pythagorean circles. Its literary systematization begins, to all appearances, in the fourth century, when it finds its way into biographical, historical, and other works. Those who in the fifth century made mention of Pythagoras seem to have found his personality and teachings more interesting than the legends. The lively interest of his contemporaries can be clearly felt in the critical comments of Xenophanes and Heraclitus, but also those who sang Pythagoras' praises did so not by reason of his wonders.

1.2 EVIDENCE

The first mention of Pythagoras, which belongs to his contemporary Xenophanes, is a satire on the core of his religious doctrine – his teaching of the transmigration of souls. A sarcastic Xenophanes projects this religious idea onto a comic situation:

> Once they say that he was passing by when a puppy was being whipped,
> And he took pity and said:
> 'Stop! Do not beat it! For it is the soul of a friend
> That I recognized when I heard it giving tongue.'[13]

This can hardly be taken simply as the enlightened Ionian making fun of Pythagorean superstitions.[14] Like Pythagoras, Xenophanes was concerned by religious problems, but his search led him in a quite

[13] B 7, tr. KRS. Although Pythagoras is not named, it is now commonly accepted that it was he whom Xenophanes had in mind, as Diogenes Laertius says (VIII, 36). See J. H. Lesher, *Xenophanes of Colophon: Fragments* (Toronto, 2002), 79.

[14] As Philip, 9, supposes.

different direction, which explains his rejection both of traditional Greek religion and of metempsychosis. At the same time, it is quite possible that Xenophanes could have taken a critical view, not so much of the transmigration of souls as such, as to Pythagoras' claim to recognize the soul of a friend in the squeal of a puppy.[15] This interpretation shifts the centre of gravity from doctrinal distinctions to disagreements in the cognitive sphere: with Heraclitus (B 81, 129), and unlike Empedocles (B 129), Xenophanes was not prepared to recognize Pythagoras' claims to special wisdom. As was demonstrated by the subsequent development of the Greek philosophers' religion, Xenophanes and Pythagoras moved in different directions, but in the same plane: Xenophanes' belief in a deity without anthropomorphic features turned out to be perfectly compatible with belief in metempsychosis.[16] In their attempts at reform they shared in bringing religion out of the sphere of pure tradition and making it an object of conscious choice.

It is clear from Xenophanes' words that metempsychosis was already widely known at the turn of the sixth and fifth centuries in Magna Graecia and was associated with the name of Pythagoras. Was this the only one of Pythagoras' teachings known to Xenophanes? In his words that the god sees and hears, but does not breathe (A 1, 26), and that the earth is not surrounded by air (A 32–3), it is customary to perceive a polemic with Pythagorean cosmogony, according to which the cosmos is formed by inhaling the 'pneuma' from the infinite void which surrounds it.[17] The mention that Xenophanes

[15] Lesher, *Xenophanes*, 80. Cf. Ch. Schäfer, 'Das Pythagorasfragment des Xenophanes und die Frage nach der Kritik der Metempsychosenlehre', in Frede and Reis (eds.), *Body and Soul*, 45–70.

[16] See H. Long, *A Study of the Doctrine of Metempsychosis in Greece from Pythagoras to Plato* (Princeton, 1948), 63 ff.

[17] Burnet, 108; Zeller and Mondolfo, i. 314 f; Guthrie, i. 200 n. 2, 277 f.; D. Babut, 'Sur la "théologie" de Xénophane', *RPhilos* 164 (1974), 433 ff. Traces of this archaic-looking cosmogony are preserved in Aristotle. 'The Pythagoreans place the infinite among the objects of sense . . . , and assert that what is outside the heaven is infinite' (*Phys.* 203a6–8). 'The Pythagoreans held that void exists and that it enters the heaven itself, which as it were inhales it, from the infinite air. Further it is the void which distinguishes the natures of things, as if it were like what separates and distinguishes the terms of a series' (213b22–7, ROT). 'In the first book of his work on the philosophy of Pythagoras Aristotle writes that the heaven is one, and that time and breath and the void, which divides for ever the regions of different things, are drawn in from the infinite' (fr. 201, ROT). See also *Met.* 1091a13–20; Aët. II,9,1; Philop. *In Phys.*, 615.26 f.; Simpl. *In Phys.*, 651.26 f. The identification of air and void was still

ἀντιδοξάσαι Πυθαγόρᾳ (D.L. IX, 18) could be connected, not only with the verse quoted, but also with a philosophical polemic. Xenophanes' criticism of Pythagoras could have more than simply a theoretical basis. Both emigrated from Ionia and landed alone in Magna Graecia, away from the support of their home *polis*, but, where Xenophanes had to make a living by reciting the Homeric poems, Pythagoras was able to achieve wide recognition and set up in Croton an influential political society. Also Pythagoras' religious teaching had much greater resonance than Xenophanes' ideas. Evidently Xenophanes' attitude to Pythagoras developed partly out of envy of a successful rival. To be sure, the words of Heraclitus, attacking both Xenophanes and Pythagoras (B 40), indicate that there were more than sufficient grounds for mutual criticism among the early Greek philosophers.

Judging by Heraclitus' reaction, the reputation of Pythagoras had extended well beyond the boundaries of Magna Graecia by the first quarter of the fifth century. While Heraclitus could have used information preserved in the Ionic tradition (Samos and Ephesus are close neighbours), it is clear from his invective that he knew of Pythagoras' activity after his emigration to Croton.[18] Heraclitus' attitude to Pythagoras was even more antagonistic than that of Xenophanes. This is not surprising: Heraclitus seems to have clearly approved only of the Ephesian aristocrat Hermodorus (B 121). Almost all the others named by him – Homer, Hesiod and Archilochus, Xenophanes and Hecataeus – attract their share of opprobrium.[19] The force of his attacks on Pythagoras demonstrates that he possibly saw in him his chief rival, which makes Heraclitus one of our most valuable witnesses. One of his fragments (B 129) contains a direct reference to Pythagoras' research:

held by Alcmaeon (A 5); later it was refuted by Anaxagoras (A 68–9) and Empedocles (B 100). As a good example of 6th-cent. natural philosophy, having distinct parallels in the cosmological theories of Anaximander (A 11, 14) and Anaximenes (A 5–7, B 2), the idea of the breathing universe clearly antedates Philolaus, whose principles, *τὰ ἄπειρα* and *τὰ περαίνοντα* (B 1–2, 6), look much more abstract (cf. Huffman, *Philolaus*, 210 f., 289 f.; Zhmud, 'Some Notes', 250 ff.). The originator of this cosmogony could have been Pythagoras. It cannot in any case, be associated with the teachings of the early Pythagoreans known to us.

[18] Cf. J. S. Morrison, 'Pythagoras of Samos', *CQ* 50 (1956), 141; Philip, 140.

[19] Fr. B 39 on Bias is too brief and ambiguous to speak with confidence of a positive assessment (cf. B 56). Thales seemed to appear in a neutral context (B 38).

> *Πυθαγόρης Μνησάρχου ἱστορίην ἤσκησεν ἀνθρώπων μάλιστα πάντων καὶ ἐκλεξάμενος ταύτας τὰς συγγραφὰς ἐποιήσατο ἑαυτοῦ σοφίην, πολυμαθίην, κακοτεχνίην.*
>
> Pythagoras, the son of Mnesarchus, practised inquiry beyond all other men and selecting of these writings made for himself a wisdom (*or* made a wisdom of his own): a polymathy, an imposture.

Diogenes Laertius quotes these words to prove that Pythagoras left writings (VIII, 6), and this has more than once aroused doubt as to the genuineness of the fragment. In reality Heraclitus is speaking of the use of someone else's books, not of writing his own, though this too for long gave rise to doubt.[20] What works could Heraclitus have meant? *Συγγραφαί* indicates that prose writings are meant,[21] not Orphic poems.[22] Here Anaximander and Anaximenes should be named first, their teaching having found direct reflection in Pythagorean philosophy and science, and then Pherecydes of Syros. Only scant information has come down to us about the prose of the sixth and the beginning of the fifth centuries, yet, since we know of the works of the architects Chersiphron and Metagenes of Crete and Theodorus of Samos, the musician Lasus of Hermione, the interpretation of the Homeric poems by Theagenes of Rhegium, the writings of Hecataeus, the voyages of Scylax of Caryanda and Euthymenes of Massalia,[23] it is a simple step to assume the existence of analogous works in other spheres of knowledge. On the other hand, there is no reason to suppose that Heraclitus had in mind Egyptian and Babylonian texts,[24] being clearly familiar with the *συγγραφαί*, from which Pythagoras allegedly borrowed his wisdom.

The central notion of this fragment, as of many others (B 32, 41, 50, 83, 108, 112, 118) is wisdom, *σοφίη*. Heraclitus evidently laid claim to

[20] Many perceived here interpolation: Zeller, 'Älteste Zeugnisse', 459 ff.; *DK*, comm. ad loc., recently KRS, 217. Cf. however: Guthrie i. 157 n. 1; Burkert, 130 f.; M. Marcovich, *Heraclitus*, 2nd edn. (Sankt Augustin, 2001), 61 ff.; J. Mansfeld, 'Fiddling the Books (Heraclitus B 129)', in his *Studies*, 443 ff.

[21] Marcovich, *Heraclitus*, 69; Ch. H. Kahn, *The Art and Thought of Heraclitus* (Cambridge, 1979), 114; M. Conche, *Héraclite: Fragments* (Paris, 1986), 106.

[22] As Rathmann, *Quaestiones*, 93; Burkert, 131, 210; B. Centrone, *Introduzione a i pitagorici* (Rome, 1996), 99; Giangiulio, *Pitagora* i. 70 n. 4.

[23] Technical treatises (Vitr. VII, praef. 12); Lasus (18 A 3; Aristox. *Harm.*, 7.19 f.); Theagenes (8 A 2); Scylax (*FGrHist* 709); Euthymenes (*FHG* IV, 408).

[24] This was suggested by W. Kranz, 'Vorsokratisches I', *Hermes* 69 (1934), 116, and supported by Zeller and Mondolfo i. 317; M. Marcovich, 'Pythagorica', *Philologus* 108 (1964), 42; id., *Heraclitus*, 69; Philip, 178; van der Waerden, 42 f.

the role of the unique possessor of wisdom, consistently denying it to everyone in general and to poets, philosophers, and scientists in particular.[25] What then is the wisdom of Pythagoras? At first Heraclitus tells how Pythagoras came to it: by research and the accumulation of knowledge from the books of others. Then, he tells what it is in reality: *πολυμαθίη* and *κακοτεχνίη*. The meaning of this last expression has been frequently discussed, yet it is still not clearly understood. The usual meaning of *κακοτεχνίη* is deception, falsification; the legal sense is falsified evidence, so something connected with fraud.[26] Interpretations connecting the word with Pythagoras' religious activity do not appear convincing: by itself *κακοτεχνίη* nowhere implies religious imposture. Besides, such an interpretation scarcely fits the general sense of the fragment. Pythagoras' claims of immortality and an ability to do wonders could not have been to Heraclitus' liking, but how can that be connected with wisdom based on reading other people's books and the accumulation of knowledge? Heraclitus could hardly think that Pythagoras had picked this up from books![27]

If *ἐποιήσατο ἑαυτοῦ* means 'claimed' or 'passed off as his own',[28] then *κακοτεχνίη* can be understood as an accusation of appropriating the thoughts of others. Pythagoras' *σοφίη* is indeed false: first, because it is not wisdom, but polymathy; second, because it is not his own, but borrowed. While Heraclitus could indeed have been struck by the similarity between Pythagoras' ideas and some written work, these charges should be assessed against the background of his determination to prove his independence of any tradition (cf. B 101). To be sure, Heraclitus could not be thoroughly consistent, and, despite his antagonism to Pythagoras, he made use of his ideas too. H. Fraenkel has shown how smoothly Heraclitus' system absorbed ideas of proportion and musical harmony, the results of Pythagoras' studies in

[25] *ἦθος γὰρ ἀνθρώπειον μὲν οὐκ ἔχει γνώμας, θεῖον δὲ ἔχει* (B 78). See D. Babut, 'Héraclite critique des poètes et des savants', *ACl* 45 (1976), 464–96.

[26] Marcovich, *Heraclitus*, 70, connects *κακοτεχνίη* with *ψευδομαρτυρέω* (B 28) and understands *κακότεχνος* as 'bearer of falsified evidence'.

[27] Marcovich, *Pythagorica*, 42; id., *Heraclitus*, 70, points out that Heraclitus' criticism is theoretical; see also Philip, 177 f.; Conche, *Héraclite*, 106 f.

[28] Zeller, i. 393 n. 5; Burnet, 134 n. 2; H. Cherniss, Review, *AJP* 60 (1939), 250; KRS, 217; cf. Marcovich, *Heraclitus*, 69. For the accusation of plagiarism made against Pythagoras, see also Guthrie, i. 158; Mansfeld, 'Fiddling the Books', 443 f.

mathematics and harmonics.[29] This emphasizes once again that the words 'practised inquiry (ἱστορίη) beyond all other men' should be understood as an indication of Pythagoras' research, not simply as some kind of 'questioning'.[30] In fr. B 35, dealing with πολλῶν ἵστορας, they seem to appear in a positive context. In this fragment ἱστορίη is side by side with an accusation of deception and plagiarism, yet, whatever extra meaning Heraclitus may have attempted to insert into the word, and however he may have sought to emphasize the distinction between Pythagoras' work and his own, the reality underlying ἱστορίη in both cases remains cognitive activity of a rational kind.[31]

When seen against the background of the entire early tradition, Pythagoras' σοφία becomes more clearly defined. Apart from Heraclitus, it is noted by the historian Herodotus (IV, 95) and the philosopher Empedocles (B 129), the philosophizing poet Ion of Chios (B 4), Socrates' pupil Antisthenes (fr. 51), and Gorgias' pupil Alcidamas (14 A 5). Were we to relate this concept only to the area of religious doctrines and cult practice, taking away its rational content, we would have to revise radically our notions of what σοφία meant to the intellectuals of that era. Meanwhile, the context of most testimonies is quite obvious: they point to the outstanding intellectual abilities of Pythagoras and his vast knowledge. It makes no sense to argue against this knowledge being connected with the sphere of religion; what is important to us is that it was not restricted to that sphere. Neither the miracles of Pythagoras nor his preaching of metempsychosis could alone establish his reputation as a wise man, the less so among people who did not believe in them. From the fifth century we have no evidence that the wonder-workers par excellence, Epimenides, Abaris, or Aristeas of Proconnesus, were called σοφοί, or that wisdom was associated with Orpheus and the Orphics.

[29] H. Fraenkel, 'Thought-Pattern in Heraclitus', *AJP* 59 (1938), 309–38; H. Cherniss, 'The Characteristics and Effects of Presocratic Philosophy', in D. J. Furley and R. E. Allen (eds.), *Studies in Presocratic Philosophy*, i (London, 1970), 17; Kahn, *Heraclitus*, 203 ff.

[30] So e.g. Zeller, 'Älteste Zeugnisse', 459 n. 4: 'Erkundigung, Nachfragen bei andern'; Riedweg, *Pythagoras*, 50: 'the desire to see, hear, and learn from others'. Cf. Burnet, 134: 'scientific inquiry', Guthrie, i. 417: 'inquiry (or research)'; Marcovich, *Heraclitus*, 68: 'scientific inquiry (or research)'; J. Mansfeld, *Die Vorsokratiker*, i (Stuttgart 1987), 41: 'Forschung'; T. M. Robinson, *Heraclitus: Fragments* (Toronto, 1987), 73: '[art of] investigation'.

[31] Marcovich, *Heraclitus*, 25 f.; Conche, *Héraclite*, 98 f.

Another fragment of Heraclitus takes us in the same direction: 'Polymathy does not teach understanding (νόον); otherwise it would have taught Hesiod and Pythagoras, and again Xenophanes and Hecataeus' (B 40). *Πολυμαθίη*, found here once more, and the names, among which Pythagoras is mentioned, prove even more definitively that the claims of Heraclitus are of a philosophical or, more accurately, an epistemological nature, as in B 129.[32] It is from this standpoint that he juxtaposes the author of the *Theogony* and Pythagoras, Xenophanes, who ridiculed both traditional religion and metempsychosis, and finally Hecataeus, also well known for his critique of common sense (*FGrHist* 1 F 1). Digressing from the distinctions between them, Heraclitus concentrates on what concerned him most of all: contrasting their method of cognition with his own. Since true insight was available only to Heraclitus, the others were left with polymathy alone. We can, however, be quite content with Pythagoras' πολυμαθίη. Against the background of Xenophanes and Hecataeus this very accusation is a clear pointer to the nature of his work.

The suggestion that Pythagoras, with Hesiod, be treated as representing religious thought, unlike Xenophanes and Hecataeus,[33] is clearly far-fetched. When Heraclitus was writing his book, Hesiod and Pythagoras were no longer alive; hence their names are juxtaposed.[34] As for Hesiod's polymathy, it is only at first glance that there is little correlation with the work of Xenophanes and Hecataeus. Heraclitus could have no doubt that Hesiod was the author of the extensive genealogical poem the *Catalogue of Women*, a typical example of polymathy, linking him with the *Genealogies* of Hecataeus and through him with Xenophanes.[35]

One more fragment of Heraclitus, this time desperately short, calls Pythagoras κοπίδων ἀρχηγός (B 81).[36] This is often rendered as 'chief of swindlers'.[37] Who are these swindlers and what is the nature of

[32] Marcovich, *Heraclitus*, 59 f., 64 f.; J. Lallot, 'Une invective philosophique (Héraclite, fr. 129 et 35 D.-K.)', *REA* 73 (1971), 15 ff., 22; Conche, *Héraclite*, 91 f.

[33] Rathmann, *Quaestiones*, 38; Burkert, 210; Centrone, *Introduzione*, 99; Giangiulio, *Pitagora*, i. 70 n. 2.

[34] Lévy, 2 n. 8; Marcovich, 'Pythagorica', 40 f.; id., *Heraclitus*, 64 f.; Conche, *Héraclite*, 92.

[35] Zaicev, 168.

[36] Marcovich, 'Pythagorica', 42; id., *Heraclitus*, 71 f.; Conche, *Héraclite*, 211.

[37] Burkert, 161; Kahn, *Heraclitus*, 41: 'prince of impostors'; Marcovich, *Heraclitus*, 72: 'chief captain of cheaters'.

their swindles? *Κόπις* denoted a speaker who could sway an audience with artful, but deceitful words.[38] If *κοπίδων* refers to people, then Heraclitus would have had in mind both Pythagoras, as an arch-cheater, and the Pythagoreans, who also deceived people with their mendacious speeches. This is possible,[39] though a reference to Pythagoras coupled with Pythagoreans would be unique in the fifth century. Besides, there is no evidence that the Pythagoreans were renowned as powerful speakers, although Pythagoras certainly was. On the other hand, the word *κοπίδες* (pl.), a cognate of *κόπις*, normally refers not to liars themselves, but to their deceitful speeches. This is how Timaeus understood Heraclitus' words, since, defending Pythagoras, he says: not Pythagoras was the originator of the lies, but his accuser Heraclitus was the liar![40] This imparts more plausibility to the interpretation which makes Pythagoras the sole target of Heraclitus: 'originator, ancestor of swindles'.[41] As Pythagoras' relations with his fellow

[38] *κοπίζειν*: *ψεύδεσθαι* (Hesych). See Euripides on Odysseus: *ὁ ποικιλόφρων κόπις ἡδυλόγος δημοχαριστὴς Λαερτιάδης* (*Hec.* 131 f.). Cf. *κόπις*: *ὁ λαλός, ὁ ῥήτωρ* (*Suda*); *κόπις*: *σύντομος, ὀξὺς τῷ λόγῳ, ὅθεν καὶ ὁ δημοκόπος καὶ κόβαλος* (*Etym. Gudian.*); 'versutus et callidus rhetor' (*TLG*).

[39] So Marcovich, *Heraclitus*, 71: '"teachers of lies" (e.g. *political* malpractice or artifice . . .)'.

[40] His fragment is preserved in the scholium to Euripides' *Hec.* 131 (where *κόπις* Odysseus is mentioned): *κοπίδας τὰς λόγων τέχνας ἔλεγον ἄλλοι τε καὶ ὁ Τίμαιος οὕτως γράφων 'ὥστε καὶ φαίνεσθαι μὴ τὸν Πυθαγόραν εὑρετὴν ὄντα* (*εὑρετὴν γενόμενον*: Jacoby, Marcovich) *τῶν ἀληθινῶν κοπίδων μηδὲ τὸν ὑφ' τὸν Ἡρακλειτου κατεγορούμενον, ἄλλ' αὐτὸν τὸν Ἡράκλειτον εἶναι τὸν ἀλαζονευμενον'* (*FGrHist* 566 F 132 = B 81). See H. Diels, 'Ein gefälschtes Pythagorasbuch', *AGPh* 3 (1890), 454 f. = *Kleine Schriften zur Geschichte der antiken Philosophie*, ed. W. Burkert (Darmstadt, 1969), 266–87; K. Reinhardt, '*ΚΟΠΙΔΩΝ ΑΡΧΗΓΟΣ*', *Hermes* 63 (1928), 107–10; Rathmann, *Quaestiones*, 41; Diels's emendation *τῶν ὑφ' Ἡρακλειτου κατηγορουμένων* (*sc. κοπίδων*) seems very likely, see Rathmann, *Quaestiones*, 41, Timpanaro Cardini, i. 15; see also Marcovich, *Heraclitus*, 72. Timaeus obviously read Heraclitus' original text, for he was a great bibliophile, eager to find references to Pythagoras in the early literature; cf. his quotation from Empedocles (below, 39 n. 48). Later pseudo-Pythagorean tradition reacted to this debate by producing Pythagoras' own book *Κοπίδες* (D.L. VIII, 8); Diels, 'Pythagorasbuch', 455 f.; Thesleff, 168 f.

[41] *DK*: 'Annherr der Schwindeleien (Schwindler)'; *LSJ*, s.v. *ἀρχηγός* II,3: 'first cause, originator *κοπίδων*'; J. Bollack and H. Wismann, *Héraclite ou la séparation* (Paris, 1972), 41, 246: 'source des fourberies'; C. Diano and G. Serra (eds.), *Eraclito: I frammenti e le testimonianze* (Milan, 1980), 41: 'inventore primo di raggiri'. Giangiulio, *Pitagora*, i. 70, translates 'inventore di raggiri', but comments that Heraclitus' original intention was probably to say 'capintesta di ingannatori'. Markovich's objection (*Heraclitus*, 72 f.) that there were liars long before Pythagoras, e.g. Homer and Hesiod, does not seem decisive: Heraclitus might have thought about something more specific (Diano and Serra (eds.), *Eraclito*, 178). One difference between Pythagoras and the two poets is obvious: he did not write, but addressed his audience directly.

citizens apparently are meant here, Heraclitus might have had in mind his speeches to various groups of the Crotoniates (see below). If this is so, it is easy to see why Heraclitus, who had earned the nickname 'mob-reviler' (ὀχλολοίδορος, D.L. IX, 6), would dislike a person trying to persuade his co-citizens of something. Let us recall that Euripides calls Odysseus κόπις,[42] while Antisthenes applies the standard Homeric epithet for Odysseus, πολύτροπος, to Pythagoras (fr. 51). Such epithets were intended to suggest to the reader the image of a clever, knowledgeable person, but one less than scrupulous in his means – as Heraclitus probably saw Pythagoras.

The next two testimonies belong to Ion of Chios and Empedocles, who were born about the 490s, that is after the death of Pythagoras. Each of them has his own reaction to the fame of the sage Pythagoras, fame which by now had spread throughout Greece. Here is what is said in the fragment of Ion's elegy to Pherecydes of Syros:

> *ὣς ὁ μὲν ἠνορέῃ τε κεκασμένος ἠδὲ καὶ αἰδοῖ*
> *καὶ φθίμενος ψυχῇ τερπνὸν ἔχει βίοτον,*
> *εἴπερ Πυθαγόρης ἐτύμως σοφός, ὃς περὶ πάντων*
> *ἀνθρώπων γνώμας εἶδε καὶ ἐξέμαθεν.*

So he, distinguished for his manly virtue and modesty, even in death has a life which is pleasing to his soul, if Pythagoras the wise truly achieved knowledge and understanding beyond that of all men.[43]

In contrast to the elegy of Xenophanes, metempsychosis is not directly mentioned, only a joyful life of the soul after death, which is contrary to traditional Greek notions. Ion, however, had in mind not only the veracity of the religious doctrine of Pythagoras, in which he perceived a clear similarity with Orphic teaching on the soul.[44] Rather he makes the intellectual greatness of Pythagoras, which in consequence, in his view, has no need of proof, the pledge of that veracity. After all, *ὃς περὶ πάντων ἀνθρώπων γνώμας εἶδε καὶ ἐξέμαθεν* is said, not about Pythagoras' investigation of the soul, but generally about his significant achievements in the acquisition of knowledge,

[42] See above, 37 n. 38.

[43] B 4, tr. Dover. – On the correction of the MMS reading *ἐτύμως ὁ σοφός περὶ πάντων*, see F. H. Sandbach, 'Ion of Chios on Pythagoras', *PCPhS* 5 (1958/9), 36; Guthrie, i. 158 n. 2; K. Dover, 'Ion of Chios: His Place in the History of Greek Literature', in *The Greeks and Their Legacy*, ii (Oxford, 1988), 1–12, at 4 n. 4.

[44] Ion even supposed that Pythagoras had written poems under the name of Orpheus (B 2); see below, 223.

and, as we would now say, his successful cognitive activity. If Pythagoras is indeed a sage, with deeper insights (γνώμας εἶδε) than others,[45] then his concepts of the soul are true; that is essentially what Ion meant.[46] Many, with reason, see in his words a polemic with Heraclitus' fr. B 129,[47] in which he was very critical of Pythagoras' wisdom. If this is so, then as early as the middle of the fifth century he had become the subject of disputes among philosophers, continued in the next generation by Democritus' *Pythagoras* and then by the Academy and the Lyceum.

We find an even more eloquent characterization of Pythagoras in Empedocles:

> Ἦν δέ τις ἐν κείνοισιν ἀνὴρ περιώσια εἰδώς,
> ὃς δὴ μήκιστον πραπίδων ἐκτήσατο πλοῦτον,
> παντοίων τε μάλιστα σοφῶν ‹τ'› ἐπιήρανος ἔργων·
> ὁππότε γὰρ πάσῃσιν ὀρέξαιτο πραπίδεσσιν,
> ῥεῖ' ὅ γε τῶν ὄντων πάντων λεύσσεσκεν ἕκαστον
> καί τε δέκ' ἀνθρώπων καί τ' εἴκοσιν αἰώνεσσιν.[48]

> And there was among them a man of surpassing knowledge, master especially of all kinds of wise works, who had acquired the outmost wealth of understanding: for whenever he reached out with all his understanding, easily he saw of all the things that are, in ten or even twenty generations of men (tr. KRS).

[45] B. Snell, *Die Ausdrücke für den Begriff des Wissens in der vorplatonischen Philosophie* (Berlin, 1924), 31 ff., stresses the double meaning of γνώμη as cognition and its result (cf. ibid. 36 f.). To elucidate the meaning of γνώμη in Ion, see Heraclitus B 78: 'Human nature has no insight, but divine nature has' (above, 34 n. 25); Anaxagoras B 12; Democritus B 11.

[46] For similar interpretations, see W. Kranz, 'Vorsokratisches II', *Hermes* 69 (1934), 228; Zeller and Mondolfo i. 318; G. Huxley, 'Ion of Chios', *GRBS* 6 (1965), 38–41; Dover, 'Ion of Chios', 4 f. One can only conjecture why Ion juxtaposed the names of Pherecydes and Pythagoras. The biographical tradition makes Pherecydes the teacher of Pythagoras (see below, 123), but it is unclear whether this was known to Ion. At all events, there is no trace of wonders in his fragment.

[47] See Delatte, *Vie*, 162 f.; Marcovich, *Heraclitus*, 67 f., and works cited in nn. 43, 46.

[48] B 129. On the order of lines 2–3, see G. Zuntz, *Persephone: Three Essays on Religion and Thought in Magna Graecia* (Oxford, 1971), 208. Empedocles does not name the sage. Timaeus (*FGrHist* 566 F 14) was the first to indicate Pythagoras; according to Diogenes Laertius (VIII, 54), some saw here Parmenides. Most scholars tend to favour Pythagoras, see in detail Long, *Study*, 17 ff. Doubt, however, cannot be finally eliminated, see Zeller, 'Älteste Zeugnisse', 463 f.; Rathmann, *Quaestiones*, 42 f.; Guthrie i. 160; N. van der Ben, *The Proem of Empedocles' Peri Physios* (Amsterdam, 1975), 108, 180 f.

The admiring assessment of Empedocles is all the more significant for us as it comes from a person congenial to Pythagoras: a philosopher and scientist, politician and religious thinker. There are some passages of Empedocles which suggest, not only that he revered Pythagoras, but also that he sought to outdo him, for example when he addressed his fellow citizens, assuring them of his immortality (B 112). The reference to Pythagoras in a fragment which is usually attributed to the *Purifications* at first glance shows the context of his evidence to be religion, not natural philosophy. There is, however, no certainty that B 129 does in fact belong to the *Purifications*; it could equally well be placed in the poem *On Nature*.[49] It is in any case revealing that it is not wonders Empedocles is speaking about: it is rather the cognitive abilities of Pythagoras which are supernatural, enabling him to surpass others 'in all kinds of wise works' and in the acquisition of knowledge.

The last two lines of this fragment have usually been taken as a reference to Pythagoras' transmigration of the soul, which enabled him to see across dozens of generations.[50] The preceding line, however, 'whenever he reached out with all his understanding', indicates the subject to be rather the level of his intellectual abilities.[51] Although we cannot exclude that Empedocles connected these abilities with Pythagoras' memory of previous incarnations, it seems that his words were not taken in antiquity as a reference to metempsychosis.[52] It is not fortuitous that some attributed the fragment to

[49] The first editors of Empedocles, Sturz (1805) and Karsten (1839), placed this fragment in an appendix. In recent decades several scholars, for different considerations, placed it in *Περὶ φύσεως*: van der Ben, *Proem*, 178 ff.; M. R. Wright, *Empedocles: The Extant Fragments*, 2nd edn. (London, 1995), 256 ff.; D. Sedley, *Lucretius and the Transformation of Greek Wisdom* (Cambridge, 1998), 29 ff. I follow the ancient tradition, according to which Empedocles was the author of the two poems, *Περὶ φύσεως* (or, most probably, *Φυσικά*) and *Καθαρμοί*.

[50] See e.g. Long, *Study*, 21 f.; KRS, 219; Burkert, 213.

[51] Zuntz, *Persephone*, 209; van der Ben, *Proem*, 185 f.; Wright, *Empedocles*, 257 f. Sedley, *Lucretius*, 30, sees Pythagoras' intellectual achievement in his recollection of his former incarnation.

[52] There is no trace of such an interpretation in Diogenes Laertius (VIII, 54), who quotes lines 1–2 with a reference to Timaeus, or in Porphyry (*VP* 30) and Iamblichus (*VP* 67). Both Neoplatonists, following Nicomachus (Rohde, 136), note that the expressions *περιώσια* (v. 1), *πραπίδων πλοῦτον* (v. 2), and *τῶν ὄντων πάντων λεύσσεσκεν ἕκαστον* (v. 5), relate to the particular nature of Pythagoras, who outdid all others in his capacity to see, hear, and think. See C. Gallavotti, *Empedocle. Poema fisico e lustrale* (Milan, 1975), 283 f.

Parmenides (D.L. VIII, 54), who is unconnected with the transmigration of souls. In any case, in no way does it follow from the words of Empedocles that he 'knew Pythagoras only as a preacher of metempsychosis'.[53] What in fact we have before us is the portrait, not of a preacher, but of an outstanding thinker. Considering the closeness of Empedocles to the Pythagoreans of his time,[54] and the influence on him of Pythagorean natural science,[55] is it reasonable to restrict his comment only to the religious sphere? The example of Empedocles himself, who successfully combined activities which many regarded as incompatible, is an argument against such a one-sided interpretation. Burkert in particular asserted that, applied to Pythagoras, the formula 'not only a "medicine man" but also a thinker' is too simple and unconvincing.[56] Instead he offers another 'either . . . or': either Pythagoras was a wonder-worker or he was a philosopher and scientist. Neither formula, however, is a priori superior to the other; in each specific case either may be true.[57] In our case it is evident that a rational, cognitive element cannot be eliminated from early references to Pythagoras' wisdom.

Chronologically the next evidence is a passage of Herodotus reflecting a popular tradition current on the eastern periphery of the Greek world. Speaking of Zalmoxis, a deity of the Thracian tribe of Getae, Herodotus asserts, from the account given by the Hellespontic and Pontic Greeks, that he was the slave of Pythagoras of Samos. At that time, the Thracians lived a miserable life and were simple-witted (*κακόβιοι καὶ ὑπαφρονέστεροι*), but Zalmoxis came to know the Ionic way of life and more refined manners through associating with Pythagoras, one of the wisest among the Greeks (*Ἑλλήνων οὐ τῷ*

[53] Frank, 356 n. 166.

[54] Alcidamas (14 A 5) and Timaeus (*FGrHist* 566 F 14) regarded him as a pupil of Pythagoras, which is chronologically impossible, Theophrastus (fr. 227A FHSG) and Neanthes (*FGrHist* 84 F 26) as a pupil of the Pythagoreans.

[55] See e.g. B. Inwood, *The Poem of Empedocles* (Toronto, 1992), 21.

[56] Burkert, 209.

[57] It is revealing that Burkert was successful precisely where he challenged the traditional approach to Philolaus' fragments on the principle 'either . . . or': either they are all genuine or all fake (so Böckh, *Philolaos*, 38, 182; C. Schaarschmidt, *Die angebliche Schriftstellerei des Philolaos und die Bruchstücke der ihm zugeschriebenen Bücher* (Bonn, 1864), 2; Frank, 290), showing that they were of both kinds. Cf. above, 3 n. 5.

ἀσθενεστάτῳ σοφιστῇ).[58] This advantage, together with a certain cunning, enabled Zalmoxis to convert his fellow tribesmen to the doctrine of immortality (IV, 94–6).[59] Without going into the details of the confused Zalmoxis story,[60] let us note the dual image of Pythagoras which Herodotus presents. On the one hand, the legendary tradition links him with Zalmoxis through a common element of wonders; on the other hand, the sage of Samos appears as the bearer of Ionic culture and enlightenment. Incidentally, the historian did not himself believe that they knew each other, thinking that Zalmoxis had lived much earlier. It must be supposed that Herodotus, ranking him among the wisest Greeks, relied more on what he himself knew of Pythagoras than on what was known to the Pontic Greeks.[61] Taking into consideration that Herodotus settled at Thurii, hence close to Croton, in the 40s of the fifth century, when the memory of Pythagoras was still vivid there, his words deserve special attention.

In what precisely was the *σοφία* of Pythagoras displayed? The range of opinions is, as always, very wide. Burnet believed that Herodotus had in mind here scientific work, translating *σοφιστής* as 'scientific man'.[62] Burkert, however, asserted that, since only 'shamanistic' activities of Pythagoras are attested in the early tradition, his wisdom should be related only to them.[63] At the present time the idea of Greek shamanism has quite receded (below, §6.1), yet Burnet's more pertinent interpretation also seems rather too straightforward. Before a quite specific category of people came to be called Sophists, *σοφιστής* was one 'who knows wise things', a bearer of knowledge and

[58] A literal translation, e.g. 'not the feeblest *sophistēs* among the Greeks' (Kahn, 16) does not convey the emphasis expressed by the negation of the superlative. Thus Herodotus calls Sparta, one of the two outstanding Greek *poleis*, *πόλις οὔτ' ἐλαχίστη οὔτ' ἀσθενεστάτη* (VII, 101); cf. Zeller, 'Älteste Zeugnisse', 466: 'einer der hervorragendsten unter den griechischen Weisen'.

[59] Here we have a typical attempt to explain religious notions by the influence of a more ancient and advanced culture. If the Greeks, according to Herodotus, adopted metempsychosis from the Egyptians (II, 123), the Greek neighbours of the Getae explained their beliefs by their own influence (Burkert, 128).

[60] See K. von Fritz, 'Zalmoxis', *RE* 9A (1968), 2301–3; cf. Burkert, 156 f.

[61] Herodotus gives the name of Pythagoras' father, which is unusual for oral legends. Morrison, 'Pythagoras', 139, supposes a literary source here, possibly Damastes of Sigeum, author of *On Poets and Sages*. Hellanicus of Lesbos follows Herodotus in his account of the story of Zalmoxis and Pythagoras (*FGrHist* 4 F 73).

[62] Burnet, 85; Zeller and Mondolfo i. 331 f.; Guthrie, i. 166 n. 3.

[63] Burkert, 211; van der Waerden, 29.

skill in archaic Greece.[64] This could designate a person distinguished in various spheres of activity: one of the Seven Sages, a poet, or a musician.[65] It was very often used for philosophers, scientists, and doctors: Anaxagoras, Alcmaeon, Empedocles.[66] Diogenes of Apollonia called his predecessors *φυσιολόγοι* and *σοφισταί* (A 4). As Pythagoras did not distinguish himself as a poet, musician, or doctor, what did Herodotus mean? His philosophical and scientific activity or his religious activity, or both? It has been noted that Herodotus applied the term *σοφισταί* to those who had more fully explained to the Greeks the cult of Dionysus after the seer Melampus had introduced the cult to Greece (II, 49). Melampus, however, was not 'a *Wundermann* par excellence';[67] in tradition he figured as a seer and physician, so could well have been called *σοφιστής*.[68] As for his anonymous successors, by whom Orpheus and Musaeus are meant, for Herodotus they were first and foremost poets, like Homer and Hesiod, who, according to the historian, gave Greek religion its final form (II, 53). To interpret *σοφιστής* as 'expert on wonders' does not stand up. There can hardly be any difference in principle between Pythagoras' wisdom as seen by Herodotus and what is common to the discrepant assessments of Heraclitus, Ion, Empedocles, and the other writers of the fifth century.

This may be confirmed by the words of the Sophist Alcidamas, the younger contemporary of Herodotus, who proves that the wise (*σοφοί*) are honoured by all:

[64] G. B. Kerferd, *The Sophistic Movement* (Cambridge, 1981), 24 f.; O. Imperio, 'La figura dell'intellettuale nella commedia greca', in A. M. Belardinelli et al. (eds.), *Tessere: Studi e commenti sulla commedia greca* (Bari, 1998), 46 ff.; R. Thomas, *Herodotus in Context: Ethnography, Science, and the Art of Persuasion* (Cambridge, 2000), 283 f. This usage was retained after Plato: A. Weiher, *Philosophen und Philosophenspott in der attischen Komödie* (diss. Munich, 1913), 40 f.; G. Rocca-Serra, 'Aristote et les sept "sophistes": pour une relecture du fragment 5 Rose', *RPh* 172 (1982), 321–338; Imperio, 'Figura', 48 f.

[65] Hdt. I, 29; Pind. *Ist.* V, 28; [Eur.] *Rhes.* 924. Applied to the area of *τέχναι* (crafts, poetry, music, medicine) *σοφία* was normally understood as 'skill, craftsmanship, competence'.

[66] Isoc. XV, 235; XX, 268; [Hipp.] *VM* 20. See also *DK* 90, 6; Isoc. X, 3.

[67] As Burkert, 211, calls him. Generally speaking, to relate Melampus to archaic wonder-workers of the type of Abaris or Aristeas (Nilsson, *GGR* i. 615 f.) seems doubtful. He was a legendary pre-Homeric figure. See M. A. Flower, *The Seer in Ancient Greece* (Berkeley, 2008).

[68] Aristophanes calls seers, poets, and doctors *σοφισταί* (*Nub.* 331–4).

> The Parians honoured Archilochus, in spite of his evil-speaking; the Chians Homer, though he was not their fellow-citizen [Sappho and the Spartan Cylon follow]; the Italiotes honoured Pythagoras, and the Lampascenes buried Anaxagoras, although he was a foreigner, and still hold him in honour.[69]

Alcidamas presents the standard list of those honoured in the fifth century as *σοφοί*: the three great poets; Chilon, counted as one of the Seven Sages, and the philosophers Pythagoras and Anaxagoras. There is no wonder-worker in the list. Nor is it noticeable that Alcidamas in any way contrasted Pythagoras and Anaxagoras.[70]

Coins with an idealized portrait and the signature *ΠΥΘΑ ΓΟΡΗΣ*, issued in 430–420 in Abdera, are unusual evidence of Pythagoras' extraordinary fame.[71] This is unprecedented for the fifth century, not only because philosophers' portraits on coins appear much later and, as a rule, in their native towns: this is the first portrait on a Greek coin, or, at least, the first signed portrait.[72] This circumstance suggests that Pythagoras is unlikely to have won the esteem of the Abderites by virtue of his philosophical teachings. These coins can be seen rather as a reflection of his many-sided fame as one of the wisest of the Greeks. Seltman supposed the appearance of Pythagoras' portrait to be connected with Democritus, whose name is found on Abderan coins (as magistrate) at that time;[73] to prove this, however, is hardly possible.

[69] Arist. *Rhet.* 1398b9–14 = 14 A 5, tr. Freese (my addition in square brackets).

[70] Cf. below, 47. *Dissoi logoi* aligns the Pythagoreans with the Anaxagoreans.

[71] The first publisher of one of these coins, R. Jameson, *Collection Jameson*, iii (Paris, 1924), 50, suggested that the portrait showed Pythagoras of Samos; he is followed by Ch. Seltman, *Greek Coins*, 2nd edn. (London, 1955), 142 f.; J. Babelon, *Le Portrait dans l'antiquité d'après les monnaies* (Paris, 1942), 63 f.; W. Schwabacher, 'Pythagoras auf griechischen Münzbildern', *SSCA* 5 (1968), 59–63. G. Richter's doubts, *Greek Portraits*, iv (Brussels, 1962), were dispelled by the publication in the 1960s of another coin of the same kind (Schwabacher, 'Pythagoras', 60 f.). See also J. M. F. May, *The Coinage of Abdera* (London, 1966), 144, 157, 183 (pl. xiii); Burkert, 110 n. 2; G. R. Jenkins, *Ancient Greek Coins* (London, 1972), 98 ff.; C. M. Kraay, *Archaic and Classical Greek Coins* (London, 1976), 155. Cf. Burkert, 'Pythagoreische Retraktationen', 305.

[72] A 4th-cent. coin from Metapontum may also represent Pythagoras; see Iamblichus, *De vita pythagorica liber*, ed. L. Deubner, corr. U. Klein (Stuttgart, 1975), p. xx.

[73] Seltman, *Greek Coins*, 143 f.

Unlike the coins, Democritus' own links with Pythagorean philosophy and science are undoubted. Apart from his book *Pythagoras* (A 33,1), the first of a long series of works on the great Samian, Democritus' contemporary Glaucus of Rhegium confirms that he studied with the Pythagoreans.[74] Democritus was born about 460 and so was almost the coeval of Philolaus.[75] If, however, Pythagoreanism before Philolaus was no more than religio-mythological doctrine and arithmological speculation, what could a person like Democritus learn from the Pythagoreans and what was it that evoked his admiration in his book on Pythagoras?[76]

Solomon Luria, who followed Frank in rejecting early Pythagorean philosophy and science, suggested, based on the placing of Democritus' *Πυθαγόρης* among his ethical works (next to *On the Disposition of the Wise Man*, D.L. IX, 46), that he had in his youth learnt ethics from the Pythagoreans and the book itself contained 'moral precepts'.[77] Even if we agree that the placing of the book in later catalogues is a reliable indication of its content, the influence of the Pythagoreans on Democritus was not limited to ethics.[78] Aristotle more than once referred to their proximity in natural philosophy.[79] Democritus' contacts with the Pythagoreans are evident in the scientific area too. 'If we ask from whom he obtained the mathematical knowledge which distinguished him from his contemporaries, the most satisfactory

[74] 14 A 6 = fr. 5 Lanata. Rhegium was one of the centres of Pythagoreanism, so Glaucus' acquaintance with the Pythagorean tradition was a very close one. Aristoxenus in particular relies on Glaucus in his account of the acoustic experiments of Hippasus (fr. 90).

[75] The Democritean Apollodorus of Cyzicus wrote that Democritus conversed with Philolaus (74 A 2), and the historian Duris of Samos that he was the pupil of Pythagoras' son Arimnestus (*FGrHist* 76 F 23).

[76] The publisher of Democritus' writings, the Platonist Thrasyllus (1st cent. AD) wrote: 'He can be thought to be a follower of the Pythagoreans and he writes admiringly of Pythagoras in the book which bears his name' (D.L. IX, 38 = 14 A 6).

[77] S. Luria, *Democritea* (Leningrad, 1970), 458 n. 154. Zeller, 'Älteste Zeugnisse', 471, combined two adjacent titles from Democritus' list of works into one: *Πυθαγόρης ‹ἢ› Περὶ τῆς τοῦ σοφοῦ διαθέσεως*.

[78] Central to Democritus' ethics were *μετριότης* and *συμμετρίη* (fr. 657 Luria), striving to avoid excess (fr. 657): *καλὸν ἐν παντὶ τὸ ἴσον* (fr. 749); happiness is *ἁρμονία καὶ συμμετρία* (fr. 742).

[79] *Cael.* 303a4: on the role of numbers among the Pythagoreans and the atomists; *Phys.* 203a6; *Cael.* 279a11; fr. 201: the cosmogony of the Pythagoreans, Leucippus (A 1), and Democritus (A 40); *De an.* 404a1: notions of the soul; *De gen. et corr.* 315a3: Democritus' criticism of Pythagorean views (cf. *Met.* 1028b16, 1090b5). See also Zeller and Mondolfo, i. 332 ff.; Guthrie, i. 389.

answer is that he studied with a Pythagorean,' noted Zeller.[80] Democritus wrote a book *On Irrational Lines and Solids* (A 33), and before him no one except for the Pythagoreans was concerned with the problem of irrationality in mathematics. Bearing in mind, on the one hand, Democritus' links with Pythagorean philosophy and science and, on the other, the polemical context of most of the evidence about Pythagoras examined above, I would suggest that Democritus in his book sided with Pythagoras by giving his own understanding of his wisdom.

Another aspect of the multifaceted *σοφία* of Pythagoras is revealed by the tradition of his speeches, first referred to by the Socratic Antisthenes (*c.*450–370). In his comment on the Homeric epithet *πολύτροπος*, characterizing the wise and eloquent Odysseus, he uses for comparison Pythagoras' ability to speak differently with different social and age groups, perceiving in it proof of his wisdom.

> So Pythagoras, it is said, when he needed to speak to children, addressed them in speech adapted for children, women in speech suitable for them, archons in speech in archontic style, and ephebes in ephebic. To find for everyone the appropriate kind of wisdom is itself wisdom.[81]

The tradition of Pythagoras' speeches, reflected later in Dicaearchus (fr. 33) and Timaeus (*ap*. Iust. XX,4), is a historical one; Heraclitus' fr. B 81, analysed above, might have been a reaction to it. Clearly his acquisition of numerous disciples at Croton and his later achievement of fame throughout Greece are in large part due to his charismatic gift.[82] Is it, however, a matter of his talent as a political orator or as a religious

[80] Zeller, 'Älteste Zeugnisse', 471; Zeller and Mondolfo i. 334 f.

[81] *οὕτω καὶ Πυθαγόρας λέγεται πρὸς παῖδας ἀξιωθεὶς ποιήσασθαι λόγους διαθεῖναι πρὸς αὐτοὺς λόγους παιδικούς, καὶ πρὸς γυναῖκας γυναιξὶν ἁρμοδίους, καὶ πρὸς ἄρχοντας ἀρχοντικούς, καὶ πρὸς ἐφήβους ἐφηβικούς· τὸν γὰρ ἑκάστοις πρόσφορον τρόπον τῆς σοφίας ἐξευρίσκειν σοφίας ἐστίν* (fr. 51 = V A 187 SSR). This fragment is found in the scholia to the *Odyssey* (I,1), which make use of material from Porphyry's *Homeric Questions*. Earlier it was thought that the mention of Pythagoras belongs to Porphyry, not Antisthenes (e.g. L. Radermacher, *Artium scriptores* (Vienna, 1951), 121 f.), but this is now rejected both by the editors of Antisthenes (see commentaries to the respective fragments) and by the students of Pythagoreanism (de Vogel, 140; Burkert, 115 n. 38; Riedweg, *Pythagoras*, 27; Giangiulio, *Pitagora* i, test. 13). Cf. Zucconi, 'Tradizione', 493 f.

[82] The term 'charismatic' which Riedweg applies to Pythagoras quite fits his personality, but in no way signals the religious nature of his activity. M. Weber, *Wirtschaft und Gesellschaft* (Cologne, 1964), 348, 832, 846, who coined the term, emphasized that it was value-neutral (*wertfrei*) and related him to such figures as Solon and Pericles.

preacher? Antisthenes has nothing to say about the content of the speeches, yet, had they dealt only with political matters, it would have made no sense for Pythagoras to address women and children. It is much more probable that this report refers to Pythagoras' activity as a moral teacher, prescribing for different social groups the standard of behaviour appropriate to them.[83] There are two testimonies from the generation following Antisthenes which are connected to this aspect of Pythagoras' activity. Isocrates maintained that the fame of Pythagoras was so great that all young men wished to become his pupils (*Bus.* 29), and Plato that he was a 'guide in education' (*ἡγεμὼν παιδείας*) and founded a particular Pythagorean way of life (*Res.* 600a–b).

The anonymous treatise *Dissoi logoi*, the author of which probably belonged to the school of Protagoras,[84] mentions, not Pythagoras himself, but the Pythagoreans. The sixth chapter of the treatise discusses whether *σοφία καὶ ἀρετή* are teachable. The author's opponents assert: in those areas where it is possible to teach something, there are acknowledged tutors, as in music, for example. The author retorts that there are in this area too:

> What is it the sophists teach, if not wisdom and virtue? And what were the Anaxagoreans and Pythagoreans, (if not teachers of these)?[85]

It is suggestive that the author does not perceive any incompatibility between the Anaxagoreans and Pythagoreans. They appear together as typical examples of the philosophical schools whose objective was to achieve wisdom and virtue. The area of interest and activity of the Anaxagoreans is well known to us, and there is no reason to suppose that the Pythagoreans of the middle of the fifth century (both schools are referred to in the imperfect tense) were engaged in anything different in principle.

At the turn of the fifth and fourth centuries, the sophist Alcidamas, whom we have already mentioned, observed in his *Φυσικὸς* (*λόγος*):

> Zeno and Empedocles were at the same time pupils of Parmenides, then left him, and Zeno began to philosophize in his own manner, while

[83] The various obligations of the four age groups (children, adolescents, adults, and the aged) are discussed in the *Pythagorean Precepts* of Aristoxenus (fr. 35).

[84] On the authorship and the date (*c.*400) of this treatise, see T. M. Robinson, *Contrasting Arguments: An Edition of Dissoi Logoi* (New York, 1979), 34 f., 41 ff.

[85] *τί μὰν τοὶ σοφισταὶ διδάσκοντι ἄλλ' ἢ σοφίαν καὶ ἀρετάν; [ἢ] τί δὲ Ἀναξαγόρειοι καὶ Πυθαγόρειοι ἦεν;* (*DK* 90, 6).

> Empedocles went to listen to Anaxagoras and Pythagoras, emulating the latter in dignity of life and bearing and the former in his study of nature (D.L. VIII, 56 = 14 A 5).

This biographical structure presented by Alcidamas is implausible: Empedocles could not have listened to Pythagoras, nor was he directly a pupil of Anaxagoras. What is, however, important to us is something else. If, in Alcidamas' evidence referred to above, Pythagoras and Anaxagoras appeared in the company of other renowned sages, the subject of this text is now famous philosophers. A rhetorical contrast between the two last teachers of Empedocles made by Alcidamas does not necessarily mean that 'φυσιολογία comes from Anaxagoras, not from Pythagoras'.[86] It is hard to conceive that Pythagoras came to be among the heroes of a book on natural philosophy for the sole reason that he taught Empedocles the dignity of life and appearance. It was φυσιολογία which Theophrastus had in mind when he called Empedocles 'an admirer and associate of Parmenides and still more of the Pythagoreans'.[87] It is highly probable that Alcidamas too had something to say on this topic beyond the passage quoted by Diogenes Laertius.

The epideictic speech of Isocrates, *Busiris* (*c.*390), glorifying that legendary Egyptian king, contains the last mention of Pythagoras in the pre-Platonic period. The ironic tone of Isocrates makes it clear that he was not among the admirers of Pythagoras and the Pythagoreans:

> After Pythagoras of Samos went to Egypt and became their student, he was the first to bring all other philosophy (τήν τ' ἄλλην φιλοσοφίαν) to the Greeks and was more clearly interested than others in the sacrificial rites and in the temple rituals. He thought that even if he got nothing more from the gods through these things, among men at least they would make him especially famous. And this is what happened. He so exceeded others in fame that all the young desired to become his students, and older people were more pleased to see their children conversing with him than attending to their own affairs. We must believe this. Even now people admire those who claim to be his students

[86] Burkert, 215.

[87] 31 A 7 = fr. 227A FHSG. The brief mention of Pythagoras in *Περὶ φυσιολόγων* by the Socratic Aristippus of Cyrene (D.L. VIII, 21 = IV A 150 SSR) refers only to the etymology of his name.

> more even when they are silent than those men who have the greatest reputation for speaking.[88]

Behind the obviously invented screen of Pythagoras' journey to Egypt,[89] there can be discerned elements familiar from other evidence (Pythagoras' great fame, his religious activity, and the education of youth), but also something fresh: Pythagoras was the first to introduce philosophy to Greece. The *φιλοσοφία* of Isocrates, of course, is not the same as Plato or Aristotle understood the term to be. Its sense is often learning in general or, more specifically, rhetoric, which he himself studied. The *φιλοσοφία* of Pythagoras, however, which he acquired from the Egyptians, or, more specifically, from the Egyptian priests, was certainly not rhetoric (as is clear from the contrast made between the silent Pythagoreans and the renowned speakers; Isocrates either did not know or ignored the tradition of Pythagoras' speeches). Somewhat earlier (21–3) Isocrates describes the nature of the priests' studies: having through Busiris obtained the privilege of leisure (*σχολή*), they discovered for the body medicine and for the soul philosophy, which has the power to legislate and to investigate the nature of reality. Busiris assigned the elder to deal with the more important matters (i.e. laws), and directed the younger to study astronomy, arithmetic, and geometry. The passages which follow (25–7) are devoted to the astonishing piety of the Egyptians. Hence Pythagoras, who introduced to the Greeks the rest of philosophy (*τήν τ' ἄλλην φιλοσοφίαν* points to *φιλοσοφία* in 22–3) and especially cared about piety (28–9), comes to be the bearer both of a scientific and philosophical and of a religious tradition acquired by him from the Egyptians.

Isocrates did not intend his speech to be taken seriously and therefore attributed various elements of Greek culture to the Egyptians with even greater freedom than his predecessor in the field, Herodotus. The Spartans come to be indebted to the Egyptians for their laws, their *syssitia,* and their physical exercises (19–20), Pythagoras for his philosophy, his mathematics, and even his piety. Leaving aside Egypt for a time, let us note that Isocrates records the combination of astronomy, arithmetic, and geometry (only harmonics are

[88] *Bus.* 28–9, tr. Mirhady, modified.

[89] For an analysis of the tradition linking Pythagoras with Egypt, including *Busiris,* see below, §2.3.

missing) which characterizes the Pythagorean school and may stem originally from the work of Pythagoras himself (below, §7.4). The testimony of Isocrates refutes the argument that pre-Platonic tradition did not know Pythagoras as a philosopher and mathematician. *Busiris* is independent of the Academic interpretation of Pythagoreanism.[90] It is, of course, possible to take Isocrates' words as a retrospective projection: knowing the scientific and philosophical studies of the Pythagoreans, he could ascribe them to the school's founder and through him to the Egyptian priests. Given, however, the testimonies quoted above, this interpretation is quite implausible. The criticism of Xenophanes and Heraclitus, the praise of Empedocles, Ion, and Democritus, and the evidence of Alcidamas and *Dissoi logoi* prove that Pythagoras had become an integral part of early Greek philosophy long before Isocrates. What is new in Isocrates is the reference to the three mathematical sciences, but that in no way contradicts Pythagoras' ἱστορία and πολυμαθία, known since the time of Heraclitus. Isocrates treated with scepticism both the Pythagoreans and mathematics[91] and had no grounds to embellish the traditional image of Pythagoras.

1.3 PYTHAGORAS BEFORE AND AFTER PLATO

So, references to Pythagoras by the authors of the pre-Platonic period do not confirm the idea that only in the Academy did he turn from a mystagogue and wonder-worker into a philosopher and scientist. The

[90] Among the possible sources of *Busiris* an early version of Plato's *Republic* written in the mid-70s was suggested; recently Ch. Eucken, *Isokrates* (Berlin, 1983), 172 ff., 183 ff., has been prominent in supporting this idea; see also N. Livingstone, *A Commentary on Isocrates' Busiris* (Leiden, 2001), 40 f., 44 ff. This suggestion does not seem convincing, for in this case we need to change the traditional dating of *Busiris* from 390/385 to the mid-70s and to postulate its dependence on an earlier version of the *Republic*, of which, as it is, we know nothing. For criticism of this hypothesis, see A. Diès (ed.), *Platon: La République* (Paris, 1947), p. cxxiv. Latterly, the idea of a *proto-Republic*, once defended by H. Thesleff, *Studies in Platonic Chronology* (Helsinki, 1982), 101 ff., does not seem to be popular among the specialists: G. R. Ledger, *Re-counting Plato: A Computer Analysis of Plato's Style* (Oxford, 1989); L. Brandwood, *The Chronology of Plato's Dialogues* (Cambridge, 1990).

[91] It is in *Busiris* that he disputes the importance of mathematical education, advanced by Archytas (Zhmud, *Origin*, 71 ff.).

dominant image of the early tradition is of Pythagoras as σοφός or σοφιστής, the possessor of outstanding intellectual qualities and extensive knowledge, a person famous both for his religious teaching and for ἱστορία and φιλοσοφία.[92] The teachings of Pythagoras and his social activity, in particular as a mentor of youth, induced some to ridicule him or accuse him of charlatanry and others to praise his multifaceted talent. The range and abundance of responses show Pythagoras to have been one of the best-known figures in the intellectual circles of the fifth and the beginning of the fourth century. Most of our evidence derives from those who were creating the philosophy and science of the time. It is they who record their admiration of Pythagoras' wisdom, polemicize with his views, write books about him, ridicule what he preaches, and learn from his pupils. When all this is taken together, it prevents us from numbering him among the wonder-workers and *theologoi* akin to Epimenides, Aristeas, and Pherecydes, none of whom achieved fame of that kind. The legendary tradition of his wonders and supernatural qualities figures highly obliquely in our sources (Herodotus; to some degree Empedocles).

The evidence of the early tradition has much to say about the *presence* of the rational, the philosophical, and the scientific in Pythagoras' activity, yet reveals little in the way of specific detail. Metempsychosis is the only doctrine of Pythagoras which is firmly attested. Apart from Isocrates, there is in the tradition no indication of which sciences he engaged in, nor indeed what results he achieved. Information of this kind is found only in fourth-century sources, together with data on the political activity of Pythagoras and the Pythagoreans. Its appearance, however, as has been noted, does not mean that the image of Pythagoras became artificially rationalized and politicized. On the contrary, Pythagoras in the fourth century appears immeasurably more often in an environment of the legendary and the supernatural than in the early evidence. Let us moreover note that, as a rule, early Pythagoras legends relate the supernatural and hence the impossible, while later inventions incline towards pseudo-historicity. Pythagoras showing his golden thigh, biting to death a poisonous snake, or making simultaneous appearances in two cities, is the typical hero of

[92] Since the early tradition in this chapter has been considered from a particular point of view, a number of aspects have been touched on only fleetingly. For detailed discussion of Pythagorean religion, see below, Chs. 5–6.

the early legends reported, for example, by Aristotle (fr. 191). Pythagoras the Syrian from Tyre, who travels to India or instructs his pupils to hold property in common – this figure, in which the legendary becomes history (and vice versa), comes into fashion among the historians and biographers of the end of the fourth century[93] and remains so until the end of Antiquity.

That a fourth-century author could be close to Pythagorean circles did not at all imply that he would prefer a more rationalistic image of Pythagoras. Eudoxus, who studied mathematics under Archytas (D.L. VIII, 86), gives information of a legendary nature about Pythagoras.[94] Heraclides, who also 'heard Pythagoreans' (fr. 3), linked the origin of the word *φιλόσοφος* to Pythagoras, yet repeated old and invented new legends about his reincarnations, placing him and Empedocles among such wonder-workers as Abaris, Aristeas, and Hermotimus.[95] One of Xenocrates' fragments ascribes to Pythagoras the discovery of the numerical structure of concords, another his descent from Apollo (fr. 87, 221).

If, from the fifth century, fragmentary and largely random comments have come down to us, from the early fourth century there begin to appear special works on Pythagoras and the Pythagoreans, some of them dealing with their philosophical and scientific legacy. The number of such works constantly increases and the subject matter broadens, especially with the emergence of new genres of historiography. It is this which provides an abundance of the most varied information on Pythagoras, both authentic and fictitious. Hence we observe in the fourth century, not a radical shift in the tradition of Pythagoras, but its natural evolution, retaining its continuity with fifth-century sources, many of which (it must be emphasized) remain inaccessible to us. The revolution in the Pythagoras tradition postulated by the hypercritics could not have happened

[93] Neanthes (*FGrHist* 84 F 29), Onesicritus (*FGrHist* 134 F 17), Timaeus (*FGrHist* 566 F 13).

[94] Porph. *VP* 7 (not only did he abstain from meat, he did not go near cooks and hunters); Iamb. *VP* 6–7 (Pythagoras' descent from Apollo) = Eudox. fr. 324–5.

[95] See fr. 40–1 (cf. 44), *Abaris* (fr. 73–5, cf. 90), *On the Woman who Stopped Breathing* (fr. 87–9). Numerous misunderstandings were connected with the dialogues of Heraclides: fictitious speeches and situations in the life of their heroes were taken seriously. See P. Corssen, 'Der Abaris des Heraklides Ponticus', *RhM* 67 (1912), 20–57; Lévy, 22 ff.; P. Boyancé, 'Sur l'Abaris d'Héraclide le Pontique', *REA* 36 (1934), 321–52; J. Bolton, *Aristeas of Proconnesus* (Oxford, 1962), 151 ff.; Burkert, 103 n. 32; H. B. Gottschalk, *Heraclides of Pontus* (Oxford, 1980), 15 ff., 112 ff.

without another revolution implied by them: the transformation of a secret religious sect into a scientific and philosophical school, of the Pythagorean 'myth' into the Pythagorean 'logos'. Neither of these speculative constructions withstands close scrutiny. In fact, it is more difficult to explain why Hippasus, the pupil of the hierophant and mystagogue Pythagoras, made a sudden decision to study natural philosophy, geometry, arithmetic, and harmonics, and to carry out experiments in acoustics, while all the other Pythagoreans known to us followed him, but not the Teacher himself, than to explain what might have caused the Academics to set about constructing a totally new image of Pythagoras.

Yet to explain this last trend is not easy either. Despite the incontestable influence of Pythagorean thought on Plato, we encounter Pythagoras in his works once only (*Res.* 600a–b), and once the Pythagoreans as a whole (530d), apart from mentions of Philolaus and his pupils in *Phaedo*, of Theodorus (in several dialogues), and of Archytas in the *Seventh Letter*. Plato's passage on Pythagoras does not differ in principle from the evidence of the early tradition. Is Homer reported, asks Socrates,

> while he lived to have been a guide in education to men who took pleasure in associating with him and transmitted to posterity a certain Homeric way of life just as Pythagoras was himself especially honoured for this, and his successors, even to this day, denominating a certain way of life the Pythagorean, are distinguished among their contemporaries? (tr. Shorey)

A mentor of youth, beloved of his pupils and followers, the founder of a particular (and, evidently, highly worthy) way of life: there is no hint here either of natural philosophy and mathematics, or of political engagement. Plato's Pythagoras teaches his pupils privately (ἰδίᾳ), not making speeches before children, young men, and archons, as Antisthenes recounted. To suppose this is all Plato knew about Pythagoras is as rash as to suppose that he knew nothing of Democritus or Xenophon, whom he does not once mention. What is the explanation for this selective silence with respect, by the way, not only to Pythagoras, but to Philolaus, Archytas, and the Pythagoreans as a whole? Is compensation to be found in the allusions to Pythagorean teachings scattered through the Platonic dialogues,[96] or in his

[96] See Burkert, 83 ff.; Kahn, 49 ff.

Timaeus, in which the ancient tradition perceived a 'Pythagorean' dialogue?[97] Are we dealing with a peculiarity of Plato's philosophical and artistic method, a method which permits him to make selective use of the ideas of the Presocratics, refracting them through the prism of his teaching and taking no particular care to present them in their actual historical perspective or to signal his dependence on them? Whatever may be the answer to these questions, there are clearly no *direct* traces of the new image of Pythagoras in Plato's written legacy.

There existed also, however, the oral teaching of Plato, ἄγραφα δόγματα, containing his later number metaphysics. According to Frank and Burkert, Plato's pupils regarded the Pythagoreans as predecessors of his mathematized philosophy.[98] I believe that this thesis can be definitely proved only in relation to one of Plato's students, namely Aristotle (below, §§12.1–2). However it may be, the Platonists' interpretations of Pythagorean philosophy and mathematics certainly were not unbiased and some of them were quite tendentious. What, however, is the basis of the hypothesis that Xenocrates, Speusippus, and Heraclides, for the sake of this interpretation, had to transform Pythagoras from a mystagogue into a philosopher and scientist? Certainly, the Academics took a selective and creative approach to the tradition on Pythagoras, but we have no evidence that they altered it radically, whereas Aristotle and the Peripatetics resisted this tendency, consistently making a distinction between the scientific Pythagoreans and the unscientific Pythagoras.[99]

Pythagoras is not mentioned in Speusippus' fragments. Heraclides ascribed to him a doctrine that happiness (εὐδαιμονία) is knowledge of the perfection of numbers.[100] The Platonism of the story told by Heraclides according to which Pythagoras coined the word φιλόσοφος – something Burkert insisted on – was very convincingly disputed by Riedweg, who took this tradition back to the time of Pythagoras himself.[101] The only account by the Academics of

[97] In *On Pythagorean Numbers* (fr. 28) Speusippus dealt with the five regular solids described in the *Timaeus* (fr. 28). A renowned student of Plato regarded the *Timaeus* as a Pythagorean dialogue: A. E. Taylor, *A Commentary on Plato's Timaeus* (Oxford, 1928).

[98] Frank, 239 ff.; Burkert, 53 ff.; see also Kahn, 58 ff.; J. Dillon, *The Heirs of Plato* (Oxford, 2003).

[99] As Burkert, 28 ff., 80 f., 412, 449 f., asserts.

[100] Fr. 44. See below, 430 f.

[101] See above, 18 n. 46 and below, 428 f.

Pythagoras' science is Xenocrates' fragment on his discovery of the numerical structure of musical harmony (fr. 87).[102] Like many other Academics, including Aristotle, Xenocrates wrote a book on the Pythagoreans (not on Pythagoras!), but this is not enough to consider him one of the founders of Pythagorizing Platonism.[103] Are there in the *testimonia* of the Academics signs of an image of Pythagoras which is new in principle? Against the background of the Platonic Socrates, the Academics' tendency to interpret the Pythagoreans in the spirit of their own philosophy is quite natural. This approach, characteristic of both Plato and Aristotle, though in different degrees, presupposes that a person to whom philosophical theories were ascribed was accounted a philosopher. It is true that other cases are known: Orpheus and Homer were turned into philosophers by virtue of an allegorical interpretation of poetic texts.[104] Pythagoras, however, left no such texts, whereas pre-Platonic tradition shows that, from the early fifth century, philosophers regarded him as a person from their own circle (as distinct from Orpheus and Homer). The Academics added new features to the traditional image of Pythagoras, but it was neither possible nor necessary for them to transform the 'shaman' into an outstanding thinker.

It can be asserted that Aristotle and the Peripatetics knew nothing about Pythagoras as a philosopher only once the traditions of the Lyceum are thoroughly purged of everything which testifies to the contrary.[105] Anyone, however, prepared to concur with this thesis cannot pass by the obvious fact that Aristotle and his pupils perceived in the Pythagoreans the precursors of the mathematically tinted philosophy of the later Plato.[106] If for this they had no need of

[102] See below, 258 f., 291 f.

[103] Aëtius attributes to Pythagoras the well-known teaching of Xenocrates about the soul as a 'self-moving number': *ὁ δέ γε Πυθαγόρας ἀριθμὸν ἑαυτὸν κινοῦντα* (sc. *ψυχὴν εἶναι)· ξυνεφώνησε δὲ τῷ λόγῳ καὶ Ξενοκράτης* (IV, 2.3–4, from Theodoretus = Xenocr. fr. 170, cf. fr. 169, 190–1). It is clear that this attribution belongs to the late Hellenistic doxography (in Theophrastus, Xenocrates is not mentioned at all), when everything connected with number was ascribed to Pythagoras, and not to Xenocrates himself, *pace* Burkert, 64 f., correctly Zeller, i. 553 f. See below, 258 f., 426.

[104] F. Buffière, *Les Mythes d'Homère et la pensée grecque* (Paris, 1956); G. Betegh, *The Derveni Papyrus: Cosmology, Theology and Interpretation* (Cambridge, 2004).

[105] See above, 54 n. 99.

[106] *Met.* 987a31. b10. b22, 990a30, 996a6, 1001a9, 1053b12, 1078b9 f.; *Phys.* 203a6; Theophr. *Met.* 11a27–b10; Eud. fr. 60; Dic. fr. 41. Aristotle's overview of Plato's famous lecture *On the Good* mentioned also the teachings of the Pythagoreans (test. and fr. 2 Ross = fr. 87 Gigon). See below, 440 f.

Pythagoras as a philosopher and mathematician, then was he so necessary to the Platonists? In reality a comparison of the traditions of the two schools demonstrates that the Peripatetics record Pythagoras as a philosopher and scientist more frequently than the Academics. Eudemus wrote of Pythagoras' significant contribution to geometry (fr. 133) and Aristoxenus of his astronomy (fr. 24), arithmetic, and number symbolism (fr. 23). Dicaearchus reviewed him in his biographies of the philosophers (fr. 33–6, 41), along with Socrates and Plato. Although in the surviving treatises of Aristotle Pythagoras appears almost as infrequently as he does in Plato,[107] fragments of his lost works contain mentions of Pythagoras' mathematical (fr. 191) and philosophical research. In a fragment of the *Protrepticus* we read:

> For which among existing objects of thinking has God brought us into being? Pythagoras, when asked about this, answered: 'To observe the heavens', and used to say he was an observer of nature (θεωρὸν τῆς φύσεως), and it was for this he had come into being'.[108]

A similar idea, close to Aristotle's own ideal of βίος θεωρητικός, is attributed to Anaxagoras as well (*Protr.* fr. 19). Even if these sayings belong to neither of them, it is revealing that Aristotle singles out among the Presocratics those figures who were frequently placed together in the early tradition.[109] We can see that Aristotle, like Heraclides, was inclined to project onto Pythagoras his own theories (at least during his Academic period),[110] from which it does not follow that Pythagoras had no theories of his own.

Aristotle's attitude to Pythagoras and the Pythagoreans is a complex problem requiring special investigation (below, §12.2). It is sufficient to note here that, in his surviving treatises, *οἱ Πυθαγόρειοι* appear very frequently, individual Pythagoreans much less frequently, and Pythagoras even less frequently. This tendency has no connection with the presence or absence of works from which he

[107] *Met.* 986a30; *MM* 1182a12; *Rhet.* 1398b14.

[108] Fr. 18, tr. Düring. See also fr. 20: 'According to this argument, then, Pythagoras was right in saying that every man has been created by God in order to acquire knowledge and observe' (ἐπὶ τὸ γνῶναί τε καὶ θεωρῆσαι). Cf. πολυμαθίη and ἱστορίη in Heraclitus (above, 33). Burkert's objections concerning the authenticity of fr. 18 and 20 ('Platon oder Pythagoras', 166 f.) are not supported by any of the publishers or translators of the *Protrepticus* known to me.

[109] See above, 43 f., 47. In *Rhet.* 1398b9–14 Aristotle cites one of these testimonies.

[110] See below, 429 f.

could obtain reliable information about the teaching of a specific Pythagorean. Hippasus, who evidently left no work of natural philosophy, is mentioned by Aristotle once (*Met.* 984a7), as is Philolaus (*EE* 1225a30), whose book he certainly made use of without once connecting its philosophical and scientific theories with the author's name. However we may interpret the peculiarity of Aristotle's approach to the Pythagorean school, there is no reason to suppose that he placed Pythagoras himself outside it. In the *Metaphysics* (986a30) Pythagoras is mentioned in connection with Pythagorean philosophy. In the monograph *On the Pythagoreans* (fr. 191–6) Aristotle records the legendary tradition of both Pythagoras and the Pythagoreans. The only surviving fragment of his *On Archytas' Philosophy* (fr. 207) has a reference to Pythagoras' philosophical theory, which is suspiciously similar to Plato's.

It would appear that Aristotle's two monographs on the Pythagoreans,[111] the material of which he used later, were written in the Academy: he refers to them in the *Metaphysics* A (986a12), usually dated before 347. In general, the overwhelming majority of all Aristotle's references to *Πυθαγόρειοι* are contained in the *Physics*, *On the Heavens*, and those parts of the *Metaphysics* (A, B, I, Λ, M, N) which are taken to belong to his early works.[112] In the later treatises such references are sporadic and, with few exceptions, free from polemics. If to these are added the *Protrepticus*, the early dialogue *On Poets* (fr. 75), and the treatise *On the Good*, which reviews the theories of Plato and the Pythagoreans,[113] it turns out that almost all that Aristotle had to say about Pythagoras and the Pythagoreans in general was said during his stay at the Academy.[114] Evidently the theories of the

[111] See above, 12 n. 28.

[112] I. Düring, *Aristoteles* (Heidelberg, 1966), 49 ff. All three references to Pythagoras (above, 56 n. 107) relate to this period too.

[113] See above, 55 n. 106. On the mention of Pythagoras in the dialogue *On Poets* see below, 62.

[114] Let us give (in accordance with Düring's chronology) the statistics of mentions of Pythagoras and the Pythagoreans: 1) Academic period: *APost* – 1, *Phys.* – 5, *Cael.* – 8, *Met.* – 21, *Rhet.* – 1, *MM* – 2 (total 38); *Protr.*, *De bono,* and *De poet.* and three special works *De Archyt.*, *De pythagor.*, and *Contra pythagor.* also relate to this period; 2) period of travel: *De an.* – 2, *De sensu* – 2, *Mete.* – 2 (total 6); 3) second stay in Athens: *EN* – 3. If in *Cael.* a whole chapter (II, 9) is devoted to the theory of heavenly harmony, the much briefer references in the texts of the middle period are of a purely doxographic nature; criticism of the Pythagoreans disappears along with the Pythagorean number doctrine. In *EN*, where the table of opposites reappears, Aristotle twice

Platonists were the background upon which he formulated his own approach to the Pythagorean school. From this standpoint, the early dating of the *Magna Moralia*, supported by the detailed analysis of Dirlmeier and accepted by Düring, is entirely logical.[115] Aristotle's customary short overview of ethical doctrines with which he opens it begins thus:

> Now Pythagoras was the first to speak of virtue, but his method is erroneous. In referring virtue to numerical relations, he considered it from an inappropriate view point. Justice, for example, is not 'the product of two equal numbers'.[116]

Unusually for him, Aristotle here is speaking, not about the Pythagoreans,[117] but about the founder of the school himself, thus recognizing 'the Pythagoras of his colleagues'.[118] If, however, Pythagoras vanishes from his writings after his leaving the Academy, this does not mean that Aristotle had developed a more cautious or more correct approach to him; *Πυθαγόρειοι* quite rapidly come to naught together with Pythagoras.

Burkert postulates that a choice must be made between the Platonic and the Aristotelian traditions, 'for only one of them can be historically correct'[119] but this is another contrived alternative ('either ... or') which cannot be accepted. Neither of these traditions is entirely correct nor entirely unreliable. Each piece of evidence from each author must be assessed individually and according to its value. Within the framework of the Lyceum, Aristoxenus, Dicaearchus, and Eudemus proposed interpretations of the figure of Pythagoras which differ one from another, not one of them implying that Aristotle knew nothing of his work in philosophy, science, or politics. It is far more natural to connect the abundance of late fourth-century accounts of Pythagoras as a mathematician with the Peripatetic and the preceding traditions than with the Academics. 'The primogenitor of number philosophy' was in no way bound to study geometry, still

praises the Pythagoreans (1096b5, 1106b30), and takes issue with them only once (1132b22).

115 F. Dirlmeier, *Aristoteles: Magna Moralia*, 2nd edn. (Berlin, 1983); Düring, *Aristoteles*, 438 ff.

116 1182a12 f., tr. Armstrong. See Dirlmeier, *Aristoteles*, 159 f.

117 Cf. *Met.* 985b23, 1078b21, 1093b13; *EN* 1132b21, etc.

118 Burkert, 79 f., 81.

119 Ibid., 81.

less to be the author of discoveries in that field. It is revealing that the wide range of pseudo-Pythagorean literature based on Academic doctrines deals endlessly with the Number, but has nothing to say about any scientific discoveries by Pythagoras; the authors of these treatises were not interested in such things.

Fortunately many others were interested. Diogenes Laertius reports the words of a certain Apollodorus the arithmetician that Pythagoras proved the theorem that the square on the hypotenuse is equal to the sum of the squares on the sides adjacent to the right angle (VIII, 12; cf. I, 25). According to a convincing surmise, this writer can be identified with the Democritean Apollodorus of Cyzicus (second half of the fourth century), the one who wrote of Democritus' acquaintance with Philolaus (74 A 2).[120] Does it make sense to connect this account with the Academic tradition? It is much more natural to perceive here the interest of Democritus' school in mathematics (cf. 77 A 1), including Pythagorean mathematics. Another Democritean, the philosopher and historian Hecataeus of Abdera (*c.*360–290), wrote that Pythagoras took from the Egyptians geometrical theorems, arithmetic, and the doctrine of metempsychosis.[121] The historian Anticleides, a contemporary of Hecataeus, affirmed that Pythagoras had brought geometry to perfection after the Egyptian Moeris had first discovered its basic elements.[122] According to Neanthes, Pythagoras had mastered all the sciences of the Chaldeans (*FGrHist* 84 F 29), the most important of which was considered to be

[120] F. Susemihl, *Geschichte der griechischen Litteratur in der Alexandrinerzeit*, ii (Leipzig, 1892), 338; H. von Arnim, 'Apollodoros' (no. 68), *RE* 1 (1894), 2895; Burkert, 428. Callimachus, who was librarian at the Museum of Alexandria, writes of Pythagoras' study of triangles and his discovery of a certain 'figure' (fr. 191, 58–62 Pfeiffer); this is usually taken as an echo of the tradition on the famous theorem. See Heath, i. 142; M. di Marco, 'Un problema di geometria nel *Giambo* I di Calimaco (fr. 191, 59ss Pf.)', *RCCM* 40 (1998), 95–107. Cf. J. Radicke, 'Apollodorus', *FGrHist* 1097.

[121] *Πυθαγόραν τε τὰ κατὰ τὸν ἱερὸν λόγον καὶ τὰ κατὰ γεωμετρίαν θεωρήματα καὶ τὰ περὶ τοὺς ἀριθμούς, ἔτι δὲ τὴν εἰς πᾶν ζῷον τῆς ψυχῆς μεταβολὴν μαθεῖν παρ' Αἰγυπτίων* (*FGrHist* 264 F 25.98). Democritus, Oenopides, and Eudoxus figure further in the same context. The influence of Herodotus (II, 81, 123) and Isocrates (*Bus.* 21–3, 28–9) can more readily be seen in Hecataeus' words than that of the Academy.

[122] *τοῦτον καὶ γεωμετρίαν ἐπὶ πέρας ἀγαγεῖν, Μοίριδος πρῶτον εὑρόντος τὰς ἀρχὰς τῶν στοιχείων αὐτῆς* (D.L. VIII, 11 = *FGrHist* 140 F 1, cf. Diod. I,52.6). If the next sentence in Diogenes Laertius, *μάλιστα δὲ σχολάσαι τὸν Πυθαγόραν περὶ τὸ ἀριθμητικὸν εἶδος αὐτῆς*, also derives from Anticleides (thus e.g. Knorr, 162 n. 12), a parallel can be seen here with Hecataeus' report.

astronomy.[123] By the turn of the fourth–third centuries, the view that Pythagoras had had great success in geometry and astronomy was so widespread that it is recorded by the learned poet Hermesianax of Colophon.[124]

Thus, in the course of the fourth century, studies in mathematics, particularly geometry and arithmetic, became a constant element of the tradition of Pythagoras; astronomy and harmonics are less frequently mentioned. Mathematics did not displace metempsychosis and wonders, nor did the tradition of Pythagoras the politician which emerged concurrently with it, yet they did edge them aside, completing the ambivalent, contradictory image of Pythagoras[125] which was retained by his Neoplatonic biographers and passed from them into modern scholarship. The temptation to 'straighten out' that image by pruning one of its constituent parts is enormous. It is this largely which feeds the debate whether Pythagoras' mathematics are a concretization of early evidence of his *σοφία*, *ἱστορία* and *πολυμαθία* based on reliable sources unavailable to us, or an invention designed to emphasize his closeness to scientific Pythagoreans. That question will be examined in detail as we analyse early Pythagorean science (below, Chs. 7–9). In the meantime we can state definitively: Pythagoras the mathematician is as little a product of the Academy as Pythagoras the philosopher.[126]

[123] Timaeus seems also to have mentioned Babylonian astronomy (Iust. XX,4.3; Strab. XIV,1,16); von Fritz. *Pol.*, 43, 53 f.

[124] *Οἵη μὲν Σάμιον μανίη κατέδησε Θεανοῦς / Πυθαγόρην, ἑλίκων κομψὰ γεωμετρίης / εὑρόμενον, καὶ κύκλον ὅσον περιβάλλεται αἰθὴρ / βαιῇ ἐνὶ σφαίρῃ πάντ' ἀποπλασσάμενον* (fr. 7.85 f. Powell).

[125] See Arist. fr. 191 (above, 20).

[126] Frank, who put forward this thesis, later rejected it; see E. Frank, *Wissen, Wollen, Glauben* (Zurich, 1955), 81 f.: 'Die Mathematik als exakte Wissenschaft ist in der Schule des Pythagoras entstanden . . . Mehr noch, die Pythagoreer haben die Grundlagen der wissenschaftlichen Astronomie und der Physik gelegt . . . Wir können natürlich nicht mehr feststellen, welchen Anteil Pythagoras selbst an diesen Errungenschaften hatte . . . , es unterliegt aber keinem Zweifel, daß er diese ganze wissenschaftliche Entwicklung in Gang gebracht hat. Er war eher ein rationaler Denker als ein beseelter Mystiker.'

2

Biography: Sources, Facts, and Legends

One of the epithets most frequently applied to Pythagoras in the majority of popular books, as well as many scholarly works, is 'legendary' or 'semi-legendary'. In the tradition on Pythagoras it is true that from the very beginning facts have been interwoven with fantastic invention, but it is not too difficult to separate the two. Extracting the real events in his life from information which appears to be quite plausible is much more difficult. This is where we encounter the greatest number of controversies, though these occur, of course, in the biographies of any of the Presocratics, and Pythagoras is no exception. Moreover, we have far more reliable information about his life than about any other philosopher of the sixth century, be it Thales, Anaximander, Anaximenes, or Xenophanes. The reason is evident: Pythagoras was spoken of and written about much more often. His great fame had the twin effects of making his name the focus of legends, which multiplied over the centuries, and of preserving the memory of the historical events of his time.

2.1 MAIN SOURCES

From fragmentary and often casual references by early authors we learn only the place of Pythagoras' birth and the name of his father (Heracl. B 129; Hdt. IV, 95). Some details of his work as an educator are communicated by Antisthenes (fr. 51), Isocrates (*Bus.* 28), and Plato (*Res.* 600a–b); Alcidamas asserts that he was a teacher of Empedocles (D.L. VIII, 56). No biographical information on Pythagoras has reached us from the Platonists; from Heraclides' historical work *On the Pythagoreans* we learn only that he introduced a meat diet for athletes (fr. 40). Fragments of Aristotle, on the other hand, contain some important details, in addition to legends of various kinds. The juxtaposition of the names of Pherecydes and Pythagoras in fr. 191 and especially the tale of their meeting on Samos (fr. 611.32)[1] reflect the story – popular by this time – of a personal connection between them. Fr. 191 further reports that 'Pythagoras foretold to the Pythagoreans the coming political strife (στάσις); that is why he departed to Metapontum unobserved by anyone'. From a reference to 'Alcmaeon being (young) at the time when Pythagoras was old',[2] it follows that Aristotle's view of Pythagoras' chronology was correct. The fragment of Aristotle's dialogue *On Poets*, in which two of Pythagoras' political opponents appear among other competing figures, turns out to be unexpectedly valuable; the two are the famous Cylon, the inspiration behind the anti-Pythagorean revolt in Croton, and Onatas,[3] whose name appears in the list of Crotonian Pythagoreans drawn up by Aristoxenus (below, §3.2). It is most likely that Aristotle mentioned Cylon in his *On the Pythagoreans* as well.

Theopompus, Andron of Ephesus, and Duris of Samos, the historians of the second half of the fourth century, are of limited value in reconstructing the biography of Pythagoras. As a rule they give us inventions, whether their own or those of others. Theopompus (born *c.*380–375) appears to be the first to report the Tyrrhenian (Etruscan) origins of Pythagoras, and to say that his philosophy was really a cover for his strivings towards tyranny.[4] Andron, probably a younger contemporary of Theopompus, in his *Tripod*, calls Pythagoras a pupil of Pherecydes and relates stories of his miraculous prophecies just like

[1] From excerpts from the *Constitution of Samos*; see Lévy, 3; M. Hose (transl.), *Aristoteles: Die historischen Fragmente* (Berlin, 2002), 259.

[2] *Met.* 986a29–30; see below, 123.

[3] D.L. II. 46: *Κύλων καὶ Ὀνάτας* (*Κύλων Κροτωνιάτης* is Menagius' conjecture, accepted by Rose, see Arist. fr. 75) = *DK* I, 103.12 = fr. 21.1 Gigon.

[4] *FGrHist* 115 F 72 (cf. F 204 on the Etruscans). Athenaeus, V, 213 f.: 'In a few days that philosopher [Athenion, the first-century Peripatetic] became a tyrant, thus displaying in practice the Pythagorean teaching about conspiracy and the true purpose of the philosophy introduced by the "noble" Pythagoras, as recorded by Theopompus in the eighth book of his *History of Philip* and by Hermippus, the pupil of Callimachus' (*FGrHist* 115 F 73 = Hermipp. fr. 21 = *FGrHist* 1026 F 27 (my addition in square brackets)). See Burkert, 118 f.; Wehrli, *Hermippos*, comm. on fr. 21; J. Bollansée, *Hermippos of Smyrna and His Biographical Writings: A Reappraisal* (Leuven, 1997), 79 f.; id., comm. on *FGrHist* 1026 F 27. Cf. below, 82 n. 91; 100.

those which Theopompus linked with Pherecydes;[5] Pythagoras' predictions include the fall of Sybaris.[6] One fragment of Duris (born *c*.340) contains an epigram (supposedly from the grave of Pherecydes) which calls Pythagoras the first Greek sage, while another contains a legend about a statue erected on Samos by Arimnestus, the son of Pythagoras and mentor of Democritus (*FGrHist* 76 F 22–3). Hecataeus of Abdera and Anticleides tell only of Pythagoras's journey to Egypt,[7] which is first mentioned by Isocrates.

If this were all that the fourth-century sources had to tell us, even the general outlines of Pythagoras' life would be difficult to discern beneath the legends. However, the situation was radically altered by the rise in the Lyceum of the genre of biography, which lent a powerful stimulus to the systematization of the tradition on Pythagoras. By a lucky chance, one of the progenitors of biography, the famous musicologist Aristoxenus of Tarentum (*c*.370–*c*.300), was closely linked with the Pythagoreans of Archytas' circle through his father Spintharus.[8] In addition, he was acquainted with the pupils of Philolaus and Eurytus, and counted them among the last Pythagoreans: Echecrates, Phanton, Diocles, and Polymnastus of Phlius, as well as Xenophilus of Chalcidice in Thrace, who died in Athens at the age of 105 (fr. 18–20).[9] Most likely Aristoxenus lived at or visited Phlius on the Peloponnese before he went to Athens, where he studied first

[5] *FGrHist* 1005 F 3–4. Cf. Theopompus on Pherecydes (*FGrHist* 115 F 70). Porphyry accused Theopompus of plagiarizing from the work of Andron but most scholars regard Theopompus' version as the primary one: P. Corssen, 'Die Sprengung des pythagoreischen Bundes', *Philologus* 71 (1912), 333 f.; id., 'Abaris', 33 f.; Lévy, 19 n. 2; E. Stemplinger, *Das Plagiat in der griechischen Literatur* (Berlin, 1919), 49; Rathmann, *Quaestiones*, 28; K. Ziegler, 'Plagiat', *RE* 20 (1950), 1981; P. Pédech, *Trois historiens méconnus: Théopompe, Duris, Phylarque* (Paris, 1989), 176; G. S. Shrimpton, *Theopompus the Historian* (Montreal, 1991), 17 f. Cf. Burkert, 144 f. Attempts to date Andron before Theopompus (Bollansée, comm. on *FGrHist* 1005 F 3; Giangiulio, *Pitagora*, i, test. 24–5, 28–9) appear to be unjustified. Even those who supposed that the two historians were independent of each other (Stemplinger, Ziegler) recognized Theopompus' version as the older one. Andron postulated two different Pherecydes, a theologian and an astronomer (*FGrHist* 1005 F 3), but the term *θεολόγος* is not attested before Aristotle (cf. *θεολογία* Pl. *Res.* 379a).

[6] In Herodotus (V, 44) the fall of Sybaris is foretold by the soothsayer Callias; see Lévy, 19 n. 2, 58 n. 1.

[7] See above, 59.

[8] Aristoxenus referred to Spintharus in *On the Pythagorean Life* and his biography of Socrates (fr. 30, 54a).

[9] Diodorus (XV,76) dates the 'last of the Pythagoreans' Ol. 103,3 (366/5). This date may have been deduced by Apollodorus, relying on Aristoxenus. See below, 72 n. 47.

under Xenophilus, then under Aristotle. Having to hand fuller and more reliable information than other writers of his day (including documentary evidence), he devoted three biographical works to Pythagoras and the Pythagoreans – all of them blatantly apologetic – and set forth their ethical and political doctrines in the *Pythagorean Precepts*.[10] Aristoxenus is a colourful and rather contradictory figure, who in his vast and varied writing brought together the traditions of several schools without being truly committed to any of them. Determined to keep his distance from all authorities, he allied himself with Aristotle against the Pythagoreans[11] and with the Pythagoreans against Aristotle.[12] Speaking against Plato and the Academy,[13] he nevertheless attributed the Academic doctrines to the Pythagoreans.[14] This reflected a tendency, which is most clearly discernible in Aristotle, to see the Pythagoreans as the philosophical forebears of Plato (below, §§12.1–2).

Aristoxenus strove to present Pythagoras and the Pythagoreans in the most favourable possible light, often in defiance of established models, including those that appear in Aristotle's *On the Pythagoreans*. His rationalistic treatment of Pythagoreanism rested on his acquaintance with the last Pythagoreans, and on the whole it faithfully reflected the realia of the late fifth and early fourth centuries. Does this treatment detract from his reports on Pythagoras and the first Pythagoreans? In Aristoxenus' account of the political struggle in

[10] *Περὶ Πυθαγόρου καὶ τῶν γνωρίμων αὐτοῦ* (fr. 11–25), *Περὶ τοῦ Πυθαγορικοῦ βίου* (fr. 26–32), *Πυθαγορικαὶ ἀποφάσεις* (fr. 33–41), *Ἀρχύτα βίος* (fr. 47–50). Wehrli's distribution of the fragments in different works is not always successful. Aristoxenus mentions the Pythagoreans in other writings: *Παιδευτικοὶ νόμοι* (fr. 43), *Μουσικὴ ἀκρόασις* (fr. 90), *Ἱστορικὰ ὑπομνήματα* (fr. 131); see also fr. 123.

[11] In musicology he breaks decisively with the mathematical harmonics of the Pythagoreans, accusing them of contradicting empirical facts (*Harm.* I, 32–3). Relying on Aristotle's qualitative approach to natural phenomena, and using his empirical descriptive method, he bases his analysis of music on the subjective perception of musical tones by the human ear. See A. Bélis, *Aristoxène de Tarente et Aristote: le traité d'harmonique* (Paris, 1986); A. Barker, 'Aristoxenus' Harmonics and Aristotle's Theory of Science', in A. C. Bowen et al. (eds.), *Science and Philosophy in Classical Greece* (New York, 1991), 188–226.

[12] Contrary to Aristotle, he shared the Pythagorean theory that the soul is the 'harmony' of corporeal elements, and therefore mortal (fr. 118–21). His approach to the tradition on Pythagoras and the Pythagoreans also contradicts Aristotle in many ways.

[13] His biographies of Socrates and Plato are filled with scandalous details, including the charge that Plato sponged off Dionysius and plagiarized Protagoras (fr. 62, 67).

[14] On his *Pythagorean Precepts*, see below, 65 n. 17.

Croton during Pythagoras' lifetime there are no fundamental departures from what Aristotle and Dicaearchus report, and his portrait of Pythagoras the scientist is supported by Eudemus and other writers of the second half of the fourth century. Viewing the last Pythagoreans as the heirs to the early school (fr. 18: ἐφύλαξαν μὲν οὖν τὰ ἐξ ἀρχῆς ἤθη καὶ τὰ μαθήματα), Aristoxenus nonetheless made a distinction between them, though not as consistently as we might like.[15] He described both the Pythagorean way of life and the Pythagorean doctrine by referring to his informants (who include Spintharus and Xenophilus: fr. 25, 30, 43), and without mentioning Pythagoras himself.[16] Aristoxenus' *Pythagorean Precepts* arouse perhaps the greatest doubts,[17] but on the whole the reports of this well-informed historian – if one makes allowances for his tendentious and polemical bent[18] – are clearly preferable to the legendary tradition which he disputes, and which much more frequently reflects the arbitrary

[15] If Aristoxenus had projected 4th-cent. Pythagorean science onto Pythagoras, far more achievements would be linked with the name of Pythagoras than we find in the fragments of the Peripatetic (fr. 23–4). Still less frequently does he connect any philosophical doctrines with Pythagoras (fr. 23).

[16] Iamblichus repeatedly felt compelled to append the note 'all of this comes from Pythagoras' to the stories of Aristoxenus (*VP* 102, 174, 183, 198, 213, 230). This is the surest indication that his source said nothing of the kind (Rohde, 141 f., 158, 160, 163).

[17] The Pythagorean stratum in the *Precepts* cannot always be confidently separated from the theories of the Academy and the Lyceum (Rohde, 162 f.; Wehrli, comm. on fr. 33–41; de Vogel, 174 ff.; Burkert, 107 f.; contra: C. Huffman, 'Aristoxenus' *Pythagorean Precepts*: A Rational Pythagorean Ethics', in M. M. Sassi (ed.), *La costruzione del discorso filosofico nell'età dei Presocratici* (Pisa, 2006), 103–21). When we read e.g. that education in the arts and sciences has to be voluntary if it is to achieve its purpose (fr. 36; cf. Iamb. *VP* 183 = fr. 41d Huffman), this reminds us unmistakably of Plato's socio-pedagogical principle: 'Nothing that is learned under compulsion stays with the mind' (*Res.* 536d–e). It is explained in the *Laws* how education that includes various playful activities (819b–c) makes future citizens obey the laws voluntarily; see K. Schöpsdau (tr. & comm.), *Platon. Nomoi. Buch IV–VII* (Göttingen, 2003), 219 f. Another idea, that true φιλοκαλία concerns ἤθη and ἐπιστῆμαι, and not what most people think, namely, things necessary and useful for life (fr. 40), is also Platonic. The necessary and the useful occupy the lowest position in Plato's hierarchy of activities, whereas Archytas praised the practical utility of mathematics (B 3; Zhmud, *Origin*, 71 ff.). The doctrines contained in the *Precepts* are never attributed to Pythagoras (cf. fr. 40 with comm.). It is interesting that it was this work which exerted a strong influence on the pseudo-Pythagorean ethical treatises: B. Centrone, *Pseudopythagorica ethica* (Naples, 1990), 38 f. Cf. below, 72 n. 47.

[18] Aristoxenus maintained that Pythagoras ate beans and suckling pigs (fr. 25), and even ascribed to him the introduction of weights and measures in Greece (fr. 24). The inclusion of the Italian lawgivers Zaleucus and Charondas among the Pythagoreans derives from a 5th-cent. tradition. This also applies to Abaris and Aristeas (see below, 114 f.).

combinations of its creators (Anaximander the Younger, Heraclides, Andron, and others) than the notorious 'archaic' stage of Pythagoreanism.[19]

Dicaearchus of Messana, like Aristoxenus, his coeval and friend from the Lyceum (fr. 67, 70), was probably in contact with the Pythagoreans of Magna Graecia (fr. 34) and the Peloponnese (cf. fr. 20) even before he arrived in Athens. Dicaearchus, though having none of Aristoxenus' tendentiousness or his fondness for extremes, shared many of the same views, for example the Pythagorean teaching on the soul as 'harmony' (fr. 8, 11–12). In his *Περὶ βίων* he also devoted most attention to Pythagoras, Socrates, and Plato,[20] and took a very critical view of Plato's philosophy (though without personal attacks),[21] which was unlike his attitude to Socrates (fr. 29). Like some other members of the Lyceum, he thought that Plato had combined Pythagoras and Socrates in his teaching (fr. 41, below §12.3). With Aristoxenus, Dicaearchus became the main source for most subsequent biographies of Pythagoras, and was already counted by Neanthes as one of *οἱ ἀκριβέστεροι* (*FGrHist* 84 F 30). His treatment of the events of the Cylonian revolt makes clear that he was using sources independent of Aristoxenus, and that they included the oral Italian tradition (fr. 34). He also broached a topic which Aristoxenus studiously avoided – the previous incarnations of Pythagoras (fr. 36), and demonstrated a clearly ironic attitude to this matter.

Περὶ βίων begins with the Seven Sages, whom Dicaearchus viewed not as philosophers but as practical men, skilled in lawmaking

[19] For a generally positive assessment of Aristoxenus as a historian, see Rohde, 117; Delatte, *Lit.* 8, 19; id., *Pol.* 213; von Fritz, *Pol.*, 27 ff.; id., 'Pythagoras', 175; A. Momigliano, *The Development of Greek Biography* (Cambridge, Mass., 1971), 74 f. Cf. Philip, 14 f. (negative); Lévy, 44 ff.; Burkert, 106 (critical). On Aristoxenus' catalogue of Pythagoreans, see below, §3.2.

[20] Other philosophers receive only sporadic mention in the fragments of *Περὶ βίων* (fr. 39, 44). – Heraclides of Pontus (fr. 22), Theophrastus (D.L. V, 42), Clearchus (fr. 37–62), and Strato (D.L. V, 59) all wrote *Περὶ βίων*. Where the material is accessible, e.g., in Clearchus, it is clear that *Περὶ βίων* is to be understood as meaning 'Biographies'.

[21] Fr. 41–4. In Philodemus' *History of the Academy*, a quotation from Dicaearchus says that Plato 'did more than anybody to advance philosophy and (at the same time) to undermine it'. See T. Dorandi, *Platone e l'Academia (PHerc. 1021 e 164) / Filodemo* (Naples, 1991), col. i, 9 f.; W. Burkert, *Platon in Nahaufnahm: Ein Buch aus Herculaneum* (Stuttgart, 1993), 25 f.; D. C. Mirhady, 'Dicaearchus of Messana: The Sources, Text and Translation', in W. W. Fortenbaugh and E. Schütrumpf (eds.), *Dicaearchus of Messana* (New Brunswick, 2001), fr. 46A.

(fr. 30–2). This may be the context of the preference he expressed for an active mode of life, rather than the ideal of a contemplative life.[22] The scarcity of evidence makes it difficult to establish whether he understood *vita activa* as purely political activity (for which he himself was not known), or rather as a way of life in accordance with one's own philosophical principles (like Socrates, fr. 29). It is unlikely, anyway, that he saw Pythagoras, Socrates, and Plato as representing opposing modes of life, while evaluating them from the viewpoint of his ideal.[23] Like Aristoxenus (fr. 16–18), he took a favourable view of Pythagoras' moral and political work, and if he valued Socrates more highly than Aristoxenus did, that had little to do with Socrates' 'untheoretische Haltung'.

The figure of the historian Neanthes of Cyzicus, who previously was in the background, has undergone a substantial reappraisal in recent decades. New editions of the Herculaneum papyri have shown that Neanthes, who was an important source for Philodemus' *History of the Academy* (first century), was personally acquainted with Plato's secretary Philip of Opus.[24] This meant placing his acme not in the third century but the last third of the fourth,[25] and renouncing the idea that the stories of Pythagoras and the Pythagoreans derived from the

[22] Cicero referred to differences between Dicaearchus and Theophrastus, who preferred *vita contemplativa* (fr. 25), but it is hardly likely that this was a matter of real theoretical debate between them; see P. M. Huby, 'The Controversia between Dicaearchus and Theophrastus about the Best Life', in Fortenbaugh and Schütrumpf (eds.), *Dicaearchus*, 311–28.

[23] See Wehrli, *Dikaiarchos*, 50 f. According to Rohde (110), Dicaearchus was the first to make Pythagoras into a politician, pursuing his own ideal of the *vita activa*; see also Burnet, 89 n. 4; W. Jaeger, 'On the Origin and Cycle of the Philosophic Ideal of Life' (1928), in his *Aristotle*, 2nd edn. (Oxford, 1967), 455 f.; however, cf. S. White, '*Principes Sapientiae*: Dicaearchus' Biography of Philosophy', in Fortenbaugh and Schütrumpf (eds.), *Dicaearchus*, 195–236.

[24] K. Gaiser, *Philodems Academica* (Stuttgart, 1988), 96, 107 f., 416 f.; Dorandi, *Filodemo*, 35 f.; W. Burkert, 'Neanthes von Kyzikos über Platon', *Mus. Helv.* 57 (2000), 76–80; S. Schorn, '"Peripatetische Biographie" – "Historische Biographie": Neanthes von Kyzikos (*FGrHist* 84) als Biograph', in M. Erler and S. Schorn (eds.), *Die griechische Biographie in hellenistischer Zeit* (Berlin, 2007), 115–56. Neanthes cites Philip on the story of Plato's being visited by a certain Chaldean (Philod. *Hist. Acad.*, col. III,34–V,22 Dorandi); he also linked Pythagoras with the *Χαλδαῖοι* (*FGrHist* 84 F 29).

[25] Neanthes was a pupil of the rhetorician Philiscus of Miletus, who, in turn, was a pupil of Isocrates. The historian Timaeus, another pupil of Philiscus, was born *c.*350; Neanthes was probably the same age, or a little older (below, 68 n. 30). On the other hand, he already had access to Aristoxenus (F 29–30), Dicaearchus (F 30), and Phanias of Eresus (F 2, 17), so was younger than they.

younger Neanthes (*c.*200).[26] Besides Pythagoras, the Pythagoreans, and Plato, Neanthes' *On Famous Men* featured Empedocles, Heraclitus, and other philosophers who were popular in the biographical tradition, and about whom he often retailed fantastic stories. To throw light on the basic facts of Pythagoras' life he usually availed himself of Aristoxenus and Dicaearchus, often enlivening their versions by means of legendary new details. Unlike Aristoxenus, Neanthes did not attempt to rationalize the figure of Pythagoras. Instead he made willing use of that part of the popular tradition which he could turn to good account.[27] Apart from his tendency to set forth several versions of events, Neanthes is of interest to us because he appears to be the first to refer to the pseudo-Pythagorean writings;[28] he is also among the first to introduce into the literature the figure of a Pythagorean woman.[29] Much use was made of Neanthes by writers of the Hellenistic period, Hermippus, for example, and especially Hippobotus, and through them by late biographers of Pythagoras.

The last valuable fourth-century source is Neanthes' fellow student Timaeus of Tauromenium (*c.*350–*c.*260).[30] Although in his few fragments relating to Pythagoras and the Pythagoreans we are dealing with matters of detail, the sum of these details clearly indicates that in

[26] As Jacoby, *FGrHist* IIc, 144c, and Burkert, 102 n. 23, thought. F. Leo, *Die griechisch-römische Biographie nach ihrer litterarischen Form* (Leipzig, 1901), 112; R. Laqueur, 'Neanthes', *RE* 16 (1935), 2108–10; von Fritz, *Pol.*, 6, and Burkert, 'Neanthes', 76 f. argued for the elder Neanthes.

[27] In the story of Myllias and Timycha their Pythagorean friends perish, not daring to cross the bean field (F 31). Since the Syrians, according to Neanthes, in ancient times did not eat meat or sacrifice animals (F 32), Pythagoras became a Syrian. His father Mnesarchus, a Syrian from Tyre, took him to the Chaldeans, under whom he mastered all the sciences (F 29). On the reincarnations of Pythagoras see F 33.

[28] He mentions a letter of Pythagoras' son Telauges to Philolaus (see D.L. VIII, 53, 74), saying, however, that he considers it a forgery (F 26).

[29] Timycha (F 31). His interest in this subject was shared by his contemporaries: Timaeus mentioned Pythagorean women (*FGrHist* 566 F 17, 131) and Hermesianax mentioned Pythagoras' wife (fr. 7.85). The Athenian historian Philochorus (*c.*340–260) had already written *Συναγωγὴ ἡρωίδων ἤτοι Πυθαγορείων γυναικῶν* (*FGrHist* 328 T 1).

[30] Timaeus made use of Neanthes' work: (1) he repeats (with variations) the story of Empedocles plagiarizing from the Pythagoreans (*FGrHist* 566 F 14), which is present in Neanthes (*FGrHist* 84 F 26); (2) in the work of Pompeius Trogus (Iust. XX,4,3), who relied on Timaeus (see below, 69 n. 35), Mnesarchus is called a merchant; this same version is set forth in detail in Neanthes (F 29); (3) in Pompeius Trogus (Iust. XX,4,3) Pythagoras studied astronomy in Babylon. Neanthes was the first to send Pythagoras to the Chaldeans (F 29), who were renowned for their knowledge of astronomy (see above, 68 n. 27). See also Burkert, 'Neanthes', 79 n. 30.

his history of Magna Graecia he endeavoured to present the history of the movement as a whole (Books IX–X), though not avoiding a great many anachronisms.[31] Like the first biographers of Pythagoras, who also came from Magna Graecia, Timaeus took a sympathetic view of him (though without any obvious bias); he upheld Pythagoras' struggle against luxury, defended him against the attacks of Heraclitus (F 132), and avoided the tradition that described his wonder-working.[32] Timaeus was much used by writers of the Hellenistic and Imperial periods, but a complete reconstruction of the information deriving from him – attempted by some historians of the early twentieth century – encountered insurmountable difficulties.[33] It proved to be impossible to attribute to Timaeus that part of the fourth-century historical tradition on Pythagoras which does not accord with Aristoxenus, Dicaearchus, and Neanthes.[34] While exercising due caution, however, it would be wrong to accept a minimalist line and reject what has been successfully reconstructed.[35] Many of the motifs of

[31] See *FGrHist* 566 F 13–14, 16–17, 131–2 with Jacoby's comm. (p. 550 f. nn. 191–8). Tauromenium, the homeland of Timaeus, was founded *c.*403, but is repeatedly mentioned in the context of Pythagorean history (Porph. *VP* 21, 27, 29; Iamb. *VP* 33, 112, 134, 136); in Aristoxenus' catalogue of the Pythagoreans Tauromenium is missing. Following Alcidamas (14 A 5), Timaeus regarded Empedocles as a pupil of Pythagoras (F 14); he attempted to prove communal property among the Pythagoreans by means of the saying 'Friends share everything' (F 13).

[32] This last point is particularly noteworthy, given that Timaeus often inserted supernatural elements into his narrative (Lévy, 59). See below, 99 n. 164.

[33] In the early 20th cent. the role of Timaeus in the tradition of Pythagoras was greatly exaggerated; see esp.: A. Delatte, 'Un nouveau fragment de Timée', *Revue de l'instruction publique en Belge* 52 (1909), 90–7; id., 'La Chronologie pythagoricienne de Timée', *Musée Belge* 19 (1920), 5–13; id., *Lit.*, 8 ff.; Bertermann, *De Iamblichi*, 75 f.; Rostagni, 'Pitagora', 3 ff.; cf. the critical response: Lévy, 122 ff.; von Fritz, *Pol.* 33 ff., 45 ff.; id., 'Pythagoras', 170 ff.; Burkert, 103 f.

[34] Von Fritz, *Pol.*, 33 ff.; Burkert, 103 f. On the role of Theopompus, see below, 82 n. 91; 119.

[35] Timaeus was used by (1) Polybius (II,39,1; Delatte, *Pol.*, 223 f.; F. Walbank, *A Historical Commentary on Polybius*, i (Oxford, 1957), 222 f.); (2) Diodorus Siculus (XII,9,2–6; Bertermann, *De Iamblichi*, 51 f.; Lévy, 57 f.; R. Laqueur, 'Timaios', *RE* 6A (1936), 1094; von Fritz, *Pol.*, 33 f., 46; Jacoby, *FGrHist* IIIb, 560 f. nn. 279–80; K. Meister, *Die sizilische Geschichte bei Diodor* (Munich, 1967), 53; L. Pearson, *The Greek Historians of the West* (Atlanta, 1987), 112 f.; Giangiulio, *Ricerche*, 14 ff.; (3) Pompeius Trogus (in the time of Augustus) in his epitome by Justin (Iust. XX,4); Timaeus was the principal source of this chapter (Rohde, 122; Delatte, *Pol.*, 225 f.; Lévy, 55 f.; von Fritz, *Pol.*, 33 ff.; id., 'Pythagoras', 176, 182 f.); (4) Strabo (VI,1,12–13; XIV,1.16; F. Lasserre (ed.), *Strabon*, iii (Paris, 1967), 225 f.; C. Talamo, 'Pitagora e la *τρυφή*', *RFIC* 115 (1987), 386 f.; Bugno, *Sibari*, 37 f.); (5) Apollonius (*FGrHist* 1064 F 2 = Iamb. *VP* 254; see below, 99 n. 162); note the reliable parallels between Timaeus

Pythagoras' four speeches, preserved by Iamblichus (*VP* 37–57), are linked with the material of Timaeus and his predecessors, but these speeches cannot be seen as an authentic Pythagorean source, or even as Timaeus' text: the final version is the work of Apollonius.[36]

Neanthes and Timaeus are chronologically the last authors in whose work it is profitable to seek traces of an independent historical tradition about Pythagoras and the Pythagoreans. Despite the fact that throughout the Hellenistic period Pythagoras and his followers were an essential component in most of the collections of philosophical biographies, the surviving evidence can only on very rare occasions be utilized for historical reconstruction. Everything that is more or less reliable goes back to earlier sources, and what is new is usually fabrication. In the work of the Peripatetics Clearchus of Soli (born *c.*340) and Hieronymus of Rhodes (born *c.*300), we find only occasional references to the religion of Pythagoras (or the Pythagoreans), and the tone of these references is hostile.[37] The biographer Hermippus of Smyrna (late third century), who was renowned for his malicious tongue, wrote a special work *On Pythagoras* in two books, as well as treating him in other works.[38] Relying on fourth-century sources, he added to the tradition a number of fables which present Pythagoras in a highly unfavourable light.[39] In Satyrus' (*c.*240–170) *Βίων ἀναγραφή*, both Pythagoras and Plato, the plagiarist of the Pythagoreans, appear in an anecdotal setting.[40] Hippobotus (*c.*200)

and Apollonius: Tim. F 17 and Iamb. *VP* 56; F 13 and Iamb. *VP* 71 f.; F 131 and Iamb. *VP* 170.

[36] The fragments of Antisthenes (fr. 51) and Dicaearchus (fr. 33) which mention the speeches do not describe their contents. On the authorship of the speeches, see above, 10 n. 20, 22; also Rohde, 132 f.; Delatte, *Pol.*, 39 f.; von Fritz, *Pol.*, 39, 41, 65; Jacoby, *FGrHist* IIIb, 553 nn. 204–205; D. S. Du Toit, *Theios Anthropos* (Tübingen, 1997), 228 f.; Giangiulio, *Pitagora*, ii. 530 f. Apollonius used several sources, including Aristoxenus' *Πυθαγορικαὶ ἀποφάσεις* (Zucconi, 'Tradizione').

[37] Clearchus (*Περὶ βίων*, fr. 38), Hieronymus (*Ἱστορικὰ ὑπομνήματα*, fr. 42; Giangiulio, *Pitagora*, i. 80 n. 75 confuses the Peripatetic with the historian Hieronymus of Cardia). The tone of Timon of Phlius (*c.*320–230) is the same; see Plut. *Numa* 8, 5; D.L. VIII, 36 = fr. 57 Di Marco with comm.

[38] *On Lawgivers* (*FGrHist* 1026 F 1) and possibly *On Those who Converted from Philosophy to Autocracy* (F 27). See Bollansée, *Hermippus*, 79 f. and comm. on F 27.

[39] Fr. 18–24 Wehrli = *FGrHist* 1026 F 1, 21–27. See Delatte, *Pol.*, 221 f.; Lévy, 37 f.; Wehrli, comm. on fr. 18–24; cf. Bollansée, *Hermippus*, 44 ff. Possibly the only thing of value is his reference to the Crotonian doctor Calliphon (fr. 22 = F 21).

[40] After burying Pherecydes, Pythagoras returns to Croton, whence, finding Cylon at a rich feast, he flees to Metapontum and dies of starvation (D.L. VIII, 40). Plato,

apparently copied from Neanthes and Hermippus in his Ἀναγραφὴ τῶν φιλοσόφων.[41] Sotion of Alexandria (*c.*200) mentions the Pythagorean Ameinias, the teacher of Parmenides, in his Διαδοχαὶ τῶν φιλοσόφων (D.L. IX, 21),[42] and provides a list of (spurious) works of Pythagoras (D.L. VIII, 7). Heraclides Lembos (early second century) compiled epitomes of the works of Satyrus (D.L., VIII, 40, 44) and Sotion (D.L. VIII, 7), and excerpted Hermippus' *On Pythagoras* (*FGrHist* 1026 T 5).

In his Διαδοχαὶ τῶν φιλοσόφων, Sosicrates (*c.*150) recounts one of the versions of the story told by Heraclides of Pontus about Pythagoras coining the word 'philosopher'.[43] The work of the same title by the grammarian Alexander Polyhistor (who worked in Rome after 82–*c.*35), which Diogenes Laertius (or his source) thought particularly valuable and from which he copied a long chapter, is interesting in that, unlike other Hellenistic διαδοχαί, which have no special doxographical sections, it sets out Pythagoras' teachings rather than his biography.[44] As may be seen, the biographers of that time often consulted the literature fabricated under the name of Pythagoras and the Pythagoreans,[45] although many writers continued to maintain

who has become wealthy, instructs Dion to buy three of Pythagoras' books from Philolaus for 100 minae (D.L. III, 9).

41 M. Gigante, 'Frammenti di Ippoboto', in A. Mastrocinque (ed.), *Omaggio a Piero Treves* (Padua, 1984), 151–93. Cf. Neanth. *FGrHist* 84 F 26, 28, 29b, 31, 33 and Hippob. fr. 12–14, 18–19.

42 H. Diels, 'Parmenidea', *Hermes* 35 (1900), 196 ff. and Jacoby *FGrHist* IIIb, 326 n. 200, surmised that Timaeus could have been Sotion's source.

43 D.L. VIII, 8. Athenaeus (IV, 163 f) tells Sosicrates' story of the para-Pythagorean Diodorus of Aspendus, about whom Timaeus (*FGrHist* 566 F 16) and Hermippus (fr. 24 = *FGrHist* 1026 F 26) had written; see below, 13 f.

44 D.L. VIII, 24–35 = *FGrHist* 273 F 140. Alexander's dating: Jacoby IIIa, 249; G. E. Sterling, *Historiography and Self-Definition* (Leiden, 1992), 144 f. On the *Pythagorean Memoirs* cited by Alexander, see above, 10 n. 18; Burkert, 53; J. Mejer, *Diogenes Laertius and His Hellenistic Background* (Wiesbaden, 1978), 66, 91 n. 60; B. Centrone, 'L'VIII libro delle "Vite" di Diogene Laerzio', *ANRW* II,36,6 (1992), 4193 ff., and below, 90 n. 128, 423 f. The combination of *bios* and *dogmata* remains a feature of Pythagorean biography.

45 The 'three Pythagorean books' mentioned by Satyrus (D.L. III, 9) are Pythagoras' famous *tripartitum*: Παιδευτικόν, Πολιτικόν, Φυσικόν (D.L. VIII, 6, 9, 15), a forgery from the late 3rd cent. (Diels, 'Pythagorasbuch', 452 ff.; Lévy, 70 ff.; Thesleff, 170 f.; Burkert, 223 f.). Hippobotus (fr. 14), who followed Neanthes (*FGrHist* 84 F 26) in not accepting that Telauges' letter was authentic, nevertheless regarded Empedocles as his pupil, relying in this on another forgery; this apart, he acknowledged the writings of Pythagoras' wife Theano. Sotion (D.L. VIII, 7) adds to the list of Pythagoras' works Περὶ τοῦ ὅλου, Ἱερὸς λόγος, Περὶ ψυχῆς, Περὶ εὐσεβείας, and others.

that the writings of Pythagoras had not been preserved, or that they had never existed.[46] Lastly, mention must be made of an anonymous biography of Pythagoras which has come down to us in excerpts from Diodorus Siculus (last third of the first century). It is based chiefly on Aristoxenus, and is therefore for the most part free from the anecdotal and pseudo-Pythagorean material which characterizes the other biographies of that time.[47]

Diogenes Laertius is the only one to present all of these Hellenistic biographers of Pythagoras.[48] The Neoplatonist biographies include only Neanthes' story of Myllias and Timycha, in the version set down by Hippobotus.[49] Iamblichus and Porphyry preferred the neo-Pythagorean writers Nicomachus and Apollonius, who were closer to them in spirit, to the Hellenistic biographers, who were fond of anecdotes and often malicious. Diogenes Laertius, on the other hand, whose attitude to the 'miraculous' aspect of Pythagoreanism was much more restrained, ignores the neo-Pythagoreans, although he avails himself of some pseudo-Pythagorean writings, including some late ones.[50] Research into the sources of his biography of Pythagoras has shown

[46] Probably Sosicrates (cf. D.L. I, 16; VII, 163; VIII, 6–7; Centrone, 'L'VIII libro', 4188 f.); Posidonius (fr. 151); Philodemus (*De piet.* 3 fr. 10, p. 66 Gomperz) and others. See Riedweg, 'Pythagoras', 70 f.

[47] Diod. X,3–11 = Thesleff, 229 f. The influence of Aristoxenus is noted by E. Schwartz, 'Diodoros', *RE* 5 (1903), 679; Delatte, *Pol.*, 225; Lévy, 87 n. 2; von Fritz, *Pol.*, 22 f.; Burkert, 104 n. 36. The similarity between Diod. X,9,3–5 and the *tripartitum* (D.L. VIII, 9 = Thesleff, 233) may be explained by their shared reliance on Aristoxenus' *Pythagorean Precepts* (cf. above, 65 n. 17, also Iamb. *VP* 210, see below, 75 n. 61), and not by Diodorus' reliance on the *tripartitum*; cf. Diels, 'Pythagorasbuch', 467 ff. In a number of cases Diodorus differs from Aristoxenus; see e.g. X,3,4 on Pythagoras travelling from Italy to visit Pherecydes (cf. below, 80 n. 80) or X,6,1 on metempsychosis and abstaining from meat. As Diodorus dates by the Olympiads, his direct source is later than Apollodorus of Athens (2nd cent.); cf. below, 82 n. 92.

[48] Authorship of the anonymous biography from Photius' library (438b–441b = Thesleff, 237 ff.) has been linked with Eudorus, the Pythagorizing 1st-cent. Platonist (Burkert, 53 n. 2; cf. H. Dörrie, *Der Platonismus in der Antike*, ii (Stuttgart, 1990), 261 f.). Mejer, *Diogenes Laertius*, 91 n. 60, however, suggests the 2nd cent. AD; Dörrie, *Platonismus*, ii. 261 f; 1st cent. BC – 1st cent. AD; Burkert, 'Pythagoreische Retraktationen', 304: 'frühkaiserzeitlich'. It is not clear when Lycon of Iasus, the author of *On the Pythagorean (Life)*, mentioned by Athenaeus (X, 418e = 57 A 3), lived. He cannot be identified with the Pythagorean Lycon of Tarentum from the catalogue of Aristoxenus (57 A 1). See *FGrHist* 570 F 15 = *FGrHist* 1110 F 2 with comm., and below, 119 f.

[49] Porph. *VP* 61, Iamb. *VP* 189 ff.

[50] E.g. Diogenes cites Androcydes' work *On Pythagorean Symbols* and Lysis' spurious letter (VIII, 17–18, 42). Androcydes' book was probably written in the first century and Lysis' letter in the 1st cent. AD (see below, 171, 189 n. 79).

that those he used were far from being the worst.[51] The fact that he had neither any philosophical programme of his own nor any Pythagorean predilections went some way to ensuring less distortion of the material than is found among the neo-Pythagorean biographers.[52] At the same time, his 'mosaic' method of compiling his sources is sometimes even more disheartening than the style of Porphyry and Iamblichus, who usually copied large segments.

Neo-Pythagorean biography differed substantially from Hellenistic biography and those writings of the Imperial period which continued the Hellenistic tradition. In neo-Pythagorean biography, Pythagoras ceased to be one of dozens of philosophers, ancient and modern, whose lives were recounted in biographical collections (Apollonius, Nicomachus, and Iamblichus, as far as is known, did not write any other biographies), and became a figure who was exceptional in all respects. A messenger from the gods, a bearer of the ancient wisdom of the Orient, a great mystagogue and wonder-worker who commanded the elements, a figure to be revered as a demigod, a teacher bringing moral and religious renewal, a fighter against tyranny who gave laws to Greece, a sage who had revealed the mystical secrets of numbers, and the forerunner of Plato – this was the way many of his admirers in the Imperial period wished to see him. Almost all these motifs were present, in varying degree, in the classical tradition, but in the neo-Pythagorean and later, in Neoplatonic biography of Pythagoras, the legendary, mysterious, and miraculous element ceases to be one motif among many and becomes practically the basis of the narrative.

It is no accident that Porphyry found for his biography of Pythagoras a source as exotic as the fantastic novel *The Incredible Wonders*

[51] Delatte, *Vie*, 40 ff.; Mejer, *Diogenes Laertius*, *passim*; Centrone, 'L'VIII libro', 4185 ff. The prototype of the biography of Pythagoras in Diogenes coincides with the short biographies in the *Suda* (from Hesychius) and in *Schol. Pl. Res.* 600c. One of the shared elements, Pythagoras' *tripartitum* (see above, 71 n. 45), is dated to the end of the 3rd cent.; another, Mnesarchus as an engraver, appears to have been invented by Hermippus (see below, 79 n. 74), and points to the same time. Attempts to link this prototype with any biographer known to us have been unsuccessful (Centrone, 'L'VIII libro', 4187 n. 19).

[52] In the short versions of Diogenes' prototype (see n. 51, above), Pythagoras is presented as a religious teacher, not as a philosopher or scientist. It is difficult to establish whether this occurred because of severe abridgements to the original, or because Diogenes added material which makes the figure of Pythagoras more rounded, but the former seems more probable.

beyond Thule by Antonius Diogenes (early second century AD),[53] of which the Pythagorean part is said to be related by Astraeus, a pupil of Pythagoras himself.[54] It is also no accident that the author of one of the first neo-Pythagorean biographies was Apollonius of Tyana (second half of the first century AD), a magician and sorcerer, a tireless seeker of 'secrets' in all Greek and Oriental teachings, who claimed that the soul of Pythagoras had taken root in him. The disputes over his biography of Pythagoras are still not over,[55] but practically all investigators of Pythagoreanism take as their point of departure the authorship of Apollonius of Tyana.[56] Porphyry owes very little to Apollonius (*VP* 2), whereas Iamblichus took large

[53] Antonius was previously dated in the 1st cent. AD (E. Rohde, *Der griechische Roman und seine Vorläufer*, 3rd edn. (Leipzig, 1914), 277), but in recent times a consensus has given preference to 100–30 AD: J. R. Morgan, 'Lucian's True Histories and the Wonders Beyond Thule of Antonios Diogenes', *CQ* 35 (1985), 490; G. W. Bowersock, *Fiction as History: Nero to Julian* (Berkeley, 1994), 38 ff.; S. A. Stephens, and J. J. Winkler (eds.), *Ancient Greek Novels: The Fragments* (Princeton, 1995), 118 f; E. L. Bowie, 'The Chronology of the Earlier Greek Novels Since B. E. Perry: Revisions and Precisions', *Ancient Narrative* 2 (2002), 58 ff.

[54] *VP* 10–14, 32–6, 44 certainly go back to Antonius, see Rohde, 125 f.; id., *Roman*, 272 n. 2; H. Jäger, *Quellen*, 36 ff., 43 ff.; K. Reyhl, *Antonius Diogenes* (diss. Tübingen, 1969), 3 f., 20 ff.; É. des Places (ed.), *Porphyre: Vie de Pythagore* (Paris, 1982), 13 ff.; Burkert, 99 n. 9; A. R. Sodano, 'Analisi filologica della Vita di Pitagora', in A. R. Sodano and G. Girgenti (eds.), *Porfirio: Vita di Pitagora* (Milan, 1998), 35 ff., 82 f. Cf. below, 189 n. 80. On Antonius' sources: Rohde, *Roman*, 272 n. 2. On Pythagoreanism in Antonius' novel, see also W. Fauth, 'Astraios und Zalmoxis. Über Spuren Pythagoreischer Aretalogie im Thule-Roman des Antonius Diogenes', *Hermes* 106 (1978), 220–241; Stephens and Winkler (eds.), *Ancient Greek Novels*, 112 f.

[55] Some dispute Apollonius' authorship: E. L. Bowie, 'Apollonius of Tyana: Tradition and Reality', *ANRW* II,16,2 (1978), 1672 n. 77, 1691 f.; Gorman, 'Apollonios', Staab, *Pythagoras*, 228 ff.; id., 'Der Gewährsmann "Apollonios" in den neuplatonischen Pythagorasviten – Wundermann oder hellenistischer Literat?', in Erler and Schorn (eds.), *Biographie*, 195–217; Radicke, 'Apollonius of Tyana' (*FGrHist* 1064), 151; others question whether this biography was used by Porphyry and especially by Iamblichus: B. L. Taggart, *Apollonius of Tyana: His Biographers and Critics* (diss. Tufts University, 1972), 85 f.; Gorman, 'Apollonios' Cf. G. Petzke, *Die Traditionen über Apollonius von Tyana und das Neue Testament* (Leiden, 1970), 37 ff.; M. Dzielska, *Apollonius of Tyana in Legend and History* (Rome, 1986), 130 ff.; Staab, 'Gewährsmann'. The critics' arguments sometimes become vicious circles: Gorman, pointing out that Apollonius was an Atticist, finds Hellenistic forms in his chapters (Iamb. *VP* 254–5); Radicke, who sees in the language of these chapters 'a strong influence of Atticism', doubts whether the 'popular healer' Apollonius could have mastered it.

[56] *Βίος Πυθαγόρου* is mentioned as one of Apollonius' works in the *Suda*. While Apollonius' authorship is not beyond dispute, no real alternative has been found. Cicero's contemporary Apollonius Molon (Staab, *Pythagoras*, 236 n. 539; id., 'Gewährsmann', 209 ff.) is clearly not suited to the role of Pythagoras' biographer.

sections from him.[57] One more source which they both shared was the biography of Pythagoras by the Platonist and neo-Pythagorean Nicomachus (first half of the second century AD), the author of popular introductions to *mathēmata*, known for his love of mystical arithmetic.[58] In particular, he is the author of a long chapter on Pythagoras' wonder-working.[59] This apart, both Porphyry and Iamblichus, who wrote independently of him, made use of a kind of biographical handbook, which was either similar or identical to that on which Diogenes Laertius relied.[60]

Notwithstanding the almost identical body of sources,[61] and the obviously similar outlook of the two Neoplatonists, whose ideal of philosophy implied a religious path to the truth, unknown to the Presocratics, there are numerous differences between their works on Pythagoras. Porphyry's *Life of Pythagoras* was part – the sole surviving part – of his *History of Philosophy*, in which Pythagoras had the role of one of the predecessors of Plato, proclaiming to Greece the divine wisdom of the Orient, *prisca sapientia*, which in essentials coincided with Plato's teaching.[62] A man of broad education,

[57] *VP* 3–25, 28, 37–57, 68–72, 215–22, 254–64. See Rohde, 125 ff.; Bertermann, *De Iamblichi*, 5 f., 75 f.; H. Jäger, *Quellen*, 12, 30 f.; Lévy, 104 ff.; Burkert, 100 n. 10, mistakenly thought to find the influence of Nicomachus in *VP* 19: the parallel text in *Theol. ar.*, 53.1 f. is not from Nicomachus but from Anatolius.

[58] On the life and teaching of Nicomachus, see F. E. Robbins and L. Ch. Karpinski (eds.), *Nicomachus of Gerasa: Introduction to Arithmetic* (London, 1929) ; W. Haase, *Untersuchungen zu Nikomachos von Gerasa* (diss.; Tübingen, 1982), 34 ff.; Dillon, *Middle Platonists*, 352 f.; O'Meara, *Pythagoras Revived*, 14 ff. Doubts as to his authorship of the biography of Pythagoras (Philip, 'Biographical Tradition', 187 ff.) are unfounded.

[59] Porph. *VP* 20–31 ~ Iamb. *VP* 30, 33–4, 36, 60–7, 134–6, 142, 150, 162. Porph. *VP* 54–61 and Iamb. *VP* 228, 233–7, 247–53 most likely also go back to Nicomachus. Cf. Rohde, 126 f.; Bertermann, *De Iamblichi*, 75 f.; H. Jäger, *Quellen*, 41 ff., 59 ff.; Lévy, 95 ff.; Minar, 68 n. 64; Burkert, 98 n. 6; Sodano, 'Analisi', 79 ff., 122 n. 90. On Iamb. *VP* 75–8 (the letter of Lysis), see Städele, *Briefe*, 203 ff.

[60] Rohde, 125 f.; H. Jäger, *Quellen*, 9 ff.; Lévy, 111 ff.; Burkert, 100 f.

[61] Porphyry had four main sources. He took the philosophy of Pythagoras (*VP* 48–53) from Moderatus. Iamblichus shared three sources with Porphyry, but also made extensive use of Aristoxenus' *Pythagorean Precepts* (Rohde, 141 ff.: through Nicomachus; Burkert, 101; id., 'Pythagoreische Retraktationen', 314: directly). Burkert attributes Iamb. *VP* 101–2, 174–6, 180–2, 200–13, 230–3 to the *Precepts*. P. Boyancé, 'Sur la "Vie pythagoricienne" de Jamblique', *REG* 52 (1939), 36–50, suggested including *VP* 96–100 but this section describes the life of the Pythagoreans, not their teaching. Parallels with Porph. *VP* 32–4 (from Antonius' novel) show that, while *VP* 96–100 contains material from Aristoxenus, the section as a whole is not his.

[62] See M. J. Edwards, 'Two Images of Pythagoras: Iamblichus and Porphyry', in H. J. Blumenthal, and E. G. Clark (eds.), *The Divine Iamblichus, Philosopher and Man*

Porphyry did not lack an interest in science and history. Although his biography of Pythagoras sometimes resembles a hagiography, it has at least the virtue that it usually indicates its sources. This is more than can be said of Iamblichus' much larger biographical work *On the Pythagorean Life*, in which distortions and repetition abound.[63] Iamblichus' work was the first part of an ambitious project: to describe in ten books (ten being a sacred number!) all of ancient Pythagoreanism and put this corpus to use in his school as an introduction to philosophy.[64] The first book in this collection presented a portrait of an ideal philosopher, whose teachings and way of life, sent down by the gods, were intended to bring to humans not only the truth, but also the salvation of their souls.[65]

of Gods (London, 1993), 159–72; Clark, 'Philosophic Lives'; Du Toit, *Theios Anthropos*, 250 f.; Staab, *Pythagoras*, 109 ff.

[63] In recent years it has become customary to stress that *Περὶ τοῦ Πυθαγορείου βίου* is not a biography in name, form or content, though opinions differ widely as to what exactly it is. Here it should be noted that Iamblichus took nine-tenths of his material from three biographies in which he found space liberally allotted to Pythagoras' miracles (Nicomachus) and his speeches (Apollonius); Alexander Polyhistor also had a doxographical section (see above, 71 n. 44), as did Porphyry, whose biography of Pythagoras was also part of a vast project and may not have borne its present title (the Greek and Arab authors who cite it refer to the first book of the *History of Philosophy*, not to the *Life of Pythagoras*; see Sodano, 'Analisi', 37 f.). Aristoxenus called his biography *Περὶ Πυθαγόρου καὶ τῶν γνωρίμων αὐτοῦ* (cf. his *Ἀρχύτα βίος*) and (like Iamblichus) told in it of Pythagoras and his pupils. Iamblichus himself referred to *VP* as *περὶ Πυθαγόρου καὶ τοῦ κατ' αὐτὸν βίου τῶν τε Πυθαγορικῶν ἀνδρῶν* (*Protr.*, 6.12). Is this so remote from Aristoxenus and other biographers, e.g. Neanthes, with his story of Myllias and Timycha? Since the Pythagorean way of life was important to Iamblichus, into *VP* he liberally inserted material from Aristoxenus' *Pythagorean Precepts* and *On the Pythagorean Life*, but these works were also used by earlier biographers. Could Iamblichus' lack of proportion, which made his book so long, have broken the framework of the genre of ancient biography?

[64] J. Dillon (ed.), *Iamblichi Chalcidensis in Platonis dialogos commentariorum fragmenta* (Leiden, 1973), 19 f.; idem, 'Iamblichus of Chalcis', in *ANRW* II,36,2 (1987) 862–909; O'Meara, *Pythagoras Revived*, 30 ff.; Staab, *Pythagoras*, 193 ff., 441 ff. From the 'Pythagorean collection', *VP*, *Protrepticus*, *De communi mathematica scientia*, and the commentary on Nicomachus' *Introduction to Arithmetic* have survived. Iamblichus' plan was not original. It derived from Nicomachus' similar project (Dillon, *Middle Platonists*, 352 f.).

[65] On the soteriological aspects of *VP* and its typological similarity to Christian literature, see M. von Albrecht, 'Das Menschenbild in Iamblichs Darstellung der pythagoreischen Lebensform' (1966), in id. et al. (eds.), *Jamblich*, 255–74; Lurje, 'Vita', ibid. 252 f. (with extensive bibliography); D. S. Du Toit, 'Heilbringer im Vergleich', ibid. 275–94; M. George, 'Tugenden im Vergleich: Ihre soteriologische Funktion in Jamblichs *Vita Pythagorica* und in Athanasios' *Vita Antonii*', ibid., 303–22.

Of course, as early as the second half of the nineteenth century these late biographies were not taken seriously, and until recently scorning Iamblichus was almost a scholarly tradition.[66] Critical studies undertaken by several generations of scholars have demonstrated that the late compilations are of value as sources on ancient Pythagoreanism only when the information in them dates back to the fifth or fourth centuries. Taking into account Porphyry's and Iamblichus' direct sources, none of which are older than the first century AD, there is nevertheless no shortage of such evidence. Among the sources named are Empedocles and Archytas, Xenocrates and Eudoxus, Aristotle, Aristoxenus, Dicaearchus, Timaeus, Neanthes, and Duris, but hardly any Hellenistic authors (unlike the biography in Diogenes Laertius).[67] This preponderance of older and therefore more reliable witnesses can be only partly explained by the tastes of the Neoplatonists themselves. Apollonius and Nicomachus apparently also preferred to cite the works of fourth-century writers,[68] although they did not use them directly. The antiquarian focus of the neo-Pythagoreans and Neoplatonists should not be overstated: most of the material in their biographies is actually later than the fourth century, but without such a focus the balance would be even less favourable for students of ancient Pythagoreanism.

[66] See e.g. Rohde, *passim*; J. Geffcken, *Der Ausgang des griechisch-römischen Heidentums* (Heidelberg, 1929), 104: 'der viel und schlecht schreibende syrische Philosophaster'; L. Deubner, 'Bemerkungen zum Text der *Vita Pythagorae* des Jamblichos' (1935), in *Kleine Schriften zur Altertumskunde* (Königstein, 1982), 476 ff.; von Fritz, *Pol.*, 16. On the other hand, Proclus, Simplicius and Damascius called him nothing less than ὁ θεῖος Ἰάμβλιχος. Iamblichus is now viewed increasingly favourably (see above, 10 n. 24), and previous objections are dismissed as unfounded or excessive. For those with a taste for ancient Pythagoreanism, it is still relevant that in copying the same text Iamblichus makes Hippasus now the leader of the *acusmatici* (*VP* 81, cf. 87), and now of the *mathematici* (*Comm. Math.*, 77.19 f.), while confusing a pentagon with a hexagon. He also turns Theocles of Rhegium (*VP* 130) into Theaetetus (172), and then into Euthycles (267), etc.

[67] See above, 72. It is not known when Antiphon, the author of *On Men Distinguished by their Virtue* (Porph. *VP* 7–8), to which Diogenes Laertius also refers (VIII, 3), lived; see J. Radicke, 'Antiphon' (*FGrHist* 1096). The same applies to Dionysophanes (Porph. *VP* 15).

[68] This fully accords with the general archaizing atmosphere of 'reborn' Pythagoreanism and in particular with the influence upon it of the Old Academy.

2.2 LIFE ON SAMOS

Reliable information about Pythagoras before his departure for Magna Graecia is extremely scarce. The early sources name Samos as his home (Hdt. IV, 95; Isoc. *Bus.* 28), and most later authors agree. But Theopompus and Aristoxenus already offer a different version: they regard him as a Tyrrhenian (an Etruscan), according to Aristoxenus, from Lemnos, whence the Tyrrhenians were later expelled by the Athenians.[69] Theopompus was not well disposed to Pythagoras, or to the Etruscans (F 204), but whether he was the author of that version is not clear.[70] Non-Greek origins were usually invented for philosophers to account for some aspect of their teaching or some biographical fact. There is no evidence of any attempt to link Pythagoras' religious doctrine with the Etruscans, and Aristoxenus, who did not believe in metempsychosis and avoided the subject in his work, would hardly have accepted any such version. Rather, Pythagoras' Etruscan origins were in some way connected to his emigration to Italy, which was thus perceived as a return home. Aristoxenus takes the theme of homecoming further. According to Neanthes, who passes on this version, Pythagoras' father came 'from Lemnos to Samos on business, stayed there and obtained citizenship, and when he went to Italy he took with him the boy Pythagoras; Italy was then prospering, and Pythagoras therefore later went there again'.[71]

The early authors call Mnesarchus the father of Pythagoras (Heracl. B 129; Hdt. IV, 95).[72] Neanthes thought that he was a wealthy merchant (ἔμπορος) who traded in grain (a Syrian merchant, to be sure); Aristoxenus' account further implies that the journeys to Samos and Italy were related to business matters; Timaeus also called Mnesarchus a wealthy merchant.[73] No other fourth-century versions

[69] Theopomp. *FGrHist* 115 F 72; Aristox. fr. 11. The mention of Aristotle among those who shared this version (Clem. *Strom.* I,62,2 = Arist. fr. 190) is based on Preller's arbitrary emendation of the manuscript reading Ἀρίσταρχος to Ἀριστοτέλης (Philip, 185). Clement's text, repeated by Theodoretus (*Graec. affect. cur.* I, 24), has Aristarchus, probably Aristarchus of Samos: A. Fraschetti, 'Aristarco e le origini tirreniche di Pitagora', *Helikon* 15–16 (1975–6), 424–37.

[70] See Burnet, 87 n. 5; Delatte, *Vie*, 147 f.; Aristox. fr. 11 with comm.; Philip, 185.

[71] Porph. *VP* 2 = Neanth. *FGrHist* 84 F 29.

[72] See K. von Fritz, 'Mnesarchos', *RE* 15 (1932), 2270–2.

[73] Neanthes (*FGrHist* 84 F 29); Timaeus (Iust. XX,4,1).

have survived, so this version may be considered historically probable, if not entirely reliable. An aristocrat from Samos might very well have been engaged in large-scale trade, and Pythagoras' education and political activity strongly suggest wealth and aristocratic origins. The story of Mnesarchus being an engraver of stones or seals (δακτυλιογλύφος) was invented by Hermippus,[74] but has been developed – surprisingly – in the scholarly literature: some have linked the rise of incuse coins in southern Italy with the arrival of Pythagoras, who was supposedly familiar with the engraver's trade.[75]

Among his predecessors, Pythagoras is most often linked with Pherecydes. If a fragment of Ion, who first mentions Pherecydes side by side with Pythagoras (B 4), says nothing about any personal connection, the story handed down by Aristotle about Pythagoras meeting a sick Pherecydes on Samos (fr. 611.32, cf. fr. 191) implies one. Andron in his *Tripod* attributes to Pythagoras miracles and prophecies originally ascribed to Pherecydes,[76] and directly calls him a pupil of Pherecydes; this version is followed by Aristoxenus, Dicaearchus, Neanthes, and Duris.[77] 'If Pherecydes had been a sage of the type naturally to attract miracle-stories (as Pythagoras was), the connection between two similar contemporaries would have been invented whether it existed or not.'[78] Strictly speaking, chronology is immaterial here: the legendary tradition linked Pythagoras with Zalmoxis, Empedocles, Hermotimus, Aristeas, and Abaris.[79] Yet unlike Hermotimus and Abaris, Pherecydes was not a legendary figure, and unlike Aristeas and Empedocles he really was a contemporary of Pythagoras. The evidence of Aristotle and the unanimity of the early biographers of Pythagoras make it impossible to view the tradition of

[74] Fr. 19 = *FGrHist* 1026 F 23. See Delatte, *Vie*, 147; Wehrli, comm. on fr. 19; Philip, 186, 197 n. 5; Bollansée, comm. on F 23. Demand's arguments on this point are fantasy: N. Demand, 'Pythagoras, Son of Mnesarchos', *Phronesis* 18 (1973), 91–6. Bollansée (260 ff.) is prepared to take them seriously, supposing that Hermippus' story may well be reliable.

[75] Seltman, *Greek Coins*, 76 f.; Guthrie, i. 176 f. Cf. Philip, 197 n. 5; de Vogel, 52 ff.; Kraay, *Coins*, 164 f. In recent years this idea seems to have faded out.

[76] See above, 63 n. 5.

[77] Andron (*FGrHist* 1005 F 4), Aristoxenus (fr. 14), Dicaearchus (fr. 34), Neanthes (*FGrHist* 84 F 29), Duris (*FGrHist* 76 F 22).

[78] See KRS, 52 f. (for a sceptical view of the link). See also Zeller, i. 383 n. 3; K. von Fritz, 'Pherekydes', *RE* 19 (1938), 2027 f.; Philip, 188.

[79] Zalmoxis (Hdt. IV, 95), Empedocles (Alcidam. *ap*. D.L. VIII, 56; Tim. *FGrHist* 566 F 14), Hermotimus (Her. Pont. fr. 89), Aristeas (cf. Hdt. IV, 13–15; Her. Pont. fr. 90), Abaris (cf. Hdt. IV, 36; Her. Pont. fr. 90; Iamb. *VP* 90–2).

his links with Pherecydes as a literary fabrication. That tradition must have been in existence as early as the fifth century, and had currency in Pythagorean circles. This is confirmed by the story that Pythagoras visited the sick Pherecydes on Delos, and buried him there. Aristoxenus and Dicaearchus place this episode during the time of Pythagoras' life on Samos, but before their time there existed a version which shifted it to the Crotonian period, and thus explained Pythagoras' absence at the time of Cylon's revolt.[80] No doubts have been expressed as to the credibility of the meeting itself.

The problem, however, is that even if we allow that Pythagoras' link with Pherecydes may be part of the ancient biographical tradition, we cannot find in Pythagoras' teaching any features close to the mythical theo-cosmogony of Pherecydes. The early Pythagorean cosmogony leads to Anaximander and Anaximenes, not to Pherecydes.[81] The doctrine of the immortality of the soul, which Pythagoras is supposed to have borrowed from Pherecydes, the metempsychosis attributed in the *Suda* to Pherecydes – these are all late inventions which arose on the basis of the biographical tradition.[82] If being a pupil presupposes a certain kinship of ideas, Pythagoras could hardly have been Pherecydes' pupil.

It is possible that Aristoxenus or Dicaearchus mentioned another teacher of Pythagoras—Hermodamas—and Neanthes certainly did. Hermodamas was a descendant of Creophylus, of the well-known family of Samos singer-poets (*aoidoi*).[83] Outside the biography of Pythagoras, Hermodamas does not appear anywhere, and his histori-

[80] Aristoxenus (fr. 14, cf. Porph. *VP* 15–16, 55); Dicaearchus (fr. 34; cf. Diod. X,3,4). See Delatte, *Vie*, 150 f.; von Fritz, *Pol.*, 5 ff.; Wehrli, *Aristoxenos*, 53. Dicaearchus (fr. 34) and, apparently, Neanthes (*FGrHist* 84 F 30) dismiss the version linking this episode with the absence of Pythagoras during the revolt; it is parodied by Satyrus (see above, 70 n. 40); Iamblichus (*VP* 248) mistakenly asserts that 'everybody accepts it'.

[81] See above, 31 n. 17.

[82] The immortality of the soul (Cic. *Tusc.* I,16,38 = 7 A 5, from Posidonius); metempsychosis (*Suda*, s.v. Pherecydes); Long, *Study*, 13 f.; cf. H. S. Schibli, *Pherecydes of Syros* (Oxford, 1990), 11 ff., 104 f. Aristotle found rational features in the teaching of Pherecydes (7 A 7), who, he thought, could rival Thales (fr. 75). Pherecydes was influenced by Anaximander: von Fritz, 'Pherekydes', 2030 f.; Ch. H. Kahn, *Anaximander and the Origin of Greek Cosmology* (New York, 1960), 240.

[83] From Neanthes (*FGrHist* 84 F 29) this version entered all the late biographies of Pythagoras: D.L. VIII, 2; Porph. *VP* 1–2, 15; Iamb. *VP* 11; *Schol. Plat. Res.* 600c; *Suda* s.v. Pythagoras. See Delatte, *Vie*, 151; von Fritz, *Pol.*, 17; Philip, 189.

city is barely credible.[84] In later times Pythagoras acquires yet more teachers, such as Anaximander and Thales (Porph. *VP* 2; Iamb. *VP* 11–12), but the efforts of the Hellenistic biographers to bind all the great philosophers with the threads of personal continuity scarcely merit serious attention. For all the undoubted closeness of Pythagoras to the Ionian tradition, and his knowledge of the ideas of the Milesian philosophers, it is unlikely that any of them was his direct mentor.

> On reaching the age of forty – says Aristoxenus – and seeing that the tyranny of Polycrates was too severe for a free man to endure this despotic rule, he therefore went away to Italy. (fr. 16)

Dicaearchus also appears to have written about Pythagoras leaving Samos because of the tyranny of Polycrates;[85] this indicates that he and Aristoxenus shared a common source, the Pythagorean tradition. Polycrates came to power on Samos in about 540 and until 522 was the sole ruler of the island. The period of his rule was very favourable for Samos: there was large-scale construction on the island, and the economy flourished. Like many Greek tyrants, Polycrates patronized talented people: the poets Ibycus and Anacreon lived at his court, where the famous doctor Democedes and the engineer Eupalinus, the designer of the Samos tunnel, also worked. What was it that induced Pythagoras to leave Samos? His links with the landed aristocracy, which was hostile to Polycrates, seem to provide a fully probable reason, and this is supported by his choice of place of emigration, Croton, which was ruled by the aristocracy.[86] The policies of the Pythagoreans at the end of the sixth century and the beginning of the fifth were distinctly anti-tyrannical and aristocratic, as was their ideology,[87] and if Aristoxenus, Dicaearchus, and Timaeus followed

[84] W. Burkert, 'Die Leistung eines Kreophyles', *Mus. Helv.* 29 (1972), 77 f. It seems that only M. Detienne, *Homère, Hésiode et Pythagore* (Paris, 1962), has needed Hermodamas as a teacher of Pythagoras.

[85] Themistius (*Sophist.* 285 a–b), who gives a condensed account of all the twists and turns of Pythagoras' political career, in full accord with Dicaearchus' account (fr. 33–5; Zeller, i. 417 n. 2; White, 'Principes' 233), says that the philosopher left Samos for Croton *διὰ Πολυκράτην*.

[86] Minar, 6 f., cf. Lévy, 46. On the forced or voluntary emigration of the Samian aristocrats under Polycrates, see Hdt. III, 44–6; G. Shipley, *A History of Samos: 800–188 B.C.* (Oxford, 1987), 91.

[87] Alcmaeon calls *ἰσονομία* the foundation of health, and *μοναρχία* the root of all ailments (B 4). In the Archaic period, *ἰσονομία* was a typically aristocratic slogan aimed at tyranny: V. Ehrenberg, 'Isonomie', *RE Suppl.* 7 (1940), 293 f.; Chr. Meier, *Die Entstehung des Begriffes Demokratie* (Frankfurt, 1970), 40 ff.; id., *Die Entstehung des*

the Pythagorean tradition, which portrayed Pythagoras as an opponent of tyranny, this tradition fully accords with the information available to us. (It is doubtful, on the other hand, whether the accusations of favouring tyranny, levelled at Pythagoras by Theopompus and Hermippus,[88] had any support in the historical tradition with which Aristoxenus supposedly took issue.[89] These accusations first appear in connection with Socrates[90] and later with the Academy, which is reflected in Aristoxenus' critique of Plato.[91]) If Pythagoras had been *only* a philosopher and scientist (or even *only* a preacher of metempsychosis), he would probably have found a niche under the rule of an enlightened tyrant. However, he was also a man of strong political convictions and not without his own political ambitions. Political activity under a tyranny could only lead him into the entourage of the tyrant, and that path would hardly have suited a person of Pythagoras' nature.

Apollodorus, evidently relying on Aristoxenus, gives Ol. 62,1 (532/1) as the year of Pythagoras' departure from Samos.[92] Following

Politischen bei den Griechen (Frankfurt, 1980), 88; K. Raaflaub, 'Einleitung und Bilanz', in K.H. Kinzl (ed.), *Demokratia: Der Weg zur Demokratie bei den Griechen* (Darmstadt, 1997), 49 f.

[88] See above, 62 n. 4 and below, 99 ff.

[89] See Burkert, 118 f.; Bollansée, comm. on *FGrHist* 1026 F 27. The anti-tyrannical pathos of Aristoxenus is too strong to be seen as merely a reaction to the charges of tyranny directed at Pythagoras. Cylon, Pythagoras's main adversary, was 'of a tyrannical bent' (fr. 18); Polyarchus, the ideological opponent of Archytas was an emissary of the tyrant Dionysius and a defender of tyranny (fr. 50); Dionysius himself was an enemy of the Pythagoreans (fr. 31), and Plato a parasite on Dionysius (fr. 32, 62). Timaeus, like Aristoxenus, was extremely negative in his attitude to tyranny.

[90] In the late 390s, the Sophist Polycrates accused Socrates of being sympathetic to tyranny. Some details of his accusations are known through Libanius, who replied to Polycrates' speech in his *Apology of Socrates* (e.g. §§38, 54, 163, etc.). See e.g. D. Gribble, *Alcibiades and Athens: A Study in Literary Presentation* (Oxford, 1999), 223 ff.; W. M. Calder III et al. (eds. and tr.). *The Unknown Socrates* (Wauconda, Il., 2002).

[91] Fr. 32, 62. It is revealing that Theopompus writes of the *philosophy* of Pythagoras, and not about any particular actions (*FGrHist* 115 F 72). The tradition accessible to the early biographers of Pythagoras did not preserve any information even about his participation in the Cylonian uprising, let alone his attempts to become a tyrant. The late tradition on Pythagoras the tyrant seems to derive largely from Theopompus and Hermippus (see below, 100 n. 165, 101 n. 169).

[92] Rohde, 119 f.; F. Jacoby, *Apollodors Chronik* (Berlin, 1902), 216 f.; Philip, 185; Burkert, 110 n. 4; A. A. Mosshamer, *The Chronicle of Eusebios and Greek Chronographical Tradition* (Lewisburg, 1979), 282. Thus Apollodorus dated Pythagoras' emigration to the very beginning of the tyranny of Polycrates: Ol. 62,1. In Diodorus

Apollodorus, the approximate date of his birth is usually taken to be 570. To be sure, the view has been expressed that Aristoxenus had already synchronized the main event in Pythagoras' life – his arrival in Italy – with the fortieth anniversary of his birth (his acme).[93] While this ploy may indeed be typical of Hellenistic biography, it does not by any means follow that Aristoxenus resorted to it. His biographies were mostly of figures from the recent past – Socrates, Plato, Archytas – so hardly needed any artificial synchronization. It remains to add that the alternative chronologies will not withstand scrutiny,[94] and in the absence of contradictory data, Apollodorus' calculations are accepted by the majority of specialists.

2.3 PYTHAGORAS' JOURNEY

Tradition unanimously dates all Pythagoras' travels outside Greece in the period of his life on Samos. This unanimity is not a matter of accident: by the fourth century this period was as little known as it is today. The desire to fill an irksome lacuna with interesting events played an important role in the steadily growing number of longer and longer journeys. Beginning with Egypt, they gradually took in a substantial part of the world as the Greeks then knew it: the Phoenicians, the Babylonians, the Syrians, the Jews, the Arabs, the Ethiopians, the Indians, the Iberians, the Thracians; nor were the Persian Magi or the Celtic Druids overlooked.[95]

The ancient writers never looked upon Pythagoras' travels as simply a biographical fact in need of confirmation and explanation. From the first reference in Isocrates to the very end of antiquity, his

(X,3,1), whose source used the calculations of Apollodorus, Ol. 61,4 is given as Pythagoras' acme.

[93] Mosshamer, *Chronicle* 234. Cf. A. C. Bowen, 'The Minor Sixth (8:5) in Early Greek Harmonic Science', *AJP* 99 (1978), 501–6.

[94] On Timaeus' chronology of Pythagoras, in so far as it can be reconstructed, see Delatte, 'Chronologie'; von Fritz, *Pol.*, 47 ff. (a critique of Delatte); id., 'Pythagoras', 179 ff.; Philip, 195 f.; de Vogel, 21 ff. Eratosthenes mistook the philosopher for the Olympic victor of 588, Pythagoras of Samos (D.L. VIII, 47 = *FGrHist* 241 F 11), although Duris (*FGrHist* 76 F 61) did distinguish them. See Rohde, 118 f.; von Fritz, 'Pythagoras', 184 f.; Burkert, 110 n. 5; cf. Lévy, 20 f.

[95] Zeller, i. 384 ff.; Delatte, *Vie*, 105; T. Hopfner, *Orient und griechische Philosophie* (Leipzig, 1925), 3 ff.

travels (and his Oriental origins) were set in the context of the search for the 'first discoverers' (πρῶτοι εὑρεταί) of the most varied elements of Greek culture.[96] Journeys were mostly inferred not from facts, but from similarities between something Greek and something non-Greek, and designed to explain the similarity. The emergence and the spread of cultural phenomena were seen by the Greeks within the narrow framework of the formula 'learning – discovery': one could either learn new things from other people, or discover them for oneself. Any phenomenon which bore even the most superficial resemblance to another, earlier phenomenon could be declared a borrowing. The idea that a discovery might be made independently by two peoples was not seriously considered.[97] By the time of Hecataeus and Herodotus, this 'naive diffusionism' had resulted in an obvious bias of Greek thought towards granting the Orient priority in the 'invention' of the most varied aspects of their own culture,[98] especially as the Greeks recognized full well that it was a young culture compared to those of Egypt and Babylon.

Within this framework it becomes clear why a journey to the Orient, which Greek tradition endowed with so many celebrities,[99] was deemed one of the most important instruments of education and transmission of knowledge. In the Hellenistic period, the Greeks' extended cultural contacts reinforced this tendency, as did the logic of the biographical genre: those who actually had travelled to Egypt (Democritus) were now said to have gone to India as well, and those who had not travelled outside Greece at all (Anaxagoras, Empedocles) were nonetheless made to have travelled somewhere.[100] Reinforced by Jewish authors, who derived Greek philosophy and science from

[96] See Zhmud, *Origin*, 34 ff.

[97] A. Kleingünther, *Πρῶτος εὑρετής* (Leipzig, 1933), 57 f., notes that in the literature known to him the question of the independent origin of two identical or similar customs or inventions was never raised. Every εὕρημα had only one πρῶτος, or μόνος εὑρετής, and never a δεύτερος.

[98] J. Vogt, 'Herodot in Ägypten', in F. Focke (ed.), *Genethliakon W. Schmid* (Stuttgart, 1929), 95–137; Ch. Froidefond, *Le Mirage égyptien dans la littérature grecque d'Homère à Aristote* (Paris, 1971).

[99] Hecataeus of Abdera wrote that Orpheus, Musaeus, Melampus, Daedalus, Homer, Lycurgus, Solon, Pythagoras, Oenopides, Democritus, Plato and Eudoxus all visited Egypt (*FGrHist* 264 F 25.96).

[100] Democritus (Plin. *NH* 25,13; D.L. IX, 35); Anaxagoras (Plin. *NH* 30,9); Empedocles (Philostr. *VA* I,2).

the Pentateuch, this tendency was passed on to the Christian Apologists, and then took root in European historiography.[101]

Many forms of Oriental influence on the culture and civilization of Greece are beyond dispute: the adoption of the alphabet from the Phoenicians, the minting of coins from the Lydians, the Oriental style in Greek art of the Archaic period, the clear imitation of Egyptian sculpture by the sculptors of that time. From the Orient came weights and measures, numerous monetary units, cultivated plants, musical instruments, fashions, and the like.[102] To be sure, our increased knowledge of the cultures of the ancient Orient leaves us ever less ground for any connection between the birth of Greek *philosophy* and *science*, and any Oriental stimuli.[103] Nonetheless, this view is still widespread,[104] and hence a need remains for the figure of Pythagoras the Traveller, for the same reasons as in antiquity.

The tradition on the travels of Pythagoras falls into two distinct stages. While up to the last third of the fourth century we have only a single reference to his journey to Egypt, which is ignored by his Peripatetic biographers, in the generation which came after Aristoxenus and Dicaearchus journeys become a standard feature of Pythagoras' life story, and the range of these is rapidly extended. Neanthes called him a Syrian from Tyre and sent him to the Chaldeans to study; Hecataeus of Abdera and Anticleides dispatched him to Egypt; in Timaeus, apparently, there is mention of Egypt and Babylon, and in Onesicritus of India.[105] Clearly, only the tradition pre-dating Neanthes is worth considering; later accounts contain no independent information.

[101] Zhmud, *Origin*, 5, 8 f., 297 f.

[102] W. Burkert, *The Orientalizing Revolution* (Cambridge, Mass., 1992). On the more contentious aspects of influence, see M. L. West, *The East Face of Helicon: West Asiatic Elements in Greek Poetry and Myth* (Oxford, 1997); W. Burkert, *Babylon, Memphis, Persepolis* (Cambridge, Mass., 2004).

[103] See e.g. G. E. R. Lloyd, 'The Debt of Greek Philosophy and Science to the Near East', in his *Methods and Problems in Greek Science: Selected Papers* (Cambridge, 1991), 278–98. Philosophy arose in India at almost the same time as in Greece, but there were no contacts in this field in the 6th cent.: K. Karttunen, *India in Early Greek Literature* (Helsinki, 1989), 108 ff. On contacts in science see below, §§7.1, 9.1.

[104] See e.g. B. L. van der Waerden, *Science Awakening* (New York, 1961); id., *Die Anfänge der Astronomie* (Basel, 1968); M. L. West, *Early Greek Philosophy and the Orient* (Oxford, 1971).

[105] Neanthes (*FGrHist* 84 F 29); Hecataeus (*FGrHist* 264 F 25.96); Anticleides (*FGrHist* 140 F 1); Timaeus (Iust. XX,4.1); Onesicritus (*FGrHist* 134 F 17).

A journey to Egypt is by no means impossible (though not, of course, for educational purposes). Before and after Pythagoras, Solon, Thales (probably), Hecataeus, Herodotus, Democritus, and others had been there. However, the earliest evidence for Pythagoras' journey – and the only evidence before the last third of the fourth century – is unconfirmed, stemming from a source which can hardly be called historical. In a speech in praise of Busiris, the mythical king of Egypt, Isocrates asserts that Pythagoras, having been to Egypt and studied under the Egyptian priests, was the first to introduce Egyptian philosophy to the Greeks, paying particular attention to sacrifices and temple rites (*Bus.* 28). The very nature of this rhetorical exercise gives rise to doubts as to the reliability of the information passed on by Isocrates;[106] moreover, he himself states that he is not concerned about truthfulness (4), and concludes his speech by admitting plainly that he is not telling the truth (33). These admissions apply in full to everything he writes about Greek borrowings from Egypt.[107] It is clear that Isocrates did not intend anybody to take his speech seriously.

At the same time, Isocrates could have drawn on an earlier source: Pythagoras' affinity with Egypt had already been suggested by Herodotus. True, he does not speak plainly of any visit, but twice he links Pythagorean teachings with that country. When he mentions the Egyptian custom of forbidding the burial of the dead in woollen clothes, he states that the Orphics and the Pythagoreans also forbid it (II, 81). Later, while telling of Egyptian metempsychosis, he adds, 'Some Greeks have also used this doctrine as their own, some earlier, some later. I know their names, but do not record them' (II, 123). Clearly those he had in mind above all were the Orphics and the Pythagoreans.[108] Thus Herodotus twice suggests to his readers a similarity between Egyptian religion and Pythagoreanism, and his information bears precisely on what Isocrates mentioned: sacred rites and religious teaching.

The similarity perceived by Herodotus between Egyptian religion and Pythagoreanism is a typical *interpretatio Graeca*. For burial the Egyptians did use only linen shrouds and papyrus, but not because of any ban on wool; it was simply because wool was unsuitable for

[106] Zeller, i. 304 f.; Burnet, 88; Hopfner, *Orient*, 11; Guthrie, i. 173; Philip, 190.
[107] See above, 49.
[108] See below, 222.

mummification.[109] The Pythagorean rite may have been linked with a ban on the use of the flesh of certain animals, which could have been extended to a ban on burial in woollen clothes since they too came from these animals.[110] As for metempsychosis, all specialists in Egyptian religion unanimously reject the idea that it was present among the Egyptians.[111] Herodotus was evidently misled by the Egyptian belief that one of the souls of the deceased person could take the form of various animals.[112] The Egyptians also believed in the immortality of the soul, but these two beliefs cannot be brought together in metempsychosis, because to them life beyond the grave was linked above all with the preservation of the body (that is why it was mummified), and this runs counter to the idea of the transmigration of the soul into another body. Thus the link between Pythagoras and Egypt in Herodotus is founded not on fact but on a seeming similarity between Pythagoreanism and Egyptian religion. If Isocrates took another step in this direction, this does not mean that he had superior knowledge of Pythagoras' biography.[113]

After Neanthes, who made Pythagoras the son of a Syrian merchant from Tyre, anything at all could be written about the Samian sage's Oriental connections. Hecataeus of Abdera, who reported visits to Egypt by many illustrious Greeks, referred to records in the sacred books of the Egyptians.[114] According to his information, Pythagoras

[109] W. R. Dawson, 'Making a Mummy', *JEA* 13 (1927), 40–50. Finds of woollen items in burials are extremely rare (A. B. Lloyd, *Herodotus, Book II. Commentary 1–98* (Leiden, 1976), 373), which indicates that wool was little used in Egypt. In Greece and Italy the climate was different, so a ban on wool applied only to the dead. It is unlikely that the reference to the Pythagorean custom of wearing only linen garments (Iamb. *VP* 100, cf. 149) derives from Aristoxenus (see above, 75 n. 61). On the contrary, a passage which clearly does contain material from Aristoxenus (D.L. VIII, 19) speaks of the wearing of woollen cloaks (cf. Delatte, *Vie*, 189 f.). Whatever the case, Aristoxenus could not have linked the ban on wool with metempsychosis, which he did not believe in (cf. fr. 118–21), or with vegetarianism, which he categorically rejected (fr. 25).

[110] Morrison, 'Pythagoras', 136.

[111] A. Wiedemann, *Herodots zweites Buch* (Leipzig, 1890), 457 f.; H. Kees, *Totenglauben und Jenseitsvorstellungen der alten Ägypter*, 4th edn. (Berlin, 1980), 6; A. B. Lloyd, *Herodotus, Book II. Commentary 99–182* (Leiden, 1988), 59 f.

[112] Wiedemann, *Herodotus*, 458; von Fritz, 'Pythagoras', 188.

[113] It is very likely that Isocrates relied exclusively on Herodotus, who, unlike Isocrates, was far more circumspect in the conclusions he drew. See Guthrie, i. 163 n. 3; A. B. Lloyd, *Herodotus*, 59 f.; Livingstone, *Commentary*, 157 f.

[114] See above, 84 n. 99. None of the Greeks who wrote about Egypt knew the language of that country: E. Iversen, *The Myth of Egypt and Its Hieroglyphs in European Tradition* (Copenhagen, 1961), 41 f.

derived from the Egyptians a ἱερὸς λόγος, the doctrine of metempsychosis, and geometrical theorems. In fact Hecataeus relied on Herodotus[115] and Isocrates, and his list as a whole reflected a tendency, well established by the end of the fourth century, to link almost every second celebrity with Egypt.

Aristotle systematized the early legendary tradition on Pythagoras and the Pythagoreans; Aristoxenus and Dicaearchus systematized the historical tradition, and Eudemus the scientific. None of them supply any information on the Oriental travels of Pythagoras, although the Orient was not an unusual topic at the Lyceum.[116] Aristoxenus obtained his knowledge from Pythagorean circles, but the legends connecting Pythagoras and the Orient clearly arose outside the Pythagorean school. Strictly speaking, we are dealing not with legends but with literary and historical conjectures, by which various writers sought to reinforce their views of Greek dependence on the ancient cultures of the Orient.[117] The conjectures include two curious pieces of evidence which would hardly merit any attention if, among other late authors, they did not name Aristoxenus. One of them is passed down by the Christian writer Hippolytus (d. AD 235).

> Diodorus of Eretria and the musician Aristoxenus say that Pythagoras came to Zaratas the Chaldean, who explained to him that there are two original causes of existing things, father and mother, and of these father is light, and mother darkness . . . And that out of these, from female and male, the entire cosmos is composed. And that the universe, he says, is by nature a musical harmony; and this is why the sun performs a harmonious circuit. According to them, Zaratas says the following of what is born of earth and cosmos: there are two demons, one celestial, one terrestrial . . . As for beans, Pythagoras is reported to have ordered not to eat them, for Zaratas said, etc.[118]

Diels and Kranz cite only the first sentence of this passage, thus turning it into a piece of historical evidence which reaches back via

[115] Metempsychosis (Hdt. II, 123); ἱερὸς λόγος (II, 81); geometry (II, 109); see Burkert, 219.

[116] Eud. fr. 89, 133, 150; Dic. fr. 55–8; Clearch. fr. 5–6, 13–14; Dem. Phal. fr. 66. To these we may add Her. Pont. fr. 68–70, 90. See F. Dirlmeier, 'Peripatos und Orient', *Antike* 14 (1938), 120–36. Eudemus showed himself to be an expert in Oriental theogony: G. Casadio, 'Eudemo di Rodi: Un pioniere della storia delle religioni tra Oriente e Occidente', *WS* 112 (1999), 39–54.

[117] On Neanthes, see above, 67 n. 24, 68 n. 27.

[118] Hippol. *Ref.* I,2,12–14 = Aristox. fr. 13 = 14 A 11.

Diodorus of Eretria to Aristoxenus.[119] But had this completely unknown Diodorus read Aristoxenus, who expended so much effort to prove that Pythagoras, like all normal people, ate beans (fr. 25)?[120] The Zoroastrian teaching on the good and evil 'demons', Hormuzd and Ahriman, was well known in the Academy and the Lyceum, but its founder was said to have lived far back in time.[121] Of all the biographers of Pythagoras, Aristoxenus was the last to venture to send him to study under Zarathustra: this would seem to undermine the Peripatetic's attempt to rationalize the image of Pythagoras and link him with the religious and ethical teaching of the Delphic oracle (fr. 15). This story appears to have arisen in the Hellenistic period,[122] between Neanthes and Alexander Polyhistor, who, in his *On Pythagorean Symbols*, reports that Pythagoras studied under Zaratas the Assyrian.[123] The story has enjoyed great popularity ever since, finding

[119] There are no grounds to suppose, as J. Radicke, 'Diodorus of Eretria' (*FGrHist* 1103 with comm.), that Diodorus was a predecessor of Aristoxenus; see Zeller, i. 385 n. 1; Lévy, 81 f.

[120] Aristoxenus' contribution to this passage may be limited to the line about musical harmony (Lévy, 82; id., *La Légende de Pythagore, de Grèce en Palestine* (Paris, 1927), 21 n. 3). Others have supposed that he may have noticed some similarity between the teachings of Pythagoras and those of the Persians (Zeller, i. 385 n. 1; W. Spoerri, 'A propos d'un texte d'Hippolyte', *REA* 57 (1955), 274 ff.; Jacoby, comm. on *FGrHist* 273 F 94. Cf. Wehrli, comm. on fr. 13; Burkert, 112 n. 16; Radicke, 'Diodorus', 400 f.). However, Aristoxenus could not possibly have attributed to Pythagoras the doctrine described by Diodorus, *pace* Burkert, *Babylon*, 115 f. (see below, 90 n. 128).

[121] Arist. fr. 6; Eud. fr. 150, cf. fr. 89; according to Aristotle (fr. 34) and Eudoxus (fr. 341), 6,000 years elapsed between Zarathustra and the death of Plato. The Academic Hermodorus of Syracuse (fr. 6) dated him even further back in time.

[122] Lévy, 81 f. Cf. P. Kingsley, 'The Greek Origin of the Sixth-Century Dating of Zoroaster', *BSOAS* 53 (1990), 245–65, who argues that the story derives from Aristoxenus. The reports on links between Pythagoras and Zarathustra and the Persians have been briefly surveyed by Guthrie, i. 251 ff., who concludes that the tradition is not historical, but almost certainly derives from Aristotle. I see no grounds for the latter conclusion. The idea that Heraclides of Pontus, who wrote the dialogue *Zoroaster* (fr. 68–70), made Pythagoras the pupil of a magus (J. Bidez and F. Cumont, *Les Mages hellénisés*, i (Paris, 1938), 33 n. 5, 83, 250; Bolton, *Aristeas*, 159) is equally unconvincing. See Gottschalk, *Heraclides*, 111 f., 114 n. 92. A. F. de Jong, *Traditions of the Magi: Zoroastrianism in Greek and Latin Literature* (Leiden, 1997), 315 f., sees neo-Pythagoreanism and Stoicism, rather than Zoroastrianism, in the teaching of Zaratas.

[123] *FGrHist* 273 F 94. The Semiticized form *Ζαράτας* occurs usually in the stories of his meeting with Pythagoras (Jacoby, comm. on F 94, p. 296 f.), in which he becomes Zaratas the Chaldean (the Assyrian), whereas in the Academy and the Lyceum he was known as *Ζωροάστρης* and represented the Persian Magi. This is one further argument against Aristoxenus' having mentioned Zaratas the Chaldean. Weighing up the

its way into all the late biographies of Pythagoras and the excerpts from these.[124]

In the late legends of Pythagoras and Zaratas the Chaldean, two related factors stand out. First, Pythagoras talks to Zaratas (or to some Magi and Chaldeans) in Babylon, which he reaches after being captured in Egypt by the Persian King Kambyses.[125] In 525, when Kambyses conquered Egypt, according to Aristoxenus' chronology (and probably Neanthes'), Pythagoras should have been in Croton. This means that Pythagoras' 'Babylonian captivity',[126] which gave him the opportunity to talk to the Chaldean Zaratas, emerged at a time when a (relatively) reliable chronology had been sacrificed in favour of a more appealing story, making it possible to bring together Egypt and Babylon, and the Persians and Chaldeans.[127] Secondly, the 'Pythagorean teaching', which, on account of its dualism, was compared with Zoroastrianism, was in reality a pseudo-Pythagorean adaptation of Plato's oral teaching, which arose in the late Hellenistic period. The teaching of Zaratas, passed down by Diodorus of Eretria, is undoubtedly akin to the *Pythagorean Memoirs* (late second – early first centuries) cited by Alexander Polyhistor.[128] Alexander's *On*

various possibilities, Jacoby (ibid. 298) suggests that *Ζαράτας* appeared only in late Hellenistic compilations, as seems most probable to me.

[124] Alex. Polyh. *FGrHist* 273 F 94 = Clem. *Strom.* I,15,70 (Cyril. *Adv. Julian.* IX); Plut. *De an. procr.* 1012 E (probably, from Eudorus); Apul. *Apol.* 31, *Flor.* 2,15; Hippol. *Ref.* VI,23,2; D.L. VIII, 3 (travelled to the Chaldeans and the Magi); Porph. *VP* 12 (from Antonius Diogenes); Iamb. *VP* 19 (from Apollonius); *Schol. Plat. Res.* 600c; *Suda*, s.v. Pythagoras Cf. Nicom. *ap. Theol. ar.*, 56.13 f. (from another source).

[125] Cf. individual elements of this story: *FGrHist* 252 F 2.7 (a chronological table from the beginning of the 1st cent. AD): Kambyses; Apul. *Flor.* 2,15: Kambyses, Magi, Zoroaster; D.L. VIII, 3: Chaldeans and Magi; Porph. *VP* 12: Babylon, Chaldeans, Zaratas; Iamb. *VP* 19: Kambyses, Babylon, Magi; *Theol. ar.*, 53.1 f.: Kambyses, Babylon, barbarian mysteries.

[126] Jacoby (comm. on *FGrHist* 273 F 94, p. 296 f.) posited the influence of Jewish tradition here. Hermippus wrote that Pythagoras took his philosophy from the Jews (fr. 22 = *FGrHist* 1026 F 21). The 2nd-cent. Jewish historian Aristobulus (fr. 2) also maintained this.

[127] Neanthes (*FGrHist* 84 F 29) has Pythagoras, himself a Syrian, sent in his youth by his father to the Chaldeans in Tyre; there is no mention of Babylon or Egypt, or of study under Zarathustra, nor is this implied. Egypt and Babylon do appear to have been mentioned by Timaeus (see above, 60 n. 123), but he was speaking only of the study of mathematics and astronomy.

[128] On the *Memoirs* see above, 71 n. 44, and below, 423 f. In Hippolytus, light opposes darkness, male–female, the good demon of heaven creates fire and air, while the evil chthonic demon creates earth and water (*Ref.* I,2,12–13). In the *Memoirs*, the Monad and the Indefinite Dyad produce numbers, and from the numbers come

Pythagorean Symbols, in which he mentions Pythagoras' studies with Zaratas, also relied on pseudo-Pythagorean literature, of course.

At points where fantastic biography and pseudo-doxography meet, nothing is impossible; any invention can be upheld by a reference to the authorities. From some remote corner of that world another piece of 'evidence' surfaced, to be cited in the late compilation *Theologoumena arithmeticae* (later than Iamblichus).[129] Citing the 'Pythagoreans' Androcydes (the author of *On Pythagorean Symbols*) and Eubulides, as well as Aristoxenus, Neanthes, and Hippobotus, it says that the metempsychosis of Pythagoras lasted 216 years (216 is the 'psychagogical cube of six'), and when he was finally incarnated in his body he fled the tyranny of Polycrates for Egypt (not Italy, as Aristoxenus has it!). There he was taken prisoner by Kambyses, and in Babylon was initiated in the barbarian mysteries.[130] From all of this, little more than Pythagoras' flight from Samos and the tyranny of Polycrates may be safely linked with Aristoxenus.[131]

So what can be said about the journeys of Pythagoras if the first reports are unreliable and the later tradition does not add a single plausible detail? Only that we have no grounds to believe that they ever happened.[132]

bodies consisting of fire, air, earth, and water. Light and darkness are 'equal' in the cosmos (D.L. VIII, 24 f. = Alex. Polyh. *FGrHist* 273 F 94). One missing detail appears in the same work by Hippolytus (and in Plutarch before him): Zaratas, the teacher of Pythagoras, called the Indefinite Dyad the mother of numbers, and the Monad the father (*Ref.* VI,23,1–2; Plut. *De an. procr.* 1012 E). Both Hippolytus' references to Zaratas undoubtedly derive from the same source, the bio-doxography of Pythagoras; cf. on the Monad and the Dyad (*Ref.* I,2,6). The same theory is implied in Antonius' novel (Porph. *VP* 12): with Zaratas, Pythagoras heard τόν τε περὶ φύσεως λόγον καὶ τίνες αἵ τῶν ὅλων ἀρχαί.

[129] *Theol. ar.*, 52.8 ff. (from *On the Decad* by Anatolius, the teacher of Iamblichus, cf. Anat. *De decad.*, 10.5 ff.) = Aristox. fr. 12 = Neanth. *FGrHist* 84 F 29a. = Hippob. fr. 13.

[130] Anatolius used a source close to the one on which Hippolytus' bio-doxography of Pythagoras is based (*Ref.* I,2). Their shared components include: (1) the use of Pythagorean apocrypha (Androcydes); (2) metempsychosis mingled with arithmology (on 'square cubes' and 'cube cubes', see *Ref.* I,2,9–10); (3) mention of Euphorbus (as the first reincarnation of Pythagoras) and the Trojan era. One of the treatises attributed to Pythagoras may have mentioned the period of 216 years (D.L. VIII, 14; Thesleff, 171 n. 3; Burkert, 140 n. 100).

[131] Wehrli, comm. on fr. 12.; Burkert, 139 n. 108.

[132] Zeller, i. 391: Pythagoras' travels are not impossible, but cannot be proven; see also Burnet, 88; Hopfner, *Orient* 11 ff.; *KRS*, 224. Von Fritz, 'Pythagoras', 186; Riedweg, *Pythagoras*, 76: travels are possible. Burkert, 112: links with the Orient are real.

2.4 MAGNA GRAECIA

The Achaean colony of Croton, like many others in Italy, was founded at the end of the eighth century. In subsequent times economic progress was steady in the cities of southern Italy, of which the main ones were Sybaris, Croton, Metapontum, Syris and Locri; from the mid-sixth century their interests begin to conflict. The reason was apparently not so much trading rivalry as land. Seeking to extend their territory, the cities of Magna Graecia ultimately clashed.[133] After a series of victories over its neighbours, Croton suffered a serious defeat at the hands of the Locrians in a battle on the river Sagras (after 550).[134] The temporary absence of Crotonian winners at the Olympic Games in 544–536 may be seen as an indirect consequence of the decline that followed this defeat. In the previous forty years (588–548) they had had six victories.[135] It seems, however, that the landed aristocracy who ruled in Croton had developed such a powerful agonistic spirit that it could not be broken even by a military defeat costing the city many lives: soon the Crotoniates achieved even more impressive sporting feats. Besides athletes, Croton was renowned for its physicians. One of them, Democedes, achieved fame throughout Greece and earned himself far more attention from Herodotus than Pythagoras (III, 125, 129, 130–7); another, Alcmaeon, set down in his book the first theory of medicine in antiquity. Both these categories – athletes and physicians – will reappear later in the entourage of Pythagoras.

In 532, when, according to Apollodorus' calculations, Pythagoras arrived in Croton, the famous wrestler Milon achieved his first victory at the Olympic Games. In the forty years that followed, Crotoniates were victorious thirteen times in wrestling and running – more than any other *polis* in the history of the Olympics.[136] Following the ancient tradition, many scholars link the upsurge in Crotonian spirit

133 Dunbabin, 356 ff.

134 Strab. VI,1,10. 12; Dunbabin, 360; Giangiulio, *Ricerche*, 251.

135 Mann, *Athlet*, 164 ff.

136 Ibid. According to Strabo (VI,1,12), who quotes the proverb 'The last Crotoniate was first among the other Greeks', at one Olympiad seven athletes who beat all the others in racing in the stadium were from Croton. Numerous other victories by Crotonian athletes in other events are also known (Mann, *Athlet* 166 f.).

with the influence of the ethical teaching of Pythagoras.[137] According to Timaeus, whose account survives in abridged form in Pompeius Trogus, after the battle on the Sagras the Crotoniates stopped seeking glory and turned away from martial deeds. Giving in to their own wishes, they would have sunk into decadent luxury, had it not been for the philosopher Pythagoras, who turned the people back towards moderation after his arrival in Croton. Speaking every day in praise of virtue, he often addressed women separately from their husbands, and children separately from their parents. He persuaded women to renounce expensive clothes and adornments, and to lead a modest life. Among adolescent boys he enjoyed even greater success (Iust. XX,4,1–13). The struggle against indulgence is a favourite motif in Timaeus, and in this case it apparently goes back to ancient Pythagorean tradition.[138] Pompeius Trogus makes no mention of the Crotonian sporting successes, but we may surmise that Timaeus did nonetheless speak of them: Strabo, who used Timaeus, calls Milon a pupil of Pythagoras.[139] And yet Milon probably won at the Olympics, in the youth category, as early as 540, and at the Pythian Games in 538,[140] so his victory in 532 can hardly be connected to the arrival of Pythagoras.

Before Timaeus, Dicaearchus had mentioned the speeches of Pythagoras, but whether he said anything about their content is unknown. However, his description of Pythagoras' arrival in Croton is such as to make clear that Pythagoras achieved instant and dazzling success.

[137] Dunbabin, 361; Morrison, 'Pythagoras', 144 f.; Guthrie, i. 175; de Vogel, 60 f.; A. Mele, 'I pitagorici e Archita' (1981), in A. Mele, *Magna Grecia: Colonie achee e pitagorismo* (Milan, 2007), 242 f.

[138] Cf. *FGrHist* 566 F 9, 44, 50; Talamo, 'Pitagora'. The struggle with τρυφή and immoderation as a whole is one of many elements that unite Pythagoras with the ideology represented by the first lawgivers, the Seven Sages, and the Delphic oracle. Xenophanes spoke out against the ἁβροσύνη of the Colophonians (B 3), seeing it as the influence of the Lydians. See R. Bernhard, *Luxuskritik und Aufwandsbeschränkungen in der griechischen Welt* (Stuttgart, 2003), 27 f.

[139] VI,1,12. See above, 69 n. 35. In Apollonius, on the other hand, Pythagoras in his speech to the adolescent boys is critical of excessive interest in athletics and care over the body (Iamb. *VP* 42–4). This reaffirms yet again that only isolated elements of these speeches go back to Timaeus (see above, 69 n. 36).

[140] L. Moretti, *Olimpionikai: I vincitori negli antichi agoni olimpici* (Rome, 1957), 71 f.; H. Buchmann, *Der Sieg in Olympia und in den anderen panhellenischen Spielen* (Munich, 1972), 20; Mann, *Athlet*, 166.

> When Pythagoras arrived in Italy and came to be in Croton – as a man who had arrived after wandering far, was exceptional and was well endowed in his personal nature by fortune, for he had a great and free-born physique, much charm and beauty in his voice, character and everything else – he had such an effect on the city of the Crotoniates that after he had influenced the council of the elders with many fine arguments, he made addresses suitable for their age in turn to the young, when bidden by the councillors, and after this to the children gathered in groups from the schools, then to women, when an assembly of women was created for him. (fr. 33, tr. Mirhady)

Dicaearchus exploited the same tradition on Pythagoras' speeches as Antisthenes (fr. 51), placing them at the moment of the philosopher's arrival in Croton. The idea that Pythagoras could so quickly attain influence over Croton's ruling aristocracy, of a thousand citizens with full rights,[141] seems improbable, whether or not we owe this version to Dicaearchus or to an earlier source. Pythagoras arrived in Magna Graecia alone, without any support from his home *polis*. In the sixth century the fate of such people was seldom to be envied – we need look no further than the example of Xenophanes. Pythagoras' subsequent success may be attributed to his charismatic qualities, but, in the account of his becoming Croton's main moral authority as soon as he arrived, the details which might make this more plausible are lacking.[142] It is revealing that the first event with which tradition links his name is the conflict between Croton and Sybaris, which took place twenty years after his arrival in Italy. This seems to suggest that the ranks of his followers – and therefore his influence – increased gradually. The Cylonian revolt and Pythagoras' flight to Metapontum – both of which events followed the war with Sybaris – confirm that even when the Pythagoreans were at the summit of their success they were not able to subject all the citizens of Croton to their influence.

Without disputing the historicity of Pythagoras' moral sermons addressed to various age groups and social groups, let us consider one

[141] On the Crotonian 'thousand', who comprised the political class of the *polis*, see Giangiulio, *Ricerche*, 29 f., 294 f. The constitution of Rhegium, Locri, and other southern Italian *poleis* was similar.

[142] Without having any formal authority vested in him, a sage whom the whole *polis* heeded could appear only at a time of crisis. The Athenians invited Epimenides to rid the city of a pestilence but when he succeeded sent him straight back to Crete (D.L. I, 109–11). In Croton a crisis arose on the eve of the war with Sybaris.

more means of gaining influence which the tradition records: the rearing of the young.[143] Though slower, this proved to be the surer route. The circle of aristocratic young followers which formed round the sage of Samos – the basis for the future Pythagorean community – extended its influence in Croton as its members grew to maturity. This is exactly how events are presented by Timaeus, whose account is reflected by Pompeius Trogus and Apollonius.[144] According to Pompeius, three hundred youths, bound by a vow in a unified association, lived apart from other citizens, and by so doing turned the city against them.[145] In Apollonius' more detailed account, the Pythagoreans were the object of envy from their childhood: as long as Pythagoras spoke to all comers, he was liked, but when he consorted only with his pupils, he lost esteem. Meanwhile as the youths, all from wealthy and reputed families, 'advanced in age, they not only became pre-eminent in their private lives, but also in publicly managing the city: they formed a large political club (*ἑταιρεία*) (for they were more than three hundred); but they were still only a small part of the city, which was not governed by their customs and way of living'.[146] Timaeus' realistic approach contradicts Aristoxenus (who sees only Cylon and his supporters as enemies of Pythagoras) and is very likely to be close to reality.

The account given by Diodorus Siculus and Strabo of the war between Croton and the much richer and stronger Sybaris (510), during which the Crotonian army, led by the Pythagorean Milon,

[143] According to Isocrates, all the youths wanted to be pupils of Pythagoras, and their fathers preferred to see them enjoying his company, rather than left to their own devices (*Bus.* 29). Plato calls him *ἡγεμὼν παιδείας*, revered by his pupils and his followers (*Res.* 600a–b).

[144] Delatte, *Pol.*, 11; von Fritz, *Pol.*, 41 ff.; id., 'Pythagoras', 182 f.; Minar, 54; Giangiulio, *Ricerche*, 26 f.

[145] Iust. XX,4,14. Cf. *προσιόντων δ' οὖν αὐτῷ τῶν νεωτέρων καὶ βουλομένων συνδιατρίβειν, οὐκ εὐθὺς συνεχώρησεν, ἀλλ' ἔφη δεῖν καὶ τὰς οὐσίας κοινὰς εἶναι τῶν ἐγτυγχανόντων* (Tim. F 13a).

[146] Apoll. *FGrHist* 1064 F 2 = Iamb. *VP* 254, tr. Dillon & Hershbell. The Pythagorean *hetairoi* are mentioned by Aristoxenus, Dicaearchus, and Neanthes, see below, 146 n. 33. – Timaeus' version found its way into the biographical vulgate, traces of which are preserved in Diogenes Laertius (VIII, 3): 'Pythagoras and his pupils were held in great estimation; for, being nearly three hundred in number, so well (*ἄριστα*) did they govern the state that its constitution was in effect a true government of the best (*ἀριστοκρατία*)' (tr. Hicks). *Schol. Plat. Res.* 600c (see above, 73 n. 51) also speaks of 300 pupils. In D. L. VIII, 15; Iamb. *VP* 29, and the *Suda* the number is doubled.

routed the Sybarites, also goes back to Timaeus.[147] It follows from this that the Pythagorean *hetairia* was by this time sufficiently powerful to exert decisive influence both on political decision-making and on the course of the war itself. According to Diodorus, Telys, the tyrant of Sybaris, first expelled five hundred eminent citizens and confiscated their property; then, when they tried to take refuge in Croton, at the altar on the agora, he demanded their return under threat of war. The council and the people hesitated, but after Pythagoras had spoken the exiles were granted asylum, and this was the cause of the war.[148] Besides Diodorus, Iamblichus twice provides an embellished story of a meeting between Pythagoras and an embassy from Sybaris, who demanded the return of the fugitives and were refused.[149] It is difficult to assess the reliability of Timaeus' account of the events.[150] Around the catastrophic defeat of Sybaris, which fell victim to its own τρυφή, legends began to take shape as early as the fifth century, and the writings of many authors reflect them.[151] Andron has Pythagoras predicting the fall of Sybaris, from which

[147] Diod. XII,9,2–10,1; Strab. VI,1,12–13. On Timaeus as a source, see above, 69 n. 35; against this, see Rohde, 150 f.; Burkert, 116 n. 65, cf. Giangiulio, *Ricerche*, 17 n. 44. Timaeus undoubtedly described this war, after which the Crotoniates – in his words – lapsed into luxury (*FGrHist* 566 F 44). According to Diodorus (X,23; XII,9,2.5) and Strabo (VI,1,13), the army (or the population) of Sybaris numbered 300,000. Since Ephorus (*ap.* Ps.-Scymn. 340 f.; F. Gisinger, 'Skymnos', *RE* 3A (1927), 682) reckoned the number of the Sybarites at 100,000, he could not have been the source for Diodorus in XII,9,2–10,1 (*pace DK* I, 102.29; Timpanaro Cardini, i. 53; N. K. Rutter, 'Diodorus and the Foundation of Thurii', *Historia* 22 (1973), 155–76; Bugno, *Sibari*, 37). Contra Bugno, there is no contrast between the accounts of the defeat of Sybaris given in Diod. X,23 and XII,9–10,1, both of which can be traced back to Timaeus.

[148] Burkert, 116 n. 65, stresses the lack of logic: Telys first expels the Sybarites, then demands their return, but does this speak against Timaeus' authorship? Herodotus (V, 44–5) provides a different version of the war, from which the Pythagoreans are absent. For inexplicable reasons, Herodotus says nothing about their participation in politics, including their ultimate defeat, which came about shortly before Herodotus settled in Thurii (cf. Philip, 20 n. 3). Herodotus does not report the causes of the war, but it is initiated by the tyrant Telys. One detail is an indication of long-standing enmity between the two *poleis*: Philip of Croton, an Olympian of 520, was expelled from the city for becoming betrothed to Telys' daughter (Hdt. V, 47).

[149] *VP* 133, 137. Rohde, 150, 158, divided the identical episodes between Iamblichus' two main sources, attributing the first to Nicomachus and the second to Apollonius. Cf. Lévy, 113, 126.

[150] Dunbabin, 362 f.; G. De Sensi Sestito, 'Gli oligarchici sibariti, Telys e la vittoria crotoniate sul Traente', *MStudStor* 3 (1983), 37–56; Giangiulio, *Ricerche*, 18 ff., 277.

[151] Arist. fr. 583; Her. Pont. fr. 49, 57.

we may conclude that the legendary tradition had long since linked that event with the name of the sage.[152]

The military victory over Sybaris made Croton the strongest city in southern Italy for over half a century. Neighbouring *poleis* became its dependent 'allies',[153] and these included Sybaris, which, contrary to a tradition widespread in antiquity, was not completely destroyed.[154] Aristoxenus' catalogue lists twelve Pythagoreans from Sybaris, some of whom apparently moved to that city after its subjugation.[155] In Croton itself the dominance of the Pythagoreans was interrupted several times by outbreaks of political struggle, the first of which is known as the Cylonian conspiracy.[156] The Pythagorean tradition handed down by Aristoxenus depicts Cylon in dark hues and reduces the motivation for his revolt to a grudge against Pythagoras.

> Cylon, a Crotoniate, by birth, reputation, and wealth was one of the first citizens, but in other respects he was ill-tempered, violent, disruptive, and tyrannical in character. Being eager to share the Pythagorean way of life, he approached Pythagoras, by then an old man, but was turned down for the reasons stated. After this happened, he and his friends began a violent struggle against Pythagoras and his companions. (fr. 18)

Aristotle also wrote of personal rivalry between Cylon and Pythagoras, and named another rival of Pythagoras, Onatas, who is listed

152 *FGrHist* 1005 F 3. The fact that Pythagoras foretells the fall of Sybaris does not exclude his participation in subsequent events (as Burkert, 116 n. 65). The legendary tradition frequently has Pythagoras predicting events in which he himself was involved. According to a legend transmitted by Aristotle (fr. 191), Pythagoras foretold the coming revolt and for this reason departed unobserved for Metapontum. Aristoxenus (fr. 18), Dicaearchus (fr. 34), and Timaeus (Iust. XX,4,16–17), however, testify that Pythagoras left Croton *because of* the Cylonian uprising, not before it. Moreover, Aristotle considered Cylon a rival of Pythagoras (fr. 75).

153 Evidence of this is furnished by the alliance coins with the Crotonian tripod on one side and the symbol of one of the dependent *poleis* – Sybaris, Temesa, Pandosia, Kaulonia, and others – on the reverse. See U. Kahrstedt, 'Zur Geschichte Grossgriechenlands im 5. Jahrhundert', *Hermes* 53 (1918), 180–7; von Fritz, *Pol.*, 80 ff.; Minar, 36 ff.; Dunbabin, 365 f.; de Vogel, 52 f.; Kraay, *Coins*, 172 f.; G. Gorini, *La monetazione incusa alla Magna Grecia* (Milan, 1981), 147 ff.

154 The first alliance coins from Croton and Sybaris date from *c.*500: C. Kraay, 'The Coinage of Sybaris after 510', *NC* 18 (1959), 13–37. After their defeat, some Sybarites moved to their colonies Laos and Skydros (Hdt. VI, 21).

155 *DK* I, 446.30 f. Some scholars posit the presence of Pythagoreans in Sybaris even before its subjugation (De Sensi Sestito, 'Oligarchici', 47 f.; Bugno, *Sibari*, 38 f.).

156 Von Fritz, *Pol.*, 42 ff.; Minar, 52 ff.; Morrison, 'Pythagoras', 147 f.

among the Crotonian Pythagoreans.[157] The presence of members of the Pythagorean *hetairia* among his political opponents suggests that Aristoxenus' account of events was intended to draw a veil over the fact that Cylon too might have had links to the Pythagorean society. Traces of a tradition testifying to this are preserved in Iamblichus, who calls Cylon 'the exarch of the Sybarites' (*VP* 74). Given the decisive role of the Pythagoreans in the victory over Sybaris and their increased influence after the war, it is natural to suppose that the office of 'exarch of the Sybarites' could hardly be open to someone unconnected to the Pythagorean *hetairia*. It is of interest that, in Iamblichus, Cylon was not immediately rejected by Pythagoras (as in Aristoxenus), but first underwent a prolonged period of tests and was only then excluded from the ranks of the Pythagoreans, and a gravestone was placed for him while he was still alive.[158] Similar legends were told of the Pythagorean Hippasus, who, in Apollonius' account of the Cylonian conspiracy, also turns out to be an adversary of Pythagoras, while – moreover – being a member of the ruling Crotonian 'thousand'.[159] On the whole Hippasus (like Cylon) is painted in dark colours in the Pythagorean tradition, and this is connected, of course, not with his betrayal of the school's mathematical 'secrets', but with his very real political rivalry with Pythagoras.[160]

[157] D.L. II, 46 = Arist. fr. 75 = fr. 21.1 Gigon = 14 A 15 *DK*, cf. *DK* I, 446.13. See Minar, 53; Timpanaro Cardini, i. 54.

[158] Rohde, 137 f., attributed Iamb. *VP* 74 to Nicomachus, according to whom the conspiracy against the Pythagoreans was led by those who had been rejected by them (i.e. had not passed the tests) and publicly shamed (*VP* 252 = *FGrHist* 1063 F 2). Minar, 69 f., suggested that Cylon was a governor of Sybaris as a Pythagorean, and was only expelled from the society later. See also Dunbabin, 366; A. Mele, 'Crotone e sua storia', *Crotone (Atti del 23 Convegno di studi sulla Magna Grecia*; Taranto, 1984), 56 n. 324; Giangiulio, *Ricerche*, 311 n. 52; Bugno, *Sibari*, 41 f.

[159] *FGrHist* 1064 F 2 = Iamb. *VP* 257. According to one of the legends, a Pythagorean who gave out the secret of irrational numbers was expelled from the community and in his lifetime a gravestone was raised for him (Iamb. *VP* 246, cf. Clem. *Strom.* V,9,58); another legend has it that Hippasus gave out the secret of the construction of the dodecahedron, and died the death of the impious at sea (*VP* 88). In the late tradition, attempts were made to present Hippasus as the leader of the *mathematici*, who were not acknowledged as Pythagoreans by the *acusmatici*, who claimed descent from Pythagoras (Iamb. *Comm. Math.*, 76.19 ff., cf. *VP* 81).

[160] See below, 100 n. 165. Another of Pythagoras' opponents from the Crotonian 'thousand', Theages (Apoll. *FGrHist* 1064 F 2 = Iamb. *VP* 257, 261), is missing from the catalogue of Pythagoreans. However, to him, as to Onatas, some pseudo-Pythagorean writings are attributed (Thesleff, 138 f., 189 f.); this implies a tradition in which Theages was considered a Pythagorean.

Thus, several independent sources point to the existence of a version of Cylon's conspiracy which is different from that of Aristoxenus and treats the events not simply as a conflict between Pythagoreans and supporters of Cylon, but as – among other things – a rift within the Pythagorean society.[161] This tradition is seen most clearly in Apollonius, who unfortunately conflated several accounts pertaining to different events: Cylon's revolt at the end of the sixth century, and the final defeat of the Pythagoreans in the mid-fifth century.[162] Apollonius displays traces of Timaeus' version, but his narrative as a whole cannot be derived from the Sicilian historian.[163] In Timaeus, Pythagoras, an opponent of tyranny, leaves Croton as a result of the revolt, while in Apollonius he leaves *before* the revolt (as in the legend transmitted by Aristotle, fr. 191), during which his supporters are accused of attempting to establish a tyranny.[164] Thus in Apollonius

[161] P. Tannery, 'Sur le secret dans l'école de Pythagore', *AGPh* 1 (1888), 35 f., who linked the schism in the Pythagorean community with the giving out of the secrets, was the first to suggest this interpretation of the events. Traces of the tradition of the schism among the Pythagoreans were noted by Corssen, 'Sprengung', 339 ff., who pointed to the passage on Cylon (Gylon) being expelled from the Pythagorean society and setting fire to the school (Olymp. *In Phaed.* I,13.18). Delatte, *Pol.*, 244 f., raised objections but his arguments are debatable. Von Fritz, *Pol.*, 59 f., followed Delatte in maintaining that the schism could not have been the *main* reason for Cylon's revolt, although he did not reject the account of the schism itself. See also Bugno, *Sibari*, 39 f.

[162] Delatte, *Pol.*, 213 f.; von Fritz, *Pol.*, 59 ff.; Giangiulio, *Ricerche*, 27 n. 73.

[163] Although Rohde, 116 ff., maintained that this account was invented by Apollonius himself (see also Corssen, 'Sprengung', 347 f.), many have linked it with Timaeus (Bertermann, *De Iamblichi*, 37 ff.; Rostagni, 'Pitagora', 5 ff.; Delatte, 'Chronologie'; id., *Pol.*, 213 ff.; Minar, 54 ff.; Morrison, 'Pythagoras' 147 f.; de Vogel, 22 f.). Von Fritz, *Pol.*, 47 ff., showed that Timaeus was not Apollonius' only source (see also Jacoby, *FGrHist* IIIb, 550 f. nn. 191–8; Giangiulio, *Ricerche*, 28 f.). The beginning of Apollonius' account (Iamb. *VP* 254 = *FGrHist* 1064 F 2), dealing with events *before* the revolt, does indeed coincide with Pompeius Trogus (Iust. XX,4,14), but from *VP* 255 he follows a different source. Von Fritz, *Pol.* 55 ff., followed by Giangiulio, *Ricerche*, 28 n. 74, thought that *VP* 255–64 also showed traces of Timaeus, but all the reliable parallels they note refer to *VP* 254, except for the figure of 300,000 Sybarites (*VP* 260). Even if one further detail is added (common property in *VP* 257, cf. Tim. F 13), this is plainly not sufficient to link *all* of Apollonius' account to Timaeus.

[164] 'But when they conquered Sybaris and Pythagoras departed . . . the masses turned against the Pythagoreans' (*VP* 255); cf. above, 97 n. 152. We should note some further discrepancies: in Timaeus the Crotoniates fall into τρυφή after the victory over Sybaris (F 44); in Apollonius there is no τρυφή. In Timaeus the enemies of the Pythagoreans intend to burn them (Iust. XX,4,15; cf. Polyb. II,38,10: συνέδρια of the Pythagoreans were burnt); in Apollonius there is no mention of any burning. While Timaeus, who was known for his δεισιδαιμονία, often introduced the rage of the gods and other such motifs (e.g. Diod. X,23; see Meister, *Sizilische Geschichte*, 7 f.), Apollonius' account is strictly realistic.

two traditions which were unconnected originally became combined: (1) a schism dividing the Pythagoreans, and (2) the tyrannical nature of their rule. While the first of these, preceding Aristotle, may reflect the historical reality, the second, which is hostile to the Pythagoreans, leads us to Theopompus, who was the first to accuse Pythagoras of tyrannical tendencies. Since one of the key elements in the account of Apollonius coincides with the charges of the Chian historian,[165] and the account as a whole has nothing in common with those of Aristoxenus, Dicaearchus, Neanthes, and Timaeus,[166] there is reason to believe that its basic components go back to Theopompus, whom Apollonius amplified in arbitrary fashion, just as he had the speeches of Pythagoras, for example (Iamb. *VP* 37–57).

Theopompus, like Timaeus, considered the life of Pythagoras within the framework of general history,[167] but unlike Timaeus he was ill-disposed towards the philosopher, and moreover was known for a tendency to offer interpretations of events which differed from those of his predecessors, and portrayed the actors in those events in a light that was far from the best.[168] From Apollonius' account it follows that the charges of tyrannical tendencies levelled against the Pythagoreans were not altogether groundless, and their opponents

[165] This was first noted by Wehrli (comm. on Hermipp. fr. 21). Ninon, one of the opponents of the Pythagoreans, compiled a pamphlet supposedly based on a study of their secret teachings, with the title Ἱερὸς λόγος, and presented their philosophy as a conspiracy against the majority: τὴν φιλοσοφίαν αὐτῶν συνωμοσίαν ἀπέφαινε κατὰ τῶν πολλῶν (*VP* 258–60). Theopompus spoke of 'Pythagorean teaching about conspiracy' (τὸ τῶν Πυθαγορικῶν δόγμα περὶ τῆς ἐπιβουλῆς), and claimed that the true aim of Pythagoras' philosophy was tyranny (*FGrHist* 115 F 73; see above, 62 n. 4, 82 n. 91). In both cases the subject is the *philosophy* of the Pythagoreans (which should have been of least concern to their adversaries), and not their politics, which did provoke opposition. According to Sotion, Hippasus wrote a Μυστικὸς λόγος, with the aim of discrediting Pythagoras (D.L. VIII, 7). The work in question is clearly the same as the one attributed to Ninon (Tannery, 'Sur le secret', 35; Delatte, *Pol.*, 217).

[166] Iamblichus notes the difference between the account of Apollonius and all the others (*VP* 254).

[167] As Radicke (comm. on *FGrHist* 1064 F 2) notes, the 'historical' approach of Apollonius' account, its political terminology and sociological model of a class struggle (democrats versus oligarchs), point to a historian of the late 4th cent. who was well acquainted with the events of Athenian history, which served him as a model. Theopompus fits the role of such a historian no worse than Timaeus. However, doubts are raised by the fact that, in the eighth book of his *History of Philip*, Theopompus deals mainly with various θαυμάσια, whereas Apollonius' account is fully realistic.

[168] R. Laqueur, 'Theopompos', *RE* 5A (1934), 2184 f.; W. R. Connor, *Theopompus and Fifth-Century Athens* (Cambridge, Mass., 1968), 117 f.; M. A. Flower, *Theopompus of Chios* (Oxford, 1984), 169 ff., 184 ff.

emerge even worse: falsification, hired assassins, bribed judges, the expulsion of families and children, etc. were all put to use. Besides numerous anachronisms, Apollonius' account abounds in details which may at first glance appear 'historical' but are not confirmed by so much as one of the early biographers of Pythagoras.[169] Although Theopompus was able to rely on a tradition which reached back to the anti-Pythagorean outbreaks of the mid-fifth century, it is not possible to use the version set down by Apollonius as the basis for a reconstruction of the events of Cylon's revolt. It is revealing that Cylon himself – strangely – is presented here not as the leader of the anti-Pythagorean party (as in all the other biographies), but merely as one of the orators who delivered a speech against the Pythagoreans (*VP* 258). Apollonius' approach to the historical sources is most strikingly characterized by the fact that Cylon, Democedes, and Hippasus, who – according to his version – played an active role in the political struggle in Croton, date from the end of the sixth century, and the events in which they take part, like the demands of the enemies of the Pythagoreans, for example, the choice of magistrates by drawing lots (*VP* 257), date from the mid-fifth century.[170] Contrary to Apollonius, Cylon's conspiracy was neither anti-tyrannical nor democratic. It was a struggle between one part of the oligarchic

[169] Theopompus's story could have entered the biographical tradition (among other ways) via Hermippus, who quoted it (see above, 62 n. 4). Hermippus preferred 'deviant' versions, hostile to Pythagoras, and wrote *On Those who Converted from Philosophy to Autocracy* (*FGrHist* 1026 T 12). Besides the 'standard' version of the death of Pythagoras (he was burned to death, with some of his followers, in the house of Milon by some who had been barred from entering the community), Diogenes Laertius (VIII, 39–40) gives another version, in which this was done by some Crotoniates who feared the establishment of a tyranny; Pythagoras perished because he did not wish to cross the bean field (*τινὲς δ' αὐτοὺς τοὺς Κροτωνιάτας τοῦτο πρᾶξαι, τυραννίδος ἐπίθεσιν εὐλαβουμένους. Τὸν δὴ Πυθαγόραν καταλειφθῆναι διεξιόντα· καὶ πρός τινι χωρίῳ γενόμενος πλήρει κυάμων κτλ.*). Hermippus, cited later by Diogenes, described the death of Pythagoras in exactly this way (fr. 20 = *FGrHist* 1026 F 25; cf. *Schol. Plat. Res.* 600c; *Suda*). Although some details do not match (Apollonius says nothing about arson or the death of Pythagoras; Hermippus has him perish in the war between Acragas and Syracuse), fragments of Hermippus confirm the merging of the two themes which are reflected in Diogenes (Delatte, *Vie*, 241 f.): tyranny and death at the bean field (Hermipp. fr. 21–2 = *FGrHist* 1026 F 21, 27).

[170] Von Fritz, *Pol.*, 61, called Apollonius' method 'large-scale historical fresco painting'. It is interesting that the Pythagoreans Alcimachus, Deinarchus, and Meton, who defended the Crotonian constitution against reform (*VP* 257), appear in Aristoxenus' catalogue as Parians, see below, 113 n. 36.

aristocracy and another.[171] The active participation of the Pythagorean *hetairia* in the political life of Croton provoked the hostility of that part of the local aristocracy which was removed from the making of important decisions. This hostility probably intensified with the increase in Pythagorean influence after the victory over Sybaris, and to this was added the schism in the Pythagorean community.

It is very difficult to form an assessment of the role of Pythagoras himself in the events of that time; the sources say nothing about his participation in the struggle for power at the time of Cylon's revolt. Aristoxenus limits himself to a brief reference, saying that 'because of those events Pythagoras went away to Metapontum, where, it is said, he ended his days' (fr. 18; cf. Arist. fr. 191); this accords with Timaeus' account (Iust. XX,4,17). Dicaearchus confirms that Pythagoras went to Metapontum after unsuccessful attempts to settle in Kaulonia and Locri, which did not admit him, and then in Tarentum, where he 'endured the same as in Croton' (fr. 34).[172] From Dicaearchus' words it is clear that he was relying on an Italian oral tradition which drew together different events: the revolt in Croton and the Italy-wide rout of the Pythagoreans.[173] This is the origin of both Pythagoras' wanderings through the cities of Magna Graecia, where the Pythagoreans put down roots after his death, and the revolt in Tarentum. The account of the death of Pythagoras given by Dicaearchus implies that political persecutions continued to the very end of his life: 'Pythagoras died after fleeing to the temple of the Muses at Metapontum, where he starved for forty days' (fr. 35). If we are to believe this account, Pythagoras died before the beginning of the fifth century, as the Cylonian revolt most likely took place soon after the war with Sybaris (510), although the exact date is not known. Apollodorus, however, relying on Aristoxenus, placed his death in 497/6. Although our sources offer no hope of resolving these chronological difficulties, the grounds for placing Pythagoras' death in the early nineties of the fifth century are stronger. We have no good reason to try to correct

[171] Von Fritz, *pol.*, 59 f.; cf. Minar, 58 f., 70 f.; Dunbabin, 366.

[172] According to Dicaearchus, the elders of Locri addressed him thus: 'We hear, Pythagoras, that you are a wise and skillful man, but our laws are beyond reproach and we wish to live by them as before; and you may take what you need from us and go somewhere else' (fr. 34). On this historical anecdote, see G. Maddoli, 'Pitagora a Locri in Dicearco', *Annali dell' Università di Lecce* 5 (1969–71), 53–62.

[173] Delatte, *Pol.*, 212; cf. Minar, 67 f.

Apollodorus, and the circumstances of Pythagoras' death passed down by Dicaearchus do not constitute one.

In conclusion, a few words about Pythagoras' family.[174] The woman usually named as his wife is Theano, the daughter of Brontinus the Pythagorean, although in late sources she also appears as the wife of Brontinus and/or the daughter of Pythagoras.[175] In the pseudo-Pythagorean literature, Theano was extremely popular. To her were attributed many writings, letters, and statements of moral instruction, all of which paint a picture of an ideal wife and mother.[176] The tradition on the children of Pythagoras is even less reliable. Timaeus reports that in her maidenhood Pythagoras' daughter was the first among the Crotonian maidens and later first among the women; according to Porphyry, her name was Myia.[177] Of Pythagoras' sons, the names of Telauges and Arimnestus are most often given,[178] but in the late tradition other names are also found for his sons and his daughters. The fabrication of a family biography for Pythagoras began at the end of the fourth century, and in it almost all members of the family had some writings ascribed to them.[179] It is hardly possible to assess the accuracy of even the names of his children. It is noteworthy, however, that tradition gives him a wife and children, while we know nothing at all of the family circumstances of other early Greek philosophers. Here too, Pythagoras was no ordinary Presocratic.

[174] See K. von Fritz, 'Telauges', *RE* 5A (1934), 194–6; id., 'Theano', ibid. 1379–81; Burkert, 114.

[175] D. L. VIII, 43. Theano as the wife of Pythagoras first appears in Hermesianax (fr. 7.85).

[176] Thesleff, *Introduction*, 193 ff.; Städele, *Die Briefe* 288 ff.

[177] Tim. *FGrHist* 566 F 131; Porph. *VP* 4.

[178] Telauges: Neanthes (*FGrHist* 84 F 26); Arimnestus: Duris (*FGrHist* 76 F 23).

[179] Thesleff, *Introduction*, 51, 188 f.

3

Who Were the Pythagoreans?

3.1 THE PYTHAGOREANS AFTER PYTHAGORAS

The history of Pythagorean societies after the death of Pythagoras is recounted by Aristoxenus, Dicaearchus, and Neanthes, together with later authors, in particular Polybius, Diodorus, and Apollonius.[1] To the extent to which their evidence can be combined with the overall picture of southern Italian history in the fifth century,[2] it turns out that the Pythagorean *hetairia* at Croton managed to survive the blow struck by the conspiracy of Cylon. Despite Pythagoras' flight to Metapontum, it retained its influence on the course of political affairs in Croton for another half-century. The seizure of power in Croton by the tyrant Cleinias *c.*494 was no more than a brief episode.[3] It was in the first half of the fifth century that Croton achieved its greatest prosperity, drawing into its sphere of influence many southern Italian cities: Kaulonia, Sybaris, Pandosia, Temesa, Terina, and others.[4]

[1] Aristox. fr. 17–19; Dic. fr. 34; Neanth. *FGrHist* 84 F 30–1; Polyb. II,39,1; Diod. XII,10; Strab. VIII,7,1; Apoll. *FGrHist* 1064 F 2. For the extent of use of Timaeus see above, 69 n. 35, 99 n. 163.

[2] Kahrstedt, 'Zur Geschichte'; E. Ciaceri, *Storia della Magna Grecia*, ii (Milan, 1927); Delatte, *Pol.*, 254 ff.; von Fritz, *Pol.*, 68 ff.; Minar, 71 ff.; Kraay, *Coinage*; Dunbabin, 366 ff.; Mele, *Crotone*, 44 ff.; id., 'La Megàle Hellàs pitagorica: aspetti politici, economici e sociali', in *Megale Hellas. Nome e immagine* (*Atti del 21 Convegno di studi sulla Magna Grecia*; Taranto, 1982), 33–80; D. Musti, 'Pitagorismo, storiografia e politica tra Magna Grecia e Sicilia', *AION* 11 (1989), 13–56; Bugno, *Sibari* 56 ff., 87 ff.

[3] Dion. Halic. XX,7. Von Fritz, *Pol.*, 68. Alternative dating *c.*453/51, see P. J. Bicknell, 'The Tyranny of Kleinias at Kroton', *Klearchos* 18 (1976), 5–25; cf. Mele. *Crotone*, 57 n. 332. Croton's war with Sybaris, which took place in the mid-470s (Diod. XI,48,3–5), belongs to the period of another temporary weakening of Croton (Bugno, *Sibari* 56 ff.).

[4] Von Fritz, *Pol.*, 80 ff; Dunbabin, 367 f.; de Vogel, 53 ff.

Croton's athletes, victors of the Olympic and other games, have become proverbial.[5]

Pythagorean societies existed also in *poleis* independent of Croton: Metapontum, Tarentum, Locri, and Rhegium, as is shown by the large number of Pythagoreans from these cities in Aristoxenus' catalogue (below, §3.2). However, the notion of a 'Crotonian empire', supposedly established by the 'Pythagorean Union' and made up of southern Italian cities seized by Croton,[6] is not supported by reliable evidence. As far as can be judged, the rule of Pythagorean *hetairiai* did not as such exist in any of these cities. Most probably their political influence was exerted, not in the form of direct rule, but through the participation of individual Pythagoreans in the organs of power of each of the *poleis*.[7] Naturally, the political and economic domination of Croton in the region facilitated access to power in the other cities for the Pythagorean *hetairiai*, but how they were interconnected remains unknown. One possible form of communication among members of the *hetairiai* from the various *poleis* of Magna Graecia was the Pythagorean *φιλία*, about which the sources of the fourth century are so insistent.[8] *Φιλία* is broader than the relations between two close friends, for example Damon and Phintias (Aristox. fr. 31); it links even Pythagoreans who are unacquainted one with another, obliging each of them to employ all means to aid their 'friends' where their lives or welfare are threatened. Friendship of this kind, going beyond personal relationship, has a quite distinct sociopolitical meaning: Pythagoreans from different cities were linked by the bonds of mutual aid even before they became personally acquainted. This circumstance greatly facilitated the spread of the Pythagoreans' political influence and also its stability.[9]

Throughout the first half of the fifth century, the Pythagoreans were active supporters of the aristocracy. Hence, when the economic

[5] Strab. VI,1,12 (see above, 92 n. 136.); Cic. *De inv.* II,1,2. Mele, *Crotone*, 44 ff.; Giangiulio, *Ricerche*, 102 ff.; Mann, *Athlet*, 164 ff.

[6] Thus Kahrstedt, 'Zur Geschichte'; Ciaceri, *Storia*, 298 ff.; Minar, 36 ff.

[7] Von Fritz, *Pol.*, 94 f.; de Vogel, 52 ff., 189 ff.

[8] Aristox. fr. 31, 43; Iamb. *VP* 230–239 = 58 D 7, 9 (from Aristoxenus); Neanth. *FGrHist* 84 F 31; Tim. *FGrHist* 566 F 13.

[9] The political reality was far from the idealized picture painted by Aristoxenus: *φιλία* could not prevent the split in the Pythagorean society at Croton at the end of the 6th cent. and Pythagoras' subsequent flight to Metapontum (above, 97 f.).

prosperity of Magna Graecia opened the way for the rise of democratic elements, the Pythagorean communities bore the first and, very likely, the most powerful impact. Shortly after 450 in many southern Italian cities the meeting places of the Pythagoreans (συνέδρια) were fired, a number of them were killed, 'the best men in each city', in Polybius' words, perishing, while others succeeded in escaping to Greece.[10] New intellectual centres of Pythagoreanism sprang up in central Greece, at Thebes and Phlius, but no longer with any perceptible political significance. Philolaus, whose pupils were Simmias and Cebes of Thebes, Eurytus of Tarentum and others, (44 B 15; 45 A 1), and Lysis, who became the teacher of the renowned military leader Epaminondas, settled at Thebes.[11] Echecrates, Phanton, Diocles and Polymnastus of Phlius, and Xenophilus of Thracian Chalcidice were in turn pupils of Philolaus and Eurytus (Aristox. fr. 18–19).

As a form of association supremely adapted for cultivating friendly ties and mutual assistance,[12] the *hetairia* facilitated the survival of the Pythagorean societies after the political catastrophe. Although, after the middle of the fifth century, philosophical and scientific interests often predominated, particularly among those living in mainland Greece, politics were hardly something secondary for the Pythagoreans of Magna Graecia. Many of those who remained at Croton, Rhegium, Locri, Tarentum, and the other *poleis* of southern Italy continued to engage in politics and legislation, by now under moderate democracy.[13] The Pythagoreans' political influence in the region was finally ended by the expanding dominion of the Syracusan tyrant Dionysius the Elder. The Italiote *poleis* fell one after another under his control; after the seizure of Croton (379), the last important centre of

[10] Polyb. II,39,1–4 (from Timaeus), cf. Aristox. fr. 18; Ciaceri, *Storia*, 333 f.; Minar, 73 ff.; von Fritz, *Pol.*, 92; id., 'Pythagoreer', 214 f. For an alternative dating of these events, see D. Musti, 'Le rivolte antipitagoriche e la concezione pitagorica del tempo', *QUCC* 65 (1990), 35–65.

[11] Aristox. fr. 18. On Epaminondas' supposed Pythagoreanism, see J. Buckler, 'Epaminondas and Pythagoreanism', *Historia* 42 (1993), 104–8.

[12] See e.g. the stories of Cleinias of Tarentum and Prorus of Cyrene, and Damon and Phintias (54 A 3; 55, from Aristoxenus).

[13] Aristox. fr. 17–18. Von Fritz, 'Pythagoreer', 216f. See below, 114 n. 40. Following the anti-Pythagorean revolt many of the *poleis* of Magna Graecia adopted a more democratic constitution from the Achaeans (Strab. VIII,7,1).

Pythagoreanism in Italy remained Tarentum, led in 367–361 by Archytas as democratically elected *strategos.*[14]

Von Fritz connected the expansion of Dionysius in Italy in the early fourth century with the second wave of emigration of the Pythagoreans to Greece (*c.*390–360), seeing confirmation for this in the appearance of poverty-stricken Pythagorists, prominent figures in Middle Comedy.[15] However, there is no evidence to show that the subjugation by Dionysius of the Italian *poleis* brought about any noticeable emigration of Pythagoreans from Italy. Not one of the comedies in which Pythagorists figure can be reliably dated before 350.[16] Some of them were staged in 330–320. Hence there is no reason to relate the appearance of Pythagorists to the time of Dionysius the Elder (died 367). Moreover the Pythagorists often turn out to be Tarentines (58 E 1, 3), and, since it was Tarentum which remained independent of Dionysius in the first half of the fourth century, the local Pythagoreans could not have had any particular reasons for emigration and/or sudden impoverishment.[17] It is also known that at Syracuse itself in the first half of the fourth century there was a group of Pythagoreans: Hicetas, Ecphantus (*DK* 50–1), Damon, and Phintias.[18]

Aristoxenus (born *c.*370) called his mentor Xenophilus and his circle 'the last Pythagoreans', from which it follows that some of them were still alive around 350.[19] Shortly afterwards ancient

[14] Ciaceri, *Storia*, 435 ff.; P. Wuilleumier, *Tarente des origines à la conquête romaine* (Paris, 1939), 67 ff.; Minar, 86 ff.

[15] Von Fritz, *Pol.*, 75 ff.; id., 'Pythagoreer', 217 f.

[16] Evidence: *DK* 58 E = Giangiulio, *Pitagora*, i. 183 f. (supplemented). Chronology: T. B. L. Webster, 'Chronological Notes on Middle Comedy', *CQ* 2 (1952), 13–26; id., *Studies in Later Greek Comedy*, 2nd edn. (Manchester, 1970), 530 f.; W. G. Arnott, *Alexis: The Fragments. A Commentary* (Cambridge, 1996), 121 f., 579 f., 624 f. Webster's dates: *Neottis* of Antiphanes after 342, *Pythagorist* of Aristophon between 345 and 320, *Alcmaeon* of Mnesimachus 340, *Tarentines* of Alexis 330–320; Arnott gives similar dates.

[17] Burkert, 201 n. 49.

[18] Whether they all lived under Dionysius the Elder we do not know. Nor is it quite clear whether Damon and Phintias actually took part in the conspiracy against Dionysius the Younger, as reported by Diodorus (X,4,3, cf. Aristox. fr. 31). See Burkert, 104 n. 36.

[19] Aristox. fr. 19–20. Dating of the last Pythagoreans to 366/5 (Diod. XV,76) probably derives from Apollodorus, who relied on Aristoxenus (see above, 63 n. 9). This date is not to be taken too literally: it does not necessarily indicate the year of death of the last Pythagorean known to Aristoxenus. Xenophilus died at Athens at the age of 105.

Pythagoreanism ceased its existence. The Pythagorizers and Pythagorists of Middle Comedy appeared just when there were no Pythagoreans left.[20]

3.2. THE CATALOGUE OF ARISTOXENUS

Who should be accounted a Pythagorean and by what criteria? Various answers are given to this question. As a rule a doctrinal criterion is tacitly made use of: Pythagoreans are primarily considered those in whose work are found traces of the number philosophy Aristotle ascribes to *οἱ Πυθαγόρειοι*, or something close to it. Those who did not subscribe to this teaching are correspondingly categorized as 'para-Pythagoreans', like Alcmaeon,[21] or are simply disregarded within the framework of Pythagoreanism, like Hippon, who, because of the similarity of his *archē* with Thales' water, is often regarded as an epigone of the Milesian school.[22] This approach does not take account of many important considerations. As has been noted, the number doctrine in the form set out in Aristotle is absent both from the early Pythagoreans (Alcmaeon, Hippasus, Menestor, and Hippon) and even from Philolaus. Moreover Aristotle ascribes this teaching to some anonymous *Πυθαγόρειοι*, not to specific representatives of the school. On those occasions when he mentions Pythagoreans known to us, in the first place he *never* calls them Pythagoreans, and in the second place he does not connect them with the doctrine that 'all is number' (below, §12.2). It is clearly impossible, based on the evidence of Aristotle, to establish who was a Pythagorean, and who not. It is equally impossible to doubt the Pythagoreanism of Alcmaeon, Philolaus, or Archytas on the grounds that Aristotle does not call them Pythagoreans.

[20] See below, 131 f., 179 f. Among the Pythagorists named not one could be identified with a Pythagorean from Aristoxenus' catalogue. G. Méautis, *Recherches sur le pythagorisme* (Neuchâtel, 1922), 9 ff., perceived in the responses of Middle Comedy confirmation of his thesis of *une tradition ininterrompue* linking ancient Pythagoreanism and neo-Pythagoreanism, but this notion had no success.

[21] Guthrie, i. 341 ff.

[22] Zeller, i. 332 f.; J. Burnet, *Greek Philosophy*, Part I. *Thales to Plato* (London, 1914), 100; cf. Timpanaro Cardini, iii. 366.

In addition, the doctrinal criterion is not the most reliable. It is not only, indeed not so much, those who recognized the existence of Forms, Prime Mover, or the four kinds of causes who are regarded as Platonists and Peripatetics, but rather those whom our sources call pupils or followers of Plato and Aristotle. The question of whom we can associate with the Pythagoreans should also be resolved on the basis of reliable sources which identify whoever it be as a Pythagorean. To follow specific philosophical teachings or to study a particular range of scientific problems remain significant, but insufficient, criteria, in the first place because, of all the Pythagoreans known to us, few were engaged in philosophy and science. Nor is to have teachers who were Pythagoreans such a criterion. Parmenides, Empedocles, Democritus, Epaminondas, Theaetetus, Heraclides of Pontus (probably), Eudoxus, and Aristoxenus were taught by Pythagoreans,[23] but, with the exception of Empedocles, the ancient Greek tradition either does not associate them with that school or does so on very rare occasions.[24] It is not sufficient either for someone to call *himself* a Pythagorean, like Diodorus of Aspendus, the Cynic, or Lycon, the critic of Aristotle,[25] since this is precisely an indication that they were not.

If, however, someone was regarded as a Pythagorean by his contemporaries or by the Pythagoreans themselves, this indicates that he shared with other Pythagoreans certain common characteristics, characteristics which made him a Pythagorean. (Although this criterion, as will be made clear by what follows, is not fully reliable, I treat it as fundamental.) Any specific combination of these characteristics depends in each instance on the historical context. In any case, there cannot be found in our sources *any one common* characteristic which would apply to all ancient Pythagoreans from the end of the sixth to the middle of the fourth centuries. Rather we must speak of

[23] Parmenides (A 1), Empedocles (Alcidam. *ap.* D.L. VIII, 56; Theophr. fr. 227A FHSG; Neanth. *FGrHist* 84 F 26; Tim. *FGrHist* 566 F 14), Democritus (14 A 6), Theaetetus (43 A 4), Epaminondas (Aristox. fr. 18; Diod. X,11, from Aristoxenus), Heraclides of Pontus (fr. 3), Eudoxus (D.L. VIII, 86 = T 7), Aristoxenus (fr. 19).

[24] Parmenides and Zeno as Pythagoreans: Callim. *ap.* Procl. *In Parm.*, 619.5–10; Strab. VI,1,1; Anon. Phot. 439b36 = Thesleff, 238.20; *Schol. Iamb. VP* 267, p. 150.7 ff. On Empedocles' Pythagoreanism see e.g. D.L. VIII, 51–77; Iamb. *VP* 104, 113–14, 166; *Schol. Iamb. VP* 267, p. 150.11 f.

[25] See below, 131 f.

a 'family resemblance'.[26] This means that certain Pythagoreans had characteristics in common with some Pythagoreans, but not with others. For example, mathematics are the common characteristic for Hippasus, Theodorus, Philolaus, and Archytas; natural philosophy for Alcmaeon, Hippasus, Menestor, Hippon, and Philolaus; medicine for Democedes, Alcmaeon, Iccus, and Hippon; and athletics for Milon, Astylus, and Iccus. However not one common characteristic can be found for Hippasus and Iccus, Milon and Theodorus, or Menestor and Eurytus, except of course that they were Pythagoreans.

For the period up to the middle of the fifth century, a common characteristic *might be* belonging to Pythagorean *hetairiai*, but we do not, unfortunately, know what it meant in each individual case and therefore cannot make use of it for our purpose. In particular it is not known whether it assumed active participation by every Pythagorean in politics.[27] In any case, political activity ceases to be one of the constituent features of Pythagorean communities after the middle of the fifth century. It is, for example, quite unclear whether we may count Philolaus' school at Thebes a *hetairia*. The 'Pythagorean way of life' Plato refers to (*Res.* 600a–b) cannot be a common characteristic either, since we do not know in fact what it comprised (cf. below, §6.1). The crux is that we do not know of any one actual Pythagorean recorded by the sources as having led a Pythagorean way of life.[28]

The most important source to permit a judgement on belonging to the Pythagoreans is the catalogue of 218 Pythagoreans passed down by Iamblichus, which, since the time of Rohde, has been taken to be connected with Aristoxenus.[29] When determining who should go into the Pythagorean sections of the *Fragmente der Vorsokratiker*, Diels relied on that catalogue, though he was not always consistent.[30]

[26] On this concept, introduced by Wittgenstein, see G. Gabriel, 'Familienähnlichkeit', in J. Mittelstraß (ed.), *Enzyklopädie Philosophie und Wissenschaftstheorie*, 2nd edn. (Stuttgart, 2005), 473 f.

[27] On the nature of Pythagorean *hetairiai* see below, 145 f.

[28] There is hence no reason to assert (as Huffman, *Philolaus*, 10 f.) that Philolaus followed this way of life and therefore was accounted a Pythagorean, while Alcmaeon did not.

[29] Iamb. *VP* 267 = *DK* 58 A; Rohde, 171. Bertermann, *De Iamblichi*, 77, wrongly related *VP* 267 to Timaeus.

[30] On Aristoxenus see H. Diels, *Antike Technik* (Leipzig, 1924), 23. Preparing his edition, Diels frequently complained in his correspondence of the difficulty of working with Pythagorean material: D. Ehler (ed.), *Hermann Diels, Hermann Usener, Eduard Zeller. Briefwechsel* (Berlin, 1989), i. 375, 575; ii. 288, 307; M. Braun et al.

Aristoxenus' authorship was subsequently supported by Timpanaro Cardini, and Burkert adduced further considerations in his favour.[31] All those in the catalogue whose chronology can be established are from the time before Aristoxenus, that is the sixth to the first half of the fourth century. Moreover the catalogue is independent of pseudo-Pythagorean literature (the names of some eighteen writers from Thesleff's collection are absent) and could not have been compiled by Iamblichus, who has eighteen more names of Pythagoreans not found in the catalogue. The origin of a number of Pythagoreans listed in the catalogue differs from the data in other sources, but coincides with that given by Aristoxenus.[32] Their distribution by cities is also instructive: the greatest number of names (forty-three) are from Tarentum, the birthplace of Aristoxenus, and twenty-nine and thirty-eight respectively are from the other two centres of Pythagoreanism, Croton and Metapontum.

The total number of names as well as their classification by twenty-seven different *poleis* and peoples indicate that Aristoxenus, apart from oral tradition, relied on some documentary sources. This is confirmed by the fact that some two-thirds of the names in the catalogue occur only there. Of the fifty-six names mentioned outside the catalogue, more than half remain simply names: either we know almost nothing of these people, or we know of a number of insignificant episodes. Since far from all of them have anything to do with philosophy or science, Aristoxenus' catalogue cannot be regarded as a list of members of the Pythagorean school.[33] Sources link some Pythagoreans with politics and legislation, others with athletics, and still others appear as heroes of oral tradition, like Damon and Phintias or Cleinias and Prorus.[34] It is difficult to say whether those who only adhered to the religious teaching of Pythagoras and led a life of

(eds.), *Philology and Philosophy: The Letters of Hermann Diels to Theodor and Heinrich Gomperz (1871–1922)* (Hildesheim, 1995), 149: 'unsäglich schwierigen Pythagoreer'. On Diels's work on the Presocratics, see W. Burkert, 'Diels' *Vorsokratiker*. Rückschau und Ausblick', in W. M. Calder III and J. Mansfeld (eds.), *Hermann Diels (1848–1922) et la science de l'antiquité* (Geneva, 1999), 169–197 (discussion: 198–206).

31 Timpanaro Cardini, iii. 38 f.; Burkert, 105 n. 40.

32 Burkert, 105 n. 40.

33 Cf. above, 5. For some strange reason all the names in the catalogue, even Abaris (!), are included in R. Goulet (ed.), *Dictionnaire des philosophes antiques* (Paris, 1989–2011).

34 See Aristox. fr. 31, 131; Diod. X,4.1 = 54 A 3 (from Aristoxenus).

abstinence are included, since practically nothing is known about these people (below, §6.1). Most likely they were of no interest to Aristoxenus and the group of 'the last Pythagoreans' (cf. fr. 19) from which his information derives.

Although Aristoxenus used documentary sources and Pythagorean oral tradition, he hardly had exhaustive and accurate information on the ancient Pythagoreans. Hence it should not be presumed that *all* Pythagoreans who were at all well known are included in the catalogue, or, on the other hand, that *only these* 218 persons are 'genuine' Pythagoreans.[35] Apart from all else, in the time which passed between Aristoxenus and Iamblichus, some names could have been left out of the catalogue or been displaced through a copyist's error, while others might have been distorted in the copying process,[36] and still others added to the catalogue.

Democedes of Croton (*DK* 19), who married the daughter of the Pythagorean athlete and military leader Milon (Hdt. III, 137), is missing from the catalogue. Amyclas is absent, but his friend Cleinias of Tarentum is there, though Aristoxenus mentions them both as Pythagoreans and friends of Plato (fr. 131). Strangely, Aristoxenus' father Spintharus, who belonged to the circle of Archytas, is missing.[37] Absent are the pupils of Philolaus, Simmias, and Cebes of

[35] See Timpanaro Cardini, iii. 39.

[36] Hippasus of Metapontum appeared among the Sybarites (*DK* I, 446.30), Ecphantus of Syracuse among the Crotoniates (446.11), Philolaus of Croton among the Tarentines (446.22), Astylus of Croton and Eurytus of Tarentum (Aristox. fr. 19) among the Metapontines (446.20, 22), Xenophilus of Thracian Chalcidice among the Cyzicenes (448.4). Alcimachus, Deinarchus, and Meton, defenders of the Crotonian constitution (Iamb. *VP* 257), are called Parians (447.2–3); it is no less strange that Paros appeared in the catalogue among the Italian *poleis*, after Sybaris and before Locri. Another Pythagorean from Paros, Thymarides, figures in Iamblichus as a Parian (*VP* 239) and as a Tarentine (*VP* 145); the latter is much more plausible (see below, 130). Four Pythagoreans from Carthage with typical Greek names (447.1) also give rise to serious doubt. O. Masson, *Mus. Helv.* 52 (1995), 229 f., supposed that they were Καλχηδόνιοι, not Καρχηδόνιοι, but how did Pythagoreans come to be at Chalcedon in Asia Minor? Besides, one of them, Miltiades of Carthage, figures in the story of mutual aid among Pythagoreans of different peoples (Iamb. *VP* 128, as Diels thought from Aristoxenus, 58 D 7). The hero of another such story, the Tyrrhenian Nausithous (*VP* 127), is subsequently also mentioned in the catalogue (448.5). K. Geus, *Prosopographie der literarisch bezeugten Karthager* (Leuven, 1994), 198 f., considered Miltiades and three other Pythagoreans from Carthage to be historical figures, although they turn out to be the only Greeks from Carthage in the classical period. I would not exclude the possibility that the Carthaginian Pythagoreans owe their existence to Aristoxenus.

[37] See above, 63 n. 8.

Thebes (44 A 1a, B 15), who appear in Plato's *Phaedo*, although another character in the dialogue, Echecrates of Phlius, is present.[38] Thebes, one of the centres of Pythagoreanism in the fifth century, is not mentioned in the catalogue. Ecphantus of Syracuse appears in the catalogue among the Pythagoreans of Croton (*DK* I, 446.11), yet his fellow countryman and contemporary Hicetas, mentioned by Theophrastus (A 1), does not. Parmenides' teacher, Ameinias, recorded by Sotion, is not named.[39] These are additions to the catalogue which deserve serious examination.

These seven 'additions' to the catalogue balance an equal number of 'excisions': those whom Aristoxenus' sources regarded as Pythagoreans, but modern scholarship for various reasons excludes. This applies, for example, to the renowned lawgivers Zaleucus of Locri and Charondas of Catana, who figure as Pythagoreans, not only in the catalogue, but also in Aristoxenus' fragments (fr. 17, 43). To all appearances Zaleucus and Charondas, who lived long before Pythagoras, were associated with him by the Pythagorean lawgivers of the second half of the fifth century from Locri and Rhegium.[40] Thus in this instance Aristoxenus recorded a venerable, though unreliable Pythagorean tradition aimed at conferring retrospectively on Pythagoras the reputation of a lawgiver by making Zaleucus and Charondas his followers.

Another such 'pair' are the well-known wonder-workers Aristeas and Abaris. Aristeas of Proconnesus (turn of the sixth century) was the author of the poem *Arimaspea*, which described his journeyings in search of the Hyperboreans. In the course of his life Aristeas twice

[38] Echecrates of Phlius is not identical with Echecrates of Locri, with whom Timaeus communicated (*FGrHist* 566 F 12, *pace* Jacoby, IIIb, p. 552). Arguments against the Pythagoreanism of Echecrates of Phlius, F. Prontera, 'Echecrate di Fliunte un pitagorico?', *AATC* 39 (1974), 3–19, and Simmias and Cebes, T. Ebert, *Sokrates als Pythagoreer und die Anamnesis in Platons Phaidon* (Stuttgart, 1994), 7 f.; id., *Platon, Phaidon* (Göttingen, 2004), 115 f., are unconvincing. Cf. below, 220 n. 15.

[39] D.L. IX, 21 = *DK* 27. His source could be Timaeus, see above, 71 n. 42.

[40] In Iamblichus (*VP* 130, 172) Zaleucus is mentioned together with another lawgiver from Locri, the Pythagorean Timares, who probably lived in the middle–second half of the 5th cent. (Delatte, *Pol.*, 182 f.; Ciaceri, *Storia*, 47 f.). In the same chapters Iamblichus names the Pythagorean lawgivers from Rhegium: Phytius, Helicaon, Aristocrates, and Theocles, who, like Timares, figure in the catalogue (to be sure, Theocles is named there as Euthycles, and in *VP* 172 as Theaetetus). On Rhegium as a centre of Pythagoreanism after the mid–5th cent., see Aristox. fr. 18; von Fritz, *Pol.*, 77. Rhegium's legislation was based on the laws of Charondas (Arist. *Pol.* 1274a23; fr. 611.55, from excerpts from the *Constitution of Rhegium*).

disappeared, and, 240 years later, as Herodotus records (IV, 13–15), he reappeared at Metapontum and commanded the citizens to set up an altar to Apollo and a statue to himself. The catalogue duly lists him among the Pythagoreans of Metapontum. Abaris, a mythical priest of Apollo and expert on the Hyperboreans, is the only representative of this legendary people in the catalogue. As Bolton demonstrated, Aristeas and Abaris were associated with Pythagoras in the legendary tradition of the fifth century, subsequently made use of and embellished by Heraclides of Pontus.[41] In this instance the legendary, the literary, and the historical traditions are partly superimposed one on another.

Parmenides and Empedocles are also the sole representatives of their *poleis* in the catalogue. There would appear to have been no Pythagorean societies in Elea and Acragas; hence, in relation to Parmenides and Empedocles, one can only speak of their Pythagorean teachers. In the biographical tradition of the fifth–fourth centuries, Empedocles is often shown as the pupil of Pythagoreans (and even of Pythagoras himself); mention of Parmenides' teacher Ameinias also does not give the impression of being someone's invention.[42] This could be the reason for their inclusion in the catalogue, although we do not know precisely whether this occurred before or after Aristoxenus. The influence of Pythagorean ideas on Parmenides and Empedocles is incontestable, yet both are philosophers too independent and important to be fully integrated into Pythagorean tradition. Rather they should be left among the 'sympathizers' with Pythagoreanism. The next and last 'excision' is Melissus, named with five other Pythagoreans from Samos. If there was a Pythagorean society on Samos, then in principle Melissus could have been a member, even if in philosophy he followed Parmenides and Zeno, just as the Pythagorean Ecphantus later followed Democritus and Anaxagoras. At the same time, unlike Zeno (who is not in the catalogue),[43] Melissus does not figure as a Pythagorean in other sources; we have no grounds other than the catalogue to regard him as one.

Seven redundant names out of 218 is a very good indicator of the reliability of the catalogue as a historical document. We may observe

[41] Bolton, *Aristeas*, 151 ff., esp. 174 f.
[42] See above, 110 n. 23, 110 n. 24, 114 n. 39.
[43] See above, 110 n. 24.

that all these instances involve famous people, three of whom (Aristeas, Zaleucus, and Charondas) lived before Pythagoras, while a fourth (Abaris) was a wholly legendary figure. The basis for their inclusion in the catalogue is understandable in each case (except that of Melissus), even though it appears unconvincing to us. The catalogue does not, however, show signs that the Pythagoreans strove to make 'their own' all those famous individuals who in one way or another had contact with them. We do not find there, for example, Democritus, Epaminondas, and Eudoxus, who had Pythagorean teachers, or Epicharmus, whom ancient tradition often associated with the Pythagoreans.[44] Since the catalogue is organized by *poleis* where there were Pythagorean societies,[45] and since the majority of the names in it are unknown to us, it cannot be regarded as a list of famous figures, like that compiled by Hecataeus of Abdera, supposedly on the basis of 'Egyptian sacred books'.[46] Hippasus, Menestor, or Hippon are mentioned here, not because they were particularly famous, but because they were Pythagoreans. The catalogue contains the names of four Pythagorean Olympic victors,[47] yet not all the Olympic victors from Croton, Tarentum, Locri, and other cities in Magna Graecia where there were Pythagorean communities.[48] Alcmaeon of Croton is named, but not Acron of Acragas[49] or the renowned physician Philistion of Locri.

While Zeller excluded certain of those listed in the catalogue from the Pythagoreans, Diels, on the other hand, basing the Pythagorean chapters of *Fragmente der Vorsokratiker* on the catalogue, extended the list of Pythagoreans to include some of those not in the catalogue. Hence in his collection the early Pythagoreans include Cercops (*DK*

[44] Epicharmus as Pythagorean: Plut. *Numa* 8; D.L. VIII, 7, 78; Clem. *Strom.* V,14,100; Iamb. *VP* 241, 266; Anon. in Pl. *Tht.* 71,12. See Zeller, i. 607 f.; Delatte, *Vie*, 164 f; Thesleff, 84, 158; Burkert, 289 n. 58.

[45] It is not accidental that three out of eight 'excisions' from the catalogue (Abaris, Parmenides, and Empedocles) are the sole representatives of their *polis* (people) in the catalogue.

[46] See above, 84 n. 99.

[47] Milon and Astylus of Croton, Iccus of Tarentum, Dicon of Kaulonia (*DK* I, 446.14. 20. 28. 447. 14). See A. Kirchner, 'Dikon', *RE* 5 (1903), 582; cf. W. A. Oldfather, 'Kaulonia', *RE* 11 (1921), 74; Burkert, 403 n. 12.

[48] Note, e.g. the absence of the victor of 520 Philip of Croton, exiled for his connection with the tyrant of Sybaris Telys, see above, 96 n. 148.

[49] Acron, a contemporary of Empedocles, wrote the book *On the Food of Healthy People* (*DK* I, 283.5). Cf. Thesleff, 1 f.; Burkert, 223 n. 25.

15), Petron (*DK* 16), Paron (*DK* 26), and Xuthus (*DK* 33). However, according to Aristotle (fr. 74), the poet Cercops lived at the time of Hesiod and could not have been a Pythagorean.[50] As a Pythagorean he first appears in the book of the Hellenistic grammarian Epigenes (early third century?) *On Works attributed to Orpheus*,[51] who ascribed to Cercops two Orphic poems, *Ἱερὸς λόγος* and *Εἰς Ἅιδου κατάβασις*. Epigenes' evidence is clearly based on conjecture, as are all other similar indications. In Cicero a reference to Cercops is attached to a quotation from Aristotle, who believed that the poet Orpheus had never existed: *Orpheum poetam docet Aristoteles numquam fuisse et hoc Orphicum carmen Pythagorei ferunt cuiusdam fuisse Cercopis*.[52] Only the first part of this evidence belongs to Aristotle, as is confirmed by a quotation in Philoponus, the second part deriving from Epigenes.[53] Aristotle could not have named as a Pythagorean a contemporary of Hesiod; it is no less material that no one at all was named by him as a Pythagorean.

We know of Petron only from a single quotation from Hippys of Rhegium transmitted by Phanias of Eresus. It is not known when Hippys lived (Phanias was Aristotle's pupil), and it is very probable that this evidence is spurious.[54] Paron, as Burkert showed, appeared wholly as the result of Aristotle's error, mistaking the participle *ΠΑΡΩΝ* for a proper noun.[55] Xuthus is known only from a single mention by Aristotle (*Phys.* 216b22); in his commentary to this passage Simplicius calls Xuthus a Pythagorean, but this point cannot be checked. Since all three are absent from Aristoxenus' catalogue and

[50] Burkert, 114, 130 n. 60; cf. *DK* I, 106.6 f.

[51] Clem. *Strom.* I,21,131 = *OF*, test. 222. On Epigenes see Susemihl, *Geschichte*, i. 344 f.; L. Cohn, 'Epigenes' (no. 16), *RE* 6 (1907), 64–5; cf. I. Linforth, *The Arts of Orpheus* (Berkeley, 1941), 110 f., 114 ff. Linforth dated Epigenes in the 4th cent., which is clearly too early. Cf. Nilsson, *GGR* i. 682.

[52] *ND* I, 107 = Arist. fr. 7.

[53] W. Kroll, 'Kerkops', *RE* 11 (1921), 314; Philop. *In de An.*, 186.21 f. = Arist. fr. 7.

[54] F. Jacoby, 'Hippys', *RE* 8 (1929), 1927 f.; *FGrHist* 554 F 5 with comm.; J. Kerschensteiner, *Kosmos: Quellenkritische Untersuchungen zu den Vorsokratikern* (Munich, 1962), 209 f.; Burkert, 114 n. 35; Pearson, *Greek Historians*, 8 ff; L. Zhmud, 'Phainias' Work *On the Socratics* and fr. 12 on Petron of Himera', in J. Engels and W. W. Fortenbaugh (eds.), *Phainias of Eresus* (forthcoming). Cf. however: Guthrie, i. 322 f.; G. Huxley, 'Petronian Numbers', *GRBS* 9 (1968), 55–7. For extensive bibliography see C. Macris, 'Petron d'Himere', *DPhA* 5 A (2011), 247 f.

[55] Burkert, 170; G. Martano, 'Il pitagorico Parone o il pitagorico "presente"?', *Elenchos* 1 (1980), 215–24.

nothing more is known of them, there are no grounds for regarding them as Pythagoreans.

Other scholars have gone further than Diels. The editions by Maddalena and Timpanaro Cardini list as Pythagoreans Epicharmus, Ion of Chios, Damon of Athens, Hippodamus of Miletus, the sculptor Polycletus, and also Oenopides and Hippocrates of Chios.[56] Not only are these not named in the catalogue, but not a single source of the classical period calls them Pythagoreans or pupils of Pythagoreans.[57]

In Diels's collection there are among the Pythagoreans of the fourth century six more names which must be erased from the Presocratics. Ocellus of Lucania (*DK* 48) is mentioned in the catalogue, which means that Aristoxenus accounted him a historical figure (cf. fr. 17), yet all the doctrines attributed to him are pseudo-Pythagorean. Thus the philosopher Ocellus is a fiction, as distinct from the Pythagorean Ocellus.[58] Timaeus of Locri (*DK* 49) owes his existence to the Platonic dialogue and, later, to a pseudo-Pythagorean treatise.[59] Simus of Poseidonia (*DK* I, 447.6), mentioned in the catalogue, can hardly be identified with the harmonic theorist Simus (*DK* 56), the central figure of the story of the dedicatory gift of Arimnestus, the son of Pythagoras, related by Duris.[60] Myonides and Euphranor, who appear in the same section of Diels (*DK* 56), are

[56] A. Maddalena, *I Pitagorici* (Bari, 1954); Timpanaro Cardini, i–ii; see also J.-P. Dumont et al. (eds.), *Les Présocratiques* (Paris, 1988). Timpanaro Cardini, iii. 334 ff., places Epicharmus, Damon, and Hippodamus in the section 'Risonanze pitagoriche'; cf. Zeller, i. 607 f. See also C. Huffman, 'Polyclète et les Présocratiques', in A. Laks and C. Louguet (eds.), *Qu'est-ce que la philosophie présocratique?* (Villeneuve d'Ascq, 2002), 303–27.

[57] Later tradition numbered Epicharmus among the Pythagoreans (see above, 116 n. 44), and spurious Pythagorean writings were attributed to Hippodamus (Thesleff, 93 f.).

[58] Thesleff, 124 ff. On the Italic Pythagoreans see A. Mele, 'Il pitagorismo e le popolazioni anelleniche d'Italia', *AION* 3 (1981), 61–96 = *Magna Grecia*, 259–98.

[59] Thesleff, 202 ff.

[60] *FGrHist* 76 F 23 =14 A 6 = 56 A 2 (cf. below, 220 n. 78). Arimnestus is clearly invented, as probably is Simus, supposed to have stolen the Pythagorean κανών. Diels, believing that Duris had relied on some literary forgery, nevertheless regarded Simus the *harmonikos* as a real person (*DK* I, 445 n.). Even if this is so, there is no reason to place him among the Pythagoreans. The *harmonikoi* are one of the schools competing with the Pythagoreans in the study of music, see A. Barker, *The Science of Harmonics in Classical Greece* (Cambridge 2007), 26 n. 12, 81 n. 24, 33 ff. The σοφίαι referred to in Arimnestus' epigram cannot be mean proportionals (as *DK* I, 445 n.), see Burkert, 455 n. 40; Zhmud, *Origin*, 173 f.

also a pseudo-Pythagorean fiction.[61] In the case of the last Pythagorean in Diels's collection, Lycon (*DK* 57), we are evidently dealing with four different people. Since Lycon of Tarentum, named in the catalogue (*DK* I, 446.23), cannot be identified with the other three,[62] only his name remains. We are, however, not interested in the names of the Pythagoreans for their own sake; we know more than sufficient of them. We are in search of Pythagoreans with individual characteristics which can be made use of to compile a collective portrait.

So, comparing the criteria used by Aristoxenus in compiling his list of Pythagoreans with those applied in modern works, we conclude that, beyond a critical approach to the sources, we enjoy no special advantages over the first historian of Pythagoreanism. The catalogue remains the primary source in determining belonging to Pythagorean societies, and its data can be revised only if there is to hand more reliable evidence. In all other cases the person named in the catalogue should be accounted a Pythagorean, and vice versa.

3.3. THE PROSOPOGRAPHY AND CHRONOLOGY OF THE PYTHAGOREANS

The fragmentary nature of the sources on ancient Pythagoreanism far from always makes it possible to determine the sequence of the

[61] In Athenaeus (IV, 182e, 184e; XIV, 634d = 44 A 7, 47 B 6) Euphranor, along with Philolaus and Archytas, is called the author of *Περὶ αὐλῶν*, which seems to be a pseudo-Pythagorean work (Thesleff, 85). Iamblichus (*In Nic.*, 113.16 f., 116.1 f.) attributes to Myonides and Euphranor the discovery of the four means, which in reality were discovered by Eratosthenes (Zhmud, *Origin*, 174; cf. Burkert, 455 n. 40, 442 n. 92).

[62] See Susemihl, *Geschichte*, ii. 330 f., 691 f.; W. Capelle, 'Lykon', *RE* 13 (1927), 2308–9; Thesleff, 109 f.; Burkert, 204; J. Radicke, 'Lycon/Lycus of Iasus' (*FGrHist* 1110 with comm.). These figures included: 1) Aristotle's critic who called himself a Pythagorean (A 4; D.L. V, 69); 2) Lycon of Iasus in Ionia, author of the book *On the Pythagorean Life* (A 3); 3) Lycon the doctor (A 5). Lycon of Iasus' book clearly was written after Aristoxenus; Aristotle's critic belongs to the same era (probably the turn of the 3rd cent.) and might be identical with Lycon of Iasus (see below, 131); the doctor is possibly Lycus of Naples (1st cent.). Whether or not Aristotle's critic and Lycon of Iasus were one person or two, he (they) cannot be identified with the Pythagorean Lycon of Tarentum, who lived no later than the first half of the 4th cent., *pace* Timpanaro Cardini, ii. 440 f; B. Centtone and C. Macris, 'Lycon d'Iasos, ou de Tarente', *DPhA* 4 (2005), 200–3.

development of ideas if one proceeds only from those ideas. Reference to biographical details, however meagre, is an important aid in deciding questions of chronology. The brief prosopography of the Pythagoreans set out below comprises only those names which occur more or less regularly in the other chapters of the book. Only some controversial figures are discussed in detail.

Bro(n)tinus of Metapontum (or of Croton: D.L. VIII, 42 = A 1) belongs to the oldest generation of Pythagoreans. In the biographical tradition he appears as the father-in-law (sometimes the son-in-law) of Pythagoras (A 1–2). In all probability he was Pythagoras' coeval, or, perhaps, somewhat older than him. Pythagoras' younger contemporary Alcmaeon (Arist. *Met.* 986a30) at the beginning of his book addressed three Pythagoreans: Brontinus, Leon, and Bathyllus.[63] Thus Brontinus takes shape as taking part in a philosophical dialogue and interested in the problems discussed in Alcmaeon's book.[64] According to Telauges' letter to Philolaus, which Neanthes considered to be spurious (*FGrHist* 84 F 26 = A 3), Empedocles was the pupil of Hippasus and Brontinus. This testimony also places Brontinus in a philosophical context. It would appear that Brontinus left behind no writings; the treatise *Περὶ νοῦ καὶ διανοίας*, attributed to him, is pseudo-Pythagorean.[65] Together with Cercops, Brontinus appears in the grammarian Epigenes as the author of two Orphic poems, *Πέπλος* and *Φυσικά*, but this evidence is of scarcely any value.[66]

Democedes of Croton. Democedes, the most renowned doctor of his time, belonged to the Crotonian school of doctors, well known in the late sixth century and closely connected with the Pythagoreans

[63] B 1; cf. *DK* I, 446.16, 447.6.

[64] G. Vlastos, 'Isonomia', *AJP* 74 (1953), 334, was wrong to contest the old opinion that Alcmaeon's book was dedicated to the Pythagoreans named in its first lines (thus Zeller i. 597 n. 2; Burnet, 194; M. Wellmann, 'Die Schrift *περὶ ἱρῆς νούσου* des Corpus Hippocraticum', *Sudhoffs Archiv* 22 (1929), 311; A. Olivieri, *Civiltà greca nell' Italia meridionale* (Naples, 1931), 112; Timpanaro Cardini, i. 147; Burkert, 289 n. 57). Although the dedication 'does not mean agreement with the ideas of those addressed' (let us add: with *all* the ideas), it assumes a certain closeness of the author's interests with the ideas of those addressed. Empedocles' address to Pausanias, quoted by Vlastos, is in fact a counter-argument, since Pausanias was a physician (Her. Pont. fr. 77; Galen. *De meth. med.*, X,6,4 = 31 A 1, 3) and could well have shared some of Empedocles' theories or, at least, shown an interest in them.

[65] Thesleff, 55 f.

[66] Clem. *Strom.* I,21,131 = A 4; see above, 117.

(below, §10.1). Herodotus records that Democedes was the physician of Polycrates of Samos, who perished *c.*522, and then of Darius, the King of Persia, from whom he was able to escape and return to his birthplace, Croton (*c.*518).[67] When serving Polycrates, he could have been no younger than 30–5, so he was born not later than 560/55. On his return to Croton, he married the daughter of the Pythagorean Milon (Hdt. III, 137), who was victorious in youth wrestling at the Olympic Games in 540 and hence must have been born *c.*558. Although Democedes is not mentioned in the catalogue, his family ties with Milon leave no doubt that he belonged to the Pythagorean society at Croton (cf. 19 A 2c). The circumstances of his participation in the political struggle against Cylon and his supporters as reported by Apollonius seem implausible,[68] but that he did take part in these events is entirely probable. Hermippus named his father Calliphon as a pupil of Pythagoras and, although this biographer's evidence about Pythagoras is normally unreliable, in this case he could have made use of a sound tradition.[69] Pliny names Democedes among the sources of the twelth and thirteenth books of his *Naturalis Historia*; the *Suda* attributes a book on medicine to him (A 2); there are no more reliable traces of any writings by Democedes.[70]

Alcmaeon of Croton. Alcmaeon was the first Pythagorean to leave behind a written tradition. His work, later considered as the first φυσικὸς λόγος,[71] has been preserved in several fragments and numerous doxographical testimonies. Alcmaeon's book opened with an

[67] Hdt. III, 125, 129, 130–7; Tim. *FGrHist* 566 F 44.

[68] Iamb. *VP* 257–261 = Apollon. *FGrHist* 1064 F 2; see above, 99f.

[69] Fr. 22 Wehrli = *FGrHist* 1026 F 21 = A 2. The *Suda* names Calliphon as a priest of Asclepius from Cnidus. Herodotus does not record the birthplace of Calliphon, but Croton is assumed (III, 125); Hermippus plainly calls him a Crotoniate; see Ciaceri, *Storia*, 67 f.; M. Pohlenz, *Hippokrates und die Begründung der wissenschaftlichen Medizin* (Berlin, 1938), 81, 116; M. Michler, 'Das Problem der westgriechischen Heilkunde', *Sudhoffs Archiv* 46 (1962), 146 ff. Cf. Burkert, 293; J. Althoff, 'Formen der Wissensvermittlung in der frühgriechischen Medizin', W. Kullmann and J. Althoff (eds.), *Vermittlung und Tradierung von Wissen in der griechischen Kultur* (Tübingen, 1993), 211 f. It is known that there was not yet a temple of Asclepius at Cnidus in the 6th cent.: H. E. Sigerist, *A History of Medicine*, ii (New York, 1961), 111 n. 45; F. Kudlien, 'Überlegungen zu einer Sozialgeschichte des frühgriechischen Arztes und seines Berufs', *Hermes* 114 (1986), 135. Kudlien nevertheless supposes that Calliphon could be from a family of Cnidian Asclepiads in which the practice of medicine was hereditary. Cf. below, 220 n. 9.

[70] M. Wellmann, 'Demokedes', *RE* 5 (1905), 132; Ciaceri, *Storia* 68.

[71] D.L. VIII, 83 = A 1; Clem. *Strom.* I, 78 = A 2.

address to three Pythagoreans (B 1), one of whom, Brontinus, is known as Pythagoras' coeval and relative. It can be assumed that Alcmaeon was born not later than 530 and his book appeared not later than 490, when Brontinus could still have been living.[72] This also accords with the indisputable influence of Alcmaeon on Parmenides (see below §10.2). Proposals to date Alcmaeon in the middle fifth century[73] have no sound basis; according to Aristotle, 'Alcmaeon lived during Pythagoras' old age'.[74]

Apart from Aristoxenus' catalogue, a number of later authors also vouch for Alcmaeon's Pythagoreanism.[75] The tradition preserved by Diogenes Laertius affirms that he heard Pythagoras himself (VIII, 83). Nevertheless, Alcmaeon's belonging to the Pythagorean school has been more than once contested, on the basis, first, of his originality as a thinker; second, that he has no number philosophy, yet a distinct interest in natural science; and, third, that Aristotle did not call Alcmaeon a Pythagorean and made a distinction between his dualism and the dualism of the Pythagorean table of opposites.[76] The originality of Alcmaeon as a thinker and scientist is incontestable, but, if one proceeds from real material, not from a supposed 'all-Pythagorean' doctrine, his views diverged from those of Pythagoras no more than the theories of any other Pythagorean.[77] Further, number

[72] J. Wachtler, *De Alcmaeone Crotoniata* (diss. Leipzig, 1896), 1 ff., 7, 16; Olivieri, *Civiltà greca*, 114; Burkert, 292; the political terminology used by Alcmaeon, ἰσονομία and μοναρχία (B 4), accords with this time, see above, 81 n. 87; C. Triebel-Schubert, 'Der Begriff der Isonomie bei Alkmaion', *Klio* 66 (1984), 40–50, at 49 n. 37; Mele, *Crotone*, 69 ff.

[73] For overview of opinions, see G. E. R. Lloyd, 'Alcmaeon and the Early History of Dissection', *Sudhoffs Archiv* 59 (1975), 114; Triebel-Schubert, 'Begriff', 40 n. 3.

[74] *Met.* 986a30; Zeller, i. 597 n. 2 and Ross, i. 152, who considered those words an interpolation (see below, 123 n. 79), nevertheless conceded that this chronology for Alcmaeon accords with reality. See also Guthrie, i. 357 f.

[75] Iamb. *VP* 104, 267; Simpl. *In de An.*, 32.3; Philop. *In de An.*, 88.11; *Schol. Plat. Alc.* I, 121 E.

[76] The last argument had already been used by Simplicius (*In de An.*, 32.3 f.). See e.g. Zeller, i. 601; Wachtler, *De Alcmaeone*, 88 ff.; Ciaceri, *Storia*, 73 f.; Heidel, 'Pythagoreans', 3 f.; Vlastos, 'Isonomia', 344 f.; Guthrie, i. 341 f.; Lloyd, 'Alcmaeon', 125 ff. (with a summary of previous opinions); *KRS*, 339 n. 1; J. Longrigg, *Greek Rational Medicine: Philosophy and Medicine from Alcmaeon to the Alexandrians* (London, 1993), 48.

[77] Alcmaeon's theory of opposite qualities, on the balance of which health depends (B 4), relies on Pythagoras' teaching that the world came into being through the interaction of opposite principles (cf. Ciaceri, *Storia*, 73 f.). Even closer to Pythagoras is his idea that the soul is immortal and, like the immortal heavenly bodies, undergoes eternal rotation (A 12). See below, 360 f., 388 f.

philosophy is not evidenced in any of the early Pythagoreans, among whom, moreover, we know of more doctors and natural scientists than mathematicians (below, §10.1). The interests of Democedes, Iccus, Menestor, and Hippon also lay mainly in the area of medicine and/or natural philosophy, while the influence of Alcmaeon on Menestor and Hippon is incontestable. Also Alcmaeon established neither his own philosophical school, as did Parmenides, nor an original philosophical doctrine, as did Empedocles, and, if the tradition is unanimous in considering him a Pythagorean, we have no reason to reject it.

As has been pointed out, Aristotle named no one as a Pythagorean, and it would have been strange if he had made an exception for Alcmaeon. Aristotle certainly drew a distinction between Alcmaeon's views and those of a particular group of Pythagoreans (*ἕτεροι δὲ τῶν αὐτῶν τούτων*, *Met.* 986b22 f.), which he evidently regarded as later than others. This group proposed as principles, not numbers, as the rest of the Pythagoreans did (985b23 ff.), but ten pairs of opposing principles: limit – unlimited, odd – even etc.[78] 'In this way Alcmaeon of Croton seems also to have conceived the matter, and either he got this view from them or they got it from him.' If the words which follow, *καὶ γὰρ ἐγένετο τὴν ἡλικίαν Ἀλκμαίων ‹νέος› ἐπὶ γέροντι Πυθαγόρᾳ* (986a29–30), belong to Aristotle,[79] then he was inclined to believe, perhaps not without hesitation, that Alcmaeon lived before these Pythagoreans; hence he influenced them, not the reverse.[80]

Although this passage remains controversial, there is another possibility to establish that Aristotle placed Alcmaeon among the Pythagoreans. Aristotle and Theophrastus were the authors of many

78 On the table of opposites see below, 449 f.

79 *νέος* is Diels's conjecture (*DK* I, 211.17). This phrase is absent from one of the manuscript traditions (A^b) and the commentary of Alexander of Aphrodisias, but has been preserved in another tradition (E), in Asclepius' commentary (*In Met.*, 39.21), and in the translation by William of Moerbeke (13th cent.). W. Ross, who normally prefers EJ (i, clxv), regarded these words as a late insertion (i. 152; cf. above, 122 n. 74). Wachtler, *De Alcmaeone*, 3 ff., analysing this passage in detail, showed convincingly that the mention of Pythagoras is Aristotle's; he is followed by *DK* I, 211.17; Ciaceri, *Storia*, 70; Timpanaro Cardini, i. 125; Guthrie, i. 342 f.; H. Dörrie, 'Alkmaion', *RE Suppl.* 12 (1970), 23. For Aristotle's chronology of Pythagoras, see fr. 75, 191.

80 Even if that text is not accepted, the conclusion that Alcmaeon lived before these Pythagoreans follows from the fact that he expressed himself 'indefinably' (*ἀδιορίστως*), whereas they indicated which opposites and how many there were of them (986b1–3).

historico-critical monographs devoted to individual Presocratics and entire schools, their subject matter nowhere intersecting. Aristotle wrote of the Eleatics (*Against Xenophanes*, *Against Zeno*, *Against Melissus*) and the Pythagoreans (*Against Alcmaeon*, *On Archytas' Philosophy*, *On the Pythagoreans*, and *Against the Pythagoreans*, D.L. V, 25), and Theophrastus of the Ionians (Anaximander, Anaxagoras, Archelaus, Democritus, Diogenes, and Metrodorus of Chios) and of Empedocles (137 nos. 27–40 FHSG). On the grounds of this division of labour in the Peripatetic school, it is most natural to place Aristotle's monograph on Alcmaeon among his writings on the Pythagoreans.

Hippasus of Metapontum. We know very little about the life of Hippasus, and his chronology is the cause of many disputes. In the tradition, he appears as the younger contemporary and rival of Pythagoras,[81] yet many scholars are inclined to place him in the middle or even the second half of the fifth century.[82] Such late datings are, however, based, not on biographical data, but on the supposed impossibility of dating the discovery of irrationality, ascribed to Hippasus, at the turn of the fifth century. From the standpoint of the history of mathematics this claim is at the very least debatable (below, §7.5), and we should not proceed from that, but from the tradition on Hippasus.

1) According to Apollonius, Hippasus, one of the dominant 'thousand' in Croton, took the side of Pythagoras' opponents at the time of Cylon's conspiracy.[83] How this relates to his origin in Metapontum is not clear; other data show his birthplace as Croton.[84] An echo of his rivalry with Pythagoras is evident in a later (and unreliable) tradition's making him leader of the *mathematici* opposed to the *acusmatici*, who, they claimed, stemmed from Pythagoras.[85] In general Hippasus is painted in dark colours in the Pythagorean tradition, which is also connected with his rivalry with Pythagoras. It is

[81] Guthrie, i. 320.

[82] Mid-5th cent.: von Fritz, *Pol.*, 61 f.; Burkert, 206 f., 456 (about 460); second half of 5th cent.: Knorr, 51 n. 7; C. J. Classen, *Ansätze: Beiträge zum Verständnis der frühgriechischen Philosophie* (Amsterdam, 1986), 153.

[83] Iamb. *VP* 254 f. = *FGrHist* 1064 F 2 = A 5. See above, 99 ff.

[84] Iamb. *VP* 81; *Comm. Math.* 25; Aristoxenus' catalogue lists him among the Sybarites.

[85] Iamb. *Comm. Math.*, 76.19 ff., cf. *VP* 81 = A 2; see below, 186 f.

indicative that, as distinct from the majority of early Pythagoreans, no pseudo-Pythagorean writings were ascribed to Hippasus, apart from a certain *Μυστικὸς λόγος*, which he is said to have written to blacken Pythagoras.[86]

2) Aristotle and Theophrastus report that Hippasus and Heraclitus proposed the same first principle, fire.[87] Since they refer to two more such pairs, Thales – Hippon and Anaximenes – Diogenes of Apollonia, it can be assumed that, in all three instances, the philosophers' names were in chronological order.[88] On the other hand, if there had been information that Hippasus had lived after Heraclitus, he would surely have been made the pupil of a more renowned philosopher. In fact the *Suda* affirms the contrary: Heraclitus heard Xenophanes and Hippasus (18 A 1a).

3) Hippasus is referred to with Lasus of Hermione (acme *c.*520/10) as experts carrying out experiments in acoustics (A 13).

4) Iamblichus says that Hippocrates of Chios and Theodorus of Cyrene (both born *c.*475/70) worked after Hippasus (*Comm. Math.*, 77.18 f.); this information presumably derives from Eudemus (cf. fr. 133).

5) According to Telauges' letter to Philolaus, Empedocles was the pupil of Hippasus and Brontinus.[89] Of course this letter is spurious, but it antedates Neanthes and could be based on a chronology which is more or less reliable.

Any single one of these pieces of evidence would be insufficient on its own to relate Hippasus' acme to the late sixth – early fifth centuries, but, taken together, and in the absence of contrary biographical data, they provide a firm basis for that conclusion.

It is unclear whether Hippasus was the author of a work on natural philosophy; certainly none was in existence in the Hellenistic period (A 1). What is related by Aristotle and Theophrastus on the *archē* of Hippasus does not support the suggestion that his philosophical treatise was known to them. On the other hand, information in the Greek tradition on Hippasus' studies in mathematics and

[86] A 3. A similar work was ascribed to Ninon, another political opponent of Pythagoras (Iamb. *VP* 258 f. = Apol. *FGrHist* 1064 F 2); see above, 100 n. 165.

[87] *Met.* 984a7; Theophr. fr. 225 FHSG = A 7, 8, 9.

[88] Arist. *Met.* 984a2–3. 5; Theophr. fr. 225–226 FHSG; see Zeller and Mondolfo, i. 626 n. 1.

[89] D.L. VIII, 55 = Neanth. *FGrHist* 84 F 26, cf. above, 120.

harmonics is sufficiently detailed to suggest that it might go back to his scientific writing via the authors of the fifth–fourth centuries (below, §§7.5, 8.3).

Ameinias. According to Sotion,[90] the teacher of Parmenides (born *c.*520). No other information about Ameinias has been preserved.

Iccus of Tarentum. Iccus, one of the first Pythagoreans from Tarentum known to us, was in his youth a famous athlete and later became a trainer and physician (A 2). In 476 he was Olympic victor in the pentathlon.[91] From Plato (*Prot.* 316d = A 1) it seems to follow that Iccus was older than the physician Herodicus of Selymbria (born *c.*500/490). Most likely, Iccus was born not later than 500 and, with Herodicus, was among the earliest Greek dieticians.[92]

Menestor of Sybaris. There are no biographical data on Menestor. The only ancient writer to refer more than once to his botanical writing is Theophrastus. Menestor is also referred to in Aristoxenus' catalogue among the Pythagoreans from Sybaris (*DK* I, 446.31). Since the birthplaces of Pythagoreans in the catalogue are muddled,[93] there can be no certainty that Menestor was indeed from Sybaris. Nevertheless Theophrastus' reference to the oak standing near Sybaris (*HP* 1,9,5) makes it possible that this report, from a city which disappeared after the middle fifth century, traces back to Menestor.[94] There is much that is debatable in Menestor's chronology. Theophrastus on the one hand relates him to *παλαιοὶ τῶν φυσιολόγων* (A 7), and on the other says that he subscribed (*συνηκολούθηκε*) to Empedocles' opinion (A 5). Hence Diels concluded that he could not be older than Empedocles.[95] In this case Menestor's date of birth could be towards the 480s: Empedocles was born *c.*495/90, but his poem appeared quite early (A 6), so it could have been used by someone not much younger than Empedocles or even his coeval. At the same time some scholars, in particular historians of Greek botany, consider Menestor

[90] D.L. IX, 21 = 28 A 1. See above, 71 n. 42.

[91] A 2; *DK* I, 217 n.; J. Jüthner, *Philostratos über Gymnastik* (Leipzig, 1909), 8 f. Moretti, *Olimpionikai*, 103, sets Iccus' victory at Ol. 84 (444), which contradicts other chronological data.

[92] G. Wöhrle, *Studien zur Theorie der antiken Gesundheitslehre* (Stuttgart, 1990), 35 ff.

[93] See above, 113 n. 36.

[94] W. Capelle, 'Menestor redivivus', *RhM* 104 (1961), 48 n. 6.

[95] *DK* I, 375 n. See also H. Steier, 'Menestor', *RE* 15 (1931), 653–5; Timpanaro Cardini, i. 166 not.

to be the predecessor of Empedocles.[96] It is clear at least that Menestor was younger than Alcmaeon and older than Hippon, born between 480 and 470. So he could have been born *c.*500–480. We do not know whether Theophrastus knew the comparative chronology of Menestor and Empedocles; he could simply have assumed that the similarity of their views was due to the influence of the greater thinker, not vice versa. On the other hand, in Theophrastus συνηκολούθηκε does not necessarily have a chronological meaning;[97] in Aristotle there are several examples where this word expresses a purely logical sequence contradictory to chronology (*Phys.* 188b26; *Poet.* 1449b10).

Hippon. The comic poet Cratinus mocked Hippon in his *Panoptai* (A 2), staged *c.*435–431.[98] If by that time Hippon was already known at Athens, he must have been at least 35–40. Hippon was the author of at least two works of natural philosophy (A 11), the titles of which are not known to us. He was influenced by Alcmaeon; following Menestor, the first Greek botanist, Hippon wrote about plants (A 19). He engaged in polemics with Empedocles (A 10), and Democritus attempted to refute one of his notions.[99] Hippon appears to have been born between 480 and 470.

Since Aristoxenus named his birthplace as Samos (fr. 21), and Aristotle (*Met.* 984a4) and Theophrastus (fr. 225 FHSG) attributed to him the same *archē* as to Thales, many associated Hippon with the Ionian school.[100] This is, of course, a misunderstanding, if only because Aristoxenus himself considered him to be a Pythagorean: Hippon of Samos is listed in his catalogue (*DK* I, 447.13). Aristoxenus frequently confused places of birth, but, even if in this case he is right, all other sources associate Hippon with the Pythagorean *poleis* of southern Italy: Croton (Aristotle's pupil Menon), Metapontum

[96] W. Capelle, 'Zur Geschichte der griechischen Botanik', *Philologus* 69 (1906), 286; W. Schmid, O. Stählin, *Geschichte der griechischen Literatur*, i/1 (Munich, 1929), 773; B. Hoppe, *Biologie: Wissenschaft von der belebten Materie von der Antike zur Neuzeit* (Wiesbaden, 1976), 140. G. Senn, *Die Entwicklung der biologischen Forschungsmethode in der Antike* (Aarau, 1933), 29, placed the *acme* of Menestor at 450.

[97] Capelle, 'Zur Geschichte', 278. See below, 384 f.

[98] J. Pieters, *Cratinus* (Leiden, 1946), 164; A. Melero Bellido, *Atenas y el pitagorismo* (Salamanca, 1972), 19.

[99] A 12; 24 A 13; 68 A 141; below, 376.

[100] Zeller, i. 254 f.; Burnet, *Greek Philosophy*, 100; Maddalena, *Pitagorici*, 161 n. 1; Timpanaro Cardini, iii. 366 f. ('Risonanze pitagoriche'). Cf. Guthrie, ii. 355: 'he was probably at one time a member of the Pythagorean brotherhood'.

(Censorinus), or Rhegium (Sextus Empiricus and Hippolytus).[101] Like many other Pythagoreans after 450, Hippon moved frequently from place to place (possibly he lived also in Athens); it is probably for this reason that Aristotle and Theophrastus do not indicate his origin. (It is not clear whether the reference to Rhegium in later doxography goes back to Theophrastus.) In any case, there are no grounds to regard Hippon as an Ionian epigon of Thales on the basis that their principles are similar (but not identical); clearly he continued the line of Alcmaeon, Empedocles, and Menestor.

Theodorus of Cyrene. Although Theodorus figured in some of Plato's dialogues, very little is known about him. According to information which traces back to Eudemus, Hippocrates of Chios (born *c.*470) and Theodorus studied mathematics after Anaxagoras (born *c.*500) and Oenopides, who was 'somewhat younger' than him.[102] Plato says (A 4) that Theodorus' companion was Protagoras (born *c.*480) and his pupil Theaetetus (born probably *c.*430);[103] his own teachers are unknown. Theodorus' probable dates are between 475/70 and 400.

In the biographical tradition Theodorus appears as a teacher of Plato (D.L. II, 103 = A 3),[104] which is confirmed by Plato's broad mathematical knowledge. Evidence that Plato travelled to him at Cyrene (Cic. *De rep.* 110,16; D.L. III, 6) is most probably unreliable. Most likely Theodorus came to Athens[105] and lived there for a long period. Theodorus figures in the tradition as a mathematician (A 2–5). Nothing is known to us of his philosophy, though his friendship with Protagoras implies philosophical interests.

Philolaus of Croton. As result of the anti-Pythagorean movement of *c.*450, he was forced to flee from Italy to Thebes (A 1a, 4a). He was still young at that time, though hardly younger than 20. He is normally regarded as the coeval of Socrates. From references in *Phaedo* (61e), the dramatic date of which is 399, it would appear that he was then still alive. It might be that, at the end of his life, he returned to Italy and lived in Tarentum.[106] It must, however, be taken

[101] Croton: A 11; Metapontum: A 1; Rhegium: A 2, 5; *Dox.*, 610.14. See Zeller and Mondolfo, i. 252; Olivieri, *Civiltà greca*, 149 ff.; Burkert, 290 n. 6.

[102] Eud. fr. 133 = A 2, see below, 220 n. 91.

[103] Zhmud, *Origin*, 94.

[104] Heath, i. 202; Knorr, 88 ff.

[105] As did other Pythagoreans: Hippon, Simmias, Cebes, Echecrates, Amyclas, Cleinias, and Xenophilus.

[106] Huffman, *Philolaus*, 6.

into account that Aristoxenus, naming him as Philolaus of Tarentum, frequently confused Pythagoreans' places of birth, or, at the least, provided alternatives. Later evidence that Plato met Philolaus on his journey to Italy in 388/7 and that Archytas was his pupil seems unreliable.[107] The report of Demetrius of Magnesia (first century) that Philolaus was first among the Pythagoreans to publish the work *On Nature*[108] does not mean that Demetrius had in mind the first work written by any Pythagorean.[109]

Eurytus of Tarentum. Tradition describes him as the pupil of Philolaus (A 1). Archytas, born *c.*435/30, refers to him (A 2). Eurytus was probably born in the middle fifth century and taught until the early fourth century, so that there were among his pupils some whom Aristoxenus would have encountered (fr. 19–20). Nothing is known of Eurytus' writings.

Archytas of Tarentum. The last significant Pythagorean, a scientist, philosopher and politician, Archytas was the author of several philosophical and scientific treatises. According to Eudemus (fr. 133), he was Plato's coeval, perhaps somewhat older than him (Archytas' influence on Plato can be traced, but not the reverse), but only by a little, since in 367–361 he was *strategos* at Tarentum. To judge by Plato's *Seventh Letter* (350a), Archytas was still living in 360. The probable dates of his life are *c.*435/30 – after 360.[110]

Zopyrus of Tarentum. The Tarentine Zopyrus, mentioned in the catalogue, was identified by Diels with the engineer Zopyrus, named by the military writer Biton (third or second century) as the inventor of the gastraphet, the first missile-projecting weapon in the history of warfare.[111] The first missile-throwing weapons were developed about

[107] Plato (D.L. III, 6 = A 5); Archytas (Cic. *De orat.* III,34,139 = A 3). Cf. Huffman, *Archytas*, 7.

[108] πρῶτον ἐκδοῦναι τῶν Πυθαγορικῶν ‹τὰ› Περὶ φύσεως (D.L. VIII, 85 = A 1, B 1, 13; τά is Reiske's conjecture, accepted by Marcovich).

[109] Thus Burkert, 225 n. 35; Huffman, *Philolaus*, 93 f. Cf.: 'The meaning is that "Philolaus was the first of the Pythagoreans to publish (the books) *On Nature*"', J. Mejer, 'Demetrius of Magnesia: On Poets and the Authors of the Same Name', *Hermes* 109 (1981), 467 f.; Riedweg, 'Pythagoras', 77.

[110] Thus Wuilleumier, *Tarente*, 67 f.; B. Mathieu, 'Archytas de Tarente', *BAGB* (1987), 239–55. Huffman, *Archytas*, 5 f., suggests a less definite dating, 435/10–360/50, probably to retain the possibility of mutual influence between Plato and Archytas.

[111] Biton, 61 f., 65. See Diels, *Antike Technik*, 19 ff.; Wuilleumier, *Tarente*, 192, 186, 606; A. G. Drachmann, *The Mechanical Technology of Greek and Roman Antiquity* (Copenhagen, 1963), 11; E. W. Marsden, *Greek and Roman Artillery: Technical Treatises* (Oxford, 1971), 98 n. 52; E. Fischer, 'Zopyrus' (no. 19a), *RE Suppl.* 15

399 in the course of the war waged by the Syracusan tyrant Dionysius the Elder against Carthage, which supports this identification.[112] As a Tarentine, Zopyrus could have belonged to Archytas' circle, which was engaged both in theoretical mechanics and in developing inventions. The identification of Zopyrus of Tarentum with Zopyrus of Heraclea, an alleged author of the Orphic poems,[113] is unconvincing.

Ecphantus and Hicetas of Syracuse. No biographical information about them has survived. To judge by their theories, they were followers, but not necessarily pupils, of Philolaus (50 A 1; 51 A 1, 5). Ecphantus, who took much from Democritus (A 1–2, 4), was probably older than Heraclides of Pontus (born *c.*385), who subscribed to his teaching that the earth revolves on its own axis.[114] The dates of Hicetas and Ecphantus should be regarded as the late fifth – first half of the fourth centuries.[115] At least one of them, Ecphantus, was the author of a philosophical treatise available to Theophrastus.[116]

Thymarides of Tarentum (?). In the catalogue Thymarides is listed among the Pythagoreans from Paros, but this group evokes grave doubts.[117] In Iamblichus Thymarides is referred to: 1) as Pythagoras' pupil (*VP* 104; origin not stated); 2) as Thymarides of Tarentum (145; with a reference to Androcydes' book *On Pythagorean Symbols*), and 3) as Thymarides of Paros (239).[118] Iamblichus' commentary on Nicomachus attributes to a certain Thymarides, whose origin is not

(1978), 1556; Huffman, *Archytas*, 15 f. Cf. Y. Garlan, *Recherches sur la poliorcétique grecque* (Paris, 1974), 167.

112 Diod. XIV,41: Dionysius recruited craftsmen from many Italian and Greek cities, and they rapidly developed powerful weapons; see Marsden, *Artillery*, 48 ff.; Garlan, *Recherches*, 156 ff.

113 As supposed by E. Rohde, *Psyche* (London, 1925), 349 n. 7; West, *OP*, 10; Kingsley, *Ancient Philosophy*, 143 ff.

114 Fr. 104 = 51 A 5; see Zhmud, *Origin*, 103 f. and below, 220 n. 59.

115 The hipparch Ecphantus of Syracuse, who fought in 413 against the Athenian army of Nicias (Polyaen. *Strateg.* I,39), could have been a relative of Ecphantus the philosopher.

116 Ecphantus' views were set out by Theophrastus in some detail (A 1–5), whereas Hicetas is mentioned in the doxography only in connection with the theory of the rotation of the Earth (fr. 240 FHSG = A 1); cf. J. Mansfeld, *Heresiography in Context. Hippolytus' Elenchos as a Source for Greek Philosophy* (Leiden, 1992), 37. The idea of Voss and Tannery that Ecphantus and Hicetas were fictitious figures in Heraclides' dialogues was discarded long ago (Zeller and Mondolfo, i. 628f.; *DK* I, 441 n.; Guthrie, i. 323 ff.).

117 See above, 113 n. 36.

118 Diels attributed the material of *VP* 239 to Aristoxenus (58 D 7).

stated, one of the definitions of the monad (περαίνουσα ποσότης) and an arithmetical problem, the so-called *epantheme*.[119] If we are dealing with one and the same person, Thymarides probably belonged to the Tarentine mathematicians of Archytas' time.[120] Diels, however, considered it impossible to date Thymarides' epantheme and his definition of the monad to the fourth century,[121] so it may be that we are dealing with a later mathematician, and Thymarides of Paros (or Tarentum) is merely a figure of Pythagorean tradition recorded by Aristoxenus. The author of a recent article on Thymarides nevertheless supposes that he could have been a younger contemporary of Eudoxus.[122] Yet Eudoxus was born *c.*390, and a younger contemporary would have been the coeval of Aristoxenus himself, who included the generation of his own teachers among 'the last Pythagoreans'. If nevertheless we resolve to identify the Pythagorean Thymarides with the mathematician and the author of the *epantheme* (which is not impossible, but debatable), he should be dated in the first half of the fourth century. We have no evidence of any Pythagorean known to us by name after the middle of the fourth century.

To conclude this chapter, it is appropriate to mention two supposed Pythagoreans, Lycon and Diodorus of Aspendus. The Peripatetic Aristocles of Messene (second century AD) says that Lycon, who called himself a Pythagorean, wrote all kinds of offensive nonsense about Aristotle.[123] According to Aristocles, Lycon was one of those critics of Aristotle who were his contemporaries or lived shortly after him, so we can date him at the last quarter of the fourth century.[124] Why he decided to call himself a Pythagorean is not known, nor did he leave

[119] *In Nic.*, 11.2 f., 27.4, 62.19, 65.9, 68.3 f.

[120] See e.g. P. Tannery, 'Sur l'âge du pythagoricien Thymaridas' (1881), in *Mémoires scientifiques*, i (Toulouse, 1912), 106–10; id., *Pour l'histoire de la science hellène* (Paris, 1887; 4th edn. 1930), 382 ff.; Heath, i. 94; O. Becker, *Das mathematische Denken der Antike*, 2nd edn. (Göttingen, 1966), 43 f.; Timpanaro Cardini, ii. 444 f.

[121] *DK* I, 447.3 n.; Burkert, 442 n. 92.

[122] M. Federspiel, 'Sur "l'épanthème de Thymaridas"', *LEC* 67 (1999), 354.

[123] 'But they are all surpassed in folly by the statements of Lycon, who styles himself a Pythagorean. For he affirms that Aristotle offered to his wife after her death a sacrifice such as the Athenians offer to Demeter, and that he used to bath in warm oil and then sell it, etc.' (Euseb. *Prep. Ev.* XV,2,8–10 = Aristocl. fr. 2.8 Chiesara).

[124] See Zeller, i. 426 n. 3 (second half of 4th cent.); Susemihl, *Geschichte*, ii. 330, 691 f. (turn of 4th–3rd cents); I. Düring, *Aristotle in the Ancient Biographical Tradition* (Gothenburg, 1957), 374 (probably end of 4th cent.). Hermippus made use of Lycon in his biography of Aristotle (ibid. 466).

any trace in the Pythagorean tradition, provided we do not take him to be identical with Lycon of Iasus in Ionia, the author of *On the Pythagorean (Life)*.[125] This identification is chronologically possible: The work of Lycon of Iasus is clearly written after Aristoxenus, and, if the author himself followed πυθαγόρειος τρόπος τοῦ βίου, he could consider himself a Pythagorean. However our information on the two Lycons is so meagre that we are unlikely to be able to treat them as identical without further evidence.

The indigent philosopher Diodorus of Aspendus, famous, not for his teaching, but for his extravagantly ascetic way of life, had greater success with his claim to be a Pythagorean. Iamblichus reports that he was received into the Pythagoreans by Aresas of Lucania, the last scholarch of the school, since by then there was a lack of Pythagoreans. Returning from Italy to Greece, Diodorus began there to disseminate the oral teaching of the school.[126] It follows from this story that, at least by the time of neo-Pythagoreanism, Diodorus successfully found a place among the Pythagoreans, although even Iamblichus, not normally inclined towards doubts, harboured some. Earlier writers, including Diodorus' contemporaries, noted that he only claimed to be a Pythagorean. Since Diodorus' chronology is debatable, it is not clear whether he was still living at the time of the last Pythagoreans, who could have overturned his claims, or lived after them. Zeller dated him *c.*300, Susemihl a generation earlier, and Corssen *c.*370. Burkert dates Diodorus to the first half of the fourth century and makes him the older contemporary of Diogenes of Sinope, the founder of Cynicism.[127] Thus spared any connection with the Cynics, among whom he was usually numbered (Athen.

[125] Zeller, i. 426 n. 3; Susemihl, *Geschichte*, II. 330, 691f.; Capelle, 'Lykon', 2309 (uncertain); Burkert, 204. Cf. above, 119 n. 62. Centrone and Macris, 'Lycon', follow Diels in combining all four Lycons in a single person.

[126] *VP* 266 (from Apollonius). There are no grounds for ascribing this passage to Timaeus (as Bertermann, *De Iamblichi*, 38 f.; Rostagni, 'Pitagora', 5 ff.; Delatte, 'Chronologie', 12 f. Burkert, 203): Pythagorean 'scholarchs', including Aresas of Lucania, are a Hellenistic invention (cf. Corssen, 'Sprengung', 348 f.) and Timaeus did not consider Diodorus a Pythagorean (*FGrHist* 566 F 16). Plutarch's account (*De gen. Socr.* 583 A–B), in which Aresas figures (the manuscripts, to be sure, give Ἄρκεσον, not Ἀρεσᾶν), inspires no confidence, *pace* R. Velardi, 'Gorgia a Tebe: l'incontro con il pitagorico Liside e il ritorno definitivo in Sicilia', *AION* 20 (1998/99), 89–106.

[127] Zeller, i. 426 n. 3; Susemihl, *Geschichte*, ii. 330 n. 449; Corssen, 'Sprengung', 351; Burkert, 202 f.

IV, 163f–164a), Diodorus stands as a fully legitimate Pythagorean of the 'acusmatic' persuasion; the scepticism of Timaeus and Sosicrates regarding his Pythagoreanism is nullified by reference to their tendentiousness.[128]

Burkert claims that the earliest witnesses, the renowned wit Stratonicus and the author of a culinary poem Archestratus, unreservedly considered Diodorus a Pythagorean, Stratonicus dying *c.*350.[129] However Stratonicus' dating is just as debatable as Diodorus',[130] and his witticism calls the philosopher 'Pythagoras' henchman',[131] which in no way resembles the normal appellation of a Pythagorean. Rather these words associate Diodorus with the Pythagorists of Middle Comedy. Note that Archestratus applies to Diodorus the verb *πυθαγορίζειν*, which, together with its participles (*πυθαγορίζων*, *πυθαγορίζουσα*, and *πυθαγορίζοντες*), we frequently encounter in comedy: 'Therefore it is clearly appropriate that those who talk this sort of nonsense keep company with vegetables and go to the wise Diodorus and temperately play the Pythagorean along with him'![132] Generally speaking, *πυθαγορίζειν* is never applied to Pythagoreans: only those Pythagorize who were not Pythagoreans, for example Plato or the Platonists.[133] If Archestratus, as is usually accepted, wrote his

[128] Burkert, 202 n. 56. Cf. Timaeus: Diodorus led an eccentric life and pretended to be a pupil of the Pythagoreans (*FGrHist* 566 F 16); Sosicrates: to gratify his vanity, Diodorus began to wear a long beard, long hair, and put on a worn cloak, whereas before him the Pythagoreans always went about in white clothing, made use of baths, and had customary haircuts (fr. 15). Cf. D.L. VI, 13.

[129] Thus P. Maas, 'Stratonikos', *RE* 4 A (1931), 326–7; Burkert, 202 f.

[130] To date Stratonicus about 410–360, Maas, 'Stratonikos', 327, rejected the evidence of Capiton (Athen. VIII, 350c), who placed the wit at Ptolemy's court, and of Machon (fr. 11, v. 156f. Gow), who connected his death with Nicokreon, king of Cyprus (died 310). See A. Gow, *Machon: The Fragments* (Cambridge, 1965), 80 f., 90. Webster, 'Chronological Notes', 17; id., *Studies*, 154 n. 5, proceeding from references to Stratonicus in a comedy, supposed that he could have been born about 390 and have lived until 323, when Ptolemy became ruler of Egypt. Even if we accept that Stratonicus died shortly after the middle of the 4th cent., it does not make Diodorus older than Diogenes of Sinope (*c.*404–323): there is nothing to prevent the supposition that about 350 Stratonicus referred to the 40-year-old Diodorus, who lived on a further thirty years.

[131] Tim. *FGrHist* 566 F 16.

[132] *ὥστε πρέπει καθαρῶς ὁπόσοι τάδε μωρολογοῦσι / τοῖς λαχάνοις προσάγειν καὶ πρὸς Διόδωρον ἰόντας / τὸν σοφὸν ἐγκρατέως μετ' ἐκείνου πυθαγορίζειν* (Athen. IV, 163d–e = fr. 23,18f. Brandt = fr. 24 Olson-Sens). Cf. *πυθαγορίζειν* in Antiphanes (fr. 225,8 K-A).

[133] Plato (Aët. II,6,6; Euseb. *Prep. Ev.* XV,38,1); Platonists (Syrian. *In Met.*, 122,20). Cf. Athen. VII, 308d: You Cynics, do not pythagorize.

Ἡδυπάθεια in about the 330s,[134] this places Diodorus, who appears in the poem as his contemporary, at a time when there were no longer any Pythagoreans, and the poets of Middle Comedy were competing for the best joke about the Pythagorists. It is no accident that Diodorus, who has nothing in common with the Pythagoreans (we know nothing of his contacts with them, nor of his teaching), is practically indistinguishable from the Pythagorists, having the appearance and way of life of an indigent vegetarian (below, §5.2). The evidence of Timaeus, and later of Sosicrates, who essentially deny Diodorus the right to be regarded as a Pythagorean, thus reflects not their tendentiousness, but the common contemporary attitude to this 'sage', who played the Pythagorean in accordance with the notions and fashion of the time.

[134] G. D. Olson and A. Sens, *Archestratus of Gela* (Oxford, 2000), XXII and n. 5.

4

The Pythagorean Communities

4.1 WHAT KIND OF COMMUNITY DID PYTHAGORAS FOUND?

The image of Pythagoras in the early tradition is by no means restricted to one of a preacher of metempsychosis. His contemporaries were fully aware of his wisdom and breadth of knowledge. To that image the fourth-century sources add the features of a political figure and mathematician, at the same time linking it with a variety of miracles, prophecies, and superstitions. Precisely how Pythagoras combined within himself the features of a rational thinker and religious teacher is a psychological question rather than a historical one. For our purposes it is sufficient to note that such a combination is far from unique. If in the time of the scientific revolution in Europe we see the most extraordinary combinations of science with the occult, even in Kepler and Newton,[1] there is no reason to suppose that in the sixth century science and philosophy – both then newborn – should have immediately and totally subsumed the world-view of all those who engaged in them.

As soon as we turn to the Pythagoreans, the problem moves out of the sphere of individual psychology into that of social and cultural history. The images of Pythagorean philosophers and scientists which have come down to us more closely resemble Anaxagoras and Democritus than Pythagoras and Empedocles. It is precisely this that is puzzling. How did the study of natural philosophy, exact sciences, natural sciences and medicine, well attested for many Pythagoreans (though a minority of the total), mesh with their belonging to an

[1] See above, 21 n. 52.

authoritarian sect utterly alien to such study? How did these 'sectarians' manage to achieve their primacy in politics and sport? Or was the Pythagorean community perhaps somewhat different (or even very different) from the picture that emerged of it in the Imperial period?

Let us recall the principal elements of that picture. In the words of Nicomachus, Pythagoras 'won over in only one lecture more than two thousand people by his words, so that they did not return home, but together with their wives and children built an immense school and colonized the region in Italy that is commonly called Magna Graecia, and, receiving laws and instructions from him as if they were divine orders they strictly abided by them. They also shared their property in common and counted Pythagoras among the gods.' Shared property is also mentioned by Diogenes Laertius (citing Timaeus), who adds that, 'For the five whole years [Pythagoras' pupils] had to keep silence, merely listening to his discourses without seeing him, until they passed an examination, and thenceforward they were admitted to his house and allowed to see him.'[2] Iamblichus (*VP* 71 ff.) explains that the five-year period of silence was preceded by three years of rigorous testing. The community was dominated by the absolute authority of the Master, and those who disobeyed were expelled. Whenever anybody questioned the rightness of their views the Pythagoreans would utter the words 'He himself said it'. They 'attributed everything to Pythagoras', even their own scientific discoveries. His pupils were forbidden to refer to him by name, saying only 'that man'. His teaching was oral and remained secret right down to the time of Philolaus, who was the first to publish it. Until his time, the Pythagoreans wrote no books. In the community there were several different trends: the *mathematici* were initiated into the essence of Pythagoras' teaching, whereas for the *acusmatici* everything was set forth without explanation, in the form of short sayings, the so-called 'symbols'. The entire life of the Pythagoreans was based on a great number of prescriptions and taboos, which included the following: Do not stir the fire with a knife, do not step over a yoke, do not sit on a bushel measure, do not make water towards the sun (D.L. VIII, 17). On departing, do not look back; do not keep swallows in your house, do not travel by the main roads, do not wear rings with images of the

[2] Porph. *VP* 20 = Nicom. *FGrHist* 1063 F 1, tr. Radicke; D.L. VIII, 10 = Tim. *FGrHist* 566 F 13.

gods (Porph. *VP* 42). Do not use the public baths, put the right shoe on first, but wash the left foot first, do not look in a mirror by the light of a lamp, etc. (Iamb. *VP* 83; *Protr.* 21).

Such is the picture painted by the late sources of the Pythagorean community. They differ in the detail (on the ban on eating meat, for example), but in the essentials they concur. What is surprising is that this picture is recognized, with some reservations, by the majority of modern scholars.[3] The established canonical image proceeds from one work to the next, and some see confirmation of it in the tradition of the Pythagorean 'symbols', preserved by Aristotle. Yet the cumulative effect of all the Pythagorean rules and taboos handed down by tradition is such as to require both the *acusmatici* and the *mathematici* to have devoted their whole lives to the observance of these 'divine commandments'. If taken seriously, this image of the Pythagorean community is strikingly at odds with what our sources report of the early Pythagoreans' successes in philosophy, science, medicine, sport, and – last but not least – politics. Attempts made to resolve this contradiction thus far can hardly be termed successful. They either reject early Pythagorean philosophy and science (with varying degrees of consistency), or try to find some explanation for their paradoxical flowering in a sect of superstitious ritualists. Thus the fusion of 'mysticism and science' in Pythagoreanism has been explained by a particular feature of Pythagorean religion, according to which the study of mathematics served to purify the soul.[4] Leaving aside the fact that such a Platonic approach to science in early Pythagoreanism is unattested, it applies only to mathematics, leaving unexplained Hippasus' studies of harmonics and acoustics, Alcmaeon's and Hippon's of medicine and philosophy, Menestor's work in botany, and Philolaus' in astronomy. Theoretically speaking, fruitful scientific research may be conducted in a religious community, such as the Jesuit Order, for example, but the achievements of the Jesuits require their own explanation, which is usually found in the particular historical circumstances of the Counter-Reformation, which caused the Order to become *omnia omnibus* and engage in secular education, among

[3] Against this background we may note the sober approach of Zeller, i. 400 ff., and Philip, 134 ff.

[4] See above, 16 n. 39.

other things.[5] The religious communities of archaic and classical Greece, as far as we can tell, were very remote from science and philosophy,[6] and if the Pythagorean community was one of these its special character still remains mysterious.

In the sixth and fifth centuries ancient Greece was only approaching the stage of setting philosophy and science against traditional religion. In the last third of the fifth century, when the contradictions between them had manifested themselves fairly clearly (as shown when the philosophers were accused of impiety, for example), as well as later, they related to natural philosophy and sophistic, and hardly ever science proper.[7] From this it does not, of course, follow that *until* the fifth century philosophy and religion were in some state of original syncretism.[8] To view ancient Pythagoreanism through the prism of that hypothetical 'primeval unity' is just as anachronistic as to confuse it with Neoplatonism, in which the scientific, philosophical, and religious paths to the truth really did complement one another. If the neo-Pythagoreans and Neoplatonists saw no contradiction in the fact that science and philosophy blossomed in the Pythagorean community, which they depicted as an authoritarian sect, the writers of the fourth century were far more sensitive to such contradictions. Aristotle, who collected a great number of legends about Pythagoras, usually avoided speaking of him in a scientific or philosophical context, and maintained a distinction between *Πυθαγόρειοι* 'in general', and individual representatives of that school, whom he never called 'Pythagoreans'. Aristoxenus did all he could to overturn the view, widespread in his day, of the Pythagoreans as a society of superstitious vegetarians.

The image outlined above is perhaps even more difficult to combine with the politics of the Pythagoreans than with their philosophy

[5] See e.g. M. Feingold (ed.), *Jesuit Science and the Republic of Letters* (Cambridge, 2003). A similar specific explanation is offered for the astronomical investigations of the Babylonian priests, or rather the learned scribes attached to the temples (below, §9.1).

[6] The author of the Derveni papyrus (late 5th cent.), whose allegorical interpretation of an Orphic poem shows clear traces of the influence of philosophical thought, was an exception to the rule. In any case the 'philosophy' of this Orphic, whose name we shall probably never learn, contains nothing original.

[7] The 3rd-cent. Stoic Cleanthes accused Aristarchus of Samos of impiety for his heliocentric hypothesis (Plut. *De facie* 923 A; *Quaest. conv.* 1006 C), but even this was no more than an isolated episode.

[8] Thus e.g. Guthrie, i. 152 (below, 152 n. 61); cf. Zhmud, *Origin*, 18 f.

and science. Their significant influence on the political life of Magna Graecia in the period 510–450 (and in some cases even later), the flowering of Croton, the subjugation of Sybaris and other Italian *poleis*, and finally the crushing of the Pythagorean *hetairiai*, which consistently sided with the aristocracy – all these facts are beyond dispute, unlike, say, the mathematical discoveries of Pythagoras and Hippasus. Since the successes of the Pythagorean politicians, lawgivers, and military leaders are almost impossible to deny, they are often simply ignored (especially in the context of discussion of the Pythagorean way of life),[9] like the successes of the Pythagorean athletes, which cannot possibly be linked with the way of life of the *mathematici* and *acusmatici*. It is difficult to conceive of anything further removed from reality than the *acusmatici* in the role of Pythagorean politicians (Iamb. *VP* 88)! However, modern sociological models will not help us to understand the Pythagorean community either, if we persist in gazing at its reflection in the distorting mirror of comedy and taking its beggarly vegetarians for Pythagoras' pupils.[10] Milon, the military commander and victor at many Olympic games, in whose house the Crotonian Pythagoreans met and whom Aristotle already called πολυφάγος (fr. 520, cf. *EN* 1106b3), is an authentic Pythagorean political figure. Even if the Hellenistic sources exaggerate when they claim that he ate 9 kilograms of meat and the same amount of bread every day, and drank 10 litres of wine,[11] those sources are far closer to the realities of the sixth century than the caricatured Pythagorists of Middle Comedy, to say nothing of Iamblichus' *acusmatici*. As for politicians who avoided the regular social banquets, at which meat was served, warriors who avoided main roads, and athletes who stayed away from the public baths – if such people ever lived in Archaic Greece the total failure of all their endeavours would have been assured, along with endless mockery from their peers.

[9] See e.g. R. Parker, *Miasma: Pollution and Purification in Early Greek Religion* (Oxford, 1983), 291 ff.: 'Pythagoras subjected his followers to a code of restrictions unique in Greek life.'

[10] Thus J. Bremmer, 'Symbols of Marginality from Early Pythagoreans to Late Antique Monks', *G&R* 39 (1992), 205–14; id., 'Rationalization and Disenchantment in Ancient Greece: Max Weber among the Pythagoreans and Orphics?', in Buxton (ed.), *From Myth to Reason?*, 71–83.

[11] Phylarch. *FGrHist* 81 F 3; Athen. X, 412e–413a.

In attempting to establish what the Pythagorean community was really like, we must not only limit ourselves to fifth- and fourth-century sources, but also take careful note of who is speaking, what is said, and about whom. Historical evidence, biographical fragments, legends about Pythagoras' miracles, the Pythagorean 'symbols', and reflections in comedy must all be considered with regard to their own particular features, and not simply lumped together indiscriminately. It is especially important to note who precisely claims the attention of our sources: Pythagoras himself, individual Pythagoreans known by name, anonymous individual Pythagoreans, the Pythagoreans in general, or – lastly – Pythagorizers and comic Pythagorists. Without trying to exclude in advance any of the available sources, we must realize that some of them have very limited value for our purposes. The Pythagorean 'symbols' and precepts belong to folklore and must be considered within the framework of that genre. The Pythagorists and Pythagorizers appeared at a time when there were no longer any Pythagoreans. To the extent that there is any reality at all behind these figures, they represent one of the filiations of Pythagoreanism, which bears the same relation to the early Pythagorean community as the treatises of pseudo-Archytas bear to Archytas' authentic writings.

The legends about Pythagoras' miracles may be able to tell us something about his personality, but can we project them onto the personalities of his pupils and followers? We know of no 'miraculous' legends related about a single one of them,[12] and there is not so much as one figure in ancient Pythagoreanism who in this respect even remotely resembles Pythagoras. Most likely those Pythagoreans whose individual features may be distinguished in the surviving tradition took from Pythagoras not everything, but only what was closest to them, and whatever corresponded to their own interests. It appears that 'miracles' were not part of this. On the other hand, the reverse projection – from the personalities of particular Pythagoreans onto the community founded by Pythagoras – is a perfectly legitimate procedure. Indeed our prosopographical analysis (above, §3.3) identified several partially overlapping categories to which the Pythagoreans known to us may be assigned: politicians, athletes, doctors, philosophers, and scientists. It is natural to suppose that the community to which they all belonged must have encouraged them in their

[12] The legends about Hippasus are of a quite different nature, see below, 275.

activities, or at least *did nothing to obstruct them.* We may even take another step into the past and on the basis of the collective portrait of the Pythagoreans attempt a portrait of Pythagoras himself. While it will not be the only possible portrait, is it not reasonable to suppose that Pythagoras had some connection with the activities for which his followers won fame, even in his lifetime? Of course, even with his *πολυμαθία* and *πολυτροπία*, Pythagoras could not have embraced all the activities of the Pythagoreans. But he could certainly have devoted himself to some of them, and given encouragement in other fields.

We shall now set Pythagoras aside for a moment, however, as our interest is not in his multifaceted personality, but rather in the principles on which the Pythagorean community was founded, its nature as an institution. A monastery may be a thriving enterprise, while the people who sing in the choir may have many common interests and connections, besides their choral singing. While allowing for this, we should nevertheless focus on the most important thing: what is the nature of the main bond linking the given group of people, and what is the place of this group in the general typology of associations. By taking as our point of departure the fact of its belonging to a particular category, and by comparing it to societies in the same category, we can clarify the features not mentioned by our sources, and at the same time evaluate the veracity of what they do tell us. Here we must, of course, confine ourselves to those types of association which actually existed in Greece in the Archaic and Classical periods. If the Pythagorean community was really a religious association, it should conform to the type of religious association of its time, and not to that of the Qumran community or a Christian monastery.

4.2 SCHOOL, *THIASOS*, *HETAIRIA*

To describe the nature of the society founded by Pythagoras, we may choose from a very small number of variants available for that period: (1) a philosophical school (*σχολή*), like those which appeared in the fourth century; (2) a cultic community (*θίασος*);[13] (3) a sociopolitical

[13] See P. Foucart, *Des associations religieuses chez les grecs: thiases, éranes, orgéons* (Paris, 1873); E. Ziebarth, *Das griechische Vereinswesen* (Leipzig, 1896); F. Poland,

association (ἑταιρεία).[14] The term 'philosophical school' is variously understood. Our primary interest is in the institutional nature of the Greek philosophical schools founded in the fourth century, first by Plato and Aristotle, and later by Zeno and Epicurus. The Academy and the Lyceum had no equivalents in the sixth century. They were created as educational establishments for joint studies under the leadership of the founder of the school, and later of a scholarch, who was appointed by his predecessor or elected by the members of the school. Each of these schools operated in a definite place, either public, like the Academy and the Lyceum, or private, like the Epicurean school.[15] The Pythagorean community was of a quite different kind, and therefore the terms used to denote a philosophical school (σχολή, διατριβή), are not found in the sources on ancient Pythagoreanism. The Pythagoreans had no scholarchs, and the reason for this is clear: the fact that the Pythagoreans were scattered in a dozen cities in southern Italy and later in Greece precluded any joint study, along with leadership from a single centre.[16] Joint searches for the truth could not have been a constituent part of the Pythagorean community because the overwhelming majority of Pythagoreans – even those mentioned in Aristoxenus' catalogue – had no connection with the study of philosophy or science.

At the same time, if we understand 'school' not as a social institution, but as a means of preserving and developing an intellectual

Geschichte des griechischen Vereinswesens (Leipzig, 1909); P. G. Vinogradoff, *Outlines of Historical Jurisprudence* (Oxford, 1920), 124 ff.; M. Guarducci, 'Orgeoni e tiasoti', *RFIC* 13 (1935), 332–40. *Thiasoi* are first mentioned by Alcman (fr. 98,1 Page) and in the laws of Solon (E. Ruschenbusch, *ΣΟΛΩΝΟΣ ΝΟΜΟΙ: Die Fragmente des Solonischen Gesetzeswerkes mit einer Text- und Überlieferungsgeschichte* (Wiesbaden, 1966), F 76a). See also Hdt. IV, 79. On other religious communities see W. S. Ferguson, 'The Attic Orgeones', *HThR* 37 (1944), 61–140; J. Vondeling, *Eranos* (Groningen, 1961).

[14] The *hetairiai* were formed in the archaic period from the institution of Homeric ἑταῖροι: G. M. Calhoun, *Athenian Clubs in Politics and Litigation* (Austin, 1913), 10 ff.; C. Talamo, 'Per le origini dell'eteria arcaica', *PdP* 16 (1961), 297–303. On their role in Athenian political life see F. Sartori, *Le eterie nella vita politica Ateniese del VI e V secolo a. C.* (Rome, 1957); W. R. Connor, *The New Politicians of Fifth-Century Athens* (Princeton, 1971), 25 ff.

[15] J. P. Lynch, *Aristotle's School* (Berkeley, 1972), 32 ff., 68 ff.

[16] Iamblichus gives the names of several scholarchs (*VP* 265–6), but they are plainly invented: Aristeas of Croton, Pythagoras' son Mnesarchus, Bulagoras and Gartydas of Croton, and Aresas of Lucania (cf. above, 132 n. 126). None of these are mentioned in Aristoxenus' catalogue.

tradition, it must be admitted that within the framework of ancient Pythagoreanism a school did exist. The fact that some of the Pythagoreans were united by being teachers and pupils, together with the steady development of certain areas of philosophy and science, is proof of this. In this broad, non-technical sense we speak of the Milesian and Eleatic schools, for example.[17] Here, however, a number of reservations need to be stated. One cannot successfully bind all the Pythagorean philosophers and scientists with the threads of continuity: of the teachers of Menestor, Hippon, Philolaus, Theodorus, and Archytas we know nothing, and those who studied under them were not all Pythagoreans. Moreover, we can hardly speak of a 'philosophical school . . . as an identifiable group committed to the teaching and manner of life prescribed by the founder'.[18] The Pythagorean philosophers did not teach Pythagoras' philosophy, but their own, and of their way of life we know too little to perceive anything they held in common. Lastly, it is not fully accurate to regard the Pythagorean school as purely philosophical: the exact sciences and medicine were just as important. The Pythagorean school, then, was what brought together Pythagorean philosophers and scientists of different generations, for example, Hippasus, Theodorus, and Archytas, or Alcmaeon, Hippon, and Philolaus. We, however, are now trying to define the character of a *community* that united all Pythagoreans living at the same time and in the same place, for example Milon, Hippasus, and Democedes.

To define the status and organizational structure of the community we must therefore choose between *hetairia* and *thiasos*.[19] The

[17] On 'schools' in Presocratic philosophy, see A. Laks, 'Die Entstehung einer (Fach) Disziplin: der Fall der vorsokratischen Philosophie', in G. Rechenauer (ed.), *Frühgriechisches Denken* (Göttingen, 2005), 19–39. In *Dissoi logoi* we find Ἀναξαγόρειοι and Πυθαγόρειοι (*DK* 90.6). Plato mentions Ἡρακλείτειοι (*Tht.* 179e3) and the 'Eleatic tribe' (*Soph.* 242d). On the development of this approach in Aristotle and Theophrastus, see Zhmud, *Origin*, 156 f., 160 f.

[18] S. Mason, '*Philosophiai*: Graeco-Roman, Judean and Christian', in J. S. Kloppenborg et al. (eds.), *Voluntary Associations in the Graeco-Roman World* (London, 1996), 31.

[19] Zeller, i. 400, 412 ff., also indicated these two types of association, but he preferred an intermediate variant, surmising that the Pythagorean community evolved from a religious association to a political one; similarly Delatte, *Pol.*, 18 f. Gigon, *Ursprung*, 129 f., believed that it was organized in the form of a *hetairia*, but that in essence it was religious. 'In fact, cult society and political club are in origin virtually identical . . . Every cult society is active politically as a ἑταιρία' (Burkert, 119). Both these theses are entirely unsupported.

choice presents no particular difficulty. The sources never call the Pythagorean community a θίασος, or its members θιασῶται, or use any other terms peculiar to religious associations.[20] The members of the *thiasoi*, if they were citizens, could take part in affairs of state, but the *thiasoi* themselves did not intervene in politics, being purely cult societies.[21] The *thiasoi* had a well-developed organizational structure: management lay in the hands of magistrates of various categories, who were changed every year; the cult was administered by special priests and priestesses; and discipline, enshrined in special νόμοι, was backed by penalties.[22] Nothing resembling this is known of the Pythagoreans. In the Archaic period, *thiasoi* usually arose around relatively new cults which had not yet taken hold in the religion of the *polis*, and the θιασῶται themselves, unlike the Pythagorean aristocracy, were people of humble origin, often not citizens.[23] There is no information on the existence of any special cult among the Pythagoreans.[24] The deity most worshipped in Pythagoreanism was Apollo, whose cult was official in Croton long before Pythagoras arrived.[25] According to Alcidamas, the Italians revered Pythagoras (that is, they rendered heroic honour to him), just as the Clazomenians revered Anaxagoras.[26] It is clear that Alcidamas was speaking of an Italian cult, rather than a specifically Pythagorean cult, around

[20] Philo of Alexandria, who mentions τὸν τῶν Πυθαγορείων ἱερώτατον θίασον (*Prob. lib.* 2,1), is the only exception known to me.

[21] With regard to the Orphics there is no information on this point either. Ju. Vinogradov's hypothesis on the political activity of the Orphics in Olbia, in 'Zur sachlichen und geschichtlichen Deutung der Orphiker-Plättchen von Olbia', in P. Borgeaud (ed.), *Orphisme et Orphée* (Geneva, 1991), 81 ff., is not supported by the material.

[22] Poland, *Geschichte*, 330 ff.; M. N. Tod, 'A Statute of an Attic Thiasos', *BSA* 13 (1906–7), 328–38; id., *Sidelights on Greek History* (Oxford, 1932), 71 ff., 86 ff.; Vinogradoff, *Outlines*, 124 ff.

[23] Foucart, *Des associations* 55 ff.; Guarducci, 'Orgeoni e tiasoti', 333 ff. Guarducci, in particular, links the rise of *thiasoi* with the spread of the cults of Dionysus and Heracles; in this context *thiasoi* are mentioned in the literature of the 5th and 4th cents.

[24] See below, 218.

[25] Croton was minting coins with the image of a tripod even before the 530s: Dunbabin, 245 f., 355 f.; A. Stazio, 'Problemi di monetazione di Crotone', in *Crotone*, 373 f.

[26] See above, 43. Judging by the other names cited by Alcidamas (the Parians revered Archilochus; the Chians – Homer; the Mytilenians – Sappho, the Lacedaemonians – Chilon), τιμῶσιν implies specifically heroic honour, rather than simply the veneration of the famous.

which a community of admirers of Pythagoras might have formed. The Pythagoreans had their own rules concerning burial (Hdt. II, 81), but it can confidently be asserted that the community itself was not created in order to observe them.[27]

In the first half of the twentieth century the view prevailed that the Academy and the Lyceum were organized like *thiasoi* dedicated to the Muses; a similar view of the Pythagorean school was developed by Boyancé.[28] Research in recent years has shown that neither the Academy nor the Lyceum were *thiasoi*.[29] What of the Pythagoreans? Dicaearchus wrote that Pythagoras ended his days in a temple of the Muses in Metapontum (fr. 35). Timaeus reports that after his death the Metapontines made his house into a temple of Demeter and called the street where he lived μουσεῖον.[30] According to Iamblichus, the Crotoniates followed Pythagoras' advice and built a temple to the Muses (*VP* 45, 50). It has not so far been confirmed that there was a temple to the Muses in Croton,[31] but even if the Crotonian Pythagoreans venerated the Muses in the same way as the Metapontines, there is nothing in any of the evidence to suggest that the community founded by Pythagoras was a *thiasos* dedicated to the Muses.

In fact, quite the reverse: it was noted long ago that the name Πυθαγόρειοι resembles those of the political *hetairiai* (Κυλώνειοι,

[27] Concern for the burial of their members was a feature of practically all Greek voluntary associations (Poland, *Geschichte*, 503 f.; Tod, 'Statute', 336).

[28] U. von Wilamowitz-Moellendorff, *Antigonos von Karystos* (Berlin, 1881), 279 f.; P. Boyancé, *Le Culte des Muses chez les philosophes grecs* (Paris, 1937), 233 ff.

[29] Lynch, *Aristotle's school*, 57 ff., 108 ff.; J. Glucker, *Antiochus and the Late Academy* (Göttingen, 1978), 229 ff.; L. Tarán, *Speusippus of Athens* (Leiden, 1981), 9; H. J. Krämer, 'Die Ältere Akademie', in H. Flashar (ed.), *Die Philosophie der Antike*, iii, 2nd edn. (Basel, 2004), 4.

[30] *FGrHist* 566 F 131. Although a fragment of Timaeus in Porphyry speaks of Croton, parallel passages in Iamblichus (*VP* 170) and Diogenes Laertius (VIII, 15) mention Metapontum. An abridged variant of Pompeius Trogus, whose source was Timaeus, also mentions Metapontum (Iust. XX,4,18), so 'Croton' is an error by Porphyry or his source (Delatte, *Vie*, 183; G. Vallet, 'Le *stenopos* des Muses à Métaponte', *Mélanges P. Boyancé* (Rome, 1974), 749–59; cf. Jacoby, comm. on *FGrHist* 566 F 131).

[31] G. Giannelli, *Culti e miti della Magna Grecia* (Florence, 1924), 79, 156. *Pace* Boyancé (*Muses*, 235 n. 1), Cicero (*De finib.* V,2,4) says nothing about a temple. C. F. Maddoli, 'I culti di Crotone', in *Crotone*, 338, relies solely on Iamblichus. Giangiulio, *Ricerche*, 51, 185 n. 119, also adduces no new data. It is entirely possible that Iamblichus' source, Apollonius, projected onto Pythagoras the story of Plato founding a temple to the Muses in the Academy (D.L. IV, 1 and 19).

Διώνειοι, etc.).[32] In Aristoxenus, Dicaearchus, Neanthes, and Timaeus, the community itself is called a *ἑταιρεία*, and its members *ἑταῖροι* and *φίλοι*.[33] Aristoxenus gave his work the title *Περὶ Πυθαγόρου καὶ τῶν γνωρίμων αὐτοῦ*, and although *γνώριμος* (like *ἑταῖρος* and *φίλος*) by no means always has a political coloration, Aristoxenus applies it several times to the political followers of Pythagoras.[34] The *συνέδρια*, which were set on fire throughout Italy in about the 450s, were the political meeting houses of the Pythagorean *hetairoi*;[35] in Croton, the house of Milon was such a meeting place.[36] The vast amount of material gathered by Minar and the abundant evidence of political activity by the Pythagoreans leave no doubt that not only was their society perceived as a *hetairia* by the fourth-century writers, it actually was one.[37]

A *hetairia* was a kind of informal association built on the personal relations of its members, who were usually coevals from an aristocratic background. Unlike a *thiasos*, it did not require the existence of any clear organizational structure, office-bearers, or other attributes of a formal association. The members of a *hetairia* were united by bonds of friendship and comradeship, by shared interests and a way of life, rather than any preset purpose. This is why the activity of a *hetairia* depended to a large extent on the particular circumstances and interests of its members, and on the presence of a leader with clearly defined tendencies. The range of interests of the membership very often did not extend beyond holding drinking sessions or other ways of passing the time,[38] organizing social support for their fellows, and the like. At the same time the *hetairia* gave a politician an outstanding opportunity to win the support of people who were

[32] Zeller, i. 446 n. 1; Minar, 21 f.; Burkert, 30 n. 8; id., 'Craft', 14. It is true that the author of *Dissoi logoi* already took the *Πυθαγόρειοι* to be the philosophical followers of Pythagoras; cf. Hdt. II, 81.

[33] *ἑταῖροι*: Aristox. fr. 18; Dic. fr. 34; Neanth. *FGrHist* 84 F 30, 31. *ἑταιρεία*: Tim. *ap.* Apoll. *FGrHist* 1064 F 2 = Iamb. *VP* 254; *ap.* Iust. XX,4,14 (sodalicium). *φίλοι*: Aristox. fr. 31; Dic. fr. 34. For later evidence, see Minar, 19 ff.

[34] Aristox. fr. 17; Neanth. *FGrHist* 84 F 30 = Porph. *VP* 55. See Minar, 21 n. 25; Burkert, 'Craft', 14. In Aristox. fr. 50 *γνώριμος*, on the other hand, is simply an 'acquaintance' of Archytas (Huffman, *Archytas*, 318).

[35] Polyb. II,39,1 (from Timaeus); see above, 69 n. 35.

[36] *ἐν τῇ Μίλωνος οἰκίᾳ ἐν Κρότωνι συνεδρευόντων τῶν Πυθαγορείων καὶ βουλευομένων περὶ πολιτικῶν πραγμάτων* ... (Aristox. fr. 18).

[37] Minar, 19 ff.; see also Dunbabin, 361 f. This was already noted by E. Ziebarth, 'Hetairia', *RE* 8 (1913), 1373.

[38] Calhoun, *Athenian Clubs*, 24 f.; Connor, *New Politicians*, 26 f.

prepared to lend assistance in any circumstances, and a chance to extend its influence beyond a circle of relations.[39] For Pythagoras, whose activities in Croton included rearing and educating the young, a *hetairia* of aristocratic young people could have offered an important way to win followers.[40] As the youths grew to manhood and entered political life, the emigrant from Samos found himself in a position to exert real influence on the political life of Croton.[41]

The Pythagoreans' family ties enhanced the strength of their community. Pythagoras married the daughter of Brontinus, while the doctor Democedes married the daughter of the athlete Milon (19 A 1–2; Hdt. III, 137). According to Timaeus, 'Pythagoras' daughter was the first among the maidens and later first among the married women' (*FGrHist* 566 F 131); this presupposes the inclusion of the family in the social life of the *polis* and participation by the family in its festivals. Athletics occupied a special place in the social activities of the Pythagoreans (above, §3.1), and tradition ascribes to Pythagoras the introduction of a meat diet for athletes (Her. Pont. fr. 40). The scientific and philosophical study which came to the fore in the work of some early Pythagoreans shows how flexible the organizational form of the *hetairia* was and on how many levels its members could be active. In such an informal community, where much depended on the personality of the leader and the nature of his influence on his fellows, it is easy to imagine a tolerant and even encouraging attitude to scholarly endeavours, a model for which was provided by Pythagoras himself. Alcmaeon's address to three Pythagoreans, at the beginning of his treatise,[42] demonstrates that by the turn of the fifth century there were already enough people in the community to make possible discussion of philosophical and scientific topics. It needs to be emphasized, however, that at first scientific and philosophical

[39] As early as the 7th cent. Cylon's conspiracy in Athens was organized with the aid of his *hetairia* (Hdt. V, 71).

[40] Timaeus writes of youths from the best families, who, when they grew to manhood, assumed leading roles in the city, forming a *μεγάλη ἑταιρεία* (*ap*. Apoll. *FGrHist* 1064 F 2 = Iamb. *VP* 254, above, 95 n. 146); see also Tim. *FGrHist* 566 F 13a; Iust. XX,4,14. In an excerpt from Aristoxenus, on the other hand, a *μεγάλη ἑταιρεία* was formed by Cylon (Diod. X,11,1).

[41] The active participation of many philosophers in politics, from Thales to Plato and his disciples, does not need to be proven. See e.g. A. Wörle, *Die politische Tätigkeit der Schüler Platons* (Darmstadt, 1981); F. L. Vatai, *Intellectuals in Politics in the Greek World* (London, 1984).

[42] B 1, see above, 121 f.

work scarcely influenced the structure of the community. Rather, the form of the *hetairia* permitted the coexistence of people with only partially overlapping interests. After the political catastrophe of the mid-fifth century and the emigration from Italy, intellectual pursuits seem to have taken precedence over political among the Pythagoreans of mainland Greece. Philolaus and his pupils in Thebes may be considered a philosophical school rather than a *hetairia*.[43] All four Pythagoreans from Phlius listed in the catalogue also turn out to be pupils of Philolaus and Eurytus (Aristox. fr. 19), which leads one to suppose that the community in Phlius was not primarily political.[44] At various times quite a number of Pythagorean philosophers and scientists lived in Athens,[45] but nothing is known of the existence of a community there. In Italy and Sicily, Pythagoreans remained active in politics down to the time of Archytas and Dionysius the Younger. The nature of the Pythagorean communities listed in the catalogue, in Samos, Paros, Cyzicus, and Cyrene remains beyond the reach of our knowledge.

4.3 A PYTHAGOREAN 'SECT'?

It will already be clear from general considerations how alien to the character of the Pythagorean community are the secret and oral teachings, the degrees of initiation and minute regimentation of life, the unchallenged authority of the teacher, and many other features which in late antiquity became inalienable attributes of ancient Pythagoreanism and were handed down to the modern literature. Unlike the contradictory personality of Pythagoras, the contradictions between the image of an authoritarian sect and what

[43] Neither Philolaus himself nor most of his pupils were natives of Thebes. It is interesting that in Aristoxenus' catalogue Thebes is not listed (nor are the Thebans Simmias and Cebes), while Lysis, Philolaus, Eurytus, and their pupils are shown by place of birth (see above, 113). Either Thebes was dropped from the catalogue, or Aristoxenus' attention was focused primarily on the type of Pythagorean *hetairia*.

[44] This is indirectly confirmed by the tradition, linked with Phlius, relating to Pythagoras' coining of the word 'philosopher' (Her. Pont. fr. 87–8; below, 428 f.). According to this tradition the study of nature is worthier than the quest for honours and glory.

[45] See above, 128 n. 105.

we know for certain of the ancient Pythagoreans have their roots not in real life, but in our sources and our approach to them. An unbiased analysis shows, first, that none of the features of a religious community listed above is confirmed by reliable evidence; second, that to apply to the Pythagoreans the term 'sect', as developed in the sociology of religion, is methodologically unsound; and third, that the tradition on Pythagorean 'symbols', reflected in Anaximander the Younger and Aristotle, mostly bears no relation to the realities of the Pythagorean way of life, while the picture which arose on the basis of that tradition, of *acusmatici* and *mathematici* dates from the Imperial period.[46]

(a) Communal property

This custom should perhaps be considered first: mention of it appears as early as Timaeus, the latest of the authors who need our attention in the study of ancient Pythagoreanism. According to Timaeus, Pythagoras made communal property a condition for youths who wished to become his pupils, and hence the proverb κοινὰ τὰ τῶν φίλων (*FGrHist* 566 F 13a) gained currency in Italy. This proverb can be found many times before Timaeus, and its interpretation was far from literal: what was meant was not communal property, but a readiness to share what one had with a friend, or (in a figurative sense) common interests.[47] Before Timaeus, nobody had linked this proverb with the Pythagoreans,[48] or mentioned their 'communal property';[49] in Greece in the sixth to fourth centuries

[46] The first two questions are considered in this chapter; Chapter 5 is devoted to the third; and Chapter 6 will continue the investigation of the religious teaching and practice of the Pythagoreans in the light of ancient evidence and new theories.

[47] Eur. *Or.* 735, *Phoen.* 243; Pl. *Lys.* 207c10, *Phdr.* 279c6, *Res.* 424a1, 449c9, *Leg.* 739c2; Arist. *EN* 1159b31, 1168b7; *EE* 1237b33, 1238a16; *Pol.* 1263a30; Theophr. fr. 535 FHSG. Diogenes Laertius links this proverb with Pythagoras (VIII, 10), Bion (IV, 53), and the Cynic Diogenes (VI, 37, 72).

[48] Timaeus' younger contemporary Epicurus (D.L. X, 11) also attributed this proverb to Pythagoras; whether he wrote before or after Timaeus is impossible to determine. At the end of the 4th cent. the Pythagorean φιλία was well known, largely thanks to the work of Aristoxenus.

[49] In the story of the famous friends Damon and Phintias (Iamb. *VP* 233 = Aristox. fr. 31), we are told: συνέζων γὰρ οἱ ἄνδρες οὗτοι καὶ ἐκοινώνουν ἁπάντων, but in the parallel passage of Porphyry (*VP* 60) we read something quite different: εἶναι γὰρ αὐτοῦ ἑταῖρον καὶ κοινωνόν. Since the preceding and following text coincides, it is clear

there was no such institution.[50] It is true that in the fourth century much was written about communal property, by Plato (in the *Republic* and *Laws*) and Ephorus, for example,[51] but what impelled Timaeus to attribute to the Pythagoreans the actual implementation of these utopian views? It looks as if Timaeus, who regarded luxury as a source of moral degradation,[52] supposed that Pythagoras practised communal property in order to combat its corrupting influence.[53] There is nothing surprising about Timaeus attempting (like Theophrastus and Dicaearchus before him)[54] to use proverbs to reconstruct the past. Any facts which might support his reconstruction are also absent.[55]

(b) Secret teachings

The Pythagorean secrets excite the imagination no less than the Greek mysteries. Two hundred years after Creuzer's *Symbolism and*

that the editing is the work of Iamblichus, because Porphyry had no reason to expunge mention of communal property from the story (it is not in Diod. X,4,3 either). Aristoxenus' story of a Pythagorean saving his friend from poverty by sharing his money with him (Diod. X,4,1 = Iamb. *VP* 239 = 58 D 7) is also contradictory to communal property. Cf. 'Whenever any of the companions of Pythagoras lost their fortune, the rest would divide their own possessions with them as with brothers' (Diod. X,3,5, from Aristoxenus).

[50] Lynch, *Aristotle's School*, 123 f. When Aristotle wrote of the Tarentines making property common for use by the poor (*Pol.* 1320b9–11), he had in mind a partial redistribution of land, rather than its total socialization. See R. Vattuone, 'Scambio di beni tra ricchi e poveri nel IV secolo a. C. Note su Archita di Taranto', *RSA* 6–7 (1976–7), 285–300.

[51] *FGrHist* 70 F 42 (on the Scythians).

[52] *FGrHist* 566 F 9, 44, 50; Iust. XX,4,5–8; see above, 93; von Fritz, *Pol.*, 47; Talamo, 'Pitagora'.

[53] From the brief summary of Timaeus given by Pompeius Trogus it follows that Pythagoras, in his campaign against luxury in Croton, persuaded the women to renounce gold-embroidered clothes and the young men to live apart from the other citizens (Iust. XX,4,14: separatam a ceteris civibus vitam exercerent). This was apparently the context of the discussion of common property.

[54] Theophr. fr. 584a FHSG (5.6, 6.1), cf. fr. 737–8; Dic. fr. 49 (explaining the same proverb as Theophrastus), esp. 59, 100–3.

[55] For objections to communal property among the Pythagoreans, see: R. von Pöhlmann, *Geschichte der sozialen Frage und des Sozialismus in der Antiken Welt*, 3rd edn. (Munich, 1925), 41ff.; K. von Fritz, 'Mathematiker nnd Akusmatiker bei den alten Pythagoreern', *SBMü* 11 (1960) 8 ff.; Philip, 142 f. Cf. E. Minar, 'Pythagorean Communism', *TAPA* 75 (1944), 34 ff., who adduces no data except Timaeus to support the historicity of this custom, and Burkert, 'Craft', 15 ff.

Mythology of the Ancient Peoples, Particularly the Greeks,[56] no specialist in Greek religion doubts the fact that there were no esoteric doctrines in the Greek mysteries.[57] Most likely in Archaic and Classical Greece there were no secret religious doctrines at all, strange as this may seem to those who cannot imagine religion without secret doctrines. The *rituals* might have been secret, but not in the sense that only a select few were admitted. The Eleusinian mysteries, the Greek cult most famous for its secrets, were open to women and men, slaves and freemen, Greeks and barbarians (if they spoke Greek), but discussion among the uninitiated of what happened there was forbidden.[58] Analogical reasoning suggests that secret rituals might be assumed among the Pythagoreans *if* their community were religious, or at least *if* they had any special cults.[59] Since neither of these conditions is met, research in this direction is unpromising. Generally speaking, the scholarly literature has displayed far less eagerness to discuss secret rituals than secret doctrines, which since the time of the neo-Pythagoreans and Neoplatonists have been the *conditio sine qua non* of any self-respecting philosophy. Numenius, the author of a special work *On Plato's Secret Doctrines*, surmised that Plato followed the example of the Pythagoreans and kept secret his principal doctrines, the key to which lay in an esoteric interpretation of his dialogues.[60] Echoes of belief in Plato's secret teaching may be heard even in contemporary discussion of his *agrapha dogmata*: although these are not seen as secret in the literal sense of the word, but merely oral, they are held to be the most important, more so than his

56 G. F. Creuzer, *Symbolik und Mythologie der alten Völker, besonders der Griechen* (Leipzig, 1810–1812).

57 Rohde, *Psyche*, 222: 'It was difficult to let out the "secret", since there was essentially no secret to let out.' See also W. Burkert, 'Der geheime Reiz der Verbogenen: Antike Mysterienkulte', in H. G. Kippenberg and G. G. Stroumsa (eds.), *Secrecy and Concealment* (Leiden, 1995), 79–100; J. Bremmer, 'Religious Secrets and Secrecy in Classical Greece', ibid. 72.; L. H. Martin, 'Secrecy in Hellenistic Religious Communities', ibid. 120 f.: 'A theoretical provenance attributed to secrecy in religion generally, and in the Hellenistic mystery cults especially, is a consequence of eighteenth-century intellectual and theological formulations which, shaped by a nineteenth-century Romantic *mentalité*, still governs the modern academic study of religion.'

58 Andocydes was accused of 'revealing the sacred things to the uninitiated, and speaking with his lips τὰ ἀπόρρητα' (Lys. 6.51).

59 Burkert (178 f.), for example, placed the Pythagorean secrets in the sphere of cult and ritual.

60 See Περὶ τῶν παρὰ Πλάτωνι ἀπορρήτων (fr. 23 Des Places) and fr. 24.

dialogues. Since this is a case of a philosopher *all of whose writing has been preserved* (and even a little more), it is no wonder that the idea of the secret teaching of Pythagoras, who wrote nothing, is taking so long to die.

Secret religious teaching, even if it was unknown to the Greeks in Pythagoras' time, still appears more probable than secret philosophy and science.[61] After all, we have often seen that Pythagoras was an exception among his contemporaries; he may have been exceptional in this case too. But does the early evidence offer even the merest hint of secrecy in the religious teaching of Pythagoras? Xenophanes had already mocked the very essence of his doctrine, metempsychosis (B 7), and in terms which leave no doubt that it was known to his readers. Heraclitus, a younger contemporary of Pythagoras, calls him 'the inventor of deceit' (B 81), thinking perhaps of his speeches to the Crotoniates; Antisthenes later wrote about the same speeches (fr. 51). Herodotus wrote about the Pontic Greeks, who linked Pythagoras with the teachings about the immortality of the soul (IV, 95); Ion of Chios also knew of this doctrine of Pythagoras (B 4). Irrespective of where this tradition came from, Samos or Italy, it contradicts the secrecy of the teaching. Herodotus himself shows that he is acquainted not only with the teaching (II, 123), but also with the ritual of the Pythagoreans, pointing out that burial in woollen clothing was proscribed (II, 81). Empedocles, who openly preached metempsychosis and abstinence from meat, beans, etc. (B 136–41), provides an instructive parallel. The Orphics also set forth their teachings openly in oral and written form. By the first half of the fourth century so many writings attributed to Orpheus and Musaeus were circulating that Plato wrote of 'a hubbub of books' (*Res.* 364e). It is very probable that in the Orphic cults there were rites to which only initiates were admitted; it is possible to say that the Orphics set themselves apart from all other Greeks, who had not grasped the wisdom of Orpheus, but quite impossible to speak of their teachings

[61] Some authors prefer to speak of the secrecy of Pythagorean religion only: Zeller, i. 409 n. 2, 415 f.; Zeller and Mondolfo, i. 414 n. 2; Burkert, 178 f. Cf. Guthrie, i. 150 f., 152: 'It has also been suggested that although doubtless certain dogmas were included among the *arcana*, they will only have been matters of religious faith: there can have been no secrecy about their purely philosophical investigations. The objection to this is similar: there is no ground for separating the religious from the philosophical or scientific side in a system like the Pythagorean.'

being secret.[62] Still less can secrecy be attributed to the Pythagoreans. The abundant references to Pythagoras in the early tradition, and the popularity of the legends that circulated about him, in which there is not so much as a hint at secret rites, also make it extremely difficult to uphold any Pythagorean religious secrets.

Is it reasonable, then, to assume secrecy for the Pythagoreans' scientific discoveries and philosophical theories? Even if we disregard the intrinsic improbability of secret science,[63] it is incompatible with a large body of well-known facts. Epicharmus, a younger contemporary of Pythagoras, parodied Pythagorean arithmetic in his comedy (B 2), taking for granted that his audience had at least a superficial familiarity with the subject; Heraclitus made use of the Pythagoreans' discoveries in mathematics and harmonics; Parmenides and Zeno used the methods of their mathematical proofs.[64] In about 440–430 Hippocrates of Chios was well acquainted with the mathematics of the Pythagoreans, Cratinus mocked Hippon (A 2), and Democritus studied under the Pythagoreans and accumulated enough information about Pythagoras to write a whole book about him (A 33,1). Finally, how can there have been any kind of secrecy if the early Pythagoreans had a number of writings on natural philosophy, science, and medicine?

To counter the mass of facts which speak against secrecy in early Pythagoreanism, the evidence for secrecy would need to be weighty indeed. Is it in fact so weighty? If we set aside the late authors, who willingly wrote of the Pythagorean secrets,[65] and turn to the fifth- and fourth-century sources, it will be seen that this thesis is based

[62] West, *OP*, 79. On the secret mysteries established by Orpheus, see [Eur.] *Rhes.* 943 f.; on secret rites in Orphism, see Burkert, 'Geheimer Reiz', 95 f.; Bremmer, 'Religious Secrets', 71. The Orphic poem commented on by the author of the Derveni papyrus was addressed to initiates, and called on all others to 'put doors to their ears', see T. Kouremenos et al. (eds.), *The Derveni Papyrus* (Florence, 2006), col. VII. References to the 'secrecy' of the teachings presented seem to have been a common device in Orphic poetry, which was accessible to all. Plato (*Phaed.* 62b3, *Crat.* 400c4–9) twice refers to the Orphic 'secret teaching' (ἐν ἀπορρήτοις λεγόμενος), according to which the human body is a prison (σῶμα = φρουρά). Cf. below, 220 n. 103.

[63] The ancient Orient (Egypt and Babylon) had no 'secret science' either (Neugebauer, *ES*, 145 f.). On the legends connected with 'giving out the secrets' of irrational numbers, see below, 275 f.

[64] See above, 35 n. 29 and below, 251 f.

[65] Plut. *Numa* 22,3; D.L. VIII, 15, 42; Porph. *VP* 19, 57–58; Iamb. *VP* 199, 226–7, 246–7, etc.

primarily on the reports of Isocrates, Aristotle, and Aristoxenus.[66] We shall consider these in more detail. Isocrates, without concealing his irony with regard to Pythagoras and his pupils, says:

> He so exceeded others in fame that all the young desired to become his students, and older people were more pleased to see their children conversing with him than attending to their own affairs. We must believe this. Even now people admire those who claim to be his students more even when they are silent than those men who have the greatest reputation for speaking.[67]

What is meant by *σιγῶντας* in this context: the legendary Pythagorean vow of silence (below, §4.3d), secrecy in teaching, or taciturnity, restraint in speech,[68] set against the art of the best orators (among whom Isocrates probably counted himself)? Secret doctrines generate suspicion, rather than admiration; pedagogical silence, if practised without moderation, would also produce perplexity and taunts,[69] whereas restraint in speech was something the Greeks really did admire.[70] What would the Pythagoreans have had to hide in the 390s (*ἔτι γὰρ καὶ νῦν* plainly refers to the contemporaries of Isocrates), when Philolaus, who had supposedly made public the school's secrets, had died, and Archytas was publishing one treatise after another? Surely not the secret of the ban on eating beans, which the courageous Timycha refused to divulge to the bloodthirsty tyrant Dionysius, instead biting off her tongue and spitting it out?[71]

[66] See e.g. O. Casel, *De philosophorum graecorum silentio mystico* (Giessen, 1919), 30 ff.

[67] *ἔτι γὰρ καὶ νῦν τοὺς προσποιουμένους ἐκείνου μαθητὰς εἶναι μᾶλλον σιγῶντας θαυμάζουσιν ἢ τοὺς ἐπὶ τῷ λέγειν μεγίστην δόξαν ἔχοντας* (*Bus.* 29, tr. Mirhady, modified).

[68] Cf. Burnet, 95 n. 1: 'disciplinary silence'; Timpanaro Cardini, i. 27: 'contegno riservato'; Philip, 146: 'taciturnity'.

[69] Xenocrates devoted one hour a day to silence (D.L. IV, 11, see also Val. Max. VII,2, ext. 6; Stob. III,33,11 = fr. 61–2), which was evidently considered a worthy activity (whether or not this story is true; Valerius Maximus speaks of restraint in speech). The Pythagoreans were supposed to maintain silence for five successive years!

[70] See e.g. the words ascribed to the Stoic Zeno: 'We have two ears and one mouth so that we can listen more and speak less' (D.L. VII, 23). When asked why he was silent, Heraclitus is said to have replied, 'Why, to let you chatter' (D.L. IX, 12). See below, 155 n. 76.

[71] This legend was most likely invented by Neanthes himself (*FGrHist* 84 F 1), possibly on the model of the well known story of Zeno of Elea, who also bit off his tongue (A 1.27, 2, 6–8).

Meanwhile, the words of Isocrates have a splendid parallel, which apparently stems from Aristoxenus: 'The Pythagoreans were much given to silence and ready to listen, and the one who was able to listen was praised by them.'[72] And it was Aristoxenus who held Archytas' self-control and restraint to be among his important qualities: in situations in which others would deliver fiery perorations, he remained calm and said nothing.[73] It is highly probable that when Isocrates wrote of Pythagorean restraint he was thinking of Archytas, since his polemics with Archytas are reflected in the same speech.[74]

Aristoxenus' words are as follows: ἔλεγόν τε καὶ οἱ ἄλλοι Πυθαγόρειοι μὴ εἶναι πρὸς πάντας πάντα ῥητά (fr. 43). What this sentence meant is clear, first, from the title of the work in which it appeared, Παιδευτικοὶ νόμοι, and second, from the reference to Xenophilus which follows it. Xenophilus was Aristoxenus' mentor, and another pedagogical maxim is placed in his mouth. In this context, the advice 'not to tell everybody everything' may mean: 'one should not say the same things to children (or adolescents) as to adults'.[75] Even if we understand these words in a broader sense – 'one should not blurt out all one's secrets too freely' – this sensible advice, which Aristoxenus takes from the *mid-fourth-century Pythagoreans*, still cannot imply secrecy in Pythagoras' teaching. The precepts of the Seven Sages, whom nobody seems to have suspected of secret teaching, are full of such advice.[76] Since Aristoxenus consistently avoided reporting anything about the Pythagoreans that went

[72] σιωπηλοὺς δὲ εἶναι καὶ ἀκουστικοὺς καὶ ἐπαινεῖσθαι παρ' αὐτοῖς τὸν δυνάμενον ἀκοῦσαι (Iamb. *VP* 163 = 58 D 1.4).

[73] Fr. 30: when angry the Pythagoreans did not punish their slaves or admonish freemen; instead they waited quietly and silently (σιωπῇ χρώμενοι καὶ ἡσυχίᾳ) until able to think rationally.

[74] *Bus.* 23, on the value of a mathematical education. See Zhmud, *Origin*, 74.

[75] In the light of the tradition on Pythagoras' speeches addressed to groups of various age and sex (above, 46, 47 n. 83, 93), this interpretation seems highly likely. Aristoxenus also mentions the different responsibilities of the four age groups: children, adolescents, adults, and old people (fr. 35).

[76] Stob. III,1,172 = *DK* 10 A 3, from the collection of the Peripatetic Demetrius of Phaleron. Cleobulus: Listen much and say little (4, cf. 6: Keep your tongue in check); Solon: Seal your words with silence, and silence with the seal of the fitting moment (5); If you know, keep silent! (18); Chilon: when drinking, do not talk too much; you will regret it (2); Do not let your tongue overtake your mind (14; cf. D.L. I, 69: What is hard? To keep a secret); Bias: listen much, and speak at the right moment (10–11, cf. 4, 17), Periander: Betray no secret speeches (14). See parallels from the collection of Sosiades, a contemporary of Demetrius (Stob. III,I,73): Be taciturn (36, 115); hold your tongue in check (82), ἄρρητον κρύπτε (108).

beyond the accepted norms of his day, he could hardly have meant anything other than the folk wisdom enshrined in the pronouncements of the sages.[77]

According to Iamblichus, 'Aristotle relates that the following division was preserved by the Pythagoreans as one of their greatest secrets (*ἐν τοῖς πάνυ ἀπορρήτοις διαφυλάττεσθαι*) – that there are three kinds of rational living creatures – gods, men, and beings like Pythagoras' (*VP* 31 = fr. 192). Why the semi-divine status of Pythagoras, which was widely known as early as the beginning of the fifth century, should have been one of the school's greatest secrets is difficult to understand. Why was it concealed and when was it disclosed? How does it differ from the other 'miraculous' stories related by Aristotle in his book *On the Pythagoreans* (fr. 191): the Crotoniates called Pythagoras Apollo the Hyperborean; he appeared in two different towns at the same time; he had a gold thigh, and so forth? The need to answer these questions evaporates if we attribute the words about *ἀπόρρητα* not to Aristotle, but to Iamblichus, who had a particular fondness for all secrets.[78] Iamblichus was quite sure that Pythagoras' most important teachings lay in his 'symbols', and the phrase '*ἐν τοῖς πάνυ ἀπορρήτοις*', judging by many parallels, meant to him 'one of the greatest secrets of the Pythagorean doctrines preserved in the symbols'.[79]

This is really all that we can learn about the secrecy of the Pythagoreans from the writings of the fourth century. In the fifth century, when this secrecy was supposed to be in full flower, it left no trace whatever. It is revealing that two of the three passages we have examined concern not Pythagoras or his pupils, but the Pythagoreans

[77] In general Aristoxenus' writings, especially the *Pythagorean Precepts*, have much in common with traditional wisdom. Cf. for example, respect for one's parents: Cleobulus (2), Thales (6), Periander (10), Aristox. fr. 34, cf. also Xen. *Mem.* IV,4,19; controlling one's anger: Chilon (15), Aristox. fr. 30; the primacy of old laws over new ones: Periander (16), Aristox. fr. 33–4; criticism of lack of moderation: Cleobulus (10, 17), Thales (12), Aristox. fr. 17.

[78] His *VP* abounds in words like *ἄρρητος, ἀπόρρητος, σιωπή, ἡσυχία, ἐχεμυθία*, etc.

[79] Iamb. *VP*: Pythagorean philosophy was concealed in outlandish sciences and secret symbols (*ἀπορρήτοις συμβόλοις*, 2), *τᾶς τῶν Πυθαγορικῶν συμβόλων ἐμφάσεις καὶ ἀπορρήτους ἐννοίας* (103), *ἀπορρήτων τρόπων . . . καὶ διὰ συμβόλων* (104), *τὰ κυριώτατα . . . τῶν ἑαυτῶν δογμάτων ἀπόρρητα διεφύλαττον ἅπαντες ἀεί* (226), *τὰ τῶν Πυθαγορείων ἀπόρρητα* (258); *De myst.* 6.6: *τῶν ἀπορρήτων συμβόλων ἡ γνῶσις*. Among the various names of symbols, Hölk (12 f.) includes *τὰ ἐν (πάνυ) ἀπορρήτοις*. Cf. Porphyry's *τὰ ἀπόρρητα* (*VP* 20), in a passage which, like Iamblichus' *VP* 31, goes back to Nicomachus.

of the fourth century, who no longer had anything to hide, while the third mentions one of the elements of the legendary tradition on Pythagoras. It is also clear why the Pythagorean silence later turned into secrecy. On the one hand, this offered an explanation of the extreme paucity of information on Pythagoras' teaching, and on the other it lent authenticity to the numerous Pythagorean treatises which were supposedly preserved in secret.[80] In the oft-quoted passage from Porphyry (sometimes it is wrongly attributed to Dicaearchus), the first of these aims is made fully explicit:

> What he said to those with him, however, it is not possible for anyone to say exactly, for there was no ordinary silence among them. However, it was especially well-known by all, first that he said that the soul is immortal, then, that it transmigrates into other kinds of animals, and in addition that what happens happens again at some time according to certain cycles, that, in short, there is nothing new, and that it is necessary to believe that all ensouled beings are of the same kind. For it appears that Pythagoras was the first to bring these teachings into Greece.[81]

Although Porphyry enumerates the basic Pythagorean doctrines here, and proceeds to a more detailed survey (*VP* 37 ff.), he remains convinced that *something* must have remained secret, and might not that 'something' have been the most important thing of all, more important than the teaching of metempsychosis, eternal recurrence, and other well-known matters? This and similar beliefs are still widespread and continue to demonstrate their irrefutability with the aid of facts and logical arguments. Guthrie, for example, was sure that the

[80] Burkert, 179 n. 95. See below on the *tripartitum*, 162 n. 95.

[81] *VP* 19, tr. Mirhady. Wehrli for good reason excluded this passage from fr. 33 of Dicaearchus (= Porph. *VP* 18); see also Philip, 139 f.; cf. however: Timpanaro Cardini, i. 44; Burkert, 115 n. 38, 122 (with summary of early opinions); Giangiulio, *Pitagora*, i. test. 47; Mirhady, 'Dicaearchus' fr. 40; Kahn, 11. Dicaearchus was dealing with Pythagoras' speeches to the Crotoniates, which accords fully with his image as the sage of Samos; Porphyry was concerned with the 'esoteric' doctrines of Pythagoras, of which nothing is known because of the strict silence maintained by his pupils. Besides the reference to σιωπή (see below, 162 f.), the following points support the view that *VP* 19 belongs to Porphyry: 1) the implied division into 'esoterics' and 'exoterics', which is absent from the 5th- and 4th-cent. texts; 2) the mention of Theano; 3) the respectful attitude to the idea of immortality of the soul, which Dicaearchus did not share (cf. fr. 8, 11–12 and the clear irony in fr. 36 on Pythagoras' reincarnations); 4) the idea that Pythagoras was the first to introduce metempsychosis in Greece, an idea which formed part of Porphyry's concept of *prisca sapientia* (see above, 75 n. 62).

accessibility of some doctrines did not rule out the secrecy of others, and even if some Pythagoreans kept secret what others had long since given out, this should not trouble us, since we are dealing here not with logic, but with religion.[82]

In the hope that in discussing the Pythagorean secrets we may after all be dealing with logic, I will cite two parallels. The first case concerns Aristophanes' comical representation of Socrates' *phrontisterion*. The first thing Socrates tells Strepsiades is about the secrecy of learning: it is permitted to speak of it only to one's pupils (*Nub*. 140). When Strepsiades assures him that he is prepared to become his pupil, Socrates agrees, but again warns him that this must remain completely secret: νομίσαι δὲ ταῦτα χρὴ μυστήρια (*Nub*. 143). If these μυστήρια had been attributed not to Socrates, who taught at the agora, but to the fifth-century Pythagoreans, they would have been taken as clear and reliable evidence of the Pythagorean secrets. Yet the words of Aristophanes demonstrate that 'secrecy' could easily be ascribed even to the most widely accessible doctrine. The second case is the Hippocratic oath, according to which doctors must not pass on what they have learned to anybody except their children, the children of their teacher, and those pupils who have taken the oath. This is an indisputable case of the preservation of professional secrets, and we cannot exclude the possibility that the Hippocratics took some unwritten prescriptions with them to the grave. We have to console ourselves with the corpus of more than sixty Hippocratic treatises, which most scholars view as ample compensation for the annoying secretiveness of the Hippocratic doctors.

While rejecting the secrecy of the early Pythagorean teachings,[83] I do not presume to assert that anybody could freely enter a Pythagorean *hetairia* or attend its meetings. No political society can do without a reasonable modicum of restrictions, and the Pythagoreans undoubtedly had their own. However, in the reliable part of the tradition we can find no restrictions on the dissemination of religious, philosophical, or scientific ideas.

[82] Guthrie, i. 151 f.

[83] See also Maddalena, *Pitagorici*, 76 n. 21, 81 n. 27; G. Casertano, 'I Pitagorici e il potere', in G. Casertano (ed.), *I filosofi e il potere nella societá e nella cultura antiche* (Naples, 1988), 20 f.; Bremmer, 'Religious Secrets', 63 ff. Gigon, *Ursprung*, 130, reasonably restricted the secrecy to politics.

(c) Oral teaching

The view – widely expressed in the late literature – of Philolaus' book as the first written record of the Pythagorean doctrines is closely linked with the 'secrecy' of these before. 'Until the time of Philolaus it was not possible to learn any Pythagorean doctrine, and only Philolaus brought out those three celebrated books for which Plato paid a hundred minas.'[84] Naturally, this view ignored the treatises of the earlier Pythagoreans. However, both Diogenes Laertius (VIII, 6–7, 49, 83) and Iamblichus (*VP* 259), with the inconsistency characteristic of the compilers, referred to the works of Pythagoras, both authentic and apocryphal, and of his closest disciples. The idea of the oral nature of early Pythagoreanism, perhaps more than any other, runs counter to the clear evidence of the tradition. Information has come down to us about the content of the books of Alcmaeon and Menestor, and of two works by Hippon; with varying degrees of probability we can posit the existence of written works by Hippasus and Iccus (above, §3.3), all of whom lived before Philolaus. Besides, Philolaus' book did not contain any general 'all-Pythagorean' teaching (there never was any such thing), but rather his own theories, which may or may not have coincided with the views of other Pythagoreans and of Pythagoras himself.

It is not surprising that in the fifth- and fourth-century sources we find not one word about the oral nature of Pythagoreanism before Philolaus. The idea cannot be linked to Aristoxenus,[85] and most of those who wrote after him did not consider Philolaus the author of the first Pythagorean work.[86] In fact, the story of the 'divulging' of the Pythagorean doctrines was first linked not with Philolaus but with the accusations of plagiarism levelled against Plato. The chain of

[84] D.L. VIII, 15; cf. Iamb. *VP* 199. See n. 85, below.

[85] Wehrli was wrong to include in fr. 43 of Aristoxenus, discussed above, 155, about the Pythagorean education, the preceding words of Diogenes Laertius on the secrecy of the teaching until the time of Philolaus (VIII, 15)—they are not related to education. The quotation from Aristoxenus begins two sentences later with *ἔλεγόν τε καὶ οἱ ἄλλοι Πυθαγόρειοι* (fr. 36–8, 41 begin with *ἔλεγον, ἔφασκον, ἔφασαν*). Apart from anything else, Aristoxenus could not have written of *τρία βιβλία* published by Philolaus, because the pseudo-Pythagorean *tripartitum* appeared at the end of the 3rd cent. (Burkert, 226 n. 40; see above, 71 n. 45, and below, 162).

[86] Demetrius of Magnesia's statement that Philolaus was the first Pythagorean to publish *Περὶ φύσεως* (D.L. VIII, 85) refers to the title of this book, and not to the fact that it is the first written by a Pythagorean; see above, 129 n. 108–9.

fabrications linking Plato's 'plagiarism' with Philolaus' book, and his book with the publication of the school's teaching, may be reconstructed as follows. Theopompus, who was hostile to the Academy, was apparently the first to accuse Plato of plagiarizing not the Pythagoreans – it is true – but Aristippus, Antisthenes, and Brison.[87] This idea was taken up by Aristoxenus, who asserted that Plato copied his *Republic* from Protagoras (fr. 67). Did he accuse Plato of copying from the Pythagoreans? There is no trace of this version in Aristoxenus, and there are no serious arguments to support his authorship of such an accusation.[88] Nevertheless, in Aristoxenus' time the charge had already been made, since in the succeeding generation it is briefly mentioned by Neanthes, who adds two new figures to the cast of characters – Empedocles and Philolaus:

> Down to the time of Philolaus and Empedocles all Pythagoreans were admitted to the discussions (λόγοι). But when Empedocles published them in his poem, they made a law that they should not be imparted to any poet. He says the same thing also happened to Plato, for he too was expelled. But which of the Pythagoreans it was who had Empedocles for a pupil he does not say. For the epistle commonly attributed to Telauges which said that Empedocles studied under Hippasus and Brontinus he held unworthy of credence.[89]

In this version the principal plagiarizer is Empedocles, who published Pythagoras' teachings in his poem. Philolaus as yet plays no active part. He is mentioned only as a contemporary of Empedocles, whom Neanthes evidently placed in the third generation after Pythagoras. Judging by the nature of the reference to Plato, Neanthes already regarded his expulsion for plagiarism as a well-known story, and modelled the Empedocles episode on it.[90] A quotation from Neanthes

[87] *FGrHist* 115 F 259. See Stemplinger, *Plagiat*, 25 f.; Dörrie, *Platonismus*, ii. 12 ff., 236 ff. (Dörrie's reconstruction as a whole is faulty.)

[88] In favour of Aristoxenus' authorship: Wehrli, comm. on Aristox. fr. 43, 61–8; Thesleff, 'Pseudo-Pythagorica', 76; Dörrie, *Platonismus*, ii, 246 ff.; against: Burkert, 226 n. 40; Bollansée (comm. on *FGrHist* 1026 F 69), 492.

[89] Neanth. *FGrHist* 84 F 26 = D.L. VIII, 55, tr. Hicks, adapted.

[90] Dörrie, *Platonismus*, ii. 248 f. The Pythagorean λόγοι, in which Empedocles took part, were oral, but what other form can discussion take? 'Apparently, this was the result of the belief, attested at least since Neanthes, that before Philolaus there were no Pythagorean writings known' (Burkert, 225 and n. 225), but this conclusion does not in any way follow from Neanthes' words; cf. K. von Fritz, 'Philolaos', *RE Suppl.* 13 (1973), 457. In Timaeus, who relied on Neanthes (see n. 91, below), Empedocles, who appropriated and published the Pythagorean teachings, was a pupil of Pythagoras

in Diogenes Laertius has come down to us by way of Timaeus, who repeats and develops the theme of Empedocles' plagiarism: 'Timaeus in the ninth book says he was a pupil of Pythagoras, adding that, having been convicted at that time of stealing his discourse (λογοκλοπία), he was, like Plato, excluded from taking part in the discussions of the school.'[91] Since Timaeus makes Empedocles a pupil of Pythagoras, Philolaus, who was born much later, does not appear in this fragment.

Thus, by the turn of the third century, the idea that Plato had copied from the Pythagoreans had wide currency. At precisely this time some unknown author linked Plato's plagiarism with Philolaus' book. This version has reached us in two *testimonia* from the third century, which most likely do derive from the same source.[92] Timon of Phlius, a younger contemporary of Timaeus, asserted that Plato's *Timaeus* was copied from a little book which the philosopher had bought for a high price (fr. 54). Timon does not name the author of the book, but he appears in Hermippus. Referring to an unnamed writer, Hermippus states that Philolaus wrote a book which Plato, who had visited Dionysius in Sicily, bought from Philolaus' relatives for 40 Alexandrian *minae*, and that he copied *Timaeus* from it.[93]

None of the evidence cited above implies that Philolaus' book was the first Pythagorean composition. The main topic of all the anecdotes was Plato's plagiarism, to which more and more fabulous new detail had accrued. As long as such a subject remains of interest, it can be endlessly varied. At the end of the third century one writer hit on a new idea: if plagiarism is to succeed, that is, to escape notice, it is important that the stolen ideas should be as little known as possible. Ideally, they should be both oral and secret, but if only one of these conditions is met that is quite sufficient! Eventually, in this way the story emerged that Plato, having become rich, bought from Philolaus, through the agency of Dion, not Philolaus' own book, but 'three Pythagorean books' published by Philolaus, containing the previously

himself, which brings the date of publication back from the end of the 5th cent. to the beginning.

[91] *FGrHist* 566 F 14 = D.L. VIII, 54. On Timaeus' dependence on Neanthes, see above, 68 n. 30.

[92] Burkert, 226 f.; Dörrie, *Platonismus*, ii. 258 n. 1; Huffman, *Philolaus*, 5, 13; Bollansée (comm. on *FGrHist* 1026 F 69), 489 f.

[93] D.L. VIII, 85 = fr. 40 = *FGrHist* 1026 F 69. Here Diogenes adduces another version.

unavailable teaching of Pythagoras – the famous *tripartitum*. The first to mention this is Satyrus, a younger contemporary of Hermippus,[94] although the story itself is found in a forged letter, supposedly by Plato, which may have been appended to the pseudo-Pythagorean *tripartitum*.[95] The historical tradition on Philolaus as the author of a single book is incompatible with the idea of his publishing Pythagoras' *tripartitum*, and any basis for taking seriously Philolaus' 'publication' of previously secret oral doctrines collapses with this invention.

(d) The vow of silence

A later variation on the theme of the Pythagorean 'secrets' is the vow of silence, which the pupils of Pythagoras are supposed to have practised for the first five years. The first to refer to this is Seneca,[96] who in his youth was involved in neo-Pythagoreanism.[97] There are no grounds for attributing to Timaeus the mention of a five-year vow of silence in Diogenes Laertius (VIII, 10). While Timaeus might not be the most reliable of witnesses, he would hardly have had the imagination to invent anything so utterly unthinkable in the Greece of his time.[98] A detailed description of this and of the accompanying rituals of the noviciate in the Pythagorean sect (Iamb. *VP* 71–73) goes back to Apollonius of Tyana,[99] and through him, as Festugière has

[94] D.L. III, 9, cf. VIII, 6, 9, 15; Aul. Gell. III,17,1–5; Iamb. *VP* 199; see above, 71 n. 45.

[95] Burkert, 224 f.; von Fritz, 'Philolaos', 459; Huffman, *Philolaus*, 14; cf. Thesleff, 'On the Problem', 77 n. 2.

[96] *Epist.* 52, 10. For references to later sources see Delatte, *Vie*, 111 f. The Pythagorean ἐχεμυθία, *pace* Burnet (95 n. 1: 'seems to be a good Ionic word'), appears only in texts of the Imperial period (without reference to the Pythagoreans, in Philo of Alexandria).

[97] Centrone, *Introduzione*, 169 f.; Kahn, 92 f.

[98] *Contra* Delatte, *Vie*, 169 f.; Burkert, 179 n. 101. From the disposition of the material in Jacoby (*FGrHist* 566 F 13b = D.L. VIII, 10) and from his commentary ('In den wirren Zusammenstellung meist stark gekürzter Einzelnachrichten wird T. mehrfach zitiert', p. 552), it does not follow that he attributed this information to Timaeus. Unlike the verbatim quotation in F 13a, where no silence is mentioned or implied, in F 13b, a totally unrelated reference (of a kind common in Diogenes) to five years of silence is appended to Timaeus' words on communal property.

[99] According to Philostratus, Apollonius himself zealously observed a five-year vow of silence (*VA* I, 14–16), the 'discoverer' of which is named as Pythagoras (VI, 11). Philostratus' source here may have been Apollonius' biography of Pythagoras.

shown, to a genre well known in Hellenistic literature: idealized descriptions of priestly castes among the 'barbarian' peoples – the Egyptians, the Essenes, the Brahmans, the Gymnosophists, and others.[100] If a comparison is made not with literature but with reality, it will be apparent that even the Essenes and early Christian monastic orders, famed for their austere way of life, could not compete with the severity attributed to Pythagoras. The five-year term of silence and the eight-year noviciate were intended to grip the reader's imagination and demonstrate the clear superiority of the old Greek teachers.[101] It is interesting that with regard to the vow of silence Festugière could find only a few distant parallels in his sources;[102] nor is there anything resembling this extreme means of preserving secrets in the Hellenistic biography of Pythagoras or the pseudo-Pythagorean literature of that time. Since almost all references to the custom of silence lead to the first century AD and are in one way or another linked to the neo-Pythagorean milieu,[103] it is probable that this invention too should be linked to it.[104] The legendary phrase αὐτὸς ἔφα, 'He himself said it', appeared somewhat earlier in the same milieu.[105]

[100] Festugière, 'Vita Pythagorica', 441 ff.

[101] The isolated Essenes had a basic noviciate of one year and an additional noviciate for another year: F. G. Martínez and J. T. Barrera, *The People of the Dead Sea Scrolls* (Leiden, 1995), 35 f. On a vow of silence during this time there is no information. 'La comparaison de la *Reg. Pachomii* avec le *de v. pyth.* est ici savoureuse: c'est Pythagore qui est le plus sévère, trop sévère! Un noviciat de huit ans n'est pas chose viable' (Festugière, 'Vita Pythagorica', 445 n. 6). On early Egyptian monasticism, see also A. L. Khosroev, *Pakhomii Velikii: Iz rannei istorii obshchezhitel'nogo monashestva v Egipte* (St Petersburg, 2004).

[102] Festugière, 'Vita Pythagorica', 447 f., explains this by saying that in monastic orders 'la règle générale du silence va de soi'.

[103] Cf. above, 162 n. 99. On the custom of silence among the neo-Pythagoreans, see Plut. *Quaest. conv.* 727 B–728; cf. *Numa* 8,6, 22,3; *De curios.* 519 C 6 (Pythagoras introduced the five-year period of silence), fr. 207. On neo-Pythagoreans among Plutarch's acquaintances, see J. Hershbell, 'Plutarch's Pythagorean Friends', *CB* (1984), 73–79. See also Luc. *Gal.* 4,24; *Vit. auct.* 3,16.

[104] Diogenes Laertius, who mentions the vow of silence (VIII, 10), did not make use of the neo-Pythagorean biographies of Apollonius and Nicomachus, but he quoted Lysis' pseudo-Pythagorean letter (VIII, 42), which is now considered to date from the 1st cent. AD (see below, 189 n. 79).

[105] It first occurs in Cicero (*ND* I,10), who may have taken it from his neo-Pythagorean friends: A. S. Pease (ed.), *Cicero: De natura deorum* (Cambridge, 1955), 150. Diogenes Laertius also mentions this expression (VIII, 46); for a selection of parallel passages, see Pease, *Cicero*, 149 f. The Doric form ἔφα may point to the pseudo-Pythagorica.

(e) Attributing one's own discoveries to Pythagoras

The only author to report that the Pythagoreans attributed their own discoveries to their Teacher is, as might be expected, Iamblichus (*VP* 158, 198). Neither before nor after him do we hear any mention of this custom.[106] The scientific achievements that are attributed to Pythagoras are never linked with any Pythagorean.[107] It is true that tradition ascribes certain astronomical discoveries to Parmenides and Oenopides, as well as Pythagoras, but Parmenides and Oenopides were no Pythagoreans, and besides it is clear that they themselves did not ascribe these discoveries to Pythagoras.[108] The letters and treatises attributed to Pythagoras and the Pythagoreans (most often to Archytas) also bear no relation to the custom under discussion. The first pseudo-Pythagorean writings appeared at the end of the fourth century, by which time the school itself had disappeared, and they did not follow any special Pythagorean practice, but rather a fashion which was then widespread: the Hippocratic doctors, Platonists, and Peripatetics also attributed their own works to their teachers. Here it is pertinent to note that the pseudo-Pythagorean writers show no interest whatever in scientific problems. These authors had no scientific discoveries of their own to attribute to Pythagoras, nor even any wish to attribute anybody else's to him.

So where did Iamblichus get the idea from? Both passages in which it is mentioned are his own;[109] in both he is dealing with pseudo-Pythagorean works which were then circulating (*τὰ συγγράμματα τὰ νυνὶ φερόμενα*), and most of which, according to Iamblichus, were said to be by Pythagoras himself.[110] This fact is what gave him the idea that the Pythagoreans attributed 'almost all' their discoveries to their Teacher: 'for there are very few of them indeed to whom works are ascribed personally'![111] Iamblichus' train of thought is so transparent

[106] The passage of Proclus (*In Tim.* XVI,1), noted in the apparatus of *VP* 198, is rather a development of the theme 'friends share everything': *τὴν κοινωνίαν ἠσπάζοντο τὴν ἐν ταῖς εὑρέσεσι τῶν δογμάτων, καὶ τὰ ἑνὸς συγγράμματα κοινὰ πάντων ἦν.*

[107] On the sole exception (Procl. *In Euc.*, 65.15f.) see below, 263 f.

[108] See below, 326 f., 333.

[109] Rohde, 155 f., 160 f.

[110] In reality a large part of the pseudo-Pythagorica goes back not to Pythagoras but to forty-three real or imaginary Pythagoreans, but such calculations did not disturb Iamblichus.

[111] *καλὸν δὲ καὶ τὸ πάντα Πυθαγόρᾳ ἀνατιθέναι τε καὶ ἀπονέμειν καὶ μηδεμίαν περι- ποιεῖσθαι δόξαν ἰδίαν ἀπὸ τῶν εὑρισκομένων, εἰ μή πού τι σπάνιον* (*VP* 198). In

that it is hard to understand how his conclusion could have deluded so many generations of scholars. If one carefully studies the tradition on Pythagoras' achievements in mathematics (below, §7.3), it will be seen that not only did the early Pythagoreans not ascribe *their own* discoveries to him, but the later authors, with rare exceptions, did not ascribe to him *those of others*. Thus, when we reconstruct early Pythagorean mathematics, we can isolate (though with varying degrees of accuracy) the part that belongs to Pythagoras himself, and not consider πάντα ὁμοῦ, as is usually done, making reference to the objective impossibility of separating it.[112] The greatest difficulties on this path lie not in Pythagorean customs, but in our sources: the further we depart from mathematics, the less reliable they become. Thus in astronomy Pythagoras is credited with numerous ideas which could not possibly have been his. This is primarily due to the fact that the ancient Greek historiography of mathematics suffered far fewer distortions than doxography, which included the astronomical theories of the Presocratics. Late doxography also links with Thales – who, like Pythagoras, did not write anything – a large number of astronomical discoveries made two to three hundred years after him, whereas the tradition on his theorems, which stems from Eudemus' *History of Geometry*, is much more reliable.[113] In philosophy the situation appears even more fraught with problems than in astronomy. The interpretation of Pythagoras' views in a Platonic spirit, which began in the Academy (below, §§12.1–2), seriously restricts our chances of accessing his original philosophical ideas. None of this, however, bears any relation to the nature of the Pythagorean community.

(f) Sect *avant la lettre*?

References to a 'sect' or an 'order' founded by Pythagoras, and descriptions of these taken from late sources, are found in practically all books on Pythagoreanism. These terms are usually applied in a

VP 158 he is more precise: some works were written by Pythagoras, while others were taken down on the basis of his lectures, which is why the writers did not give their names, but ascribed everything to Pythagoras. See also *VP* 88; *Comm. Math.*, 77.18 f.

112 Thus Guthrie, i. 149 f., for example.

113 On astronomical discoveries, see below, 322 f. On the differences between the history of the exact sciences and doxography, see Zhmud, *Origin*, 147 f., 153 ff.

(semi-)metaphorical way, *per analogiam*, so they can easily be replaced by others: religious fraternity, cultic community, and the like. What is meant is that the Pythagorean community was religious and *resembled* what we are used to calling a sect or an order.[114] In 1982 Burkert decided to place this concept on a methodological foundation. Relying on the work of Bryan Wilson on the sociology of modern sects,[115] he attempted to demonstrate that the Pythagorean community met the basic criteria of a sect proper, and therefore did not simply *resemble* a sect; it was one.[116] To what extent is such a procedure justified? I will note here that my doubts and objections bear on the methodology, not the principle. There are no reasonable grounds for believing that antiquity should remain an area free from the application of the modern methods of the social sciences and the terms developed by them. In this case, however, it is not a matter of novelty. Both *αἵρεσις* and its Latin equivalent *secta* are venerable old terms. Beginning with Hippobotus' *Περὶ αἱρέσεων*, they were attributed to the philosophical schools, and later to the Pythagorean school as well.[117] The problem is that the term 'sect', used in the sociology of religion, was developed on the basis of material from Christianity, and it may be applied to Greek religion with the same measure of success as the term 'heresy'. Whatever our definition of 'sect', whether theological or sociological, its opposition to the dominant system of religious beliefs and values in a given society remains fundamental.[118] In a polytheistic religion, which knew no church, no theology, no

[114] 'The Pythagorean Order was simply, in its origin, a religious fraternity' (Burnet, 89). 'Analogies are always misleading if taken literally,' observes von Fritz (*Pol.*, 96 f.), comparing the Pythagoreans with an 18th-cent. Masonic order.

[115] B. Wilson, *Sects and Society: A Sociological Study of Three Religious Groups in Britain* (London, 1961); id., *Religious Sects: A Sociological Study* (London, 1970).

[116] Burkert, 'Craft', 12 ff.; his example has been followed by Riedweg, *Pythagoras*, 129 ff.; C. Macris, 'Pythagore, un maître de sagesse charismatique de l'époque archaïque', in G. Filoramo (ed.), *Come nasce una religione: il carisma profetico come fattore di innovazione* (Brescia, 2003), 255 f.; J. Taylor, *Pythagoreans and Essenes, Structural Parallels* (Leuven, 2004), 48 ff.

[117] Gigante, 'Frammenti di Ippoboto'; *αἵρεσις* applied to the Pythagoreans see e.g. Porph. *In Ptol. Harm.*, 37.6, 104.1; Simpl. *In Cat.*, 3.31.

[118] M. Weber defined a sect as a voluntary association with restricted membership, and churches as compulsory associations with universalistic aspirations. His research was continued by E. Troeltsch in *The Social Teaching of the Christian Churches* (London, 1931). B. Wilson, who focused his study on the non-traditional Christian sects of the 19th and 20th cents, tried to move away from the sect-church opposition, but retained as a central criterion a sect's protest against 'the orthodox system of religion' – which is what did not exist in ancient Greece.

sacred scripture, no dogmas binding upon all adherents, a religion which had absorbed one foreign cult after another, this opposition loses all meaning.[119] Although Bryan Wilson endeavoured to develop a general typology of religious sects, there is absolutely nothing in his work to indicate a readiness to include Greek religion in it. On the contrary, he warned of the dangers of theorizing that was divorced from reliable empirical data: 'The danger in sociological theory is always that models are likely to be mistaken for reality; explanatory principles too often become substitutes for factual knowledge.'[120] In the case of Pythagoreanism this danger is all the greater because, besides 'sect', Burkert applies such terms as 'puritanism' and 'shamanism', without explaining how all these relate to one another.

Burkert made very free use of Wilson's typology,[121] and his application of selected features of a sect to the Pythagorean material is extremely problematic. Some of them (communal property, action against apostates) are not supported in the sources, while others (regular group meetings) are typical of a political association such as the Pythagorean *hetairia*.[122] The 'alternative life style', which characterizes Empedocles (D.L. VIII, 73), to some extent Socrates, and especially the Cynics, is not linked in the tradition with any of the Pythagoreans known to us. The 'Pythagorean way of life', noted

[119] See e.g. K. Rudolph, 'Wesen und Struktur der Sekte', *Kokalos* 21 (1979), 253: 'Eine Sekte ist eine religiöse Gruppe oder Gemeinschaft, die sich im Rahmen einer Stifter-, Buch, Offenbarungs- oder Bekenntnisreligion gebildet hat . . . Sekte ist kurz gesagt religionswissenschaftlich "Kleingemeinde" im Gegensatz zur beherrschenden "Großgemeinde"'. S. G. Wilson, 'Voluntary Associations: An Overview', in Kloppenborg et al. (ed.), *Voluntary Associations*, 15: 'The dominance of the church-sect distinction in modern discussions of sectarianism, usually with reference to a historically limited period, makes it a particularly treacherous and problematic category to transfer to the ancient world.'

[120] B. Wilson, 'A Typology of Sects', in *Types, dimensions et mesure de la religiosité* (Actes de la X Conférence Internationale; Rome, 1969), 35.

[121] Cf. Wilson, *Sects and Society*, 3–4, 325–7; id., *Religious Sects*, 22–35; Burkert, 'Sect', 3. Three of Burkert's central features of a sect are absent in Wilson's definitions of a sect: an 'alternative life style', 'regular group meetings', and 'some sort of communal or co-operative property'. 'Action against apostates' only formally corresponds to 'expulsion' in Wilson, who stresses the weakening of the rigoristic principles of early sects. Burkert, on the other hand, in contrasting 'sect' and 'religion', omits one of Wilson's key components: the *orthodox system* of religion. All other writers (above, 166 n. 116) follow Burkert rather than Wilson.

[122] On common property, see above, 149; action taken against apostates belongs to the realm of legend or applies to political opponents, not to religious apostates (above, 97 f.). On the Pythagoreans' political συνέδρια, see above, 146.

approvingly by Plato (*Res.* 600a–b), was certainly not seen by him as an 'alternative', but merely as different from that of the majority, and moreover as *better*. Among its exponents, Plato was thinking first and foremost of Philolaus, Archytas, and their associates. There is no reason to project onto them the style of life of Diodorus of Aspendus or the Pythagorists of comedy.[123] 'A high level of spiritual integration, agreement on beliefs and practices, based on authority, be it a charismatic leader or a sacred scripture' is a poor match for what we know of the philosophy and religion of the Pythagoreans. Their philosophical theories were highly individual; they never had any sacred scripture; and the contradictions in our sources concerning metempsychosis and the vegetarianism that was linked with it are so great that it is impossible to see them as binding dogmas of Pythagorean religion.[124] As a result it is not difficult to foresee that the same fate awaits the Pythagorean 'sect' as shamanism, which has already been abandoned as incapable of explaining anything in the religion of Archaic Greece.

[123] On Diodorus of Aspendus see above, 131 f.; on the Pythagorists and the taboos contained in the 'symbols', see below, 179 f., 192 f.

[124] See below, 222 ff. Metempsychosis is not attested in the case of a single Pythagorean known to us.

5

Mathematici and *Acusmatici*. The Pythagorean 'Symbols'

5.1 TWO TRADITIONS

The tradition of the Pythagorean 'symbols' appears to be inseparable from the story of their custodians, the *mathematici* and the *acusmatici*. The very existence of the 'symbols' presupposes the presence of people who understood the meaning of the wisdom contained in them and did as they prescribed or forbade. However natural this supposition may seem, it is quite wrong: from the outset these traditions were independent of each other. While the Pythagorean 'symbols' were known as early as the fifth century, the *mathematici* and the *acusmatici* appeared in Greek literature in the Imperial age, becoming joined with the 'symbols' for a short time only at the end of the third century AD.

The problem of the Pythagorean 'symbols' and their bearers, whose appearance came so late, is a convenient point for us to move from an analysis of the Pythagorean community to a consideration of Pythagorean religion. The subject of religion has, of course, arisen more than once in the preceding chapter and for a perfectly understandable reason. After the Pythagorean tradition as such ended in the mid-fourth century, the ancient Greek tradition of the Pythagoreans came more and more to depict them as a religious fraternity. In this sense there is nothing new in principle in the story of the *mathematici* and the *acusmatici*; it is one of the many fictions engendered as ancient Pythagoreanism underwent interpretation over many centuries. As distinct from the *mathematici* and the *acusmatici*, the 'symbols' were not a late invention. Some proportion of the 'symbols' known in antiquity did actually exist in the sixth–fifth centuries, some of them connected with Pythagoreanism. It is this which makes the problem of the 'symbols' particularly difficult, since endeavours to establish *precisely which* part of them was related to the Pythagoreans, and *precisely what* that relationship was, lead inevitably to a result which is only approximate.

The 'symbols' are short sayings divided into three kinds (*DK* 58 C 4) according to the question they answer.[1] The first kind answer the question, 'What is . . . ' (τί ἐστιν;). For example: What are the Isles of the Blest? – The sun and the moon. What is the Oracle of Delphi? – The tetractys, i.e. the harmony of the Sirens. What are the planets? – The dogs of Persephone. What is the sea? – The tears of Cronus. What are the Pleiades? – The lyre of the Muses. What are the Great and Little Bear? – The hands of Rhea. What is the rainbow? – The brightness of the sun. What is the sound of bronze when it is struck? – The voice of a daemon imprisoned in the bronze. What is an earthquake? – A gathering of the dead. What is an echo? – The voice of mightier beings. The second kind answer the question, 'What is most . . . ?' (τί μάλιστα;). For example: What is most just? – To sacrifice. What is holiest? – Mallow leaf. What is wisest? – Number, and in the second place is he who gave names to things.[2] What is wisest among us? – Medicine. What is strongest? – Insight. What is most truly said? – That men are wicked. What is finest? – Harmony. Finally the third, the most important kind, already discussed above, contains precepts and prohibitions (τί δεῖ πράττειν ἢ μὴ πράττειν;). On rising, one should straighten the bedclothes and eliminate the traces of one's presence. One should put on the right shoe first. One should sacrifice and enter the temple barefoot. Libations should be poured over the handle of the cup, etc. One should not use the public baths, speak when there is no light, walk on public roads, wear the images of gods on rings, have children by a woman who wears gold

[1] This schema probably goes back to Aristotle (Delatte, *Lit.*, 284; Burkert, 169, 173).

[2] *ὁ τοῖς πράγμασι τὰ ὀνόματα θέμενος* (Ael. *VH* IV,17, cf. Iamb. *VP* 82) is most likely a later addition (Burkert, 169 n. 22), based on the *Cratylus* (H. Steinthal, *Geschichte der Sprachwissenschaft bei den Griechen und Römern*, 2nd edn. (Berlin, 1890), 153 f.). See: *ὁ θέμενος πρῶτος τὰ ὀνόματα* (436b5); cf. 419a4, 427a6, 437c5, 438a1. Procl. *In Crat.*, 16.1 f.: *Ὅτι τῆς Κρατύλου δόξης γέγονεν Πυθαγόρας τε καὶ Ἐπίκουρος . . . ἐρωτηθεὶς γοῦν Πυθαγόρας, τί σοφώτατον τῶν ὄντων· ἀριθμὸς ἔφη· τί δὲ δεύτερον εἰς σοφίαν, ὁ τὰ ὀνόματα τοῖς πράγμασι θέμενος.*

jewellery, step over a yoke, break bread, poke the fire with a sword, pick up what has fallen from the table, sacrifice a white cock, etc.

The Pythagorean 'symbols', in particular the third kind, enjoyed enduring and ever increasing popularity in antiquity. The first commentary on them in writing, by Anaximander of Miletus (the Younger), probably appeared *c.*400;[3] Aristotle made extensive use of it in the monograph *On the Pythagoreans*.[4] Whether Philochorus' book *Περὶ συμβόλων*, known to us only by its title, was related to the Pythagorean 'symbols' or to something else remains under discussion.[5] The 'symbols' formed part of the Hellenistic biographies of Pythagoras;[6] Alexander Polyhistor wrote a special work *On Pythagorean Symbols* in the first part of the first century.[7] Androcydes' pseudo-Pythagorean treatise with the same title, highly influential in the subsequent tradition, probably belongs to the same century.[8] Plutarch took an active interest in the 'symbols', devoting a chapter of his *Table Talks* to the topic. Lucian, the Sophist Aelian, author of *Historical Miscellany*, and Athenaeus all wrote about them.[9] The 'symbols' have an important place in the biographies of Diogenes

[3] E. Schwartz, 'Anaximandros' (no. 2), *RE* 2 (1894), 2086; Philip, 148 n. 3; Burkert, 166 n. 2.

[4] Fr. 194–6 (fr. 197 does not belong to Aristotle: Rohde, 139 n. 1; Hölk, 38 f.; Burkert, 166 n. 4). The 'symbol' 'What is most beautiful of bodies and figures? – The sphere and the circle' (D.L. VIII, 35), goes back not to Aristotle but to Alexander Polyhistor (see below, 171 n. 7), who used his material. Rose and Ross excluded this and the next two 'symbols' from Aristotle's fragment (fr. 195 = fr. 5 Ross), Diels bracketed them (58 C 3), to indicate that they do not belong to Aristotle; cf. Delatte, *Lit.* 277, id., *Vie*, 239; Burkert, 169 n. 18, 169 n. 23. The idea of the perfection of the sphere is expressed most fully in the *Timaeus*. *τὰ ἐπίπεδα* and *τὰ στερεά* point to developed mathematical terminology, see Pl. *Res.* 528a9, *Tht.* 148b2, *Phil.* 54c4 (*τὰ ἐπίπεδά τε καὶ στερεά*).

[5] *FGrHist* 328 T 1.16. In view of Philochorus' interest in religion and that he wrote on Pythagorean women (above, 68 n. 29), this supposition seems plausible (Burkert, 167 n. 6).

[6] See Hermippus fr. 22–3 = *FGrHist* 1026 F 21–22.

[7] *FGrHist* 273 F 94. The only fragment of this work contains no 'symbols' (see below, 193), but we find them in Alexander's excerpt from the *Pythagorean Memoirs*, in which he also inserted material fom Aristotle's collection (D.L. VIII, 33–36 = F 140 = Arist. fr. 195). The *Pythagorean Memoirs* already contain neo-Pythagorean doctrines, see above, 10 n. 18, 71 n. 44, 90 n. 128, and below, 423 f.

[8] Androcydes (Tryphon, *De tropis*, 193.31 f.); Nicom. *Ar.* I,3; Clem. *Strom.* V,8,45; Iamb. *VP* 145; *Theol. ar.*, 52.8); Hölk, 40 f.; Burkert, 167. See below, 192 f.

[9] Plut. *Quaest. conv.* 727 A, *De Isid.* 354 E, *De lib. educ.* 12 D–F, *Num.* 14; Luc. *Gall.* 4, *Ver. hist.* 2,28, *Vit. auct.*, 3–6; Ael. *VH* IV,17; Athen. II, 65 f, VII, 308c, X, 452d–f.

Laertius, Porphyry, and in particular Iamblichus.[10] There are references to the 'symbols' in many Christian writers and in late antique commentators;[11] the Neoplatonist Hierocles (fifth century AD) in his commentary on Pythagoras' *Golden Verses* collected some fifty of them. Interest in the topic was maintained in Byzantium and in the medieval Arabic tradition and became particularly brisk in the age of the Renaissance.[12] The fate of the *mathematici* and *acusmatici* was quite different. First emerging in the writings of Clement of Alexandria (*c.*150–215 AD) they achieved a rapid, but short-lived rise to fame in neo-Pythagorean biography, in Porphyry and particularly in Iamblichus. After Iamblichus, in fact not a single writer in antiquity mentions the *mathematici* and *acusmatici*.

The two traditions levelled in popularity only in modern times, when they became an indispensable element of any general work on Pythagoreanism.[13] With the passage of time the history of the *mathematici* and *acusmatici* acquired increasing significance, since it became evident that it could be used with equal success to support quite different positions. For example, those who hold that philosophy, science, and religion (expressed in the 'symbols') *coexisted* in Pythagoreanism from the outset postulate that there were two directions among Pythagoreans: the *mathematici* were initiated into the philosophical and scientific doctrine of Pythagoras, while it fell to the *acusmatici* merely to observe strictly his religious precepts. On the other hand, those who regard philosophy and science as appearing in

[10] D.L. VIII, 17–18, 34–5; Porph. *VP* 37, 41–5; Iamb. *VP* 82–6, 103–5. Iamblichus also dealt with the 'symbols' in *Protrepticus* (104.26 ff.) and wrote a special work *Περὶ συμβόλων* (*VP* 186, *Protr*, 112.2; see Hölk, 20, 66 f.; Dillon, *Iamblichi fragmenta*, 24).

[11] Clem. *Strom.* V,5,27–30; Hippol. *Ref.* VI,27; Hieron. *Adv. Rufin.* III,39 f.; Stob. III,1,199; Hierocl. *In Carm. aur.*, XXVI,5; Procl. *In Tim.* I,30.4 f., II,246.7; Damasc. *Princ.*, 93.20; Simpl. *In Epict.*, 134.50; Philop. *In de An.*, 116.31 f.; *In Phys.*, 610.19. In more detail: A. Hüffmeier, *Die pythagoreischen Sprüche in Porphyrios'* Vita Pythagorae, *Kapitel 36 (Ende) bis 45* (diss. Münster, 2004), 9 f. Almost all ancient and medieval parallels are assembled in this extensive work.

[12] The article on the 'symbols' in the *Suda* is almost bigger than Pythagoras' biography. On the interpretation of the 'symbols' in the Middle Ages and the Renaissance: Celenza, *Piety*; Hüffmeier, *Sprüche*, 21 f., 33 f.

[13] Among specialized works we note some learned dissertations on the 'symbols': Hölk; Boehm; Hüffmeier, *Sprüche*. Corssen, 'Schrift', supported by Bertermann, *De Iamblichi*, and Delatte, *Lit.*, 285 f., developed an interesting theory on Androcydes' book (see above, 10 n. 21), which was not confirmed. Delatte, *Lit.*, 271 ff., and Burkert, 166 ff., dealt with the two traditions in particular detail. On the *mathematici* and *acusmatici* see von Fritz, 'Mathematiker'.

Pythagoreanism later, as a result of a *transformation* of Pythagorean religion, paint the early Pythagorean community as a religious commune totally subject to the rules established by Pythagoras and preserved in the 'symbols', ascribing the division of the school into *mathematici* and *acusmatici* to the second half or even the end of the fifth century. Rohde proposed an interesting intermediate version. Recognizing that the *mathematici* and *acusmatici* were a later invention, he supposed that the ancient commentators had attempted to use it to explain the opposing sides of Pythagoreanism, bringing together in time the Pythagorean 'myth' and 'logos', which in reality (i.e. from the standpoint of notions prevalent at the end of the nineteenth century) belonged to different periods.[14]

Before moving to analyse the separate and the combined development of the two traditions, it is important to establish a number of indisputable facts. First, the term *acusmata*, the name commonly used for the Pythagorean 'symbols' in contemporary scholarship, is certainly not Pythagorean and is merely misleading. Although the word ἄκουσμα ('that which is heard') was current in classical times, it was first applied to the Pythagorean 'symbols' by Iamblichus.[15] The whole of the tradition which preceded him, including Porphyry, usually called these sayings σύμβολα;[16] Iamblichus himself uses this term in *Protrepticus*, which presents a whole collection of these commandments, and elsewhere.[17] It is revealing that Iamblichus' innovation made no impression in antiquity: after him everyone continued as before to write of σύμβολα, not of ἀκούσματα.[18]

Second, even were one to suppose that there were different movements or groups within ancient Pythagoreanism (about which the

[14] Rohde, 107 f., 138 f. Cf. Zeller, i. 415 n. 1: division into two groups is the invention of the neo-Pythagoreans.

[15] *VP* 82–3, 85. Hüffmeier (*Sprüche*, 13 n. 40) notes that ἄκουσμα occurs in the second pseudo-Platonic letter 'in einem vergleichbaren Zusammenhang'. Nevertheless the subject of the letter is the 'secret' and hence oral teachings of Plato, not the Pythagorean 'symbols'; the word ἀκούσματα occurs once (314a3, cf. nearby λεγόμενα and ἀκουόμενα) and has no terminological meaning.

[16] Anaximander of Miletus (*FGrHist* 9 T 1), Aristotle (fr. 196), Philochorus (see above, 171 n. 5), Alexander Polyhistor (*FGrHist* 273 F 94), Androcydes (Iamb. *VP* 145; *Theol. ar.*, 52.8), Plutarch (*Quaest. conv.* 727 A), Clement (*Strom.* V,5,27–8), Diogenes Laertius (VIII, 17), Porphyry (*VP* 41–2). For alternative terms for the 'symbols' see below, 193 n. 91.

[17] *VP* 2, 103–5 passim, 186, 227; *Protr.*, 104.26 ff.; Περὶ συμβόλων (above, 172 n. 10); Hölk, 20, 66 f.

[18] See above, 172 n. 11.

sources of the classical period are resolutely silent), they could not possibly have been called *mathematici* and *acusmatici*. The word μαθηματικός first occurs in one of the late dialogues of Plato (*Soph.* 219c) and was most probably introduced either by him or not long before him.[19] When Archytas wrote about his Pythagorean predecessors who had studied mathematics (B 1), he called them οἱ περὶ μαθήματα, not μαθηματικοί. In first- and second-century AD sources we find μαθηματικοί among other categories of Pythagoreans,[20] but the first to refer to a division of the school into *mathematici* and *acusmatici* was Clement of Alexandria, to whom belongs also the first use of the term ἀκουσματικοί (*Strom.* V,9,59). The *mathematici* and *acusmatici* become the main groupings of Pythagoreans in Porphyry and Iamblichus.[21] Accordingly the ἀκούσματα, which only appear in Iamblichus, occur in those sections which deal with the *acusmatici*.[22] Evidently it seemed natural to him that the *acusmatici* should have *acusmata*; it was also important to emphasize the oral nature of their wisdom, which was not at all implied by the term σύμβολον. After Iamblichus, as has been noted, the *mathematici* and *acusmatici* practically vanish from ancient literature,[23] while other names remain in use.[24] Hence it was in Iamblichus that the two ancient traditions,

[19] Words with the suffix -ικος appear in large numbers at the turn of the 4th cent., owing to the influence of the Sophists, it is supposed: A. N. Ammann, *-ικος bei Platon* (diss. Freiburg, 1953); A. Willi, *The Languages of Aristophanes: Aspects of Linguistic Variation in Classical Attic Greek* (Oxford, 2003), 142 ff. Plato has about 350 such words.

[20] Anon. Phot. 438b19–23; Aul. Gell. I,9,1–8; see below, 184.

[21] Porph. *VP* 37; Iamb. *VP* 81, 87–8, *Comm. Math.*, 76.16–77.24. In Porphyry they oust all other groups; Iamblichus has also *politici*, whom he associates at times with *mathematici*, at times with *acusmatici* (cf. *VP* 89 and 150), as well as Pythagorists (*VP* 80–1).

[22] Apart from *VP* 82–3, 85, ἄκουσμα in its 'Pythagorean' meaning occurs only in one place (*VP* 140), but not in any other of Iamblichus' books (in *VP* 245 ἀκούσματα is rather 'oral teaching' in general than 'symbols'; cf. Burkert, 175 n. 74 'musical entertainment'). If the term ἄκουσμα was used by Aristotle (thus Hölk, 12 f., 39; Delatte, *Lit.*, 279 f.; Burkert, 175, 196), why do we not find it in Aristotelian material in Diogenes Laertius, Aelian, and Porphyry (fr. 194–6), and how did it come to appear in Iamblichus, who did not have access to a single ancient source? (cf. above, 75 n. 61). Both before and after Aristotle, in Anaximander and Philochorus, these sayings were called σύμβολα (above, 173 n. 16).

[23] A brief mention of 'the acusmatic Hippasus' in Syrianus (*In Met.*, 123.7) and Stobaeus (I,49,32) is a quotation from Iamblichus (cf. *In Nic.*, 10.20; Stobaeus cites Iamblichus' Περὶ ψυχῆς).

[24] Procl. *In Tim.* I,22.11; *Schol. Theocr.*, XIV,5b–c; *Suda*, s.v. Pythagoras, p. 267.15 Adler.

having reached the high point of their development, became so closely intertwined that many still see the connection between them as indissoluble.

In order not to invent new terms, I will call the two supposed categories of Pythagoreans *mathematici* and *acusmatici*, having full regard to the conventionality of these names. In fact the fundamental problem is not what the various groupings or categories of Pythagoreans were called – 'Pythagorics' and 'Pythagorists', 'esoterics' and 'exoterics', or *mathematici* and *acusmatici* – but whether such a division did indeed exist in ancient Pythagoreanism. In its application to the 'symbols', the problem can be formulated thus: was there in the history of ancient Pythagoreanism a period in which the precepts and taboos they contain were observed *to the letter*, and, if there was, then what circle of persons was affected?

5.2 IN SEARCH OF THE *ACUSMATICI*

As we have already established (above, Ch. 4), the Pythagorean community was not a religious fraternity, but a political *hetairia*; consequently the 'symbols' could not have been a code of conduct for all early Pythagoreans.[25] The way of life of the Pythagorean aristocracy as a whole, to the extent that we can conceive it, was in many aspects close to the way of life of the Greek aristocracy of the sixth–fifth centuries. Pythagoras merely modified it, taking account of new ideas,[26] some of which were held, not only by him, but also, for example, by Xenophanes (a reflective attitude to religion, rejection of luxury, an increased role for σοφία, etc.).[27] If, though, specific Pythagoreans from Alcmaeon and Hippasus to Archytas and Xenophilus are considered, then, in those cases where we can distinguish their individual traits, it is evident that they in no way resemble people prepared to subjugate their lives to the observance of such commandments. There is not so much as a hint of any taboos in any of the

[25] Philip (138 ff.) firmly emphasizes this circumstance. Cf. von Fritz, 'Mathematiker', 12 f.

[26] See E. Stein-Hölkeskamp, *Adelskultur und Polisgesellschaft. Studien zum griechischen Adel in archaischer und klassischer Zeit* (Stuttgart, 1989) (criticism of the aristocracy: 123 f.).

[27] See Bernhard, *Luxuskritik*, 51 ff.

sources relating to them. If, however, all those regarding whom evidence has been preserved were *mathematici*, who then were the *acusmatici*? Iamblichus says that the *acusmatici* stem from the politicians, who, at their age, did not have the leisure to listen to detailed expositions of Pythagoras' teachings, which were therefore provided to them in the form of brief maxims (*VP* 88). Could, however, people who comprised the political elite of Magna Graecia accept such a form of ritualization of their lives, which would have the effect of isolating them from the rest of the political class, making them the butt of general mockery? When, *c.*450, the wave of anti-Pythagorean outbreaks swept southern Italy and 'the best men in each city perished' (Polyb. II,39,1, from Timaeus), were these the men who were not to walk on public roads, not to step over a yoke, and not to speak in the dark?[28] Anyone who answers 'yes' to these questions will have also to explain why it is that contemporary sources are silent on all this. Greek comedy from Epicharmus onwards held up to ridicule things much more innocuous. Why then was Epicharmus silent in this instance, while Cratinus preferred to mock Hippon's philosophy, not this superstitious ritualism never encountered in the Greek world either before or after the Pythagoreans? After all, any observance of the literal meaning of the 'symbols' must have been patently obvious to all around, unlike the geometric theorems and experiments in acoustics, which were of interest only to few and hence left no direct trace in the fifth-century tradition of Pythagoras (above, §1.1).

The regulation of life prescribed by the 'symbols' is in striking contradiction, not only to what we know of the *hetairiai* of the sixth–fourth centuries,[29] but also to what we know of the *thiasoi* of the time. The rules of the internal life of the *thiasoi* which have come down to us are no different from the usual norms of life in a *polis*;[30] they contain no taboos like the Pythagorean taboos. Nor does the Pythagorean 'catechism' resemble the rules of the religious societies of the Near East, like, for example, the Qumran community or the monastery of St Pachomius. Their charters are of a quite different

[28] Von Fritz, 'Mathematiker', 22 f., 26, supposed that the *acusmatici* appeared after the political disaster of the mid-5th cent. Wishing, unlike the *mathematici*, to preserve the old doctrine without any change, they 'understood many things more literally and narrowly than was originally intended'.

[29] Some of them, in Athens at least, were defiantly areligious and even profaned the mysteries (Calhoun, *Athenian Clubs*, 36 f.).

[30] See above, 144 n. 22.

nature and do not contain the primitive superstitions of which the 'symbols' are full. The way of life and the conduct of the members of the Qumran community, totally isolated from the outside world, were most harshly regulated; any infringement brought strictly graduated punishment. It was forbidden to doubt the teachings of the community, to oppugn its principles, to slander, to lie, to display temper, anger, or malice, to appear naked in front of one's fellows, to sleep, spit, or laugh loudly during an assembly or to leave without a reason, to communicate with anyone expelled from the community, etc.[31] However deeply these 'fanatical separatists', as the expert on Qumran Garcia Martinez calls them, were obsessed with their ritual purity, they placed *moral* injunctions at the basis of their communal life and committed them to writing (only a ban on gesticulating with the left hand could be counted as a superstition).[32] Their code reveals a real life, austere though it may have been, constrained by religious discipline.[33] What kind of life lies behind the precepts of the 'symbols'? What do they regulate, and to what end? In Greek religion, unlike the ethical monotheism of Judaism and Christianity, the main role was played by the cult. The commandments, however, for the most part are unrelated to the cult;[34] they totally regulate a man's entire daily life. Burkert writes:

[31] I. D. Amusin, *Kumranskaia obshchina* (Moscow, 1983), 124 f.; F. Garcia Martínez (ed.), *The Dead Sea Scrolls Translated*, 2nd edn. (Leiden, 1996), 3 ff.; for a detailed list of 'crimes' and 'punishments' see J. Baumgarten, 'Judicial Procedures', in *Encyclopedia of the Dead Sea Scrolls* (Oxford, 2000), 458 f.

[32] Cf. however a precept of Chilon, one of the Seven Sages: *λέγοντα μὴ τὴν χεῖρα κινεῖν· μανικὸν γάρ* (D.L. I, 70).

[33] The rule of the monastery of St Pachomius is notable for even greater detail (Khosroev, *Pakhomii Velikii*, 391 ff.). The only regulation common to the Pythagoreans and the Pachomians which can be found is a ban on speaking in the dark, but the reason for its introduction into the monastic rule is anything but superstition.

[34] Boehm, drawing no distinction between the early and late sources, treated all the commandments attributed to the Pythagoreans as ancient Pythagorean superstitions. Consequently, the main source of the cultic precepts of the Pythagoreans (seven of the ten commandments in Boehm, nos. 1, 2, 4, 5–7, 10) turned out to be the pseudo-Pythagorean *Ἱερὸς λόγος* in Latin (?) cited by Iamblichus (*VP* 152–156); Thesleff, 167 f., dates it to the 1st cent., but it could be much later. From this work, which paints Pythagoras as the primogenitor of a significant portion of Greek rituals, Boehm took 15 of the 75 commandments he comments on, not one (!) of which coincides with the commandments from the traditions of Aristotle or Androcydes (cf. below, 192 f.).

> To take the *acusmata* seriously means an almost frightening constriction of one's freedom of action in daily life. Whether a Pythagorean gets up or goes to bed, puts on his shoes or cuts his nails, stirs the fire, puts on the pot, or eats, he always has a commandment to heed. He is always on trial and always in danger of doing something wrong.[35]

What could lead us to believe that the Pythagoreans took these taboos seriously? Neither the classical nor the later sources know of a single Pythagorean (named or unnamed) who did not poke the fire with a sword, or break bread, or speak in the dark. Whenever the subject arises, we learn, not of a real person, but of the *sayings* which contain these taboos! In the entire tradition of the 'symbols' nothing is said about the punishment of transgressors in this or the afterlife,[36] or about rewards for the strict observance of the commandments. Did expulsion from the commune or fearful torment in Hades await those who walked on public roads? Did those who shunned public baths hope to achieve the eternal bliss which the members of the Qumran community and the early Christian monks looked forward to? The sources say nothing about this, which once again demonstrates that the commandments, in the form in which they have come down to us, were not rules for life, but sayings, a part of religiously coloured folklore. They were interesting to interpret, but not obligatory to observe, in any case not without additional religious authority.

Revealing in this respect is the argument of the Etruscan Lucius, Plutarch's friend, who asserted that Pythagoras was also an Etruscan, though not through his father, as was held by many, but by birth and upbringing, since the Etruscans were the only nation *actually* to observe and preserve the Pythagorean 'symbols', such as 'do not keep swallows at the house', 'pour libations over the handle of the cup', 'do not step over a broom', etc.[37] Among the Greeks, including neo-Pythagoreans, of whom Lucius himself was one,[38] he knew no such people. Nor did Porphyry, who gave a symbolic interpretation of

[35] Burkert, 191. Riedweg, *Pythagoras*, 67: 'The life of the Pythagoreans was thoroughly ritualized by means of countless prohibitions and obligations.'

[36] According to Aristotle, the explanation of the ban on breaking bread, that it will affect the judgement in Hades, belongs to later commentators on the Pythagorean 'symbols', not to the Pythagoreans themselves (Iamb. *VP* 86; D.L. VIII, 35 = Arist. fr. 195); see below, 196 f.

[37] *ταῦτα γὰρ ἔφη τῶν Πυθαγορικῶν λεγόντων καὶ γραφόντων μόνους ἔργῳ Τυρρηνοὺς ἐξευλαβεῖσθαι καὶ φυλάττειν* (*Quaest. conv.* 727 B4–C7).

[38] See Hershbell, 'Plutarch's Pythagorean Friends'.

the Pythagorean commandments (*VP* 41–2). Iamblichus presents the 'symbols' as the φιλοσοφία, δόγματα, σοφία of the *acusmatici* (*VP* 81–2, 87): they were to be learnt by heart and preserved as divine commandments, but Iamblichus doggedly evades the question whether their literal meaning was actually observed. Moreover he understands perfectly well that, without an allegorical interpretation of the 'hidden' meaning of the 'symbols', they may seem 'silly and stupid gabble' (*VP* 105, 227).

Let us take another approach to this problem. The tradition of two directions in Pythagoreanism, of which the story of the *mathematici* and *acusmatici* is a later version, stems from the second half of the fourth century, when comedies mocking Pythagorists and Pythagorizers appeared on the Athenian stage. That these grotesque characters were the reflection of a certain historical reality is shown by the figure of Diodorus of Aspendus, who attempted to combine Cynicism with Pythagoreanism.[39] The question lies in what that reality was. Was there beyond the comic characters a community of superstitious ritualists who took seriously the observance of the dozens of precepts in the 'symbols'? Are they not these very *acusmatici* whom we cannot find at all,[40] appearing though they do after the *mathematici* have disappeared? Let us take a closer look at them.[41] The first thing to strike one is that the Pythagorists come into being as rapidly as they vanish. Their stage life is limited to the second half of the fourth century. They are absent both from the Old and from the New Comedy, though both were eager to portray philosophers. Further, it is revealing that the comic Pythagorists do not appear on stage (they are merely talked about) and are, as a rule, anonymous, as for example in the *Tombs* and the *Knapsack* of Antiphanes, the *Pythagorist* of Aristophon, and the *Tarentines* of Cratinus the Younger. Those who are named, for example Epicharides, Melanippides, Phaon, Phyromachus, and Phanus from the *Tarentines* of Alexis (58 E 1 = fr. 223 K-A), turn out to be, not indigent followers of

[39] See above, 132 f.

[40] Thus, e.g. Méautis, *Recherches*, 10; Burkert, 198 ff.; von Fritz, 'Mathematiker'; Giangiulio, *Pitagora*, i. 197 f.

[41] On Pythagorists in Middle Comedy see Weiher, *Philosophen*, 55 ff.; Méautis, *Recherches*, 9 ff.; Burkert, 198 ff.; Melero Bellido, *Atenas*, 65 f.; R. Hošek, 'Die Gestalt des Philosophen auf der Bühne der mittleren attischen Komödie', *Graecolatina Pragensia*, 13 (1991), 23–35; J. L. Llopis, 'Los pitagóricos en la Comedia Media', *Habis* 26 (1995), 67–82; Arnott, *Alexis*, passim.

Archytas (who were of no interest to the Athenian public), but more or less well-known Athenians, 'some of them at least beggars or paupers whose paraded impoverishment allowed comic poets to explain their circumstances ludicrously as due to Pythagorist asceticism'.[42] Epicharides, who eats dogs after first killing them (Pythagorists eat nothing alive!), turns out to be a well-known spendthrift, Phyromachus an even better-known parasite and gourmand, whose appearance among indigent Pythagorists, dining on barley once in five days, must have been particularly appreciated by the Athenian public.[43] In front of us are *supposed* Pythagorists, i.e. Athenians whose way of life is played on through their illusory Pythagoreanism. In fact, as Aristophon in the *Pythagorist* declares, their beggarly way of living and their asceticism come from destitution: give them a portion of meat or fish and they will eat it with glee! (58 E 2 = fr. 9 K-A).

The impression is created that the character of the Pythagorist, cropping up in one comedy after another, is to be found only on the Athenian stage, to which in reality it owes its appearance. The Pythagorists, not fortuitously, are ignored by all other contemporary sources,[44] so the only real figure remains, as before, Diodorus of Aspendus. It does not follow that, since Alexis and Cratinus the Younger gave their comedies identical titles the *Pythagorizing Woman* and the *Tarentines*, we should seek Pythagorists in Tarentum or among women. Tarentum, which flourished under Archytas, is selected simply as a centre of Pythagoreanism known to all (and especially to Alexis, who was born in Thurii),[45] while Pythagorean women, in whom other writers of the second half of the fourth century displayed an interest,[46] remain for us the same literary characters as the Pythagorists themselves.

[42] Arnott, *Alexis*, 639.

[43] Ibid. 635, 640. In the *Pythagorist* (fr. 10 K-A) Aristophon compares his starving heroes with the notorious Athenian parasite Tithymallus and the politician Philippides, no less well-known for his thinness. On them see Arnott, *Alexis*, 60 f., 245 f., 449 f.

[44] Weiher, *Philosophen*, 57; the pale, barefoot, and hungry Pythagorist from Theocritus' idyll (XIV, 3ff. = 58 E) is, of course, a reminiscence of the comedy, which is indicated by his Athenian origin.

[45] The appearance of Pythagorists on the Athenian stage is in no way connected with an emigration of Pythagoreans from Italy to Greece *c.*390 supposed by von Fritz (above, 108).

[46] See above, 68 n. 29.

The typical character traits shown by the Pythagorists also lead to the supposition that Middle Comedy did not so much copy reality as use the ready-made comic figure of the philosopher, with little relation to the particular school to which he belonged. In contrast to the *acusmatici*, obsessed with ritual purity, the Pythagorists are always dirty; they constantly go barefoot, not only when making sacrifices; like other philosophers, they wear only shabby cloaks; they live on grasses and cereals and drink only water, abstaining from meat and wine. The dramatists' choice of poverty to explain the Pythagorists' asceticism is on their conscience; let us suppose that we have before us a deliberately chosen way of life. Does it resemble what is prescribed by the 'symbols'? The only coincidence is abstinence from animal foods; the rest is all at variance: the Pythagorists did not observe what the 'symbols' required, and, the reverse, not one of the 'symbols' forbade drinking wine and wearing a clean chiton and sandals. This one coincidence, moreover, is incomplete: the 'symbols' demanded, not entire rejection of animal foods, but only abstinence from certain organs (e.g. the uterus and the heart) or certain kinds of meat (e.g. from non-sacrificial animals) and fish (Arist. fr. 194; Iamb. *VP* 85). Hence the Pythagorists turn out to be stricter than the *acusmatici* on one point and depart from them on all others.

It is easy to surmise that it was vegetarianism, one of the main features of Pythagoreanism in popular tradition,[47] which became that final touch which turned the customary comic character of the grubby, barefoot philosopher in his shabby cloak into the figure of the Pythagorist.[48] In all other respects the Pythagorists are surprisingly like Socrates and his pupils in Aristophanes' *Clouds* and

[47] Alexis in *Attis* (fr. 27 K-A) exalts Pythagoras through the words of a parasite: 'The first to say that a wise man should not eat anything living was himself a wise man'. Subsequently this rule is easily evaded by a familiar trick: everything eaten by the hero of the comedy is already dead. See also Antiphanes' *Neottis* (fr. 166 K-A) and below, 182 n. 52.

[48] The appearance of the Pythagorists at Pluto's feast (Aristophon, fr. 12 K-A = 58 E 3) belongs among common themes in comedy, not to some special Pythagorean κατάβασις εἰς Ἅιδου. In Aristophanes' *Frogs* (758 ff.), the best representatives of each τέχνη feast with Pluto, and Euripides, taking advantage of the rabble's favour, takes the place of Aeschylus. For a picture of gastronomic luxury in Hades see Pherecrates, fr. 113 K-A. In contrast to this picture, in Aristophon the Pythagorists observe their diet even in the underworld.

other philosophers on the Athenian stage.[49] The author of comedies Amipsias made fun of Socrates' shabby cloak as early as 423; in Aristophanes Socrates is poor and dirty, he suffers from cold and hunger and hence is pale, goes barefoot and does not drink wine – exactly as the Pythagorists did![50] Like Socrates, the Pythagorists entice the simple into their toils with clever rhetoric, and their λόγοι λεπτοί refer us directly to *Clouds*.[51] If, however, the Pythagorists of comedy turn out to be the same construction of familiar components as the Socrates of comedy, who then was their actual prototype? They cannot be identified directly with the Cynics, whom they most resemble: the Cynics had no ban on meat.[52] However, Diodorus of Aspendus, who claimed acquaintance with Pythagoreans, actually was an indigent *vegetarian*, which may have been quite sufficient to earn the sobriquet of 'Pythagoras' henchman' and 'Pythagorizer'.[53] If there were in Athens other such figures as Diodorus, comedy could have taken from them some crucial details, transforming the by now dated character of the poor philosopher, Socrates, into the figure of the indigent vegetarian-Pythagorist. The readiness of comic authors to adopt the successful devices of their colleagues is well known, and should caution us against identifying a particular comic type with some Pythagorean community existing at that time. In fact the comic writers themselves, calling their characters Pythagorists and

[49] For an analysis of the image of Socrates in comedy, see Weiher, *Philosophen*, 5 ff.; K. J. Dover (ed.), *Aristophanes. Clouds* (Oxford, 1968), pp. xxxii ff.

[50] Amips. fr. 9 K-A = D.L. II, 27–8; Ar. *Av*. 1554; *Nub*. 103, 175, 362 f., 414 f., 836 f., 1112. Cf. 'the lean and hungry Sophists from the Lyceum' (Antiphanes, fr. 120 K-A); Weiher, *Philosophen*, 40 f. Seeing the resemblance of the Pythagorists and Socrates, Melero Bellido, *Atenas*, 83 ff., even supposed that the Pythagoreans were ridiculed in *Clouds*.

[51] Rhetoric: Cratinus the Younger's *The Tarentines* (58 E 3 = fr. 7 K-A); λόγοι λεπτοί: Alexis' *The Tarentines* (58 E 1 = fr. 223 K-A), cf. *Nub*. 153, 320, 1496.

[52] Weiher, *Philosophen*, 57 f. True, the Cynic Onesicritus maintained in conversation with an Indian gymnosophist 'that Pythagoras taught a similar doctrine, and enjoined his disciples to abstain from whatever has life; that Socrates and Diogenes, whose discourses he had heard, held the same opinions' (Strab. XV,65 = *FGrHist* 134 F 17). Socrates' appearance in this company is highly symptomatic. – Another detail, σιωπή, found in Alexis' *Pythagorizousa* (58 E 1 = fr. 201 K-A), has a parallel in Diogenes the Cynic (D.L. VI, 31), who taught that one should make do with simple food and water and go about in only a cloak, barefoot, and silent (σιωπηλούς).

[53] See above, 133 f.

Pythagorizers, were making it clear that they drew a distinction between them and the entirely respectable Pythagoreans of the past.[54]

5.3 FORMATION OF A LEGEND

Although *acusmatici* cannot be found among the Pythagorists, in the end these two categories have turned out to be connected. Through their very obvious differences from the ancient Pythagoreans, the Pythagorists of comedy and the real Pythagorizers launched the tradition of the existence (and then the *co*existence) within Pythagoreanism of different directions, as a result of which the *mathematici* and *acusmatici* appeared. Admittedly, this took five hundred years. The historians and biographers of the late fourth century, as has been noted, did not notice the Pythagorists of comedy. Aristoxenus, often criticized for ignoring them, in this respect was no different from his contemporaries. Comments on Diodorus of Aspendus, including the very earliest, emphasize, not only his resemblance to the Pythagoreans, but also that he differed from them. Timaeus reports that 'he introduced the eccentric way of life and pretended to have associated with the Pythagoreans' (*FGrHist* 566 F 16). According to Sosicrates (*c.*150), 'Diodorus adopted the wearing of a long beard, put on a worn cloak, and grew long hair, introducing this practice as an innovation in order to gratify a kind of vanity, since the Pythagoreans before his time always dressed in white clothing and made use of baths, ointment, and the customary mode of hair-cut' (fr. 15, tr. Gulick). If Sosicrates still takes account of the difference in time between the Pythagorizing Diodorus and the Pythagoreans who lived before him, later it becomes erased, with the Pythagoreans and the Pythagorists becoming contemporaries. In scholia on Theocritus, who referred to a pale, barefoot, and hungry Pythagorist (XIV, 5 f.), we read:

> The Pythagoreans differ from the Pythagorists in that the Pythagoreans take great care of their bodies, whereas the Pythagorists lead a very simple and wretched life. Some consider that the Pythagorists accept the

[54] Sometimes, probably for the sake of variety, comedy also uses the usual terms, *Πυθαγόρειος* (Alexis, fr. 201, 223 K-A) and *Πυθαγορικός* (Antiphanes fr. 158 K-A; this last, however, is often corrected to *Πυθαγοριστής*). Cf. Weiher, *Philosophen*, 56; Burkert, 198 n. 25.

rules of Pythagoras, but not his opinion, whereas the Pythagoreans hold to the same way of thinking as Pythagoras.[55]

Hippolytus formulates the same more briefly: the esoterics were called Pythagoreans and the others Pythagorists.[56] Elsewhere Hippolytus reports that Pythagoras named these two groups esoterics and exoterics, initiating the first into the nobler sciences and the others into the humbler; he was, after all, said to engage in magic and invented physiognomics.[57] Finally Iamblichus, who could not admit that followers of Pythagoras, however remote, might lead a life of poverty, provides the following explanation: Pythagoreans differ from Pythagorists in the same way as 'Attics' (*Ἀττικοί*) from 'Atticists' (*Ἀττικισταί*); Pythagoras identified the former as his true followers and the latter as emulators of these (*VP* 80–81). The only aspect of the way of life of the Pythagorists to be reported was that these retain their own possessions but meet together to study with one another.

At some stage, alongside the binomial construct, there comes into being a trinomial, occurring first in an anonymous biography of Pythagoras in Photius.[58] Pythagoras' close associates become here *Πυθαγορικοί*, their pupils *Πυθαγόρειοι*, and those who imitated Pythagoras outwardly and in some other way (*οἱ δὲ ἄλλως ἔξωθεν ζηλωταί*) *Πυθαγορισταί*. Alongside this scheme another was presented: those who devoted themselves to *θεωρία* were called *σεβαστικοί*; those who engaged in human affairs *πολιτικοί*; and specialists in mathematical sciences (geometry and astronomy) *μαθηματικοί*.[59] On the whole these two divisions do not intersect,

[55] *διαφέρουσι δὲ Πυθαγορικοὶ τῶν Πυθαγοριστῶν, ὅτι οἱ μὲν Πυθαγορικοὶ πᾶσαν φροντίδα ποιοῦνται τοῦ σώματος, οἱ δὲ Πυθαγορισταὶ περιεσταλμένῃ καὶ αὐχμηρᾷ διαίτῃ χρῶνται. τινὲς δὲ Πυθαγοριστὰς μὲν λέγουσι τοὺς ἀποδεχομένους τὰ Πυθαγόρου, μὴ ὄντας δὲ τῆς ἐκείνου δόξης, Πυθαγορικοὺς δὲ τοὺς τὰ Πυθαγόρου φρονοῦντας* (XIV, 5a, cf. another version in XIV, 5c). – The oldest scholia to Theocritus stem from the 1st cent.

[56] *Ref.* I,2,17. The same in Origen (*Contra Cels.* I,7).

[57] *Ref.* I,2,4. Echoes of the same tradition are found in Artemidorus (2nd cent. AD), where the Pythagorists appear in bad company with all kinds of physiognomists and fortune-tellers, whose teaching is accounted false (II, 69).

[58] 438b23–5. For the same scheme, see *Schol. Theocr.*, XIV,5b; *Suda*, s.v. Pythagoras. On dating Anonymus Photii see above, 72 n. 48; on the scheme itself: Dörrie, *Platonismus*, ii. 261 f.

[59] 438b19–23. This scheme is reproduced by *Schol. Theocr.*, XIV,5b; *Suda*, s.v. Pythagoras. Beyond these three places, *σεβαστικοί* are not found in Greek literature, unlike *σεβαστοί*. Cf. *σεβαστικόν* and *σεβαστικῶς*: Porph. *Quaest. Hom.* I, 215; Iamb. *VP* 17; *Protr.*, 110.9.

so that in the second scheme there is no place for Pythagorists. Another trinomial construct, mentioned by Aulus Gellius (I, 9, 1–8) with a reference to his teacher, the Platonist Calvisius Taurus (acme *c.*150 AD), differs from the others in that all three categories in it represent successive stages in a Pythagorean's education.[60] The candidate underwent a physiognomic test, then joined the ἀκουστικοί,[61] who were to hear Pythagoras in silence, in two years progressed to the category of μαθηματικοί, engaged in μαθήματα, and later became one of the φυσικοί, devoting himself to philosophical research proper.[62]

So we find in the literature of the first three centuries AD various schemes of dividing up the Pythagoreans, most of which are based on the degree of closeness to Pythagoras: his chosen pupils take up worthier things than outside supporters or novices (Pythagorists, exoterics, *acustici*). The 'symbols' do not figure in a single one of these schemes; the two traditions hitherto have a separate existence. Clement, the first to make a brief reference to the *mathematici* and *acusmatici* (*Strom.* V,9,59),[63] still makes no evident connection with them when he considers the 'symbols' (V,5,27–30 and 8,50). The first to connect the two traditions in sources available to us was Porphyry (*VP* 36–43), in whom, as has been noted, there are no groups other than the *mathematici* and *acusmatici*:

> Pythagoras instructed the pupils who came to him either through a detailed exposition or through symbols, since he had two methods of teaching, and of those who came to him some were called *mathematici*, and the others *acusmatici*: *mathematici* were those who studied a comprehensive and detailed exposition of his scientific teaching;

[60] See M.-L. Lakmann, *Der Platoniker Tauros in der Darstellung des Aulus Gellius* (Leiden, 1995), 9 ff.

[61] No other substantivized ἀκουστικοί are found in the literature; cf. Iamb. *VP* 163 = *DK* 58 D 1.4 on the Pythagoreans: σιωπηλοὺς δὲ εἶναι καὶ ἀκουστικούς (probably from Aristoxenus).

[62] These three categories correspond to the three groups of Pythagoras' pupils in Socrates' epigram (*AP* 14.1; conjectural date, 1st cent. AD: Burkert, 193 n. 6): Some study nature, some are engaged in μαθήματα, the others are silent. The groups are not named in the epigram. As von Fritz, 'Mathematiker', 5, notes, the privileged place of the 'physicists' reflects the Stoic view of philosophy, particularly typical of Posidonius (see Zhmud, *Origin*, 288 ff.).

[63] Ναὶ μὴν καὶ ἡ Πυθαγόρου συνουσία καὶ ἡ πρὸς τοὺς ὁμιλητὰς διττὴ κοινωνία, ἀκουσματικοὺς τοὺς πολλοὺς καί τινας μαθηματικοὺς ἑτέρους καλοῦσα, τοὺς γνησίως ἀνθαπτομένους τῆς φιλοσοφίας.

> *acusmatici* were those who listened to chief heads from the works without a more detailed explanation (*VP* 36–7).[64]

Porphyry has little more to say about these two groups than Clement, moving on immediately to Pythagoras' teaching, at first his teaching by means of detailed exposition (37–41), then with the aid of the 'symbols'. The 'symbols' in Porphyry become the philosophy of the *acusmatici*, while retaining their old name.

The fullest account of the tradition of the *mathematici* and *acusmatici* is found in Iamblichus, where there are two contradictory versions. In *VP* 81, 87–8 the *acusmatici* recognize the *mathematici* as Pythagoreans, while the latter do not recognize the former, asserting that the doctrine of the *acusmatici* derives from Hippasus. In *Comm. Math.*, 76.16–78.5 all is reversed. Iamblichus copied both versions at different times from Nicomachus,[65] *Comm. Math.* retaining the original text, as was shown by Burkert, while Iamblichus introduced two substantial amendments into *VP* 81–8.[66] In the first place, he changed the *mathematici* and *acusmatici* around, turning Hippasus into an 'acusmatic';[67] in the second place, he inserted into this account a long passage on the 'symbols' (*VP* 82–6), which is absent from *Comm. Math.* Nicomachus' original version is this:

> There are two kinds of Italian philosophy called Pythagorean, for there were two kinds of those pursuing it: some were *acusmatici* and others were *mathematici*. Of these, the *acusmatici* are agreed to be Pythagoreans by the others, but the *acusmatici* do not agree that the *mathematici* are Pythagoreans, saying that their philosophical activity derives not from Pythagoras but from Hippasus. Some say Hippasus was a Crotoniate, others that he was a Metapontine. And those Pythagoreans who are concerned with the *μαθήματα* agree that the others are Pythagoreans, but say that they themselves are even more so, and that what they

[64] *ὅσα γε μὴν τοῖς προσιοῦσι διελέγετο, ἢ διεξοδικῶς ἢ συμβολικῶς παρῄνει. διττὸν γὰρ ἦν αὐτοῦ τῆς διδασκαλίας τὸ σχῆμα. καὶ τῶν προσιόντων οἱ μὲν ἐκαλοῦντο μαθηματικοί, οἱ δ' ἀκουσματικοί. καὶ μαθηματικοὶ μὲν οἱ τὸν περιττότερον καὶ πρὸς ἀκρίβειαν διαπεπονημένον τῆς ἐπιστήμης λόγον ἐκμεμαθηκότες, ἀκουσματικοὶ δ' οἱ μόνας τὰς κεφαλαιώδεις ὑποθήκας τῶν γραμμάτων ἄνευ ἀκριβεστέρας διηγήσεως ἀκηκοότες.*

[65] Rohde, 138 f.; Bertermann, *De Iamblichi*, 75; Thesleff, 91.

[66] Burkert, 192 ff.

[67] The confusion with Hippasus continues in a further text of Iamblichus (*In Nic.*, 10.20, 116.4): First he is called an 'acusmatic', then a 'mathematic'. On the other hand, in *Comm. Math.*, 77.20 Iamblichus confuses a hexagon with a pentagon.

say is true. And the cause of the dissimilarity between them was the following.

When Pythagoras arrived from Ionia and Samos during Polycrates' tyranny, while Italy was flourishing, the foremost men in the cities became his associates. To the older amongst these, who had little leisure, being busy with political affairs, he spoke simply, since it was difficult to teach them scientifically with proofs. He considered it no less beneficial for them to do what was necessary, even without knowing the reasons ... But those who were young and able to work hard and to learn, he addressed with proofs and mathematical sciences. They themselves, then, the *mathematici*, descend from these, but those, the *acusmatici*, descend from the others. As for Hippasus, they say in particular that he was one of the Pythagoreans, but because of having disclosed and given in writing for the first time the sphere constructed from the twelve pentagons, he perished in the sea, since he committed impiety. He acquired fame as having made the discovery, but in reality all the discoveries were of 'that man', for so they refer to Pythagoras, and do not call him by his name (*Comm. Math.*, 76.16–77.24, tr. after Dillon & Hershbell).

Of the three histories of the *mathematici* and *acusmatici* available to us, at least two, those of Iamblichus (both versions) and Clement,[68] derive from Nicomachus, and Clement's version, despite its brevity, allows us to obtain a fuller idea of the context of the history in Nicomachus. It turns out that to this context also belongs the pseudo-Pythagorean letter of Lysis to Hipparchus,[69] presented by Iamblichus immediately before the story of the two groups.[70] Clement retained the same three elements as Iamblichus, but in condensed form and with the order changed: immediately following the short quotation from Lysis' letter, Hippasus is mentioned (V,9,57), and

[68] Burkert, 459 n. 63; Städele, *Briefe*, 204 ff., 208 n. 12.

[69] Rohde, 138; Burkert, 'Hellenistische Pseudopythagorica', 17 ff., 24 n. 1; Städele, *Briefe*, 205 ff. Delatte, *Lit.*, 85 f., wrongly connected the letter with Apollonius. Lysis' letter exists in two versions, the original (*Epistol. gr.*, 601 f.) and the revised (Iamb. *VP* 75–8). Burkert, 'Hellenistische Pseudopythagorica', 20 n. 2, 24 n. 1, thought Iamblichus himself the author of the revised version, Städele, *Briefe*, 208 f., Nicomachus. Burkert's arguments seem more convincing to me. Another quotation from Lysis' letter in *Strom.* II,7,3–4 was discovered by M. Tardieu, 'La Lettre à Hipparque et les réminiscences pythagoriciennes de Clément d'Alexandrie', *Vig. Chr.* 28 (1974), 241–7, but it does not enable us to determine which version was quoted by Clement.

[70] *VP* 75–8. Ch. 79 is Iamblichus' own; Ch. 80 deals with the Pythagoreans and the Pythagorists (from Apollonius); Ch. 81 with the *mathematici* and *acusmatici*.

then the *mathematici* and *acusmatici* following an intervening passage (V,9,59). Admittedly, Clement calls Hippasus Hipparchus, taking him to be the addressee of the letter, also accused of revealing secrets.[71] Moreover he gives a different version of the legend of Hippasus: he was driven out of the community and a stele set up to him as if he was dead.[72] This version has a closer connection with Lysis' letter than death at sea; Clement probably chose it for this reason out of the two variants in Nicomachus.[73]

So the story of the *mathematici* and *acusmatici* in Nicomachus occurred alongside other pseudo- and neo-Pythagorean material which sheds light on its origin. Like Lysis' letter, it deals with oral and secret doctrines,[74] and its narrator is a contemporary of the Pythagoreans (this is emphasized by the regular use of *praesens*), listening to the views of each of the groups. This takes the author into a time before Aristoxenus, who always described the Pythagoreans in the past, i.e. it actually makes him a contemporary of Lysis! This pseudo-contemporary tone, however, cannot mislead: synchronizing Pythagoras with the tyranny of Polycrates points to Aristoxenus.[75] The oral and secret teachings of the Pythagoreans were invented not earlier than the third century (above, §4.3 b–c), and the image of the politicians without the leisure to study the sciences appeared scarcely earlier than the Hellenistic age, when the examples of Archytas and Eudoxus no longer had currency.

[71] An analogous error: Tertul. *De an.* 5,2; Macr. *Somn. Sc.* I,14,19–20. The confusion occurs in reverse in Diogenes Laertius (VIII, 42), who names the addressee of the letter as Hippasus.

[72] *φασὶ γοῦν Ἵππαρχον τὸν Πυθαγόρειον, αἰτίαν ἔχοντα γράψασθαι τὰ τοῦ Πυθαγόρου σαφῶς, ἐξελαθῆναι τῆς διατριβῆς καὶ στήλην ἐπ' αὐτῷ γενέσθαι οἷα νεκρῷ* (V,9,57). Cf. Iambl. *VP* 88: *καὶ γράψασθαι πρώτως σφαῖραν* . . . *VP* 74 (from Nicomachus) also refers to expulsion from the community and the setting up of a memorial stele.

[73] In the letter Lysis warns Hipparchus: if you do not change your ways, for me you are dead (*Epistol. gr.*, 603.12). Iamblichus gives both versions of Hippasus' death in *VP* 246–7, in which Rohde, 168, noted reminiscences from *VP* 76, 88, i.e. from Nicomachus. Deubner also notes in the apparatus of Iamb. *VP* (pp. 43, 132) parallels between Lysis' letter, *VP* 246 (from Nicomachus), and Clement (*Strom.* V,9,57).

[74] In the middle part of Lysis' letter, Pythagoras was not called by name either (Städele, *Briefe*, 206). The same in Iamb. *VP* 255 (from Nicomachus).

[75] Fr. 16. The same is indicated by the reference to Hippomedon of Argos (*VP* 87), whose name occurs only in Aristoxenus' catalogue (*DK* I, 447.8). Aristoxenus wrote of the last Pythagoreans that they *ἐφύλαξαν τὰ ἐξ ἀρχῆς ἤθη καὶ τὰ μαθήματα* (fr. 18) – in our story this is put into the mouths of the *mathematici*.

Iamblichus inserted into his revised version of the story of the *mathematici* and *acusmatici* a description of the 'symbols' (*VP* 82–6) absent from *Comm. Math.* and the corresponding section of Nicomachus. Since this description unltimately derives from Aristotle,[76] Delatte attempted to link with him the story of the *mathematici* and *acusmatici* as well.[77] Burkert supported and developed Delatte's idea, but later distanced himself from it.[78] In fact the differences between the two layers, *VP* 81, 87–9 and 82–6, are self-evident: Aristotle ascribes the explanations of the 'symbols' to outsiders (*VP* 86); in Nicomachus both groups take them back to Pythagoras, while the account of the *mathematici* is essentially absurd: how could μαθήματα and ἀπόδειξις serve as a basis for the precepts? Aristotle sourced the 'symbols' in Anaximander the Younger, but how did he come to be acquainted with the substance of the dispute beween the groups, of whose existence we first learn from Nicomachus? Had Aristotle actually known custodians of the Pythagorean tradition, the information we have from him on Pythagoreanism would have been immeasurably greater than that which we have before us.

A close lexical analysis of Lysis' letter has shown that it was written not long before Nicomachus, probably in the first century AD.[79] Did the story of the *mathematici* and *acusmatici* appear before Nicomachus, or did he make it up himself? The answer to this depends largely on whether we can establish the source of Porphyry's version (*VP* 37), and here a number of difficulties arise. Rohde considered the source of Porphyry's entire section *VP* 32–45 to be the romance of Antonius Diogenes; subsequently he excluded *VP* 37–43, 45 from Antonius' material, but this idea was taken up again later.[80] Rohde did, however,

[76] See below, 197 n. 110.

[77] Delatte, *Lit.*, 271 ff. This reflected his general tendency to date many Pythagorean apocrypha to the 5th–4th cents.; see above, 10 nn. 19–20 and below, 189 n. 79.

[78] Burkert, 192 ff.; cf. id., 'Pythagoreische Retraktationen', 314: 'Daß der exzerpierte Text allerdings ein Werk von Aristoteles war, ist ebenso einleuchtend wie unbeweisbar'.

[79] Städele, *Briefe*, 212 ff.; Du Toit, *Theios Anthropos*, 234. Earlier it had been dated in the 3rd cent. (Burkert, 'Hellenistische Pseudopythagorica', 24 f.; Thesleff, 'On the Problem', 78), and Delatte (*Lit.*, 91 f.) even saw in it a genuine letter of Lysis. Against this H. Dörrie, 'Lysis', *KP* 3 (1975), 844, suggested the 1st cent. AD.

[80] Rohde, 126, cf. his *Roman*, 272 n. 2: only *VP* 32–6, 44 go back to Antonius. Conversely, H. Jäger, *Quellen*, 36 ff., 43 ff.; Reyhl, *Antonius Diogenes*, 20 ff.; W. Fauth, 'Zur kompositorischen Anlage und zur Typik der Apista des Antonius Diogenes', *Würzburger Jahrb.* 4 (1978), 61, 66; Sodano, 'Analisi', 66 n. 61, as before link *VP* 37 with Antonius. See also Burkert, 99 n. 9; des Places (ed.), *Porphyre*, 15 ff.

have sound grounds to change his position: in his novel, especially in Astraeus' story of Pythagoras, Antonius could not quote the sources directly, as Porphyry does in *VP* 41, referring to Aristotle. Moreover Porphyry took from Antonius a description of 'the everyday way of life' of Pythagoras (*VP* 32), to which the subjects of the *mathematici* and *acusmatici* and the 'symbols' (*VP* 37, 41–3) bave no direct relation.[81] Hence we must either postulate another unknown source of this legend or investigate whether Porphyry's *VP* 37 depends on Nicomachus, who would, in such a case, become the source of all three passages.[82]

Porphyry's words διττὸν γὰρ ἦν αὐτοῦ τῆς διδασκαλίας τὸ σχῆμα are very reminiscent of Clement's ἡ πρὸς τοὺς ὁμιλητὰς διττὴ κοινωνία (*Strom.* V,9,59). Further, according to Porphyry, the *acusmatici* only heard τὰς κεφαλαιώδεις ὑποθήκας τῶν γραμμάτων. These words have even closer lexical parallels in the material from Nicomachus. While ὑποθήκας refers us to the divine commandments (θείας ὑποθήκας), received by Pythagoras' hearers,[83] the passage on the last Pythagoreans says: they composed certain memoirs summarizing their teachings briefly (ὑπομνήματα κεφαλαιώδη συνταξάμενοι).[84] It is indicative

[81] Relating Porphyry's *VP* 37 to Antonius, we are faced with the following choice. Since Clement and Iamblichus did not make use of Antonius, but sourced the *mathematici* and *acusmatici* from Nicomachus, then Nicomachus must have relied on either Antonius (if the latter invented the story) or an earlier source which he and Antonius used independently one of the other. Both these propositions hang fire, since there is no trace of Nicomachus' use of Antonius' romance, or independent evidence of the presence in this romance of the *mathematici* and *acusmatici*. Antonius is now dated *c.* AD 100–30 (see above, 74 n. 53), making him a (younger?) contemporary of Nicomachus, whose chronology is, however, very approximate.

[82] Rohde, *Roman*, 272 n. 2, found in *VP* 37–43 'not the slightest trace of Nicomachus'. H. Jäger, *Quellen*, 43 ff., supposed that Porphyry had copied the whole section *VP* 32–47 from Antonius, who had in turn used a biographical manual (*Handbuch A*), one of the main sources of Diogenes Laertius. The resemblance to Clement was explained by Jäger through their common dependence on the manual, overlooking that the *mathematici* and *acusmatici* are absent from Diogenes Laertius and from all other authors who made use of this manual, while the corresponding passage of Iamblichus (*VP* 81, 87–9) goes back to Nicomachus. Hölk, 15, presumed the dependence of Porph. *VP* 37 on Nicomachus without presenting any argument.

[83] Porph. *VP* 20 = Iamb. *VP* 30 = Nicom. *FGrHist* 1063 F 1. ὑποθήκη does not occur anywhere else in Porphyry's *VP*. Cf. also θεῖα δόγματα in Iamb. *VP* 82 (from Nicomachus).

[84] Porph. *VP* 58 = Iamb. *VP* 253 = Nicom. *FGrHist* 1063 F 2–3. See Rohde, 115 ff; Burkert, 98 n. 5; Städele, *Briefe*, 206 f. Since Porphyry denied the presence of published works by Pythagoras (*VP* 57), τὰ γράμματα in *VP* 37 is used in the sense of ὑπομνήματα, unpublished, but used in the presentation of the note. See Hüffmeier,

that Porphyry names Lysis among these last Pythagoreans (*VP* 58), while the end of this section contains a quotation from Lysis' letter to Hipparchus, which Nicomachus had earlier presented in full. Hence it is very probable that Porphyry's *VP* 37, like the passages in Clement and Iamblichus, goes back to Nicomachus.[85] Whether Nicomachus was the author of the story of the *mathematici* and *acusmatici* remains open to question. Although much points to this,[86] there is insufficient evidence for a definite conclusion. Anyway, even if an earlier source for this story did exist, the search for it would be unlikely to take us back further than the first century AD.

It remains for us to consider whether Nicomachus himself connected the *mathematici* and *acusmatici* with the 'symbols', or Porphyry and Iamblichus came to this independently and detached one from the other. Although Iamblichus' passage on the 'symbols' (*VP* 82–6) is taken from Nicomachus, it is by no means obvious that, in Nicomachus' biography of Pythagoras, it was part of the story of the *mathematici* and *acusmatici*. The original version of the story, copied by Iamblichus from Nicomachus (*Comm. Math.*, 76.16–78.5), contains no 'symbols', while in *VP* 81–9 they are inserted into the story with clear signs of editorial emendations by Iamblichus.[87] Clement does not connect the 'symbols' with the *mathematici* and *acusmatici* either, although he deals with them in the same book. A comparison of the treatment of the 'symbols' in Clement, Porphyry, and Iamblichus confirms that, in Nicomachus, these topics were treated separately. Whereas Clement and Porphyry coincide in many respects

Sprüche, 106 f. ὑπομνήματα appear in the same sense in Lysis' letter (Städele, *Briefe*, 249).

85 Note that Porphyry and Clement abridge and alter Nicomachus' text, unlike Iamblichus' *Comm. Math.* Parallel borrowings from Nicomachus demonstrate that Porphyry habitually abridged greatly, while Iamblichus, whose book was five times longer, provided a fuller version (H. Jäger, *Quellen*, 42). If Clement, for whom abridgements and transpositions were a normal method, retained the quotation from Lysis' letter and the reference to Hippasus (Hipparchus), Porphyry had no interest in Hippasus (he does not mention him at all), or in Lysis' letter.

86 There are no traces of this legend before Nicomachus. Apollonius seemed to know only the classical Πυθαγόρειοι and Πυθαγορισταί (Rohde, 138); the names of all the other groups appear in the 2nd–3rd cents. AD. The legend of the *mathematici* and *acusmatici* is closely linked with mathematical discoveries and the 'disclosure' of Pythagorean geometry (Iamb. *Comm. Math.*, 77.18–78.5 = *VP* 88–9) – both topics must have been of particular interest to the mathematician Nicomachus.

87 See above, 186. One of these is a new designation for the 'symbols', ἀκούσματα, which he invented and which is absent from Clement and Porphyry.

and go back through Nicomachus to two common sources, Aristotle and Androcydes, Iamblichus here uses Aristotelian material, and not that of Androcydes.[88] As is clear from Diogenes Laertius, different ways of interpreting the 'symbols' coexisted peacefully in one and the same biography,[89] so Nicomachus too was quite capable of quoting Aristotle in one chapter and Androcydes in another, linking neither of these traditions with the *mathematici* and *acusmatici*. Hence Porphyry took the commandments as treated by Androcydes and made of them the philosophy of the *acusmatici*, whereas Iamblichus took them as treated by Aristotle. The motives for their choices remain beyond the bounds of our investigation.

5.4 THE 'SYMBOLS'

While, in the later sources, we encounter the most varied types of lower-rank Pythagoreans (Pythagorists, *acustici*, exoterics, *acusmatici*), we do not find among them those who followed the direct sense of the 'symbols'. In fact this is as it should be. Once a metaphorical interpretation of the 'symbols', the model of which Androcydes' book had become, came to dominate in the literature of the Imperial age, there was simply no place left for Pythagoreans observing the literal sense of the maxims. The moralizing allegory of Androcydes did away with the direct meaning of the taboos: if 'do not walk on public roads' *actually* meant not following popular opinion, and 'do not poke the fire with a sword' meant not inciting anger, then a Pythagorean was

[88] Clement and Porphyry present only the first and third kinds of 'symbols', Iamblichus all three. Both 'symbols' of the first kind in Clement (*Strom.* V,8,50) coincide with those given by Porphyry (*VP* 41, five in all), but not one coincides with the two 'symbols' in Iamblichus (*VP* 82). Of the eight commandments in Clement (V,5,27–31), five are identical with those presented by Porphyry and only two with those presented by Iamblichus. The main point is that Clement and Porphyry give *identical moral* grounds for the commandments, while Iamblichus' interpretation, taken from Aristotle, is of a quite different nature. Porphyry gives the 'symbols' of the first kind with a reference to Aristotle (*VP* 41), but the commandments and their interpretation in Clement (V,5,27–31; VII,6,32) and Porphyry (*VP* 42) go back to Androcydes. Androcydes is mentioned both by Nicomachus (*Ar.* I,3,3; Iamb. *VP* 145, from Nicomachus; Rohde, 154) and Clement (*Strom.* V,8,45). See Rohde, 139 n. 1; Hölk, 50 ff.; Hölk, 60 f., was wrong to exclude Clement.

[89] D.L. VIII, 17–18 – from Androcydes, 34–5 – from Aristotle.

free to go wherever he wished and poke his fire with whatever he wished. The concealed, deeper meaning which was sought in these sayings was accessible only to the initiated; the rest were compelled to be content with the direct, superficial meaning.[90] The names borne by the 'symbols' confirm that they were treated as sayings, the true meaning of which was hidden from outsiders, not as rules governing the everyday life of the ancient Pythagoreans.[91]

To enhance the integrity of his collection Androcydes, it would seem, rejected the 'symbols' of the first two kinds; at any rate they do not appear in the material which goes back to him.[92] From the third kind he selected those commandments which lent themselves to metaphorical interpretation, adding new ones to his taste.[93] The presence of a commandment in Androcydes' collection is no guarantee that it was included in the two collections of the classical period known to us, those of Anaximander and Aristotle, and vice versa.[94] If we wish to know which commandments Anaximander and Aristotle treated as Pythagorean, we must, as in all other instances, separate from the later material everything which can be taken back directly or indirectly to the sources of the fifth–fourth centuries and focus our attention on this evidence.[95] Although Androcydes' collection contains a number of ancient superstitions, only a comparison of his material with sources previous to him can establish whether anyone before him connected them with the Pythagoreans.

In the earlier period there was no unanimity in interpreting the 'symbols'; they were understood both literally and allegorically. The only fragment of Alexander Polyhistor's book *On Pythagorean Symbols* says that Pythagoras was taught by Zaratas the Chaldean,

[90] Plut. fr. 202; Clem. *Strom.* V,9,57.

[91] *Αἰνίγματα, ἀλληγορίαι, ἀποφάσεις, ἀποφθέγματα, γνῶμαι, γρίφοις ἐοικότα, δόγματα, παραγγέλματα, σύμβολα, ὑποθῆκαι,* doctrina, sententiae (Hölk, 12, 18; Hüffmeier, *Sprüche*, 14 ff.).

[92] For evidence, see Hölk, 50 f.; Burkert, 170 f. In Porphyry and Clement the first kind are taken from Aristotle, the third from Androcydes (see above, 192 n. 88). Maxims of the type 'What is best?' were totally unsuited to allegorical interpretation, while the 'symbols' of the first kind evidently did not provide Androcydes with the moral meaning he required.

[93] Among them was a common proverb (Boehm, no. 50; *LSJ*, s.v. ἀμίς).

[94] In Boehm 22 commandments derive from Aristotle, 15 from Androcydes; 6 of them coincide (nos. 8–9, 11–12, 41, 61); two more of Androcydes' commandments coincide with Anaximander (nos. 30–33).

[95] As a result Boehm's collection is reduced to a third, from 75 to 24 commandments (n. 94, above).

but, in the *Pythagorean Memoirs* (late second – early first centuries), much quoted by Alexander, there is a whole series of taboos which are understood literally and which forbid the eating of beans, eggs, and various kinds of fish.[96] Among the four Pythagorean precepts passed on by Hermippus, not one coincides with the earlier or the later collections.[97] This demonstrates once again that the collections of precepts were not constant. At least one taboo in Hermippus assumes literal understanding; the two others permit both interpretations. The closer we get, however, to the classical period, the clearer it becomes that there are no differences of principle between the early and late traditions. It is not real people observing the commandments who await us in the fifth–fourth centuries, but still the same sayings. It is evident that we are not dealing with a historical tradition of the lives of Pythagoreans, known or unknown to us, but with a literary tradition of interpreting the 'symbols' begun by Anaximander the Younger's *Συμβόλων Πυθαγορείων ἐξήγησις* (58 C 6). The title of the book was (and still is) itself the main guarantee that all these 'symbols' are actually Pythagorean. Are we unreservedly to trust Anaximander?

The allegorical interpretation of Homer originated in the sixth century and was very popular in the fifth.[98] What results can come from this method were shown by the author of the Derveni papyrus (a contemporary of Anaximander), who applied it to Orphic theogony. Among the very few things known about Anaximander, it is notable that he belonged to the allegorical interpreters of Homer.[99] Although the fruits of his work in this area have not come down to us, they were in demand in Athens, where Anaximander taught for a time, asking a considerable fee from his pupils. In the *Suda*, however, he is called, not a Sophist, but a historian, probably on the strength

[96] *FGrHist* 273 F 94; F 95 = D.L. VIII, 35.

[97] The Pythagoreans abstained from cypress coffins, since the sceptre of Zeus was made of cypress (fr. 23 = *FGrHist* 1026 F 22; Boehm, no. 25; Burkert, 173). This commandment has its parallel in the Latin *Ἱερὸς λόγος* (Iamb. *VP* 155; see above, 177 n. 34), which is not, strictly speaking, a collection of commandments. Cf. the remaining three taboos: 'Pythagoras prescribed not to walk past any place where an ass has crouched down, to abstain from water that causes thirst and to avoid all kind of defamation' (fr. 22 = *FGrHist* 1026 F 21 with comm.). It is quite possible that Hermippus himself invented them.

[98] J. Tate, 'On the Early History of Allegorism', *CQ* 28 (1934), 105–14.

[99] Xenophon mentions him together with Stesimbrotus of Thasos (*Symp.* III,6), also known for his allegorical interpretation of Homer (Pl. *Ion* 530c–d). Metrodorus of Lampsacus also belonged to this trend (*DK* 61).

of a work in which he continued the tradition of Hecataeus of Miletus.[100] How long he stayed in Athens is not known; the only mention by Xenophon indicates that it was not long. All of this brings us to the problem of his sources. Did Anaximander know any Pythagoreans? If so, then which ones? Did he rely on oral or written tradition? Was this tradition Italian or Ionian? Only a conjectural answer can be given to some of these questions. We know nothing of the Pythagoreans at Miletus.[101] In the Athens of the late fifth and early fourth centuries, Anaximander could have encountered Hippon (if he was still alive), Theodorus, Philolaus' pupils Simmias, Cebes, and Echecrates, and possibly Xenophilus. None of those looks like an informant from whom something interesting about the 'symbols' could be learnt. There are no traces of Anaximander's making use of the Italian tradition on which Aristotle relied.[102] He wrote in the Ionian dialect and a number of 'symbols' from his collection are clearly of Ionian origin.[103] If Anaximander did rely on some written sources, they are not available to us. In any case his material indicates oral tradition.[104]

Everything points to Anaximander's understanding the *σύμβολα* he collected as sayings, the meaning of which was obscure and which

[100] 58 C 6; Schwartz, 'Anaximandros', 2086.

[101] Aristoxenus linked a number of Pythagoreans with Samos, Paros, and Cyzicus (*DK* 58 A).

[102] The identification of Pythagoras with the Hyperborean Apollo should evidently not be related to the 'symbols' (thus Delatte, *Lit.*, 278 f.; Burkert, 170, cf. 141 n. 117; otherwise Hölk, 22 ff.). It is first found in Iamblichus, in a form like the form of the 'symbols', but not identical with it: 'One of their *acusmata* is this: "Who are you, Pythagoras?" For they say that he is the Hyperborean Apollo' (*VP* 140; the text of the question is damaged and everyone restores it in his own way: Hölk, 23 f.; Lévy, 14 n. 3; Deubner, 'Bemerkungen', 677 f.). In the remaining sources this subject is related, not to the 'symbols', but to the Italian legendary tradition: 'Aristotle says that the Crotoniates called Pythagoras the Hyperborean Apollo' (Ael. *VH* II, 26 = fr. 191, see ibid. IV, 17; D.L. VIII, 11, cf. Iamb. *VP* 30). Since traces of that tradition are clearly visible in Iamblichus' *VP* 140–1 also, and the 'symbol' he quotes appears nowhere else in the form of a question, it is very probable that Iamblichus himself turned the identification of Pythagoras with Apollo into a 'symbol'.

[103] Dialect: D.L. II, 12 = 58 C 6. The 'symbol' of the white cock, sacred to the god Men (Moon), comes from Asia Minor (Burkert, 172 n. 47). See also parallels with Hippocratic material, below, 201.

[104] An oral tradition of Pythagoras was quite vivid in Ionia. Herodotus heard the legend of Pythagoras and Zalmoxis from Greeks living in Pontus and on the Hellespont (IV, 95); Ion of Chios drew together the Pythagorean teachhig on the soul and the Orphic (B 2); Andron of Ephesus passed on legends about the wondrous predictions of Pythagoras (*FGrHist* 1005 F 3–4).

required interpretation: hence ἐξήγησις.[105] This is fully apposite for the 'symbols' of the third kind and in part for those of the first, but not for the sayings of the second kind, the sense of which is quite transparent. Note that interpretations of the 'symbols' of the first two kinds have not come down to us and it is not known whether there were any. Anaximander's material is very heterogeneous, and it could be supposed that, choosing a general title for the whole collection, he focused on the commandments, as the most numerous kind of 'symbols' and the kind which interested him most, selecting various interpretations for them. It seems likely that Anaximander had in mind less the usual meaning of *σύμβολον*, a 'conventional sign',[106] than that which the word had acquired in the mysteries, the Orphic cults, etc. Here *σύμβολα* indicated cryptic formulae, the sense of which was intelligible only to the initiated.[107] Hence they acquired a secondary meaning, 'sayings with a concealed meaning',[108] which is the one used by Anaximander.[109]

What were the interpretations proposed by Anaximander? The *Suda* quotes three of his 'symbols'—'do not step over a yoke', 'do not poke the fire with a sword', 'do not eat from a whole loaf' (58 C 6)—but

[105] In Theophrastus' *Characters*, the superstitious man who has a mouse gnaw a hole in a sack of grain asks an exegete (ἐξηγητής) what he should do (16,6).

[106] In a story going back to Aristoxenus (Iamb. *VP* 238 = 58 D 7), *σύμβολον* means a 'conventional sign' intelligible only to Pythagoreans, rather than a saying. In Aristox. fr. 43 = D.L. VIII, 16 *σύμβολον* probably belongs, not to Aristoxenus, but to Diogenes, who offers a collection of 'symbols' in VIII, 17. Cf. Rohde, 149 n. 1; Delatte, *Vie*, 185; Aristox. fr. 43 with comm., and above, 159 n. 85.

[107] See e.g. the 'symbols' on the Orphic tablet of the 4th cent. from Thera: *σύμβολα. Ἀν<δ>ρικεπαιδόθυρσον. Ἀνδρικεπαιδόθυρσον. Βριμώ. Βριμώ. εἴσιθ<ι> ἱερὸν λειμῶνα. ἄποινος γὰρ ὁ μύστης*; in A. Bernabé (ed.), *Poetae epici Graeci: Testimonia et fragmenta*, ii. 2 (Munich, 2005), 72, fr. 493; cf. 154, fr. 578 = Pap. Gurob I, 23b, 3rd-cent. magic papyrus). 'Passwords. For man-and-child-thyrsos. For man-and-child-thyrsos. Brimo. Brimo. Enter the holy meadow. For the initiate paid the price', J. N. Bremmer, *The Rise and Fall of the Afterlife* (London, 2002), 22. 'Bit by bit *σύμβολα* acquired the meaning of "symbolic reference", or of "hidden allusions" ("symbolic" in our current meaning) to profound beliefs, with phrases that superficially seem to mean something else', A. Bernabé and A. I. Jiménez San Cristóbal, *Instructions for the Netherworld: The Orphic Gold Tablets* (Leiden, 2008), 153.

[108] See J. G. Smyly, *Greek Papyri from Gurob* (London, 1921), 7 f.

[109] Let us note that only the secondary *meaning* of *σύμβολα* was transferred to the Pythagorean 'symbols', but in no way their *function* as 'passe-paroles', 'passwords' to the mysteries or directly into the other world (thus W. Müri, '*ΣΥΜΒΟΛΟΝ*: Wort- und sachgeschichtliche Studien', in *Griechische Studien* (Basel, 1976), 374; Burkert, 176). Leaving alone that the Pythagoreans had no mysteries, dozens of sayings could not serve as 'passwords' of this kind.

does not provide a single example of interpretation. Fortunately, Aristotle's material, preserved in Diogenes Laertius and Iamblichus,[110] throws light precisely on Anaximander's treatment of the taboo concerning the loaf. Iamblichus says the following about the commandments as a whole:

> In the case of some, a reason why is added . . . but for other (instructions) no reason is added. And some of the reasons given seem to have been attached from the beginning and others later; for example, not to break bread, because it is not advantageous for judgement in Hades. The probable explanations given about such matters are not Pythagorean, but were devised by ingenious outsiders trying to give a likely reason, as for example, that now mentioned, why one should not break bread,[111] some say one should not separate that which unites (for in the past, all who were friends came together for one loaf of bread, as barbarians do), others that one should not make such an omen at the beginning of a meal by breaking and crushing (*VP* 86, tr. after Dillon & Hershbell).

The fragment of Aristotle in Diogenes Laertius contains the following additional details:

> Not to break bread; for once friends used to meet over one loaf, as the barbarians do even to this day; and you should not divide bread which brings them together; some give the explanation of this that it has reference to the judgement of the dead in Hades, others that bread makes cowards in war, others again that it is from it that the whole world (*τὸ ὅλον*) begins (VIII, 35 = fr. 195, tr. Hicks).

As these passages show, in the collections of Anaximander used by Aristotle, the commandments were accompanied, first by an indication of the reasons why the commandment should be observed, and second by explanations (i.e. interpretations). Among the reasons are, for example, the following: 'Not to sacrifice a white cock, for he is a suppliant and sacred to the god Men', or 'not to drive out one's own wife, for she is a suppliant'. These indications, attached only to a few commandments, were considered by Aristotle to be Pythagorean, as distinct from the explanations (which probably accompanied all the

[110] Arist. fr. 195 = D.L. VIII, 33–35; Iamb. *VP* 82–6, p. 47.11–50.17 (= 58 C 3–4). See Rohde, 139; Hölk, 10, 31 ff.; Boehm, 43; Delatte, *Lit.*, 279 f.; id., *Vie*, 237 f.; Burkert, 1661 ff. There is, however, no certainty that Iamblichus' *VP* 82–6 derives wholly from Aristotle; cf. above 170 n. 2, 171 n. 4 and below, 303 and n. 62.

[111] 'Do not break bread' and 'Do not eat from a whole loaf' are synonymous: bread was to be cut with a knife (Boehm, no. 39; Burkert, 172 n. 51).

commandments), 'added from without by those who attempted to think up a likely reason'. Among the exegetes Aristotle no doubt had Anaximander in mind, but not him alone. In Iamblichus the ban on breaking bread is accompanied by two explanations; Diogenes Laertius adds three more; and both refer to certain authorities ('some – others'). So many explanations should not dismay us: in Aristotle, the ban on beans was accompanied by six different explanations.[112] Clearly Anaximander relied on some tradition of interpreting what he called the Pythagorean 'symbols'.

As distinct from Androcydes' entirely metaphorical interpretation, the interpretations of the 'symbols' collected by Anaximander did not, as a rule, dismiss the direct meaning of the precepts, but only attached to it a new meaning, sometimes unexpected ('this dismays in war'), and sometimes wholly symbolic ('from this the whole world begins'). As follows from *τὸ ὅλον* (twice in Aristotle) and the 'cosmological' interpretations of the taboos underlying it, however, the boundary line between the various kinds of allegorical interpretations was very fine, and one could easily turn into another. 'One should not destroy that which unites' could easily become the 'true' meaning of the ban on breaking bread; even if it did not dismiss the direct meaning, it did not in any case imply its unquestioning observance. Aristotle rejected the interpretations of the commandments collected or presented by Anaximander himself, preferring their literal understanding and the primacy of their religious 'justifications'.[113] Logically and historically Aristotle was right: the direct meaning of most (though not all) of the commandments is primary.[114] The only

[112] Fr. 195 = D.L. VIII, 34: 'Pythagoras counselled abstinence from beans, either because they are like the genitals, or the gates of Hades, *** as being alone unjointed or because they are injurious, or because they are like the form of the universe (*τὸ ὅλον*), or because they belong <not> to oligarchy, since they are used in election by lot' (tr. Hicks). Markovich notes in his apparatus a lacuna after 'the gates of Hades' (see *DK* I, 463.110), where the plural changes to the singular, and inserts into the text Richards's conjecture *ὅτι <οὐκ> ὀλιγαρχικόν*, which makes much better sense.

[113] Delatte, *Lit.*, 285; Burkert, 174.

[114] In a number of cases the initial meaning was figurative, as von Fritz, 'Mathematiker', 16, supposed (cf. Burkert, 177 n. 82) in relation to the commandments 'do not poke the fire with a sword' and 'do not step over a yoke' (*ζυγόν* could mean both 'yoke' and 'balance beam', which was understood as 'one should not violate justice'). The commandment 'do not help to unload a burden (because it is wrong to encourage lack of effort), but help to load it' (Boehm, no. 61), as its justification indicates, had from the outset a figurative meaning; hence in Androcydes its justification is unchanged (D.L. VIII, 17; Porph. *VP* 41; Iamb. *VP* 84; Delatte, *Lit.*, 288).

question is when, by whom, and in what situation it was observed. If Aristotle did know of Pythagoreans observing all these commandments, nowhere did he concede it. A different version is much more probable: Aristotle learnt that all these sayings and commandments were Pythagorean 'symbols' from the same source as everyone else: from Anaximander's book.

Let us note in connection with this a circumstance which has not hitherto attracted the attention it should. Beyond Anaximander's and Aristotle's books, the tradition of the Pythagorean 'symbols' is surprisingly meagre. In the sources of the Classical period either they are not found, or, if they are found, they are in no way linked to Pythagoras and the Pythagoreans – like the proverb 'Friends share everything' (above, §4.3a). Only one of the first kind of 'symbols', on the tetractys, exists in its own right, but even that one is not attested earlier than the first century.[115] Aristotle in his treatises often refers to metaphorical identifications of numbers with justice, marriage, opportunity, etc., identifications which can well be allotted to the first kind,[116] although there is no evidence of them in the tradition stemming from Anaximander. That some 'symbols' of the first kind imply direct understanding (earthquake = gathering of the dead), while others imply figurative (Oracle of Delphi = tetractys), produces a strange impression. The group of cosmological 'symbols' (Porph. *VP* 41 = Arist. fr. 196) seems doubtful.[117] Of the 'symbols' of the

[115] Aët. I,3,8. See below, 300 f. In Speusippus (fr. 28) the tetractys as such does not figure; what does appear is the first (arithmetical) progression (1, 2, 3, 4), the sum of whose parts is equal to 10; nothing is said about its relation to music. Cf. Frank, 260 n. 1; Burkert, 72, 186 f.; Tarán, *Speusippus*, 273 f.; for later evidence, see Delatte, *Lit.*, 249 ff. The identification of Pythagoras with Apollo (above, 195 n. 102) is not related to the 'symbols'.

[116] *Met.* 985b29–30, 990a23, 1078b22–3; *EN* 1132b23; *MM* 1182a11; fr. 13 Ross = 162 Gigon (see below, 446 f.). For example, justice is four, because it returns equal for equal.

[117] An explanation of them as 'remnants of ancient astronomical nomenclature' (Delatte, *Lit.*, 278) is unconvincing, yet no better one has so far been proposed (cf. summary of opinions: Hüffmeier, *Sprüche*, 250). 'The sea – the tears of Cronus' and 'The planets – the dogs of Persephone' are also found in several late sources (Plut. *De Isid.* 364 A; Clem. *Strom.* V,8,50); no trace of two other 'symbols', 'The Pleiades – the lyre of the Muses' and 'The Great and Little Bear – the hands of Rhea' has yet been found in ancient literature (cf. Hüffmeier, *Sprüche*, 241 f.). Could Porphyry or his source have erred in connecting these 'symbols' with Aristotle? Numenius, amply used in Porphyry's *On the Cave of Nymphs*, was very much interested in astral interpretations, referring to Pythagoras in this context, see below, 220 n. 116. A similar cosmological 'symbol'

second kind one maxim *similar in form* is known, which Eudemus ascribed to an anonymous Pythagorean.[118] Of the commandments, only the taboos on the meat of non-sacrificial animals and on beans are more or less reliably linked to the Pythagoreans;[119] the ban on interment in woollen garments is also known (Hdt. II, 81), but it is absent from Anaximander's and Aristotle's material. It is these bans, each time intersecting with the Orphic, which contemporaries took to be the *customs* of the Pythagoreans or of Pythagoras, not as 'symbols' requiring interpretation of some kind. There is one more commandment, a parallel to which can be found in the early tradition on Pythagoras.[120] Thus only a handful of the 'symbols' are reliably linked to ancient Pythagoreanism; all the rest derive from a great variety of sources, some of which can be easily established.

Aristotle had noted that in form some 'symbols' resembled the maxims of the Seven Sages (Iamb. *VP* 83); parallels in content are also evident. The commandments on good advice and the choice of a wife are identical with the maxims of the Sages or very like them; one of the 'symbols' directly quotes Bias that most people are bad.[121] The saying 'It is right to die standing one's ground and having wounds in the front, but to have them on the opposite side is wrong' has the

in Iamb. *VP* 82, 'What are the Isles of the Blest? – The sun and the moon', also does not have direct parallels; see Delatte, *Lit.*, 274 f. and the apparatus in Deubner's edition.

[118] Eud. fr. 90, cf. Arist. *Phys.* 227b17: Simonides called time σοφώτατον and a certain Pythagorean called it ἀμαθέστατον; see Burkert, 170. Of course the Pythagoreans, and Philolaus in particular, *could have* thought that number is wisest and harmony is most beautiful, but we cannot here go beyond probability. There is no direct proof, and moreover not only Pythagoreans thought in this way.

[119] The tradition of vegetarianism is highly contradictory. If Eudoxus wrote that Pythagoras abstained from animal food and even avoided cooks and hunters (fr. 325), the 'symbols' assert that the most just is to sacrifice, and prohibit only the meat of non-sacrificial animals. Heraclides ascribed to Pythagoras the introduction of a meat diet for athletes (fr. 40), and Aristoxenus refuted the ban on meat and beans (fr. 25, 28–9). For more detail see below, 234 f.

[120] 'One should not have children by a woman who wears gold jewellery' is close to the tradition of the speeches of Pythagoras, who persuaded women to renounce clothes embroidered with gold (Iust. XX,4,11, from Timaeus; see above, 93). Pythagoras shared with many others the ideology of combating luxury; see n. 121, below.

[121] 'Give only the best to one asking advice' (Arist. ap. Iamb. *VP* 84); Cleobulus: 'Give best advice to the citizens' (10 A 3, no. 9), Solon: 'Give the citizens not the most pleasing advice, but the best' (12). 'One should not have children by a woman who wears gold jewellery' (Arist. ap. Iamb. *VP* 84); Cleobulus: 'Mate with one of your own rank' (18); cf. Chilon, 'Do not make an extravagant marriage' (6). Arist. *ap.* Iamb. *VP* 82, cf. Bias (1).

appearance of a typical Spartan virtue akin to those extolled by Tirtaeus. 'Labours are good, but pleasures are bad in every way; for having come for punishment, one must be punished,' one of the 'symbols' asserts, whereas Aristotle in *Protrepticus* ascribes this idea to Orpheus and the Orphics, and pseudo-Philolaus ascribes it to 'ancient theologians and seers'.[122] Anaximenes wrote that 'the rainbow is the brightness of the sun' (A 7, 18). Even the saying 'the wisest is number', which appears to be fully Pythagorean, is known from the tragedy of Aeschylus.[123]

It has long been known that the commandments contain superstitions widely encountered; Boehm found many parallels in the folklore of the Indo-European peoples.[124] There were many Greek cults, the Eleusinian mysteries in particular, which practised the ban on beans, eggs, and various kinds of fish– the same kinds, moreover, which figure in the tradition of the Pythagoreans.[125] Particularly suggestive are the coincidences already frequently noted between the commandments and a passage from the Hippocratic treatise *On the Sacred Disease* (2), the author of which was an older contemporary of Anaximander and also an Ionian. The method of treating epilepsy practised by magi, purifiers, begging-priests, and frauds (*μάγοι τε καὶ καθάρται καὶ ἀγύρται καὶ ἀλαζόνες*) which he refuted included the following measures: the patient must not wash in the baths, eat the flesh of certain animals and birds (in particular dogs and cocks) and also certain fish (among them red mullet and blacktail), must not wear black or sleep on a goatskin, place one foot on another or one hand on another, etc. The picture drawn by the Hippocratic is important in many regards: as a possible source for Anaximander, an indication of the boundary between reason and superstition in the last quarter of the fifth century, and as an example of how the Pythagoreans *should have* appeared to their enlightened

[122] Arist. *ap.* Iamb. *VP* 85, cf. Arist. fr. 60 = *Protr.* fr. 106 Düring (*οἱ τὰς τελετὰς λέγοντες, οἱ ἀρχαιότεροι*); Philolaus (B 14). See Burkert, 168 n. 14, 248 n. 47; Huffman, *Philolaus*, 402 ff. This saying in form is unlike the commandments with which it is placed.

[123] Arist. *ap.* Ael. *VH* IV,17; Iamb. *VP* 82, cf. *πάνσοφος ἀριθμός* (Aesch. fr. 181a Radt).

[124] Boehm, *passim*.

[125] Delatte, *Vie*, 231 f; Burkert, 177 f.; Parker, *Miasma*, 291 ff., 358 ff. The fish usually named are: sea anemone (*ἀκαλήφη*), red mullet (*τρίγλη*) and blacktail (*μελάνουρος*). See Arist. fr. 194–5; D.L. VIII, 33, from *Pythagorean Memoirs*; this paragraph is erroneously included in Arist. fr. 195, see Burkert, 166 n. 4.

contemporaries, had they observed everything prescribed by the 'symbols'. Is it only by chance that in the classical sources there is no such portrait of the Pythagoreans, individual or collective?

Some 'symbols' contradict what we know of the Pythagoreans, others each other, and still others any plausibility. Hippasus conducted an experiment with bronze discs (Aristox. fr. 90), confirming the numerical expressions of the principal concords discovered by Pythagoras; in the 'symbols' the sound made by bronze when struck is the voice of a daemon. Alcmaeon knew of the independent movement of the planets from west to east (A 4); Eudemus ascribes to the Pythagoreans of the fifth century the correct order of the planets (fr. 146); in the 'symbols' the planets are 'the dogs of Persephone'. Could it be that the very same people believed that 'an earthquake is a gathering of the dead' and yet provided a quite scientific explanation: 'the rainbow is the brightness of the sun'? Would those who believed that 'the strongest is insight' and 'the wisest among us is medicine' collect ancient superstitions from everywhere and blindly follow them? In Anaximander's Pythagoreans one perceives more than a split personality; it is rather a splintered personality. Some 'symbols' imply scientific astronomy and mathematics, others lead straight to the 'superstitious man' from Theophrastus' *Characters*, others to the Seven Sages, and yet others to sacrifices, mysteries, and purification ceremonies. The Pythagoreans of Anaximander in some things recall the author of the Derveni papyrus, also characterized by a highly original combination of 'myth' and 'logos',[126] with, however, the difference that they were the subject of interpretation, while he was an interpreter. What he brought together in his book belonged to different worlds outside it. To what world and to what time did Anaximander's 'symbols' belong and in what did their Pythagoreanism actually consist? The overwhelming majority of the taboos collected by him are in no way connected with the fundamental religious doctrine of Pythagoras, metempsychosis. In Homer and Hesiod, in popular superstitions, and in the practice of various cults we find

[126] 'At different points of the text, he emerges as an enlightened exegete of sacred lore, an allegorical expounder of religious texts as well as rituals, an acerbic critic of the conventional polis religion, and a maverick intellectual who advocates a Presocratic *Weltbild* derived from Anaxagoras and Diogenes of Apollonia. Wearing multiple hats, the Derveni commentator resists being classified by his outlook or identified with known figures of the late fifth-century enlightenment', A. Henrichs, 'Hieroi Logoi and Hierai Bibloi', *HSCP* 101 (2003), 232.

many parallels to them which show that they certainly did not originate in Pythagoreanism.[127] Besides, the taboos of the cults were restricted in number (normally not more than 5–7) and in time: they were observed over several days once a year, or once in two to three years, or even once in a lifetime at initiation into the mysteries. Inclusion in Anaximander's collection removed them from their natural environment; instead they acquired a cumulative effect and a timelessness which they did not initially possess, as if dozens of commandments regulated the entire life of Pythagoreans from beginning to end![128] It is by no means obvious that Anaximander himself reckoned on such an effect. Timaeus ascribed communal property to the Pythagoreans, basing this first on the Pythagorean origin of the proverb 'Friends share everything' and second on its being taken literally (above, §4.3a). Anaximander, it seems, stopped short of the second step. Nothing implies that he intended to analyse the Pythagorean way of life on the basis of the sayings he collected.

Just as the figure of Pythagoras became a magnet for legends which had no initial connection with him, so it was that very few Pythagorean sayings and maxims formed the basis of Anaximander's collection.[129] Since we are dealing with oral tradition, we must be aware both of a huge expansion of the initial nucleus and of all manner of distortions in the tradition. The tradition of the Seven Sages provides an obvious example of both. Initially just one saying was attributed to each, whereas two collections of the late fourth century (Demetrius of Phaleron and Sosiades) contain respectively 124 and 143 sayings,[130] the maxim 'Democracy is better than tyranny' being put, as if by design, into the mouth of the tyrant Periander! None the less the tradition of the Seven Sages, accumulating 'popular wisdom', appears much more consistent than the highly heterogeneous and multi-layered collection of 'symbols', full of contradictions both within each kind and among them. It is very difficult to say what criteria

[127] Burkert, 188 f.; Philip, 136; Parker, *Miasma*, 296 f.

[128] See Parker, *Miasma*, 297: 'What was apparently [Pythagoras'] innovation, and a drastic one, was to change temporary abstinence, confined to the period preceding a ritual act, into permanent rules of life on which salvation depended.' Cf. ibid. 358 f.: 'Of permanent abstinence from particular foods by devotees of particular cults there is no trace.'; 365: 'permanent abnormality of the Pythagorean life'.

[129] Cf. Burkert, 189.

[130] Stob. III,1,172–3; Snell, *Leben und Meinungen*; J. Althoff and D. Zeller (eds.), *Die Worte der Sieben Weisen* (Darmstadt, 2006).

Anaximander used to select his material. In principle he should have worked from the similarity of various sayings in form or content, as did, for example, the Sophist Hippias in his *Συναγωγή*, putting together related (in fact quite different) sayings of poets and philosophers.[131] Contradictions, however, did not disturb Anaximander, as is evident from the explanations he offers of the 'symbols' and even more so from the very composition of the book. In any case, there can be no doubt that what Anaximander was engaged in was *interpreting the 'symbols'*, oral sayings to which he, for reasons not always clear to us, ascribed a Pythagorean origin, and not describing the manners, customs, and beliefs of a particular group of Pythagoreans. Anaximander's contemporaries had no knowledge of such a group, and hence his *Interpretation of Pythagorean Symbols* cannot be regarded as an independent source on ancient Pythagoreanism, still less as a principal source.

Martin Nilsson regarded the Pythagorean commandments as a direct continuation of Hesiod's rules (for example, *Op.* 727, 742–3) and saw in them the same legalistic spirit as in the instructions of the Delphic oracle and the sayings of the Seven Sages.[132] In principle one can agree with this. If Pythagoras is to be included within some direction in Greek religion, then it should be that 'which strove to attain the favour of the gods through the exact observance of religious commandments and rules',[133] rather than that which embraced the mystic and ecstatic. At the same time no one would be ready seriously to relate to Solon, Chilon, or Thales all the sayings attributed to them in the fourth-century collections, or even a part of them.[134] Which of the commandments from Anaximander's collection could have been connected with the Pythagoreans must be decided in each specific case. The primary nucleus must most probably contain those precepts which are in some way linked with metempsychosis and are known beyond the collection of 'symbols'. As has been noted, this takes in the ban on the meat of non-sacrificial animals, beans, and interment in woollen garments. The first two bans are known in Empedocles, and

[131] 86 B 4, 6; Patzer, *Hippias*. Herodotus, who identified foreign gods with Greek gods according to their external resemblance, did the same.

[132] Nilsson, *GGR* i. 669.

[133] Ibid. 578, 662 ff.

[134] 'In meisten Fällen wirkt die Verbindung bestimmter Weiser mit bestimmten Sprüchen willkürlich', M. Asper, '"Literatursoziologisches" zu den Sprüchen der Sieben Weisen', in D. Zeller and Althoff (eds.), *Worte*, 91.

all three in Orphism.[135] In Empedocles we know a total of three food taboos: on meat, beans, and laurel leaf (B 136–41); in Orphism, seemingly, three also.[136] It is difficult to imagine that Pythagoras demanded of his followers substantially more than Empedocles did of his, or that the Pythagorean way of life was much stricter than *βίος Ὀρφικός*.

[135] B 137, 140–1; *OF*, test. 212–3, fr. 291.

[136] Meat, beans, and eggs; sources: Parker, *Miasma*, 302; Burkert, *Greek Religion*, 301. Eggs are mentioned only in the Imperial age (Plut. *Quaest. conv.* 635 E).

6

Shamanism and Metempsychosis

6.1 SHAMANISM IN ANCIENT GREECE?

In the 1960s to 1980s the traditional image of Pythagoras the mathematician seemed to be slowly but surely giving way to that of Pythagoras the shaman. At any rate, many leading authorities were attempting to show that this image was real. In the motley company of their shaman 'colleagues', who included mythological figures (Orpheus, Abaris) and early Greek wonder-workers (Epimenides, Aristeas, Hermotimus), Pythagoras and Empedocles represented those Greek philosophers who personally experienced the formative influence of shamanism. In recent decades the position regarding Greek shamanism has undergone a fundamental change: under pressure from criticism, and partly also from new material, this theory is now gradually being abandoned by even its most faithful adherents. It is steadily receding into the sphere of historiography,[1] as one further failed attempt to apply an anthropological approach to Greek religion.

Notions of Greek shamanism form part of the theory of pan-shamanism which took shape at the end of the nineteenth century. At that time the study of Siberian shamanism, then still mostly descriptive, was developing a theoretical basis and seeking comparative material even in remote cultures. If in 1903 van Gennep made a reproachful reference to an article about shamanism in Assyria,[2] later, in spite of his warnings, the geographical and temporal range of

[1] It is revealing that recent criticism of Greek shamanism (Bremmer, *Rise*, 27 ff.) is predominantly historiographical in nature. Bremmer independently arrived at the same conclusions as mine.

[2] A. van Gennep, 'De l'emploi du mot "chamanisme" ', *RHR* 47 (1903), 51.

shamanism was greatly extended.[3] In the latter half of the twentieth century, the fame of pan-shamanism was due primarily to W. Schmidt (who conceived a theory of proto-monotheism), and in particular to M. Eliade, whose famous book was translated into the main languages of Europe.[4] According to Eliade, the distribution of shamanism coincided with that of human beings, and its origins went back to the Palaeolithic era.[5]

In the literature on shamanism from the end of the twentieth century three main schools of thought can be identified.[6] The first confines this religious phenomenon to a certain geographical area, usually Siberia, Central and Northern Asia (sometimes including Alaskan tribes related to those of Siberia). The second considers Siberian shamanism the *locus classicus*, but recognizes the existence of other forms, some of them in regions very distant from Siberia, in India or Australia, for example. The third takes shamanism to be no less universal than religion itself. From the standpoint of the latter two schools, in order to prove the existence of shamanism in antiquity there is no need to seek the missing links between historical Siberian shamanism and ancient Greece. For scholars of religion who stand close to functionalism and the phenomenology of religion, a typological similarity between certain features of Greek religion and shamanism is sufficient. Researchers who are more historically inclined proceed from the premise that shamanism has its roots in the Palaeolithic era, and therefore the Greeks could have inherited it.

Fortunately, *Altertumswissenschaft* as a discipline generally tends to prefer historical explanations. Here only a view of shamanism which could point to intermediaries between the Greeks and Siberian shamanism had any chance of success. It is therefore no accident that, after what seems to have been the first mention of shamanism, in the work of Diels on Parmenides, for a long time this topic was not

[3] A single collection contains works on shamanism among the Afghan Kafirs, the Hungarians, the Swedes, the North American Indians, in Nepal, and in the Old Testament: C.-M. Edsman (ed.), *Studies in Shamanism* (Stockholm, 1967).

[4] W. Schmidt, *Der Ursprung der Gottesidee*, ix–xii (Münster, 1949–55); M. Eliade, *Le Chamanisme et les techniques archaïques de l'extase* (Paris, 1951). In English: *Shamanism: Archaic Techniques of Ecstasy* (New York, 1964).

[5] M. Eliade, 'Recent Works on Shamanism: A Review Article', *HR* 1 (1961), 153: 'The only continent where shamanism is a rather rare phenomenon is Africa.'

[6] Cf. H. Motzki, *Schamanismus als Problem religionswissenschaftlicher Terminologie* (Cologne, 1977).

popular. Diels wrote about it in passing, as a parallel which shed light on certain features of Archaic Greek poetry.[7] In order to bring these parallel lines together, traces of actual historical contacts were needed; an intermediary was necessary. Meuli's famous article identified one: the Scythians.[8] It was Scythian shamanism, reconstructed by Meuli, that, in the view of many, was a decisive influence in the appearance in Greece of a whole pleiad of shamans.[9] In mid-century Dodds's famous work and Cornford's posthumously published book appeared at almost the same time.[10] Both contained chapters devoted to shamanism, but Dodds's view turned out to be much the more influential, because Dodds, relying on Meuli, proposed a historical solution to the problem, while to Cornford the Greek poets were 'like shamans', that is, he was comparing two phenomena from similar developmental stages. From the beginning of the 1960s the Meuli-Dodds theory was energetically developed by Burkert,[11] who later, however, moved away from the theme of shamanism.[12] In the 1980s and 1990s many new works appeared which took up and elaborated the theory of Scythian-Greek shamanism, especially in connection with Orphism.[13] As Graf has noted, Orpheus as a 'mythical shaman

[7] H. Diels, *Parmenides Lehrgedicht* (Berlin, 1897), 14f. In an article in the same year he rejected outright any historical contact between the Greeks and shamanistic cultures: H. Diels, 'Über Anaximanders Kosmos' (1897), in his *Kleine Schriften*, 19f.

[8] K. Meuli, 'Scythica', *Hermes* 70 (1935), 121–76 = *Gesammelte Schriften*, ii (Basel, 1975), 817–873. One year earlier the following article appeared: E. G. Kagarov, 'Shamanstvo i iavleniia ekstaza v grecheskoi i rimskoi religiiakh', *Izvestiia AN SSSR OON* 5 (1934), 387–401. Owing to its baldly schematic approach, it was ignored even by Russian scholars.

[9] To be sure, Meuli found traces of shamanism even in Homer and among the Proto-Indo-Europeans, but these ideas were not taken up by classicists.

[10] E. Dodds, *The Greeks and the Irrational* (Berkeley, 1951); F. Cornford, *Principium Sapientiae* (Cambridge, 1952). The preface to Cornford's book shows that Dodds had read it in manuscript.

[11] Burkert, 120ff.; id., '*Γόης*: zum griechischen "Schamanismus"', *RhM* 105 (1962), 36–55.

[12] In his history of Greek religion we find only three brief mentions of shamans (Burkert, *Greek Religion*, 180, 320, 446), which is only slightly more than in the work of his predecessor Nilsson (*GGR* i. 164 n. 5, 617f.), who devoted a few lines to shamanism, stressing that on the whole it is not found among the Indo-Europeans. Burkert's recent works make no mention of shamanism at all.

[13] See e.g. West, *OP*, 4ff., 144 ff; R. B. Claus, *Toward the Soul* (New Haven, 1981), 111f.; J. F. Kinstrand, *Anacharsis* (Oxford, 1981), 18ff.; F. Hartog, *The Mirror of Herodotus* (Berkeley, 1988), 150ff.; C. Fiore, 'Aspetti sciamanici di Orfeo', in A. Masaracchia (ed.), *Orfeo e l'orfismo* (Rome, 1993), 409–24; P. Kingsley, 'Greek Shamans and the Magi', *Studia Iranica* 23 (1994), 187–98.

or prototype of shamans' (Dodds) is 'the most fashionable idea nowadays'.[14]

It cannot be said that Greek shamanism has escaped the attention of the critics, but as a rule critics dealt only with certain elements of the theory. Kahn, for example, convincingly showed that the tradition on Empedocles does not even remotely recall the history of the shamans; Bolton refuted in detail any shamanist influence on Aristeas of Proconnesus.[15] In his article on Orpheus, Graf mentioned shamanism mostly out of habit, observing each time that in reality these references do not explain anything.[16] Dowden demonstrated that Meuli's reconstruction was essentially built on sand.[17] Pythagoras has been less fortunate than others: his shamanism has been not so much refuted as emotionally rejected.[18] The most serious and thorough critique of shamanism in Greece accords hardly any consideration to the Pythagorean material.[19] Among the many questions which arise in connection with Greek shamanism in general and Pythagorean shamanism in particular, the following appear to be the most fundamental. First, did shamanism exist at all in the sixth century? Second, did it exist among the Scythians of the Black Sea coast, and did it influence Greek cult practice? Third, can traces of shamanism, or at least of ecstatic practice, which is considered to be the *conditio sine qua non* of shamanism, be discovered in Pythagoreanism?

The view that shamanism is ubiquitous and of great antiquity is based mainly on two misconceptions: first, it is too readily identified with almost any ecstatic cult of pre-literate peoples,[20] second, the beliefs of such peoples are a priori conceived to represent a kind of primary phase of religion, which originated in the most distant past.[21]

[14] F. Graf, 'Orpheus: A Poet among Men', in J. Bremmer (ed.), *Interpretations of Greek Mythology* (London, 1987), 102 n. 2.

[15] Ch. H. Kahn, 'Religion and Natural Philosophy in Empedocles' Doctrine of the Soul', *AGPh* 42 (1960), 3–35; Bolton, *Aristeas*, 125 f., 132 ff.

[16] Graf, 'Orpheus', 80 ff.

[17] K. Dowden, 'Deux notes sur les Scythes et les Arimaspes', *REG* 93 (1980), 486–92.

[18] A. Maddalena, 'Pitagora sciamano?', *RFIC* 92 (1964), 103–17; C. de Vogel, *Philosophia*, Part I. *Studies in Greek Philosophy* (Assen, 1969), 78 ff.

[19] J. Bremmer, *The Early Greek Concept of the Soul* (Princeton, 1983), 25 ff.; id., *Rise*, 24 ff.

[20] Such is Eliade's position, for example; cf. L. Vajda, 'Zur phaseologischen Stellung des Schamanismus', *Ural-Altaisches Jahrbuch* 31 (1959), 456–85, at 458 ff. = C. A. Schmitz (ed.), *Religions-Ethnologie* (Frankfurt, 1964), 265–95.

[21] See e.g. H. Findeisen and H. Gehrts, *Die Schamanen* (Cologne, 1983), 20 ff.

Both these notions have done much to foster the theoretical chaos which reigns in the study of shamanism, and which the specialists in the field themselves often lament. In particular they lament the excessive profusion of definitions of a shaman and shamanism, and the resulting contradictory interpretations.[22] Against this background, Shirokogoroff's classic work on shamanism among the Evenks (the Tungus), from whose language Europeans have borrowed the word 'shaman', stands out clearly. Shirokogoroff's analytical rigour, the profundity of his judgements, and his great experience of contact with those who practise shamanism make his work the best point of departure for a study of the phenomenon.

Shirokogoroff provides the following definition of shamans: 'Persons of both sexes who have mastered spirits, who at their will can introduce these spirits into themselves and use their powers over spirits in their own interests, particularly helping other people, who suffer from the spirits; in such a capacity they may possess a complex of special methods for dealing with the spirits.'[23] Accordingly, shamanism is characterized by the following: the presence of people who have mastered spirits (and not are just possessed by them); a certain number of malevolent and benevolent spirits; socially recognized methods of dealing with the spirits; shamanistic paraphernalia (special dress; musical and other instruments, at least a drum); a 'theoretical basis', in the form of common conceptions of the spirits; and recognition for the social position of shamans.[24] On the origin of this complex, Shirokogoroff offers the following hypothesis: since the influence of Buddhism and Lamaism (the Tibetan variant of Buddhism) can clearly be traced in shamanism, its genesis should be linked with the penetration of these religions into Central Asia and dated to the last centuries of the first millennium AD.[25] Hermanns in his historical study of shamanism comes to a similar conclusion.[26] He devotes special attention to the influence of higher forms of religion, such as Zoroastrianism, Mithraism, and Buddhism, on shamanism.

[22] See e.g. Vajda, 'Zur phaseologischen Stellung', 456 f.; V. Voigt, 'Shaman – Person or Word?', in M. Hoppál (ed.), *Shamanism in Eurasia*, i (Göttingen, 1984), 13 ff.

[23] S. M. Shirokogoroff, *Psychomental Complex of the Tungus* (London, 1935), 269 (repr. Berlin, 1999).

[24] Ibid. 271 ff.

[25] Ibid. 276 ff., 282 ff.

[26] M. Hermanns, *Schamanen – Pseudoschamanen, Erlöser und Heilbringer*, 3 vols. (Wiesbaden, 1970).

Seeing shamanism as the result of the interaction of the ideology of hunting tribes and the religions of agrarian peoples with their advanced ecstatic technique,[27] Hermanns takes the place of origin of shamanism to be the region between Iran, Tibet, and India, and the period of origin to be the first centuries AD.[28]

We may leave it to the specialists to resolve the problem of the geographical and temporal origins of shamanism, and note the points of greatest importance to us. First of all, shamanism should be seen as a complex phenomenon. Following Shirokogoroff, Vajda rightly emphasized that 'shamanism is not an element of culture but a complex of phenomena having characteristic and meaningful connections one with another. No single one of its components suffices to define the whole complex; each one may also be found outside the limits of shamanism, and only their typical interaction gives rise to the complex phenomenon which we call shamanism.'[29] Moreover, historical and ethnographic research into shamanism cannot ignore the fact that its rise was conditioned by the influence of the new forms of religion which arose in Asia in the middle of the first millennium BC. Lastly, the lines of influence and diffusion lead from South-West and South-East Asia to Central Asia, and on to North Asia, not the reverse. All these facts make the existence of shamanism as far back as the Archaic period in Greece highly improbable. A typological similarity between some elements of Greek religious and folk tradition and the shamanistic complex is not evidence of the great age of the latter, not least because we are dealing here with such widespread motifs as the soul travelling into the underworld, etc.

Meuli reconstructed Scythian shamanism in almost the same way as palaeontologists reconstruct fossils – relying on two bones, or in this case on two elements. The first of these was a description of a Scythian steam bath, and the second a reference to Scythian Enarees, or seers.[30] This in itself is surprising, since shamanism – where it exists – is easily noticed. Shamanistic rituals, beliefs, costumes and paraphernalia, and the role of shamans in society – these are all things that strike an external observer at first glance. To Herodotus,

[27] For a similar approach, see Vajda, 'Zur phaseologischen Stellung', 475 ff.
[28] Hermanns, *Schamanen*, i. 181 f., 197 f.; ii. 343 ff.
[29] Vajda, 'Zur phaseologischen Stellung', 476.
[30] Steam bath: Hdt. IV, 73–5; Enarees: Hdt. I, 105; IV, 67; [Hipp.] *Aer*. 22.

barbarian religion was always one of the first things to catch his interest, but he overlooked Scythian shamanism; otherwise Meuli would not have had to reconstruct it, relying on two pieces of indirect evidence. And although Herodotus was not the only one to write about the Scythians, who lived side by side with the Greeks for many centuries, Meuli failed to find anything else worthy of attention in the Greek sources, and all who wrote later on the subject merely repeated his arguments.

Not much is known of Scythian religion, of course, but the absence of both the shamanistic complex as a whole and its most important elements in the accounts cannot be explained by the poverty of the sources alone. In effect, we do not even know whether the Scythians had ecstatic cults, but it is known that their attitude to such cults among the Greeks was particularly negative: when they learned that King Scyles had been initiated into the cult of Dionysus, they promptly killed him (IV, 79). This might be explained by the Scythians' distaste for all foreign cults, were it not for the words of Herodotus: the Scythians rebuke the Greeks for their Bacchic frenzies, 'saying that it is not reasonable to set up a god who leads men to madness' (*οὐ γάρ φασι οἰκὸς εἶναι θεὸν ἐξευρίσκειν τοῦτον ὅστις μαίνεσθαι ἐνάγει ἀνθρώπους*). Everything indicates that the very idea of a deity that produced a state of ecstasy was alien to the Scythians. The story of Anacharsis, who paid with his life for trying to demonstrate to the Scythians the ecstatic cult of Cybele, confirms this (Hdt. IV, 76).

Let us now turn to what Meuli regarded as the capstone of all evidence. According to Herodotus (IV, 73–5), following the burial of a king the Scythians would arrange a steam bath for purposes of purification: the men pitched a tent, lit a fire in it, and threw hemp onto the heated stones; when the hemp gave off steam they would cry out in rapture (*ἀγάμενοι τῇ πυρίῃ ὠρύονται*). Herodotus was convinced that all this served them instead of bathing (the Scythians never washed in water), but it is plain from the context that the main reason for the Scythians' cries of joy was the effect of the vapours from the hemp. What we see here is ritual purification combined with elements of narcotic intoxication; it would take a vivid imagination to see it as a shamanistic ritual performance since the most important elements of that 'performance' are absent: the shaman's dance, representing a struggle against evil spirits, before his audience; the beating of a drum or play on another musical instrument, and lastly the trance of the shaman himself, a figure who is paradoxically absent from the scene described by Herodotus![31]

Herodotus' story has received unexpected confirmation: in the burial mound of one of the so-called Altai Scythians, along with tent poles, burners containing stones and hemp seeds have been found.[32] It is clear that the Altai Scythians, like those of the Black Sea coast, used the stones and the hemp seed not only for ritual purposes, but also in everyday life. However, the use of hemp as a drug could not have originated in Siberia, and much less be unambiguously connected with shamanism.[33] Among some Siberian peoples, shamans use vodka or tobacco (both taken from the Russians) to produce an ecstatic state, but by no means all who drink vodka and smoke tobacco are shamans. It is also uncertain whether in this case we can use the term 'ecstasy' as applied in the psychology of religion, meaning that the soul departs from the body and makes contact with supernatural beings. In this sense ecstasy, besides a psychosomatic state, implies a certain ideology, which in the Siberian peoples is extremely rich but which is absent in Scythian religion.[34] The Scythian cult of the dead, in so far as it is known from excavations, offers no evidence whatever of such an ideology,[35] and Scythian art contains no clear record of any such thing.

The interpretation of Scythian Enarees, or seers, as shamans seems even stranger. Meuli attempted to prove that they were close to shamans solely on the grounds that they looked like women and wore women's clothes. Cases of transvestism (both male and female) certainly occur in shamanism, although they are not widespread. However, what is meant here is precisely transvestism, whereas the Greek sources persistently speak of 'female disease' (θήλεα νοῦσος), or impotence.[36] Unlike Enarees, transvestite shamans never constituted a distinct class consisting of effeminate males. The Enarees served the goddess Aphrodite (Hdt. IV, 67), whose cult, according to the

31 'Seul problème: pas de chaman,' observes Dowden ironically ('Deux notes', 487).

32 S. I. Rudenko, *Frozen Tombs of Siberia* (Berkeley, 1970), 62, 384 f.

33 Rudenko did not accept shamanism among the Altai Scythians (ibid. 384). An attempt to prove the opposite (L. Hančar, 'Altai-Skythen und Schamanismus', *Actes du IVe Congrès intern. des sciences anthropologiques et ethnologiques*, ii (Vienna, 1956), 183–9) is based only on parallels and is therefore unconvincing.

34 Bremmer, *Early Greek Concept*, 48.

35 R. Rolle, *Totenkult der Skythen* (Berlin, 1979), 118 n. 219.

36 Hdt. I, 105; [Hipp.] *Aer.* 22; Arist. *EN* 1150b14.

Scythians themselves, they adopted from the Syrian city of Ascalon (I, 105). In this Aphrodite it is not difficult to discern the goddess Ishtar, whose cult was served by eunuch priests.[37] On the nature and causes of the 'female disease' of the Enarees, a wide range of views has been expressed.[38] The very first interpretation, offered by a Hippocratic doctor (*Aer.* 22), linked it with excessive horse-riding by the Scythians. The latest, a thoroughly plausible medical interpretation, sees it as haemochromatosis, a chronic hereditary ailment, in which iron metabolism in the body is disrupted, often resulting in impotence.[39] In any case, the only aspect of the Enarees of interest to the Greeks was the fact that they resembled women, and if they failed to notice any shamanistic rites or ideas, how could they adopt them?[40]

Strange as it may seem, the concept of 'shamanism' sheds least light on the very thing for which it was introduced: the spread in ancient Greece of new ideas on the soul and of ecstatic cults that were untypical of Homeric religion. This is not, of course, a matter of terminology: after all, even those who had long been prepared to dispense with the concept accepted that it helped to perceive the realia of cult practice behind the legend and the myth.[41] Despite the oft-refuted but nevertheless popular theory that behind every myth (or legend) there must be a ritual,[42] the legends about Pythagoras' superhuman qualities, his prophecies and his wonders do not lead us automatically to any Pythagorean cults. The same or similar stories were told about Pherecydes of Syros, who is not linked with any

[37] H. Haussig (ed.), *Herodot. Historien* (Stuttgart, 1963), 642 n. 100; Dowden, 'Deux notes', 489.

[38] W. R. Halliday, 'A Note on the *ΘΗΛΕΑ ΝΟΥΣΟΣ* of the Scythians', *ABSA* 17 (1910–11), 95–102; A. M. Khazanov, 'Skifskoe zhrechestvo', *Sovetskaia etnografiia*, 6 (1973), 41–50; J. Pigeaud, 'Remarques sur l'inné et l'acquis dans le Corpus hippocratique', in F. Lasserre and Ph. Mudry (eds.), *Formes de pensée dans la Collection Hippocratique* (Geneva, 1983), 49 ff.; A. Ballabriga, 'Les Eunuques scythes et leurs femmes', *Métis* 1 (1986), 132 ff.

[39] E. Lieber, 'The Hippocratic "Airs, Waters, Places" on Cross-dressing Eunuchs: "Natural" yet also "Divine"', in R. Wittern and P. Pellegrin (eds.), *Hippokratische Medizin und antike Philosophie* (Hildesheim, 1996), 451–76; Bremmer, *Rise*, 32; S. West, 'Scythians', in E. J. Bakker et al. (eds.), *Brill's Companion to Herodotus* (Leiden, 2002), 449 f.

[40] Dowden, 'Deux notes', 489.

[41] Bremmer, *Early Greek Concept*, 48.

[42] For a convincing critique of the myth-ritualist theory, see esp. J. Fontenrose, *The Ritual Theory of Myth* (Berkeley, 1971).

particular cult.[43] As we have already noted, the legendary tradition on Pythagoras, oral and written, is far from identical with the Pythagorean tradition. In the fifth century, and even more so in the fourth, legends about Pythagoras often circulated far outside the Pythagorean circles (in Ionia, for example), increasing in scale not because of their 'cult basis', but thanks to the imagination of writers such as Heraclides, Andron or Neanthes, who combined traditional motifs and added new ones. To form judgements about the followers of Pythagoras on the strength of these legends would be incautious in the extreme, especially because the Pythagoreans known to us do not pass on any legends about their Teacher, and they themselves do not figure in any 'miraculous' legends.[44]

The unconvincing nature of the obligatory myth-ritualist parallels is particularly apparent in the example of the 'ritual katabasis', which many researchers have attempted to attribute to Pythagoras the Shaman. To begin with, the writers of the fifth and fourth centuries still know nothing of the journey Pythagoras made in his lifetime to Hades.[45] Stories about this first begin to appear in the writings of Hieronymus of Rhodes (second third of the third century), and then in those of Hermippus, and both versions are distinctly comical in their nature. Given the heightened interest from Old and Middle Comedy in the world beyond the grave, this is quite natural. Even before Pythagoras himself was dispatched to Hades, the hero of Aristophon's *Pythagorist* (staged in *c.*340–330), visited it and reported

> That the Pythagorists differed much
> From all the rest; for that with them alone
> Did Pluto deign to eat, much honouring
> Their pious habits. – He's a civil God,
> If he likes eating with such dirty fellows.[46]

In Hieronymus, when Pythagoras descends into Hades he sees the souls of Homer and Hesiod there, enduring torments for the stories

[43] See above, 63 n. 5.

[44] On the legends of Hippasus, see below, 275.

[45] Heraclides of Pontus (fr. 89) wrote of the soul of Pythagoras residing in Hades during the intervals between his incarnations, but not of his travelling there during his lifetime (Rohde, *Psyche*, 600 f.; Delatte, *Vie*, 154 f.; Gottschalk, *Heraclides*, 117 ff.; Bollansée (*FGrHist* 1026 F 24), 265 f.).

[46] Fr. 12 K-A = 58 E 3, tr. Yonge. On the comedic accounts of feasts in the kingdom of the dead, see above, 181 n. 48.

they told about the gods. He also witnesses the punishment of those who avoided sexual relations with their wives; this was why he was honoured in Croton.[47] Hermippus, who was renowned for his fantastic tales, hostile to Pythagoras, remained true to form in this case too. He reports that on his arrival in Italy the sage made himself a small subterranean abode and lived there for a while, having ordered his mother to register on tablets every occurrence and to send her notes down to him. When he emerged, withered and skeletal, he betook himself to the assembly and declared he had returned from Hades, and to prove it he read out to them everything that had happened in his absence. The lawgivers were moved by his words, they wept and lamented and became so convinced he was of divine nature that they sent their wives to him in order that they would learn some of his doctrines. Consequently they were called Pythagorean women.[48]

An interest in the underworld, typical of folklore, is apparent as far back as in the *Odyssey*, although the Nekyia is often considered a later insertion. During the religious revolution which took place in Archaic Greece, bringing with it new views on the afterlife, this interest only increased. In their identically titled *Περὶ τῶν ἐν Ἅιδου*, Protagoras and Democritus criticized the then widespread notions of the afterlife.[49] It is understandable that far from all to whom the Greeks attributed a journey to Hades – Heracles, Odysseus, Orpheus – were linked with a cult which included a ritual katabasis. Unlike Odysseus, the epic hero, Orpheus became the central figure of a religious movement, and yet the myth of his descent into Hades in search of his dead wife seems more like a poetic invention, having little connection with Orphism, than a cult myth.[50] The variety of motifs appearing in the stories of Pythagoras in Hades shows that in essence all that they have in common is the figure of Pythagoras himself, who, being an expert in the immortality of the soul, would sooner or later have to be credited with a journey into the kingdom of

[47] D.L. VIII, 21 = fr. 42. On the parallel tradition, see Delatte, *Vie*, 155 f., 194, 244; Burkert, 155 f.

[48] D.L. VIII, 41 = fr. 20 = *FGrHist* 1026 F 24. *Πυθαγορικαί* recalls the comedies of Alexis and Cratinus the Younger *Πυθαγορίζουσα* (58 E 1, 3). On Pythagorean women see also above, 180 n. 46; on Pythagoras' instructions to women, 46f. Bollansée's commentary on F 24 of Hermippus basically follows Burkert (see below, n. 52).

[49] D.L. IX, 46, 55; Dem. fr. 582 Luria with comm. Heraclides of Pontus also wrote a work *On the Underworld* (fr. 22, 68, 72); Gottschalk, *Heraclides*, 108 f.

[50] K. Ziegler, 'Orpheus', *RE* 18 (1939), 1268 ff., 1280 f.

the dead. Are these stories backed by Pythagorean tradition, and if so, are there grounds for seeing in it an echo of cult practice? – Most likely not, particularly if we bear in mind that the earliest evidence comes from Hieronymus, who was writing almost a century after the demise of ancient Pythagoreanism. There are still fewer grounds for seeing Hermippus as the keeper of the Pythagorean ritual tradition.[51] Burkert's reconstruction, in which Pythagoras' mother, μήτηρ, is turned into Δημήτηρ, and Pythagoras himself into 'a hierophant in the cult of Demeter',[52] is as unconvincing as it is superfluous. One could equally well show Pythagoras to be the hierophant in a chthonic cult on the basis of Aristophon's comic verses; his Pythagorists, after all, take part in a feast (no doubt a ritual feast) with none other than Pluto!

Essentially, of the cultic side of Pythagoreanism we know so little that it is perfectly reasonable to ask whether the Pythagoreans really had any separate cult of their own, different from those of the cities in which they lived. This question has already arisen, in the course of discussion of the Pythagorean communities (§4.2), and provisionally been answered in the negative. Indeed, in what sense can one speak of a Pythagorean cult? Does it mean that Pythagoras introduced the veneration of some new deities, like the worshippers of Astarte? Or that he and his followers chose as their patron a hero who was already present in the tradition, but they lent a particular character to his cult and made it inaccessible to the uninitiated, as happened with the Orphics? Among the Pythagoreans we know of no special deities; Apollo, whom they venerated above all, was a traditional cult object in Croton. In none of the several dozen cities where, to judge from Aristoxenus' catalogue, Pythagorean communities existed, have any traces survived of a cult specific to them, traces such as the Orphic tablets, for example, found in abundance in southern Italy.[53]

[51] Hermippus' story is very similar to the one known from Herodotus about Zalmoxis' three-year sojourn in a subterranean abode (IV, 95–6), and may have arisen under its influence; thus Corssen, 'Abaris', 43; Lévy, 39; Boyancé, 'Abaris', 335 f.; Bolton, *Aristeas*, 144 f.; Gottschalk, *Heraclides*, 118; contra see Burkert, 156 f.; Bollansée (*FGrHist* 1026 F 24), 267 ff.

[52] Burkert, 159. The only passage to mention Pythagoras in connection with Demeter is from Timaeus: after Pythagoras' death his house in Metapontum (not in Croton!) was turned into a temple to Demeter, and the street in which he lived was named after the Muses (*FGrHist* 566 F 131).

[53] Bernabé and Jiménez San Cristóbal, *Instructions*.

But even if some traces were to be found of a special Pythagorean cult, there is absolutely nothing that might lead one to suspect an ecstatic cult.

Judging by the account of Alcidamas, Pythagoras was heroicized after his death, like Anaxagoras, and later Plato and Epicurus.[54] Here it is significant that veneration of heroicized philosophers was not restricted to their followers, the Pythagoreans and Anaxagoreans: Alcidamas speaks of the Italians and Clazomenians. Echoes of this veneration may also be seen on coins with idealized images of Pythagoras, minted in Abdera in *c*.430, and in this case there is no basis for an assumption of any influence from a local Pythagorean community. But even if Pythagoras the hero were venerated only by the Pythagoreans, this would explain very little, since what interests us is not how he was venerated after his death, but whether in his lifetime there existed a specific Pythagorean cult which he himself introduced. All that is known of Pythagorean rites points less towards a special cult than towards a special mode of life, *Πυθαγόρειος τρόπος τοῦ βίου*.[55]

Unfortunately we know little of the specifics of this mode of life.[56] It is clear that at least in the early period it included a series of religiously based rules, such as a preference for a particular kind of sacrifice, for example, a ban (complete or partial) on certain kinds of food, or on burial in woollen garments. However, the source of these rules was no cult, but Pythagoras' religious teaching, which, be it remembered, was not binding for all Pythagoreans, and this meant that the rules and taboos that flowed from it were not binding either. (As in other similar cases, the features characteristic of Pythagoreanism as a whole cannot automatically be attributed to each individual Pythagorean; see above, §3.2) The specific set of rules and the rigour of their observation varied with time, and in the end these were determined by personal taste. Empedocles, imitating Pythagoras 'in the solemnity of his way of life and his appearance',[57]

[54] Arist. *Rhet.* 1398b9–14 = 14 A 5; cf. D.L. III, 2 (on Plato) and D. Clay, 'The Cults of Epicurus', *CErc* 16 (1986), 12–28 = *Paradosis and Survival* (Ann Arbor, 1998), 75–102.

[55] Burkert, *Greek Religion*, 302, admits this.

[56] Cf. above, 111. From Plato's words it is clear only that those who observed it stood out as being better than the majority (*Res.* 600a–b). As the defining characteristics of the *βίος Ὀρφικός*, Plato cites abstinence from all animal foods (*Leg.* 782c7).

[57] Alcidamas (D.L. VIII, 56 = 14 A 5).

also created a special style of life, but his imitation was as selective as it was creative. If the tradition is to be believed, he wore purple clothing, a golden band, bronze sandals, long hair, and a Delphic garland; his facial expression was invariably dourly solemn, and he was followed everywhere by his attendants.[58] Basing himself primarily on the Orphic version of metempsychosis, Empedocles offered his followers a set of rules and taboos similar to that of Pythagoras.[59] He claimed to have no fewer adherents than Pythagoras (B 112), although they were not united in communities like the Pythagorean *hetairiai*, and therefore the way of life chosen by Empedocles died with him.

On close inspection, then, we do not find any traces of shamanism or its most important component, ecstatic cult practice, either in Pythagoreanism or among the Scythians who supposedly influenced it, even if we assume that shamanism existed at that time. Furthermore, it seems unlikely that the Pythagoreans had any special cult at all, of the kind which characterized the Orphics, for example. Given what we know about the institutional nature of the Pythagorean communities and the personalities of individual Pythagoreans (above, §§4.1, 3.3), both these conclusions are only to be expected. The Pythagorean *hetairiai* were not cultic communities. In fact, we do not even know how widespread the cult of the heroicized founder, later typical of the followers of Plato and Epicurus, was among the Pythagoreans. Outside Italy, in particular in the Peloponnese, in Thebes or Athens, where many Pythagoreans lived, there is no information on it. The biographical tradition on the Pythagoreans and what has survived of their writings contain practically nothing that might suggest an interest in the sphere of religion as manifested by, for example, Xenophanes, Parmenides, or Heraclitus, to say nothing of Empedocles. (Hippon, by way of contrast, enjoyed the reputation – perhaps undeserved – of a staunch atheist.)[60] The personality of Pythagoras is indissolubly linked with religion, but no similar personalities from ancient Pythagoreanism are known to us.

[58] D.L. VIII, 73. Many stories have survived about the wonders of Empedocles; he himself writes in *Purifications* of his gifts as a seer and healer, and of his immortality (B 112).

[59] See above, 205 n. 135–6 and below, 234 ff.

[60] A 2, 4, 6, 8, 9. This reputation goes back to Cratinus' comedy *Panoptai* (A 2). We do not know what exactly Cratinus was relying on (Zeller, i. 336).

6.2 METEMPSYCHOSIS: PYTHAGOREANISM AND ORPHISM

The name of Pythagoras is so closely associated with metempsychosis that many regard this doctrine as almost the most important component of Pythagoreanism. And indeed the fifth- and fourth-century sources state quite clearly that Pythagoras taught the transmigration of souls.[61] Unfortunately, this clarity vanishes as soon as we move on from simply stating the fact to an analysis of the historical and religious context of metempsychosis. Was metempsychosis borrowed by the Greeks, and if so from whom? Who in Greece was the first to preach it, the Orphics or Pythagoras, and did any Orphics live in Pythagoras' lifetime? How widespread was it among the Pythagoreans, and how consistent were they in observing the behavioural norms that sprang from it, such as the ban on eating meat? Can Pythagorean metempsychosis be considered an ethical doctrine? Behind each of these questions lies a long history of contradictory interpretations.

Happily the history of Greek religion is evolving not only through debate but also thanks to new textual discoveries which sometimes make it possible to resolve old questions. In recent decades a stream of new Orphic tablets from Italy, Macedonia, Thessaly, the Black Sea coast, and other parts of the Greek world, and especially the publication of the Derveni papyrus,[62] have, we may say, saved Orphism as a religious movement from the pitiless and mostly destructive criticism to which it has been subjected since Wilamowitz pronounced his famous words: 'Die Modernen reden so entsetzlich viel von Orphikern'.[63] The 'deconstruction' of Orphism, which took place almost in parallel with the 'shamanization' of Pythagoreanism, considered above, seemed to have completely demolished it. Orphism as a term is an invention of modern scholarship, and one that should therefore

[61] Doubts about this (Rathmann, *Quaestiones*., 37 ff.; G. Casertano, 'Orfismo e pitagorismo in Empedocle?', in M. Tortorelli Ghidini et al. (eds.), *Tra Orfeo e Pitagora: Origine e incontri di culture nell'antichità* (Naples, 2000), 203 ff.) appear to be unfounded.

[62] The most recent edition of the tablets is Bernabé, *Poetae epici Graeci*, ii, 2; Bernabé and Jiménez San Cristóbal, *Instructions*.; the latest edition of the Derveni papyrus is Kouremenos et al. (eds.), *Derveni Papyrus*.

[63] U. von Wilamowitz-Moellendorff, *Der Glaube der Hellenen*, ii (Berlin, 1932), 199.

be avoided: 'There is no such thing as Orphism.'[64] There were never any people who called themselves Orphics and formed themselves into religious communities; Dionysus and the Dionysian mysteries have nothing to do with Orphism.[65] The so-called Orphic tablets in reality belonged to the Pythagoreans.[66] The Orphic poems are either a doctrinal appendix to the Eleusinian mysteries, or were also written by the Pythagoreans.[67] The traditional view, that Pythagoras took metempsychosis from Orphism,[68] is incorrect: in reality the Greeks owe this doctrine to Pythagoras himself,[69] and the existence of Orphic metempsychosis has yet to be proven.[70] The new finds, which have overturned almost all these theories, have once again confirmed that Orphism was no artificial construct but a real religious movement,[71] which Pythagoreanism never was, although it contained a religious doctrine. The question of the origin of metempsychosis remains unresolved, however.

The earliest evidence, Xenophanes' biting verses (B 7), links metempsychosis with Pythagoras (above, §1.2). From this, however, it does not follow that Pythagoras was its founding father. Xenophanes speaks of metempsychosis as something to be taken for granted; it does not seem as if he is encountering it for the first time, or as if he

[64] M. L. West, 'Graeco-Oriental Orphism in the Third Century BC', *Travaux du VIe congrès international d'études classiques* (Paris, 1976), 221. See also L. Moulinier, *Orphée et l'orphisme à l'époque classique* (Paris, 1955), 116. Cf. U. Bianchi, 'L'Orphisme a existé', *Mélanges d'histoire des religions offerts à H.-C. Puech* (Paris, 1974), 129–37.

[65] Wilamowitz, *Glaube*, ii. 190; Linforth, *Arts*, 53, 288 f.

[66] Zuntz, *Persephone*, 340 ff., 392 f.

[67] Eleusis: F. Graf, *Eleusis und orphische Dichtung Athens vorhellenistischer Zeit* (Berlin, 1974); Pythagoreans: West, *OP*, 7 ff.

[68] Zeller, i. 69 ff., 563 f.; Rohde, *Psyche*, 337; O. Kern, *Die Religion der Griechen*, ii (Berlin, 1935), 144; W. K. C. Guthrie, *Orpheus and Greek Religion* (London, 1935), 216 ff.; K. Ziegler, 'Orphische Dichtung', *RE* 18 (1942), 1383 f.; Nilsson, *GGR* i. 701 f.

[69] Wilamowitz, *Glaube*, ii. 188, 192 ff.; P.-M. Festugière, Review, *REG* 49 (1936), 306–10; Long, *Study*, 89 ff.; Zuntz, *Persephone*, 265 ff., 321 ff.; Burkert, 126 ff., 133; Bremmer, *Rise*, 1 ff.

[70] Wilamowitz, *Glaube*, ii. 194; Long, *Study*, 89 ff.; Graf, *Eleusis*, 93 f.; L. J. Alderink, *Creation and Salvation in Ancient Orphism* (Chico, 1981), 83 f.

[71] As seen for example by Guthrie, *Orpheus*; M. P. Nilsson, 'Early Orphism and Kindred Religious Movements' (1935), in his *Opuscula selecta*, ii (Lund, 1952), 626–83. On Orphism as a religious movement see: Bernabé and Jiménez San Cristóbal, *Instructions*, 179 ff. On the history of the study of Orphism, see L. Zhmud, 'Orphism and Graffiti from Olbia', *Hermes* 120 (1992), 159–68; A. Bernabé, 'Tendencias recientes en el estudio del orfismo', *Ilu. Revista de Ciencias de las Religiones* (1995), 23–32.

regards Pythagoras as its founder. We still lack direct and incontrovertible evidence that the Orphic poems contained a doctrine of reincarnation which was adopted and modified by Pythagoras. And yet such a conclusion accords far better with the facts now known to us[72] than the alternative explanation: that a religious movement, Orphism, took one of its central doctrines from the thinker from Samos. According to Ion of Chios, Pythagoras ascribed some of his poems to Orpheus (B 2). Did Ion really know some poems by Pythagoras which were unknown to anybody else, and how did he determine their authorship? Nothing that we know of early Pythagoreanism makes it possible to assume the existence of any authoritative religious text emanating from Pythagoras. It is no accident that the Hellenistic grammarian Epigenes named Brontinus and Cercops, not Pythagoras, as authors of Orphic poems.[73] West's idea of the Pythagorean community as a kind of creative workshop in which Orphic poems were written cannot be supported, as we have not a single Pythagorean reference to Orpheus. Ion's words are best understood as conjecture based on a similarity between the Pythagorean ideas known to him and what could be found in an Orphic poem. The similarity between Orphism and Pythagoreanism lay precisely in metempsychosis, with all the doctrinal and practical consequences that flowed from it. Any similarity hardly went further than this.[74] In the mid-fifth century, therefore, Orphism already included the doctrine of the transmigration of souls.

If Ion considered Pythagoras a writer of Orphic poetry, his contemporary Herodotus posited an Egyptian origin for metempsychosis (above, §2.3), and noted further, 'Some Greeks have also used this doctrine as their own, some earlier, some later. I know their names, but do not record them' (II, 123). Whose were the names Herodotus did not record? The main claimants whose names appear in the literature are Orpheus, Pythagoras, and Empedocles.[75] Whether or

[72] Thus G. Casadio, 'La metempsicosi tra Orfeo e Pitagora', in Borgeaud (ed.), *Orphée*, 119–55. See also Bernabé and Jiménez San Cristóbal, *Instructions*, 120.

[73] *OF*, test. 222. On Cercops, whom Epigenes regarded as a Pythagorean, see above, 116.

[74] Nilsson, *GGR* i. 701; Burkert, *Greek Religion*, 300: 'Orphic and Pythagorean coincide in the doctrine of metempsychosis and ascetism'. Other similarities known to us are matters of detail.

[75] See Burkert, 126 n. 38. Although Herodotus' version of metempsychosis more closely resembles Pythagoras' teaching than that of the Orphics and Empedocles (see

not the historian meant Empedocles, in a parallel passage on Egyptian borrowings in the sphere of religion, he says (II, 81):

> (The Egyptians) wear linen tunics . . . but nothing woollen is brought into the temple, or buried with them: that is impious. They agree in this with the so-called Orphics and the Pythagoreans; for no participant of their rites can be buried in a woollen shroud. There is a sacred story (*ἱρὸς λόγος*) about this.[76]

The second sentence of this passage appears in the two manuscript versions: *ὁμολογέουσι δὲ ταῦτα τοῖσι Ὀρφικοῖσι καλεομένοισι καὶ Πυθαγορείοισι* (Flor.); *ὁμολογέει δὲ ταῦτα τοῖσι Ὀρφικοῖσι καλεομένοισι καὶ Βακχικοῖσι, ἐοῦσι δὲ Αἰγυπτίοισι καὶ Πυθαγορείοισι* (Rom.). The short version speaks of the Orphics and Pythagoreans (dat. pl. masc.); the long one of the Orphic and Bacchic rites, which were in fact Egyptian and Pythagorean (dat. pl. neut.). The most detailed commentary on this passage is by Linforth, and although he had no knowledge of other instances of the use of *Ὀρφικοί* in the classical period, unlike *τὰ Ὀρφικά*, relating to the rites and the literature, he showed convincingly that the long version had arisen as a result of interpolation.[77] Linforth's arguments are all the more valuable because they go against his own tendency, and that of his time, to deny the existence of Orphiccommunities in the sixth to fourth centuries. For Pythagoreanism this tendency had entirely predictable consequences: if there were no Orphics, that meant that both Orphic poems and metempsychosis

below, 229 f.), the historian may not have known of these differences, or may have chosen to ignore them.

[76] The ban on wool is linked to the vegetarianism that stems from metempsychosis. 'To be sure, it was possible to obtain wool without committing the crime of murdering a kinsman, which was involved in eating mutton, but perhaps to rob him was also considered unworthy of the pure' (Guthrie, *Orpheus*, 198); *ἱερὸς λόγος* is to be seen as an Orphic poem (ibid.), rather than an Egyptian legend (Burkert, 219). Cf. Henrichs, 'Hieroi Logoi', 236 f.

[77] He referred in particular to a passage in Apuleius (*Apolog.* 56 = *OF*, fr. 217) which preserved the short version (Linforth, *Arts*, 47). Apart from everything else, Herodotus could not have supposed that Pythagoras took from Egypt the ban on burial in woollen clothing and passed it on to the Orphics, as follows from the long version (see Rohde, *Psyche*, 349). The historian said nothing about Pythagoras' journey to Egypt, although he did maintain that the seer Melampus took from the Egyptians the cult of Dionysus and the sages who came after him gave a fuller account of the significance of that cult (II, 49). In these sages it is not difficult to recognize Orpheus and Musaeus (see above, 43); Hecataeus of Abdera wrote, in a context which shows the influence of Herodotus (above, 59 n. 121), of a journey to Egypt by Orpheus and Musaeus (*FGrHist* 264 F 25.96 = *OF*, test. 96).

could well have arisen in a Pythagorean environment. However, the publication a quarter of a century ago of a graffito from Olbia with the inscription *Διο(νύσωι) – ὀρφικοί* showed that in the mid-fifth century there were people who called themselves Orphics,[78] and lent additional weight to the short version.[79]

The inscription on another Orphic graffito from Olbia, *βίος θάνατος βίος*, and below this – *ἀλήθεια*, supports the contention that when Herodotus spoke of Greeks who taught the transmigration of souls he included Orpheus. The words imply a belief in life after death,[80] that is, in the existence of a cycle in which a temporary death is followed by rebirth. The words *σῶμα – ψυχή*, read by Vinogradov on the recto of Olbian graffito no. 3, provided even more persuasive evidence.[81] Here we see the well-known opposition between body and soul, noted by Plato in his passage on Orphic metempsychosis (*Crat.* 400c). Other Orphic tablets also contain clear references to birth following death.[82] Metempsychosis is inseparably linked with abstinence from all animal foods, a fact which is mentioned by Euripides and Aristophanes, and which Plato considered the central point of the *βίος Ὀρφικός*.[83]

The earliest of the Orphic tablets now known to us, the Olbian tablets, date from the second or third quarter of the fifth century.

[78] A. S. Rusiaeva, 'Orfizm i kul′t Dionisa v Ol′vii', *VDI* 1 (1978), 87–104. These graffiti can be palaeographically dated to the second or third quarter of the 5th cent. (Vinogradov, 'Zur sachlichen Deutung', 78).

[79] The short version is supported by Rathmann, *Quaestiones*, 52 f.; Wilamowitz, *Glaube* ii, 189 n. 1; Nilsson, 'Early Orphism', 656 n. 94; Long, *Study*, 24; Maddalena, *Pitagorici*, 326 f.; Timpanaro Cardini, i. 21 f.; Morrison, 'Pythagoras', 136 n. 8. The following support the long version: Dodds, *Greeks*, 169 n. 80; Burkert, 127 f. (with some hesitation); Graf, *Eleusis*, 92 n. 60; West, *OP*, 8 n. 10; Kahn, 20; Riedweg, *Pythagoras*, 77; Bremmer, *Rise*, 18 n. 61; Henrichs, 'Hieroi Logoi', 236 n. 100. As Casadio ('Metempsicosi', 128 n. 23) has noted, the find from Olbia nullifies Burkert's central argument: 'the ancient *testimonia* speak of *Ὀρφικά*, not *Ὀρφικοί*'.

[80] M. L. West, 'Orphics in Olbia', *ZPE* 45 (1982), 18; Vinogradov, 'Zur sachlichen Deutung', 80.

[81] Vinogradov, 'Zur sachlichen Deutung', 79.

[82] 'I have escaped the cycle of heavy grief and pain' (A 1, from Thurii, before 350); 'From a man you have become a god' (A 4, from Thurii, mid-4th cent.); 'Now you have died and now you have been born, O thrice-happy one' (from Pellina in Thessaly, end 4th cent.). Cf. *OF* 348. On metempsychosis in the texts of the tablets see Zuntz, *Persephone*, 335 f.; West, *OP*, 22 f.; R. Merkelbach, 'Die goldenen Totenpässe: Ägyptisch, orphisch, bakchisch', *ZPE* 128 (1999), 1–13, at 6 f.; Bernabé and Jiménez San Cristóbal, *Instructions*, 117 ff.

[83] Eur. *Hipp.* 952; Ar. *Ran.* 1032; Pl. *Leg.* 782c.

A little earlier, in the year 476, at the other end of the Greek world, in Acragas in Sicily, Pindar's Second Olympian Ode, composed in honour of King Theron and containing ideas plainly influenced by the Orphic teaching on reincarnation, received its first performance.[84] Empedocles, a native of Acragas, was then about 20 years old. The biographical tradition persistently links him with the Pythagoreans and even with Pythagoras himself, whom he greatly revered.[85] Nonetheless, the version of metempsychosis preached by Empedocles in his *Purifications* is much closer to Orphism than to Pythagoreanism.[86] Thus, within a few decades of the death of Pythagoras, in various parts of the Greek world we find traces of the *Orphic* teaching on the transmigration of souls and of *Orphic* cultic communities, whose rituals imply that teaching. It is superfluous to assert that any attempt to link these phenomena with Pythagoras will appear artificial in the extreme. Unlike the Orphics and Empedocles, Pythagoras avoided leaving any written record of his religious doctrines, and other channels of distribution turned out to be more problematic. It is hardly possible to maintain that metempsychosis achieved wide currency among the Pythagoreans (see below); even the early tradition on Pythagoras only infrequently links him with this teaching.[87] In view of all this it is difficult to imagine that already by the beginning of the fifth century Pythagoras' doctrine of the transmigration of souls had reached far beyond the borders of Italy and, having undergone a transformation, was integrated into the Orphic beliefs, myths, and cults.[88]

Nilsson maintained that what the literature of the fifth and fourth centuries tells us about Orphism must reach back to an earlier time;

[84] H. J. Rose, 'The Grief of Persephone', *HThR* 36 (1943), 247–250; H. Lloyd-Jones, 'Pindar and the After-Life', in A. Hurst (ed.), *Pindare* (Geneva, 1984), 245–79.

[85] B 129; see above, 39 f.

[86] O. Kern, 'Empedokles und die Orphiker', *AGPh* 1 (1888), 488–508; W. Kranz, 'Vorsokratisches III', *Hermes* 70 (1935), 111–19; West, *OP*, 108; Parker, *Miasma*, 291; C. Riedweg, 'Orphisches bei Empedokles', *A&A* 41 (1995), 34–59; Bremmer, *Rise*, 24. Cf. Zuntz, *Persephone*, 263 f.; Burkert, 133 n. 72. On the difference between Orphic and Pythagorean teaching, see below, 228 f.

[87] After Xenophanes (B 7) a hint of metempsychosis may possibly be found in Empedocles (B 129); it is implied by Ion of Chios (A 2), and referred to by Herodotus (II, 123), without mention of any names, it is true. In another *testimonium* (B 4), Ion spoke of a happy life after death, while Herodotus in his story of Zalmoxis (IV, 94–6) wrote of the immortality of the soul.

[88] Cf. Bremmer, *Rise*, 24: 'Orphism was the product of Pythagorean influence on Bacchic mysteries in the first quarter of the fifth century.'

the heyday of Orphism was in the Archaic period, and some Orphic poems could even pre-date Hesiod.[89] In recent decades it has become common to date the Orphic poems, and in particular the theogony, on which the Derveni papyrus comments, at the turn of the fifth century or even later.[90] For this there are no serious grounds.[91] Pherecydes, who personally experienced the influence of Anaximander's philosophy, was the author of the first theogony in prose, and in about 500 Acusilaus transposed Hesiod into prose (9 A 4, B 1). It is natural to date a theogonic Orphic poem which followed Hesiod, but outdid him in shocking details,[92] to an earlier period. Herodotus maintained that Orpheus and Musaeus lived after Homer and Hesiod (II, 53), but is hardly likely that he meant the turn of the fifth century. The tradition on the authorship of the Orphic poems is highly unreliable,[93] yet it can yield certain information. The *testimonia* linking the editing and publishing or forgery of Orphic literature with Onomacritus, who lived at the court of Pisistratus and the Pisistratids, are particularly noteworthy.[94] Herodotus reports that Onomacritus compiled a collection of Musaeus' oracles, but forged one of them and for this was expelled from Athens by Hipparchus (VII, 6). It is very probable that Onomacritus collected and edited Orphic poetry, and even if late authors write of this in much greater detail than Herodotus, this will not suffice to dismiss the existence of

[89] Nilsson, *GGR* i. 621, 680 f., 682 n. 4. For similar datings of Orphic poetry, see Ziegler, 'Orphische Dichtung', 1343 f. (6th cent.); Burkert, *Greek Religion*, 296 (mid-6th cent.).

[90] See e.g. Graf, *Eleusis*, 149 (end of the 6th cent.); West, *OP*, 108 f. (*c*.500).

[91] Thus West's dating (*c*.500) is based on the assumption that the poem mentions (1) the deity Time (Chronos), borrowed from the Orient, and (2) the Moon, which is earth-like, spherical and shines with reflected light (West, *OP*, 92 f., 103 ff., 108 f.). Both these conjectures rely not on the text of the poem, but on West's supplements to it, taken from the late Hellenistic Orphic *Rhapsodies*. Cf. Betegh, *Derveni Papyrus*, 157 f., 244 f.; Kouremenos et al., *Derveni Papyrus*, 25, 189, 260 f.

[92] Castration, eating the sexual organs, incest, etc. Isocrates noted that Orpheus stood out particularly by the varied forms of bestiality that he attributed to the gods (XI, 38 = *OF*, fr. 17).

[93] See *DK* 1 A 1. 'That the poems were actually anonymous, and that no one really knew who composed them is clear' (Linforth, *Arts*, 351). Most of the supposed authors of the poems are either unknown to us or fictitious (Orpheus of Croton, Orpheus of Camarina), while the reports mentioning Pherecydes (A 2, from the *Suda*), Pythagoras, and the Pythagoreans are unreliable.

[94] *OF*, test. 182–9. The Greek sources date him to 50 Ol. (580–577), meaning his date of birth; Kern (*OF*, test. 182) corrected this to 55 Ol. (560–557). See also F. Stoessl, 'Onomakritos', *RE* 18 (1939), 491; Burkert, *Greek Religion*, 440 (acme *c*.520).

Orphic poems in Athens in the last third of the sixth century.[95] There is no reason to doubt that in Magna Graecia too, the principal focus of Orphism in the classical period, these poems circulated before Pythagoras arrived in Croton.

Many scholars prefer Pythagoras as the πρῶτος εὑρετής of metempsychosis simply because, unlike Orpheus, he was a tangible historical figure. Yet the urge to identify a 'religious genius', a forefather of metempsychosis, has no more justification than attempts to present Pythagoras as the transmitter of a borrowed doctrine, an Egyptian doctrine, in the ancient view, or an Indian one in the modern view.[96] No indications of borrowing have yet been discovered in Greek metempsychosis, and among the Greeks' neighbours any clear traces of metempsychosis are also absent. On the other hand, metempsychosis does occur in many preliterate cultures from Australia to Siberia,[97] so there is no need to seek a discoverer for it, or to link it with any influences or borrowings. The rise of metempsychosis may be adequately explained in the context of the transformation of Greek religion which took place in the eighth to sixth centuries and manifested itself prominently in a change in the traditional way of regarding man, his relations with the gods, and lastly, his soul.[98]

Although the old habit of writing about 'Orphico-Pythagoreans' (of whom there is no evidence in any sources) has still not died out, the more we learn about Orphism the clearer its fundamental differences from Pythagoreanism become, even in what they have in common. Greek religion was above all a cult; Orphism, besides

[95] The tradition on Onomacritus is accepted by, among others, Rohde, *Psyche* 336 ff.; Guthrie, *Orpheus*, 13 f., 107 f., 115; Kern, *Religion*, ii. 163; Nilsson, 'Early Orphism', 646; *GGR* i. 683; Burkert, 130 n. 58 (with reservations); Masaracchia (ed.), *Orfeo*, 22 f.; M. di Marco, 'Dioniso ed Orfeo nelle *Bassaridi* di Eschilo', ibid. 143 f. It is opposed by Linforth, *Arts*, 350 ff.; Graf, *Eleusis*, 147 ff. (with reservations); West, *OP*, 9 n. 13, 249 f.

[96] On the absence of metempsychosis in Egypt, see above, 86 f. India is favoured by K. von Fritz, Review, *Gnomon* 40 (1968), 8 f.; Burkert, 133; id, *Greek Religion*, 444; Kahn, 19. The author of a detailed work on Indo-Greek contacts rejects the possibility of metempsychosis having been adopted from India (Karttunen, *India*, 112 f.); see also Bremmer, *Rise*, 24.

[97] See e.g. A. Jensen, *Myth and Cult among Primitive People* (Chicago, 1963), 281 f., 290 f.

[98] Nilsson, *GGR* i. 694 f.; Bremmer, *Early Greek Concept*, *passim*. For new views on the soul, see A. Dihle, 'Totenglaube und Seelenvorstellung im 7. Jahrhundert vor Christus', in *Jenseitsvorstellungen in Antike und Christentum. Gedenkschrift für A. Stuiber* (Münster, 1982), 9–20.

being a cult, included a religious doctrine, while Pythagoreanism had no cult of its own. An oft-quoted description has it that, 'Bacchic, Orphic, and Pythagorean are circles each of which has its own centre, and while these circles have areas that coincide, each preserves its own special sphere'.[99] This description needs some refining. New discoveries indicate that the Orphic and the Bacchic (Dionysian) coincide and are often identical,[100] whereas the Pythagorean and Bacchic circles nowhere intersect. Pythagoras was probably the first but not the only Greek philosopher to take from Orphism the doctrine of reincarnation. Later the same path was trodden by Empedocles and Plato, in whose wake came many known and unknown followers. Pythagorean metempsychosis looks like a borrowed doctrine because, unlike Orphic metempsychosis, it lacks a primary context and is divorced from the anthropogony and eschatology which lent it meaning within the framework of a religion of salvation. According to Orphic anthropogony, as set down in the myth of the murder of Dionysus by the Titans, man was created from divine and titanic elements, and from birth carries within himself what is called (perhaps not entirely accurately) original sin.[101] Notions of the innate guilt of mankind, of punishment for it by having the soul caged in a body, seen as a prison, or even a tomb, and above all, the idea of the possibility of escaping this punishment and achieving eternal bliss played a central role in Orphism.[102] It is possible that the myth of Dionysus being torn asunder by the Titans, and the consequent idea of ancestral guilt, on the one hand, and notions of the transmigration of souls, on the other, have different origins. For us, however, they appear together from the very beginning of Orphism's historical

[99] Burkert, *Greek Religion*, 298.

[100] See Burkert, *Babylon*, 76 f.; F. Graf and S. I. Johnston (eds.), *Ritual Texts for the Afterlife: Orpheus and the Bacchic Gold Tablets* (London, 2007); Bernabé and Jiménez San Cristóbal, *Instructions*; A. Henrichs, 'Mystika, Orphika, Dionysiaka', in A. Bierl and W. Braungart (eds.), *Gewalt und Opfer: Im Dialog mit Walter Burkert* (Berlin, 2010), 87–114, at 91 f.

[101] Guthrie, *Orpheus*, 107 f.; Nilsson, *GGR* i, 684 f. L. Brisson's and R. Edmonds's doubts concerning the age of the Orphic myth of Dionysus and the Titans have been dispelled by A. Bernabé, 'La Toile de Pénélope: a-t-il existé un mythe orphique sur Dionysos et les Titans?', *RHR* 219 (2002), 401–33; id., 'Autour du mythe orphique sur Dionysos et les Titans: Quelques notes critiques', in D. Accorinti and P. Chuvin (eds.), *Des Géants à Dionysos: Mélanges offerts à F. Vian* (Alessandria, 2003), 25–39.

[102] Guthrie, *Orpheus*, 107 f.; Nilsson, *GGR* i. 687 f.; Alderink, *Creation*, 65 ff.; West, *OP*, 22 f.

course. The idea of guilt, of ancestral impurity and complicity in transgression served to explain why in Orphism the soul was doomed to multiple reincarnations. For the initiated, Orphism offered an opportunity, by ritual purification and observance of the βίος Ὀρφικός, to rid oneself of guilt and again become one with the gods.

In Pythagoreanism there is nothing resembling this anthropogony, nor is there any of the eschatology which is linked with it. In none of the early *testimonia* on Pythagoras or the Pythagoreans do we find any evidence that transmigration of souls was seen as a punishment for any previous sins. The likening of the body to a prison (σῶμα–φρουρά), ascribed by some scholars to the Pythagoreans, is in fact the property of the Orphics, as is clear from Plato.[103] The even more pessimistic likening of the body to a tomb (σῶμα–σῆμα), in which the soul is interred for its previous sins, is linked by Plato in his *Gorgias* with a certain 'mythologist' from Italy or Sicily; Aristotle in *Protrepticus* attributes a similar view to Orpheus and the Orphics.[104] It is probable that this idea appears in a spurious fragment of Philolaus (B 14),[105] replicating Aristotle's reference to οἱ παλαιοὶ θεολόγοι τε καὶ μάντεις, i.e. Orpheus and Musaeus, as a result of a conflation of these two passages. The real Philolaus regarded the soul as the

[103] Pl. *Phaed.* 62b (φρουρά), *Crat.* 400c (δεσμωτήριον) = *OF*, fr. 7–8. In the first case Plato is referring to secret teaching (ἐν ἀπορρήτοις λεγόμενος λόγος), in the second, directly to the Orphics. See P. Boyancé, 'Note sur la *ΦΡΟΥΡΑ* platonicienne', *RPh* 37 (1963), 7 ff; Burkert, 126 n. 33, 229 n. 55; J. C. G. Strachan, 'Who *Did* Forbid Suicide at *Phaedo* 62b?', *CQ* 20 (1970), 216–220; C. J. Rowe (ed.), *Plato*: *Phaedo* (Cambridge, 1993), 128. Cf. Ebert, *Platon*, 119.

[104] Pl. *Crat.* 400c, *Gorg.* 493a–b (cf. below, 416 n. 5); Arist. fr. 60 = *Protr.* fr. 106 Düring. See Nilsson, *GGR* i. 687; G. Rehrenböck, 'Die orphische Seelenlehre in Platons Kratylos', *WS* 88 (1975), 17–33; A. Bernabé, 'Una etimología platónica σῶμα–σῆμα', *Philologus* 139 (1995), 204–37 (with a bibliography on the subject). Wilamowitz, *Glaube*, ii. 199, and those who followed him in minimizing Orphism (Linforth, *Arts*, 147 f.; Moulinier, *Orphée*, 24 ff.) attributed this formula to the Pythagoreans. Burkert, 218 n. 47, was more cautious: 'we may suppose that, if it is not Orphic, it is likely to be Pythagorean'. While directly linking the formula σῶμα-φρουρά with the Orphics, Plato does not indicate the author of the formula σῶμα–σῆμα, but his evasions do not mean that it is Pythagorean. By their content, both formulae are closely linked, reflecting the same view of earthly life as a punishment, a view which is abundantly represented in the Orphic sources and absent from the Pythagorean sources. Pythagoreanism, which encouraged athletics (see above, 92), can hardly have taken such a dim view of the body.

[105] On the spurious nature of B 14, see Burkert, 248 n. 47; Huffman, *Philolaus*, 402 ff.

principle of life and movement (B 13);[106] there is no evidence that he believed in metempsychosis.

A further example sometimes adduced to show that the Pythagoreans shared the theory of ancestral guilt is the commandment passed down by Iamblichus: 'Labours are good, but pleasures are bad in every way; for having come for punishment, one must be punished' (*VP* 85).[107] Although this is taken from the collection of 'symbols', containing basically Aristotelian material (above, §5.4), its form is unlike any of the three types of 'symbol' (What is . . . ? What is the most . . . ? What should be done?). Instead it is more like a combination of the first type and the third. This hybrid impression is underlined by the fact that only the first, anti-hedonistic part of the 'symbol' has parallels in the Pythagorean tradition,[108] while the second is a paraphrase of Aristotle's *Protrepticus*, excerpted by Iamblichus.[109] The idea of life as a punishment is attributed here to οἱ τὰς τελετὰς λέγοντες and οἱ ἀρχαιότεροι, that is, to the Orphics and Orpheus. In this situation it is difficult to assert that this 'symbol' is really Pythagorean, or even that it is taken from Aristotle's book *On the Pythagoreans*.[110] Finally, according to the Peripatetic Clearchus, a younger contemporary of Aristoxenus, a certain Pythagorean named Euxitheus maintained that the soul was bound to the body as a punishment, and resided in it until a god set it free (fr. 38). This fragment aside, we know nothing of the existence of the Pythagorean Euxitheus; he is clearly a fictitious figure,[111] into whose mouth Clearchus placed a popular doctrine.

106 See below, 390 f.

107 ἀγαθὸν οἱ πόνοι, αἱ δὲ ἡδοναὶ ἐκ παντὸς τρόπου κακόν· ἐπὶ κολάσει γὰρ ἐλθόντας δεῖ κολασθῆναι. See West, *OP*, 22.

108 See e.g. Iamb. *VP* 84, p. 48.20. Pythagoras upheld moderation as a way of life (Iust. XX,4,1–13, from Timaeus), see above, 93 n. 137–8; the Pythagoreans Iccus and Astylus, whose Olympic victories demanded special efforts, were also distinguished by their special moderation (see below, 353). Anti-hedonism may also be seen in the Pythagorean works of Aristoxenus (fr. 17, 30, 50; Huffman, *Archytas*, 283 ff., 307 ff.); an extended passage from the *Pythagorean Precepts* is particularly revealing: above all one should beware of enjoyment, etc. (Iamb. *VP* 204 f., cf. above, 75 n. 61). Of course, there is no mention here of any punishments.

109 τὸ φάναι διδόναι τὴν ψυχὴν τιμωρίαν καὶ ζῆν ἡμᾶς ἐπὶ κολάσει μεγάλων τινῶν ἁμαρτημάτων (Arist. fr. 60 = *Protr.* fr. 106 Düring = Iamb. *Protr.*, 47.21 ff.). See above, 230 n. 104, cf. above, 201 n. 122; Burkert, 168 n. 14.

110 To be sure, the latter does not guarantee Pythagorean origin either; see above, 194 ff.

111 Burkert, 124 n. 21.

The motif of ancestral guilt cannot be found in ancient Pythagoreanism. On the contrary, early and late sources alike observe that it is natural and even proper that souls should revolve through the bodies of humans and animals.[112] Diogenes Laertius writes that Pythagoras was the first to teach that the soul completed a cycle of necessity (κύκλος ἀνάγκης), assuming the guise of first one body, then another (VIII, 14). This notion is very distant from the Orphics' overriding urge to 'escape the cycle of heavy grief and pain', as stated on the gold tablet from Thurii (A 1), to leave one's earthly being behind and again become at one with the gods. If the rotation of the soul is part of the order of things,[113] it is clear why we do not find in the Pythagorean tradition the idea that each successive incarnation is not only a punishment for past sins, but also a step towards a future blessed state, and therefore must be better than the previous incarnation.[114] Any soul can inhabit any body, remarks Aristotle, referring to the 'Pythagorean myths' (*De an.* 407b22). Previous incarnations of Pythagoras do not form themselves into a 'progressive' series: first he was Euphorbus, a hero, then, in one version, a fisherman, and in another version a *hetaira*.[115] How did Euphorbus transgress, and what did the *hetaira* do to deserve the soul of Pythagoras? What would await him at the end of all his reincarnations? Would he become a god, as Empedocles prophesied with reference to himself? Would his soul return to the gods, as the Orphics wished? To this question there is no clear answer.[116] It is quite possible that the

[112] Hdt. II, 123; Her. Pont. fr. 89; Arist. *De an.* 407b22; Porph. *VP* 19. In this connection Marcovich ('Pythagorica', 38) wrote of the 'Notwendigkeit eines Naturgesetzes'.

[113] Cf. the teaching of Alcmaeon, who believed that the soul was immortal since it remained in eternal rotation, like the immortal heavenly bodies (A 12). See below, 390 f.

[114] According to Rohde (*Psyche*, 375 n. 44), Pythagorean doctrine did determine each successive reincarnation on the basis of deeds done in the last life, but the evidence adduced for this is highly unconvincing. 'Pythagorean justice' meant rendering equal returns for equal deeds, but why should this apply to a past or future life?

[115] Her. Pont. fr. 89; Dic. fr. 36. It is highly likely that the tradition originally named only Euphorbus, while the others were invented by Heraclides and those who came after him (Gottschalk, *Heraclides*, 116 f.).

[116] Referring to the wisdom of Pythagoras, Ion wrote that Pherecydes after his death dwelt in joy (B 4), but he did not have metempsychosis in mind (see above, 38). According to Numenius, quoted by Porphyry, Macrobius, and Proclus, Pythagoras called the Milky Way 'Hades' and the 'place where souls gather' (fr. 32, 34–5 des Places), but this notion hardly goes further back then the Academy; see Burkert, 360 ff.; I. Kupreeva, 'Heraclides on the Soul and Its Ancient Readers', in W. Fortenbaugh and

Pythagorean version of metempsychosis implied the eternal rotation of the soul (described in Herodotus, II, 123), and not its final liberation from its corporeal embodiment.[117]

There is, then, much to suggest that in Pythagoreanism metempsychosis had ceased to be part of a religion of salvation. For the Pythagoreans, therefore, it could not have the same significance as it did for the participants in the Orphic mysteries. We can only guess at the extent of its diffusion among the Pythagoreans. This is not simply because of the absence of evidence linking this teaching with particular Pythagoreans: as we have seen, the sources relate everything that concerns the Pythagorean religion either to Pythagoras himself or to anonymous Pythagoreans. There is no doubt that Pythagoras and many of his followers believed in the transmigration of souls, yet we have no grounds to link metempsychosis with any Pythagorean. While the Orphic tablets over many centuries demonstrate the remarkable stability of rituals and shared beliefs,[118] it is much harder to discover any unity of views in Pythagoreanism. Alcmaeon maintained that the soul moved in continual motion like the heavenly bodies and was therefore immortal (A 12, cf. A 1). If this is connected to metempsychosis, it looks like a transformation of it into a purely philosophical doctrine, close to the doctrine of eternal recurrence.[119] According to Hippasus, the soul is fiery; Hippon, who figures in the tradition as an atheist, suggested that it consisted of moisture; Philolaus probably regarded the soul as the principle of life and movement, whereas his students regarded it as the

E. Pender (eds.), *Heraclides of Pontus: Discussion* (New Brunswick and London, 2009), 106 ff.

[117] The contrast between Pythagoreanism and the teaching of the Orphics and Empedocles was already noted by Rohde, *Psyche*, 398 n. 50, but metempsychosis without final release from the body seemed to him 'hardly thinkable'. Cf. W. Stettner, *Die Seelenwanderung bei Griechen und Römern* (Stuttgart, 1934), 7 ff., 29 f.; B. Gladigow, 'Zum Makarismos des Weisen', *Hermes* 95 (1967), 412 n. 6: 'Es ist zudem überhaupt fraglich, ob die Pythagoreer ursprünglich an eine Befreiung aus dem κύκλος gedacht haben.'

[118] Ch. Riedweg, 'Initiation-Tod-Unterwelt: Beobachtungen zur Kommunikationssituation und narrativen Technik der orphisch-bakchischen Goldblättchen', in F. Graf (ed.), *Ansichten griechischer Rituale* (Stuttgart, 1998), 359–98; id., 'Éléments d'un Hieros Logos dans les lamelles d'or', *RHR* 219 (2002), 459–81.

[119] See Eud. fr. 88; Burkert, 296 n. 97–8. On the other hand, it is difficult to reconcile metempsychosis with the anatomical experiments of Alcmaeon and Hippon (below, 375 f.).

'harmony' of corporeal elements.[120] Aristoxenus, a disciple of the last Pythagoreans, whose father was close to Archytas, shared the view of the soul as 'harmony' (fr. 118–21) and denied that Pythagoras observed the prohibitions that flowed from metempsychosis (fr. 25, 28–9). According to Aristotle, some Pythagoreans descried the soul in dust particles suspended in the air (ξύσματα), others in what moved those particles (*De an.* 404a17 f.). The last two opinions (anonymous, be it noted) may have been connected with a belief in reincarnation, but this is by no means certain.[121] We cannot rule out the possibility that the religious beliefs of the Pythagorean philosophers were unconnected with their theoretical views on the soul, and for that reason are not reflected in the doxographical sources.[122] However, this hypothesis too does nothing to clarify what proportion of Pythagoreans believed in the transmigration of the soul.

The position with the prohibitions linked with metempsychosis, in particular that regarding vegetarianism, is also far from clear. If the Orphic tradition, in the classical period at least, is unambiguous: ἐμψύχων ἀπέχεσθαι,[123] the *testimonia* of that time on Pythagoras and the Pythagoreans contradict one another.[124] Whereas Herodotus reports an Orphic and Pythagorean taboo on burial in woollen clothing (II, 81) which must be linked with vegetarianism and metempsychosis, another part of the tradition knows nothing of any Pythagorean abstinence from meat or the practice of bloodless

[120] For more detail, see below, 389 f.

[121] Cf. below, 391. In an Orphic poem it is stated that we inhale the soul, borne by the winds (Arist. *De an.* 410b27 = *OF*, fr. 27). This has been associated, perhaps wrongly, with the Pythagorean view on ξύσματα (Guthrie, *Orpheus*, 94). Aristotle mentions Pythagorean metempsychosis in a different place (*De an.* 407b21 f.). An affinity between the soul and breath is a general Greek idea. It is expressed in a belief in impregnation by the wind, which was shared by Aristotle (*HA* VI,2,15). Whether this belief was linked in Orphism with metempsychosis is not clear, although it is possible (Nilsson, 'Early Orphism', 664 f.; Burkert, 126).

[122] The parallel with Empedocles, whose teaching on the soul was varied, is only partially apposite, since he set down both his philosophical and religious views in writing.

[123] Eur. *Hipp.* 952 f.; Pl. *Leg.* 782c = *OF*, test. 212–13; J. Haussleiter, *Der Vegetarismus in der Antike* (Berlin, 1935), 83 ff. A 3rd-cent. Orphic papyrus, on the other hand, speaks of sacrificial animals: J. H. Hordern, 'Notes on the Orphic Papyrus from Gurob', *ZPE* 129 (2000), 131–40.

[124] Evidence on the subject was collected by Haussleiter (*Vegetarismus*, 97 ff.), who, unfortunately, placed too much faith in the results of the *Quellenforschung* of the early 20th cent., readily attributing many late reports to Timaeus, 'Androcydes', and others; cf. Burkert, 180 f.

sacrifice. 'More conspicuously than others Pythagoras seriously interested himself in sacrifices and in the temple rituals,' writes Isocrates (*Bus.* 28). 'What is most just? – To sacrifice,' says one of the 'symbols' preserved by Aristotle (above, §5.4). The 'symbols' did not demand complete abstinence from animal foods, only from the flesh of non-sacrificial animals or from certain organs (Arist. fr. 194; Iamb. *VP* 85). Heraclides of Pontus reports that Pythagoras introduced a meat diet for athletes and that the Pythagoreans ate the meat of sacrificial animals.[125] The second part of this *testimonium* is confirmed in the 'symbols', and the first in the tradition on the Pythagorean athlete Milon: this πολυφάγος (Arist. fr. 520) made a name for himself by his immoderate consumption of meat and wine.[126]

Against this background, Eudoxus' words from Book VII of his *Circuit of the Earth* sound a discordant note: 'Pythagoras was distinguished by such purity and so avoided killings and killers that he not only abstained from animal foods, but even kept his distance from cooks and hunters' (fr. 325). As a disciple of Archytas, Eudoxus could in principle have known the tradition of the Pythagorean school, but both his reports on Pythagoras are clearly of a legendary nature.[127] In the second half of the fourth century, both lines are developed further, and in the popular tradition vegetarianism becomes one of the main distinguishing marks of Pythagoreanism. Diodorus of Aspendus was an indigent vegetarian; these are the features of the 'Pythagorists' which are given the main emphasis in Middle Comedy (above, §5.2). Aristoxenus, on the other hand, staunchly maintained that Pythagoras abstained only from plough oxen and rams, while using other animal flesh as food and being especially partial to suckling pigs and

[125] Fr. 40 = Porph. *De abst.* I, 26. Besides Heraclides, Porphyry referred to a certain Clodius of Naples (cf. ibid. I, 3). It is therefore not fully clear what exactly in this fragment belongs to the Academic (Burkert, 181 n. 111; Gottschalk, *Heraclides,* 114). J. Bouffartigue (ed.), *Porphyre: De l'abstinence* (Paris, 1977), i. 25 f., makes it appear highly probable that the late compiler Clodius used Heraclides here. See also Wehrli, comm. on fr. 40.

[126] See above, 139 n. 11.

[127] Cf. fr. 324 (probably from the same book) on the divine origin of Pythagoras. It is also unclear whether abstinence from meat is linked with metempsychosis or whether it merely lends emphasis to the 'purity' of the sage of Samos; see F. Lasserre (ed.), *Die Fragmente des Eudoxos von Knidos* (Berlin, 1966), 354 f.; cf. Burkert, 180 n. 108. The legendary Hyperboreans, renowned for their virtue, also abstained from meat (Hellanicus, *FGrHist* 4 F 187b).

tender kids.[128] According to Apollodorus of Cyzicus, Pythagoras sacrificed an ox on the occasion of his discovery of his famous theorem, while in Neanthes of Cyzicus he becomes a Syrian because in ancient times the Syrians did not eat meat or sacrifice animals.[129]

In spite of many attempts to divide the evidence by periods (a complete ban in Pythagoras' time, with subsequent relaxation) or by groups (*mathematici* and *acusmatici*), all the versions cannot be fully harmonized. Despite everything that flowed from the doctrine of metempsychosis, it seems unlikely that Pythagoras adhered to strict vegetarianism.[130] As for the early Pythagoreans, it seems that only the extreme positions can be ruled out, that is, that *all* abstained from meat or that *none of them* observed any taboos. The Pythagorean *hetairiai*, unlike the Orphic *thiasoi*, were very closely associated with political activity, which was incompatible with a complete ban on eating meat. Any religious holiday would require a politician in power to take part in sacrificial ceremonies and in the feasts that came after them. 'By their refusal to eat animal flesh, the Pythagoreans (whatever the attitude of the master himself) isolated themselves from central institutions of social and even political life,' affirms Parker.[131] To be sure, he gives no examples of such isolation, and the reason for this is plain: until the mid-fifth century, and often later (in Tarentum until the 360s), the Pythagoreans were firmly integrated into the socio-political life of Magna Graecia. As far as we can tell, the way out that they found was simple and elegant: the souls of the departed do not enter the bodies of sacrificial animals, and therefore the meat of such animals may be consumed without fear. It is precisely this that is stated in the 'symbol' preserved by Iamblichus (*VP* 85), which nullifies assertions that the *acusmatici* ate no meat at all, while the *mathematici* refrained only partially. The solution found by the Pythagoreans (perhaps by Pythagoras himself) made it possible for those who believed in the doctrine of metempsychosis to follow it without renouncing political activity. This decision can hardly be seen

[128] See fr. 25, 28–9 with comm.; Burkert, 180 n. 109. Aristoxenus also mentions Hippon's 'experiment', in which the male is killed immediately after copulation (fr. 21).

[129] Apollodorus (D.L. VIII, 12; see above, 59 n. 120); Neanthes (*FGrHist* 84 F 29, 32; see above, 68 n. 27).

[130] The best-informed writers of the 4th cent. testify against this: Heraclides (fr. 40), Aristotle (fr. 194; Iamb. *VP* 85), Aristoxenus (fr. 28–9).

[131] Parker, *Miasma*, 296.

as a late rationalization of what was originally a complete ban on meat: it was necessary at precisely the time when the Pythagoreans held power, and not later, when they had come to be less actively engaged in politics.

The tradition on the ban on eating beans is of a more definite nature.[132] Although Aristoxenus maintained that Pythagoras was particularly fond of beans,[133] he knew that this taboo was traditionally linked with Pythagoras. A similar taboo existed in Orphism and in Empedocles (*OF*, fr. 291; 31 B 141), and in both cases it was interpreted in the light of metempsychosis. Originally, however, the taboo bore hardly any relation to the transmigration of souls; it was practised, for example, in the Eleusinian mysteries.[134] Beans, in which much similarity with the human body was perceived, had long been linked with various popular superstitions.[135] Aristotle preserved six different interpretations of the Pythagorean ban on beans, none of which, incidentally, bears any direct relation to metempsychosis.[136] Callimachus provides a more rational explanation: beans are difficult to digest, and therefore, following Pythagoras, it is best to refrain from eating them (fr. 553). In recent times the medical and dietetic aspect of the Pythagorean taboo has been discussed in connection with

[132] See Aristotle (fr. 195); Neanthes (*FGrHist* 84 F 31: the death of the Pythagoreans at the bean field); Callimachus (fr. 553). Heraclides' fr. 41 on the ban on eating beans is attributed to his book *On the Pythagoreans* (Wehrli, comm. ad loc.; Burkert, 183 n. 124), although the Pythagoreans are not named in it, and it cites a verse from an Orphic poem (*OF*, fr. 291). Since Heraclides mentioned the reincarnation of Pythagoras' soul in animals and plants (fr. 89), we cannot rule out that fr. 41 could also have had something to do with the Pythagoreans. For bibliography of the question, see Burkert, 183 f.; Marcovich, 'Pythagorica', 29 f.; M. D. Grmek, *Diseases in the Ancient Greek World* (Baltimore, 1989), 233 ff. It should be noted that the beans meant here are broad beans (*Vicia faba*), long widespread in the Mediterranean region.

[133] 'Of the leguminous plants, Pythagoras especially prized beans, for they have a softening and relaxing effect; for this reason he ate them more often than anything else' (fr. 25).

[134] Paus. 1,37,4, cf. VIII,15,3; D.L. VIII, 33; Porph. *De abst.* IV, 16. Herodotus refers to a ban on beans in Egypt (II, 37), which, however, has not been confirmed (A. B. Lloyd, *Commentary 1–98*, 168 f.). Artemidorus noted the incompatibility of beans with religious ceremonies as a whole (I, 68).

[135] F. Olck, 'Bohne', *RE* 3 (1897), 619 f.; Boehm, 14 ff.; R. Onians, *The Origins of European Thought about the Body, the Mind, the Soul, the World, Time and Fate* (2nd edn., Cambridge, 1954), 111 f.; Marcovich, 'Pythagorica', 29 ff.

[136] Fr. 195 = D.L. VIII, 34 (from the book by Anaximander the Younger), see above, 198 n. 112.

favism (from *Vicia faba*),[137] a disease to which historians of medicine had previously paid little attention. Widespread in Magna Graecia, as in other regions of the Mediterranean, it is a hereditary allergy to beans, an allergy which can lead to serious ill health and even death. Having investigated this topic in detail, M. Grmek concluded that, bearing in mind the particular attention which the Pythagoreans paid to the effects of food on one's bodily state, it could be assumed that Pythagoras and Empedocles knew of favism, though their knowledge was vague.[138] Without turning a religious taboo into a medical prescription, this conclusion points to the possibility that the two coexisted in the Pythagorean environment. To what extent this concerns Pythagoras himself, who did not go in for medicine, remains unknown.

[137] R. S. Brumbaugh and J. Schwartz, 'Pythagoras and Beans: A Medical Explanation', *CW* 73 (1980), 421–2; J. Scarborough, 'Beans, Pythagoras, Taboos, and Ancient Dietetics', *CW* 75 (1982), 355–8.

[138] Grmek, *Diseases*, 240 f. Note, however, that Aristoxenus, who wrote particularly about the various effects of food on the spiritual state (Iamb. *VP* 207–8, from the *Pythagorean Precepts*, see above, 75 n. 61), decisively rejected the ban on beans.

7

Mathematics

7.1 GREEK MATHEMATICS AND THE ORIENT

Turning from Pythagorean religion to Pythagorean science, primarily to mathematics, we retain unchanged the principle which governs our study of sources: a reconstruction of the scientific work of Pythagoras and his followers which is to any degree reliable can be based only on evidence from the fifth and fourth centuries. Contrary to the commonly held view, there is quite a quantity of such evidence, such that, combining it with the few surviving fragments of the ancient Pythagoreans and the reliable part of their doxography, we can compose a much more detailed picture of early Pythagorean science than, for example, religion or politics. This circumstance is connected, not only with the quantity, but also with the quality of the sources accessible to us. For natural reasons the fourth-century tradition on Pythagorean science contains less distortions than, say, the biographical tradition on Pythagoras, to which we have frequently referred in previous chapters, or Aristotle's philosophical treatment of the Pythagoreans, to which we have yet to refer (below, §12.2). Confusion, misinterpretations, and sheer inventions do occur, of course, in the area of the historiography of science. For example, Hellenistic doxography ascribed to Thales and Pythagoras a large number of astronomical discoveries which were not theirs.[1] This instance is, however, explained rather by the absence of written works by Thales and

[1] Thales divided the heavens into five zones (*Dox.*, 340.7), explained eclipses of the sun (353.20), moonlight (358.15), and the phases of the moon (360 b 14), and believed the earth to be a sphere (376.22). Pythagoras was first to call the firmament the cosmos (327.8), knew the five regular solids (334.17), discovered the inclination of the ecliptic (340.21), etc.

Pythagoras and the peculiar evolution of doxography after Theophrastus than by the nature of the science history tradition itself (above, §4.3e).

Yet systematic aberrations were inherent in the ancient historiography of science, too. Foremost among these was a propensity to explain the birth of Greek mathematics and astronomy by the introduction of knowledge from Egypt and Babylon (above, §2.3). A considerable part of the fourth-century evidence of Pythagoras' work in the exact sciences links him to the Egyptians or the Babylonians.[2] There is a parallel and equally persistent tradition of Thales, regarded as the founder of Greek mathematics and astronomy. Both these traditions were transmitted from the ancient historiography of science to the modern, and to this day are the subject of unending disputes.[3] Inasmuch as the beginnings of Greek mathematics and Oriental borrowings therein are connected with early Pythagoreanism, they are reviewed in this chapter (on the situation in astronomy see below, §9.1).

We have in fact already analysed the 'Oriental trail' in the context of Pythagoras' biography (above, §2.3), the result of that analysis being negative: there is no evidence of a journey to the Orient by Pythagoras which is at all reliable. This conclusion is not new; it was drawn in the second half of the nineteenth century and has been confirmed many times since, which has not prevented Pythagoras from being seen in each succeeding generation as a bearer of Oriental wisdom. The image of Pythagoras as a conveyor of Oriental knowledge, esoteric or scientific, has a surprising aptness for regeneration. The need to consider both the historical background against which Pythagorean mathematics developed and the modern research situation prompts us once again to address the issue of Oriental influences, this time from the standpoint of content. If Pythagoras had actually been in Egypt (as were Thales before him and Democritus after him) and even in Babylon (which Herodotus, for example, succeeded in reaching), could this have had any tangible consequences for the development of Greek mathematics?

[2] Isocrates (*Bus.* 21–3, 28–9), Hecataeus of Abdera (*FGrHist* 264 F 25), and Anticleides (*FGrHist* 140 F 1) to Egypt; Neanthes (*FGrHist* 84 F 29) and Timaeus (Iust. XX 4.3) to Babylon (the Chaldeans). See above, 60 nn. 121–3.

[3] See Zhmud, *Origin*, 34 ff., 191 ff., 238 ff.

As early as the Classical period the Greeks were disposed to ascribe an Oriental origin to many of their own achievements, including mathematics; later this tendency only increased. According to Herodotus, geometry was a creation of the Egyptians, driven by the practical needs of surveying and administration (II, 109). Eudemus in his *History of Geometry* also observed that practical needs led to the appearance of geometry with the Egyptians and arithmetic with the Phoenicians. Thales, having visited Egypt, was the first to bring geometry to Greece, while Pythagoras was the first to turn it into a theoretical science (fr. 133). Aristotle, however, supposed that theoretical mathematics also had its origin in Egypt, with priests enjoying sufficient leisure (σχολή) to study problems unconnected with everyday needs (*Met.* 981b23). Aristotle was not the first to express a similar view. According to Isocrates (*Bus.* 21–3), Egyptian priests took up astronomy, arithmetic, and geometry after they, through the solicitude of Busiris, had achieved affluence and leisure (σχολή). Democritus asserted that no one surpassed him in the construction of lines with proofs, even the Egyptian *harpedonaptai* ('rope stretchers', i.e. surveyors).[4] Everything indicates that the prestige of Egyptian geometry was very great in Greece, the talented mathematician Democritus boasting of winning a scientific competition against Egyptian surveyors.

In modern times Egypt continued to be regarded as the home of almost all the Greeks' mathematical achievements before Euclid. Apart from the unanimity of Greek writers (and the inaccessibility of Egyptian texts), the absence of written sources on Greek practical and computational mathematics of the seventh–sixth centuries, the background to the theoretical investigations of Thales and Pythagoras, played its part. Neither the economic texts of that period nor the school problems, found in such abundance in Egyptian papyri and Babylonian tablets of the earlier times, have survived, and we can judge the level of the Greeks' practical mathematics only indirectly, from the remains of architectural monuments and engineering structures. The discoveries of Thales and Pythagoras appeared to come almost from nowhere; hence a natural impulse to perceive in them the result of borrowing. This view, shared by the German school of

[4] B 299 = test. 14 Luria (contra Diels, Luria defended the genuineness of the fragment); S. Gandz, 'Die Harpedonapten oder Seilspanner und Seilknüpfer', *Q&St* B 1 (1931), 255–77.

the history of mathematics, was reflected in the capital work of Moritz Cantor: almost all the theorems traditionally ascribed to Thales and Pythagoras were known to the Egyptians; the distinction between Egyptian and Greek mathematics lies only in the method – inductive in the former and deductive in the latter.[5]

The study of Oriental influences on Greek science was placed on a sound basis only after Egyptian, and then Babylonian, mathematical and astronomical texts were deciphered. One of the chief lessons learnt by the history of science here was this: the Greeks' testimony on Oriental mathematics and astronomy can be trusted only when it is confirmed by the unambiguous data of Oriental texts (see below, §9.1). The publication in the 1870s of the Rhind mathematical papyrus, which demonstrated the very primitive nature of Egyptian geometry, led to a much more restrained assessment of the Egyptians' achievements and the level of their influence on the Greeks. As it was later phrased by Luria, 'All researchers agreed on the main points: 1) that the very fact of influences on early Greek geometry must be recognized as indisputable; 2) that this was not of vital importance, because, even if the Greeks borrowed some numerical data from the Egyptians, then the logically clear and consistent system of demonstrations was independent of this and thanks to Greek genius.'[6]

Pointing out the practical origin of Egyptian geometry, Herodotus and Eudemus were much closer to the truth than Democritus, Isocrates, and Aristotle. After more than a century's investigation of Egyptian mathematics, there is no basis to suppose the presence in it of anything resembling theory or proof. Moreover geometry in Egypt did not take shape in the milieu of priests and was never their prerogative.[7] The Greeks could not borrow from Egypt scientific notions which were not to be found there, and their high opinion of Egyptian geometry merely indicates that they knew of it only by

[5] See C. A. Bretschneider, *Die Geometrie und die Geometer vor Euklides* (Berlin, 1870), 15 f., 43 f.; H. Hankel, *Zur Geschichte der Mathematik im Altertum und Mittelalter* (Leipzig, 1874), 91 f.; M. Cantor, *Vorlesungen über Geschichte der Mathematik*, i (Leipzig, 1880), 109, 112 f., 140.

[6] S. Luria, 'On the Problem of Egyptian Influences on Greek Geometry', *Archive of the History of Science and Technology* 1 (1933), 45 (in Russian).

[7] T. L. Heath, *Mathematics in Aristotle* (Oxford, 1949), 195 f.; J. G. Griffiths, 'Herodotus and Aristotle on Egyptian Geometry', *CR* 2 (1952), 10–11; M. Clagett, *Ancient Egyptian Science: A Source Book*, iii. *Ancient Egyptian Mathematics* (Philadelphia, 1999), 15 ff.

hearsay. All reliable evidence on Egyptian borrowings relates to practical mathematics, moreover to arithmetic, not to geometry.[8] It is clear that these practical methods, as a rule quite primitive, were borrowed and used, not by learned people, but by merchants, navigators, or technicians of various kinds, connected to the Orient by much closer links than Greek mathematicians. Even in those instances when a philosopher's journey to Egypt is indubitable, the probability of direct scientific contacts appears minute. While it can quite well be imagined that Democritus, through Egyptian interpreters, actually attempted to demonstrate to the *harpedonaptai* some theorems or other, does it therefore follow that they responded in kind? For the work in which Egyptian surveyors were engaged, proving theorems was of no use whatsoever.[9] Doubtless Democritus' attempt to establish scientific contacts would fail on both sides.

One of the chief obstacles in this path was the language barrier: in order to comprehend Egyptian or Babylonian mathematics, a foreign language and a highly complicated script had to be learnt. In the Orient, scribes dealing with calculations underwent long years of training.[10] Could a Greek master them in the course of a short visit? The stubborn refusal of the Greeks to learn foreign languages is well known.[11] It was clearly demonstrated in the Hellenistic age also, when contacts with the Orient became much more intensive than earlier: whoever wished to have access to the Greek public had to write in its

[8] Scholia to Plato's *Charmides* (163e) refer to Egyptian methods of multiplication and division, and also to operations with fractions; see Heath, i. 14, 41 f., 52 f.; K. Vogel, 'Beiträge zur griechischen Logistik', *SBAW, math.-naturwiss. Abt.* (1936), 366 f., 429 f. Tannery, *Géométrie*, 48 f., quoting this text, noted that Greek methods were more advanced. Since our information is based on sources from Hellenistic and Roman times, the question when it was that Egyptian methods came to Greece remains unanswered. The earliest example known to me of the presentation of fractions 'in the Egyptian manner' is a Greek papyrus from Egypt of the early third century: D. H. Fowler and E. G. Turner, 'Hibeh Papyrus i 27: An Early Example of Greek Arithmetical Notations' *HM* 10 (1983), 352.

[9] See above, 241 n. 4; K. Vogel, *Vorgriechische Mathematik*, i (Hanover, 1958–1959), 59 n. 4.

[10] See e.g. E. Robson, 'More than Metrology: Mathematics Education in an Old Babylonian Scribal School', in J. M. Steele and A. Imhausen (eds.), *Under One Sky: Mathematics and Astronomy in the Ancient Near East* (Münster 2002), 325–65.

[11] A. Momigliano, *Alien Wisdom: The Limits of Hellenisation* (Cambridge, 1972), 7 f.; J. Werner, 'Zur Fremdsprachenproblematik in der griechisch-römischen Antike', in C. W. Müller et al. (eds.), *Zum Umgang mit fremden Sprachen in der griechisch-römischen Antike* (Stuttgart, 1992), 1–20; A. Strobach, *Plutarch und die Sprachen. Ein Beitrag zur Fremdsprachenproblematik in der Antike* (Stuttgart, 1997), 160 ff., 187.

language (Manetho, Berossus, etc.). A foreign language might be learnt by someone needing it for professional purposes: a doctor or a mercenary serving at the court of an Oriental ruler, a merchant travelling frequently in Oriental lands, etc.[12] Even in later times, however, we know of not one Greek author who knew the Egyptian language and script, including those who lived in Egypt and left accounts of it.[13] There is no evidence that any Greek scientist knew the Akkadian language, in which the Old Babylonians' mathematical texts were written. Rüdiger Schmidt, analysing all references to *Ἀσσύρια / Περσικά / Χαλδαικὰ γράμματα*, concluded that, although the Greeks knew of the existence of cuneiform, they made no distinction among its different forms, regarding cuneiform as some 'oriental script'.[14] Hence the figure of the Greek scientist of the sixth–fifth centuries studying Egyptian hieroglyphics or Akkadian cuneiform in the hope of penetrating the secrets of foreign knowledge remains the fruit of learned imagination and bears no relation to actual contacts between East and West at that time.[15]

The journey of Thales to Egypt seems quite probable;[16] on the other hand, the tradition of his geometrical studies has more than once been doubted.[17] However two theorems worked on by Thales are reported by Eudemus, our most reliable source on early Greek geometry (fr. 134–5); two more are mentioned by Proclus (*In Euc.*, 157.10 f., 250.20 f.), who obtained his information from the same

[12] Egyptians, in fact, interpreted for Greek soldiers in Egypt (Hdt. II, 154). On non-Greek interpreters see also: Xen. *Anab.* IV,8.4; Werner, 'Fremdsprachenproblematik', 12 f.; P. R. Franke, 'Dolmetschen in hellenistischer Zeit', in Müller et al. (eds.), *Umgang*, 85–96.

[13] Iversen, *Myth*, 41 f.

[14] R. Schmitt, 'Assuria grammata und ähnliche: Was wussten die Griechen von Keilschrift und Keilinschriften?', in Müller et al. (eds.), *Umgang*, 21–35. Schmitt mentions not one Greek who knew Babylonian cuneiform.

[15] The widespread borrowing of Babylonian astronomical data and methods of calculation in the 2nd cent. most probably became feasible by dint of their translation into Greek by some Babylonian expert (below, 470 n. 29).

[16] Thales proposed an explanation for the Nile floods which Herodotus (II, 20) mentioned, though without naming him (cf. Diod. I,38,2). The Peripatetic Hieronymus of Rhodes (fr. 40) asserted that Thales measured the height of a pyramid by the length of its shadow.

[17] See e.g. Neugebauer, *ES*, 148; Dicks, 'Thales'; cf. Heath, i. 128 ff.; id., *Euclid: The Thirteen Books of the Elements*, i (Cambridge, 1926), 36 f.; Becker, *Denken*, 37 ff.; Burkert, 416. Aristophanes (*Nub.* 180; *Av.* 1009) presents Thales as a great geometrician, reflecting his reputation in 5th-cent. Athens.

Eudemus, although indirectly.[18] According to Eudemus, Thales 1) was the first to prove that the diameter divides the circle into two equal parts (Euc. I, def. 17); 2) was the first to learn and state that the angles at the base of any isosceles triangle are equal (I, 5), calling them, in the archaic manner, similar, not equal; 3) was the first to discover that if two straight lines intersect, the vertical angles are equal (I, 15), whereas the scientific proof for this theorem was given later by the author of the *Elements*; and 4) knew the theorem about the equality of the triangles that have one side and two angles equal (I, 26), which he must have used to determine the distances of ships from the shore. What of this can we relate to Egyptian geometry? Absolutely nothing. Thales did not need to go to Egypt to be convinced that the diameter divides a circle in half. That the vertical angles formed by intersecting lines are equal can be easily determined by the method of superposition, as can the equality of the angles at the base of an isosceles triangle. As von Fritz observed, the theorems attributed to Thales are 'either directly linked with the problem of symmetry or of a sort where the first step of any demonstration is based on the consideration of symmetry and the second, which leads the demonstration to a conclusion, is a simple addition or subtraction'.[19] The Greeks did not trouble to seek material for proofs; on the contrary, the really original and revolutionary idea of Greek geometry was an aspiration to prove 'obvious' mathematical facts.[20] Thales' theorems of angles and triangles cannot have originated in Egyptian geometry, since neither did the Egyptians ever engage in comparing the size of angles and the similarity of triangles. Neither in Egyptian nor Babylonian mathematics was there the notion of the angle as a measurable magnitude.[21] The geometry of the Egyptians was 'linear',

[18] For a detailed analysis of the sources, see Zhmud, *Origin*, 169 ff., 196 ff.

[19] K. von Fritz, 'The Discovery of Incommensurability by Hippasos of Metapontum', *Annals of Mathematics* 46 (1945) 259.

[20] E. Stenius, 'Foundations of Mathematics: Ancient Greek and Modern', *Dialectica* 32 (1978), 258. It is interesting that Zeuthen wrote in the early 20th cent.: 'However it is difficult to make sense of Eudemus' ascription to Thales of the theorem that a circle is divided into equal halves by a diameter, since one can scarcely have begun by proving something quite so obvious' (H. G. Zeuthen, *Die Mathematik im Altertum und im Mittelalter* (2nd edn., Leipzig, 1912), 35).

[21] See e.g. Vogel, *Vorgriechische Mathematik*, i. 72; ii. 23 n. 2, 39 n. 4; Becker, *Denken*, 39; J. Høyrup, 'Pythagorean "Rule" and "Theorem"', in J. Renger (ed.), *Babylon: Focus mesopotamischer Geschichte, Wiege früher Gelehrsamkeit, Mythos in der Moderne* (Saarbrucken, 1998), 393–407, esp. 402.

as distinct from the 'angle-geometry' of the Greeks, where angles first became objects of measurement.[22]

Even if it is accepted that Pythagoras travelled to Egypt, the discoveries attributed to him in ancient tradition (below, §7.3) bear no relation to Egyptian mathematics. In particular the proposition often advanced that the Egyptians knew the theorem of Pythagoras, or, at least, the fact that a triangle with sides 3, 4, 5 is right-angled, is not confirmed. This triangle's properties in fact were known in Babylon, India, and China, i.e. wherever mathematical culture was to any degree developed. In Egyptian mathematics, however there is nothing indicating familiarity with this or indeed a single instance of the theorem of Pythagoras.[23]

In the 1930s Babylonian mathematics was discovered, proving to be the most developed branch of pre-Greek mathematics. This turned the attention of researchers to seeking its influence on Greek mathematics. Egypt receded into the background and began ever more often to figure as a channel between the Babylonians and the Greeks. Like all the other mathematics of the Orient, Babylonian mathematics grew from a practical environment, but, as it developed, came to solve problems which went far beyond everyday needs. In the scribal schools of the Old Babylonian period (*c.*1800–1600 BC) quadratic equations were solved, which, while they were formulated numerically and took the form of housekeeping problems, clearly served no practical purpose.[24] Despite moving beyond the purely utilitarian, Babylonian mathematics remained pre-scientific and computational: 'in the overwhelming majority of cases the objective of research was to compose a school problem and show ways to solve it'.[25] The

[22] S. Gandz, 'The Origin of Angle-Geometry', *Isis* 12 (1929) 452–82; id., 'Studies in Babylonian Mathematics, ii. Conflicting Interpretations of Babylonian Mathematics', *Isis* 31 (1940) 405–25.

[23] Heath, *Euclid*, i. 352; O. Neugebauer, *Vorlesungen über Geschichte der antiken mathematischen Wissenschaften*, i. *Vorgriechische Mathematik* (Berlin, 1934), 122 n. 1, 168; R. J. Gillings, *Mathematics in the Time of the Pharaohs* (Cambridge, 1972), 238, 242. Some examples known from Demotic papyri are late Mesopotamian borrowings.

[24] A. A. Vaiman, *Shumero-vavilonskaia matematika* (Moscow, 1961), 207 f. J. Høyrup, *In Measure, Number, and Weight: Studies in Mathematics and Culture* (Albany, NY, 1994), 45–87, at 82, regards the demonstration of technical virtuosity as one of the chief stimuli in the development by Babylonian scribes of increasingly complex types of calculation.

[25] Vaiman, *Shumero-vavilonskaia matematika*, 210. Cf. similar assessment: in Babylon we find, not pure mathematics, but pure computation (Høyrup, *In Measure*, 82 f.).

presentation of problems in general terms and deductive proof appeared only in Greek mathematics.[26]

If the Greek tradition on the origin of the sciences is accepted, then the Babylonians yield emphatically to the Egyptians. One of the most popular versions holds that the Egyptians invented geometry, the Babylonians astronomy, and the Phoenicians arithmetic. However the Egyptians were frequently ascribed authorship of all three mathematical sciences, while the Babylonians figured only in connection with astronomy.[27] It was astronomy which was implied by the story about Pythagoras as a pupil of the Chaldeans, and the actual, though very few, borrowings by the Greeks in the sixth–fourth centuries also relate to astronomy.[28] On the other hand, Babylonian mathematics is not once mentioned in Greek literature of the sixth–fourth centuries; it is hard to say whether they had any knowledge at all of it.[29] Not a single reliable trace of Babylonian influence has yet been found in the elementary mathematics and computational methods of the time. Nevertheless the Babylonians are unequivocally more popular than the Egyptians in the contemporary history of ancient mathematics, Pythagoras being often portrayed as an intermediary between the mathematics of the age of Hammurabi and Euclid's *Elements*. Even those who reject Pythagoras' contribution to mathematics find it necessary to point out that Pythagoras' theorem had been known in ancient Babylon.[30]

The modern view of Babylonian mathematics was largely shaped by O. Neugebauer, to whom above all we owe its discovery.[31] It was he who, more than eighty years ago, drew attention to a number of possible points of contact between Babylonian calculations and Greek scientific geometry which are still the subject of discussion in scholarly literature and to which nothing new has been added in the

[26] Becker, *Denken*, 11 f.; van der Waerden, *Science*, 35; K. von Fritz, *Grundprobleme der Geschichte der antiken Wissenschaft* (Berlin, 1971), 335 f.

[27] For evidence see Zhmud, *Origin*, 297 ff.

[28] Including, probably, those of Thales; see below, 318 f. On the Chaldaeans, see above, 60 n. 123.

[29] Iamblichus was the first to connect Pythagoras with the mathematics of Babylon (below, 266 n. 98).

[30] Burkert, 429; Riedweg, *Pythagoras*, 27, 90.

[31] For a history of the study of Babylonian mathematics, see J. Høyrup, 'Changing Trends in the Historiography of Mesopotamian Mathematics: An Insider's View', *HS* 34 (1996), 1–32.

interim.[32] One of them was Pythagoras' theorem;[33] the other was the theory of application of areas (also called geometric algebra), which Eudemus attributed to the Pythagoreans (fr. 137). Although Neugebauer himself rejected the tradition of the scientific studies of Pythagoras, his findings impelled succeeding scholars, van der Waerden in particular, to see Pythagoras as a link between Babylonian and Greek mathematics.[34]

The theory of application of areas (I, 44–5 and the whole of Book II of Euclid's *Elements*) deals with the transformation of one rectilinear figure into another. Investigating its propositions, mathematicians in the eighteenth century had discovered that they could be reformulated in algebraic terms in the form of identities and quadratic equations. For example, proposition II, 3 can be presented as the identity $(a + b)a = a^2 + ab$ and II, 4 as $(a + b)^2 = a^2 + 2ab + b^2$. Since Tannery and Zeuthen the propositions of book II (and the similar propositions in VI, 28–9) have come to be known as geometric algebra and seen as a geometric reformulation of algebraic problems.[35] Finding in ancient Babylonian mathematics corresponding identities and equations, Neugebauer concluded that the algebra reformulated by the Greeks was Babylonian. That Neugebauer regarded his interpretation as a working hypothesis, unconfirmed by documentary evidence,[36] did not prevent it from soon becoming the dominant theory.

The similarity of the Babylonian and Greek methods can be explained both by genetic affinity and as an independent discovery. In the mathematics of ancient China and ancient India there are also problems in the application of areas in which the same identities can

[32] Later attempts to extend the list of putative Babylonian borrowings have been unsuccessful: H. J. Waschkies, *Anfänge der Arithmetik im Alten Orient und bei den Griechen* (Amsterdam, 1989), 71 ff., 304; J. Høyrup, 'Dynamis, the Babylonians and *Theaetetus* 147c7–148d7', *HM* 17 (1990), 201–22.

[33] It is the subject of one of O. Neugebauer's first articles on Babylonian mathematics: 'Zur Geschichte des pythagoräischen Lehrsatzes', *NGWG, math.-phys. Kl.* (1928), 45–8; id., *ES*, 36 f.

[34] Neugebauer, *ES*, 148; van der Waerden, *Science*, 87 ff., 94 ff., 118 ff.; id., *Pythagoreer*, 17 f.

[35] P. Tannery, 'De la solution géométrique des problèmes du second degré avant Euclide' (1882), *Mémoires scientifiques*, i. 254–80; H. G. Zeuthen, *Die Lehre von den Kegelschnitten im Altertum* (Copenhagen, 1886), 6 ff. Thus, to apply a parallelogram with a defect (VI, 28) means the construction on a given straight line a of a rectangle ax such that when square x^2 is subtracted a given square b^2 remains, or $ax - x^2 = b^2$.

[36] Neugebauer, *ES*, 147.

be perceived as in book II of the *Elements,* but evidently they appeared without any external influence.[37] The Babylonian solutions are complex, require special interest and also special training, and could hardly have reached Greece by way of oral transmission (as, for example, occurred with the Babylonian names for the planets). The notion of a Greek mathematician being apprenticed to a Babylonian 'colleague' is not to be taken seriously. The entire terminology of Greek mathematics is of local origin (with the exception of the word 'pyramid'), which also casts doubt on the actuality of borrowings; as a rule, they leave a trail in the language. Last but not least, we have no evidence of the practice of mathematics analogous to Book II of the *Elements* in Mesopotamia in the sixth–fifth centuries: all extant texts relate to the Old Babylonian period.[38] As a result, more and more historians of Greek mathematics are inclined to believe that the application of areas was not a reformulation of Babylonian algebra, but arose on Greek soil in the course of solving purely geometric problems.[39] In recent years experts in Babylonian mathematics have begun to accede to this view: 'So Old Babylonian mathematics cannot have influenced early Greek developments: it was a part of a scribal culture that all but died out nearly a millennium before the earliest Greek literate culture, 1200 miles away.'[40]

[37] E. I. Berezkina, *Matematika Drevnego Kitaia* (Moscow, 1980), 255 f.; I. G. Bashmakova and G. S. Smirnova, 'Novyi vzgliad na geometricheskuiu algebru drevnikh', *IMI* 1/36 (1996), 55–65. Van der Waerden practically excluded the possibility of an independent discovery. Finding similarities among the five ancient mathematics, he postulated their common source in megalithic culture of the 3rd–2nd millennia BC in Great Britain: B. L. van der Waerden, *Geometry and Algebra in Ancient Civilizations* (Berlin, 1983). See criticism: W. R. Knorr, 'The Geometer and the Archaeoastronomers: On the Prehistoric Origins of Mathematics', *BJHS* 18 (1985), 197–212.

[38] Vogel, *Vorgriechische Mathematik*, ii. 12 n. 3; H. Gericke, *Mathematik in Antike und Orient* (Berlin, 1984), 43; E. Robson, 'Influence, Ignorance, or Indifference? Rethinking the Relationship between Babylonian and Greek Mathematics', *BSHM Bulletin* 4 (2005), 1–17.

[39] Á. Szabó, *The Beginnings of Greek Mathematics* (Dordrecht, 1968), 332 ff.; S. Unguru, 'On the Need to Rewrite the History of Greek Mathematics', *AHES* 15 (1975), 67–114; id., 'History of Ancient Mathematics', *AHES* 70 (1979), 555–65; I. Mueller, *Philosophy of Mathematics and Deductive Structure in Euclid's Elements* (Cambridge, 1981), 170 f., 179; B. Artmann, 'Euclid's *Elements* and Its Prehistory', *Apeiron* 24 (1991), 45 f.; I. Grattan-Guinness, 'Numbers, Magnitudes, Ratios, and Proportions in Euclid's *Elements*: How Did He Handle Them?', *HM* 23 (1996), 355–75; C. M. Taisbak, 'Exceeding and Falling Short: Elliptical and Hyperbolical Application of Areas', *Science in Context* 16 (2003), 299–318.

[40] Robson, 'Influence', 13. Cf. J. Høyrup, *Lengths, Widths, Surfaces: A Portrait of Old Babylonian Algebra and Its Kin* (New York, 2002), 400 f. Høyrup continues to

A similar evolution was undergone by Neugebauer's thesis that the Babylonians knew Pythagoras' theorem and also investigated the number-theoretical problem of producing 'Pythagorean numbers' (the combinations of whole numbers satisfying the equation $a^2 + b^2 = c^2$). As Høyrup points out, the Babylonians knew not the theorem, but the rule for determining the values numerically, which they did not prove or even formulate explicitly.[41] An analogous general rule (a square on the diagonal of a rectangle or square is equal to the sum of the squares on the two sides) was known in ancient Indian and ancient Chinese mathematics, so the Greeks could well have discovered it independently. Recently a new interpretation was given to the famous tablet Plimpton 322 (the age of Hammurabi), which had served as the chief evidence that the Babylonians knew 'the fundamental formula for the construction of triples of Pythagorean numbers'.[42] A detailed examination of the tablet has shown that it has nothing to do with number-theoretical problems in general, nor with Pythagorean numbers in particular, but contains a school problem using a list of inverse values.[43] While the general method attributed to Pythagoras of finding Pythagorean numbers is connected to investigations of odd and even numbers (below, §7.3), there is no reason to suppose that the mathematics of the ancient Babylonian period was familiar with the notions of odd and even.[44]

So, on closer examination, some similarities between Oriental calculations and Greek geometry turn out to be delusory, while others are perceived only by someone raised on the analytical geometry of Descartes and capable of translating Babylonian problems into the language of geometrical theorems. Many of the facts which served the first Greek mathematicians as material for proofs were taken from practical mathematics, and it cannot be excluded that some of them might earlier have been borrowed by the Greeks from their neighbours. Semitic borrowings in the Greek related to weights, measures, and practical calculations confirm that this area was open to Oriental

regard the propositions II, 1–10 of the *Elements* as based on data taken from Near Eastern surveyors and transmitted orally.

[41] Høyrup, 'Pythagorean "Rule"', 395 f.

[42] Neugebauer, *ES*, 40.

[43] E. Robson, 'Neither Sherlock Holmes nor Babylon: A Reassessment of Plimpton 322', *HM* 28 (2001), 167–206; ead., 'Words and Pictures: New Light on Plimpton 322', *Amer. Mathem. Monthly* 109 (2002), 105–20.

[44] Robson, 'Neither Sherlock Holmes nor Babylon', 177.

influences, though by no means necessarily Babylonian.[45] Yet the scale of these borrowings should certainly not be exaggerated and their influence on the development of investigations in mathematics proper has not hitherto found reliable confirmation.

7.2 DEDUCTIVE PROOF

It has long been recognized that the systematic application of deductive proof was the most important factor in the formation in ancient Greece of theoretical mathematics on an axiomatic basis. In the first place this led to the formulation of theorems valid for any numbers, and consequently to a rejection of empirical, computational mathematics. In the second place, it stimulated the search for the axiomatic bases of mathematical theory, since deductive constructions, to which one attempts to give a true and non-contradictory nature, must of necessity rest on initial propositions accepted without proof. Nevertheless the deductive method itself, as distinct from simply logical reasoning, is not something inherent in dealing with numbers and figures: for thousands of years mathematics developed without it in the ancient Orient, including India and China. Could mathematics of the practical and computational kind, as it existed in Archaic Greece, give rise *of itself* to a striving for strict proof? Hardly: in geometry, and later in arithmetic, the Greeks began by proving things of no practical use and too simple to be demonstrations of technical virtuosity. We are therefore faced with alternatives: either proof was introduced to mathematics ready-made from outside, or it took shape within mathematics itself, but under the influence of external impulses.

This question relates to Pythagoras inasmuch as he, together with Thales, has traditionally been seen as one of the founders of deductive mathematics. A theory put forward by Á. Szabó (and supported by Burkert) cast doubt on this tradition.[46] According to Szabó, Greek mathematics until the beginning of the fifth century developed empirically, deductive proof, in particular *reductio ad absurdum*,

[45] See e.g. Burkert, *Orientalizing Revolution*, 36 f.

[46] Á. Szabó, 'The Transformation of Mathematics into Deductive Science and the Beginnings of Its Foundation on Definitions and Axioms', *Scripta Mathematica* 27 (1964), 27–48, 113–39; id., *Beginnings*, 185 ff. See also Burkert, 425 f.; Philip, 200.

appearing from the philosophy of the Eleatics. The first examples of deductive proof to have come down to us are in fact fragments of Parmenides and Zeno. Parmenides advances his fundamental thesis that being is, but not-being is not (B 8), from which he derives logically the character of reality: unchanging, unified, eternal etc., then, through *reductio ad absurdum*, refuting other options: the becoming of being, its qualitative diversity, etc. Zeno, refuting the possibility of movement and plurality, also has recourse to indirect proof (A 15, B 1–2). Parmenides was probably the first philosopher to rely on the deductive method, but did he invent it or take it from mathematics, i.e. from Pythagorean mathematics, as was unanimously held until Szabó?[47]

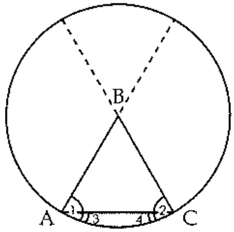
Deductive proof, indirect included, in early Pythagorean mathematics will be discussed below (§7.4). As for Thales, Szabó supposed that he 'proved' his theorems empirically, relying on the visualizability of geometric drawings. Thales did indeed often make use of the method of superposition, from which even Euclid could not entirely free himself (Euc. I, 4, 8),[48] and relied on facts the truth of which is in a number of instances clear to the eye. It does not, however, follow that Thales appealed in his demonstrations to nothing but the visualizability of the geometrical drawing. Aristotle (*APr* 41b13–22) uses as an example a proof of a theorem attributed to Thales (Euc. I, 5) which differs from that provided by Euclid and could well go back to Thales.[49] It is based on the equality of mixed angles, in particular angles in a semicircle and angles of a segment of a circle, which could be proved only by using the superposition method or could follow from the definition of such angles.[50] The process of a proof which demonstrates the normal procedure of deductive reasoning can be re-established as shown in Fig. 7.1:

[47] 'System des Parmenides verdankt seine Form der Mathematik des Pythagoras', Th. Gomperz, *Griechische Denker*, i (Leipzig, 1895), 139; see also I. L. Heiberg, *Naturwissenschaften und Mathematik im klassischen Altertum* (Leipzig, 1912), 10; Burnet, 69; K. Reidemeister, *Das exakte Denken der Griechen* (Leipzig, 1949), 10; Cornford, *Principium Sapientiae*, 117; Cherniss, 'Characteristics', 336; L. Tarán, *Parmenides* (Princeton, 1965), 4. Parmenides' teacher was the Pythagorean Ameinias (D.L. IX, 21); this report of Sotion may go back to Timaeus (see above, 71 n. 42).

[48] Heath, *Euclid*, i, 225 f.; von Fritz, *Grundprobleme*, 401 ff., 477 f.

[49] Heath, *Euclid*, i. 252 f.; Becker, *Denken*, 38 f.; von Fritz, *Grundprobleme*, 475 f.; Neuenschwander, VB, 358 f.

[50] I. L. Heiberg, *Mathematisches zu Aristoteles* (Leipzig, 1904), 25 f.



ABC is an isosceles triangle with its vertex in the centre of the circle. Prove that its base angles are equal. Angle 1 is equal to angle 2, since they are angles of a semicircle; angle 3 is equal to angle 4, since they are angles of a segment of a circle. Taking equal angles from equal angles, we obtain that angles BAC and BCA are equal.

Fig. 7.1 Theorem attributed to Thales.

In the history of science there are many examples where one branch of science adopts a method successful in another area of knowledge. No one, however, is going to adopt a method if its use has not produced tangible results where it arose. Yet deductive proof in the philosophy of the Eleatics, indeed in philosophy in general, does not possess the logical cogency and irrefutability which it does in mathematics.[51] The Eleatics did not in fact succeed in proving any of their basic theses. Their younger contemporaries, the atomists, were quick to reject the idea that there can be no not-being (i.e. void, *κενόν*): it is the void and the atoms moving in it which make up their cosmos. Zeno's attempts to refute the possibility of motion and plurality did not, and could not, succeed,[52] although the problems he raised stimulated the development of philosophy. The Eleatics' influence on the philosophy which followed is due to the depth and boldness of their thought, not to the irrefutability of their conclusions. If the very modest results of the deductive method in philosophy are compared with its contribution to mathematics, the question 'from whom was it taken?' will be seen to be rhetorical.

Philosophers, logicians, historians of mathematics, and philologists united in criticizing various aspects of Szabó's theory;[53] it now has no

[51] Zaicev, 172 f.

[52] Interestingly, Eudemus, whose *History of Geometry* preserved many elementary theorems, described one of Zeno's attempts to refute motion as 'most stupid' and concealing evident sophism (fr. 106).

[53] See e.g. W. C. Kneale, 'Priority in the Use of *reductio ad absurdum*', in I. Lakatos (ed.), *Problems in the Philosophy of Mathematics* (Amsterdam, 1967), 9–10; P. Bernays, 'Some Doubts about the Eleatic Origin of Euclid's Axiomatics', ibid. 14–16; W. R. Knorr, 'On the Early History of Axiomatics: The Interaction of Mathematics and Philosophy in Greek Antiquity', in J. Hintikka et al. (eds.), *Theory Change, Ancient Axiomatics and Galileo's Methodology*, i (Dordrecht, 1981), 145–186;

active supporters. Once again the history of mathematics has turned out to be a barren field for the application of purely externalist explanations. Even those, however, who accept that mathematics is less prone to outside influence than other sciences are unable to exclude it altogether, particularly in respect of the radical transformation which Greek mathematics underwent in the sixth–fifth centuries. If mathematics did not of itself give rise to deductive proof, or adopt it from outside, then, most probably, it came into being in mathematics under the influence of external impulses. Among the conceptions emphasizing social and psychological factors in the birth of theoretical mathematics, the theory of cultural upheaval advanced by Alexander Zaicev merits most attention.[54] One of its central propositions is that, driven by specific historical circumstances, in the Greece of the eighth–fifth centuries, for the first time in human history, all forms of creativity, all aspects of productive cultural activity, including those lacking a direct utilitarian purpose, gained public approval.[55] It is only in such an atmosphere that Thales, an influential and wealthy person, could, without being a professional, as were the Egyptian and Babylonian scribes, undertake to prove that the angles at the base of an isosceles triangle are equal. Moreover he not only undertook this, but achieved in this pursuit public recognition: tradition has preserved his fame as a mathematician and passed down to us the essence of the theorems he worked on. Hence the social climate of the time encouraged any creative achievements, independent of the extent of their practical value, thus setting up the most powerful stimuli for new investigations in this field.

A second important factor in the cultural upheaval was a particular type of competitiveness which characterized Greek society of the time, recognizing as superior a victory which brought fame, not the material benefits entailed. This spirit of pure competition arose in Greek agonistics, then spread to areas of intellectual creativity, first to literature, subsequently to philosophy and science, multiplying tenfold the force of those striving for truth. Once set on the path of free research, unconstrained by narrow practicalness and corporative

Waschkies, *Anfänge*, 1 ff., 14 ff.; A. Zaicev, 'Encore une fois à propos de l'origine de la formalisation du raisonnement chez les Grecs', *Hyperboreus* 9 (2003), 265–73.

[54] Zaicev, 115 ff., 165 ff.

[55] On the important role of supra-utilitarian problems in the development of ancient Babylonian mathematics, see Høyrup, *Lengths*, 362 ff.

ethos, the mathematicians very quickly realized that to apply strict, logical proof makes it possible in this pursuit to achieve irrefutable and hence universally recognized results.

> The first mathematical proofs were the natural fruit of a social climate where the discovery of a new truth not only gave an immediate satisfaction but could also bring fame. For it is clear that in these conditions, mathematical truths confirmed with proof became a particularly attractive object of search; one who found a faultless proof could as a rule count on public recognition, while the achievements in any other field of knowledge could as a rule be disputed.[56]

However many times Thales measured the angles at the base of an isosceles triangle, it could always be objected that one of them was greater or smaller than the other. Deductive proof was a different matter: any sceptic could follow all the stages independently and be persuaded of its irrefutability. The history of geometry in the sixth–fifth centuries allows us to follow how methods based mainly on the evidence of the senses were consistently squeezed out and the deductive method triumphed.[57] The incontrovertible nature of the results thereby achieved was so obvious and alluring that the philosophers followed the mathematicians in adopting it.

7.3 PYTHAGORAS' MATHEMATICS IN FOURTH-CENTURY TESTIMONIES

Our path to Pythagoras' mathematics is long and full of a variety of obstacles. In attempting to show that there was in Pythagoras' personality and in the community he founded nothing incompatible with scientific activity, or that the birth of deductive mathematics is associated with Thales, not Parmenides, we have covered only part of that path. If Pythagoras was not a shaman and theorems were already being proved in his time, this does not imply that he also tried to prove theorems. Let us take the basis on which rests the notion of

[56] Zaicev, 167. 'The competitiveness of Greek intellectual life' was the decisive factor in the formation of Greek science and, in particular, axiomatico-deductive mathematics (G. E. R. Lloyd, *Ancient Worlds, Modern Reflections* (Oxford, 2004), 133, 140, 144).

[57] Reidemeister, *Denken*, 51 f.; von Fritz, *Grundprobleme*, 419 f.

Pythagoras as a mathematician. First of all, this is the firm tradition of the fourth century, which attributes to him engagement in various *mathēmata*. Evidence of this appears from the 390s onwards, yet it does not contradict an earlier tradition of his σοφία, ἱστορία, and πολυμαθία. It is indicative in this context that the authors of the fourth century associate him with *various* mathematical sciences.[58] Such a reputation could not have been based only on certain Platonists having regarded Pythagoras as the founder of number philosophy, which is in itself very doubtful (below §12.1).

There is no doubt that the pupils and followers of Pythagoras from Hippasus to Archytas were engaged in *mathēmata*. It is therefore quite natural to suppose that these studies were launched by the founder of the school. It is true that this natural supposition could have been made in antiquity, indeed even had Pythagoras actually not engaged in science. The logic of the development of Greek mathematics, which makes up in part for the acute lack of reliable evidence, permits an escape from this circle of suppositions. Between Thales, to whom Eudemus attributes the first geometrical theorems, and the author of the first *Elements*, Hippocrates of Chios (*c*.440), from whom came the first mathematical text,[59] there passed a century and a half, during which geometry was transformed into an axiomatic and deductive science. Although we shall never be able to establish the authors of *all* the discoveries made in that period, in a number of cases a combination of historical evidence and mathematical logic makes it possible to do so sufficiently reliably. If Hippocrates makes use of Pythagoras' generalized theorem for acute- and obtuse-angled triangles (II, 12–13), it is clear that an analogous theorem for right-angled triangles had been proved before him. Further, tradition connects the discovery of irrationality with Pythagoras' pupil Hippasus,

[58] Isocrates (*Bus.* 21–2, 28–9)—arithmetic, geometry, astronomy; Xenocrates (fr. 87)—harmonics; Aristotle (fr. 191)—*mathēmata* as a whole and arithmetic in particular; Neanthes (*FGrHist* 84 F 29) and Timaeus (Iust. XX,4.3)—astronomy; Hecataeus (*FGrHist* 264 F 25.98)—geometry and arithmetic; Apollodorus (D.L. VIII, 12) and Anticleides (*FGrHist* 140 F 1)—geometry; Hermesianax (fr. 7.85 f.)—geometry and astronomy.

[59] On the squaring of lunes, as reported by Eudemus (fr. 140), see F. Rudio, *Der Bericht des Simplicius über die Quadraturen des Antiphon und des Hippokrates* (Leipzig, 1907); O. Becker, 'Zur Textgestaltung des Eudemischen Berichts über die Quadratur der Möndchen durch Hippokrates von Chios', *Q&St* B 3 (1936), 411–19; R. Netz, 'Eudemus of Rhodes, Hippocrates of Chios and the Earliest Form of a Greek Mathematical Text', *Centaurus* 46 (2004), 243–86; Zhmud, *Origin*, 202 f.

and the Pythagorean proof that the diagonal of a square is incommensurable with its side, i.e. irrationality $\sqrt{2}$, preserved at the end of book X of the *Elements*, is based on Pythagoras' theorem. Clearly it was proved before Hippasus. Finally, Apollodorus the arithmetician, probably identical with Apollodorus of Cyzicus (second half of the fourth century), attributes the discovery of this theorem to Pythagoras, to which virtually all the authors of antiquity who wrote about it assent.[60] Is it worthwhile to reject the attribution, the history of mathematics having not yet proposed a single worthy alternative to Pythagoras?

Not infrequently even those who accept that Pythagoras engaged in mathematics leave open the question of his specific contribution to the science.[61] As a rule, this is associated with the custom of the Pythagorean school to attribute its scientific achievements to Pythagoras. Hence we are not in a position to single out the part belonging to him.[62] This custom, however, is confirmed neither by early nor late sources (above, §4.3e). We do not know of a single Pythagorean who actually attributed his mathematical discoveries to Pythagoras. The only mention of this custom in ancient literature belongs to Iamblichus (*VP* 158, 198) and is his own conjecture. Were Iamblichus correct, the number of discoveries ascribed to Pythagoras would be beyond the capabilities of a single person; his name would be attached to discoveries going beyond the mathematics of his time and attributed by another branch of tradition to his pupils. Does this picture correspond to what we know from fourth-century sources about Pythagoras' mathematics?

1. According to Isocrates (*Bus.*28), Pythagoras took his philosophy from the Egyptians, more precisely the Egyptian priests (above §1.2.). This is, of course, Isocrates' invention, but it is extremely interesting that the philosophy he describes consisted, *inter alia*, of studies in astronomy, arithmetic, and geometry (23). It bears no relation, naturally, to the concerns of the priests, but is well in agreement with the evidence of other sources on the development of *mathēmata* in the Pythagorean school of the fifth century.[63] Clearly, Isocrates

[60] See above, 59 n. 120 and below, 267 f.; Proclus alone expressed doubt.
[61] Zeller, i. 320 f.; Vogt, 'Geometrie', 48 ff.; von Fritz, 'Pythagoras', 197.
[62] See e.g. Heath, *Euclid*, i. 411; Guthrie, i. 149; similarly Becker, *Denken*, 12.
[63] Delatte, *Pol.*, 45; Froidefond, *Mirage*, 244 f.; Eucken, *Isokrates*, 186 f.

projected onto the priests what he knew about Pythagoras and the Pythagoreans.

2. Xenocrates testifies to Pythagoras' discovery of the numerical expression of concords; he is quoted by Porphyry through a certain Heraclides:[64] 'Pythagoras, Xenocrates says, discovered also that the intervals in music do not come into being apart from number, for they are an interrelation of quantity with quantity. So he set out to investigate under what conditions concordant intervals come about, and discordant ones, and everything well attuned and ill attuned.'[65] Xenocrates paints Pythagoras as the discoverer of mathematical harmony, who investigated the numerical nature of musical intervals.[66] Since this is chronologically the first evidence to attribute to Pythagoras a significant discovery in the area of *mathēmata*, it is very important to determine to what extent it is reliable. Burkert places it in the context of Xenocrates' interpretation of Plato's *Timaeus*: Xenocrates' doctrine of the soul as a 'self-moving number', which doxography takes back to Pythagoras (Aët. IV,2,3–4), is based on Plato's *Timaeus*; hence the Academic treated the ideas of that dialogue as the teaching of Pythagoras. Accordingly the link between number and music also

[64] This was not Ponticus but Heraclides of Heraclea (junior), a musicologist of the 1st cent. AD. On this Heraclides, see D. Creese, 'Herakleides of Herakleia (junior)', in P. Keyser and G. L. Irby-Massie (eds.), *Encyclopedia of Ancient Natural Scientists* (London, 2008), 372 f. For discussion see R. Heinze, *Xenokrates* (Leipzig, 1892), 5 ff.; P. L. Schönberger, *Studien zum I. Buch der Harmonik des Claudius Ptolemäus* (Augsburg, 1914), 113 ff.; I. Düring, *Ptolemaios und Porphyrios über die Musik* (Gothenburg, 1934), 154 ff.; Guthrie, i. 222 f.; Burkert, 64, 380 ff.; M. Isnardi Parente, *Senocrate-Ermodoro: Frammenti* (Naples, 1982), 314 ff.; Barker, *GMW* ii. 230; cf. id., 'Heraclides and Musical History', in Fortenbaugh and Pender (eds.), *Heraclides*, 277 n. 12.

[65] *Πυθαγόρας, ὥς φησι Ξενοκράτης, εὕρισκε καὶ τὰ ἐν μουσικῇ διαστήματα οὐ χωρὶς ἀριθμοῦ τὴν γένεσιν ἔχοντα· ἔστι γὰρ σύγκρισις ποσοῦ πρὸς ποσόν· ἐσκοπεῖτο τοίνυν, τίνος συμβαίνοντος τά τε σύμφωνα γίνεται διαστήματα καὶ τὰ διάφωνα καὶ πᾶν ἡρμοσμένον καὶ ἀνάρμοστον* (Porph. *In Ptol. Harm.*, 30.1 f. = fr. 87). Burkert (64, 380) breaks off the quote from Xenocrates at the first sentence (after *ἔχοντα*) without producing any argument, cf. Barker, *GMW* ii. 30 and 235 n. 113); Heinze and Isnardi Parente, on the contrary, ascribe to Xenocrates the entire reasoning of Heraclides (Porph. *In Ptol. Harm.* 30.1–33.4).

[66] Although Xenocrates does not indicate what intervals are involved, it can be concluded from the evidence of Aristoxenus (fr. 90) and Eudemus (fr. 142) that the ratios of the octave, the fifth, and the fourth were meant.

derives from *Timaeus*, not from Pythagoras.[67] This construct collapses once we remove its main component: to suppose that Xenocrates *himself* attributed his definition of the soul to Pythagoras is unfounded and implausible; it is clearly the work of later doxographers.[68] Since there is no other evidence that Xenocrates took the ideas of *Timaeus* for the teaching of Pythagoras, this obviates the necessity to consider this fragment within the context of Plato's dialogue. The link between number and music is an entirely Pythagorean idea, attested in the tradition regarding Hippasus, Philolaus, and Archytas.[69] Xenocrates' words at least explicate the well-known fact that mathematical harmonics began in the Pythagorean school. It seems likely, moreover, that Xenocrates knew much more than was generally known about this subject: he left behind numerous works on all the sciences of the mathematical quadrivium as a whole and individually.[70] Prominent among them is the book *On (Musical) Intervals* (*Περὶ διαστημάτων*), and our fragment, which twice mentions *τὰ ἐν μουσικῇ διαστήματα*, matches the subject matter of that book much better than it does a philosophical interpretation of *Timaeus*. That Xenocrates' words about Pythagoras originated in a special work on music is indirectly shown by their being quoted in works on harmonics from Heraclides' *Introduction to Music* onwards.[71]

3. A fragment of Aristotle's monograph *On the Pythagoreans* reads: 'Pythagoras, the son of Mnesarchus, first dedicated himself

[67] Burkert, 64 f.

[68] See above, 54 n. 103. Dillon, *Heirs*, 153 f., considers it possible that 'Xenocrates himself was concerned to make the connection', see also Isnardi Parente, *Senocrate*, 383; D. Thiel, *Die Philosophie des Xenokrates im Kontext der Alten Akademie* (Munich, 2006), 333, but even a cursory reading of the section 'On the Soul' in Aëtius shows that this was a tendency of the doxographers, not of Xenocrates. For example, Plato's doctrine on the 'ever-moving' or 'self-moving' soul is attributed here to Thales (IV, 2,1). In Cicero, who was acquainted with the *Vetusta placita* (Aëtius' source, a doxographical compendium of the mid-1st cent.), the definition of the soul as number is attributed to Xenocrates, while the general teaching on the power of numbers is attributed to Pythagoras, who lived much earlier (*Tusc.* I,10,20 = fr. 119; see *Dox.*, 202). Outside Aëtius' doxography and the sources dependent on it the connection of Xenocrates' teaching on the soul with Pythagoras is not attested; see e.g. fr. 172–4.

[69] Hippasus (A 12–15), Philolaus (B 6), Archytas (A 16–19); celestial harmony (Arist. *Cael.* II, 9).

[70] *Περὶ τὰ μαθήματα* in six books, *Περὶ ἀστρολογίας* in six books, *Περὶ γεωμετρίας* in two books, *Περὶ γεωμετρῶν* in five books, *Περὶ διαστημάτων*, *Λογιστικά* in nine books, *Περὶ ἀριθμῶν*, *Ἀριθμῶν θεωρία* (D.L. IV, 13–14 = fr. 2).

[71] On this Heraclides see above, 258 n. 65.

to the study of mathematical sciences, especially numbers, but later could not refrain from the wonder-working of Pherecydes'.[72] Aristotle speaks, not of specific discoveries of Pythagoras, but in general of his studies in *mathēmata,* subsequently giving way to wonder-working in the vein of Pherecydes. This form of words, revealing Aristotle's ambivalent attitude to Pythagoras, hardly contradicts his mentioning Pythagoras only twice in the treatises which have survived, in no way connecting him with *mathēmata.*[73] He also referred to Hippasus, Philolaus, and Archytas without making any connection with their work in *mathēmata,*[74] attributing progress in these sciences to 'the so-called Pythagoreans' (*Met.* 985b23 f.). Overall in the field of *mathēmata* Aristotle is no privileged witness: e.g., he has not a word to say about Thales' work in geometry and astronomy, to which Eudemus attests in detail (fr. 133–5, 143–5). In any case fragments of the *Protrepticus*[75] confirm that Aristotle shared the view common to the Academy and the Lyceum of Pythagoras' scientific activity, and the fragment of the *Polity of Samos* (fr. 611.32) confirms that he knew of the tradition which linked Pythagoras with Pherecydes. Bear in mind that the monograph *On the Pythagoreans* belongs to the same Academic period of Aristotle's life as the *Protrepticus* and, if it mainly brings together the legendary tradition on Pythagoras, that does not mean that we should indiscriminately eliminate everything else. It is significative that only those who completely deny Pythagoras' scientific work contest the authorship of the lines of Aristotle cited above.[76]

[72] *Πυθαγόρας Μνησάρχου υἱὸς τὸ μὲν πρῶτον διεπονεῖτο περὶ τὰ μαθήματα καὶ τοὺς ἀριθμούς, ὕστερον δέ ποτε καὶ τῆς Φερεκύδου τερατοποιίας οὐκ ἀπέστη* (Apollon. *Mirab.* 6 = Arist. fr. 191). The paradoxographer Apollonius (2nd cent.?) goes on to cite legends about Pythagoras collected by Aristotle. Before Pythagoras, Apollonius told of wonder-workers from Epimenides to Pherecydes. The material on Pherecydes was taken from Theopompus (cf. *FGrHist* 115 F 70).

[73] *Met.* 986a30; *Rhet.* 1398b14. If Aristotle was the author of the *Magna Moralia* (see above, 90), then in his mention of Pythagoras (1182a12 f.) a connection with number can nevertheless be traced.

[74] Hippasus (*Met.* 984a7); Philolaus (*EE* 1225a30); Archytas (*Met.* 1043a19, *Pol.* 1340b25, 1412a12).

[75] Fr. 18, 20, see above, 88 n. 108.

[76] In an unpublished work Frank ascribed these words to Theopompus, cf. above, 260 n. 72 (see Philip, 'Aristotle's Monograph', 188). In an article dismissing the early Pythagoreans' contribution to the development of mathematics, Heidel, 'Pythagoreans', 8, contested Aristotle's authorship. His sole argument was this: 'There is, however, no reason whatever to think that the statement derives from Aristotle,

4. In a fragment of Aristoxenus' work *On Arithmetic* we read: 'Pythagoras more than anybody else seems to have valued the science of numbers and to have advanced it, separating it from the merchants' business and likening all things to numbers. For number contains all things as well, and there is a ratio between all the numbers to each other'.[77] Pythagoras' work on numbers in one form or another was mentioned in three preceding testimonies. Aristoxenus' book *On Arithmetic* builds this work into the historical scheme adopted at the Lyceum: mathematics came into being in the Orient stimulated by practical needs; the Greeks turned it into a theoretical science.[78] In accordance with this scheme Eudemus (fr. 133) claimed that the Egyptians invented geometry out of necessity (*ἀπὸ τῆς χρείας*), and the Phoenicians arithmetic, being engaged in maritime trade (*ἐμπορία*). Making use of the same key notions, Aristoxenus states that Pythagoras aided the progress of the science of numbers, freeing it from utilitarian needs (*ἡ τῶν ἐμπόρων χρεία*), i.e. giving it a theoretical character. In the second part of the fragment Aristoxenus cites a number of versions of the Oriental origin of number, or the art of counting, then quotes definitions of unit,

who is expressly cited only as authority for several statements in the sequel'. Philip ('Aristotle's Monograph', 188; id., *Pythagoras*, 23 f.) referred to Heidel without producing any new arguments. According to Burkert (412), 'the transitional sentence between Pherecydes and Pythagoras which also separated the two sources, Theopompus and Aristotle, is supplied by the compiler, either Apollonius himself or his source Bolus'. Nevertheless the first words, *τούτοις δὲ ἐπιγενόμενος Πυθαγόρας κτλ.*, which distinguish Pythagoras from all his predecessors, are sufficient for a transition. It is also hard to explain why the paradoxographer Apollonius found it necessary to insert in legendary material a reference to Pythagoras' mathematics and why there can be clearly felt in it censure of Pythagoras for engaging in wonders. Despite Burkert, the notion of Pythagoras as an authority in *mathēmata* is not at all typical of Hellenism: Aëtius (IV,13,10) attributes it to *ἔνιοι* and it is a frequent aberration in doxography (cf. above, 239 n. 1; below, 323 n. 34); in its form it looks like a late insertion. If, in the 4th cent., some ten authors mention Pythagoras' mathematics, in the 3rd cent. only Callimachus does so, making use of the 4th-cent. tradition (see above, 59 n. 120); it was on this that Cicero and Vitruvius relied in the 1st cent. (see below, 267 n. 100); Diodorus Siculus (I,98,2) cited Hecataeus of Abdera (*FGrHist* 264 F 25.98).

[77] Stob. I, Proem. 6 = Aristox. fr. 23: *Τὴν δὲ περὶ τοὺς ἀριθμοὺς πραγματείαν μάλιστα πάντων τιμῆσαι δοκεῖ Πυθαγόρας καὶ προαγαγεῖν εἰς τὸ πρόσθεν, ἀπαγαγὼν ἀπὸ τῆς τῶν ἐμπόρων χρείας, πάντα τὰ πράγματα ἀπεικάζων τοῖς ἀριθμοῖς. τά τε γὰρ ἄλλα ἀριθμὸς ἔχει καὶ λόγος ἐστὶ πάντων τῶν ἀριθμῶν πρὸς ἀλλήλους* ... Wehrli, following Diels and Meineke, noted a lacuna here. For a detailed analysis of this fragment, see Zhmud, *Origin*, 218 ff.

[78] Zhmud, *Origin*, 210 ff.

number, and even and odd numbers, and deals briefly with the significance of odd days in medicine.

Three of the four definitions cited by Aristoxenus (unit, even and odd numbers) differ from the definitions in the *Elements* (VII, def. 1, 6–7) and derive, to all appearances, from Pythagorean fifth-century work on arithmetic.[79] Philolaus also mentions the division of numbers into even and odd (B 5), and Plato regularly calls arithmetic a science of even and odd.[80] However arithmetic as known from Euclid is *not* a science of even and odd. In the three arithmetical books of the *Elements*, definitions of even and odd are made use of only once, this being in the theory of even and odd numbers (IX, 21–34), which, as Becker demonstrated, belongs to the most ancient stratum of Pythagorean mathematics.[81] This theory is of an elementary nature and has no logical connection with the content of the arithmetical books of the *Elements*. The only proposition in which it is used is the ancient proof that the diagonal of a square is incommensurable with its side,[82] referred to earlier in connection with Hippasus. If Hippasus actually did rely on the theory of even and odd numbers, then it must go back to the time of Pythagoras.[83] Although Aristoxenus' fragment does not directly say that Pythagoras was the author of the theory, it is highly probable that the Peripatetic referred to it as an example of 'the

[79] A unit is a beginning of number; even numbers are divisible into equal parts (not into two, as in Euclid); odd numbers are divisible into unequal parts and have a middle (cf. Arist. *Top.* 142b6, 149a30; *Soph. el.* 173b8). To speak of a number as having middle makes sense only where it is seen in the form of counting pebbles, *psephoi*, as the early Pythagoreans did (Arist. *Met.* 1092b10 f.; Theophr. *Met.* 6a15 f.). As early as Archytas (A 19) and, of course, Euclid, represented numbers are line segments; hence there is no 'middle of the number' in Euclid's definitions: the middle of a segment is a point, not another segment. On the other hand Nicomachus (*Ar.* I,7.2–3, 8.2), Theon of Smyrna (*Exp.*, 19.21, 21.22), and Iamblichus (*In Nic.*, 12.11), who preserved Pythagorean material, present definitions of unit, even and odd numbers similar to those cited by Aristoxenus.

[80] *Charm.* 166a5–10; *Gorg.* 451b1, 451c2; *Res.* 510c4; *Prot.* 357a3; *Tht.* 198a6.

[81] O. Becker, 'Die Lehre von Geraden und Ungeraden im IX. Buch der Euklidischen Elemente', *Q&St* B 3 (1934), 533–53; id., *Denken*, 44 f. Becker dated it to the first half of the 5th cent., van der Waerden (392) to *c.*500. Its antiquity is confirmed by a fragment of a comedy by Epicharmus (born *c.*540) playing on Pythagorean operations with even and odd numbers using *psephoi* (B 2). See von Fritz, 'Pythagoras', 204 f.

[82] Euc. X, app. 27. Aristotle referred to it (*APr* 41a24, 50a37). See Heiberg, *Mathematisches*, 24; Heath, i. 90 f.; Becker, 'Lehre', 544 f., 547; van der Waerden, 398 f.; cf. Knorr, 22 ff.

[83] Von Fritz, 'Pythagoras', 203.

theory of numbers' (ἡ περὶ τοὺς ἀριθμοὺς πραγματεία) advanced by Pythagoras.

5. Probably the most controversial testimony on Pythagoras' mathematics is preserved in an extract from Eudemus' *History of Geometry*, known usually as the catalogue of geometers. This text contains short accounts of the work of twenty geometers from Thales to the older contemporaries of Euclid, six of whom are nowhere else recorded. The catalogue was preserved in Proclus' commentary on Book I of Euclid's *Elements*, but it was not Proclus who compiled it, but an earlier commentator, most probably Porphyry, who abridged and edited Eudemus' text in the Platonic spirit.[84] The passage which interests us runs as follows: 'Pythagoras transformed the philosophy of geometry into the form of a liberal education, searching in an upward direction for its principles and investigating its theorems immaterially and intellectually. He discovered the theory of irrationals and the construction of the cosmic figures.'[85] What is there in this testimony which belongs to Eudemus? He could not ascribe to Pythagoras the construction of the five regular ('cosmic') figures: according to the information which goes back to him, the Pythagoreans had constructed the pyramid, the cube, and the dodecahedron, and Theaetetus the octahedron and the icosahedron.[86] Another fragment of Eudemus attributes the discovery of irrationality to the Pythagorean school (but not to Pythagoras himself), and the development of the theory of irrational magnitudes to the very same

[84] *In Euc.*, 64.16–68.4 = Eud. fr. 133. Proclus does not mention Eudemus in connection with the catalogue, but refers to 'those who wrote the history of geometry before Euclid' (*In Euc.*, 68.4); fragments of the *History of Geometry* coincide thematically with the catalogue. The opinion that the catalogue derived from Eudemus firmed at the end of the 19th cent. (J. G. van Pesch, *De Procli fontibus* (Leiden, 1900), 80); Eggers Lan contested this in favour of Proclus, Lasserre in favour of Philip of Opus, both unsuccessfully: C. E. Lan, 'Eudemo y el "catálogo de geómetras" de Proclo', *Emerita* 53 (1985), 127–57; F. Lasserre, *De Leodamas de Thasos à Philippe d'Oponte* (Naples, 1987), 433 ff., 611 ff. For more detail on the catalogue and its authorship, see Zhmud, *Origin*, 89 ff., 179 ff. The condensed version of the catalogue preserved at the end of Hero's *Definitiones* (136.1) relies on Proclus and hence cannot be Hero's.

[85] Πυθαγόρας τὴν περὶ αὐτὴν (sc. γεωμετρίαν) φιλοσοφίαν εἰς σχῆμα παιδείας ἐλευθέρου μετέστησεν, ἄνωθεν τὰς ἀρχὰς αὐτῆς ἐπισκοπούμενος καὶ ἀΰλως καὶ νοερῶς τὰ θεωρήματα διερευνώμενος, ὃς δὴ καὶ τὴν τῶν ἀλόγων πραγματείαν καὶ τὴν τῶν κοσμικῶν σχημάτων σύστασιν ἀνεῦρεν (*In Euc.*, 65.15 f. = Eud. fr. 133), tr. Mueller.

[86] *Schol. Eucl.* XIII,1, p. 654.3 f. Sachs, *Die fünf platonischen Körper*, 79 f.; Burkert, 450; Neuenschwander, VB, 372 f.

Theaetetus.[87] Whereas Pythagoras was as early as Aëtius linked to the five regular solids,[88] the version that he discovered the theory of irrationals is to be found only in Proclus' catalogue. In order to dispose of this discrepancy, it was long ago proposed that, not 'theory of irrationals' (τῶν ἀλόγων πραγματεία), but 'theory of proportions' (τῶν ἀνὰ λόγων πραγματεία) should be read.[89] This reading, however, is not reliably attested in the manuscripts. Moreover ἀΰλως and νοερῶς are Neoplatonic terms which could not have been used by Eudemus, and the statement that Pythagoras gave to geometry the form of a freeman's education coincides almost word for word with Iamblichus' text.[90] This last coincidence can be explained by the dependence of Iamblichus and Proclus on Porphyry,[91] but this does not solve other problems posed by this passage[92] and leaves open the

[87] From the Arabic version of Pappus' commentary: 'This science (or knowledge) had its origin in the school of Pythagoras, but underwent important development at the hands of Theaetetus', G. Junge and W. Thomson, tr., *The Commentary of Pappus on Book X of Euclid's Elements* (London, 1930), 63–4; cf. Burkert, 440 n. 182; Eud. fr. 141.I; Zhmud, *Origin*, 172. Scholia to book X (415.7, 416.4, 417.12), following Pappus, tell of the discovery of irrationality in Pythagoras' school.

[88] Aët. II,6.5 = 44 A 15, see further Sachs, *Die fünf platonischen Körper*, 8 ff. Speusippus referred to regular solids in *On Pythagorean Numbers* (fr. 28), from where they probably entered doxography (Sachs, *Die fünf platonischen Körper*, 65 f.; Burkert, 71; cf. Tarán, *Speusippus*, 265 f.). It appears that he connected them with the Pythagoreans, not with Pythagoras; in any case, the doxography of Achilles, who, like Aëtius, made use of the *Vetusta placita*, has here *οἱ Πυθαγόρειοι* (*Dox.*, 334 n. = Achill. *Isag.* 6, p. 37.29 f.). Unlike Achilles, Aëtius has *Πυθαγόρας, οἱ ἀπὸ Πυθαγόρου* and *οἱ Πυθαγόρειοι* as practically interchangeable.

[89] See G. Junge, 'Wann haben die Griechen das Irrationale entdeckt?', *Novae Symbolae Joachimicae* (Halle, 1907), 261 ff.; Vogt, 'Geometrie', 38 f.; *DK* i. 98.23; Heath, i. 84 f.; id., *Euclid*, i. 351; Heidel, 'Pythagoreans', 17; von Fritz, 'Pythagoras', 198. Cf. Burkert, 411 n. 64.

[90] *Πυθαγόρας τὴν περὶ τὰ μαθήματα φιλοσοφίαν εἰς σχῆμα παιδείας ἐλευθερίου μετέστησε* . . . (*Comm. Math.*, 70.1). See Vogt, 'Geometrie', 31; Sachs, *Die fünf platonischen Körper*, 30 f.; Burkert, 409 f.

[91] In the same work of Iamblichus (*Comm. Math.* 77.24 f.) there is a short reference to Theodorus and Hippocrates which is absent from the parallel passage in his biography of Pythagoras (*VP* 89). It closely resembles the place in the catalogue where Theodorus and Hippocrates are also mentioned together (*In Euc.* 66.4 f. = Eud. fr. 133). Evidently Iamblichus used the same source, derived from Eudemus, as Proclus (Rudio, *Bericht*, 99 f.; A. Björnbo, 'Hippokrates von Chios', *RE* 8 (1913), 1782; von Fritz, 'Discovery', 245; S. Heller, 'Die Entdeckung der stetigen Teilung durch die Pythagoreer', *AAW* 6 (1958), 7 f.; Burkert, 458 n. 59), i.e. Porphyry.

[92] If it was Porphyry who attributed regular solids and the theory of irrationals to Pythagoras, why does neither he nor even Iamblichus, prone to pan-Pythagoreanism, report this anywhere? Supposing that it was Proclus who did this, we encounter

question whether Eudemus is responsible for its beginning or for some other part.

The account of the discovery of proportions helps to solve this question. The proportions played a very important part in pre-Euclidean mathematics, and Eudemus touched on them more than once in the *History of Geometry*: Hippocrates reduced the problem of doubling the cube to finding two mean proportionals between two given magnitudes; Theaetetus in his classification of incommensurable lines made use of the arithmetic, geometric, and harmonic means; Eudoxus added to the three known proportions three more.[93] Since Eudemus was particularly interested in *prōtoi heuretai*, it is natural to suppose that he referred to the person who discovered the first three proportions. This is reported in Nicomachus: the arithmetic, geometric, and harmonic proportions came down from Pythagoras to Plato and Aristotle, while the three other proportions were discovered later.[94] This report looks plausible, but lacks details making feasible a link with Eudemus, details which we find in Iamblichus' commentary on Nicomachus:

> Of old there were but three means in the days of Pythagoras and the mathematicians of his times, the arithmetic, the geometric, and the third in order, which once was called the subcontrary, but had its own name changed forthwith to harmonic by Archytas and Hippasus, because it seemed to embrace the ratios that govern the harmonized and tuneful. And it was formerly called subcontrary because its character was somehow subcontrary to the arithmetic ... After this name has been changed, those who came later, Eudoxus and his school, invented

another contradiction: outside the catalogue Proclus was very restrained in his attitude to Pythagoras: in the whole commentary he mentioned him twice more and even doubted the authenticity of the story of Pythagoras' discovery of his famous theorem (see below, 267 f.).

[93] Hippocrates (A 4), Eudoxus, and Theatetus (Eud. fr. 133, 141I). Most Greek authors used the terms μεσότης (mean proportional) and ἀναλογία (proportion) interchangeably (Heath, ii. 292 f.; E. P. Wolfer, *Eratosthenes von Kyrene als Mathematiker und Philosoph* (Groningen, 1954), 23 f.; Huffman, *Archytas*, 179).

[94] *Ar.* II, 28, p. 142.21, cf. II, 22, p. 122.11. The theory of the ten proportions transmitted by Nicomachus (II, 22–28) derives from *Περὶ μεσοτήτων* of Eratosthenes, the discoverer of the last four proportions (Iamb. *In Nic.* 116.1 f.; van der Waerden, *Science*, 385 f.; Wolfer, *Eratosthenes*, 20 ff.). This theory is set out in Pappus (*Coll.* III, 70.16 f., 84.1 f.), who frequently referred to *On Means* (ibid. 637.24, 672.5, cf. 662.15). Pappus repeats Nicomachus' short note, omitting all the names. Theon of Smyrna, who also made use of Eratosthenes, attributes the first six proportions to the Pythagoreans (*Exp.*, 116.3).

> three more means, and called the fourth properly subcontrary because its properties were subcontrary to the harmonic . . . and the other two they named simply from their order, the fifth and the sixth. The ancients and their successors thought that this number, i.e., six, of means could be set up; but the moderns have found four more in addition (tr. D'Ooge).

Clearly we have here a fragment of the history of mathematics derived from a reliable and informed source. In Iamblichus the names of Hippasus, Archytas, and Eudoxus, absent from Nicomachus, appear, together with other details of the history of proportions.[95] Archytas' fragment confirms those details: in music there are three proportions, arithmetic, geometric, and subcontrary, 'which we call harmonic'.[96] Eudemus' *History of Geometry* is the most likely source of the story of the discovery of proportions, in which, apart from Eudoxus, Pythagoras, Hippasus, and Archytas figured.[97] This is in full agreement with the evidence of Aristoxenus, indicating that Hippasus in his acoustic experiment made use of arithmetic and harmonic means (fr. 90). This again is an indirect indication that Pythagoras knew the first three proportions.[98] Xenocrates' assertion (fr. 87) that he discovered the numerical basis of the concords (see below, §7.4) should also be understood in the same sense. Hence we have tangible confirmation of what was supposed by many scholars: Eudemus mentioned Pythagoras *at least* in connection with the discovery of the first proportions.[99] Subsequently the compiler of the catalogue and/or Proclus himself edited this passage in a Neoplatonic vein, greatly exaggerating the merits of Pythagoras.

[95] Iamblichus twice more addresses this history, introducing, as he usually does, considerable confusion (*In Nic.*, 113.16 f., 116.1 f., cf. 116.5).

[96] Porph. *In Ptol. Harm.*, 92 = B 2; Huffman, *Archytas*, 162 ff.

[97] Lasserre, *Eudoxos*, 175, also connected this story with Eudemus, but he regarded Eratosthenes, not Porphyry, as the intermediary; cf. Zhmud, *Origin*, 174 n. 33.

[98] According to Iamblichus, Pythagoras took from the Babylonians 'musical' proportion (*In Nic.*, 118.19 f. = 44 A 24), comprising arithmetic and harmonic means. However, the Babylonians had no notion of proportion: O. Becker, 'Frühgriechische Mathematik und Musiklehre', *Archiv für Musikforschung* 14 (1957), 156, 160.

[99] See above, 264 n. 89. That Pythagoras is absent from other fragments of the *History of Geometry* is not a decisive argument: of twenty mathematicians mentioned in the catalogue, only six figure in the remaining fragments.

6. A whole range of writers from Cicero to Proclus mentions or cites the epigram of Apollodorus Logistikos (Athenaeus calls him the arithmetician) on the discovery of Pythagoras' theorem:

> As when Pythagoras the famous figure found,
> For which a sacrifice renowned he brought.[100]

The first to report that the epigram relates to the theorem that the sum of the squares on the sides in a right-angled triangle is equal to the square on the hypotenuse (Euc. I, 47) was Vitruvius; the theorem features in all other sources.[101] Doubts which arose related rather to the sacrifice of a bull[102] than to the authorship of the theorem. It is in this sense that Proclus should be understood, clearly distancing himself from the story of Pythagoras' discovery of the theorem, while not denying it.[103] Such a durable tradition could hardly rest on the text of the epigram alone, from which it is not clear which theorem is involved. Evidently Apollodorus, not for nothing called the mathematician, provided an explanation on this account (quoted in particular by Athenaeus and Diogenes Laertius). The most likely candidate for the authorship of the epigram, Apollodorus of Cyzicus,[104] came from a city where a school of mathematicians founded by Eudoxus was active up to the end of the fourth century.[105] It is

[100] *Ἡνίκα Πυθαγόρης τὸ περικλεὲς εὕρετο γράμμα / κεῖν', ἐφ' ὅτῳ κλεινὴν ἤγαγε βουθυσίην* (*AP* 7, 119, tr. Thomas). See Cic. *ND* III, 88; Vitr. IX, praef.; Plut. *Non posse.* 1094b; *Quaest. conv.* 720a; Athen. X, 418 f; D.L. VIII, 12, cf. I, 25; Porph. *VP* 36; Procl. *In Euc.*, 426.6 f. Plutarch, Athenaeus, and Diogenes cite the epigram with minor variants. Analysis of the testimonies: Junge, 'Wann haben die Griechen', 248 f.; Vogt, 'Geometrie', 16 ff.; Heath, i. 144 ff.; id., *Euclid*, i. 350 ff.

[101] Plutarch found it difficult to decide whether the sacrifice was made on the occasion of Pythagoras' discovery of his theorem or of the theory of the application of areas, which he assessed higher (*Quaest. conv.* 720a). Nevertheless his words make it clear that he regarded Pythagoras as the author of the theorem which bears his name.

[102] First expressed by Cicero: 'It is told of Pythagoras that he, having discovered something new in geometry, sacrificed a bull to the Muses, but I do not believe it, his having refused to sacrifice even to Apollo of Delos' (*ND* III, 88). Porphyry (or his source) attempted to resolve the difficulty as follows: *οἱ ἀκριβέστεροι* assert that the bull was made of dough (*VP* 36).

[103] *In Euc.*, 426.6 f. Proclus himself went to great lengths to avoid meat (Marin. *Vit. Procl.* 12, 19). Interestingly, commenting on the same theorem I, 47, Proclus reports: one of the methods of calculating Pythagorean triples is attributed to Pythagoras (*In Euc.*, 428.7 f.). Proclus expresses no reservations about the authorship of this method, which is directly connected to Pythagoras' theorem.

[104] See above, 59 n. 120.

[105] Zhmud, *Origin*, 98 f., 209, 284 f. The theme of the sacrifice of a bull, contradicting the notion of Pythagoras as a vegetarian which took hold later, also points to

hard to say on which sources Apollodorus relied; we find no traces of any mention by Eudemus of Pythagoras' theorem.

7. The last three testimonies add nothing substantial to what is already known. Hecataeus of Abdera and Anticleides write of Pythagoras' work in geometry and arithmetic in the context of his Oriental borrowings, saying nothing specific about his discoveries.[106] The tradition of Pythagoras' achievements in geometry, popular at the end of the fourth century, is reflected in the lines of the elegy of Hermesianax of Colophon.[107]

As was to be expected, we find in the fourth-century tradition no trace of the story invented by Iamblichus that the Pythagoreans attributed their own scientific discoveries to their teacher. Moreover the evidence cited indicates that the authors of that period were in no way inclined to link *other people's* discoveries to Pythagoras. The majority of writers, as might naturally be expected, speak of his studies in geometry and arithmetic in general terms; those who report specific discoveries (Xenocrates, Eudemus, and possibly Aristoxenus and Apollodorus) deal, not with the higher reaches, but the very beginnings of harmonics, arithmetic, and geometry. The discovery of the numerical expression of concords, the first three proportions, the theory of even and odd numbers, and Pythagoras' theorem all correspond fully with the stage *mathēmata* had reached before Hippasus. Hence nothing was attributed to Pythagoras which could not *in principle* have been his, or, in more cautious terms, could not have belonged to a predecessor of Hippasus. Note the close interrelation of the mathematical problems reported by our sources. This all compels

the 4th cent. (Burkert, 428): Heraclides of Pontus, Aristotle, and Aristoxenus maintained that Pythagoras and the Pythagoreans ate the meat of sacrificial animals (see above, 236 n. 130).

[106] Hecataeus: Pythagoras took from Egypt geometrical and arithmetical theorems (*FGrHist* 264 F 25.98); Anticleides: the Egyptians discovered geometry; Pythagoras perfected it; he was particularly involved in its arithmetical aspect (*FGrHist* 140 F 1). See above, 59 nn. 121–2.

[107] Above, 60 n. 124. The poetic exaggerations of Hermesianax – 'Pythagoras discovered the intricacies of the geometry of curves' (*Πυθαγόρην, ἑλίκων κομψὰ γεωμετρίης εὑρόμενον*) – should not be taken seriously, the less so since his words are hard to connect with a specific discovery. Heath, for example, related them to astronomy ('discovered the subtle geometry of [the heavenly] spirals'), which he discusses further (i. 163; similarly Burkert, 407). Cf. G. Giangrande, 'Textual and Interpretative Problems in Hermesianax', in *Scripta minora Alexandrina*, ii (Amsterdam, 1981), 404–7: 'Pythagoras, who had discovered the niceties of the spirals of geometry . . . '; Di Marco, 'Un problema', 100, 105.

us to treat this tradition, if not with total confidence, at least entirely seriously.

To what extent did the tendency to attribute others' discoveries to Pythagoras manifest itself after the fourth century? The practice of ascribing to philosophers and scientists faked works and letters, familiar sayings, and the inventions and discoveries of others was widespread in antiquity. In this respect Pythagoras was no different from Thales, Democritus, Plato, and many other famous figures. Against what was written about Pythagoras as a philosopher, the post-Classical tradition on his discoveries in mathematics appears very moderate. There is little that can be added to the evidence already cited. In Callimachus we read that Pythagoras, having discovered a certain 'figure' (τὸ σχῆμα), 'was the first to construct scalene (right-angled?) triangles'; a hint of the famous theorem is perceived here too.[108] Plutarch supposed that the bull might have been sacrificed in connection with the theory of application of areas, a more important discovery than Pythagoras' theorem.[109] Favorinus asserts that Pythagoras was the first to provide definitions in mathematics (D.L. VIII, 48 = fr. 59a). According to Iamblichus, Pythagoras knew 'musical' proportion (*In Nic.*, 118.19 f.) and discovered friendly numbers, where each was the sum of the other's divisors (ibid. 34.24 f.). Finally, our last witness, Proclus, ascribes to Pythagoras one of the methods of calculating Pythagorean triples,[110] and the catalogue of geometers passed on by him attributes to Pythagoras the transformation of geometry into a theoretical science, the theory of irrationals, and the construction of regular solids.[111] Hence no writer of antiquity, besides Proclus, links any great discovery to Pythagoras.[112] Beyond the area outlined by the fourth-century authors, little emerges, and beyond early Pythagorean mathematics only the report of friendly numbers. Looking ahead, let us note that we

[108] ὅστις ἀνθρώπων τρίγωνα καὶ σκαληνὰ πρῶτος ἔγραψε (fr. 191, 58 f.). Some treated τρίγωνα σκαληνά as 'right-angled scalene triangles', e.g. 3, 4, 5, which were used in the proof of Pythagoras' theorem (Timpanaro Cardini, iii. 53 f.; Di Marco, Un problema, 104).

[109] See above, 267 n. 101. The end source of Plutarch's doubts could have been Eudemus, who attributed the theory of application of areas 'to Pythagorean muse' (fr. 137).

[110] See below, 239 n. 159. Pseudo-Hero's *Geometrica* (8,1, p. 218) repeats Proclus.

[111] See above, 263 f.

[112] For the doxographical tradition on the five regular solids, see above, 264 n. 88.

observe a similar picture in harmonics. The situation in astronomy is more complicated, chiefly because of distortions in the doxographical tradition.[113]

7.4 PYTHAGORAS AS A MATHEMATICIAN

The tradition on Pythagoras' discoveries in mathematics most probably derives from Pythagorean circles; about its direct sources we can only guess. The case of Thales' science is similar. We do not know and most likely will never know on what sources Xenophanes and Herodotus relied, reporting Thales' prediction of a solar eclipse, or Aristophanes and Eudemus on his geometry, or the Sophist Hippias and Aristotle on his natural philosophy.[114] The solution proposed by Neugebauer, to reject everything connected with the discoveries of Thales and Pythagoras,[115] seems to me a dead end. Eudemus began the history of Greek geometry and astronomy with Thales (fr. 133, 143), and the best thing for us is to follow his reports, while subjecting them to critical examination. To write the history of pre-Euclidean geometry on the basis of texts contemporary with it is impossible: there are no such texts for the period from Thales to Hippocrates of Chios, and almost none for that from Hippocrates to Euclid.[116] That history would have to be begun from Hippocrates,[117] paying no heed to the preceding century and a half, in the course of which geometry came into being and took shape. Note that Hippocrates wrote the first *Elements*, and squared three of the five possible lunes (moon-shaped areas between circular arcs); the other two were squared in the nineteenth century. There would be equally few grounds to begin

[113] See above, 239 n. 1.

[114] Xenoph. (B 19); Hdt. I, 74; Ar. *Nub.* 180; *Av.* 1009; Hippias (B 7); Arist. *Met.* 983b20, *Cael.* 405a19; Eud. fr. 133–5, 140.

[115] Neugebauer, *ES*, 148.

[116] We have at best the evidence of 4th-cent. authors (Plato, Aristotle, Eudemus), some of which, e.g. fragments of Eudemus' *History of Geometry*, are preserved in an altered form in Proclus, Simplicius, and Eutocius, and at worst data from Byzantine sources (scholia to Euclid, the *Suda*). We have no information on the writings of Theodorus, Theaetetus, and Eudoxus on geometry. After Hippocrates, Archytas was the only one of the mathematicians mentioned by Eudemus to have had fragments survive (B 1–2), but they are also unrelated to geometry.

[117] See above, 256 n. 59.

arithmetic and harmonics with Archytas, the author of the first special works on those sciences (*Περὶ μαθημάτων*, *Ἁρμονικός*), fragments of which have survived (B 1–2), since he himself attributed the fundamentals of the four *mathēmata* to his Pythagorean predecessors (B 1). We find traces of studies in all the sciences of the quadrivium in Theodorus of Cyrene (A 2–5) and Philolaus (A 7a, 16, B 5–6), in three of them (geometry, arithmetic, and harmonics) in Hippasus (A 4, 12–15), whereas the Ionians Oenopides and Hippocrates of Chios did not study arithmetic and harmonics. Who then was the predecessor of Hippasus, who added arithmetic and harmonics to the astronomy and geometry which had come into being in Ionia? We have no more suitable candidate than Pythagoras.[118]

One of the significant connecting links among arithmetic, geometry, and harmonics was the theory of proportions. Everything points to Pythagoras' being aware of the first three proportions:[119] the arithmetic $a-b = b-c$ (the difference of the first and second terms is equal to the difference of the second and third terms), where the arithmetic mean is $b = \frac{a+c}{2}$; the geometric $a{:}b = b{:}c$ (the first term is to the second as the second is to the third), where the geometric mean is $b = \sqrt{ac}$; and the harmonic $(a-b) : (b-c) = (a{:}c)$ (the difference of the first and second terms is to the difference of the second and third as the first term is to the third), where the harmonic mean is $b = \frac{2ac}{a+c}$. The arithmetic and harmonic means are closely connected with the ratios discovered by Pythagoras of the basic concords, the octave (2:1), the fifth (3:2), and the fourth (4:3). The octave divides into a fifth and a fourth (2:1 = 3:2 :: 4:3). Moreover the fifth (3:2) is the arithmetic mean between the terms of the octave (2:1), and the fourth (4:3) is the harmonic mean between them. These numbers all form a 'musical' proportion in which the middle terms are the arithmetic and harmonic means between extremes, $a : \frac{a+b}{2} = \frac{2ab}{a+b} : b$, or 12:9 = 8:6.[120]

Pythagoras probably made use of the arithmetical theory of proportions applied to commensurable magnitudes in proving his famous theorem.[121] According to Heath's reconstruction, it went as

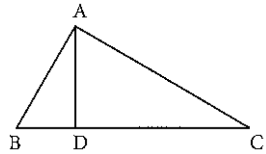
[118] On the origin of the Pythagorean quadrivium, see Zhmud, *Origin*, 62 f.

[119] Heath, i. 84 f.; von Fritz, 'Pythagoras', 203; van der Waerden, 369 f.

[120] Becker, 'Frühgriechische Mathematik', 160 f.

[121] Heath, i. 147 f.; id., *Euclid*, i. 353 f.; Neuenschwander, VB, 369 f.; van der Waerden, 359. Since Euclid set out the general theory of proportions developed by Eudoxus only in book V of the *Elements*, he presented a new proof of Pythagoras' theorem which did not make use of proportions.

follows. Given that in similar triangles ABC, ABD, and DAC the sides are proportional, we obtain the equations shown in Fig. 7.2:



$\frac{AB}{BC} = \frac{BD}{AB}$, hence, $AB^2 = BC{\cdot}BD$;
$\frac{AC}{BC} = \frac{DC}{AC}$, hence, $AC^2 = BC{\cdot}DC$.
Adding these, we obtain: $AB^2 + AC^2 = BC(BD + DC)$, or $AB^2 + AC^2 = BC^2$.

Fig. 7.2 Theorem of Pythagoras.

The next section of Pythagoras' arithmetic is the theory of even and odd, which became the first model of number theory.[122] As Becker thought, and he has been followed by most historians of Greek mathematics, it was preserved in Euclid (IX, 21–34) without substantial changes.[123] Let us take as an example the five propositions of the theory in abridged form:

21. The sum of even numbers is even.
22. The sum of an even number of odd numbers is even.
23. The sum of an odd number of odd numbers is odd.
24. An even number minus an even number is even.
25. An even number minus an odd number is odd.

The proofs of these propositions are based on the definitions of book VII and follow strictly logically. Although Euclid saw numbers in the form of segments, whereas the Pythagoreans used counting pebbles, *psephoi*, this makes no essential difference. Becker showed that the proofs retained by Euclid (not only the propositions themselves) are easily illustrated through the use of *psephoi*.[124] The Pythagorean definitions of unit, number, even and odd numbers passed on by Aristoxenus (fr. 23) were also premised on operations with *psephoi*, while being simultaneously the basis of the deductive theory of even and odd numbers.

It is most unlikely that Pythagoras set out the propositions of this theory without proofs, which were added later by someone: the

[122] See above, 262 f.

[123] Becker, 'Lehre'; id., *Denken*, 44 f.; Reidemeister, *Denken*, 31 f.; von Fritz, 'Pythagoras', 202 f.; Knorr, 135 ff.; van der Waerden, 396 f.; Waschkies, *Anfänge*, 29 ff., 269 ff. Cf. Szabó, *Beginnings*, 246 f.; Burkert, 434 f.

[124] Becker, 'Lehre', 538. Knorr, 140 ff., proposed a simpler method of proofs which, nevertheless, was based on the definitions and the previous propositions.

propositions themselves are for the most part self-evident. The obviousness of the mathematical facts and their deductive proof, however, are in no way contradictory. Like Thales in geometry, Pythagoras in arithmetic began by proving 'obvious' facts which earlier it had not been thought necessary to prove.[125] The fact which follows demonstrates how far he had progressed in working out the deductive method: four propositions of the theory of even and odd numbers are proved by indirect proof (IX, 30–1, 33–4). Szabó, taking notice of this, refused to concede that the proofs are as ancient as the propositions.[126] In essence the only argument he produced, the absence of historical evidence, does not stand up to criticism. There are so few sources on early Greek mathematics that it would be thoroughly utopian to expect to find evidence for every proof.[127] Turning to the mathematical aspect of the problem, we must recognize that Becker's conclusions were correct: the entire theory of even and odd should be considered *en bloc*. (The minor changes noted by him did not affect propositions 30–1, 33–4.) The propositions proved by indirect proof follow quite naturally from those proved directly and do not differ from them in complexity. For example, to prove propositions 33–4 requires nothing but the definitions VII, 8–9. There is no reason to suppose that the initial direct proof was later replaced by the indirect: Greek mathematics systematically avoided such operations. Briefly, everything points to the proofs of the theory of even and odd numbers having reached us in their original form. This confirms once again that indirect proof originated in sixth-century mathematics,[128] after which the Eleatics attempted to apply it in philosophy (above, §7.2).

[125] If the Babylonian scribes could count on recognition of their achievements only within a narrow circle of professionals, the first Greek mathematicians, not being professionals, addressed a similarly non-professional audience. This may well account for the simplicity of their propositions.

[126] Szabó, *Beginnings*, 246 f.

[127] Szabó (ibid.) gives the example of the proof of the incommensurability of the diagonal of a square with its side referred to by Aristotle. Note, however, that Aristotle referred to that theorem more than fifteen times (Heiberg, *Mathematisches*, 24), but only twice to its proof (*APr* 41a24, 50a37).

[128] Another example of the early use of indirect proof is the theorem that the sides of a triangle which subtend equal angles will also be equal (I, 6), the reverse of the theorem proved by Thales that the angles of an isosceles triangle are equal. It could have been proved as early as the 6th cent. (Zaicev, 177).

Our list of Pythagoras' discoveries in mathematics, in which arithmetic noticeably predominates over geometry, is based merely on what follows directly from the evidence of the fourth century, and hence does not claim to be complete. In reconstructing the achievements of Archytas, Theaetetus, Eudoxus, and the other mathematicians of the fifth–fourth centuries, it is accepted practice to combine early and late sources, up to Byzantine.[129] In the case of Pythagoras it is not the completeness, but the reliability of the reconstruction which is in principle important. Otherwise it would be impossible to dispel doubts (regarded by many as insurmountable) as to whether he had any engagement whatever with mathematics. Although a final resolution of that question is hardly attainable, let me note that the evidence we have used of Pythagoras' mathematics stems from the same time, often from the same authors, as the tradition of his life, his politics, his religion, etc. If we accept this tradition in general, then we have no serious grounds to doubt the scientific work of Pythagoras, particularly in those instances when our evidence coincides with the general picture of the development of mathematics.

7.5 HIPPASUS AND PYTHAGOREAN MATHEMATICS OF THE FIRST HALF OF THE FIFTH CENTURY

Of the Pythagorean mathematicians of the first half of the fifth century we know only Hippasus. The names of others have not been preserved, yet this does not mean that there were none: in the period between Pythagoras and Hippocrates, the Pythagoreans achieved too much in mathematics for that to be connected with Hippasus alone. It is possible that, among the dozens of names in Aristoxenus' catalogue which tell us nothing, there were those who engaged in mathematics in Hippasus' time, but no information about them has survived. There was an independent tradition on Hippasus reflected in fourth-century sources. Moreover later authors link with him the construction of a dodecahedron inscribed in a sphere and the discovery of irrationality. Both discoveries are surrounded by dark legends, in some versions of

[129] See above, 270 n. 116.

which Hippasus is named, while in others only an unidentified Pythagorean is spoken of.

1) Hippasus appropriated for himself the discovery of the dodecahedron inscribed in a sphere, and hence perished at sea for his impiety, since 'in reality' all the discoveries are Pythagoras' (Iamb. *Comm. Math.*, 77.18–23 = *VP* 88).

2) He who disclosed to the uninitiated the construction of the dodecahedron perished in a shipwreck at the will of an angry god (Iamb. *VP* 247).

3) The Pythagorean who disclosed to the uninitiated the teaching of irrationals was expelled from the community and a stele was erected to him as to one deceased (Iamb. *VP* 246).

4) The Pythagorean Hipparchus, who disclosed in writing the teachings of Pythagoras, was expelled from the school and a monument was erected to him as to one deceased (Clem. *Strom.* V,9,57).[130]

5) He who disclosed the Pythagorean teaching on irrationality perished for this in a shipwreck (Iamb. *VP* 247; Elias. *In Arist. Cat.*, 125.12).

6) The theory of irrationals originated in the Pythagorean school. He who disclosed it drowned at sea (Papp. *Comm.*, 63–4; *Schol. Euc.*, X, 415.7, 416.4, 417.12).

One does not need a rich imagination for combinations to conclude that all these versions relate to one and the same person, Hippasus. The growth of legends on the disclosure of secrets and subsequent punishment was aided by the double meaning of *ἄρρητος*: 'irrational, not able to be expressed in numbers' and 'sacred, secret'.[131] One notes that Clement and Iamblichus, relying on Nicomachus, name Hippasus, whereas Pappus, who often omitted historical details, and scholia dependent on him, tell only of a Pythagorean.[132] Iamblichus is known for his manner of recounting one and the same episode in contradictory versions,[133] but in this case the various

[130] On the confusion of the names Hippasus/Hipparchus, see above, 188 and n. 71.

[131] This explanation is contained in Pappus' source (Burkert, 461 f.; Knorr, 51 n. 6). On Hippasus and other rivals of Pythagoras (Cylon, Ninon), see above, 97 f.

[132] On Nicomachus see above, 75 and §5.3; Iamb. *VP* 246–7 derives from Nicomachus. On Pappus, see Zhmud, *Origin*, 190.

[133] See above, 186 f.; 266 n. 95.

versions of Hippasus' death were contained in Nicomachus, who represented him as the leader of the *mathematici*. Although Nicomachus is not the most reliable of authors, he often relied on fourth-century sources, even though this might be at second hand. Eudemus, as we remember, attributed to the Pythagoreans the discovery of irrationality and of three polyhedra (including the dodecahedron).[134] Did he in so doing name Hippasus? If Eudemus wrote of anonymous Pythagoreans, while Nicomachus (or his source) replaced them with Hippasus, then the latter may be erased from the history of mathematics, having no other discoveries to his name. Why then does he appear in Nicomachus as claimant to these specific discoveries? Neither Hellenistic biography nor pseudo-Pythagorean literature was able to support Nicomachus.[135]

Naturally, later authors could have had a great variety of motives, yet the name of Hippasus is not simply a peg on which to hang anonymous discoveries. To Aristotle and Theophrastus he was known as a philosopher (*Met.* 984a7; fr. 225 FHSG); Aristoxenus refers to his experiment with discs (fr. 90); he figures in Eudemus in connection with the theory of proportions.[136] Theon of Smyrna, a contemporary of Nicomachus, and later Boethius (from Nicomachus) preserved detailed evidence, derived from fourth-century sources, of Hippasus' mathematical harmonics and acoustic experiments (A 13–14). Thus, since the Pythagorean Hippasus was in fact engaged in philosophy, harmonics, and mathematics, and since this was known to Eudemus, who ascribed to the Pythagoreans the discovery of irrationality and the construction of the dodecahedron, the later tradition, linking these discoveries to Hippasus, could well derive from Eudemus. If, however, Eudemus did name Hippasus, why is his name omitted from the catalogue of geometers and absent from Proclus (as from Porphyry)? There is at least one important reason for this. The catalogue attributes to Pythagoras precisely those discoveries which others ascribe to Hippasus: the discovery of

[134] See above, 263 nn. 86–7.

[135] Diogenes Laertius' biography of Hippasus (VIII, 84) consists of six lines, in which there is not a word about mathematics. According to Demetrius of Magnesia, Hippasus' works were not preserved. The only apocryphal work attributed to him is *Μυστικὸς λόγος*, denigrating Pythagoras (VIII, 7, from Sotion). Hippasus was better known in the 4th cent.; he was regarded as the teacher of Empedocles (D.L. VIII, 55 = Neanth. *FGrHist* 84 F 26).

[136] See above, 265 f.

irrationality and the construction of five regular solids, including the dodecahedron. Hence there was simply no place for Hippasus in the catalogue. Evidently the author (or editor) of the catalogue accepted the tradition firmly linking Hippasus with claiming the discoveries and disclosing the secrets of others, and decided to sacrifice him.

Since Theodorus demonstrated the irrationality of magnitudes from $\sqrt{3}$ to $\sqrt{17}$ (Pl. *Tht.* 147d), the discovery of the irrationality $\sqrt{2}$,—the classic example of which is the incommensurability of the diagonal of a square with its side—is usually attributed to Hippasus.[137] The arithmetical proof of this proposition preserved at the end of book X of the *Elements* (app. 27) makes use of the theory of even and odd numbers, the method of *reductio ad absurdum*, and the least numbers in a given ratio. This all points to its Pythagorean origin. The Pythagoreans, Archytas in particular (A 17, cf. A 19), called the least numbers in a given ratio πρῶτοι ἀριθμοί or *pythmenes* (πυθμένες, 'base' numbers). In his *History of Arithmetic* (fr. 142), Eudemus reports that the Pythagoreans used them to demonstrate the ratios of concords:

> (They said) moreover that it turned out that the ratios of the three concords, of the fourth, the fifth and the octave, taken in the first numbers (ἐν πρώτοις), belong to the number nine. For 2 and 3 and 4 are nine.

According to Porphyry's testimony, which derives eventually from Archytas, the Pythagoreans made use of 'first numbers' to define the most consonant intervals, their calculations clearly being related to an early stage of Pythagorean harmonics (below, §8.1). In a word, much indicates that the proof of irrationality $\sqrt{2}$ which has been preserved derives in its basic features from early Pythagorean arithmetic.[138]

[137] Von Fritz, 'Discovery', 294 ff., supposed that Hippasus had discovered irrationality by investigating the properties of a regular pentagon which make up a dodecahedron. Attempts to find a common measure for the diagonal and the sides of such a pentagon lead to the construction of ever more pentagons, clearly demonstrating that the procedure is infinite. This hypothesis is attractive, since it brings together the two discoveries attributed to Hippasus. Fourth-cent. sources, however, in particular Plato (*Tht.* 147d; *Parm.* 140b–c) and Aristotle (see above, 273 n. 127) connect the discovery of irrationality with the side of a square, not a pentagon. See Becker, *Denken*, 73 f.; Knorr, 21 ff., 26 f.; van der Waerden, 398 f.

[138] Heath, i. 90 f. Becker ('Lehre', 544 n. 11; id., *Denken*, 51) and Knorr, 25, supposed that the least numbers in a given ratio did not enter the initial proof. The

The problems evoked by the discovery of irrationality provided the impulse for the research of Theodorus, Theaetetus, and Archytas and led to the development of Eudoxus' theory of proportions, which was applicable to commensurable and incommensurable magnitudes. Many were even inclined to overrate the significance of this discovery, supposing that it had led to the so-called foundation crisis in Greek mathematics – by analogy with what happened in mathematics at the turn of the twentieth century. This view has now been abandoned, since there is no evidence of such a crisis.[139] Nor has the notion, still widespread, that Hippasus' discovery had dealt a 'fatal blow' to the Pythagorean dogma 'all is number' been confirmed.[140] Even in the late fourth century Aristoxenus, in no way irked by the problem of irrationality, wrote, 'there is a λόγος between all the numbers to each other' (fr. 23). The importance of the discovery of irrationality is one reason why some researchers sought to date it as close as possible to the end of the fifth century. However the necessary mathematical premises for the discovery were already present at the beginning of the fifth century. That two generations passed between Hippasus and Theodorus, who continued his researches, should not disturb us. A time interval of this order, or even greater, is no rarity in the history of science. So the first three proportions were discovered by Pythagoras; the following three were found by Eudoxus; the last four by Eratosthenes.

A notion of the Pythagoreans' achievements in mathematics by the time of Hippocrates can be obtained by comparing the evidence of Eudemus with what emerges from the fragments of Hippocrates himself.[141] Eudemus' basic source on the discoveries of the early

proof which has been preserved proceeds from the fact that such numbers are relatively prime. In the *Elements* this fact is demonstrated (VII, 22), but, at the beginning of the 5th cent., it could have been accepted without proof. Cf. Theon of Smyrna's definition 'Of all the ratios . . . those that are expressed in the smallest numbers and prime to one another are called firsts among those having the same ratio, or *pythmenes* of the same species' (*Exp.*, 80.15 f.).

139 Reidemeister, *Denken*, 30 f.; Burkert, 462 n. 75; Knorr, 40 f., 305 f.; id., 'The Impact of Modern Mathematics on Ancient Mathematics', *RHM* 7 (2001), 121–35.

140 See e.g. Knorr, 42 f. (he dated this discovery to the 430s); cf. below, §11.2.

141 Between Pythagoras and Hippocrates Eudemus named Anaxagoras, of whose mathematics nothing is known, and Oenopides (fr. 133), to whom he attributed two elementary constructions (I, 12, 23) and proposition IV, 16 (fr. 138; Procl. *In Euc.*, 283.7 f., 269.8 f.). See Zhmud, *Origin*, 200 f., 264 f.

Pythagoreans was presumably a mathematical compendium which preceded the *Elements* of Hippocrates and contained the basis of the first four books of Euclid.[142] It is most probable that among its contents were the first explicitly formulated definitions and axioms of geometry, on which proof was based.[143] It follows from reports deriving directly or indirectly from Eudemus that the following geometrical discoveries and theorems belonged to the Pythagoreans: 1) the theorem that the angles of a triangle are equal to two right angles (Euc. I, 32); 2) the theory of the application of areas, to which I, 44–5 and the whole of Book II of the *Elements* are devoted; 3) the theorem, not included in the *Elements*, that only the following polygons can fill up the space around a point: six equilateral triangles, four squares, and three equilateral equiangular hexagons; 4) Book IV of the *Elements*, which deals with the relations between regular polygons and the circle; 5) the construction of the three regular solids; 6) the bases of the theory of irrationality.[144]

The theorems which were known to Hippocrates confirm the reports of Eudemus and at the same time broaden our notions of the level of Pythagorean mathematics. Hippocrates was well aware of a large number of the theorems of Book I of the *Elements*, in particular propositions 1–12, 22–3, 29, 32, 47–8.[145] He was also aware of Pythagoras' generalized theorem for acute- and obtuse-angled triangles (II, 12–13) and the theorem of the regular hexagon inscribed in a circle (IV, 15). At the same time, the regular pentagon inscribed in a circle (IV, 11) must have been known to Hippasus. This confirms the report of the scholia that the whole of Book IV of the *Elements* was known to the Pythagoreans, with the exception of the last proposition on a regular fifteen-angled figure (IV, 16), which

[142] It was reconstructed by B. L. van der Waerden, 'Die Postulate und Konstruktionen in der frühgriechischen Geometrie', *AHES* 18 (1978), 354 ff., who relied on a historical analysis of books I–IV of the *Elements* (Neuenschwander, VB). Since Eudemus' information on Pythagorean mathematics in the first half of the 5th cent. refers not to individuals, but to 'Pythagoreans' in general, the compendium evidently did not contain the names of its authors, presenting the achievements of the school as a whole.

[143] Van der Waerden (360 f.) in particular ascribed to the Pythagoreans the formulation of the first–third and seventh–eighth axioms.

[144] 1) fr. 136; 2) fr. 137; 3) Procl. *In Euc.*, 304.11 f.; 4) *Schol. Euc.* IV, 2, p. 273.3–13); 5) *Schol. Euc.* XIII, 1, p. 654.3; 6) Papp. *Comm.*, 63 f. For an analysis of sources see Zhmud, *Origin*, 169 ff.

[145] Van der Waerden, 'Postulate', 353 f.

probably belongs to Oenopides.[146] Since Book IV is reliant on the propositions of Book III, a number of which are very ancient, while others were used by Hippocrates in the quadrature of lunes, the conclusion should be that the Pythagoreans also knew a large part of Book III.[147] It is true that a number of other theorems were added later, while the older ones were partially revised by Euclid or someone not long before him; a number of the theorems of Book IV were also subject to minor revision.[148] All the propositions of Book II deal with the application of areas, which Eudemus deemed 'ancient' and attributed to the 'Pythagorean muse'.[149] The last proposition (II, 14) deals with the squaring of a rectangle, whereas Hippocrates was engaged in the squaring of lunes. It is clear that Hippocrates not only knew the propositions and theories which Eudemus attributes to the Pythagoreans, but also relied on them in solving his own much more complicated problems.

So, in the field of plane geometry, by the middle of the fifth century, the contents of Books II and IV, most of the propositions of book III, and a significant part of Book I were known to the Pythagoreans.[150] Book I stands alone, since it underwent major revision in the second half of the fourth century; in particular, propositions on parallelograms were added.[151] Moreover Eudoxus' general theory of proportions was set out in Book V of the *Elements*, making it necessary to edit all those propositions in the first four books which relied on the old theory of proportions.

In solid geometry, the construction of the cube, the pyramid, and the dodecahedron can be ascribed to the Pythagoreans. It is true that doubts have been expressed over the dodecahedron, since the construction of the octahedron, a combination of two pyramids on a square base, is much simpler; nevertheless the octahedron is

[146] The style of proposition 16 differs from the remaining theorems of book IV, which permits us to regard it as a later insertion (Neuenschwander, VB, 374) related to astronomy. See K. von Fritz, 'Oinopides', *RE* 17 (1937), 2260 f.; van der Waerden, 348 f.; Zhmud, *Origin*, 200 f., 264 f.

[147] Neuenschwander, VB, 374 f. van der Waerden, 341 ff.

[148] Heath, *Euclid*, i. 370 f., 414; ii. 97 f.; Neuenschwander, VB, 369 f., 378; van der Waerden, 'Postulate', 343.

[149] *ἔστι μὲν ἀρχαῖα, φασὶν οἱ περὶ τὸν Εὔδεμον, καὶ τῆς τῶν Πυθαγορείων μούσης εὑρήματα ταῦτα* (fr. 137). See Heath, *Euclid*, i. 343 f.; Becker, *Denken*, 60 f.; van der Waerden, 341 ff.

[150] Van der Waerden, 357.

[151] Neuenschwander, VB, 357 f.

attributed to Theaetetus and the dodecahedron to Hippasus.[152] To divide the theories of regular polyhedra into two stages (the investigation of individual polyhedra and their general theory) helps to clarify why the more complex polyhedron was constructed before the simpler and petty one.[153] Hippasus studied, not the theory of regular solids as such, but the dodecahedron itself. On the other hand Theaetetus, having posed the question of which regular solids could be constructed, easily discovered the octahedron.

Aristotle maintained that contemporaneously with Leucippus and Democritus and before them, the Pythagoreans devoted themselves to mathematics and 'were the first to advance this study' (*Met.* 985b23 f.). His words imply that, in the period between Hippasus (who lived before Leucippus) and Theodorus (the contemporary of Democritus and Hippocrates), the Pythagoreans achieved substantial success in all the sciences of the quadrivium. If they did not have a monopoly in geometry, in arithmetic all the mathematicians of the fifth–fourth centuries were either Pythagoreans or their pupils, like Theaetetus and Eudoxus. In the opinion of Aristoxenus the founder of the theoretical science of numbers was Pythagoras (fr. 23); the Pythagoreans figured both in the *History of Geometry* and the *History of Arithmetic* of Eudemus (fr. 133, 136–7, 142). Heath believed that the basis of Euclid's three arithmetical books (VII–IX) derived from the Pythagoreans, including Theodorus and Archytas.[154] The high standard of Archytas' arithmetical proofs presupposes an established and deductively developed discipline. He had good reason to assert that arithmetic surpasses geometry in clarity and exactness, accomplishing proofs where geometry fails (B 4).[155] This assessment must in the first place relate to the Pythagorean arithmetic which preceded him. Many believed that an arithmetical compendium analogous to Hippocrates' *Elements* in

[152] Sachs, *Die fünf platonischen Körper*, 82 f.

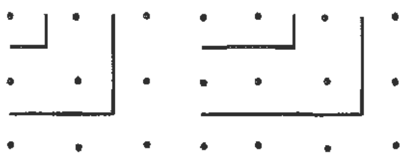
[153] W. C. Waterhaus, 'The Discovery of the Regular Solids', *AHES* 9 (1972), 212 ff.; E. Neuenschwander, 'Die stereometrischen Bücher der Elemente Euklids', *AHES* 14 (1974), 104.

[154] Heath, *Euclid*, ii. 294. Van der Waerden (416 f.) ascribed book VIII to Archytas or his school, and book VII to Pythagoreans before Archytas. Knorr, 244, attributed book VII to Theaetetus, and book VIII to Archytas, but according to Eudemus (fr. 133) they belonged to the same generation (Zhmud, *Origin*, 92 ff.). Huffman, *Archytas*, 468 f., admits that Archytas relied on the basis of book VII.

[155] See Knorr, 58 n. 71, 92 f. 'The analysis of certain classes of problems in geometry, e.g. the construction of irrational lines, can only be completed by means of arithmetical principles' (311); Zhmud, *Origin*, 60 f.

geometry existed before Archytas;[156] definitions cited by Aristoxenus (fr. 23) confirm this hypothesis (above, §7.3).

Let us note that *early* Pythagorean arithmetic is reflected only to a minor degree in the Euclidean *Elements*. The remaining material, conveyed through Speusippus, Philip of Opus, and others, was accessible to authors of Imperial times and found in them zealous admirers. Most historians of Greek mathematics date a significant part of this material, in particular figured numbers, to the first half of the fifth century.[157] The construction of figured numbers by means of a gnomon (a gnomon retains unchanged the form of that to which it is attached) belongs to the same type of psephic arithmetic as the theory of even and odd numbers. It is the sum of simple arithmetical series, for example even and odd numbers, as shown in Fig 7.3.



square number $1 + 3 + 5 + \ldots + (2n - 1) = n^2$
oblong number $2 + 4 + 6 + \ldots + 2n = n\,(n + 1)$.

Fig. 7.3 Figured numbers.

Figured numbers are set out in a popular form, without proofs, in Nicomachus (*Ar.* I, 7–11, 13–17), Theon (*Exp.*, 26–42), and in Iamblichus' commentary to Nicomachus. A plausible reconstruction of the deductive theory of figured numbers was proposed by Knorr, even though he doubted whether the Pythagoreans had constructed it as strictly axiomatically as he did.[158] Isolated fragments of

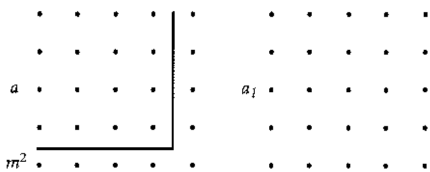
[156] P. Tannery, 'Un traité grec d'arithmétique antérieur à Euclide', *Mémoires scientifiques*, iii. 244–250; Heath, i. 90, id., *Euclid*, ii. 295; Becker, *Denken*, 44 f.; van der Waerden, 392 ff., 411 ff.; Huffman, *Archytas*, 467 f. On the contrary, Burkert, 427 ff., believes that Pythagorean arithmetic before Archytas consisted of formulae borrowed from the Babylonians, number mysticism, and vague speculations on even and odd. Cf. Waschkies, *Anfänge*, 275 f.

[157] Heath, i. 65 ff.; Reidemeister, *Denken*, 15 f.; Becker, *Denken*, 40 f.; Knorr, 131 ff.; van der Waerden, 392 ff.; Waschkies, *Anfänge*, 29 ff., 37 ff., 261 ff. Aristotle mentioned people who 'bring numbers into the forms of triangle and square' (*Met.* 1092b13; cf. *Phys.* 203a13); Speussipus discussed 'polygonal numbers' (fr. 28). Philip of Opus wrote *On Polygonal Numbers* (20 T 1 Lasserre).

[158] Knorr, 142 ff.; see also Waschkies, *Anfänge*, 37 ff.

Pythagorean arithmetic come to light even later. To conclude, let us indicate some. Proclus ascribes to Pythagoras the method of defining Pythagorean triples, which was most probably discovered as square numbers were investigated.[159] This is his reconstruction. Adding a gnomon to a square, we obtain the square shown in Fig. 7.4; hence a gnomon must be found which is itself a square number.

a side of a square,
gnomon $m^2 = 2a + 1$,
hence (1) $a = \frac{m^2-1}{2}$;
(2) $a_1 = a + 1 = \frac{m^2+1}{2}$



For m^2 to satisfy equations (1) and (2), m must be odd. Hence we obtain $m^2 + \left(\frac{m^2-1}{2}\right)^2 = \left(\frac{m^2+1}{2}\right)^2$, which corresponds to Pythagoras' theorem.

Fig. 7.4 Method of finding Pythagorean triplets.

In his commentary to the *Republic*, Proclus attributes to the Pythagoreans the method of finding the so-called 'side and diameter numbers', used in approximating the ratio between the sides and diagonal of a square.[160] This algorithm reduces to the theorem that the square of an irrational diameter differs from the square of the corresponding rational diameter by a single unit.[161] Unlike this arithmetical method, the respective geometrical theorem is preserved in the *Elements*, contained in the Pythagorean theory of the application of areas (II, 10).[162]

159 *In Euc.*, 428.7 f. See Heath, *Euclid*, i. 356 ff.; von Fritz, 'Discovery', 252; van der Waerden, *Science*, 99; Knorr, 155 f.; Waschkies, *Anfänge*, 271.

160 *In Rem publ.* II, 24, 16 f. Cf. Pl. *Res.* 546c; Theon. *Exp.*, 42 f.

161 Heath, i. 96; Becker, *Denken*, 67 f., 73 f.; Knorr, 33 f.; van der Waerden, 402 f.

162 See Heath, *Euclid*, i. 398 ff.; Neuenschwander, VB, 349, 371.

8

Harmonics and Acoustics

8.1 PYTHAGORAS AND THE SCIENCE OF MUSIC

Music occupied a special place in Greek culture. Of all the arts at which the Greeks excelled – painting, sculpture, or architecture – they valued none so highly as music. It enjoyed the patronage of the Muses, and particular forms of music and even certain instruments were seen as deriving from the gods: Hermes, Apollo, and Athena. Music was thought to have the power to purify the body and soul, to heal and cultivate, or on the other hand to rouse to a frenzy. Music was the only art taught to youth. Musical training, on an equal plane with reading and writing, began to appear in the sixth century. In the mid-fourth century Plato asserted that one who is untrained in music and dancing is uncultivated (*Leg.* 654a). There was no form of art that the Greeks discussed as often as music, and to no other did they devote so many special writings. The author of the first work on the subject was a younger contemporary of Pythagoras, Lasus of Hermione,[1] and a thousand years later 'the last Roman' Boethius set down in *De institutione musica* the fundamentals of Greek harmonic science, derived mostly from the neo-Pythagorean Nicomachus.[2]

Theory apart, nothing of ancient Greek music survived down to the Renaissance except its fame. A few dozen surviving musical scores were deciphered only in the nineteenth century. However, even if Greek music were directly accessible for perception, it still could not

[1] *Suda*, s.v. Lasus: *πρῶτος δὲ οὗτος περὶ μουσικῆς λόγον ἔγραψε*. Cf. Aristox. *Harm.*, 7.19 f.; Theon. *Exp.*, 59.4 f. = A 3.

[2] C. Bower, 'Boethius and Nicomachus: An Essay Concerning the Sources of the *De institutione musica*', *Vivarium* 16 (1978), 1–45.

lay claim to any role as an unsurpassed ideal, in the way that ancient fine arts have served for centuries. This is one of those cases in which the *opinio communis* of antiquity is at variance with that of modern specialists. In the development of musicology there has been much greater continuity. The fundamental principles of Greek musical theory were taken up and developed by European musicologists. Three basic elements of that theory which the ancient tradition linked with Pythagoras continue to be associated with his name: (1) the mathematical treatment of music, (2) the doctrine of a musical ethos, or the psychagogic and educative effects of music, (3) the famous 'harmony of the spheres' generated by the movement of the heavenly bodies.

The Pythagorean origin of the first and third of these elements is not open to serious doubt. The establishment by Pythagoras of a link between music and number led to the inclusion of harmonics in the *mathēmata*[3] and predetermined all the further development of ancient (and not only ancient) musicology. It is no accident that works of musical theory were written by outstanding mathematicians like Archytas, Euclid, Eratosthenes, and Ptolemy. Throughout antiquity, Pythagorean mathematical harmonics remained one of two principal directions in musical science, competing with the theory of Aristoxenus. Though a pupil of the Pythagoreans in music, as in other things, Aristoxenus opposed treating it mathematically and argued for greater faith in the ear.[4] Apart from arithmetic, Pythagorean harmonics was bound up with astronomy. The affinity between these two sciences is mentioned by Plato with a reference to the Pythagoreans (*Res.* 530d), meaning above all Archytas (B 1); in the same dialogue Plato sets forth his version of the heavenly harmony (616b–617d; cf. *Tim.* 34b–36d). Aristotle's account of this doctrine (*Cael.* 290b) also has parallels in Archytas. Although the idea of heavenly harmony is not attested in Philolaus, there are solid grounds to suppose that it dates back to the early Pythagorean school (below, §9.3).

By contrast any connection between Pythagoreanism and ideas of the ethos of music is a matter of conjecture. In the late tradition, Pythagoras sometimes appears as the protagonist of stories which illustrate how music affects the soul by means of certain modes and

[3] Xenocr. fr. 87; Aristox. fr. 90 = A 12; Theodor. A 2–5; Philol. B 6; Archyt. B 1–2.

[4] See above, 64 n. 11.

metres. Thus Sextus Empiricus, embarking on a critique of views of music current in his time, writes:

> If, they say, we welcome philosophy as regulating human life and repressing passions of the soul, much more shall we welcome music because it produces the same results as philosophy not by commanding us in a violent manner but by means of seductive persuasiveness. Thus Pythagoras, having noticed on one occasion that the youths who were in a state of Bacchic frenzy from drunkenness differed not at all from madmen, advised the flute-player who was with them in their revels to play them the 'spondean' tune; and when he had done as instructed, they suddenly changed and became sober just as if they had been sober from the beginning.[5]

A similar episode figures in Iamblichus (*VP* 112), who gives a detailed account of the methods of education through music devised by Pythagoras and the Pythagoreans, and their ways of using music to treat mental illness.[6] In Galen, Damon of Athens, a teacher and theorist of music who was close to Pericles, is the protagonist of an analogous tale.[7] The appearance in this context of Damon, who was far less famous than Pythagoras, is no accident.[8] Plato, in whom we find quite pronounced ideas of the ethos of music, linked them with none other than Damon.[9] Assertions that Damon was a Pythagorean, or at least was influenced by Pythagoreanism, migrate from one work to another,[10] but the sources do not confirm them.[11] In the

[5] *Adv. math.* VI,7–8, tr. Bury. This story is first mentioned by Cicero (*De consiliis suis*, fr. 3 = Opera iv.3, p. 339 Müller), see also: Plut. *De Isid.* 384a; Quint. *Inst. or.* I,10,32; Elias. *In Porph.*, 31.11 f.; Ammon. *In Porph.*, 13.24 f; Boeth. *Inst. mus.* I,11.

[6] *VP* 110–14, 164, cf. Porph. *VP* 33; Cael. Aurel. *De morb. acut.* IV,47.

[7] *De Hipp. et Plat.* V,6,21 = 37 A 8. Like some other members of Pericles' circle, Damon was ostracized, probably in the 430s: P. Siewert (ed.), *Ostrakismos-Testimonien I.* (Stuttgart, 2002), 459 f.; R. W. Wallace, 'Damon of Oa: A music theorist ostracized?', in P. Murray and P. Wilson (eds.), *Music and the Muses* (Oxford, 2004), 249–68.

[8] The story was most probably transferred from Damon to Pythagoras: F. Lasserre (ed.), Plutarque: *De la musique* (Lausanne, 1954), 62 f.

[9] *Lach.* 180d, 197d, 200a; *Res.* 400b–c, 424c = *DK* 37.

[10] See e.g. W. D. Anderson, *Ethos and Education in Greek Music* (Cambridge, 1966), 36 f.; M. L. West, *Ancient Greek Music* (Oxford, 1992), 246 f.; cf. above, 118.

[11] R. W. Wallace, 'Music Theorists in Fourth-Century Athens', in B. Gentili and F. Perusino (eds.), *Mousike: Metrica ritmica e musica greca* (Pisa, 1995), 19 ff. The scholia to Plato's *Alcibiades* (118 C = 37 A 2) give a very strange genealogy: 'Pythoclides was a musician . . . and a Pythagorean; Agathocles was his pupil, Lamprocles was a pupil of Agathocles, and Damon was a pupil of Lamprocles.' Plato himself called Damon's teacher Agathocles (*Lach.* 180d); of the Pythagoreanism of Pythoclides of

Pythagorean tradition of the fifth–fourth centuries, including Philolaus and Archytas, any judgements on the ethos of music are absent. A treatise on music by an unknown author, usually dated to the years 390/80, attributes the idea that some melodies rear abstemious people, others – courageous people, yet others – fair-minded people, etc. to the so-called *harmonikoi*,[12] a trend in musicology which opposed the Pythagoreans in almost everything. According to Aristoxenus, 'the Pythagoreans used medicine to purify the body and music to purify the soul' (fr. 26), but this indicates a therapeutic effect of music rather than a pedagogical one.[13] According to Theophrastus, Aristoxenus used music to treat mental illness,[14] and his Pythagorean teachers, such as Xenophilus, may also have applied musical psychotherapy. Yet the idea of purifying the soul, in particular, by using music has such close parallels in Plato and Aristotle that it cannot be said to be Pythagorean in origin.[15]

Fifth- and fourth-century sources clearly testify that Pythagoras and his followers were interested primarily in the numerical nature of musical harmony and the physics of sound, rather than the effect of particular musical forms on the human psyche or character.[16] Fortunately for Pythagoras and Greek science as a whole, elementary calculations showed that the height of a note was in inverse proportion to the length of the string, and that basic concords could be expressed by means of simple numerical ratios. An octave, for example, could be obtained by dividing a string in a ratio of 2:1, a fifth 3:2, and a fourth 4:3. In acoustics the Pythagoreans encountered more

Keos, who taught Pericles music (Pl. *Prot.* 316e; Arist. fr. 401) nothing is known. See West, *Music*, 350; Barker, *Science*, 87 f.

[12] See Anderson, *Ethos*, 147 ff.; Barker, *GMW* i. 183 f.

[13] Aristotle, for one, contrasted education and purification through music (*Pol.* VIII, 5 and 7, esp. 1341b27 ff.).

[14] Aristox. fr. 6 with comm. Theophrastus himself believed that music could heal both mental and physical ailments: fr. 716 (end), 726 a–c FHSG; Barker, *Science*, 433.

[15] Pl. *Phaed.* 67c–e: the opposition of body and soul, κάθαρσις through philosophy (Burkert, 211 f.); Arist. *Pol.* 1342a8: sacred music acts on the soul as ἰατρεία and κάθαρσις. See A. Ford, 'Catharsis: The Power of Music in Aristotle's *Politics*', Murray and Wilson, *Music*, 309–36.

[16] The identification of ψυχή with ἁρμονία, found in some of Philolaus' pupils (A 23, Pl. *Phaed.* 88d), has nothing to do with the ethos of music (see below, 390 f.). It is indicative that Archytas ascribed to arithmetic, not to music, the potential to improve moral qualities (B 3); Zhmud, *Origin*, 71 f.

serious problems, but here too they were able in the end to come close to an accurate solution.

The names which represent Pythagorean harmonics are practically the same as the those representing mathematics: Pythagoras, Hippasus, Philolaus, and Archytas. Of course there were far more Pythagoreans working on harmonics and acoustics, but their names and/or their contribution to musical knowledge are unknown.[17] Information on specific achievements linked with particular individuals is also distributed in a familiar pattern: in each case we know more of the later generations than of those who preceded them. From a historian's perspective, this is absolutely natural. The situation is complicated, however, by the fact that the neo-Pythagoreans and Neoplatonists developed a vast legendary tradition on Pythagoras' acoustic experiments, his skill in playing the monochord, his ability to hear the music of the spheres, etc. In late antique Rome he was seen as a music theorist par excellence.[18] Citing the scarcity of reliable and the abundance of unreliable information, some scholars begin their study of Pythagorean harmonics not with Pythagoras and Hippasus, but with Philolaus. The leading contemporary authority on ancient music, Andrew Barker explains this approach thus:

> What we know, reasonably securely, about Pythagorean harmonics around 400 BC certainly presupposes an earlier tradition which may go back to Pythagoras himself. But we are deceiving ourselves if we think that we can pin down its content with any precision, let alone attribute specific ideas with justifiable confidence to particular individuals and dates. In the light of these dismal reflections I shall abandon the search for a historical beginning.[19]

Although there are grounds for this position, it must be admitted that our attitude to the sources depends in large measure on our attitude to Pythagoras. With reference to another sixth-century figure, Lasus,

[17] Of Theodorus we know only that he taught harmonics as well as other sciences of the quadrivium (A 4); of Spintharus the father of Aristoxenus, who was close to Archytas, and of Xenophilus, that they were experts in the science of music (Aristox. fr. 69d; 52 A 2–3).

[18] The astronomer Ptolemy, the geometrician Euclid, the logician Aristotle, and Archimedes the mechanic figure in the list of classics of Greek science and philosophy translated into Latin, according to Cassiodorus (*Var.* I, 45), by his friend Boethius. *Pythagoras musicus* heads the list.

[19] Barker, *Science*, 20.

Barker relies on the testimony of Martianus Capella (fifth century AD) and the *Suda* (tenth century AD), and leaves aside that of Xenocrates on Pythagoras and Aristoxenus on Hippasus.[20] As in many other cases, Hippasus falls victim to his closeness to Pythagoras. Everything we know of his harmonics and acoustics indicates that he continued the researches of Pythagoras. In acknowledging Hippasus, we therefore ought to acknowledge Pythagoras. Given an unbiased approach to the fifth- and fourth-century sources, we can state with justifiable confidence that Pythagorean harmonics *must* go back to Pythagoras himself, so there is no reason to separate Pythagoras and Hippasus from the subsequent development of this science. As in the history of mathematics, our point of departure will not be the first coherent text in the discipline in question (like the fragments of Hippocrates of Chios and Philolaus representing geometry or harmonics), but rather the first reliable testimony of the beginnings of that discipline. The best support for this approach, in spite of all the difficulties it entails, was expressed by Aristotle:

> For in the case of all discoveries the results of previous labours that have been handed down from others have been advanced bit by bit by those who have taken them on, whereas the original discoveries generally make an advance that is small at first though much more useful than the development which later springs out of them. For it may be that in everything, as the saying is, 'the first start is the main part': and for this reason also it is the most difficult; for in proportion as it is most potent in its influence, so it is smallest in its compass and therefore most difficult to see.[21]

Aristotle and his pupils did not simply declare this as a principle; they also practised it in their works. Thus in their view the history of Greek science and philosophy began not with Anaximander, the author of the first prose text accessible to them, but with Thales, who wrote nothing.[22] Attempts to remove Thales from the position he has held since then have as yet yielded no palpable results.

There is indeed little reliable evidence concerning Pythagorean harmonics in the period between Pythagoras and Philolaus, but

[20] Ibid. 19. Hippasus' experiment is mentioned in passing in connection with Glaucus of Rhegium, who was a source for Aristoxenus (ibid. 84), but no analysis is given.

[21] *Soph. el.* 183b17 f., tr. Pickard-Cambridge.

[22] See Zhmud, *Origin*, 127, 131, 155, 191 ff., 238 ff.

what evidence there is makes it possible to trace the basic course of its development. It is indicative that during that century mathematical harmonics remained a monopoly of the Pythagorean school. No research of this nature is known outside that school.[23] This confirms yet again that we are dealing with a tradition which goes back to the founder of the school. I may cite again the words of Xenocrates on Pythagoras' discovery of the numerical nature of concordant intervals, which would later become the main focus of Pythagorean harmonics:

> Pythagoras discovered also that the intervals in music do not come into being apart from number, for they are an interrelation of quantity with quantity. So he set out to investigate under what conditions concordant intervals come about, and discordant ones, and everything well attuned and ill attuned (fr. 87).[24]

Ancient theory considered those notes concordant intervals (concords) which, when sounded simultaneously, blended together; discordant intervals (discords, dissonances) were those in which this did not happen. For us, the most important points in Xenocrates' testimony are that he (1) speaks of Pythagoras' scientific discovery (*εὕρισκε*), which (2) was based on his research (*ἐσκοπεῖτο*) into concordant and discordant intervals (*τὰ σύμφωνα διαστήματα καὶ τὰ διάφωνα*), and (3) on his research into the broader connections between number and musical harmony. The late tradition adds two no less important points to Xenocrates' account: (4) Pythagoras' discovery was made by means of an experiment, (5) the intervals studied were the octave, the fifth, and the fourth.[25] From a fragment of Aristoxenus based on Glaucus of Rhegium,[26] it follows that the latter two points also go back to sources of the Classical period. According to Aristoxenus, Hippasus fashioned four bronze discs of the same diameter, with thickness in the ratios 2:1, 3:2, and 4:3; when struck they produced harmonic concordance (fr. 90). Hippasus' experiment is too complex to be a first attempt, in which the ratios of the octave, fifth, and fourth were successfully found. It was conducted in order to *confirm* what Pythagoras had already discovered,

[23] On empirical harmonics see Barker, *Science*, 33 ff. The sophist Hippias taught astronomy, geometry, and arithmetic, but it does not seem that his *μουσική* was mathematical (Pl. *Hipp. mai.* 285b = 86 A 11).

[24] Cf. above, 258 f.

[25] Nicom. *Harm.* 6; Aristid. Quint. III, 2; Gaud. *Harm.* 11.

[26] Cf. above, 45 n. 74.

most likely by observations and experiments with a stringed instrument. The ratios of the octave, fifth, and fourth are closely bound up with arithmetic and harmonic means, which, according to information that goes back to Eudemus, were known to Pythagoras.[27]

Pythagoras' idea that musical intervals could be expressed by numerical ratios had its predecessors, if only indirect ones. Anaximander had also tried to apply simple numerical progressions to explain nature: in his cosmological model the earth was a flat cylinder, whose diameter and height were in the ratio 3:1, and the distances between the heavenly 'rings' were multiples of three: 9, 18, 27 (A 10–11, 21–2). Anaximander's numbers were of a speculative nature,[28] but on a heuristic level his model was able to stimulate a search in nature for *verifiable* and therefore more precise ratios. On the other hand, the supposition that long before Pythagoras the ratios of the basic concords were known to the craftsmen who made musical instruments[29] cannot be reliably confirmed.[30] Although the Greeks were very fond of attributing even the most ordinary things to *prōtoi heuretai*, in this case Pythagoras' discovery was seen by all as precisely that, a discovery. The fact that something as elusive as musical harmony was subject to simple numerical ratios made a profound impression on Pythagoras and his followers, and gave them a powerful incentive to 'liken all things to numbers' (Aristox. fr. 23), including things as uncountable as justice or *καιρός*. Empedocles and the Hippocratic doctors had sought proportion in the components of the human organism.[31] Philolaus stated: 'And indeed all the things that

[27] See above, 265 f.

[28] In Hesiod (*Th.* 720 f.) the distance between the sky, the earth and the underworld was also a multiple of three.

[29] Frank, 11 f., 161; van der Waerden, 371; Barker, *GMW* ii. 256 n. 43.

[30] See Burkert's objections (374 f.). In the Peripatetic *Problems* (919b1–14) it is stated that the craftsmen who made *auloi* and triangular harps knew the ratios of the octave, fifth, and fourth, but does this reflect actual practice, in particular, 6th-cent. practice? The triangular harp with strings of varying length, for which the ratio of 2:1 would make sense, appeared in Greece later than the mid-5th cent.: S. Maas and J. M. Snyder, *Stringed Instruments of Ancient Greece* (New Haven, 1989), 156 f. The distance between the openings in the *auloi*, judging by the available material, did not correspond to the Pythagorean ratios: J. G. Landels, 'The Reconstruction of Ancient Greek *auloi*', *World Archeol.* 12 (1980), 298–302.

[31] A 78, B 69, 96–8. Empedocles supposed that bone, for example, consisted of two parts water, two of earth, and four of fire (2:2:4); nerves were one part fire, one earth, and two water (1:1:2); while blood comprised all four elements in equal proportions. On concordant intervals in medical literature see *De victu* I, 8; A. Delatte,

are known have number. For without it we can neither understand nor know anything' (B 4). Is it reasonable to suppose that the stone from which so many circles spread did not actually exist?

8.2 THE THEORY OF HARMONIC INTERVALS

The basic principles of correspondence between sounds and numbers adopted in Pythagorean harmonics were set out by Ptolemy (*Harm.* I, 5), who most likely relied on Archytas.[32] The Pythagoreans associated equal-toned notes with equal numbers, and unequal-toned notes with unequal; here all numbers are whole and rational. Musical intervals were divided into concordant and discordant, and ratios into multiple, epimoric and epimeric. In a multiple ratio (πολλαπλάσιος λόγος) the greater number is divided by a smaller one with no remainder ($n : 1$). 'Epimoric' (ἐπιμόριος) was the name given to ratios in which the larger number contains the smaller plus one part of the smaller: $(n + 1) : n = 1 + 1/n$. 'Epimeric' (ἐπιμερής) was a ratio in which the greater number exceeded the smaller by more than one of its parts: $n + m : n$, where $m > 1$. Concordant intervals were associated with numbers that are in multiple and epimoric ratios to each other. The octave (2:1), the twelfth (3:1), and the double octave (4:1) corresponded to the multiple ratio; the fifth (3:2), the fourth (4:3), and the tone (9:8), representing the difference between a fifth and a fourth, to the epimoric. Those intervals whose ratios were not multiple or epimoric, such as the eleventh (8:3), were not considered concordant. Thus the Pythagoreans explained the audible differences between τὰ σύμφωνα and τὰ διάφωνα διαστήματα by different numerical ratios, regarding the boundary between consonance and dissonance as not relative but absolute.

Long before Ptolemy the mathematical principles of Pythagorean harmonics were reflected in the Euclidean *Sectio canonis*, which relied

'Les Harmonies dans l'embryologie hippocratique', *Mélanges P. Thomas* (Bruges, 1930), 160–71; Barker, *Science*, 279 f.

[32] A. Barker, 'Ptolemy's Pythagoreans, Archytas, and Plato's Conception of Mathematics', *Phronesis* 39 (1994), 13–135. Ptolemy's immediate source was Didymus, the musicologist of the 1st cent. AD: Barker, *GMW* ii. 230, 241 f.; id., 'Greek Musicologists in the Roman Empire', *Apeiron* 27 (1994), 53–74. Ptolemy often used Didymus without acknowledging him (Porph. *In Ptol. Harm.*, 5.12 f.).

even more than Ptolemy on the research of Archytas.[33] Thus the preface to the treatise ends with the following thesis: since in concords two notes produce a single blend (μίαν κρᾶσιν), they are expressed by ratios which have a single name (ἐν ἑνὶ ὀνόματι), to wit, multiple or epimoric.[34] The author of *Sectio canonis* did not attempt to demonstrate the principle – fundamental to Pythagorean harmonics – of the connection between concords and a particular type of ratio (which is in principle not demonstrable), but considered it necessary to provide an explanation which to his way of thinking was plausible. What we do not find in *Sectio canonis* is any extended value judgement on the numerical ratios, which Ptolemy's source also attributes to the ἀρχαί of Pythagorean harmonics. Here we come up against another important problem of musical science which is related to that of consonance and dissonance. If numerical ratios can express not only neutral concepts (the pitch of a sound, speed, vibration frequency) but also the *beauty* of musical harmony, can they not also reflect or even explain the differences in concords according to their beauty? In other words, since some concords are perceptibly more harmonious than others, the Pythagoreans attempted to find a correspondence between the different aesthetic value of intervals and their mathematical expression.

Ptolemy (*Harm.* I, 5) reports that they argued that concords are finer (κάλλιον) than discords, and that multiple and epimoric ratios are better (ἀμείνων) than epimeric because of the simplicity of the comparison: in multiple ratios a smaller number is contained within a larger one, and in epimoric ratios the excess forms a certain part of the larger one. The finest concord (καλλίστη) is the octave, and the best (ἄριστος) ratio is a twofold one; the octave because it is closest to equality of tones, and 2:1 because in it alone the excess is equal to the lowest term. At first sight these judgements resemble Pythagorean

[33] Barker, *Science*, 364 ff., convincingly defends the dating of the treatise at c.300. On Pythagorean influences in *Sectio canonis* see Timpanaro Cardini, iii. 395 f.; T. J. Mathiesen, 'An Annotated Translation of Euclid's "Division of a Monochord"', *JMT* 19 (1975), 236 ff.; A. Barbera, *The Euclidean Division of the Canon* (London, 1991), 23 ff., 58 f.; A. C. Bowen, 'Euclid's *Sectio canonis* and the History of Pythagoreanism', in Bowen et al. (eds.), *Science and Philosphy*, 164–87; O. Busch, *Logos syntheseos: die euklidische 'Sectio canonis', Aristoxenos, und die Rolle der Mathematik in der antiken Musiktheorie* (Berlin, 1998), 113 ff.; Barker, *Science*, 382 f., 406 f.

[34] On this see Barbera, *Division of the Canon*, 55 f.; Busch, *Logos syntheseos*, 122 f.; Barker, *Science*, 375 f.

number symbolism, in which righteousness, repaying in equal measure, is identified with four (2×2). In fact, however, there is something far bigger behind them. The identification of (musical) beauty with (mathematical) simplicity is based on intuitions which have shown their enormous productivity in the development of scientific knowledge. In modern mathematics concepts such as simplicity or perfection have also played an important part, albeit an informal one, and when mathematics was applied to natural laws these notions often proved decisive. In the simpler mathematics of the Copernican system compared with that of Ptolemy, Galileo saw convincing proof that the heliocentric system was indeed correct. Euler, perhaps influenced by Leibnitz, affirmed that human reason found a particular charm in simple numerical ratios because they could be best understood.[35] We prefer order to disorder, and the more simply we perceive the order in objects, the simpler and more perfect those objects will appear to us. These notions, which formed the basis of Euler's theory of music, were shared by most eighteenth-century scientists.

Similar considerations were not alien to the mathematician Ptolemy. He shared the basic principles of Pythagorean harmonics, including its evaluative component. Among the particular propositions of which he was critical, one concerned the eleventh (following Aristoxenus and contrary to the Pythagoreans, he included it in the concords); another concerned the method of comparison of concords against one another (*Harm.* I, 6). Ptolemy gives a brief account of this method; Porphyry, more detail, in his commentary on Ptolemy's *Harmonics*, referring to Didymus and Archytas.[36] Here it should be noted that this method did not belong to Archytas himself, but dated back to an earlier stage of Pythagorean harmonics.[37] To determine the most concordant intervals, the Pythagoreans proceeded as follows: taking the 'first numbers',[38] which they called *pythmenes* (i.e. 2:1, 3:2, 4:3), and assigning them to concords, they subtracted a unit from each

[35] Cf. 'Musica est exercitium arithmeticae occultum nescientis se numerare animi', G. W. Leibniz, *Epistulae ad diversos*, ed. C. Kortholtus, vol. i. (Leipzig, 1734), 241 (letter to Goldbach, 17 Apr. 1712).

[36] *In Ptol. Harm.*, 107.15 ff. = A 17. Here too Didymus was the shared source of Ptolemy and Porphyry. See Barker, *GMW* ii. 34 n. 25; id., *Scientific Method in Ptolemy's Harmonics* (Cambridge, 2000), 71 f.; Huffman, *Archytas*, 428 f.; Zhmud, *Origin*, 214 ff.

[37] Barker, *GMW* ii. 34 n. 25; id., *Scientific Method*, 71 f.; Huffman, *Archytas*, 428 f.

[38] See above, 277 f.

of the terms of the ratio and compared the remainders. Thus, subtracting a unit from both terms of the octave (2:1) they obtained one, from the fourth (4:3) five, and from the fifth (3:2) three. They termed the subtracted units 'similars' (ὅμοια), since one unit was equal to another, and the remainders 'dissimilars' (ἀνόμοια), since multiple and epimoric ratios that represented concords consisted of unequal terms, which meant that if equal numbers were subtracted from them the remainders would always be unequal. The fewer the 'dissimilars', the more concordant was the interval; the octave was the most concordant, followed by the fifth, then the fourth.

Ptolemy called this method 'utterly ludicrous' (*Harm.*, 14.6), pointing out, in particular, that it could be applied only to *pythmenes*: if the octave, fifth, and fourth are expressed as the ratios 12:6, 9:6, 8:6, we arrive at a directly opposite result. (However, since it was precisely *pythmenes* that the Pythagoreans took as their starting point, Ptolemy was not quite right.) Subtracting a unit from the ratio of concords may seem strange, but the intuition behind it—what is closer to equality is more concordant—is perfectly correct from an acoustic point of view: the smaller the numbers representing an interval, the more concordant it sounds. The tradition established by the Pythagoreans, in which intervals were ranked according to their relative concordance, continued to flourish in the sixteenth–eighteenth centuries, when the numerical ratios expressing intervals received a new interpretation in physics in addition to the previous mathematical one. Thus one of Galileo's predecessors in acoustics, D. B. Benedetti, arrived at the same ranking by multiplying the numbers of the concords: unison – 1, octave – 2, fifth – 6, fourth – 12, and so on.[39] Euler, applying the original mathematical method, arrived at a sequence of concords very close to that of the Pythagoreans: unison, octave, twelfth and double octave, fifth, fourth, eleventh, etc.[40]

Both the theories set forth by Archytas were based on the same principles: concords are expressed by multiple and epimoric ratios consisting of relatively prime numbers. However, if in the first case

[39] F. H. Cohen, Quantifying *Music: The Science of Music at the First Stage of the Scientific Revolution* (Dordrecht, 1984), 75, 94 f. Galileo adhered to the same sequence of intervals.

[40] S. Dostrovsky and J. T. Cannon, 'Entstehung der musikalischen Akustik (1600–1750)', in F. Zaminer (ed.), *Geschichte der Musiktheorie*, vol. vi (Darmstadt, 1987), 71 f. Euler's sequence was in turn supported by H. Helmholtz, *On the Sensations of Tone*, tr. A. Ellis, 2nd edn. (New York, 1954), 230.

what was meant was a correspondence between the concords and the numerical ratios, in the second the numbers were taken as the cause of concordance. In other words, the numerical ratios did not simply express the concords, they *determined* them.[41] The following detail may indicate that this method of rating concords goes back to the first half of the fifth century: contrary to the standard mathematical terminology, ὅμοιος and ἴσος, ἀνόμοιος and ἄνισος are used here without any apparent distinction: units were equal, but were called similar; remainders were unequal, but were called dissimilar. According to evidence which goes back to Eudemus, Thales 'in the ancient manner (ἀρχαϊκώτερον) called equal (ἴσας) angles similar (ὁμοίας)';[42] the Pythagorean method might reflect traces of a use of ὅμοιος, which by the time of Hippocrates of Chios had passed into history.[43]

All the indications are that Eudemus' testimony (fr. 142), cited above (§7.5), is related to the ranking of concords by 'similars' and 'dissimilars'. Porphyry, who concurred with Ptolemy's critical view of this method, stressed that it was based on 'first numbers' (*In Harm.*, 109.1 ff.). As confirmation of this he cited Eudemus: according to the Pythagoreans, 'the ratios of the three concords, of the fourth, the fifth and the octave, taken in the first numbers, belong to the number nine. For 2 and 3 and 4 are nine'.[44] Why the Pythagoreans needed to add the numerators of three concords taken in the smallest numbers remains unclear, as does the mathematical meaning attached to the number nine. Everything points to calculations of the kind that are found in the method handed down by Archytas.

If the method of ranking of concords by 'similars' and 'dissimilars' dates back to the first half of the fifth century, by combining this testimony with other sources of the classical period we can isolate the mathematical principles of Pythagorean harmonics which most likely were already familiar to Hippasus. The first is the expression of basic

[41] Plato and the Platonists upheld a similar view. This is precisely how the words of Xenocrates (fr. 87) should be understood: Pythagoras discovered the numerical nature of intervals and investigated under what conditions (τίνος συμβαίνοντος) concords and discords occur.

[42] Procl. *In Euc.*, 157.10 = A 20; Zhmud, *Origin*, 170, 191 f.

[43] According to Hippocrates (Eud. fr. 140), similar segments of a circle contain equal angles (καὶ γωνίας ἴσας δέχεται τὰ ὅμοια τμήματα). See D. Panchenko, '"Ομοιος and ὁμοιότης in Anaximander and Thales', *Hyperboreus* 1 (1994) 28–55, esp. 37 ff.

[44] ἔτι δὲ τοὺς τῶν τριῶν συμφωνιῶν λόγους τοῦ τε διὰ τεσσάρων καὶ τοῦ διὰ πέντε καὶ τοῦ διὰ πασῶν ὅτι συμβέβηκεν ἐν πρώτοις ὑπάρχειν τοῖς ἐννέα· β' γὰρ καὶ γ' καὶ δ' γίνεται ἐννέα.

concords by multiple and epimoric ratios taken in the smallest numbers. It is clear that this principle could be proposed and substantiated only by a mathematician of the calibre of Hippasus. Philolaus was not one of these. On the basis of this principle, intervals with epimeric ratios, such as the eleventh, were excluded from the ranks of the concords. Possibly, Hippasus was responsible for this too.[45] The second is the technique of 'division' of intervals: when they are added together their ratios are multiplied; when they are subtracted one from another, the ratios are divided. The division of an octave into a fifth and a fourth (2:1 = 3:2 × 4:3), which are the arithmetic and harmonic means between the terms of the octave, was probably already familiar to Pythagoras.[46] The realization of the fact that an octave could not be divided into two equal parts, because the geometric mean between 2 and 1 is equal to $\sqrt{2}$, should be linked with Hippasus, who discovered irrationality. Philolaus, who divided the octave into a fifth and a fourth, also departed from the premise that it could not be divided in half. In Philolaus, who relied on an earlier school tradition to give mathematical expression to the diatonic scale (B 6), we find the following examples of the division of intervals: the difference between an octave and a fifth gives a fourth (2:1) : (3:2) = 4:3; the difference between a fifth and fourth gives a whole tone (3:2) : (4:3) = 9:8; and by subtracting two tones from a fourth we obtain a minor semitone (4:3) : (81:64) = 256:243. An octave therefore consists of five tones and two minor semitones; a fifth of three tones and one minor semitone; and a fourth of two tones and one minor semitone.

Archytas, who perfected the development of Pythagorean harmonics, demonstrated in a general way the impossibility of finding a geometric mean between numbers in epimoric ratio (A 19), and hence the impossibility of dividing the corresponding intervals into equal parts. Using arithmetic and harmonic means he divided the fifth and the fourth as follows:

a fifth = a major third + a minor third (3:2 = 5:4 × 6:5);

a fourth = a diminished minor third + an augmented tone (4:3 = 7:6 × 8:7).

[45] A. Barbera, 'The Consonant Eleventh and the Expansion of the Musical Tetractys: A Study of Ancient Pythagoreanism', *JMT* 28 (1984), 191–223.
[46] See above, 271 f.

Relying on these principles, Archytas created a mathematical division of the tetrachord for all the musical genera then in use: diatonic, enharmonic, and chromatic (A 16).

The Pythagorean theory of music comprised two components. The first, the empirical, explained the difference in pitch of a sound relying on the movement of the sounding body as an observable physical phenomenon. The second, the mathematical, expressed the audible musical intervals by means of certain ratios of whole rational numbers. While mathematics imposed considerable limitations on the empirical material, it cannot be said that the Pythagoreans discounted it or relied exclusively on numbers. Not even such a critic of the Pythagorean theory of music as Aristoxenus levelled this charge against them. Seeking to base the analysis of music on a subjective perception of tones by the ear and its ability to hear differences in pitch, Aristoxenus thought that the Pythagoreans

> used arguments quite extraneous to the subject, dismissing perception as inaccurate and inventing theoretical explanations, and saying that it is in ratios of numbers and relative speeds that the high and the low come about. Their accounts are altogether extraneous, and totally in conflict with the appearances (*Harm.* I, 32, tr. Barker).

It follows from the references to 'numbers and speeds' that the Pythagoreans took both a mathematical and physical approach to sound; this is confirmed by Archytas' *Harmonics* (B 1). Theophrastus put forward an even more radical critique of Pythagorean harmonics, rejecting outright the fact that differences in pitch could be explained quantitatively.[47] Aristotle, on the other hand, always regarded harmonics, which was akin to arithmetic, as a legitimate part of *mathēmata*. A fragment of his early work, probably *On Philosophy*, contains a mathematical theory of concords which is clearly Pythagorean in origin.[48] In this sense Aristotle was closer to the Pythagoreans than some of his pupils; the Peripatetic *Problems* took his line further (Book XIX).

Plato, unlike Aristoxenus and Theophrastus, criticized the Pythagoreans from a directly opposing position, reproaching them

[47] Fr. 716 FHSG. See Barker, *GMW* ii. 110 ff.; id., *Science*, 364 ff.

[48] Fr. 47 Rose = fr. 25 Ross. M. Timpanaro Cardini, 'Il frammento musicale di Aristotele 47 Rose', *PdP* 18 (1962), 300–12; ead. Timpanaro Cardini, iii. 388 f.; M. Untersteiner, *Aristotele: Della filosofia* (Rome, 1963), 248 ff.; Barker, *Science*, 329 ff.

(Archytas above all) for excessive empiricism. He regarded their measurements and comparisons of intervals perceived by ear as futile.

> Their method exactly corresponds to that of the astronomer; for the numbers they seek are those found in these heard concords, but they do not ascend to generalized problems and the consideration which numbers are inherently concordant and which not and why in each case. (*Res.* 530e–531c, tr. Shorey)

As we can see, Plato had no interest in empirical confirmation of harmonics. To him, harmony reigned in the sphere of numbers, not that of real concords.[49] Pythagorean theory, by contrast, could easily be developed in such a way as to incorporate far more empirical data, and this was subsequently done by Ptolemy, and later still by modern scientists.

The harmonics of Philolaus and Archytas have been the subject of several excellent modern studies,[50] so I shall not treat them in any detail here. My main concern has been to show that Pythagorean harmonics, known from Philolaus and Archytas, was the result of almost a century of development, which was initiated by Pythagoras and Hippasus. If Pythagoras and his followers relied in geometry and astronomy on their Ionian predecessors and contemporaries, the progress of mathematical harmonics in the late sixth to early fourth century is due almost entirely to the Pythagorean school. Nothing is known of the Ionian contribution to this discipline.

To conclude this survey of the Pythagorean theory of concords I turn to the subject with which consideration of this topic usually begins: the famous tetractys (τετρακτύς), which traditionally symbolizes the connection between harmonics, arithmology[51] and religion. According to the *opinio communis*, the tetractys, which goes back to the time of Pythagoras and Hippasus, comprised the numbers from

[49] A. Meriani, 'Teoria musicale e antiempirismo', in M. Vegetti (ed.), *Platone: La Repubblica*, vol. v (Naples, 2003), 565–602 (with bibliography).

[50] Huffman, *Philolaus*, 145 f., 364 ff.; id., *Archytas*, 402 ff.; Barker, *Science*, 263 ff.

[51] Delatte, *Lit.*, 139, defined arithmology as 'ce genre de remarques sur la formation, la valeur et l'importance des dix premiers nombres, ou se mêlent la saine recherche scientifique et les fantaisies de la religion et de philosophie'. Thus also F. E. Robbins, 'Posidonius and the Sources of Pythagorean Arithmology', *CPh* 15 (1920), 309–22, at 309 n. 1. Arithmology understood in this way should be distinguished from traditional number symbolism, which concentrates on individual numbers, for example, three or seven, without including them into the system of the first ten numbers, and treating their purely mathematical properties.

one to four expressing the basic concords from the octave to the double octave.[52] Accordingly, it is widely believed that the Pythagoreans excluded from the concords those which fell outside the numbers one to four, such as the eleventh (8:3). The sum of the numbers in a tetractys is equal to ten, and the Pythagoreans supposedly considered this number 'perfect'. One of the Pythagorean 'symbols' identifies the tetractys with the most important fount of wisdom, the oracle at Delphi: 'What is the oracle at Delphi? The tetractys, which is the harmony in which the Sirens sing'. Finally, the tetractys figures in the famous Pythagorean oath, which is broadly represented, with slight variations in form, in the literature of the Imperial era. The Pythagoreans swore not by the gods but by their Master, and regarded his discovery of the tetractys as his principal achievement:

> *Οὔ, μὰ τὸν ἁμετέρᾳ κεφαλᾷ παραδόντα τετρακτύν*
> *παγὰν ἀενάου φύσεως ῥίζωμά τ' ἔχουσαν.*
>
> No, I swear by him who gave the tetractys to our head,
> which has the source and root of everlasting nature.[53]

At first glance the complex of notions of the tetractys appears thoroughly archaic, or more ancient, at least, than the evidence about Pythagorean harmonics considered above. This impression, however, is deceptive. It is based not on facts but on the presumption that everything religious must be older than everything scientific. The history of the study of Pythagoreanism constantly demonstrates a kind of duality in its approach to the material: much greater faith is placed in late evidence of Pythagorean religion than in early evidence of Pythagorean science. The erroneous nature of this approach as a whole needs no detailed explanation, and in our particular case it is more than apparent. The early Pythagoreans did indeed assign special significance to the numbers that expressed concords, but in

[52] *πάσας δὲ τὰς συμφωνίας περιέχει ἡ τετρακτύς. συνέστησε μὲν γὰρ αὐτὴν α' καὶ β' καὶ γ' καὶ δ'. ἐν δὲ τούτοις τοῖς ἀριθμοῖς ἔστιν ἥ τε διὰ τεσσάρων συμφωνία καὶ ἡ διὰ πέντε καὶ ἡ διὰ πασῶν, καὶ ὁ ἐπίτριτος λόγος καὶ ἡμιόλιος καὶ διπλάσιος καὶ τριπλάσιος καὶ τετραπλάσιος* (Adrastus, *ap.* Theon. *Exp.*, 58.13 f.).

[53] Aët. I,3,8 = 58 B 15. Delatte, *Lit.*, 250, thought that the original reading was *ἁμετέρᾳ ψυχᾷ* (Ps.-Plutarch, Theon); Diels preferred the variant *κεφαλᾷ* (Stob. = *Dox.* 282b2; Sext. Emp. *Adv. math.* 7, 94, Hippol. *Ref.* VI,23,4). Iamblichus (*VP* 162) and Porphyry (*VP* 20) give *γενεᾷ*; cf. Iamb. *VP* 150: *τὸν ἁμετέρας σοφίας εὑρόντα τετρακτύν.*

harmonics what interested them was not numbers as such, but ratios, λόγοι. Behind the Pythagorean approaches to λόγοι, even those approaches which might now seem strange, mathematical or acoustic foundations can always be found, while the fact that the ratios of the basic concords consist of the first four numbers, which add up to ten, is more likely to please lovers of arithmology (such as Speusippus) than a mathematician. The number ten plays no part in harmonics, unlike nine, which is found in 'musical' proportion;[54] it should be remembered that Eudemus (fr. 142) obtained nine, not ten, when he added together the numerators of three concords. At a later point we shall consider the fact that the 'perfect' number ten goes back to the Academy and bears no relation to ancient Pythagoreanism.[55] The word τετρακτύς as well as the 'Pythagorean oath' that contains it appear first in Aëtius, whose collection relied on *Vetusta placita*, a doxographical compendium of the mid-first century, compiled in the school of Posidonius.[56] It is significant that before Aëtius the expression φύσις ἀέναος is used only by Posidonius. The publishers of his fragments see in this a reference to the Pythagorean oath.[57] The 'Pythagorean oath' is a typical specimen of pseudo-Pythagorica. This is clear from the pseudo-Doric dialect (φύσεως is an Attic form) and the verse form, which is not attested in authentic oaths, and the fact that Pythagoras is not named in it.[58]

As Robbins has shown, Posidonius used a pseudo-Pythagorean arithmological treatise, probably from the second century. Traces of it were preserved in many authors, in particular Philo of Alexandria[59]

[54] See above, 271 f.

[55] See below, 404 ff., 425 f.

[56] I,3,8 = 58 B 15. Chronologically the closest source to mention the τετρακτύς, Anonymus Photii (439a8), has been dated to the 1st cent. AD (see above, 72 n. 48). The evidence of the tetractys attributed to Philolaus (A 11; Huffman, *Philolaus*, 355) and Lysis (46 A 4) is spurious.

[57] Strab. III,2,9 (ed. Lasserre) = Posid. fr. 19 Theiler = fr. 239 E-K.

[58] Cf. Iamb. *VP* 255 and *Comm. Math.*, 77.23 (from Nicomachus); for more detail see Zhmud, 'Some Notes', 268 f. The most detailed analysis of the oath remains Delatte, *Lit.*, 249 ff., who, like most researchers, considered it authentic; see Diels, 'Pythagorasbuch', 457; Zeller, ii. 1, 1014 n. 3; Timpanaro Cardini, iii. 104 f.; Burkert, 72 f., 186 f.

[59] Though not using the word τετρακτύς, Philo sets forth in detail the same doctrine of the τέλειος τετράς as the decad *in potentia* (*De opif.* 47–53, 97–8; *De plant.* 123–5; *De vita Mosi* II, 115), which Aëtius (I,3,8) attributes to Pythagoras. On Philo's sources, see D. T. Runia, *Philo of Alexandria: On the Creation of the Cosmos According to Moses* (Leiden, 2001), 27 f.

and Sextus Empiricus. The latter also cites the text of the oath.[60] The context in which the oath figures in Aëtius clearly points to a source shared with Posidonius and Sextus, that is, the pseudo-Pythagorica.[61] Last but not least: the 'symbol' which mentions the tetractys as the harmony of the Sirens is found *only* in Iamblichus (*VP* 82) and no other ancient writer.[62] On the other hand, the harmony of the Sirens (without the tetractys) figures twice in Plato's *Republic* (and nowhere earlier), in the passage in which the famous heavenly harmony is described.[63] Thus the 'symbol' adduced by Iamblichus is not the 'higher wisdom' of the ancient Pythagoreans, but a combination of Plato's harmony of the Sirens with the late Hellenistic pseudo-Pythagorean tetractys. The tetractys, for its part, most probably arose from the tetrad extolled by Speusippus in his work *On Pythagorean Numbers*.[64]

8.3 ACOUSTICS: THEORY AND EXPERIMENTS

References to various kinds of acoustic experiments are found in the ancient literature of musical theory of all periods, from Archytas to

[60] *Adv. log.* I, 94; *Adv. math.* IV, 2. Robbins, 'Posidonius'; id., 'The Tradition of Greek Arithmology', *CPh* 16 (1921) 97–123. Robbins did not, unfortunately, take account of Aëtius' material.

[61] Aët. I,3,8 attributes to Pythagoras the doctrine of the monad and the indefinite dyad. Here too we find such concepts as the formal cause, potentiality etc. On the influence of Speusippus on Aët. I,3,8 see Frank, 260 n. 1; *Aristoteles: Problemata Physica*, tr. H. Flashar (Berlin, 1962), 567 ff.; Burkert, 73 n. 122; against: Tarán, *Speusippus*, 273 f.

[62] Although the collection of symbols in *VP* 82–6 as a whole goes back to Aristotle's book *On the Pythagoreans* (above, 189), it is clear that Iamblichus did not use Aristotle himself but an intermediate source, in which the early 'symbols' may have been diluted by later ones. The 'symbol' about the wisdom of him who gives names to things (*VP* 82, cf. 56) also appears to be post-Platonic (see above, 170 nn. 2 and 4, 197 n. 110.).

[63] *ἐπὶ δὲ τῶν κύκλων αὐτοῦ ἄνωθεν ἐφ' ἑκάστου βεβηκέναι Σειρῆνα συμπεριφερομένην, φωνὴν μίαν ἱεῖσαν, ἕνα τόνον· ἐκ πασῶν δὲ ὀκτὼ οὐσῶν μίαν ἁρμονίαν συμφωνεῖν* (617b4–7); *πρὸς τὴν Σειρήνων ἁρμονίαν* (617c4).

[64] 'For 1 is a point, 2 is a line, 3 is a triangle and 4 is a pyramid; all these are elements and principles of the figures like them. In these numbers is seen the first of progressions . . . and they have 10 for their sum' (fr. 28, tr. Tarán). For more detail see Zhmud, 'Some Notes', 259 ff. The Pseudo-Aristotelian *Problems* (mid-3rd cent.) repeat Speusippus' reasoning that 1, 2, 3, and 4 give in sum 10 (XV, 3), although the word *τετρακτύς* is lacking.

Boethius; without experiments in acoustics it would hardly have been possible to achieve even the simplest of results. The discoveries of the Greeks in acoustics, albeit less impressive than in mathematics and astronomy, nevertheless provided the basis for development in modern times. At the turn of the seventeenth century the science of music, which was still dealing with the problems posed by the Pythagoreans, became one of those disciplines in which the combination of experiments and mathematics first took on a systematic character.[65] May we suppose, without being guilty of anachronism, that this combination, which transformed the natural sciences during the scientific revolution of the seventeenth century, was a methodological development of the research methods initiated by the Pythagoreans?

Clearly, the role of experiments in ancient science is not to be compared with that in modern science. The Greeks knew no regular practice of experimentation, of what is known as the experimental method. Partly for this reason the modern age was reluctant to recognize any continuity between ancient and European science in what concerned experiments. This tendency is already seen in Francis Bacon (*Nov. org.* I, 63, 66, 71), who wrote even before the rise of modern experimental science. On the basis not so much of scientific practice as of philosophical views, for example, a preference for contemplative science in late Platonism,[66] Greek scientists were long depicted as contemplators of nature who did not dare to interfere in its processes. Only when the contemplative stance of antiquity towards nature gave way to a desire to dominate – so it was said – did scientists begin experimenting.

Such notions have long encountered an objection: critics have given examples to demonstrate that experiments were widely known in Greek science.[67] The argument today is less about whether

[65] S. Drake, 'Renaissance Music and Experimental Science', *JHI* 31 (1970), 483–500; Cohen, *Quantifying Music.*

[66] See Plutarch's well-known story of the solution of the Delian problem; Zhmud, *Origin*, 84 f.

[67] J. Burnet, 'Experiment and Observation in Greek Science', *Essays and Addresses* (London, 1929), 253 f.; W. A. Heidel, *The Heroic Age of Science* (Baltimore, 1933), 153 ff.; V. Zouboff, 'Beobachtungen und Experiment in der antiken Wissenschaft', *Altertum* 5 (1959), 223–32; G. E. R. Lloyd, 'Experiment in Early Greek Philosophy and Medicine', *PCPhS* 10 (1964), 50 ff.; von Fritz, *Grundprobleme*, 73 f., 550 ff.; H. von Staden, 'Experiment and Experience in Hellenistic Medicine', *BICS* 22 (1975), 178–99;

experiments were performed in antiquity or not (there is so much evidence that it cannot be ignored) than the differences in theory and practice between ancient and modern experiments. As Lloyd has rightly emphasized, in research into the experiments of the ancients a differentiated approach is needed, making it possible to identify, first, the areas of science in which experiments were really accessible to the Greeks (acoustics, optics, mechanics), secondly, the periods when these were actually practised, and thirdly, the results obtained by using them.[68] It is also important to consider the highly complex correlation between the experiments and the hypotheses they were intended to verify.[69] The history of science is rich in experiments correctly conducted but incorrectly interpreted. A positive result is no guarantee that the hypothesis itself was correct, and vice versa: the wrong experiment, or one that is fundamentally not feasible, may be used to confirm a correct theory. Thus none of the three acoustic experiments described in detail by Galileo could be conducted in reality, although all three illustrate points in his theory of sound which are themselves correct.[70]

In any attempt to identify similarities and differences between ancient and modern experiments with the aid of definitions, success is unlikely: the experiments of the ancients will fit under any definition which gives an adequate description of the experiments of European scientists in the corresponding field. I. Rozhanskii and H. von Staden define experiments in practically identical terms, but the former rejects the notion of Greek experiments, while the latter adduces a long list of them.[71] Among the features of experiments that they identify, the following seem the most important. An experiment artificially reproduces a natural phenomenon in pure form, free of external influences, with the aim of proving or disproving a hypothesis. It must be reproducible and (if relevant) quantitatively measurable; a theoretical analysis of the conditions under which it is

G. Wöhrle, 'Zu den Experimenten in den biologischen Schriften des Aristoteles', *Eos* 74 (1986), 61–75; Barker, *Scientific Method*, index *s.v.* experiments.

[68] Lloyd, 'Experiment', 51 f.

[69] Von Staden, 'Experiment', 180 f. See von Fritz, *Grundprobleme*, 73 f. on the experiments of Empedocles.

[70] Cohen, *Quantifying Music*, 92 f. One of his experiments cannot be reproduced, while the other two are based on mental errors.

[71] I. D. Rozhanskii, 'Nauka v kontekste antichnoi kul′tury', in V. Kelle (ed.), *Nauka i kul′tura* (Moscow, 1984), 194; von Staden, 'Experiment', 180.

conducted is also essential. From this point of view, the 'experiments' of Anaxagoras and Empedocles with a clepsydra and a wine-skin inflated with air (31 B 100; 59 A 68–9) were not experiments, but test demonstrations of the thesis that air is corporeal. In both cases there was no actual intervention in nature; the phenomenon was not taken in isolation but in its 'natural' form, and used to demonstrate visually what happens in nature.[72] These exercises are akin to the more scientific ancient experiments by virtue of their common aim of confirming an original hypothesis rather than verifying it or discovering something new by means of the experiment. Admittedly, by dint of attempting to confirm their own theories experimentally, Greek scientists rebutted competing theories.[73]

Evidence of acoustic experiments by the Pythagoreans is scant, and chronologically distributed according to a pattern that is already familiar to us. We learn of Archytas' experiments from a fragment of his *Harmonics* (B 1), and of Hippasus' experiment with discs from a fragment of Aristoxenus (fr. 90); another important source is the Peripatetic Adrastus, an older contemporary of Nicomachus (*ap.* Theon. *Exp.*, 59.4 f.). We first hear of Pythagoras' experiments from sources of the Imperial period, the same Adrastus and Nicomachus who attribute to him either too much, or things that are incorrect in terms of physics. In Adrastus, Pythagoras not only creates a mathematical theory of concords, but also verifies it with the aid of almost every experiment known to have been conducted in antiquity:

> It seems that Pythagoras was the first to have identified the concordant notes in their ratios to one another . . . He investigated the ratios through both the lengths and the thicknesses of the strings, and again through tension arising from the turning of *kollaboi*, or in a more clearly discernible way from the attachment of weights, and also in wind instruments through the width of the bores or through the tension and relaxation of the breath; or again through solid bodies and weights such as discs and vessels. For whichever of these is taken according to

[72] We may note that in another instance such intervention did take place. The seer Lampon on seeing the head of a ram with one horn growing in the middle of its forehead, declared it to be a miracle, while Anaxagoras cut open the skull of the ram and showed that the brain had the form of an egg with its small end turned towards the root of the single horn (A 16).

[73] See von Fritz, *Grundprobleme*, 75.

> one of the ratios mentioned, other factors being equal, it will produce the concord that corresponds to the ratio (Theon. *Exp.*, 55.10 ff., tr. Barker).

Knowing that the pitch of the sound of a string depends on its length, thickness and tension, Adrastus, unlike the legendary Pythagoras, preferred to demonstrate the ratios of concords on the simplest and most reliable of instruments, the monochord (ibid. 57.11 f.), which consisted of a string stretched along a ruler with divisions marked on it, and a movable bridge. For his story of Pythagoras' discovery, Nicomachus chose a more complex experiment (Adrastus calls it γνωριμώτερον), in which weights were attached to strings. While walking past a smithy, Pythagoras heard the ring of hammers on an anvil and recognized an octave, a fifth, and a fourth. Delighted by this, he made haste to enter the smithy and by means of a series of experiments with hammers established that the difference in pitch depended on the weight of the hammers, which stood in ratios to one another of 2:1, 3:2, and 4:3. By attaching weights in proportion to the weight of the hammers to four strings, he obtained an octave, a fifth, and a fourth (*Harm.* 6). From the point of view of physics, this experiment is flawed (the pitch of a note is in proportion to the square root of the string tension; to obtain an octave, the weight of the hammers should be in the ratio 4:1, not 2:1), but the tale entered almost all the musical works of late antiquity.[74] The exception is the *Harmonics* of Ptolemy, who carefully checked all the experiments of his predecessors and came to the conclusion that the exercise with the weights did not allow control over all the necessary parameters (I, 8).

The hammer experiment was overturned only in the modern age, first by Galileo's father Vincenzo,[75] and then again by Marin Mersenne. With time Nicomachus' story came to enjoy almost as much popularity as it had in antiquity, except that it was negative. This led to doubts even about those Pythagorean experiments which were, from an acoustic perspective, beyond reproach; thus van der Waerden rejected Hippasus' experiment for a long time. This reaction was plainly excessive. By the Imperial period the Presocratics

[74] For evidence, see A. Meriani, 'Un "esperimento" di Pitagora (Nicom. *Harm. ench.* 6, pp. 246–248 Jan)', Gentili and Perusino, *Mousike*, 82.

[75] C. V. Palisca, 'Scientific Empiricism in Musical Thought', in H. H. Rhys (ed.), *Seventeenth Century Science and Arts* (Princeton, 1961), 127 ff.

had often acquired a mantle of legend; according to Diogenes Laertius, Anaxagoras foretold the fall of a meteorite (II, 10), whereas in fact he had merely been seeking an explanation for the phenomenon by saying that the heavenly bodies consisted of heated stones. Since the time of Bolus of Mende (third or second century), an Egyptian who wrote in Greek, Democritus had acquired a series of pseudonymous works in magic and alchemy, such as *Φυσικὰ καὶ μυστικά* (B 300). To suppose that the legendary entourage of Nicomachus' story is older than Pythagoras, and that it takes us back to the even older Idaean Dactyls and the like,[76] is like seeing Bolus as distant predecessor of Democritus. The story of the smithy is a fabrication (probably by Nicomachus himself); the experiment with the weights is incorrect in its physics, but not a fabrication. From the experiment with two strings of equal length and thickness with different weights attached, described by Adrastus, it follows that the pitch of a note is in proportion to the tension, and that the tension, in turn, is in proportion to the weight (Theon *Exp.*, 64.10 ff.). There is no doubt that the ancient musical scientists experimented with all three parameters on which pitch depends (the length, thickness, and tension of the string), although they were not always able to express precisely in mathematical terms the laws that they found. The experiments of Lasus and Hippasus indicate that by the turn of the fifth century the practice of experimentation had already been transferred to other sounding objects, including some specially made for the purpose. We have no reliable evidence that Pythagoras was the one who initiated the practice, although there is reason to believe that he participated in it.

In Xenocrates' testimony on Pythagoras' discovery (fr. 87) he does not say how Pythagoras investigated musical intervals. In Xenocrates' day, the main instrument which served this purpose was the monochord, or canon (*κανών*), so it cannot be ruled out that he mentioned Pythagoras' experiments with the monochord, or had them in mind.[77] The tradition passed down by Diogenes Laertius (VIII, 12) and others, according to which Pythagoras discovered the

[76] Thus Burkert, 376 f.; F. Levin, *The Harmonics of Nicomachus and the Pythagorean Tradition* (University Park, 1975), 73.

[77] F. Levin, '*πληγή* and *τάσις* in the Harmonika of Klaudios Ptolemaios', *Hermes* 108 (1986), 208; Meriani, 'Teoria', 79 f. Cf. Burkert, 376.

division of the monochord goes back at least as far as the end of the fourth century: the historian Duris linked the invention of the canon with Pythagoras' son Arimnestus.[78] The *Sectio canonis*, behind which there undoubtedly stands a solid tradition of experiments with the monochord, was also written around this time (*c.*300). Who invented the monochord and when we do not know. There is no evidence of it before the end of the fourth century, and the range of opinion is very wide: some place it in the second half of the fourth century; others suppose that Archytas experimented with it; yet others link this instrument with Pythagoras.[79] The invention of the monochord could well have been attributed to him, as the discoverer of the numerical ratios of concords, in hindsight. The fact remains that by Hippasus' day these ratios were already in circulation amongst scientists, and he himself was using specially constructed instruments to test them. If Pythagoras really knew the ratios of the basic concords it would be most natural to assume that he discovered (or demonstrated) them by means of experiments with one or several strings; there was no need to invent the monochord for this purpose.

While Pythagoras' experiments can be reconstructed only hypothetically, an account of Hippasus' experiment was preserved in Aristoxenus:

> A certain Hippasus made four bronze discs in such a way that while their diameters were equal, the thickness of the first disc was epitritic in relation to that of the second (4:3), hemiolic in relation to that of the third (3:2), and double that of the fourth (2:1), and when they were struck they produced a concord (fr. 90 = A 12, tr. Barker).

Having made these discs in accordance with 'musical' proportion (12:9 = 8:6) and obtained the same intervals as Pythagoras, Hippasus thus proved that the ratios Pythagoras had found were correct also for three-dimensional bodies and that pitch is in inverse proportion

[78] *FGrHist* 76 F 23 (see above, 160 n. 60); D. Creese, *The Monochord in Ancient Greek Harmonic Science* (Cambridge, 2010), 97 ff.

[79] 1) Burkert, 375 n. 22; Barker, *GMW* ii. 497 n. 14; id., *Science*, 409 n. 75; 2) West, *Music*, 79, 240; 3) S. Wantzloeben, 'Das Monochord als Instrument und als System' (diss.; Halle, 1911), 4, 11; Burnet, 106; Heath, i. 46; Heidel, *Science*, 182 f.; Guthrie, i. 222 f.; van der Waerden, 371 f. The suggestion to take as a *terminus post quem* the fact that Aristotle never mentions the canon (Burkert, 375 n. 22) is unconvincing. Nor is the canon mentioned by Aristoxenus or Theophrastus, who lived at the time of the *Sectio canonis* (on its dating see above, 294 n. 33).

to the thickness of the disc. If one agrees that Pythagoras was performing not experiments but *observations* (this formulation is more acceptable to many), Hippasus may well be considered the author of the first experiment to give a true mathematical expression of a physical law.[80] The experiment with the discs was indeed performed to test the hypothesis that pitch depends on one of the parameters of the sounding body. Steps were taken to isolate that parameter and to show the correlation between the thickness of the disc and the pitch of the sound in the clearest possible way. The experiment was conducted with objects made specially for the purpose;[81] it could easily be reproduced, and its results were expressed in mathematical terms. It thus met all the fundamental requirements applied to an experiment.

It is clear that Hippasus was interested not only in mathematical harmonics, but also the physics of sound. Relying on the dependence of pitch on the length of the string, established by Pythagoras, and on his own experiments, he attempted to go further and explore the physical nature of high- and low-pitched sounds. This is indicated in a passage from Adrastus immediately following the mention of Pythagoras' experiments and the demonstration of his discovery on the monochord (Theon. *Exp.*, 56.10–58.12):

> Some people thought it proper to derive these concords from weights, some from magnitudes, some from movements and numbers, some from vessels. Lasus of Hermione, so they say, and the followers of

[80] Cf. 'The kind of experimentation which interests historians of physics is the deliberate manipulation of physical objects for the purpose of corroborating by their behavior a definitely preconceived mathematical rule, or for the purpose of discovering a mathematical rule applicable to their behavior' (Drake, 'Renaissance Music', 485).

[81] Nothing suggests that Hippasus was using an existing musical instrument. *Κατασκεύασε* implies that the discs were made specially for the experiment. Moreover, Aristoxenus further notes that Glaucus 'was the first to start playing on discs as on a musical instrument', and that this was seen to be a special art, *Γλαύκου τέχνη* (fr. 90). West (*Music*, 234, cf. 126) links Hippasus' experiment with the southern Italian tradition of metal tube and disc chimes, although it is by no means obvious that the bronze cone to which he refers, consisting of discs of varying thickness and diameter, was a musical instrument; see P. Zancani Montuoro, *ASMG*, 15–17 (1974/6), 42: 'questo bronzo resta enigmatico'. Cf. Barker, *Science*, 84: 'The essential point to glean from this report is that although the apparatus was originally devised for theoretical purposes of a student of acoustics and mathematical harmonics, Glaucus . . . deployed it in the quite different context of practical music-making.'

> Hippasus of Metapontum, a Pythagorean, pursued the speeds and slownesses of the movements, through which the concords arise ...[82]

Lasus and Hippasus (οἱ περὶ τὸν Ἵππασον here, as usual, means simply 'Hippasus') in this survey stand for those who derived concords from 'movements and numbers', in particular 'fast and slow movements' (τῶν κινήσεων τὰ τάχη καὶ τὰς βραδυτῆτας). There is then a lacuna in Theon's text, followed by a description of several experiments. The first was conducted with vessels, one of them empty, one half full, one a quarter full, and one a third full. If the empty vessel was struck, and then one of those containing water, they produced an octave, a fourth, and a fifth.[83] The second experiment resembled that with the monochord but involved not one string but two; the third experiment, with a syringe, is not described in detail (ibid. 59.10–60.11). Since the text following the lacuna continues in the singular, without the name of the experimenter, and his experiments feature not fast and slow movements but numerical ratios, it remains unclear who was conducting them: Lasus, Hippasus, or somebody else.[84] Considering the state of the text and Adrastus' readiness to link Pythagoras with the most varied experiments, it would be rash to attempt to wring too much out of this account. Nor does the fact that Lasus was linked with the interpretation of intervals on the basis of numbers inspire confidence: unlike Hippasus, Lasus was not a mathematician but a practising musician. Whatever the case, Adrastus, whose information may go back to Aristoxenus,[85]

[82] *Exp.*, 59.4 f., tr. Barker. The text of the passage is corrupt; Theon's publisher also excluded καὶ ἀριθμῶν, but this is not necessary.

[83] If this experiment is conducted in the way Adrastus describes it, the intervals derived will be less than an octave, a fourth, and a fifth. These intervals can be derived if the column of air inside the vessel resonates. The Peripatetic *Problems* (XIX, 50) mention a similar experiment, also connected with resonance (ἠχώ).

[84] See various versions: Frank, 160; Lasserre, *Plutarque*, 35 f.; Burkert, 377; G. A. Privitera, *Laso di Ermione* (Rome, 1965), 69 f.; van der Waerden, 371 f.; Barker, *Science*, 19.

[85] Privitera, *Laso*, 44 f., 73 f. Aristoxenus is mentioned twice in the excerpt from Adrastus (Theon. *Exp.*, 53.9, 55.15). He in turn mentions Hippasus (fr. 90) and Lasus (*Harm.*, 7.20; fr. 86–7 with comm.). This apart, his description of the Pythagoreans, καὶ φάσκοντες λόγους δέ τινας ἀριθμῶν εἶναι καὶ τάχη πρὸς ἄλληλα ἐν οἷς τό τε ὀξὺ καὶ τὸ βαρὺ γίγνεται (*Harm.*, 41.21), is repeated in Adrastus' words about Lasus and Hippasus: οἱ δὲ ἀπὸ κινήσεων καὶ ἀριθμῶν, in particular τῶν κινήσεων τὰ τάχη καὶ τὰς βραδυτῆτας (Theon. *Exp.*, 59.5 f.). See below on Archytas and Eudoxus: ἐν κινήσεσιν εἶναι τοὺς λόγους (ibid. 61.12 f.).

confirms the tradition on Hippasus' acoustic experiments and his interest in the physics of sound.

An excerpt from Adrastus devoted to experiments ends by saying:

> And those in the circle of Eudoxus and Archytas thought that the ratio of the concords is numbers, they too agreeing that the ratios are in movements (ἐν κινήσεσιν εἶναι τοὺς λόγους) and that swift movement is high-pitched . . . , while the slow is low-pitched.[86]

This account draws the views of Hippasus and Archytas closer together in saying that numerical ratios exist not only between the dimensions of bodies producing sound, but also between movements which generate and transmit sound, or the speed of those movements. A fragment of Archytas' *Harmonics* confirms the affinity in the opinions of these two Pythagoreans, who viewed sound as a kind of moving body. At the beginning of this work Archytas sets forth the theory of his Pythagorean predecessors, οἱ περὶ μαθήματα (see above, §7.4): sound is produced as a result of a collision between two bodies moving in opposite directions, or in the same direction but at different speeds (B 1). Since we know nothing of Philolaus' acoustic studies, it is natural to link this theory with Hippasus, who investigated 'fast and slow movements'.[87] Whether Archytas' next thesis, that the pitch of a sound depends upon the speed of movement, is also Hippasus' is not altogether clear, but fully possible.[88] Archytas sought to prove this thesis by various observations and experiments, including the movement of a stick and that of a projectile, the propagation of the human voice, of the sounds of *auloi*, *rhomboi*, and a reed pipe (*kalamos*).[89] From his words it seems to follow that he made no clear distinction between the vibration frequency of a sounding instrument and the speed of propagation of sound (which, as we know, is constant), considering pitch of sound to be proportionate to the speed of its propagation. This is the standard interpretation of his theory, to

[86] Ibid. 61.12–16 = A 19a, tr. Barker.

[87] Von Fritz, *Grundprobleme*, 552 f.; Lasserre, *Plutarque*, 36 n. 1. Cf. Burkert, 382 f.; Huffman, *Archytas*, 134 f., 138 f.; Barker, *Science*, 305. Huffman compares this theory with the views of Archelaus and Democritus, but they did not take up acoustics and mathematical harmonics and thus cannot be related to οἱ περὶ μαθήματα.

[88] Cf. Huffman, *Archytas*, 139 f.; Barker, *Science*, 27 f., 29 n. 19.

[89] It should be noted that here it is not only the monochord that is absent, but all stringed instruments. On the basis of B 1 it is therefore hardly possible to conclude that the monochord was invented later.

which, it is true, some have objected.[90] The fact that at first these two types of speed were confused is not surprising: it is by no means easy to establish that increased speed of vibration does not result in increased speed of propagation of sound. The relation between pitch and vibration frequency of a sounding instrument was clearly formulated for the first time in the foreword to *Sectio canonis*,[91] but became firmly established in acoustics only in the seventeenth century.[92]

Thus there is reason to assert that in the framework of Pythagorean harmonics and acoustics the practice of experiments acquired the features familiar to us and was joined with mathematical theory. Nevertheless, having become a method of confirming a hypothesis and obtaining new knowledge, experiments were conducted only sporadically. Even if there were more of them in Pythagorean acoustics than are known to us, they can hardly be considered regular. The methodological importance of systematic experiments was not recognized by the Pythagoreans; this incidentally is typical of all of ancient science.[93] In the mathematical interpretation of concords the Pythagoreans made greater strides than in the physical interpretation of sound; some of their experiments were incorrect, and others misinterpreted. We should not, however, forget that the relation between theory and experiment is by no means straightforward. Ptolemy's acoustic experiments were much richer, more precise, and systematic than those of the Pythagoreans, but even he was able to modify their theory only in a few substantive points (sometimes resorting to the ideas of Aristoxenus). For example, in his

[90] Timpanaro Cardini, ii. 326 ff.; C. A. Ciancaglini, 'L'acustica musicale nei primi Pitagorici', *RAL* 9/2 (1991), 47–77.

[91] It was also set down in the Peripatetic *De audibilibus* (803b–804a) and in a quotation from a certain Heraclides in Porphyry (*In Ptol. Harm.*, 30.1–30.21). See Barker, *Science*, 373.

[92] Dostrovsky and Cannon, 'Entstehung', 11.

[93] 'If, then, scientific investigation in antiquity involved considerable experimental activity, we may well ask why it was that Greek science falls short of modern science. It falls short in the maturity and the universality of its use of mathematical-experimental techniques. There is no question that a mathematical-experimental science existed in nascent form, at least, in optics, in statics, and in applied mechanics; [. . .] and that an experimental science existed in zoology and physiology. But the techniques of these sciences were not yet commonly considered as the necessary methods in all fields of natural investigation. Before mathematical and experimental techniques had become the common property of Greek science, that science began to level off' (M. Clagett, *Greek Science in Antiquity* (New York, 1955), 32).

Harmonics there is no clear formulation of the relation between pitch and vibration frequency. On the other hand, the experiments of the Galilei, father and son, who made the next substantial step in acoustics, were no more complex or systematic than those of Ptolemy.[94] Here a decisive role was played by a new theory of sound which was not accessible to Greek scientists.

[94] See above, 305 n. 70.

9

Astronomy

9.1 GREEK ASTRONOMY AND THE ORIENT

The previous chapter did not touch upon the question of Oriental borrowings: there was nothing to be said about Egypt, while Babylonian musical texts partly deciphered recently reveal nothing resembling the Pythagorean theory of music.[1] The situation in astronomy is different: an old and firm tradition going back to Herodotus (II, 104, 109) links its development with the influence of Egypt and Babylon. Ancient literature contains a mass of references to the astronomical wisdom of the Egyptian priests and the Chaldeans, of whom Pythagoras, as we recall, was accounted a pupil.[2] As Neugebauer noted half a century ago, there is scarcely another chapter in the history of science where an equally deep gap exists between an ancient Greek *communis opinio* long accepted by scholars and the results of the modern investigations of Babylonian (and Egyptian) sources.[3] It became plain long ago that most of the evidence of the Greeks relating to the astronomy of the Egyptians is apocryphal. Egypt had no astronomy other than observations of the stars with the aim of compiling a calendar;[4] not one record of astronomical observations has been found in Egyptian texts.[5] The question of Babylonian

[1] See K. Volk, 'Musikalische Praxis und Theorie im Alten Orient', in K. Volk et al. (eds.), *Vom Mythos zur Fachdisziplin: Antike und Byzanz* (Geschichte der Musiktheorie, 2) (Darmstadt, 2006), 1–46.

[2] See above, 59, 85 n. 105.

[3] Neugebauer, *ES*, 106.

[4] G. J. Toomer, 'Mathematics and Astronomy', in J. R. Harris (ed.), *The Legacy of Egypt*, 2nd edn. (Oxford, 1971), 45 f.

[5] R. A. Parker, 'Ancient Egyptian Astronomy', in D. G. Kendal (ed.), *The Place of Astronomy in the Ancient World* (Oxford, 1974), 51–64; Neugebauer, *HAMA* ii. 559 ff.

influence began to be elucidated only after astronomical cuneiform texts were deciphered and systematically compared with Greek. It was established that, from the middle of the second century, Greek astronomers, particularly Hypsicles and Hipparchus, made use of the results of Babylonian observations and calculations.[6] This provided a new impulse for Greek astronomy, enabling it to achieve an accuracy which had earlier been impossible, as it moved from qualitative to quantitative models. But what was happening in the sixth–fourth centuries, when the conceptual fundamentals of Greek astronomy were taking shape?

Unlike some historians of astronomy, who regarded close to the majority of the accomplishments of early Greek astronomy as borrowed, Neugebauer dated the beginning of any tangible Babylonian influence to the Hellenistic age, when the Greeks and the Babylonians found themselves for a long period subjects of the same states.[7] Apart from external factors, the reason for such tardy (and one-way) contacts was the differences between the astronomical traditions of Babylon and Greece, almost as great as those between the mathematical ones.[8] If the mathematics of the Babylonians was directed towards solving specific computational problems, the main aim of their astronomy was to predict correctly the apparent positions of the moon, sun, and planets at fixed points above the horizon. To this aim they made use, both of observations which they began to make at least from the eighteenth century onwards and record systematically from the eighth,[9] and of calculations based on increasingly complex arithmetical schemes. Apart from the objectives of calendar astronomy, the Babylonians needed the predictions also for the reason that the movements of the celestial bodies and eclipses of the sun and moon were considered to be omens of the course of state affairs, the outcome of

[6] Neugebauer, *HAMA* ii. 589 ff.; A. Jones, 'The Adaptation of Babylonian Methods in Greek Numerical Astronomy', *Isis* 82 (1991), 441–53. On Babylonian methods in Greek astrology see A. Jones, *Astronomical Papyri from Oxyrhynchus*, 2 vols. (Philadelphia, 1999).

[7] Neugebauer, *HAMA* ii. 589 ff.; see also Jones, 'Adaptation', 442 f.

[8] 'Periodicity was almost the only theoretical assumption shared by the Babylonian schemes and the Greek kinematic models', Jones, 'Adaptation', 444.

[9] A. J. Sachs and H. Hunger, *Astronomical Diaries and Related Texts from Babylonia*, i (Vienna, 1988), 12 ff. The astronomical collection MUL.APIN belongs to an earlier period, the 10th cent.: H. Hunger and D. Pingree, MUL.APIN: *An Astronomical Compendium in Cuneiform* (Horn, 1989), 10 f.

war, the volume of the harvest, etc.[10] Admittedly, astrology in its current meaning, i.e. the doctrine of the connection between the destiny of the individual and the movement of the celestial bodies, appears relatively late among the Babylonians (the end of the fifth century), while it comes into being on Greek soil only in the Hellenistic age.

In the final stage of its existence, falling in the Hellenistic age, Babylonian astronomy turned into a complex, technically developed discipline, devising effective methods to calculate and predict the apparent movement of the celestial bodies, in particular the moon and sun. At the same time it reveals features as distinctive as does the mathematics of the Babylonians, lacking in proofs. The Babylonian astronomers showed no interest in what was the real, and not the apparent, motion of the bodies across the firmament, nor in how they were actually positioned in relation one to another. The Greek astronomers, from Anaximander onwards, were concerned primarily to create a geometric model to reflect the true structure of the cosmos and explain the apparent motion of the celestial bodies. Babylonian astronomy, on the other hand, was in principle ageometric; notions of the celestial and terrestrial spheres and of uniform circular motion of the planets did not belong to it, nor did any other explanatory models.[11] The Babylonians could predict lunar eclipses, but were uninterested in their causes. Attempting to calculate with the greatest accuracy the appearance of the planets at a number of fixed points in the firmament, they set them out in an order which in no way reflected their actual positions in space.[12] Even in the Hellenistic period, when Babylonian astronomy acquired complex numerical methods, it made no attempt to comprehend the actual arrangement of the solar system. The very urge to do this remained alien to it. Bearing in mind these distinctions, together with the complexity of communicating astronomical knowledge,[13] it should be recognized

[10] S. Parpola, 'Mesopotamian Astrology and Astronomy as Domains of the Mesopotamian "Wisdom" ', in H. D. Galter (ed.), *Die Rolle der Astronomie in den Kulturen Mesopotamiens* (Graz, 1993), 47–59; F. Rochberg, *The Heavenly Writing: Divination, Horoscopy, and Astronomy in Mesopotamian Culture* (Cambridge, 2004).

[11] A. Aaboe, 'Observation and Theory in Babylonian Astronomy', *Centaurus* 24 (1980) 14–35; on the one exception see Neugebauer, *ES*, 108 f.; cf. id., *HAMA* ii. 577.

[12] See below, 330 n. 63.

[13] See on this point D. R. Dicks, *Early Greek Astronomy to Aristotle* (London, 1970), 168 ff.; Lloyd, 'Debt', 292.

that the scarcity of Babylonian borrowings during the sixth–fourth centuries is entirely natural, the more so since there is no evidence at all of contacts in mathematics at that time (above, §7.1) The fame of Babylonian astronomers reached Greece long before its geometrical astronomy had matured sufficiently to make successful use of the numerical methods and parameters of the Babylonians.

Not one of a number of known instances of borrowing in the early period relates to the Pythagoreans. The first instance is Thales' famous prediction of the solar eclipse of 585.[14] The very idea of predicting an eclipse is clearly of Babylonian origin, and it was long thought that Thales relied on some Babylonian scheme.[15] Later it became known that the Babylonians were unable *reliably* to predict solar eclipses for a given point either in the sixth century or later.[16] This does not mean that the tradition of Thales' prediction is fallacious. It is quite probable that he had access to information about one of the Babylonian periods, on the basis of which lunar eclipses were predicted, and made bold use of it to fix the date of the next solar eclipse.[17] Thales' 'prediction' came true only through a lucky chance: not only did the eclipse take place in the year he named, but it was visible in Ionia. The successful prediction reinforced the prestige of the famous sage and could have been a model for imitation. Could have, but did not. Greek astronomy in the person of Anaximander took a different course: the development of kinematic models to explain the movement of the celestial bodies. Whereas tradition is virtually silent regarding further predictions of eclipses, there were many Presocratics who sought an explanation for them.[18]

Herodotus reports that the Greeks learnt of the gnomon, the *polos*, and the division of the day into twelve parts from the Babylonians, not the Egyptians (II, 109). The division of the day into twelve parts

[14] Mentioned by Xenophanes (B 19), Heraclitus (B 38), Herodotus (I, 74), and Eudemus (fr. 143). See Zhmud, *Origin*, 239 f.

[15] The scheme was usually thought to be the so-called Saros, a period of 223 lunar months, used by the Babylonians to predict lunar and solar eclipses: F. K. Ginzel, *Spezieller Kanon der Sonnen- und Mondfinsternisse* (Berlin, 1899), 167 f., 171 f.

[16] Neugebauer, *ES*, 142 f; id., *HAMA* ii. 604. In fact, no one could do this before the 18th cent.

[17] Tannery, *Science*, 60; van der Waerden, *Anfänge*, 121 f.; Dicks, *Astronomy*, 43 f.; Zaicev, 191; F. R. Stephenson and L. J. Fatoohi, 'Thales's Prediction of a Solar Eclipse', *JHA* 28 (1997), 279–82.

[18] Anaximander (A 11, 19, 21–2), Xenophanes (A 41), Alcmaeon (A 4), Heraclitus (A 1, 12), Anaxagoras (A 76) et al. On predictions see Zhmud, *Origin*, 244 n. 69.

(probably by analogy with the division of the year into twelve months) was accepted in Egypt as early as the second millennium, and it is likely that the Greeks adopted it from Egypt rather than from Babylon.[19] The gnomon (sundial) consisted of a rod perpendicular to a plane surface with divisions marked on it. It is possible that Herodotus did not see the gnomon in Egypt, but observed it in Babylon, though the instrument was actually in use in both cultures. The *polos* is a more complex version of the gnomon, in which the shadow of the indicator fell on the concave surface of a hemisphere with concentric lines marked on it to indicate the movement of the sun. In 430 the *polos* was used by the Athenian astronomers Meton and Euctemon; the very form of the instrument is premised on concepts of the celestial sphere which neither the Egyptians nor the Babylonians possessed.[20]

The possibility that two calendar cycles known in Babylon were borrowed – the eight-year, introduced by Cleostratus of Tenedos, and the nineteen-year, introduced by Meton and Euctemon – has long been discussed, but no reliable positive data have been found.[21] Nor is there an end to the old dispute on the degree to which Greek notions of the zodiac are dependent on Babylonian. It is now accepted that all geometric models, like the ecliptic circle inclined to the celestial equator, are of Greek origin, whereas the twelve zodiacal constellations and the twelve signs of the zodiac are of Babylonian origin. By whom and when they were adopted remains obscure.[22] The case of

[19] R. A. Parker, 'Astronomy', 52; Toomer, 'Mathematics and Astronomy', 56 ff.; O. Neugebauer, 'On Some Aspects of Early Greek Astronomy', in *Astronomy and History: Selected Essays* (New York, 1983), 361 f.

[20] Ch. H. Kahn, 'On Early Greek Astronomy', *JHS* 90 (1970), 114; F. Franciosi, 'Herod. 2.109: Astronomia come scienza esatta e parti del giorno', *A&R* 27 (1982), 172 f., 178 f. Aristophanes mentions the *polos* (fr. 169, 227 K.–A.). See A. Rehm, 'Horologium', *RE* 8 (1913), 2417 ff.; id., *Parapegmastudien* (Munich, 1941), 28 f.

[21] For the independence of the Greeks: Neugebauer, *ES*, 140 f.; id., *HAMA* ii. 619 ff.; A. E. Samuel, *Greek and Roman Chronology* (Munich, 1972), 21 ff. For borrowing: J. Fotheringham, 'Cleostratus', *JHS* 39 (1919), 164–84; 45 (1925), 78–83; G. Huxley, *The Interaction of Greek and Babylonian Astronomy* (Belfast, 1964), 4 f.; van der Waerden, *Anfänge*, 258 f.; A. Bowen and B. Goldstein, 'Meton of Athens and Astronomy in the Late 5th Century B. C.', in E. Leichty et al. (eds.), *A Scientific Humanist: Studies in Memory of A. Sachs* (Philadelphia, 1988), 39–81.

[22] See: H. G. Gundel and R. Böker, 'Zodiakos', *RE* 19 (1972), 462–543; J. P. Britton, 'Scientific Astronomy in Pre-Seleucid Babylon', in Galter (ed.), *Rolle*, 61–76; L. Brack-Bernsen and H. Hunger, 'The Babylonian Zodiac: Speculations on Its Invention and Significance', *Centaurus* 41 (1999), 280–92.

the borrowing of the planet names is more definite. In the beginning the Greeks had no fixed names for the planets, with the exception of Venus, which they called the Evening and Morning Stars, depending on the time of its appearance. The names of the planets, first attested in Plato's *Timaeus* (38d: Hermes) and then all five in the *Epinomis* (986e–987a: the stars of Hermes, Aphrodite, Ares, Zeus, and Kronos), are fully analogous to the Babylonian. It is typical that the Greeks took from Babylon the names, but not the order of the planets, which did not correspond to their actual location in space: Marduk (Jupiter), Ishtar (Venus), Ninurta (Saturn), Nabu (Mercury), Nergal (Mars).[23]

That is, I suggest, all that is more or less credibly known of Babylonian influence on Greek astronomy in the first three centuries of its development. In principle, all the information given above could have been conveyed orally, including by Babylonian visitors to Greece. One of them could have been the χαλδαῖος who visited Plato not long before his death. Philip of Opus, Plato's secretary and author of works on astronomy, reports the conversation of this 'Chaldean' with Plato,[24] from which it might follow that he also spoke with him. Interestingly, it is in the *Epinomis*, of which Philip is usually considered to be the author, that the names of all five planets first appear, and it is said that the barbarians were first to study astronomy, and the Greeks, adopting their knowledge, would perfect it (986e–987e). We seem to have a meeting in the course of which the learning of the Orient was ready to fall onto the 'fertile soil' of the Occident! What we learn from *Epinomis*, however, is a disappointment. Philip writes that astronomy began in Egypt and Syria (Babylon), because the sky there is always clear, to which a contemporary commentator responds: Egyptian astronomy was very primitive, and the famous clear skies in Babylon are a cliché which does not reflect reality.[25] More important is that nothing in *Epinomis* suggests that Philip gained access to some new data which had hitherto been inaccessible. The astronomy of *Epinomis* is entirely congruent with the level known through Plato's dialogues.[26]

23 This was the Babylonian order of the 5th cent. Later it was replaced by another: Jupiter, Venus, Mercury, Saturn, Mars (Neugebauer, *HAMA* ii. 690).

24 Dorandi, *Filodemo*, 132 f., 219 f.

25 Neugebauer, *ES*, 98.

26 L. Tarán, *Academica: Plato, Philip of Opus, and the Pseudo-Platonic Epinomis* (Philadelphia, 1975), 98 ff.

Aristotle's evidence presents a similar case. Speaking about the occultation of Mars by the moon, he adds, 'Similar observations about the other planets are recorded by the Egyptians and the Babylonians, who have been watching the stars from the remotest past, and to whom we owe many incontrovertible facts about each of them' (*Cael.* 292a5–9, tr. Guthrie). As usual the Egyptians are irrelevant here: no records of planetary observations have yet been found in Egypt. Information about observations by the Babylonians is factually sound. Had this passage been written by Hipparchus, not Aristotle, no suspicions would have been aroused. Yet how did Aristotle gain access to Babylonian data, and why is there no trace of their use in him or among the astronomers of the fourth and even the third centuries?[27] From what is said by Philip and Aristotle, it follows that there were tales about Oriental astronomy circulating in Athens in the fourth century, the ubiquitous Egyptians always figuring alongside the Babylonians,[28] but the stage of borrowing technical data had not yet been reached. The actual synthesis of Greek theories and Babylonian calculations came about only in the mid-second century, when Greek astronomy reached a level at which it was able to make use of them and when the data themselves were translated into Greek by a Babylonian.[29]

[27] Neugebauer, *HAMA* ii. 608. In his commentary on this point Simplicius (*In Cael.*, 506.8 f.) reports, referring to Porphyry, that Aristotle's nephew, Callisthenes, a member of Alexander's expedition, sent back from Babylonia records of observations over 31,000 years (!).

[28] The tendency continued in later times. The Peripatetic Adrastus (*ap.* Theon. *Exp.*, 177.9 ff.) stated that the Babylonians made use of arithmetical methods in astronomy and the Egyptians geometrical. Since, unlike the Greeks, they did not study the nature of celestial phenomena, they themselves rendered their methods imperfect. Clearly the Egyptians are inserted into this passage for the sake of symmetry.

[29] 'Greek astronomy was not ready for the Babylonian lesson until the work of Apollonius of Perga (*c.* 200 BC) on epicyclic models', A. Aaboe, 'Babylonian Mathematics, Astrology and Astronomy', in J. Boardman et al. (eds), *The Cambridge Ancient History*, iii/2, 3rd edn. (Cambridge, 1991), 291. Of the Babylonian astronomers of the 3rd–2nd cents., Soudines is known (Strab. XVI,1,6; Vett. Val., p. 354.3 Kroll), who lived around 240 at the court of Attalus, king of Pergamon, and wrote on astrology in Greek: W. Hübner, 'Zum Planetenfragment des Sudines (Pap. Gen. inv. 203)', *ZPE* 73 (1988), 33–42, 109–10, and also Seleucus of Seleucia, an older contemporary of Hipparchus (Neugebauer, *HAMA* ii. 610 f.). Some historians believe that Hipparchus had personal access to cuneiform data: G. J. Toomer, 'Hipparchus and Babylonian Astronomy', in Leichty et al. (eds.), *Scientific Humanist*, 353–62; Jones, 'Adaptation', 443. See also A. Jones, 'Evidence for Babylonian Arithmetical Schemes in Greek Astronomy', in Galter (ed.), *Rolle*, 77–94.

9.2 PYTHAGOREAN ASTRONOMY BEFORE PHILOLAUS?

The development of Pythagorean astronomy before Philolaus is very poorly documented. Unlike mathematics, we have practically no evidence about Pythagoras' astronomy from the Classical period. Unlike harmonics, Hippasus made no mark in astronomy. Practically nothing is known of Archytas' astronomy either.[30] It was in astronomy that Philolaus, on the other hand, displayed originality and also had non-Pythagorean teachers, so it is only with caution that he can be made use of as a source on early Pythagorean astronomy. A Pythagorean stratum cannot be distinguished in the generalizing works of the end of the fourth century, Euclid's *Phenomena* and the two treatises of Autolycus of Pitane, at least with the same degree of reliability as in Euclid's *Elements* or *Sectio canonis*. To some extent they can be substituted by Plato's astronomical system, presented in the *Republic* and in *Timaeus*; it must be borne in mind only that Plato did not copy Philolaus or the earlier astronomy of the Pythagoreans.[31] A reconstruction of early Pythagorean concepts is made still more complicated since astronomy, as a hypothetico-deductive science, has a logic of development different from that of mathematics. Once it had been proved in the fifth century that the sum of the angles of a triangle is equal to two right angles, it is hard to imagine that a geometrician of the fourth century might have a different view. Astronomical propositions do not have the absolute incontestability of theorems. Hence in this area bold ideas appearing too early often yield to the pressure of 'obvious' facts and must wait many decades to become firmly established, like the idea that the earth is a sphere, or even centuries, like the heliocentric system of Aristarchus of Samos.

As if trying to make up for the paucity of classical sources, later tradition ascribes too much to Pythagoras: assigning the word 'cosmos' to the universe, discovering the sphericity of the earth, the obliquity of the ecliptic, and the planets' own motion along the

[30] A fragment of Eudemus' *Physics* briefly sets out Archytas' contention that beyond the celestial sphere there is infinity (fr. 65 = A 24; Huffman, *Archytas*, 540 ff.). It has no direct bearing on astronomy.

[31] Van der Waerden (433 ff.) believed that Plato's astronomy derived from the Pythagoreans.

ecliptic, dividing the celestial and terrestrial spheres into zones, identifying the Morning and Evening Stars with Venus, discovering the 'great year', etc.[32] Most of this information derives from the *Vetusta placita*, a first-century doxographical compendium which represents Thales and Pythagoras as the sources of virtually all the fundamental notions of Greek astronomy.[33] How it was that this image took shape is shown by a lemma in Aëtius: 'Some ascribe this opinion [i.e. Hipparchus' opinion on visual rays] also to Pythagoras, as an authority in the mathematical sciences.'[34] The fame of Pythagoras as an expert in *mathēmata* was sometimes sufficient for some scientific notion to be attributed to him. The same tendency is typical not only of doxography. The quite competent *Introduction to Astronomy* of Geminus, who, like the author of the *Vetusta placita*, belonged to the school of Posidonius, also notes the fundamental role played by the Pythagoreans in establishing mathematical astronomy.

> The hypothesis underlying the whole astronomy is that the sun, the moon, and the five planets revolve at constant speed in the direction opposite to that of the universe. The Pythagoreans were the first to approach such investigations, and they assumed that the motions of the sun, the moon, and the five planets are circular and uniform (I, 19).

Eudemus in his *History of Astronomy* attributed to Eudoxus the principle of 'saving the phenomena' by means of uniform and ordered circular movement; the Peripatetic Sosigenes in the second century AD made Plato its author.[35] Geminus is somewhere between these two positions: he does not yet mention Plato, but the arguments he ascribes to the Pythagoreans are of a Platonic nature.[36] Platonized Pythagoreanism, inseparable from pseudo-Pythagorean literature, was also reflected in the doxography, which systematically links the

[32] Aëtius II,1,1 (the cosmos), II,12,1 (division of the celestial sphere into zones), III,14,1 (division of the earth into zones), II,12,2 (obliquity of the ecliptic), II,32,2 (the 'great year'); Apollodorus of Athens (*FGrHist* 244 F 91), D.L. VIII, 14 (Venus) and 48 (sphericity of the earth).

[33] See above, 239 n. 1. On the *Vetusta placita* see above 259 n. 68, 302.

[34] Ἔνιοι καὶ Πυθαγόραν τῇ δόξῃ ταύτῃ συνεπιγράφουσιν ἅτε δὴ βεβαιωτὴν τῶν μαθημάτων (IV,13,10).

[35] Eud. fr. 148 = Simpl., *In Cael.*, 488.18–24; Zhmud, *Origin*, 86 f., 231 f.

[36] It is impossible to imagine that the divine and eternal celestial bodies might move at times fast, at times slowly; their immortal nature assumes only a uniform circular motion (I, 19 f.).

teachings of Plato and the Academy with Pythagoras.[37] The subsequent development of Platonism and the appearance of neo-Pythagoreanism reinforced even further Pythagoras' position as Plato's forerunner. He appears as such, for example, in Adrastus' commentary on the *Timaeus* (first half of the second century AD), already familiar to us (above, §8.3): while Plato, as it turns out, knew the theory of epicycles (devised at the end of the third century by Apollonius of Perga), it is to Pythagoras that the discovery of the uniform circular movement of the planets along the ecliptic, which Geminus connected with the Pythagoreans, is attibuted:

> The apparent variety in the motion of the planets arises because they, bound to certain circles and spheres of their own and moved by them, appear to us to be carried through the signs of the zodiac, as Pythagoras was first to perceive; thus to their movement, uniform, simple and regular by itself, is added accidentally something erratic and irregular.[38]

Nicomachus also had something to say on this. According to Simplicius (*In Cael.*, 507.12 f.) he attributed to Pythagoras the theory of excentres; he was followed by Iamblichus. In *VP* 31 Iamblichus asserts that it was thanks to Pythagoras that the correct concept of the motion of the celestial bodies became established, including excentres and epicycles. Proclus' *Hypotyposis*, which begins with the words *Πλάτων μὲν ὁ μέγας*, also connects Pythagoras and the Pythagoreans with the theory of excentres and epicycles, since this hypothesis is the most economical, and corresponds to the nature of the divine bodies (I,34). So a distinct tendency emerges: the greater the significance acquired by the figure of Plato, who knew in advance the answers to all the most important questions, the more accomplished became the astronomy of his predecessor Pythagoras.

Returning to the fourth-century tradition, we note that, as a rule, it links Pythagoras with astronomical studies as a whole, while attributing to the Pythagoreans, both individual and anonymous, more

[37] See above, 90 n. 128, and below, 423 f. Kerschensteiner (*Kosmos*, 228 f.) is right to connect this tendency with Stoic revision of the doxography.

[38] Theon. *Exp.*, 188.25 f. (Plato), 150.12 ff. (the Pythagoreans). On Adrastus' predilection for Platonism and Pythagoreanism see P. Moraux, *Der Aristotelismus bei den Griechen*, ii (Berlin, 1984), 304 f. Burkert, 325 n. 10: 'Adrastus makes Pythagoras the inventor of epicycles and excentres', but this does not directly follow from Adrastus' words.

specific achievements. At the beginning of the fourth century Isocrates portrays Pythagoras as a pupil of the Egyptian priests, whose studies include astronomy (*Bus.* 23, 28). At the end of the same century Neanthes and, probably, Timaeus write that he studied under the Babylonian Chaldeans, famous for their astronomy; the poetry of Hermesianax also connects him with astronomy.[39] Testifying to Pythagoras' fame as an expert in *mathēmata*, these writers provide no details. Plato's sole mention of the Pythagoreans (*Res.* 530d) relates to astronomy and harmonics as kindred sciences and is based on Archytas' ideas (B 1). Aristotle more than once discussed the Pythagoreans' astronomical theories, but he was writing of *οἱ Πυθαγόρειοι* as a whole, including when dealing with Philolaus' system.[40] Only once, in the *Protrepticus*, does Pythagoras figure in connection with astronomy. Even here, however, the subject is a saying attributed to the renowned sage: man is born to observe the heaven (*τὸ θεάσασθαι τὸν οὐρανόν*), not any specific theories or discoveries.[41] Although Aristotle did not exclude Pythagoras from those of whom it is reasonable to speak in the context of observing the firmament, evidently he had no sound information about the results of these observations. Nor did Theophrastus and Eudemus, who studied the history of astronomy and collected valuable evidence of the discoveries of Thales and Anaximander.[42] It is unclear whether Theophrastus referred to anything relating to Pythagoras' astronomy in the *Opinions of the Physicists*; where the same discoveries are attributed to both Pythagoras and Parmenides, Theophrastus favours the latter (see below). In any case the system of Philolaus was represented in Theophrastus' doxography, as were Alcmaeon's theories, and the theory of Ecphantus and Hicetas of the earth's diurnal rotation about its own axis.[43] Eudemus' *History of Astronomy*

[39] See above, 59, 85 n. 105.

[40] *Cael.* 293a18 ff., *Met.* 985b23 ff., fr. 203–4.

[41] Fr. 18, cf. above, 56, and below, 428 f. An analogous saying is ascribed to Anaxagoras: to observe the heaven and the stars, sun, and moon upon it (fr. 19). It would be wrong to diminish the importance of that fragment by referring to the fact that the *Protrepticus* was written at the Academy, when Aristotle viewed the Pythagoreans through the eyes of his colleagues; see above, 57 f.

[42] See Zhmud, *Origin*, 238 ff.

[43] Alcmaeon (Aët. II,16,2, 22,4, 29,3); Philolaus (II,7,7, 20,12, 30,1; III,11,3, 13,2); Ecphantus (II,1,2; III,13,3), Hicetas (fr. 240 FHSG). Archytas was absent from the *Opinions of the Physicists*, probably since he was considered to be a mathematician (Zhmud, *Origin*, 127 ff., 131 f.).

ascribed the order of the celestial bodies to the Pythagoreans (fr. 146), saying nothing about Pythagoras himself.

Aristoxenus might be regarded as the one exception among the Peripatetics. 'According to Aristoxenus the musician,' Diogenes Laertius remarks, 'Pythagoras was first to introduce weights and measures into Greece. It was he who first declared that the Evening and Morning Stars are the same, though others say it was Parmenides.'[44] It is quite possible that the words about Venus belong to Aristoxenus, but this cannot be asserted confidently: Diogenes frequently 'patched together' different authors' reports.[45] Moreover, if these are the words of Aristoxenus, their juxtaposition with the assertion that Pythagoras was the first to introduce into Greece weights and measures casts doubt on them. The chief obstacle is that the version which makes Parmenides author of this invention (28 A 40a) derives from Theophrastus and relies on a *written* source, the poem of Parmenides. Aristoxenus' version could not have relied on such a source.

Parmenides competes with Pythagoras in relation to the authorship of two more discoveries: the sphericity of the earth and its division into zones. In both cases the Eleatic is supported by an earlier and more reliable source, Theophrastus in the first instance and Posidonius in the second.[46] It follows from the very names of the zones (Arctic from *Ἄρκτος*, the Great Bear; Antarctic its opposite) that initially the division into zones related to the celestial sphere and was then assigned to the earth. In turn the division of the celestial sphere into zones is premised on concepts of a celestial equator and two tropic circles at the points at which the equator is intersected by the inclined zodiac circle. In Aëtius the division of the celestial sphere

[44] *καὶ πρῶτον εἰς τοὺς Ἕλληνας μέτρα καὶ σταθμὰ εἰσηγήσασθαι* (sc. *τὸν Πυθαγόραν*), *καθά φησιν Ἀριστόξενος ὁ μουσικός. πρῶτόν τε Ἕσπερον καὶ Φωσφόρον τὸν αὐτὸν εἰπεῖν, οἱ δέ φασι Παρμενίδην* (VIII, 14 = Aristox. fr. 24). Favorinus mentioned Parmenides (fr. 46 = D.L. IX, 23). See Burkert, 307 n. 401. In place of the manuscript reading *ὥς φησι Παρμενίδης* Wehrli accepted Casaubon's conjecture *οἱ δέ φασι Παρμενίδην*. Diels proposed in his apparatus *ὥς φησι <καὶ> Παρμενίδης* (A 40a). Marcovich accepted an old conjecture by Karsten, *ὥς <δὲ Φαβωρῖνός> φησι Παρμενίδην*.

[45] As distinct from Wehrli, Diels left to Aristoxenus only the report on weights and measures (14 A 12), as does Burkert, 415 n. 79. Giangiulio, *Pitagora*, i, test. 63, follows Wehrli.

[46] Theophrastus (D.L. IX, 21 and VIII, 48 = 28 A 1, 44 = fr. 227E FHSG). Posidonius (fr. 49b = 28 A 44a), see also: Achil. *Isag.* 31, p. 67.27 (from Posidonius); Aët. III,11,4. Diogenes Laertius ascribes to Pythagoras the sphericity of the earth (VIII, 48), and Aëtius its division into zones (III,14,1).

is attributed to 'Thales, Pythagoras, and their successors' (II,12,1), while a more accomplished variant of the division of the earth into zones (II,14,1) than that which Posidonius connects with Parmenides, is ascribed to Pythagoras alone. All this inspires no confidence and compels one to perceive retrospective projection in evidence about Pythagoras. Nevertheless Pythagoras was generally favoured in this contest by researchers until the middle of the twentieth century.[47] Much of this is related to serious problems in the interpretation of Parmenides' teaching. Were the author of the discoveries named above to be Parmenides, to whom some attribute also the idea that the moon shines with reflected light,[48] this would make him the leading astronomer of his time. This is, however, countered by the first (and major) part of his poem, according to which the world perceived by the organs of sense is no more than an illusion, while real being is a spherical body, eternal and immutable. It is also contradicted by the fact that his pupils Zeno and Melissus saw him predominantly as a metaphysician and logician, with which most of the researchers of Parmenides in the second half of the twentieth century concur, showing little interest in his astronomy. Theophrastus had a different view of Parmenides, but the fragments accessible *to us* do not support his interpretations regarding Venus and the sphericity of the earth, though neither do they contradict them. In the context of such significant discoveries by Parmenides, it seems particularly paradoxical that no one yet has succeeded in comprehending how his celestial system looked as a whole. To reconstruct it

[47] Pythagoras or Pythagoreans before Parmenides were supported for the sphericity of the earth by: Tannery, *Science*, 214; F. Hultsch, 'Astronomie', *RE* 2 (1896) 1832; T. L. Heath, *Aristarchus of Samos* (Oxford, 1913), 48 f., 64 f.; Burnet, 44, 191; W. Nestle, 'Parmenides', *RE* 18 (1949), 1556; Timpanaro Cardini, i. 128 n.; Guthrie, ii. 65; Tarán, *Parmenides*, 266. Dicks, *Astronomy*, 51, 64, 72 f., rejected the priority of Parmenides in favour of 5th-cent. Pythagoreans, von Fritz, *Grundprobleme*, 145 ff., 150, in favour of Anaxagoras.

[48] B 14–15; Aët. II,26,2 = A 42 (in II,28,5 this idea is ascribed at once to six philosophers, including Pythagoras, Parmenides, and Anaxagoras); G. Wöhrle, 'Wer entdeckte die Quelle des Mondlichts?', *Hermes* 123 (1995), 244–7. Diels contested the authorship of Parmenides (*Parmenides Lehrgedicht*, 110; *DK* I, 243 n.). Plato (*Crat.* 409a = 59 A 76) and Hippolytus (*Ref.* I,8,10 = A 42), who made use of a source going back to Theophrastus, testify in favour of Anaxagoras. See D. O'Brien, 'Derived Light and Eclipses in the Fifth Century', *JHS* 88 (1968) 114–27: in Parmenides the moon shines, not with reflected light, but with light derived from the sun.

appears hopeless, owing both to a lack of evidence and to his 'intentional use of ambiguity'.[49]

Many followed Tannery in seeing the solution of the problem in that the second part of Parmenides' poem, which dealt with the deceptive δόξαι of mortals, contained in the main the cosmological concepts of Pythagoras or of the Pythagoreans.[50] Tannery also suggested that Zeno's aporias be seen as predominantly an anti-Pythagorean polemic.[51] Both these directions of interpretation have been exhausted, almost without producing any tangible result. Pythagorean influence on Parmenides, perceptible for example in his logical argumentation (above, §7.2), is still possible in the field of astronomy too. Unfortunately there is nothing on which this hypothesis can be tested: the astronomy of Hippasus is unknown, nor does any one of the discoveries attributed to the Eleatic appear in Alcmaeon, who was older than Parmenides.[52] Eudemus' *History of Astronomy*, which focused on discoveries in mathematical astronomy,[53] has nothing to say about Parmenides. This stands against Parmenides but, in this case, *argumentum ex silentio* is not decisive. Even if Theophrastus and Posidonius overvalued Parmenides,[54] we have no more reliable evidence about Pythagoras to set against them.

[49] Kahn, 'Astronomy', 105 n. 22. Similarly Burkert, 307 n. 40; *KRS*, 259. Suggestive in this sense are disagreements in the treatment of Parmenides' cosmology: A. Finkelberg, 'The Cosmology of Parmenides', *AJP* 107 (1986) 303–17; K. R. Popper, 'How the Moon Might Throw Some of Her Light upon the Two Ways of Parmenides', *CQ* 86 (1992), 12–19; T. Drvota, 'Die Kosmologie des Parmenides', *LF* 129 (2006), 1–50.

[50] Tannery, *Science*, 236; F. Boll, 'Finsternisse', *RE* 6 (1909), 2342; Nestle, 'Parmenides', 1556 f.; Burnet, 185; Guthrie, ii. 65; Tarán, *Parmenides*, 266.

[51] Tannery, *Science*, 258 ff. This idea was developed by Cornford, 'Mysticism and Science'; Burnet, 314 ff.; J. E. Raven, *Pythagoreans and Eleatics* (Cambridge, 1948), 43–65; see below, 413 f.

[52] Empedocles (B 45) repeats Parmenides' words about moonlight, ἀλλότριον φῶς, cf. 28 B 14. To be sure, he was also influenced by Anaxagoras, the first to explain correctly eclipses of the moon: D. O'Brien, 'The Relation of Anaxagoras and Empedocles', *JHS* 88 (1968), 93–113; id., 'Derived Light'.

[53] Zhmud, *Origin*, 250 f.

[54] On Parmenides' division of the earth into zones see: H. Berger, 'Die Zonenlehre des Parmenides', *BSGW* 47 (1895), 82 f., 106 f; A. Fresa, 'Parmenide di Elea e la teoria delle zone celesti e terrestri', *AAP* 12 (1962/3), 263–74; K. Abel, 'Zone', *RE Suppl.* 14 (1974), 996 ff. Abel attributes the discovery of the obliquity of the ecliptic to Oenopides; Kidd (comm. to Posid. fr. 49b) believes that Parmenides had no astronomically based theory of zones.

If we cannot firmly establish the authorship of the discoveries attributed to Pythagoras and Parmenides, their subsequent history may shed light on them. The terrestrial and celestial spheres are first clearly attested in Philolaus, and the division of the celestial sphere into zones in his contemporary, Hippocrates of Chios. In both cases the planets move in circular orbits along the ecliptic.[55] This provides a reliable *terminus ante quem*, *c.*430, from which we can proceed to earlier stages. Hippocrates' geometry was indubitably founded on Pythagorean (above, §7.4), but what was the situation with his astronomy? In Philolaus' system all the heavenly bodies – the stars, the five planets, the sun, the moon, and also the earth and the counter-earth which he postulated – revolved about a central fire, Hestia. The introduction of Hestia and the counter-earth, the transformation of the earth from the centre of the universe into one of the planets – these and other innovations clearly indicate that Philolaus' system was preceded by another, geocentric system. The question is only whether that system was Pythagorean. Burkert was quite correct to emphasize that question,[56] there being quite enough traces of various influences on Philolaus to reject a simple extrapolation of his ideas onto early Pythagorean astronomy. Moreover, evidence about Pythagoras being highly problematical and evidence about Hippasus lacking, it is the existence of early Pythagorean astronomy which requires demonstration.[57]

Burkert's reply to the question he poses is quite predictable: Pythagorean astronomy before Philolaus was pre-scientific. It is based, not on geometric models, but on notions known to us from the 'symbols': 'The planets are the dogs of Persephone', etc. Philolaus' detailed knowledge of the five planets does not derive from Pythagorean tradition, but was borrowed by the Greeks from Babylon not long before him.[58] The result has been that valid criticism of

[55] 42 A 5; 44 A 21. The celestial sphere was in Parmenides (B 8), and possibly earlier in Anaximenes: A 12–13; Kahn, 'Astronomy', 106 ff.; G. Wöhrle, *Anaximenes aus Milet* (Stuttgart, 1993), 72 f.

[56] 'That the astronomy which preceded the Philolaus system was Pythagorean … is nothing but a historical hypothesis, which cannot be corroborated or refuted by the inner logic of the history of science, but must be known from the external testimony', Burkert, 303.

[57] Kahn, 'Astronomy', 109 n. 36: 'This does not mean that there was no Pythagorean astronomy around 500 B. C.; only that we can scarcely hope to know anything about it'; similarly Kahn, 38.

[58] Burkert, 310 f., 313, 330.

late antique and contemporary 'pan-Pythagoreanism'[59] goes to the opposite extreme: rejection of *any* contribution to astronomy by the early Pythagoreans and relativization of Philolaus' contribution to it. In fact, we should not assume a priori that any 'symbol' is more ancient than any scientific idea; a historical analysis of the sources is required. We are reminded that the 'symbol' of the dogs of Persephone occurs first in the third century AD in Clement of Alexandria and Porphyry,[60] and nowhere else. Porphyry attributes the group of astronomical 'symbols' to Aristotle, but this attribution is doubtful, the more so since two of the four 'symbols' are not mentioned anywhere else.[61] Since there is nothing in the 'symbol' itself of the planets which might lead us to the beginning of the fifth century,[62] it is as wrong to adduce it with the aim of reconstructing Pythagorean astronomy as to adduce Iamblichus' words on excentres and epicycles originating with Pythagoras (*VP* 31). Nor is there anything to confirm a 'Babylonian trace' in Philolaus' system. In Philolaus the order of the heavenly bodies (with the exception of Hestia and counter-earth) coincides with that accepted in the fourth century (see below) and has nothing in common with the Babylonian order of the planets.[63]

Let us turn our attention to a number of testimonies which connect Philolaus' teaching of the planets with the views of earlier Pythagoreans. In Anaximander the planets had not yet been identified as a separate group. Anaximenes evidently marked them out as distinct

[59] The ancient tradition on the Pythagoreans as the authors of the theory of epicycles retained its attraction right up to recent times: van der Waerden, 450 f. Cf. criticism: Burkert, 323 f.

[60] Clem. *Strom.* V,8,50; Porph. *VP* 41. On their dependence on neo-Pythagorean sources see above, 187 ff.

[61] *VP* 41 = Arist. fr. 196. See above, 199 n. 117. That this group is missing from Aelian, Diogenes Laertius, and Iamblichus, who preserved most of the 'symbols' derived from Aristotle's book (Burkert, 167 f.), makes it particularly suspicious.

[62] The first appearance of the planets as living beings is in Plato's *Timaeus*: W. Gundel and H. Gundel, 'Planeten', *RE* 20 (1950), 2022, 2052. It remains unclear why the planets are the dogs of Persephone; M. P. Nilsson, 'Die astrale Unsterblichkeit und die kosmische Mystik', *Numen* 1 (1954), 108: 'Was sie damit meinten, ist dunkel'; similarly Gundel and Gundel, 'Planeten', 2022. The range of interpretations is very wide: Hüffmeier, *Sprüche*, 253 f. In traditional Greek religion the planets were not regarded as divinities (Nilsson, *GGR* i. 839 ff.); on Alcmaeon (A 12) cf. below, 318.

[63] See above, 320 n. 23.

from the fixed stars, but said nothing specific about them.[64] Aëtius has this to say about Alcmaeon:

> Some mathematicians believe that the planets move from west to east in a direction opposite to the movement of the fixed stars. Alcmaeon agrees with this.[65]

Let us first be precise: *μαθηματικοί* are unrelated to the Pythagorean *mathematici*; the name was given to mathematicians who specialized in astronomy.[66] The opinions of a number of astronomers (Eudoxus, Aristarchus, Eratosthenes, and others) were included in the *Vetusta placita*, their individual opinions figuring under their names and their common opinions normally attached to analogous views expressed earlier by the 'physicists'.[67] Thus Alcmaeon was mentioned in Theophrastus without any *μαθηματικοί*. Alcmaeon's astronomical views produce a contradictory impression. On the one hand, he considered the sun to be flat and had a naive explanation for lunar eclipses (A 4). On the other, he was aware that the planets, sun, and moon, apart from their diurnal movement, have also an annual movement along the ecliptic from west to east, i.e. rise each day further to the east in the zodiacal constellations. Few, however, have been bold enough to claim that the doctor and natural philosopher Alcmaeon was himself responsible for the discovery of the independent motion of the planets from west to east. Most historians have believed that he gained this knowledge from Pythagoras or one of his pupils, otherwise remaining loyal to old Ionian views. Others have perceived here Babylonian influence, while yet others have totally rejected Aëtius' report.[68] Although Alcmaeon's

[64] A 14; Gundel and Gundel, 'Planeten', 2042; H. Schwabl, 'Anaximenes und die Gestirne', *WS* 79 (1966), 33–8; Wöhrle, *Anaximenes*, 72.

[65] Aët. II,16,2–3 = 24 A 4: (*τῶν μαθηματικῶν τινες*) *τοὺς πλανήτας τοῖς ἀπλανέσιν ἀπὸ δυσμῶν ἐπ' ἀνατολὰς ἀντιφέρεσθαι. τούτῳ δὲ συνομολογεῖ καὶ Ἀλκμαίων.*

[66] Thus Festugière, 'Mémoires', 430 n. 2; Burkert, 332 n. 45; cf. Timpanaro Cardini, i. 128 n.: the mathematicians are Pythagoreans. For more detail see Zhmud, *Origin*, 295 f.

[67] See Zhmud, *Origin*, 296. Cf. Aët. II,15,5: *Τῶν μαθηματικῶν τινὲς μὲν ὡς Πλάτων φασὶν εἶναι τὴν τάξιν τῶν ἀστέρων, τινὲς δὲ μέσον πάντων τὸν ἥλιον.* It is incorrect therefore to regard the mention of Alcmaeon as an 'afterthought' and 'later addition' (thus Burkert, 311 n. 64, 332 n. 45); on the contrary the mathematicians are a later addendum.

[68] The Pythagoreans: Tannery, *Science*, 213 f.; Heath, *Aristarchus*, 49 f.; Burnet, 195; Gundel and Gundel, 'Planeten', 2043; Timpanaro Cardini, i. 128 f. Babylonian influence: van der Waerden, 436. Dicks, *Astronomy*, 74 f., was sceptical of Aëtius'

knowledge seems too advanced for the beginning of the fifth century, we have a similar situation with the sphericity of the earth: at least half a century separates Parmenides, if he was the one to express this idea, from Philolaus, who shared it. After Alcmaeon, the circular movement of the planets along the ecliptic is adduced in Oenopides, born roughly when Alcmaeon's book appeared (*c.*490/85). I know of no more suitable candidate for this discovery in the interval between them.

The evidence of Aëtius implies that the motion of the planets along the ecliptic is circular, as we see later in Philolaus and Hippocrates. It would seem that this view found reflection also in Alcmaeon's notion of the immortality of the soul, passed on by Aristotle. The soul is immortal because, like all divine celestial bodies, it is in constant motion: *κινεῖσθαι γὰρ καὶ τὰ θεῖα πάντα συνεχῶς ἀεί, σελήνην, ἥλιον, τοὺς ἀστέρας καὶ τὸν οὐρανὸν ὅλον* (A 12). In this context *ἀστέρας*, most probably, meant 'planets', and the motion of all celestial bodies was circular.[69] In fact the circular motion of the sun and moon, by analogy with the motion of the stars, was postulated also by Anaximander's system, but his 'wheels' related rather to the diurnal motion of the two luminaries than to their motion along the ecliptic.[70] Transferring this model to the motion of the sun, moon, and planets along the ecliptic, the Pythagoreans must have proceeded both from observations and from considerations of symmetry as they attempted to regularize the motion of all the celestial bodies following a single principle. Since a circle was at that time the only possible method of geometrical presentation of the planetary motion,

report. A. Thivel, 'L'Astronomie d'Alcméon', in *L'Astronomie dans l'antiquité classique* (Paris, 1979), 59–72, attributed to Alcmaeon only views similar to the Ionian philosophers. Burkert (311 n. 64, 332 ff.) supposed that Alcmaeon meant only the sun.

[69] J. B. Skemp, *The Theory of Motion in Plato's Later Dialogues*, 2nd edn. (Amsterdam, 1967), 39 f., 134 f.; Guthrie, i. 351 ff.; A. Graeser, *Probleme der platonischen Seeleneinteilungslehre* (Munich, 1968), 47. Cf. Festugière, 'Memoires', 429 ff. According to Alcmaeon, people die because 'they cannot join the beginning to the end' (B 2), when the cycle through which life moves is broken (see below, 389). The planets were often called *οἱ ἀστέρες*, e.g. in Aristotle. Only a circular motion is continuous (*συνεχής*). In it the beginning and the end are joined (Arist. *Phys.* 264b9–28).

[70] Abel, 'Zone', 1010; D. Couprie, 'The Visualization of Anaximander's Astronomy', *Apeiron* 28 (1995), 159–82; I. Bodnár, *Oenopides of Chius* (Berlin, 2007) (preprint 327 of the Max Planck Institute for the History of Science), 6 f. Cf. Guthrie, i. 96 f.

the planets' numerous deviations from circular orbits were simply ignored.

Surviving evidence of Oenopides, strictly speaking, refers only to the motion of the sun,[71] but it is difficult to doubt that he also knew of the motion of the planets along the ecliptic. Theon's excerpt from Eudemus' *History of Astronomy* says that Oenopides 'was first to discover the obliquity of the zodiacal circle and the great year', i.e. the calendar cycle of fifty-nine years.[72] Hellenistic doxography makes Pythagoras the author of both discoveries, and Oenopides accordingly a plagiarist.[73] Later fabrications about plagiarism from Pythagoras, however, cannot cast a shadow on Oenopides' actual contacts with Pythagorean mathematics and astronomy. I have noted above that the construction of a fifteen-angled figure inscribed in a circle (Euc. IV, 16) probably belongs to Oenopides.[74] This problem, notes Proclus (*In Euc.*, 269.8 f.), is useful for astronomy (as is Oenopides' other problem),[75] since, inscribing the side of a fifteen-angled figure in a circle passing through the poles, we obtain the angle between the celestial equator and the zodiacal circle. The excerpt from the *History of Astronomy* which asserts that Oenopides discovered the obliquity of the ecliptic goes on to say: 'and others found that the angle between the circle of the zodiac and the celestial equator is equal to the side of a fifteen-angled figure, or 24°' (fr. 145). As von Fritz long ago demonstrated, the latter discovery also belonged to Oenopides: he was first to establish the *angle of obliquity* of the ecliptic, not the fact itself of the obliquity, which was known before him.[76]

[71] It moves from west to east in an inclined circle in a direction opposite to the motion of the stars (Diod. I,98,2; Macr. *Somn. Sc.* I,17,31 = A 7).

[72] Theon. *Exp.*, 198.15 = Eud. fr. 145 = A 7. On the basis of parallel passages from Diodorus, Aëtius, and Macrobius, Diels corrected the reading of διάζωσις (belt) to λόξωσις (inclination).

[73] Oenopides appropriated (σφετερίζεται) Pythagoras' discovery of the obliquity of the ecliptic: Aët. II,12,2 = A 7. The 59-year cycle is attributed to Oenopides and Pythagoras (Aët. II,11,2 = A 9). This version could not derive from Theophrastus, who is silent on Pythagoras' astronomy. Besides, Oenopides, as a mathematician, did not figure in the *Opinions of the Physicists* (Zhmud, *Origin*, 260 ff.).

[74] See above, 280 n. 146.

[75] Cf. *In Euc.*, 283.7 f.: Oenopides considered problem I, 12 useful for astronomy.

[76] Von Fritz, 'Oinopides', 2260 f.; Burkert, 306 n. 38; Gundel and Böker, 'Zodiakos', 490; van der Waerden, 349; Zhmud, *Origin*, 200 f., 264 f.; Bodnár, *Oenopides of Chius*, 4 ff. Abel, 'Zone', 1009 f., defends a literal reading: Oenopides discovered the obliquity of the ecliptic, but there are too many mistakes and transpositions in this excerpt from Eudemus (fr. 145) for it to be taken without corrections: Thales was supposed to have 'discovered'

It is justifiable to see Pythagorean influence in the obliquity of the ecliptic being expressed as the side of a fifteen-angled figure.[77] The scientific contacts of the Pythagoreans and Oenopides were not unilateral. Philolaus borrowed the fifty-nine-year cycle from Oenopides.[78] Aristotle writes of two Pythagorean theories of the Milky Way. According to one of them, it is the former course of the sun; doxography ascribes the same theory to Oenopides.[79] The Pythagoreans referred to by Aristotle might have lived either before Oenopides or after him.[80]

In the case of Hippocrates, the younger contemporary and fellow countryman of Oenopides, we are also dealing with reciprocal influence: while the *Elements* of Hippocrates were based on the geometry of the Pythagoreans, it was Archytas who solved the problem he posed of doubling a cube. According to Aristotle's *Meteorologica*, some Pythagoreans thought that a comet was one of the planets, visible at long intervals and rising low over the horizon.[81] Hippocrates and his pupil Aeschylus expressed similar views.[82] Hippocrates' theory as set out by Aristotle is more complex than the Pythagorean, demonstrating advanced concepts of the geometry of the universe: the celestial sphere is divided into zones; the planets move in circular orbits along the ecliptic; the horizon divides these circular orbits into unequal segments; and the earth, to all appearances, is spherical.[83] Hippocrates may have owed part of this knowledge to Oenopides, to whom the first work on mathematical astronomy probably belonged.[84] However the process of geometrizing astronomy began as early as the time of Anaximander, and it is as

the solar eclipse, not to have predicted it; the earth in Anaximander is in motion, not at rest; it was Anaximenes, not Anaxagoras, who explained lunar eclipses; contrary to chronology, Oenopides is placed before Thales. See Zhmud, *Origin*, 235.

[77] Heath, *Aristarchus*, 131 n. 4; von Fritz, 'Oinopides', 2261; Neugebauer, *HAMA* ii. 629.

[78] A 22; Burkert, 322; Huffman, *Philolaus*, 276 f.

[79] Arist. *Mete.* 345a13 f.; Achil. *Isag.* 24, p. 55.18 f.

[80] See Burkert, 314 n. 79, 322; Bodnár, *Oenopides of Chius*, 8 f.

[81] It follows from this that these Pythagoreans were familiar with the behaviour of the inner planets.

[82] *Mete.* 342b29 ff. = 42 A 5. Nothing else is known of Aeschylus.

[83] M. Wilson, 'Hippocrates of Chios's Theory of Comets', *JHA* 39 (2008), 141–60.

[84] Zhmud, *Origin*, 262 f.

incorrect to exclude from it the early Pythagoreans as it is to assign to them the whole of mathematical astronomy up to 450. Aristotle's 'some Pythagoreans' is unlikely to stand for Hippocrates' contemporary Philolaus;[85] instead, Aristotle's placing of the two theories and their nature point rather to the Pythagoreans' theory preceding that of Hippocrates. This also corresponds to Aristotle's chronology: the Pythagoreans, the first to advance *mathēmata*, lived at the same time as Leucippus and Democritus and before them (*Met.* 985b23 f.). In the time of Hippocrates, Philolaus, and Democritus, Theodore of Cyrene was studying astronomy (A 4); unfortunately we know nothing of the results of these studies. The Pythagoreans who lived before Leucippus were older than both Hippocrates and Oenopides.

It is not impossible that Hippocrates and Philolaus are more indebted to Oenopides than follows from surviving testimonies. Unfortunately it is not possible to reconstruct Oenopides' astronomical system, and his theory of planets can only be conjectured. If Alcmaeon's concept of the circulation of the planets along the ecliptic is taken into account (A 4), Philolaus' theory of the planets is more naturally linked to the Pythagoreans. The important evidence of Eudemus, preserved by Simplicius, also points to this:

> Anaximander was the first to find an account of the sizes and distances (of the planets), as Eudemus says, adding that the Pythagoreans were the first who found the order of their position.[86]

It is clear from the context that *τὰ πλανώμενα* included the planets, the sun, and the moon (Simplicius refers to both bodies in the next sentence). Anaximander was first to present an account (*λόγος*) of the size of the sun and moon and their distance from earth (A 21–2); he wrote nothing about the planets separately. The Pythagoreans were much further ahead compared with him. They knew all five planets visible to the naked eye and their order. Although Eudemus' fragment does not indicate the number and order of the heavenly bodies, he clearly had in mind their 'correct' arrangement, which was

[85] For Aristotle, the system of Philolaus was Pythagorean astronomy par excellence, but in this case we are dealing with a separate opinion. Burkert, 321, rejected Philolaus on the grounds that the latter could not have had more than ten planets; on the number ten cf. below, 449 f.

[86] *Ἀναξιμάνδρου πρώτου τὸν περὶ μεγεθῶν καὶ ἀποστημάτων (τῶν πλανωμένων) λόγον εὑρηκότος, ὡς Εὔδημος ἱστορεῖ τὴν τῆς θέσεως τάξιν εἰς τοὺς Πυθαγορείους πρώτους ἀναφέρων* (Simpl. *In Cael.*, 470.29 f. = fr. 146 = A 19).

accepted in the astronomy, and then in the philosophy, of the fourth century.[87] The following order was considered at that time to be correct: moon – sun – Venus – Mercury – Mars – Jupiter – Saturn – celestial sphere.[88] It is based on two facts: the sidereal period of the planet (the time it takes to complete one revolution relative to the stars) and its brightness. The Pythagoreans are unlikely to have known the exact sidereal period of all the planets (Saturn's is equal to thirty years); that would have required systematic observations over many years.[89] They could well, however, have established that, relative to the stars, Mercury and Venus move fastest, Mars more slowly, Jupiter more slowly still, and Saturn extremely slowly. These observations, together with data on the relative brightness of some of the planets (Venus brighter than Mercury), formed the basis of their order. The astronomy of the time equated the sidereal period of Venus and Mercury to that of the sun, i.e. one year. It could not be calculated more accurately owing to the great complexity of the motion of the inner planets.[90] Since the visible light of Venus was much brighter than that of Mercury, it was placed closer to the earth.

The key question is this: whom did Eudemus have in mind, the early Pythagoreans or Philolaus? Aristotle and doxography are agreed that Philolaus located five planets between the moon and the sun on one side and the stars on the other.[91] The order of the planets is nowhere indicated, but, had it differed from that accepted in the fourth century, this would have been noted.[92] Setting out Philolaus' system, Aristotle wrote simply about the Pythagoreans. Did Eudemus follow the manner of his teacher, rejected by Theophrastus and

[87] Simplicius is commenting on the passage where Aristotle writes: data on the location of the celestial bodies (τὰ ἄστρα) and the distance between them should be taken from astronomy (*Cael.* 291a29 f.).

[88] It is found in Plato (*Res.* 616e–617b; *Tim.* 38d), Philip of Opus ([Pl.] *Epin.* 986d), Aristotle (fr. 13 Ross), and the so-called *Ars Eudoxi*, a 2nd-cent. papyrus, the text of which is dated *c.*300 (Neugebauer, *HAMA* ii. 687, 692). Archimedes still held to that order (ibid. 691).

[89] P. Kayser suggested to me that 'two generations of not even very careful observations would suffice to determine that the period was "about 30 years" and then the usual "rounding off" would tend to reinforce that value'.

[90] Eudoxus accepted the following sidereal periods: Venus and Mercury – 1 year; Mars – 2 years; Jupiter – 12 years; Saturn – 30 years (Simpl. *In Cael.*, 497.26 f. = fr. 124). Modern data: Mercury – 88 days; Venus – 225 days; Mars – 1.9 years; Jupiter – 11.9 years; Saturn – 29.5 years.

[91] Arist. fr. 203 = fr. 13 Ross; Aët. II,7,7 = A 16.

[92] F. Boll, 'Hebdomas', *RE* 7 (1912), 2566; Burkert, 313.

Menon (44 A 9, 16–21, 27)? In Eudemus' fragments, Philolaus is not mentioned: he discovered nothing in mathematics. In astronomy Eudemus registered only discoveries which were accepted by the specialists of his time;[93] Philolaus' innovations were not included. Unnamed Pythagoreans figure in all Eudemus' works on the history of science, but, where their chronology can be established, they belong to the first half of the fifth century.[94] Eudemus could consider Philolaus' order of the celestial bodies 'correct' only if he disregarded the central peculiarity of Philolaus' system, emphasized by Aristotle: Hestia is situated in the centre of the cosmos; counter-earth and the earth revolve round it.[95] But even in this case Philolaus could have had a claim to the authorship of the 'correct' part of his system (moon, sun, and five planets), if Eudemus had known nothing of the earlier Pythagoreans. The first of these propositions (Eudemus ignored Philolaus' moving earth and counter-earth) is unconvincing; the second (Eudemus knew nothing of earlier Pythagoreans) wrong. It is more likely that the Pythagoreans whom Eudemus had in mind lived before Philolaus.

9.3 'THE HARMONY OF THE SPHERES'

As distinct from mathematics and harmonics, an individual contribution to astronomy by Pythagoras or specific early Pythagoreans cannot be identified. Even in the case of Alcmaeon, there is no certainty that he was the author of the idea of the independent motion of the planets. In consequence we are forced, following Eudemus, to speak of some anonymous Pythagoreans. Although this happens more frequently in astronomy than in mathematics, the Pythagorean astronomers are no more to blame for their anonymity than the Pythagorean mathematicians: this is chiefly connected with the nature of our sources.[96] Another difference between Pythagorean

[93] Zhmud, *Origin*, 250 f.

[94] *History of Geometry* (fr. 136–7), *History of Arithmetic* (fr. 142), *History of Astronomy* (fr. 146). See above, 279 f., 297.

[95] Arist. *Cael.* 293a–b; *Met.* 986a8 f.; fr. 203–4.

[96] The authors of a compendium on geometry which preceded Hippocrates' *Elements* are also unknown, as are those of an analogous work on arithmetic; see above, 278 ff., 281 f.

astronomy and mathematics is that in astronomy, both before and after Philolaus, there is not a trace of a theoretical work similar, for example, to Oenopides' treatise. Philolaus expounded his cosmology within the framework of a treatise on natural philosophy, traditional among the Presocratics. Evidently Ecphantus and, possibly, Hicetas did the same.[97] What then was the astronomy of the Pythagoreans before Philolaus?

The evidence analysed above, while it leaves no doubt about the existence of this astronomy, sheds light only on a number of separate discoveries. There is nothing unusual in that: Oenopides, Hippocrates, Meton, and Euctemon made a significant contribution to the development of astronomy, but it is impossible to reconstruct from surviving information each of their systems. Chance played its role in this: as astronomer-mathematicians they became the heroes of Eudemus' *History of Astronomy*, which, unlike Theophrastus' *Opinions of the Physicists*, described individual discoveries, εὑρήματα, not entire astronomical systems. Bearing in mind that the physics of the early Pythagoreans was noted for its great range of views, one could hardly suppose that their astronomy had a common system. Nevertheless the sources shed light on one of their astronomical models. I mean the famous theory of the harmony of the spheres, which we first encounter in Plato's *Republic*. Agreeing in Book VII with the Pythagoreans that astronomy and harmonics are sisters,[98] he postpones his version of the harmony of the spheres to the end of the dialogue and places it in the context of the eschatological legend of Er. Hence the mythological ambience of this version: Ananke's spindle, the Sirens, standing on the circles of the planets and making sounds, Ananke's daughters the Moirae, etc. Contrary to the straightforward thesis 'from myth to logos', the Platonic λόγος certainly derives from the Pythagorean, whereas not one of his mythological details has any relation to Pythagorean theory.[99] This is clear from the several

[97] See above, 130 n. 116.

[98] *Res.* 530c. According to Plato, the first studies visible motion and the second audible. It is quite probable that this idea is also Pythagorean (Barker, *GMW* ii. 40 n. 44, cf. Huffman, *Archytas*, 116 ff.). In Aristotle it is found in his essay on Pythagorean harmonics ([Plut.] *De mus.* 1140 A–B = fr. 47). It was later developed by Ptolemy (*Alm.*, 6.11–21).

[99] This applies also to the Sirens; see above, 303. The arguments for a Pythagorean origin of Ananke came down to her being found in Parmenides: J. Adam (ed.), *The Republic of Plato*, ii (Cambridge, 1902), 452; Zeller, i. 542 n. 2.

descriptions of Pythagorean teaching in Aristotle, in this case our main source. The first of these is given in *De Caelo* (290b):

> The theory that music is produced by their (*sc.* planets and stars) movement, because the sounds they make are harmonious, although ingeniously and brilliantly formulated by its authors, does not contain the truth. It seems to some thinkers that bodies so great must inevitably produce a sound by their movement: even bodies on earth do so, although they are neither so great in bulk nor moving at so high a speed, and as for the sun and moon, and the stars, it is incredible that they should fail to produce a noise of surpassing loudness. Taking this as their hypothesis, and also that the speeds of the stars, judged by their distances, are in the ratio of the musical consonances, they affirm that the sound of the stars as they revolve is concordant. To meet this difficulty that none of us is aware of this sound, they account for it by saying that the sound is with us right from birth and has thus no contrasting silence to show it up; for voice and silence are perceived by contrast to each other, and so all mankind is undergoing an experience like that of a coppersmith, who becomes by long habit indifferent to the din around him (tr. Guthrie).

Aristotle, a tireless critic of the Pythagoreans, although he acknowledges their theory,[100] nevertheless refutes it (290b30). More importantly, he presents us not with a mythologized astronomy as in the *Republic*, but with a physical doctrine, largely consonant with the theories of the Pythagorean predecessors of Archytas, *οἱ περὶ μαθήματα.*[101] The kinship of harmonics and astronomy that in Archytas is called the science 'of the speed of stars, their rising and setting', was founded on both mathematical and physical principles. Hippasus supposed that consonances were produced by fast and slow movements.[102] It was contended by *οἱ περὶ μαθήματα* that there

[100] The epithets he lavishes on it, *κομψῶς μὲν εἴρηται καὶ περιττῶς ὑπὸ τῶν εἰπόντων, ἐμμελῶς μὲν λέγεται καὶ μουσικῶς*, are rare for him, and still rarer in application to the Pythagoreans.

[101] B 1; Huffman, *Archytas*, 131. Huffman suggests that we see in *οἱ περὶ μαθήματα* both Pythagoreans and non-Pythagoreans (ibid. 126 f., 129), but a systematic linking of the four *mathēmata* is found only in the Pythagorean milieu, as indeed also is the study of them (Arist. *Met.* 985b23 f.). The Ionians and Athenians did not study harmonics and arithmetic before the end of the 5th cent. In Aristophanes the statues of geometry and astronomy stood at the entrance to Socrates' 'thinkery' (*Nub.* 200 f.), but not of the other two sciences.

[102] A 13. See above, 310.

was no sound without movement.[103] Consequently there can be no movement without sound! It is noteworthy that the theory passed on by Archytas deals not only with musical sounds, but with sounds in general (one of the examples is the flight of a thrown missile) and contains moreover an unambiguous reference to celestial harmony:[104]

> Many of these sounds are not capable of being discerned by our nature, some because of the weakness of the impact, some because of the extent of their distances from us, and some even of their excessively great magnitude. For large sounds do not slip into the ear just as nothing enters the narrow neck of a vessel when one pours a large quantity (tr. Barker).

Archytas provides a different explanation from Aristotle's as to why the celestial music is not heard, and hence he cannot be the latter's source. Nor could Philolaus be the source: in him there is no evidence of the doctrine of the harmony of the spheres. It is not connected either with Hicetas and Ecphantus, younger contemporaries of Archytas. So at least one of these explanations leads us to a time before Philolaus.

Let us summarize the basic principles of Pythagorean theory: 1) the circular motion of the celestial bodies produces a sound; 2) the loudness of this sound is proportional to their speed and magnitude (according to Archytas, the loudness and pitch of the sound depends on the force with which it is produced; 3) the velocities of the celestial bodies, being proportional to their distances from the earth, have the ratios of concords; 4) hence the planets and stars produce harmonious sound; 5) we cannot hear this harmonious sound. The greater part of these principles are confirmed and developed in the critical summary of Pythagorean doctrines which Aristotle provides in the monograph *Against the Pythagoreans*. Naturally enough, it contained many more details than a general theoretical work. In his commentary on the *Metaphysics*, Alexander of Aphrodisias presents an extensive fragment of that monograph, devoted to a critique of notions that 'the heavens are made up of numbers and according to

[103] There cannot be sound without an impact of bodies upon one another, and the impact occurs when moving bodies collide (B 1).

[104] Thus Porphyry (*In Ptol. Harm.*, 80.28 f.). See: Barker, *GMW* ii. 41 n. 46; Huffman, *Archytas*, 136 f.

harmony'.[105] As one of the examples, Aristotle refers to the harmony of the spheres:

> For the bodies that move round the centre have their distances in a certain proportion, and some move faster and others slower, and in their movement the slower make a low-pitch sound and the faster a high-pitch sound, and these notes, being proportionate to the distances, make the resultant sound harmonious. And since they said that number was the first principle of this harmony, they naturally made number the first principle of the heavens and of the universe. For they thought the sun to be, say, twice as far from the earth as the moon, Venus to be three times as far, Mercury four times, and each of the others to be in a certain arithmetical ratio, and the movement of the heavens to be harmonious, and the bodies that move the greatest distance to move the fastest, those that the least distance the slowest and the intermediate bodies to move in proportion to the size of their orbit.[106]

Among the principles set out above we do not find in this text the second and the fifth, which relate to acoustics, yet the idea that the speed of the celestial bodies is proportional to their distance from the earth is more clearly formulated. We learn further that the pitch of the sound (like the loudness) is directly proportional to the speed of the planets. Another important detail is the distances of the planets from the earth. Alexander gives the first four figures of the arithmetical progression 1, 2, 3, 4 . . . $(n + 1)$; the ratio of its first two members is twofold and of those remaining is epimoric: 3:2, 4:3 . . . $(n + 1) : n$ (cf. Theon. *Exp.*, 22.16 ff.). Pythagorean harmonics was based on the same *ἀριθμητικοὶ λόγοι*; above in the same fragment we read that the Pythagoreans expressed the basic concords by the ratios 2:1, 3:2, 4:3, etc.[107] It is worth noting that *ἀριθμητικὸς λόγος* is found in another fragment of Aristotle setting out the fundamentals of Pythagorean mathematical harmonics; it begins

[105] *In Met.*, 38.8–41.15 = fr. 203 Rose = fr. 13 Ross = fr. 162 Gigon. Aristotle notes (*Met.* 986a13) that he has examined Pythagorean astronomy 'in more detail in other works'. Wilpert has shown that Alexander retained more material from Aristotle's monograph than Rose believed: P. Wilpert, 'Reste verlorener Aristotelesschriften bei Alexander von Aphrodisias', *Hermes* 75 (1940), 369–96. Cf. however, below, 406 n. 68.

[106] 39.24–40.9 = fr. 13 Ross; after ROT.

[107] Alex. *In Met.*, 39.20 f. = fr. 13 Ross. See also: Porph. *In Ptol. Harm.*, 36.3, 37.11, 59.14; Nicom. *Arrf.* I,5,1–2; Simpl. *In Phys.*, 294.27: *καὶ ἡ ἁρμονικὴ λόγους ἀριθμητικοὺς ἐπόγδοον καὶ ἡμιόλιον καὶ ἐπίτριτον καὶ διπλάσιον ὡς ἡ ἀριθμητική.*

with the words '*Harmonia* is celestial, and its nature is divine, beautiful and wonderful'.[108]

Since Alexander introduces the distances of the planets with the expression *φέρε εἰπεῖν*, 'let us say', many scholars regarded them as fictitious,[109] despite a reference to the Pythagoreans (*ἡγοῦντο*) in the same sentence. The expression *φέρε εἰπεῖν*, typical of Alexander, is found also in very close paraphrases of the *Metaphysics*, sometimes in place of Aristotle's characteristic *λέγω δ' οἷον*, 'as for example'.[110] So it is quite possible that Alexander gives the distances of the planets, not simply *exempli gratia*, but relying on Aristotle. The order of the planets given in the fragment (moon – sun – Venus – Mercury) was accepted in Aristotle's time, not in Alexander's.[111] The occurrence of a fictitious example in a commentary so rich in historical material is justified only if Aristotle himself did not have data on the distances of the planets from the earth. Why did he then so insistently assert that for the Pythagoreans 'the heavens were made up of numbers'? – after all he adduces no other numbers related to the celestial bodies! Empedocles' opinion also speaks for the Pythagorean origin of Alexander's data: the distance from the earth to the sun is twice that to the moon (A 61), which is the start of the same progression. In the *Timaeus* (36b) Plato presents the same figures for the first four planets as Alexander does, followed by 8, 9, and 27.

In one way or another the example of Alexander merely explicates Aristotle's words: 'the speeds of the stars, judged by their distances (from the earth), are in the ratio of the musical consonances' (*Cael.* 290b). Even if the example is rejected, the picture of heavenly

[108] Aristotle refers here to the same numerical ratios: [Plut.] *De mus.* 1139 C = fr. 47 Rose = fr. 23 Ross. See Lasserre, *Plutarque*, 168 f.; Barker, *Science*, 329 ff.

[109] Heath, *Aristarchus*, 111 n. 2; Guthrie, i. 301; Burkert, 354; Huffman, *Philolaus*, 256.

[110] See e.g. *λέγω δ' οἷον, εἰ ἔστιν ὁ Καλλίας λόγος ἐν ἀριθμοῖς πυρὸς καὶ γῆς καὶ ὕδατος καὶ ἀέρος, καὶ ἄλλων τινῶν ὑποκειμένων ἔσται* (*Met.* 991b16) and *εἰ γὰρ ὁ Καλλίας φέρε εἰπεῖν ἢ ὁ ἄνθρωπος ὁ ὡμοιωμένος τῇ ἰδέᾳ λόγος ἐν ἀριθμοῖς τισίν ἐστι πυρὸς καὶ γῆς καὶ ὕδατος καὶ ἀέρος ἢ ἄλλων τινῶν ὑποκειμένων* (*In Met.*, 109.12 f), or *καὶ γὰρ τούτων ἕκαστος οὐ τὸ κοινὸν λέγει στοιχεῖον, οἷον τὸ σῶμα, ἀλλὰ πῦρ καὶ γῆν* (*Met.* 992a4) and *οὐ γὰρ λέγουσι σῶμα τὸ κοινόν, ἀλλ' ὁρίσαντές τι τῶν ὑπὸ τὸ κοινὸν σωμάτων, τόδε τι φέρε εἰπεῖν πῦρ ἢ ἀέρα* (*In Met.*, 115.9f), or: *ἅπαντος δὲ γένους καὶ αἴσθησις μία ἑνὸς καὶ ἐπιστήμη, οἷον γραμματικὴ μία οὖσα πάσας θεωρεῖ τὰς φωνάς* (*Met.* 1003b19) and *ὁμοίως πάλιν ἡ γραμματικὴ οὐ τῆσδε τῆς φωνῆς, φέρε εἰπεῖν τῆς ὀξείας, ἐστὶ θεωρητικὴ μόνης, ἀλλὰ καὶ πάσης φωνῆς καθὸ φωνή* (*In Met.*, 245.11 f).

[111] In Alexander's time the order of the planets was: moon – sun – Mercury – Venus or moon – Mercury – Venus – sun (Neugebauer, *HAMA* ii. 691).

harmony will not change significantly. What is much more problematical is the contamination of the various astronomical models of the Pythagoreans found in Alexander. He begins by referring to Philolaus' system with Hestia and counter-earth (*In Met.*, 38.22–39.3), then, in connection now with heavenly harmony, describes a geocentric model (39.24–40.9), while at the end of his overview (starting from 40.21) there appear again τὰ δέκα τὰ κινούμενα σώματα, this time arranged according to harmony and producing harmonious sound (41.2–9). Burkert and Huffman believe that there is no contamination here: Aristotle linked cosmic music to Philolaus' model, the first astronomical system of the Pythagoreans.[112] Obviously, however, the geocentric model described in 39.24–40.9 is in contradiction to Philolaus' teaching: he had Hestia in the centre, and the earth revolved around her. The rotation of the earth destroys all the heavenly music, and it is not fortuitous that this idea is not found in the tradition of Philolaus.[113] Besides, he believed that the bodies close to the centre revolve faster and the distant ones more slowly, whereas, in the system described by Alexander, the reverse holds. Burkert takes the thesis that the velocity of the planets is directly proportional to their distance from the earth for Aristotle's account of Philolaus' system, showing how unscientific it was: the result is that the celestial sphere moves fastest of all, which is absurd in the context of the diurnal rotation of the earth. Huffman, salvaging Philolaus' system, asserts that this thesis is not based on Aristotle's book, but forms part of a speculative reconstruction by Alexander, who 'illustrated the harmony of the spheres in terms of Aristotelian astronomy'.[114] However Aristotle (*Cael.* II, 10), like Plato (*Tim.* 39a), adhered to a different principle: those planets with a wider orbit rotate more slowly, and those with a narrower orbit faster; the

[112] Burkert, 352 f.; Huffman, *Philolaus*, 255 f., 279 ff.

[113] Zeller, i. 432 n. 2; Heath, *Aristarchus*, 108; Gundel and Gundel, 'Planeten', 2057; Ross, i. 145 f.; Philip, 127. Huffman, *Philolaus*, 279 ff., also concedes that there is no direct evidence in Philolaus of the harmony of the spheres. General usage indicates that χορεύειν applied to the heavenly bodies expresses in Philolaus (A 16) the idea of harmonious and ordered motion around Hestia (the altar), not musical harmony. Cf. Eur. *Ion* 1080; [Pl.] *Epin.* 982e.

[114] Burkert, 352 f.; Huffman, *Philolaus*, 256. Huffman confuses a directly proportional ratio κινεῖσθαί τε κατὰ ἀναλογίαν τῶν διαστημάτων, ὡς προείρηκε (*In Met.*, 41.5) with an inversely proportional ratio, which was indicated by ἀνάπαλιν λόγος/ἀναλογία (Euc. V, def. 13; Arist. *Cael.* 273b31); see commentary on this passage, Simpl. *In Cael.* 223.16: τὰ βάρη καὶ οἱ χρόνοι τὴν ἀναλογίαν ἀνάπαλιν ἕξουσιν.

celestial sphere is the sole exception: located further away than all the planets, it rotates fastest. Consequently, it turns out that Alexander made up an example which was not consistent with any system of that time.

Most of these difficulties can be avoided by accepting that, in 39.24–40.9, Alexander relied on Aristotle, who connected with Philolaus neither the harmony of the spheres nor the geocentric model on which it is based. The surviving works of Aristotle actually contain no indication that he associated the harmony of the spheres with Philolaus' system. In Alexander's commentary the two theories also figure separately: 38.22–39.3 speaks of Philolaus' system without any hint of music, and 39.24–40.9 of heavenly harmony, totally unconnected with the astronomy of Philolaus. Only in that commentary's recapitulation, which begins with the words 'he speaks about this in greater detail in the treatise *On the Heavens* and in the books on Pythagorean opinions' (41.1–2), does Alexander insert into a repeated description of heavenly harmony words about the ten bodies in motion (41.3). That insertion is the only new element in Alexander's recapitulation in comparison with Aristotle, and it is the only one to contradict the other, early descriptions of the heavenly harmony. Hence a connection of the system of Philolaus with the music of the spheres belongs rather to Alexander than to Aristotle.

Thus, in Pythagorean theory, the speed of rotation of the celestial bodies is directly proportional to their distance from the earth: the heavenly sphere fastest, Saturn somewhat slower, the moon slowest. In the case of the heavenly sphere this is in accord both with observations and with acoustics: since it was the most distant, it had to make a louder sound than the others; otherwise its sound would not reach the earth. If, however, the order of the planets in early Pythagorean astronomy accorded with their sidereal periods, then the moon should have moved fastest and Saturn most slowly. Heath believed that the Pythagoreans took as their basis the absolute angular velocity of the heavenly bodies from east to west, which increases with their distance from the earth.[115] Saturn, the sidereal period of which is thirty years, 'lags behind' the rotation of stars moving in the opposite direction only by 1/30° in twenty-four hours, the sun by 1°, and the moon by 13°. Hence it was natural to conceive

[115] Heath, *Aristarchus*, 108 f.

that, in motion common to the celestial sphere and the planets, Saturn was the swiftest planet and the moon the slowest. Philolaus, for whom not the celestial sphere, but the earth, rotated fastest, took as his basis the relative angular velocity of the planets, expressed in their sidereal period: twenty-four hours for the earth, twenty-nine and a half days for the moon, one year for the inner planets and the sun, etc. Plato and Aristotle followed a similar scheme, only geocentric.

Unlike the astronomical part, the musical part of the doctrine of heavenly harmony does not lend itself to reconstruction.[116] Contradictory explanations offered by Greek and Roman writers rely on the concepts of their times and are inapplicable to the model described by Aristotle. An analogy between the seven planets and the seven-stringed lyre is also deceptive: according to the Pythagoreans and to Plato (*Res.* 617a–b), the heavenly sphere also produced a sound, so the sounds of the eight bodies must together have produced the scale of an octave.[117] It follows from Alexander's words that he had a rising order: the moon had the lowest tone, the heavenly sphere the highest. The connection between the heavenly harmony and the scale of an octave is the more probable since for the Pythagoreans ἁρμονία meant among other things an octave (44 B 6). How they understood that connection, however, remains unclear. There is sound evidence only of an analogy between the concords and the distances of the planets which lends itself to many interpretations. It is suggestive that the authors of that doctrine were not embarrassed by obvious contradictions. According to the Pythagoreans' harmonics, the height of a note is inversely proportionate to the length of a string, whereas here the body located furthest away produces the highest note. Moreover, if the planets are in constant motion, their tones must be sounded simultaneously and cannot combine in a sequential octave scale! At all events, no one in antiquity was disconcerted by this circumstance.

Through Martianus Capella and Boethius the harmony of the spheres was passed down to the medieval West and remained for centuries one of the few concepts associated with the name of Pythagoras. Later the picture of a universe filled with divine harmony attracted many Renaissance poets and thinkers.[118] Of the

[116] Ibid. 110 ff.; Burkert, 352 ff.
[117] Barker, *GMW* 33 n. 22, 58 n. 10.
[118] Kahn, 153 ff.

astronomers of modernity, Kepler was the most enthusiastic about the idea of heavenly harmony, but he presents it in a much altered form. Kepler did not believe in an actual music of the spheres and sought harmonious ratios, not in the distances of the planets from the sun, but in the ratios between their least and greatest angular velocities. More than by anything else Kepler differed from earlier adherents to this idea by his refusal to be satisfied with approximate results. In the course of his research, Kepler, relying on the exact observations of Tycho Brahe, tried and rejected many variants, until finally he formulated in his *Harmonice mundi* his famous law: the ratio of the squares of the periods of any two planets is equal to the ratio of the cubes of their average distances from the sun. It was that law, not correspondences with concords discovered by Kepler, yet passed over by later astronomy, which became perhaps the most valuable scientific outcome of the development over the centuries of the Pythagorean idea.

10

Medicine and Life Sciences

10.1 MEDICINE AND PYTHAGOREANISM

The exact sciences, the *mathēmata*, discussed in the preceding chapters, surpassed the pre-scientific level before the Classical period was over. Even at the peak of its development (the third century), Greek medicine was not scientific. The establishment of scientific medicine, which reached completion only in the nineteenth century, was prepared on the one hand by the research and discoveries of many generations of physicians, and on the other by the changed social and cultural climate, the vigorous growth of natural and life sciences, the invention of the microscope, the discovery of cells, micro-organisms, and the like. A comparable social and cultural upheaval in Ancient Greece gave rise to philosophy and science,[1] and at the turn of the fifth century led to the birth of rational medicine, which sought to explain illnesses by relying on experience. In the treatises of the Hippocratic Corpus, mostly written by the physicians of Cos and Cnidus between the years 430 and 350, the rationalism and empiricism of the new medicine assumed its final shape. Unlike the medical texts of the Egyptians and Babylonians, which combined rational practical advice with appeals to the gods and magic formulae, the Hippocratic treatises contain no more than a few isolated examples of that nature.[2] However, most Greeks

[1] Zaicev, 115 ff.

[2] On the relationship between medicine and religion in Greece, see e.g. L. Edelstein, 'Greek Medicine in Its Relation with Religion and Magic', *Ancient Medicine: Selected Papers* (Baltimore, 1968), 205–46; F. Kudlien, 'Early Greek Primitive Medicine', *Clio Medica* 3 (1968), 305–36; G. E. R. Lloyd, *Magic, Reason and Experience* (Cambridge, 1979), 15 ff.; J. Mansfeld, 'Theoretical and Empirical Attitudes in Early Greek Scientific Medicine', in M. D. Grmek (ed.), *Hippocratica* (Paris, 1980), 371–90; Ph. van der

continued to believe that the gods sent down pestilences and provided the cure. Religious-magic medicine did not disappear; the cult of Asclepius, for example, significantly expanded during and after the Peloponnesian War. While sharply critical of healers, magicians, and charlatans of all kinds, the Hippocratics remained neutral with regard to the methods of healing practised in the temples of Asclepius.[3]

Although Hippocratic medicine had a mainly empirical orientation, its experience and knowledge were still too restricted to explain most diseases and offer treatments for them. Life sciences were also at the stage of conception and could not provide doctors with sound knowledge of nature or the human body. In an effort to compensate for these shortcomings, doctors often turned to the teachings of natural philosophers, and many Presocratics, in their turn, showed great interest in problems of medicine and life sciences. On the whole the interplay between medicine and natural philosophy enriched both, though the extent and particularly the degree of the influence of philosophy on medicine should not be overestimated, as is often the case. The traditional approach to philosophy as a *scientia universalis*, a fundamental source of new ideas, methods, and cognitive instruments, assumes that all other sciences, including medicine, depend on it: 'Die Philosophie ist die Mutter der Medizin in wissenschaftlichen Rücksicht.'[4] Tertullian's formulation, 'medicina soror philosophiae' (*De an.* 2), seems to me greatly preferable. Such important treatises of the Hippocratic Corpus as *On the Nature of Man* and *Ancient Medicine* contain sallies against 'philosophical' medicine. Both doctors and philosophers frequently relied on traditional

Eijk, 'Divination, Prognosis and Prophylaxis', in H. F. J. Horstmanshoff et al. (eds.), *Magic and Rationality in Ancient Near Eastern and Graeco-Roman Medicine* (Leiden, 2004), 187–218. For a comparative analysis of Greek and Near Eastern medicine, see the same collection of papers; of Greek and Chinese medicine: G. E. R. Lloyd and N. Sivin, *The Way and the Word: Science and Medicine in Early China and Greece* (New Haven, 2002). On the possible influence of Oriental, especially Egyptian medicine, on Greek medicine, see G. Harig, 'Bemerkungen zum Verhältnis der griechischen zur altorientalischen Medizin', in R. Joly (ed.), *Corpus Hippocraticum* (Mons, 1977), 77–94; V. Nutton, *Ancient Medicine* (London, 2004), 41 ff.; J. Jouanna, 'Médecine égyptienne et médecine grecque', in J. Jouanna and J. Leclant (eds.), *La Médecine grecque antique* (Paris, 2004), 1–21.

[3] J. Jouanna, *Hippocrate* (Paris, 1992), 259 ff.; G. E. R. Lloyd, *In the Grip of Disease* (Oxford, 2003), 40 ff.

[4] K. Sprengel, *Versuch einer pragmatischen Geschichte der Arzneikunde*, i (Halle, 1792), 2. See esp. J. Schumacher, *Antike Medizin: Die naturphilosophischen Grundlagen der Medizin in der griechischen Antike*, 2nd edn. (Berlin, 1963).

premises, so the significant role played by even and odd numbers, for example, in the Hippocratic Corpus, is no evidence of the influence of Pythagoreanism.[5] Nor does the similarity between the views of the Presocratics and Hippocratics on particular questions of physiology, embryology, or anatomy mean that philosophy was the source. It is much more natural to view this as the influence of medicine.[6] It is even more erroneous to suppose that Presocratic philosophy was the source of the rationalism and empiricism of Greek medicine.[7] These properties are a consequence of the general process of secularization, which deeply affected the most varied aspects of Greek life and set its seal on philosophy and medicine alike.

If in Plato's time the most famous centres of Greek medicine were Cos and Cnidus, in the lifetime of Pythagoras the physicians of Croton enjoyed the greatest renown (Hdt. III, 131). The volume of evidence on medicine in Croton does not compare with the legacy of the physicians of Cos and Cnidus, yet it does allow us to judge its nature and its role in the development of Greek medicine. Historians of medicine noted long ago that Crotonian medicine and the Pythagorean school, which arose at almost exactly the same time, were closely linked with each other,[8] although students of Pythagoreanism very rarely pay attention to this fact. They hold that the most important element of Pythagoreanism is the *mathēmata*, number metaphysics and number symbolism, setting against these the Ionian περὶ φύσεως ἱστορία. An unbiased analysis of the ancient tradition leads to different conclusions. Natural sciences and medicine played a defining role in the philosophy of many early Pythagoreans; physiology,

[5] F. Kudlien, 'Die Bedeutung des Ungeraden in der hippokratischen Krisenarithmetik', *Hermes* 108 (1980), 200–5; V. Langholf, *Medical Theories in Hippocrates* (Berlin, 1990), 79 ff., 118 ff.

[6] Thus Jouanna. *Hippocrate*, 379 ff. Cf. a different view: 'I think that in Antiquity philosophy influenced medicine rather than being influenced by it. Philosophical insight guided the physicians in their biological, physiological, and anthropological studies' (L. Edelstein, 'The Relation of Ancient Philosophy to Medicine', *Ancient Medicine*, 350). Similarly M. Frede, 'Philosophy and Medicine in Antiquity', *Essays in Ancient Philosophy* (Oxford, 1987), 225.

[7] Thus e.g. Mansfeld, 'Attitudes', 378 ff., and esp. Longrigg, *Greek Medicine*, 1 ff.

[8] See e.g. Pohlenz, *Hippokrates*, 82; Sigerist, *History*, 94; W. H. S. Jones, *Philosophy and Medicine in Ancient Greece* (Baltimore, 1961), 1 ff.; Michler, 'Problem', 136 ff.; Kudlien, *Beginn*, 54 f.; G. Wöhrle, *Studien zur Geschichte der antiken Gesundheitslehre* (Stuttgart, 1990), 35 ff.

embryology, and botany interested them no less, and often more, than they interested the Ionians. These life sciences, in turn, in no small degree owe their birth to medical practice, which focused attention on things which could help prevent or cure disease: diet (understood as a healthy way of life), medicinal plants, the structure and functioning of the human body, etc. Here follow only the essential facts which demonstrate Pythagorean study of the theory and practice of medicine: Democedes of Croton was the most famous doctor of his time (Hdt. III, 125); Hermippus called Calliphon, the father of Democedes, a pupil of Pythagoras (19 A 1). The most famous of the Pythagorean physicians, Alcmaeon of Croton, set down the first medical theory to come down to us in his book (B 4). The successful athlete Iccus of Tarentum later became a teacher of gymnastics and a doctor (A 2). Menestor of Sybaris, the author of the first work on plants, was also interested in problems of medicine (A 7). Hippon wrote two treatises on natural philosophy, and one of these considered the causes of disease (A 11); Philolaus also dealt with this matter in his *On Nature* (A 27–8). Hippon and Philolaus are the only Presocratics mentioned in Menon's *Medical Collection* (Anon. Lond. XI, XVIII), a doxographical compendium containing theories of the origins of disease; all the other individuals mentioned here, except for Plato, were doctors. It is clear that medicine, which for a century was a Pythagorean area of interest and study, deserves no less attention than the exact sciences.

On Calliphon, the first of the Crotonian physicians known to us, very little information has survived. He evidently belonged to the family of Cnidian Asclepiads, and on moving to Croton he joined the followers of Pythagoras.[9] Physicians, who often came from aristocratic families and held prominent positions in society,[10] could be members of Pythagorean *hetairiai*, as may be seen from the biography of Democedes, the son of Calliphon (above §3.3). He followed his father's profession and while still young became famous throughout Greece as a doctor. For a substantial fee he was invited first to Aegina and Athens, and later by Polycrates to Samos. After the murder of Polycrates he was taken prisoner by the Persians. On his return to

[9] See above, 121. The Asclepiads were not priests but members of an aristocratic clan which regarded Asclepius as its forefather: Pohlenz, *Hippokrates*, 81 n. 3, 82; Langholf, *Medical Theories*, 25 f.; Longrigg, *Greek Medicine*, 22 f.

[10] Kudlien, 'Überlegungen', 130 f., 139; Langholf, *Medical Theories*, 25 f.

Croton, Democedes married the daughter of Milon the athlete and thus became one of the Pythagorean *hetairoi*. During the Cylonian revolt, he was one of those who defended the supremacy of the Pythagoreans.[11] Herodotus' account of the turbulent years of Democedes' youth contains information which sheds light on his medical practice.[12] When King Darius dislocated his ankle badly he called in some Egyptian doctors, who were unable to help him and only made things worse. Democedes, who was then summoned to the king, applied his mild remedies instead of the Egyptians' violent means (ἤπια μετὰ τὰ ἰσχυρὰ προσάγων), and soon cured him. It is possible that his experience of treating trauma in athletes, for which Croton was then famed, helped him in this. Some time later Democedes cured an ulcer on the breast of Queen Atossa. It is supposed that she had inflammatory mastitis, and that Democedes applied therapeutic means.[13]

Historians of medicine have long pointed to the mutual links between Crotonian medicine, especially dietetics, and the practice of training athletes.[14] The connection was also noted, in general terms, by the Hippocratic doctors. The author of *Ancient Medicine* virtually identified the methods of dietetics with those of athletic training (*VM* 3), while his colleague saw the aims of dietetics as restoring the sick to health, preserving the health of those who are well, and bringing good condition to athletes in training (*De victu acut.* 9). It is surprising how many of those who won renown in medicine and athletics were adherents, pupils, or followers of Pythagoras: the Olympic victors Milon, Astylus, and Iccus, who went on to become a trainer and doctor; the doctors Calliphon, Democedes (Milon's son-in-law), and Alcmaeon, who brought together medicine and natural philosophy. Athletics and medicine were developing in Croton before Pythagoras arrived, and he, of course, drew heavily on these.[15] Pythagoreanism, for its part, played a major role in uniting speculative

[11] Iamb. *VP* 257, 261. For an assessment of this tradition, see above, 99 n. 163, 121.

[12] III, 129–34. J. Hofstetter, *Die Griechen in Persien* (Berlin, 1978), 46 f.: 'Herodots Erzählung über D. scheint im großen und ganzen auf guten Quellen zu beruhen.' A. Griffiths, 'Democedes of Croton: A Greek Doctor at Darius' Court', in H. Sancisi-Weerdenburg and A. Kuhrt (eds.), *Achaemenid History*, ii. *The Greek Sources* (Leiden, 1987), 37–51, is more critical, but he too does not deny the basic facts.

[13] Grmek, *Diseases*, 351, 438 n. 28.

[14] Wachtler, *De Alcmaeone*, 90 f.; Jüthner, *Philostratos*, 30 ff.; Sigerist, *History*, 96 ff., 236 f.; Michler, 'Problem', 140 f.; Mann, *Athlet und Polis*, 171 ff.

[15] Pythagoras' biographers write of his work on medicine (Diod. X, 7; D.L. VIII, 12; Porph. *VP* 30, 33; Iamb. *VP* 110 f., 163–4), but early evidence of this is lacking.

thought with empirical research in a union which became a defining feature of Greek medicine. The mutual influence of Pythagoreanism, medicine, and athletics manifested itself clearly in a practical area too. Aristoxenus wrote that the Pythagoreans purified the body with the aid of medicine; their diet was bread and honey, and 'those who observe this diet constantly are best protected against disease'.[16] Pythagoras, as we recall, won fame as an educator of young people,[17] and the Pythagorean way of life included sport and an emphasis on winning. A tradition which deserves attention ascribes to Pythagoras the introduction of a diet of meat for athletes, who had previously followed an age-old custom of eating cheese and dried figs.[18] Another important part of the Pythagorean way of life was the renunciation of luxury, excess, and immoderation,[19] of which we are constantly reminded in the Pythagorean works of Aristoxenus. 'We should avoid and banish by all means, by fire, iron, and every other means, disease from the body, ignorance from the soul, excess from the belly, strife from the city, discord from the house, immoderation from everything.' 'Boys and girls must be brought up in labour, exercise, and appropriate endurance, with food suited to a hard-working, self-controlled, and persevering way of life.'[20] Even if we allow for

According to Celsus, Pythagoras, Empedocles, and Democritus studied medicine more than other philosophers (*De med.*, praef. 7).

[16] Fr. 26–7. 'Pythagoras urged his followers to cultivate the simple life, since extravagance (πολυτέλεια) he maintained, ruins not only the fortunes of men but their bodies as well. For most diseases, he held, come from indigestion, and indigestion, in turn, from extravagance' (Diod. X,7,1, tr. Oldfather). This passage may also go back to Aristoxenus, see above, 72 n. 47.

[17] Antisthenes (fr. 51), Isocrates (*Bus.* 29), Plato (*Res.* 600a), Dicaearchus (fr. 33), Timaeus (Iust. XX,4).

[18] Her. Pont. fr. 40 = Porph. *De abst.* I, 26; Favorin. fr. 58 = D.L. VIII, 12; Porph. *VP* 15. This tradition, which contradicts the later view that Pythagoras was a vegetarian, arose no later than the 4th cent. (Burkert, 180 and n. 111).

[19] See above, 145 n. 137, 226 n. 53. On sexual abstinence see Aristox. fr. 39.

[20] Porph. *VP* 21 = Iamb. *VP* 34 = fr. 17; Iamb. *VP* 209 = 58 D 8 *DK* (tr. after G. Clark); see above, 118 n. 60. This material is particularly abundant in the *Pythagorean Precepts* (see above 101 n. 16). The Pythagoreans said 'that it was necessary, right from childhood, even to have a diet that is well ordered, teaching that order and due proportion are fine and advantageous, but disorder and lack of due proportion are shameful and disadvantageous' (fr. 35). 'Everything that is eaten or drunk is responsible for a distinct condition. Wherefore indeed it is a characteristic of great skill to detect and notice what sort and how many things should be employed for nourishment.' (Iamb. *VP* 208; Aristox. fr. 37; tr. Huffman). Gluttony and drunkenness were rejected because they were harmful both in themselves and to healthy procreation (fr. 39).

Aristoxenus' tendency to idealize the Pythagoreans, there can be little doubt that submission to strict rules, moderation, and self-restraint lay at the basis of the way of life proposed by Pythagoras.

Plato wrote respectfully of Iccus (*Leg.* 839e–840a), the Pythagorean from Tarentum who won the pentathlon at Olympia in 476 and then became the best teacher of gymnastics of his time, and a doctor. Iccus himself led a life of such moderation that he became proverbial: the Greeks called a frugal meal 'an Iccus meal' (A 2); while training he adhered to a strict diet and sexual abstinence.[21] Alongside Iccus, Plato mentions another Pythagorean athlete, the triple Olympic victor (488–480) Astylus of Croton, of whom 'similar things are told'.[22] Plato has Protagoras express the thought that Iccus' gymnastics was really a disguised *σοφιστικὴ τέχνη* (*Prot.* 316d). He may have had in mind the theoretical basis of the way of life and prescriptions which Iccus proposed. Jüthner took it that Iccus was the author of a book on dietetics as the foundation of athletic training. Although no direct evidence of his writing has survived, the context in which he is referred to in Plato and particularly in Lucian (*Hist. conscr.* 35) provides a sound basis for the proposition that such a book did indeed exist.[23] As the Crotonian Astylus was older than Iccus, the way of life which they followed must have developed in Croton. The reputation of Milon (Arist. fr. 520) provides evidence that it did not arise suddenly.

Diet played an important part in the Hippocratic Corpus, being in effect the principal means of treatment for internal ailments.[24] Special works such as *Regimen*, *Regimen in Health*, and *Regimen in Acute Diseases*, were devoted to it; many others, for example *Diseases* and *Internal Affections*, gave it much attention, and *Sacred Disease* offered a dietary treatment for epilepsy. The author of *Ancient Medicine* identified the whole of medicine with dietetics and viewed its history

[21] Pl. *Leg.* 839e–840a = A 2; Ael. *VH* XI, 3; *De nat. an.* VI, 1.

[22] Pl. *Leg.* 840a5; Clem. *Strom.* 3,6,50; cf. *DK* I, 446.20; Paus. 6,13,1. Mann, *Athlet und Polis*, 177 f. See W. Fiedler, 'Sexuelle Enthaltsamkeit griechischer Athleten und ihre medizinische Begründung', *Stadion* 11 (1985) 137–75. The sexual abstinence of Pythagorean athletes is linked with the theory that semen originated in the brain and the marrow; see below, 375.

[23] Jüthner, *Philostratos*, 8 f.; see also Ciaceri, *Storia*, 2, 61; Fiedler, 'Sexuelle Enthaltsamkeit', 172 n. 70; Wöhrle, *Studien*, 58; Mann, *Athlet und Polis*, 178.

[24] Heidel, *Medicine*, 121; O. Temkin, 'Greek Medicine as Science and Craft', *Isis* 44 (1953), 213.

as the discovery and development of the dietary method, which consisted of systematic study of which food best suited the nature of the patient.[25] Two contemporary experts in Greek medicine, I. Lonie and W. Smith, have lent support to that position. First, they assert, dietary methods do indeed coincide with the therapeutic practice reflected in the Hippocratic Corpus. Secondly, the dietary theories of fifth-century doctors represent the 'superstructure', built on methods established within the framework of traditional medicine, which had long been accumulating information on the properties of various foodstuffs.[26] If the practical methods of dietetics were really developed in the early period, they can hardly be attributed to Crotonian or any other doctors of the end of the sixth century. However, the establishment of rational-empirical medicine should not be reduced to the systematization of accumulated knowledge.

In traditional societies, diseases are usually divided into two categories: to the first belong open wounds and injuries received in combat or at work; to the second, internal ailments, whose cause is beyond comprehension and whose origin is therefore considered supernatural. This is the picture we see in the ancient Orient and in Homer and Hesiod in Greece,[27] but the Hippocratic Corpus views all illnesses from the viewpoint of their natural causes. It is clear that by the turn of the fifth century (there is no information on earlier times), a radical change in the view of illness had occurred: it had been desacralized and turned into a phenomenon of nature. As a result, the divine causes, which had previously explained internal ailments, were replaced by natural causes: heat, cold, and especially food and drink, through which diseases supposedly entered the organism. In the fifth century these notions are found not only among physicians: Pindar named only boils, wounds, and the effects of heat and cold as causes of disease (*Pyth.* III, 47 f.); Herodotus linked most illnesses with the changing seasons, while ascribing to the Egyptians the view

[25] H. W. Miller, 'On Ancient Medicine and the Origin of Medicine', *TAPA* 80 (1949), 187–202; J. Jouanna (ed.), *Hippocrate: L'ancienne médicine* (Paris, 1990), 34 f.

[26] I. M. Lonie, 'A Structural Pattern in Greek Dietetics and the Early History of Greek Medicine', *Med. Hist.* 21 (1977), 235–60, at 258; W. D. Smith, 'The Development of Classical Dietetic Theory', in Grmek, *Hippocratica*, 439–48, at 446.

[27] On disease as a punishment sent down by a deity, see: Kudlien, *Beginn*, 33, 48 ff.; id., 'Primitive Medicine', 308 f; D. Goltz, *Studien zur altorientalischen und griechischen Heilkunde* (Wiesbaden, 1974), 261 ff.; M. Grmek et al. (eds.), *Western Medical Thought from Antiquity to the Middle Ages* (Cambridge, 2002), 243 ff.

that food was the cause of all ailments (II, 77).[28] Euryphon and Herodicus, the earliest Cnidian physicians known to us,[29] upheld the 'feeding' theory on the causes of disease (Anon. Lond. IV, 31 f., 40 ff.); in the Hellenistic period, Herodicus of Cnidus even became the *prōtos heuretēs* of dietetics.[30] Since the influence of Alcmaeon on both physicians can be traced with reasonable reliability,[31] this again leads us back to Crotonian medicine.[32]

Our sources on Crotonian medicine are random and fragmentary. They are silent, for example, about the medical theories of Calliphon and Democedes, and Alcmaeon's practice as a doctor. This latter silence, which is fully understandable, given the almost total absence of biographical information about Alcmaeon, has caused some to assert that he was a natural philosopher with an interest in medicine, rather than a doctor.[33] From the ancient tradition it seems rather that

[28] F. Heinimann, *Nomos und Physis* (Basel, 1945), 172 ff.; Mansfeld, 'Attitudes', 388 f.; Thomas, *Herodotus*, 37 f.

[29] In Menon's doxography, Hippocrates follows Euryphon and Herodicus of Cnidus, which matches their chronology. It is unlikely that Euryphon was born in *c.*500 (thus H. Grensemann, *Knidische Medizin* (Berlin, 1975), 197 ff.); biographical information suggests that he worked in *c.*450–420.

[30] Porph. *Quaest. Hom.*, XI, 514: 'Dietetics began with Herodicus and was perfected by Hippocrates, Praxagoras, and Chrysippus.' Previously it was believed that this meant Herodicus of Selymbria (see, however: Pohlenz, *Hippokrates*, 38 n. 4), but in recent times this view has been challenged: J. Kollesch, 'Die diätetischen Aphorismen des sechsten Epidemienbuches und Herodikos von Selymbria', in G. Baader and R. Winau (eds.), *Die hippokratischen Epidemien* (Stuttgart, 1989), 194 f., 197. It is much more probable that Herodicus of Cnidus was meant: D. Manetti, 'Medici contemporanei a Ippocrate: problemi di identificazione dei medici di nome Erodico', in Ph. van der Eijk (ed.), *Hippocrates in Context* (Leiden, 2005), 295–313.

[31] Wachtler, *De Alcmaeone*, 90 ff.; C. Fredrich, *Hippokratische Untersuchungen* (Berlin, 1898), 34 ff.; M. Wellmann, 'Euryphon', *RE* 6 (1907) 1342 f.; A. Palm, *Studien zur hippokratischen Schrift Περὶ διαίτης* (Tübingen, 1936), 110 ff.; I. M. Lonie, 'The Cnidian Treatises of the Corpus Hippocraticum', *CQ* 15 (1965), 1–30, at 4 n. 3; H. Grensemann, *Die hippokratische Schrift über die heilige Krankheit* (Berlin, 1968), 27 ff.; G. Lorenz, *Antike Krankenbehandlung in historisch-vergleichender Sicht* (Heidelberg, 1990), 174 ff.

[32] On the Crotonian/Pythagorean origin of dietetics, see Palm, *Studien*, 110 ff.; W. H. S. Jones, *Philosophy and Medicine*, 1 ff., 44; R. Joly (ed.), *Hippocrate: Du régime* (Paris, 1967), pp. xi–xiii; Kudlien, *Beginn*, 36 ff., 54 f.; Wöhrle, *Studien*, 35 ff. The passage twice adduced by Iamblichus also deals with this (*VP* 163, 244); some link it with Aristoxenus (Rohde, 156; 58 D 1 *DK*; Timpanaro Cardini, iii. 286).

[33] Kudlien, *Beginn*, 56, 148; J. Mansfeld, 'Alcmaeon: "Physikos" or Physician?', *Kephalaion. Studies in Greek Philosophy Offered to C. J. De Vogel* (Assen, 1975), 27–38.

he combined in himself the philosopher and the doctor.[34] Although Alcmaeon wrote no special work on medicine (in his time there were no such works),[35] the greater part of his book was devoted to τὰ ἰατρικά (D.L. VIII, 83). Unlike Hippon, Philolaus, and other natural philosophers, he demonstrated originality precisely in medicine and allied areas. Only relying on his own vast knowledge, experience, and his independent research, Alcmaeon was able to lend Presocratic philosophy a new 'physiological' direction, focusing its attention on problems of the structure and vital activity of the human organism (physiology, anatomy, embryology, psychology). Following Alcmaeon's lead, other thinkers, as diverse as Parmenides, Anaxagoras, and Empedocles, turned their attention to these problems, which were absent from the thought of the early Ionians. Soon it would become a staple part of works of natural philosophy. Alcmaeon figures more than once in the *Opinions of the Physicists* by Theophrastus, who supplied a particularly detailed description of his physiology of the sensory organs. In Menon's *Medical Collection*, Alcmaeon is not mentioned, but the papyrus containing this text (or, more precisely, an overview of it) has substantial lacunae, one of which might well account for the disappearance of his theory. Be this as it may, the Sicilian physicians Acron and Pausanias do not appear in it either.

Greek medicine is indebted to Alcmaeon for many fundamental concepts, including the dynamic concept of illness, which frequently occurs later among the Hippocratics: health is a balance of opposing qualities, or powers (δυνάμεις) in the organism, and sickness is the predominance of one of them (B 4).[36] Among the direct and indirect causes of illness Alcmaeon names excessive heat and cold, and a surfeit or an insufficiency of food, in addition to water, locality, and other external factors, thus combining the 'dietary' and 'climatic'

[34] Jouanna, *Hippocrate*, 370. For a critique of Mansfeld, see L. Perilli, 'Alcmeone di Crotone tra filosofia e scienza', *QUCC* 69 (2001) 55–79. In Photius' *Library* (115b7), Alcmaeon is unambiguously called ἰατρός. He appears in the company of such doctors as Diocles, Euryphon, Erasistratus, and others.

[35] The first medical writings belong to contemporaries of Empedocles, Euryphon and Acron of Acragas, who, according to the *Suda*, wrote *Περὶ τροφῆς ὑγιεινῶν* (31 A 3).

[36] Grmek, *Western Medical Thought*, 246 f. For examples from the Hippocratic Corpus, see J. Jouanna (ed.), *Hippocrate: La nature de l'homme* (Berlin, 1975), 256. See also Palm, *Studien*, 110 ff.; Pohlenz, *Hippokrates*, 80 ff.; Sigerist, *History*, 317; Goltz, *Studien*, 275 ff.

approaches, mentioned by Herodotus, to the aetiology of disease.[37] The variety of factors which, in Alcmaeon's view, could cause disease mark him more as a physician than a natural philosopher, since natural philosophers usually attributed illness to one or two causes only. The methodological empiricism, which later was also characteristic of the Hippocratics, found its theoretical expression in the very first sentence of Alcmaeon's book (B 1), a sentence addressed to Brontinus, Leon, and Bathyllus: only the gods have clear knowledge (σαφήνεια) of invisible things (περὶ τῶν ἀφανέων); humans can judge only on the basis of evidence (τεκμαίρεσθαι).[38] Thus he goes further than Xenophanes, who doubted the possibility of knowing anything definite (τὸ σαφές) about the gods (B 34), and was the first in the surviving tradition to formulate a positive programme of research based on empirical evidence, τεκμήρια.[39] It is possible that evidence of this empirical position can be seen in the statement πεῖρά τοι μαθήσιος ἀρχά (fr. 125 Page), preserved under the name of Alcman and attributed by D. Lanza to Alcmaeon.[40]

An analysis of Alcmaeon's theory of disease is complicated by the fact that fragment B 4, which contains it, is not an accurate quotation, but a brief overview by Aëtius, like those preserved from Menon's medical doxography. Diels believed that this text found its way into the *Vetusta placita* (Aëtius' source) from a doxographical work by Alexander Philalethes, a first-century physician.[41] This origin explains the presence in it of both Peripatetic (ὑφ' οὗ, τὰ ποῖα) and Stoic terminology (συνεκτική, ποιητική), which characterizes the

[37] Kudlien, *Beginn*, 56.

[38] Text of B 1 is corrupt; for corrections see: Wachtler, *De Alcmaeone*, 34 f.; *DK* I, 214 not.; H. Gomperz, 'Alkmaion's Frg. 1 Diels', *PhW* 48 (1928) 1597; Timpanaro Cardini, i. 146 f.; Guthrie, i. 344 n. 1; L. Gemelli Marciano, 'Lire du début: Quelques observations sur les *incipit* des Présocratiques', *PhilosAnt* 7 (2007), 7–37.

[39] See H. Diller, '*ΟΨΙΣ ΑΔΗΛΩΝ ΤΑ ΦΑΙΝΟΜΕΝΑ*', *Hermes* 67 (1932) 14–42. τεκμαίρεσθαι is often encountered among the Hippocratics: *De arte* 12; *Affect.* 46; *Prorrhet.* II 1,21; *Progn.* 24.57; *De victu acut.* (Sp.), 18,52, etc. Cf. Thuc. I,1,3: σαφῶς μὲν εὑρεῖν διὰ χρόνου πλῆθος ἀδύνατα ἦν, ἐκ δὲ τεκμηρίων . . .

[40] D. Lanza, 'Un nuovo frammento di Alcmeone', *Maia* 17 (1965) 278–280; Perilli, 'Alcmeone', 64 n. 16. Ἀλκμάν is a Doric form of the name Ἀλκμαίων, which is why they have often been confused.

[41] H. Diels, 'Über das physikalische System des Straton' (1893), *Kleine Schriften*, 239 f. For criticism, cf. H. von Staden, 'Rupture and Continuity: Hellenistic Reflections on the History of Medicine', in Ph. J. van der Eijk (ed.), *Ancient Histories of Medicine: Essays in Medical Doxography and Historiography in Classical Antiquity* (Leiden, 1999), 164 f.

author of the *Vetusta placita*, who came from the school of Posidonius.[42] In any case, Theophrastus' *Opinions of the Physicists* contain no aetiology of disease; that appeared in the *Vetusta placita*.[43]

> Alcmaeon holds that what preserves health is the equality (ἰσονομία) of the powers – moist and dry, cold and hot, bitter and sweet and the rest – and the supremacy (μοναρχία) of any of them causes disease; for the supremacy of either is destructive. The cause of disease is an excess of heat or cold; the occasion of it surfeit or deficiency of nourishment; the location of it blood, marrow or the brain. Disease may come from external causes, from quality of water, local environment or toil or torture. Health, on the other hand, is a harmonious blending of the qualities (tr. Longrigg).

It is generally accepted that this text preserves both Alcmaeon's views on health and sickness, and certain concepts of his, in particular δύναμις, ἰσονομία, and μοναρχία.[44] At the same time we should remember that B 4 is a reconstruction by Diels of Aëtius' text, based on the differing versions by Pseudo-Plutarch and Stobaeus.[45] Σύμμετρος κρᾶσις has long been seen as a later formulation of the idea which Alcmaeon expressed with the aid of the concepts of ἰσονομία and μοναρχία,[46] which bore the stamp of the aristocratic ideology of the Pythagoreans. Alcmaeon's ἰσονομία bears no relation to democracy, which it later came to signify.[47] It refers to equality within the political class, which in Croton numbered one thousand.

[42] H. von Staden and J. Jouanna again pointed out the late terminology in Alcmaeon B 4, see Ch. Schubert, 'Menschenbild und Normwandel in der klassischen Zeit', in H. Flashar and J. Jouanna (eds.), *Médecine et morale dans l'antiquité* (Geneva, 1997), 121–43, discussion at 148 f.

[43] Diels, *Dox.*, 232; D. Runia, 'The Placita Ascribed to Doctors in Aëtius' Doxography on Physics', in van der Eijk (ed.), *Ancient Histories of Medicine*, 189–250, at 233; Zhmud, *Origin*, 127 ff. Cf. J. Mansfeld, 'Doxography and Dialectic: The *Sitz im Leben* of the "Placita"', *ANRW* II 36/4 (1990), 3058 f.

[44] Diels, *Dox.*, 223; Wachtler, *De Alcmaeone*, 77; Timpanaro Cardini, i. 150 f.; Triebel-Schubert, 'Begriff'; G. Cambiano, 'Pathologie et analogie politique', in Lasserre and Mudry (eds.), *Formes de pensée*, 441–58. In medical literature the last two terms are no longer found.

[45] This was rightly emphasized by Grmek (*Western Medical Thought*, 246 f.). φθοροποιὸν γὰρ ἑκατέρου μοναρχία and τὴν δὲ ὑγείαν τὴν σύμμετρον τῶν ποιῶν κρᾶσιν are found only in Pseudo-Plutarch, and γίνεσθαι δέ ποτε καὶ ὑπὸ τῶν ἔξωθεν αἰτιῶν ὑδάτων ποιῶν ἢ χώρας ἢ κόπων ἢ ἀνάγκης ἢ τῶν τούτοις παραπλησίων – only in Stobaeus, whose version is clearly closer to the original.

[46] Olivieri, *Civiltà greca*, 111; E. Montanari, *ΚΡΑΣΙΣ e ΜΙΞΙΣ: un itinerario semantico e filosofico* (Florence, 1979), 189 ff.; Triebel-Schubert, 'Begriff', 43 f.

[47] See above, 81 n. 87.

Μοναρχία, the power of a tyrant, upsets that equality, just as the supremacy of one of the *δυνάμεις* in the organism upsets their balance and leads to illness. Although Alcmaeon tried to rely on observations and research, he inevitably had to resort to judgement by analogy in explaining health and sickness as such.

Moist and dry, cold and hot, bitter and sweet, and other *δυνάμεις*, which Alcmaeon did not restrict in number,[48] are not cosmic principles or elements; they belong to the world of humans (*δύο τὰ πολλά ἐστι τῶν ἀνθρωπίνων*, A 1, 3)[49] and represent specific physical 'qualities' which pertain to the human body. Deficiency or excess of nourishment may upset the balance and cause disease.[50] If the separation of external and internal causes, noted in the outline of Alcmaeon's theory, reflects his views, 'cold' and 'hot' are not to be understood as climatic cold and heat, but rather as inner 'qualities' of the organism, corresponding to their counterparts in the macrocosm. This interpretation is supported by the fact that Alcmaeon explained vision as the presence in the eye of 'water' and 'fire' (see below), while in his explanations of phenomena in the macrocosm opposites do not occur.[51] Among the external causes which Alcmaeon had the foresight to indicate were bad water, insalubrious locations, exhaustion, trauma or wounds, and other factors. The number of *loci* in which disease occurs was probably not established either: in addition to the blood, marrow, and brain one would naturally expect mention of the stomach.

It is not easy to appraise the originality of Alcmaeon's theory, because the earlier medical and philosophical texts on the aetiology of disease are unknown; some believe that he took his theory from the Crotonian physicians. His use of political metaphors – like Anaximander's use of 'judicial' metaphors (B 1) – most likely

[48] Isocrates' report (*Antid.* 268 = A 3) that Alcmaeon had two *archai* is incorrect: he had none, and the number of opposing qualities was not fixed (A 3; B 4).

[49] Their treatment by Aristotle as *ἀρχαὶ τῶν ὄντων* (*Met.* 986b3 = A 3) should not be understood in an ontological sense.

[50] Kudlien, *Beginn*, 53 f.: 'Wenn der Mikrokosmos Mensch aus bestimmten Grundstoffen besteht, so bedarf er doch zur Erhaltung dieser Grundstoffe und ihres Gleichgewichtes gewisser von außen kommenden Hilfen – vor allem die Nahrung. In diesem Angewiesensein auf etwas Äußeres, das dann innen wirksam wird, liegt aber auch grundsätzlich eine Gefahr, nämlich die einer Störung des körperlichen Gleichgewichts – und das heißt eben die Gefahr der Erkrankung.'

[51] In Alcmaeon's fragment on plants (see below, 380), he speaks of the sun and the earth as father and mother of plants, but these are not opposites.

indicates that both were faced with the need to formulate new theories and a conceptual apparatus in their chosen fields. The concept of *δύναμις*, later accepted in the Hippocratic Corpus, is not found among the Presocratics before Alcmaeon; we cannot rule out the possibility that it too was taken from the sphere of politics.[52] Against this background the supposition that Alcmaeon borrowed his theory from an earlier medical tradition seems unconvincing, especially when we consider his undisputed originality in psychology, physiology, and embryology (see below). Alcmaeon, who wrote in the Ionian dialect, was of course familiar with Ionian philosophy (A 4); the influence on him of Pythagoras' notions of the soul and the astronomical views of the Pythagoreans is also beyond dispute.[53] The view of health as a balance of opposite 'qualities' called forth associations with the cosmogony of Anaximander, in which, according to the doxography, the unlimited produces 'a germ of hot and cold',[54] and with the Pythagorean doctrine on *πέρας* and *ἄπειρον*.[55] A similarity with one of Alcmaeon's pairs points towards Anaximander, while the fact that, after Pythagoras, dualism – in the sense of a theory of opposites as a basic explanatory mechanism – became a characteristic feature of Italic philosophy points towards Pythagoras. It is clearly seen in Alcmaeon, Parmenides, Menestor, Empedocles and Philolaus,[56] and absent in Ionian philosophy, although this philosophy was of course very familiar with the opposing qualities themselves (see Heracl. B 126). At the same time the originality of Alcmaeon's views is clear. Unlike most of the Presocratics, he did not develop a doctrine of principles; cosmogony was absent from his

[52] Kudlien, *Beginn*, 60.

[53] See above, 233, 330, and below, 388 f.

[54] *φησὶ δὲ τὸ ἐκ τοῦ ἀιδίου γόνιμον θερμοῦ τε καὶ ψυχροῦ κατὰ τὴν γένεσιν τοῦδε τοῦ κόσμου ἀποκριθῆναι* (Ps.-Plut. *Strom.* 2 = A 10; Cf. Arist. *Phys.* 187a20 = A 9). Diels (*Dox.*, 579.13, apparatus criticus) suggested *δέ τι ἐκ τοῦ ἀιδίου γόνιμον θερμοῦ τε καὶ ψυχροῦ*. Hölscher and Kahn follow him. The pair moist–dry has not been reliably attested.

[55] Wachtler, *De Alcmaeone*, 75, 83 ff.; Palm, *Studien*, 112 f.; Pohlenz, *Hippokrates*, 82. Those who deny Pythagoras as a philosopher stress the link between Alcmaeon and the Ionians (Burkert, 295 n. 89). It is true that we have no reliable evidence that the pair *πέρας–ἄπειρον* goes back to Pythagoras, although this is fully possible.

[56] As Burkert notes (297), dualism was not a universal principle in Pythagoreanism (cf. Hippasus and Hippon), and no 'well-defined scientific and philosophical system' can be discerned behind the teachings of the Italics. Pythagoras indeed never had such a system, and therefore no dualism that was binding for all Pythagoreans could take shape.

book, while cosmology received very scant treatment. His teaching on the balance of many opposing δυνάμεις belongs to physiology, not cosmology. Anaximander, on the other hand, spoke not of 'hot' and 'cold' in themselves, but rather of fire and mist, of which the heavenly bodies, in particular, consisted; it does not appear that a balance of opposites played any part in his thinking.[57] In any case, to Alcmaeon what mattered was not specific opposites, but the balance of many pairs of δυνάμεις one with another in the human body, and the effect of the external environment on them, so the similarity with Anaximander is not only superficial but also most likely deceptive. Pythagoras' cosmogonic forces, the limit and the unlimited, resemble Alcmaeon's 'qualities' in that they are opposites which explain processes occurring in the macrocosm and microcosm respectively; however, their character and the way they interact are completely different. If the doctrine of the δυνάμεις arose under Pythagoras' influence, the end result differed from the original just as much as Alcmaeon's views on the soul differed from Pythagoras' metempsychosis (below, §11.1).

The distinctiveness of Alcmaeon, who combined in his person the physician and the philosopher, is clear when he is compared with Hippon. Continuing the 'physiological' trend of Pythagorean natural philosophy, Hippon mostly studied problems of physiology, embryology, botany, and medicine. Even more than Alcmaeon he focused his attention on living nature, rather than nature as a whole; in the evidence available to us there are no traces of cosmogony and hardly any of cosmology (cf. B 1). Hippon's principle, moisture (ὑγρότης, τὸ ὑγρόν), is only superficially similar to Thales' water; strictly speaking, it is not the origin of all that exists, like air in Anaximenes or fire in Heraclitus, but only the origin of all *life*. As Menon reports, Hippon supposed that the bodies of all living things contain moisture which is characteristic of them (οἰκεία ὑγρότης), and thanks to which they live and feel. He relied on this principle to explain life, death, and disease:

[57] U. Hölscher, 'Anaximander und die Anfänge der Philosophie', *Hermes* 81 (1953), 257–77, at 264 f., 272 = Furley and Allen (eds.), *Studies*, 300: 'But on the whole the picture is not of a schema of complementary opposites, but the "arrangement of time", in which conquest is paid for with downfall'; B. J. Hijmans, 'Anaximanders biologische Fragmente im System seiner Philosophie', *AClass* 3 (1960), 32–5; G. E. R. Lloyd, 'Hot and Cold, Dry and Wet in Early Greek Thought', *JHS* 84 (1964), 92–106, at 95 ff.; Wright, *Empedocles*, 25 f. Cf. KRS, 119 ff.

> When such moisture is in its normal condition, the living creature is healthy, but when it dries up, the animal loses consciousness and dies. For this reason old men are dry and insensitive, because they lack moisture. Similarly the soles of the feet, because they have no share of moisture, are insensitive. [. . .] but in another book the same author says that the aforementioned moisture changes through excess of heat and excess of cold, and thus brings on diseases. He says it changes to become moister or drier or coarser or finer or changes into other substances. Thus he defines the cause of disease, but he gives no indication of the individual diseases that arise (Anon. Lond. XI = A 11, tr. Longrigg).

We may assume that the first book dealt with living nature as a whole, and the second considered in detail the causes of disease. It is indicative, however, that Hippon as a natural philosopher did not deal with particular diseases, and his theory displays a tendency – sometimes even a schematic one – to reduce everything to a single principle. Instead of a balance of many 'qualities', which may be upset by external and internal factors set forth in Alcmaeon's theory, we find the 'normal condition' of moisture and changes in it owing to heat and cold. By ὑγρότης in this context Hippon evidently meant the element common to all physiological fluids in the body, the element which in its turn depended on liquid food.[58] It is likely that excessive heat and cold also applied to food, although we cannot exclude the action of heat and cold from outside. The idea that old age and dryness were linked with lack of sensation and death, while youth was linked with moisture, is traditional in nature and widespread in Greek literature of various genres.[59] The reverse process, by which moisture becomes thinner and finer under the influence of cold, is also known from the medical literature.[60] It is interesting that in Philolaus' theory of disease, in addition to Alcmaeon's well-known causes (a deficiency or surfeit of heat, cold, or food), a central role is played by the state of three fluids: blood, bile, and phlegm;[61] blood in

[58] D. Manetti, 'Hippo Crotoniates', in *Corpus dei Papiri Filosofici Greci e Latini*, I/1 (Florence, 1992), 458 ff.

[59] Onians, *Origins*, 212 ff.; Manetti, 'Hippo', 461; see Ar. *Pl.* 1054, *Lys.* 385; [Hipp.] *Nat. mul.* 1; *Mul.* II, 111; Arist. *GA* 784a30 f.

[60] See e.g. M.-P. Duminil, *Le Sang, les vaisseaux, le coeur dans la Collection hippocratique* (Paris, 1983), 295 ff., 223 ff.

[61] Anon. Lond. XVIII = A 27. See D. Manetti, 'Doxographical Deformation of Medical Tradition in the Report of the Anonymus Londinensis on Philolaus', *ZPE* 83 (1990) 215–33; Huffman, *Philolaus*, 289 ff.

particular can cause disease, by becoming thicker or thinner according to changes in human flesh. From this it follows that healthy blood is neither too thick nor too thin, like Hippon's 'normal liquid'.

In the various Pythagorean figures who studied medicine or were interested in it, it is not easy to find one feature which is common to all. What unites Democedes, Alcmaeon, Iccus, Hippon, and Philolaus is probably a rational approach to medicine and the absence in their theories and practices of any link with religious or magic healing. By contrast, the tradition of another Italian thinker, Empedocles, shows that aspect very clearly. The combination of natural science and medicine with religious prophecy and healing has often captivated scholars, who have seen in Empedocles a kind of relic of 'archaism'. 'Shamanistic *γοητεία* and medical art, "medicine man" and medicine do go together, and in Empedocles the two are still combined,' wrote Burkert.[62] Here the crux of the matter is that the union of magic and medicine looks to the past: Empedocles *still* unites things which later would be divided. Opinions differ as to precisely when this came about,[63] but the early Pythagoreans, and moreover, Pythagoras himself, at any rate remain, according to this logic, within the field of the 'indivisible' unity of magic and medicine. And since the tradition on individual Pythagoreans contains nothing to substantiate this idea, we are assisted by the 'Pythagorean way of life', with its famous taboos: 'The transition from the *βίος Πυθαγόρειος* (or *'Ορφικός*) to a rationally based regimen is only a new approach to the same thing.'[64] Earlier Wehrli had written, in the same spirit:

> The origins of Pythagorean dietetics lie in the famous taboos on certain foods, which are themselves deeply rooted in magical beliefs. They then became part of the comprehensive regimentation of life which Plato

[62] Burkert, 291 f., 296 f.; Parker, *Miasma.*, 207 ff. It is sometimes claimed that Empedocles, like Melampus, was a soothsayer and healer, a *ἰατρόμαντις*, see e.g. W. Kranz, *Empedokles* (Zurich, 1949), 20 ff., 26 ff.; M. Vegetti, '*Iatromantis*: Previsione e memoria nella Grecia antica', in M. Bettini (ed.), *I signori della memoria e dell'oblio* (Florence, 1996), 65–81. Cf., however, Flower, *Seer*, 81 n. 23.

[63] Jouanna, *Hippocrate*, 372: 'Empédocle ne semble donc pas encore avoir établi une distinction nette entre magie et médicine, comme le feront quelques années plus tard les médecins hippocratiques.' Nutton, *Ancient Medicine*, 113: 'In the sixth and early fifth centuries healers could act like Empedocles as roving shamans, and the boundaries between magic and medicine were almost non-existent. By 350 BC, however, barriers had arisen.'

[64] Burkert, 293.

> knows as the 'Pythagorean way of life' (*Res.* 600) in which superstition and ethical views are hard to separate [. . .] If this picture of the process is correct then it is one aspect of the separation of an independent science of medicine from what was originally a magical therapy with much broader aims.[65]

I suggest that the extraordinary figure of Empedocles, the coeval of Zeno of Elea, Anaxagoras, and Pericles, can be fully explained without invoking the relics of archaism.[66] In any case, in the chronology of the relations between religious-magical and rational medicine Empedocles is a very unfortunate starting point. The tradition on his achievements as a healer, such as the resuscitation of the dead and of people in prolonged comas, and the saving of whole cities from epidemics by changing the course of rivers or the winds, is increasingly being seen as a biographical interpretation of his poems (see especially B 111–12, 146), an interpretation conceived in the mid-fourth century, rather than historical evidence.[67] The very first mention of Empedocles is in *Ancient Medicine* (last third of the fifth century); while extremely critical of his 'philosophical' medicine, the Hippocratic physician finds nothing 'supernatural' in it.[68] The latter also applies to the physicians Acron and Pausanias, who were close to Empedocles; to the latter he dedicated his poem *On Nature*.[69]

The 'primeval unity' of magic and medicine bears no relation to Pythagoras, as he was neither a medicine man nor a physician. The

65 F. Wehrli, 'Ethik und Medizin: Zur Vorgeschichte der aristotelischen Mesonlehre', *Mus. Helv.* 8 (1951) 59.

66 On the relation between the rational and the religious in Empedocles, see Lloyd, *Magic*, 33 ff.

67 Wright, *Empedocles*, 9 ff., 20; J. R. Pinault, *Hippocratic Lives and Legends* (Leiden, 1992), 48 f.; Inwood, *Poem*, 6 f.; A. Chitwood, *Death by Philosophy* (Ann Arbor, 2004), 39 ff.; R. Goulet, 'Empedocles', *DPhA* 3 (2000) 76 ff.; cf. Lloyd, *In the Grip of Disease*, 24 ff. This tradition most likely goes back to the dialogue of Heraclides Ponticus *On the Woman who Stopped Breathing* (fr. 76–89); see Gottschalk, *Heraclides*, 13 ff.

68 'Some doctors and sophists say that it is impossible for anyone to know medicine who does not know what the human being is; anyone who is going to treat patients correctly must, they say, learn this. Their account tends towards philosophy just like Empedocles or others who have written about nature from the beginning, what the human being is and how it originally came to be and from what things it was compounded' (*VM* 20, tr. Schiefsky). See A.-J. Festugière (ed.), *Hippocrate: L'ancienne médicine* (Paris, 1948), 55 f.; Jouanna (ed.), *L'Ancienne Médicine*, 22 f., 206 f.; M. Schiefsky, *Hippocrates: On Ancient Medicine* (Leiden, 2005), 55, 299 ff.

69 On Acron see M. Wellmann, *Die Fragmente der sikelischen Ärzte* (Berlin, 1901), 108 f.; on Pausanias, 31 A 1.60, 1.71, A 3; B 1, 156.

introduction of a meat diet for athletes, linked with him in the classical tradition,[70] appears to be a fully contemporary and pragmatic innovation, which also defied well-known taboos. The ban on eating beans, which brings together Pythagoreanism, Orphism, and Empedocles, goes back to ancient superstitions, but was treated in a rationalist manner even in antiquity, and with particular insistence in the historical-medical literature of recent decades, in connection with the favism caused by beans.[71] But how are medical and sport dietetics, theorized about by Alcmaeon and practised by Iccus, connected with that taboo? None of the Hippocratic treatises contains a ban on beans. On the contrary, they often form part of a diet prescribed by a doctor.[72] If Crotonian medicine is linked through Calliphon with that of the Cnidian Asclepiads, it is appropriate to mention that they traced their origins from Asclepius, Machaon, and Podalirius, army physicians in Homer's poems,[73] and not from the soothsayer and healer Melampus. The secularization of notions of non-traumatic ailments, relying on the experience of those who treated combat wounds and sport trauma and who had therefore freed themselves from the need to appeal to supernatural forces, was the path which the Crotonian physicians were among the first to take. The idea of rational dietetics being born of the spirit of magic is as remote from reality as the transformation of myth into logos.

10.2 PHYSIOLOGY AND ANATOMY

Thanks to a lucky chance which has preserved for us Theophrastus' short treatise *On the Senses*, the theories of many Presocratics on sensory perception are known to us from a coherent summary compiled by an expert in the field.[74] Theophrastus divides 'physiologists'

[70] See above, 352 n. 18.

[71] See Callim. fr. 553, and above, 237 ff.

[72] *Epid.* II 6,6, VII 1,6, 1,9; *De victu* II 44; *De victu acut.* (Sp.), 21, 30.

[73] E. J. and L. Edelstein, *Asclepius: A Collection and Interpretation of the Testimonies*, ii (Baltimore, 1945), 19 f., 53 ff.

[74] See J. J. Beare, *Greek Theories of Elementary Cognition from Alcmaeon to Aristotle* (Oxford, 1906); G. M. Stratton, *Theophrastus and the Greek Physiological Psychology Before Aristotle* (London, 1917); H. Baltussen, *Theophrastus Against the Presocratics and Plato: Peripatetic Dialectic in the* 'De sensibus' (Leiden, 2000).

into two groups: some, like Parmenides, Plato, and Empedocles, followed the principle 'like perceives like'; others advanced the opposite principle. In Theophrastus, however, the latter group does not assume a clear identity: the first in the group, Alcmaeon, did not follow any of the declared principles, and of the others, Anaxagoras, Clidemus, Diogenes, and Democritus, only Anaxagoras consistently adhered to the principle 'opposite is perceived by opposite'. Theophrastus does not focus on Alcmaeon; he devotes only two paragraphs of his survey to him, as he does to Parmenides, but Alcmaeon's special position as the founder of the 'physiological' tendency in Presocratic thought is clearly apparent.

Chronologically speaking, physiology and more particularly the physiology of the sensory organs begins with Alcmaeon. As a rule, the theories of Parmenides, Anaxagoras, Empedocles, Diogenes, and Plato are a response to questions first posed by him.[75] Unlike many other Presocratics, Alcmaeon offered a theory of all the sensory organs except touch, both as a whole and individually, and distinguished sensation and thought, something that Theophrastus also appreciated highly (*DS* 25). In his survey of Alcmaeon's theory there is no criticism, whereas he is very harshly critical of the views of Anaxagoras, Democritus, and especially Empedocles. Following his teacher, Theophrastus regarded the heart as the seat of thought and sensation, and was therefore unable to appraise the principal virtue of Alcmaeon's theory, which distinguishes it clearly from all others, although he did note it. Alcmaeon asserted that all the sensory organs were linked with the brain by 'passages' (πόροι) carrying sensations, and the brain was also the organ of thought. If it was disturbed or shifted the sensory organs were incapacitated, for it obstructed the passages through which the sensations were conveyed (*DS* 26 = A 5). Those philosophers who allocated any role in sensation to the brain either linked it only with hearing, or, like Diogenes, with hearing and smell.[76] Alcmaeon's position was much more logical. He explained hearing by saying that within the ear was a cavity filled with air. By resonating, it transmitted sounds to the brain. Smell was

[75] Longrigg, *Greek Medicine*, 53 ff.

[76] Anaxagoras (*DS* 28), Diogenes (39–40), Democritus (56, 114), Plato (6, 85). F. Solmsen, 'Greek Philosophy and the Discovery of the Nerves', *MH* 18 (1961), 150–67, 169–97; G. E. R. Lloyd, 'Diogenes of Apollonia: Master of Ducts', in Sassi (ed.), *Costruzione*, 237–58.

sensed through the nostrils, which breathed in air and conveyed it to the brain, and taste was sensed by the warm, moist tongue, which by its warmth dissolved particles of taste and conveyed them to the brain. Vision is 'due to the gleaming and the transparent, when (the transparent) reflects'.[77] Visual sensations are also conveyed along *πόροι* leading from the eye to the brain (A 5–6, 10). Only humans think (literally: understand, *ξυνίησι*); animals can only feel (*αἰσθάνεται*), and not think (B 1a).[78]

The theory of the primary role of the brain in thought and perception, the first rational theory on this matter, is deeply impressive in its sobriety (Empedocles and Anaxagoras endowed even plants with emotions), and its independence from the standard thought patterns of the natural philosophers (like/unlike) and from attempts to explain sensations through elements selected a priori. Alcmaeon's fundamental discoveries prepared the empirical ground for the further development of physiology and psychology, but were not recognized in full or at once. Philolaus and Plato supported him in what concerned the brain as the organ of thought, while still linking perception with the heart,[79] thus breaking Alcmaeon's causal connection between perception and thought.[80] The idea of a connection between the brain and

[77] Alcmaeon believed that the eye contained water and fire, because if the eye was struck, sparks would fly (A 10)! Everything points to the 'gleaming' (*τὸ στίλβον*) being fire, and the 'transparent' (*τὸ διαφανές*) water (thus H. Diels, 'Empedokles und Gorgias', *SBB* (1884) 354; Wachtler, *De Alcmaeone*, 48 f.; Lloyd, 'Alcmaeon', 121 n. 32; cf. Beare, *Greek Theories*, 11 f.; Stratton, *Theophrastus*, 176 n. 79). According to Empedocles, the eyes contain fire, which emitted light, and water, which reflected it: A 86, 91, B 84; D. O'Brien, 'The Effect of a Simile: Empedocles' Theories of Seeing and Breathing', *JHS* 90 (1970) 140 ff. For a different interpretation, see: M. G. Leboucq, 'Alcméon de Crotone, père de la biologie', *Bulletin de l'Académie de Médecine de Belgique* 6 (1946) 240 f.

[78] Aristotle also stressed this difference: *ὅτι μὲν οὖν οὐ ταὐτόν ἐστι τὸ αἰσθάνεσθαι καὶ τὸ φρονεῖν, φανερόν· τοῦ μὲν γὰρ πᾶσι μέτεστι, τοῦ δὲ ὀλίγοις τῶν ζῴων* (*De an.* 428b6–8).

[79] Philol. B 13: *κεφαλὰ μὲν νόου* (sc. *ἀρχή*), *καρδία δὲ ψυχᾶς καὶ αἰσθήσιος*; Huffman, *Philolaus*, 307 ff; Pl. *Tim.* 70 a–d, 77 c–e; G. R. S. Harris, *The Heart and the Vascular System in Ancient Greek Medicine* (Oxford, 1973), 116 ff. Although we have no direct evidence, it is possible that Alcmaeon, like Philolaus, situated the *ψυχή*, understood as the principle of life and movement (A 12), in the heart.

[80] This connection is supported by Socrates' words on early theories of thought: 'What do we think with: blood, air, or fire? Or is it none of these three, but our brain that produces the feeling of hearing, seeing and smelling?' (*ὁ δ' ἐγκέφαλός ἐστιν ὁ τὰς αἰσθήσεις παρέχων τοῦ ἀκούειν καὶ ὁρᾶν καὶ ὀσφραίνεσθαι*; Pl. *Phaed.* 96a–b = A 11). See also: *διὸ καὶ δοκεῖ τισιν αἰσθάνεσθαι τὰ ζῷα διὰ τὸν ἐγκέφαλον* (Arist. *De iuvent.* 469a).

the individual senses – sight, sound, and smell – became widespread among the Hippocratics, for example, in *Places in Man* (2) and *On Flesh* (16–17); the *Coan Prognoses* (IV, 489), like Alcmaeon, affirmed that concussion led to loss of vision, hearing, and voice.[81] *Sacred Disease* (3, 14, 16), which saw the brain as the seat of sensations and thought and criticized traditional notions of the connection between thought and the heart or diaphragm (17),[82] was more logical than others and closest to Alcmaeon. Nevertheless, those notions continued to receive the support of physicians and philosophers for many centuries to come. In the fourth century they were shared by precisely those who excelled at dissection: Diocles of Carystus and Praxagoras of Cos, the authors of the first systematic works on anatomy; Aristotle, who performed many dissections of animals; and lastly, at the turn of the third century, the author of the Hippocratic treatise *On the Heart*, whose wealth of anatomical knowledge was also based on experiments.[83] Even after Alcmaeon's theory had been developed and experimentally demonstrated by the two Alexandrian doctors Herophilus and Erasistratus, who described the sensory and motor nerves running to the brain,[84] the Stoics, Epicureans, and Peripatetics continued to place a reasoning part of the soul in the heart. The dispute about the role of the heart and the brain is strongly reminiscent of the famous debate on the causes of the Nile floods: in both cases we see a whimsical mixture of empirical and speculative arguments, and the discussion continues for many more centuries after the correct answer has been found. Even among physicians, the empirical arguments made headway only with great difficulty, particularly because the interpretation of the results of dissection in the light of the then current physiological theories was no simple matter. With regard to Alcmaeon, the question is this: can the consistency and empiricism of his theory be explained by a reliance on dissections, and if so, on what kind of dissections?

[81] The material is collected in C. Oser-Grote, *Aristoteles und das Corpus Hippocraticum: Die Anatomie und Physiologie des Menschen* (Stuttgart, 2004), 241 f., 248 ff., 261 ff., 272 ff.

[82] They go back to the preliterate period: Onians, *Origins*, 13 ff., 40 f.

[83] Solmsen, 'Greek Philosophy', 159 ff.; Oser-Grote, *Aristoteles*, 82 ff.

[84] Solmsen, 'Greek Philosophy', 187 ff.; J. Longrigg, 'Anatomy in Alexandria in the third century B. C.', *BJHS* 21 (1988) 455–88; H. von Staden, *Herophilus: The Art of Medicine in Early Alexandria* (Cambridge, 1989).

The information available to pre-Hippocratic medicine on the structure of the human organism was obtained from the treatment of injuries or from observation of dead humans and animals; at that time nobody studied anatomy as such. The level of knowledge of the Hippocratic physicians in anatomy and the evidence from the Classical period available to us show an absence of any *regular* practice of dissection of human bodies,[85] but do not rule out sporadic experiments of this kind. There is much more information on the dissection of animals, which was practised in the fourth century by Diocles, Praxagoras, Aristotle, and other doctors and natural scientists.[86] In the first third of the third century, Herophilus and Erasistratus systematically performed dissections of human bodies and even practised vivisection on criminals sentenced to death.[87] After Herophilus and Erasistratus, vivisection was no longer practised on humans, while dissection of dead bodies became increasingly uncommon and eventually died out, although it remains unclear exactly when.[88] In any case, Galen, the enthusiastic advocate of dissection, practised it on animals, especially on monkeys, but not on humans. The reasons why the study of human anatomy developed in this way have been investigated more than once, but to this day remain unclear. It has been usual to see as the main reason the fact that in Greece there were religious and psychological prejudices against dissection of dead bodies, and the custom sanctified by religion required prompt burial.[89] The practice of dissecting human bodies was thus a temporary departure from these prejudices by individual physicians. While secularization undoubtedly played an important role in the development of anatomy in Greece, the explanation

[85] L. Edelstein, 'History of Anatomy in Antiquity', *Ancient Medicine*, 252 ff.; F. Kudlien, 'Antike Anatomie und menschlicher Leichnam', *Hermes* 97 (1969), 78–94; id., 'Anatomie', *RE Suppl.* 11 (1969), 38–48; Lloyd, 'Alcmaeon', 128 ff.

[86] Ph. van der Eijk, *Diocles of Carystus* (Leiden, 2001), fr. 17–24 with comm.; id., 'Between the Hippocratics and the Alexandrians: Medicine, Philosophy and Science in the Fourth Century BCE', in R. W. Sharples (ed.), *Philosophy and the Sciences in Antiquity* (Aldershot, 2005), 72–109; Nutton, *Ancient Medicine*, 119 f.

[87] Cels. *De med.*, praef. 23–4; von Staden, *Herophilus*, 138 ff.

[88] In the 1st cent., Celsus describes and defends the need to dissect corpses (*De med.*, praef. 23–6, 74–5), but does this reflect the practice of his time? See: Edelstein, 'History of Anatomy', 285 ff.; Ph. Mudry, *La Préface du De medicina de Celse* (Rome, 1982).

[89] See Edelstein, 'History of Anatomy'; Kudlien, 'Antike Anatomie'; H. von Staden, 'The Discovery of the Body: Human Dissection and Its Cultural Contexts in Ancient Greece', *Yale Journal of Biology and Medicine* 65 (1992), 223–41; Nutton, *Ancient Medicine*, 128 ff.

offered above seems too speculative.[90] Lloyd, for example, leaves out of his account the influence of religion and points out that dissection procedures in Greek medicine are themselves problematic.[91]

Indeed, the idea that clinical practice should be founded on knowledge of internal anatomy of the human body, self-evident in modern times, was first recognized by the Alexandrian physicians. The 'methodology' which guided doctors and natural philosophers in the fifth–fourth centuries consisted in making judgements about invisible processes within the body by analogy with physical processes known from everyday experience.[92] Precisely this naive physics may be seen in Alcmaeon's explanation: the brain, when shaken, obstructs the 'passages' through which sensations are conveyed from the sensory organs (A 5). At the same time, this explanation, and indeed the whole of Alcmaeon's theory of sensory perception, presupposes that the *πόροι*, of which he wrote, had some definite material substratum. Usually this has been taken to mean the optic nerves: first, because they are easy to discover in dissection (the auditory nerves are much smaller in diameter); secondly, Chalcidius' evidence (fourth century AD) of Alcmaeon's dissection of an eye has been preserved. In his commentary on *Timaeus* he notes (p. 257.16–20): to explain Plato's teaching on sight we must turn to those physicians and philosophers who practised dissection of human organs (*artus humani corporis facta membrorum exsectione rimati sunt*). This, Chalcidius goes on to say, is the way to view the nature of the eye:

> About this very many others have brought many things to light very clearly, especially Alcmaeon of Croton, who, well versed in natural philosophy, first dared to proceed to dissection, and Callisthenes, Aristotle's pupil, and Herophilus.[93]

[90] Neither the Hippocratics nor Aristotle record any religious or other prejudices against the dissection of human bodies. The medical school of the Empiricists, which rejected human dissection, also did not resort to 'religious' arguments: Cels. *De med.*, praef., 40–4; K. Deichgräber, *Die griechische Empirikerschule* (Berlin, 1930), fr. 66–70.

[91] Lloyd, 'Alcmaeon', 128 ff.

[92] See esp. *VM* 22.2–4; Edelstein, 'History of Anatomy', 292; Schiefsky, *Hippocrates*, 322 ff.

[93] 'Demonstranda igitur oculi natura est, de qua cum plerique alii tum Alcmaeo Crotoniensis, in physicis exercitatus quique primus exectionem aggredi est ausus, et Callisthenes, Aristotelis auditor, et Herophilus multa et praeclara in lucem protulerunt' (p. 256.22 f. = A 10, tr. von Staden). Here Chalcidius used an unknown but very well-informed source. This is shown also by the reference to Callisthenes, who appears nowhere else in a medical context.

On the basis of this evidence and Theophrastus' overview, Alcmaeon has usually been seen as the pioneer of anatomical research, who first discovered the optic nerves. Taking Alcmaeon's statement that goats breathe through their ears (Arist. *HA* 492a13 = A 7), one may conclude that in dissecting the organs of hearing he found the Eustachian tubes (the ducts between the middle ear and nasopharynx), which he also took to be πόροι leading to the brain. Having found the 'passages' between certain sensory organs and the brain, Alcmaeon postulated their presence for all the others.[94] Most scholars have supposed that he dissected the bodies of animals; only a small number assumed human dissection.[95]

After the mid-twentieth century, the epithets previously applied to Alcmaeon – founder of physiology and anatomy, father of psychology and psychiatry, creator of embryology – went out of fashion, and earlier appraisals of his methods and the results of his investigations began to be revised. Thus F. Solmsen concluded that, in the fifth–fourth centuries, ideas of the nerves were strictly speculative, and empirical research in this field was first undertaken by the Alexandrians. 'The previously expressed view that Alcmaeon dissected human bodies in about 500 is without any evidence or probability,' claimed Kudlien, while not denying his 'systematic dissection of animals'. Lloyd and Mansfeld strongly dispute Alcmaeon's human dissections, while Mansfeld rejects the idea that he studied medicine and anatomy at all. J. Rocca sums up the scepticism which surrounds Alcmaeon: his claims to have made discoveries in anatomy are dubious and probably linked with supposed status as a doctor, for which there is no confirmation. There is no reliable evidence that he dissected human bodies. Even if he did remove the eye of an animal and discovered the optic nerve, it is highly questionable that he

[94] M. Unna, 'De Alcmaeone Crotoniata', in Ch. Petersen (ed.), *Philologisch-historische Studien*, I (Hamburg, 1832), 55 ff.; Wachtler, *De Alcmaeone*, 40 f., 45 f.; 50 f.; M. Wellmann, 'Alkmaion von Kroton', *Archeion* 11 (1929), 159; Sigerist, *History*, 101 f., 114 n. 51–2; Harris, *Heart*, 6 f.; P. Manuli and M. Vegetti, *Cuore, sangue e cervello* (Milan, 1977), 31 f.; Longrigg, *Greek Medicine*, 58 ff. On the Eustachian tubes: Lloyd, 'Alcmaeon', 122 f.

[95] See e.g. L. Stella, 'L'importanza di Alcmeone nella storia del pensiero greco', *MAL* 8 (1938), 245 f.; M. Timpanaro Cardini, 'Originalità di 'Alcmeone', *A&R* 6 (1938), 241; H. Erhard, 'Alkmaion, der erste Experimentalbiologe', *Sudhoffs Archiv* 34 (1941), 88; Leboucq, 'Alcméon', 237 f.; Perilli, 'Alcmeone', 62 ff.

recognized it for what it was, let alone that he understood the role of the brain as the centre of cognitive activity.[96]

Lloyd again convincingly demonstrated what was already well known: 'For a long time after Alcmaeon dissection was not carried out for its own sake as part of a routine procedure of investigation. Such dissections as were performed were evidently undertaken for a particular and quite definite purpose, to explain strange phenomena, to support a theory or settle a controversy.'[97] The systematic study of animal anatomy was first undertaken by Aristotle, and of human anatomy, the brain and nervous system, by Herophilus and Erasistratus. The problem, however, is that after the third century human dissection was not carried out for its own sake as part of a routine procedure of investigation for even longer. Long intervals and sudden halts in the development of the sciences are well known in antiquity. We need only remember the fate of zoology after Aristotle, or botany after Theophrastus.[98] Alcmaeon, the first to link consistently sensations and thoughts with the brain, was an exception among physicians and philosophers in the sixth–fourth centuries. From this point of view, there are no serious obstacles to his being seen as the first (even the only) physician of his time to conduct anatomical investigations into the human sensory organs and discover the optic nerves leading to the brain, as this follows from Chalcidius' passage.[99] If Chalcidius had been thinking of those of Herophilus' predecessors who dissected animal eyes, it would have been more natural to expect the name of Aristotle here (see *HA* IV,8,80; VI,3,21), rather than his nephew Callisthenes or Alcmaeon.

[96] Solmsen, 'Greek Philosophy', 152 f.; Kudlien, 'Antike Anatomie', 85 n. 54; Lloyd, 'Alcmaeon, 114 ff.; Mansfeld, 'Alcmaeon, 27 ff.; J. Rocca, *Galen on the Brain* (Leiden, 2003), 22 f.

[97] Lloyd, 'Alcmaeon', 142; similarly Kudlien, 'Anatomie', 40 f.

[98] J. G. Lennox, 'The Disappearance of Aristotle's Biology: A Hellenistic Mystery', *Apeiron* 27 (1994), 7–24. See also Zhmud, *Origin*, 283 f. Until Theophrastus, the only specialized work on plants was by Menestor, Alcmaeon's younger contemporary (below, 382 f.). On acoustic experiments of the kind conducted by Hippasus (above, 309 f.), we have nothing before the end of the 4th cent.

[99] His words 'Alcmaeo Crotoniensis, in physicis exercitatus quique primus exectionem aggredi est ausus' plainly refer to human dissection; thus Lloyd, 'Alcmaeon', 116; Mansfeld, 'Alcmaeon', 32; von Staden, *Herophilus*, 238; Perilli, 'Alcmeone', 64 f. A parallel from Tertullian (*De an.* 10) supports the view that *exectio* in Chalcidius meant 'dissection'; see von Staden, *Herophilus*, 238.

Chalcidius' detailed account of the path of the optic nerves, as well as the detail on the anatomy of the eye, in particular the four membranes of different thickness, mentioned further on (p. 257.12–15), most likely go back to Herophilus.[100] The fundamental affinity between the ideas of Herophilus and Alcmaeon lies in the fact that both of them regarded the optic nerves as πόροι, which conveyed sensations to the brain. Noting that Alcmaeon could quite well have discovered these πόροι by dissection, Solmsen concludes: 'After many *ambages* physiological research again returned to his [i.e. Alcmaeon's] pioneering achievements.'[101] The fact that now the sensory nerves are conceived not as 'passages' along which air and water (Alcmaeon) or 'sensory pneuma' (Herophilus) move,[102] but as a bundle of nerve fibres conveying impulses from the receptors to the brain, in no way diminishes the significance of their discovery. Precisely what anatomical procedure led Alcmaeon to his discovery remains a matter of dispute,[103] as does the question whether he dissected human bodies or only animals. We have no other direct evidence of human dissection before the beginning of the Hellenistic period, though few historians of medicine would go so far as to assert that *nobody* ever practised it in this period. To be sure, the experimental method in life sciences means only dissection, not necessarily the dissection of humans. Alcmaeon could well have dissected goats, and extrapolated the resnlts to humans, as was done by the author of *Sacred Disease*, Aristotle, Herophilus, and Erasistratus.[104]

It is possible that Alcmaeon's explanation of sleep and death points to dissections which he performed: 'Alcmaeon says that sleep occurs

[100] Herophilus established the exact number of eye membranes, but these themselves were familiar earlier: Empedocles (B 84); O'Brien, 'Effect of a Simile', 144, 163 ff.; [Hipp.] *De loc. in hom.* 2 f.; *De carn.* 17 (contains a theory of vision which was close to Alcmaeon's theory of vision); Arist. *GA* 744a8. See Oser-Grote, *Aristoteles*, 248 ff. Cf. Lloyd, 'Alcmaeon', 119 f.

[101] Solmsen, 'Greek Philosophy', 187 and n. 219.

[102] A 5–8 (hearing, sense of smell), A 5, 10 (sight). On Herophilus: von Staden, *Herophilus*, 252 ff.

[103] Lloyd, 'Alcmaeon', 118 ff., 124, gives a detailed description of various options and tends towards the conclusion that Alcmaeon 'may have done no more than cut off the eyeball' of an animal; thus also C. Oser-Grote, 'Das Auge und der Sehvorgang nach Aristoteles und der hippokratischen Schrift *De carnibus*', in W. Kullmann and S. Föllinger (eds.), *Aristotelische Biologie* (Stuttgart, 1997), 333–49. Longrigg, on the other hand, believes that what is being discussed is a surgical operation on a human being (*Greek Medicine*, 59 f.).

[104] *De morbo sacro* 11; Arist. *HA* 494b21 f.; von Staden, *Herophilus*, 140, 179 f.

through the retreat of the blood into the blood-flowing vessels (αἱμόρρους φλέβας); the awakening occurs through its dispersal, and that complete retreat is death'.[105] The expression αἱμόρρους φλέβας, which apparently belongs to Alcmaeon, implies that besides blood-flowing vessels there were others which were hollow.[106] According to a widely accepted interpretation, Alcmaeon had noticed that in the dead the arteries, unlike the veins, are empty or almost empty, and on this basis he regarded death as a retreat of blood from the arteries into the veins.[107] A different interpretation, which does not assume knowledge of the differences between veins and arteries, was proposed by Lloyd: sleep is due to a reflux of blood towards the interior of the body.[108]

10.3 EMBRYOLOGY

Like physiology, ancient embryology for us begins with Alcmaeon.[109] In his book he is the first in the written tradition to formulate the

[105] A 18. Cf. interpretations of Empedocles: 'sleep results from the proportionate cooling of the heat in the blood, death from its absolute cooling' (A 85), and of Diogenes: 'if blood as it circulates completely fills the vessels, and it pushes the air contained in them into the chest and the belly, sleep arises ... but if all the airy material leaves the vessels, death ensues' (A 29), tr. D. Graham.

[106] In the 5th–4th cents. φλέβες could mean both veins and arteries, and ἀρτηρίαι arteries and bronchial tubes. αἱμόρρους φλέβες see *De morb.* I, 3, 8, 14, II, 5; *Affect.* 28; *De haemor.* 5; the treatises of the Hippocratic Corpus which distinguish veins and arteries: *Epid.* II, 4, V, 46; *De articulis* 45, 69, *De carn.* 5; *De oss.* 2–7 (cf. I. M. Lonie, *The Hippocratic Treatises "On Generation", "On the Nature of the Child", "Diseases IV"* (Berlin, 1981), 88 f.; Jouanna, *Hippocrate*, 437 n. 70). Cf. Διογένης ἐν τῇ ἀρτηριακῇ κοιλίᾳ τῆς καρδίας, ἥτις ἐστὶ πνευματική (εἶναι τὸ ἡγεμονικὸν τῆς ψυχῆς) (Aët. IV,5,7 = 64 A 20); Lloyd, 'Diogenes of Apollonia'.

[107] Tannery, *Science*, 223; Wachtler, *De Alcmaeone*, 71 f; Fredrich, *Hippokratische Untersuchungen*, 67; Olivieri, *Civiltà greca*, 118 f.; Stella, 'Importanza', 273; Leboucq, 'Alcméon', 245 f.; Onians, *Origins*, 80 n. 6; Timpanaro Cardini, i. 126; Harris, *Heart*, 8, 59.

[108] Lloyd, 'Alcmaeon', 126; Longrigg, *Greek Medicine*, 62.

[109] Besides teaching on the development of the foetus from conception to birth or the hatching of the egg, embryology included questions of heredity. See E. Lesky, *Die Zeugungs- und Vererbungslehren der Antike und ihr Nachwirken* (Wiesbaden, 1950); Lonie, *Hippocratic Treatises*; H. N. Parker, 'Greek Embryological Calendars and a Fragment from the Lost Work of Damastes', *CQ* 49 (1999), 515–34; L. Brisson et al. (eds.), *L'Embryon: formation et animation* (Paris, 2008). Our main sources on the embryology of the Presocratics, Aristotle, Aëtius, and Censorinus, are selective and

basic questions of embryology and try to answer them. Where does male sperm come from? When does it first appear? Does female sperm exist? What determines the sex of a child? What is the cause of infertility? Which part of the foetus takes shape first? How is the foetus nourished, and on what? Such is the part of Alcmaeon's embryological 'questionnaire' preserved in the doxography.[110] Beginning with Parmenides, Anaxagoras, and Empedocles, it gained currency among philosophers, and later among physicians as well.[111] Many of these questions, of course, had been discussed before Alcmaeon, and one of his answers coincides with an answer given by Solon.[112] Coincidences between his views and those of the Hippocratics, which appear in particular in the embryological treatises *On Generation*, *On the Nature of the Child*, and *Disease IV*, should not necessarily be seen as establishing the primacy of Alcmaeon; some of these ideas could go back to a common source. Among Alcmaeon's theories there are, however, some that are undoubtedly original, although completely incorrect, for example, his theory concerning the origin of semen. Attributing a central role to the brain, and relying on an outward similarity, Alcmaeon supposed that semen originated in the brain.[113] This theory was taken up by Hippon, who took a lively interest in embryology.[114] He linked his vital principle, moisture (*ὑγρότης*), with the soul, because the soul was born of moist semen,

contradictory. In a survey of opinions in *GA* 4,1, Aristotle focuses attention on Empedocles and Democritus. Alcmaeon and Hippon, whom he does not mention here (cf. *GA* 752b22 f.), are introduced briefly in Aëtius and more fully (Hippon) in Censorinus, 4–9. Censorinus, the most detailed source, often contradicts the other two; he had not read Aristotle but made use of the same tradition as Aëtius, through Varro (*Dox*., 188 ff.). Where Aëtius and Censorin diverge, the former is usually preferable: *Dox*., 190 not. 1; E. Lesky, 'Alkmaion bei Aetios und Censorin', *Hermes* 80 (1952), 249–55.

[110] In Aëtius these questions are formalized (5,3. *Τίς ἡ οὐσία τοῦ σπέρματος*. 5,5. *Εἰ καὶ αἱ θήλειαι προΐενται σπέρμα*. 5,13. *Διὰ τί αἱ ἡμίονοι στεῖραι*. 5,16. *Πῶς τρέφεται τὰ ἔμβρυα*. 5,17. *Τί πρῶτον τελεσιουργεῖται ἐν τῇ γαστρί*). Theophrastus set these down in freer form, but he too had his 'questionnaire'.

[111] Longrigg, *Greek Medicine*, 54 ff. (Parmenides' views are omitted); Jouanna, *Hippocrate*, 380 ff.

[112] See below, 380 and n. 133.

[113] A 13; according to the *Pythagorean Memoirs*, the seed is a drop of brain (D.L. VIII, 28). This theory has no reliable parallels in traditional notions (*pace* Onians, *Origins*, 108 f.; Lonie, *Hippocratic Treatises*, 102). Lesky, *Zeugungs- und Vererbungslehren*, 10 f., placed its origins in Persia.

[114] Censorinus regularly refers to his views (5.2, 5.4, 6.1, 6.3, 6.4, 6.9, 7.2., 9.2 = A 12–18).

which in turn originated in the brain.[115] Another part of this theory has come down to us in evidence that Hippon regarded semen as a product of the spinal marrow (A 12), and in its full form this theory may be seen in a number of Hippocratic treatises: from the brain, the semen travels through veins which pass behind the ears into the spinal cord, and from there into the testicles.[116] As confirmation of his views, Hippon referred to an original 'experiment'. According to Censorinus,

> Hippon . . . believed that the seed flows from (spinal) marrow, and thought that his theory was proved by the fact that, if one butchers the males after the animals have mated, no marrow is found, because it has been exhausted, as you might expect.[117]

Although the result of which Hippon speaks compels one to query the reality of the experiment, it does not appear that it was pure invention. Anaxagoras and Democritus opposed the theory that semen originated in the brain and marrow, postulating that it was a product of the whole body.[118] According to Censorinus, they maintained that after copulation males lost not only part of their marrow, but also a substantial proportion of their fat and flesh.[119] Anaxagoras is known for at least one anatomical experiment (A 16), but this instance is more likely to be a matter of simple observation.

[115] *τὴν δὲ ψυχὴν ποτὲ μὲν ἐγκέφαλον λέγει, ποτὲ δὲ ὕδωρ· καὶ γὰρ τὸ σπέρμα εἶναι τὸ φαινόμενον ἡμῖν ἐξ ὑγροῦ, ἐξ οὗ φησι ψυχὴν γίνεσθαι* (Hippol. *Ref.* I,16,2 = A 3); here Hippolytus relied on a Peripatetic source (*Dox.*, 553 ff.). The argument which Aristotle (*Met.* 983b22–26 = A 10) and Theophrastus (fr. 225 FHSG) attribute to Thales was in fact Hippon's: that the semen of all living creatures is moist (*KRS*, 91 n. 1, cf. above, 27 n. 6), see Arist. *De an.* 405b1–3. Hippon believed that in the body of a child the first thing to take shape was the head, which contained the beginnings of the soul (Hippon vero caput, in quo est animi principale, Cens. 6.1.= A 15).

[116] A 12; *De gen.* 2; *Nat. hom.* 11; *Aer.* 22. See also Diocles, fr. 41a–b; Pl. *Tim.* 91a.

[117] Hipponi . . . ex medullis profluere semen videtur, idque eo probari, quod post admissionem pecudum si quis mares interimat, medullas utpote exhaustas non reperiat (5.1 = A 12; tr. N. H. Parker).

[118] 59 B 10; 68 A 141. This theory was widely accepted among the Hippocratics (Lesky, *Zeugungs- und Vererbungslehren*, 70 ff.; Lonie, *Hippocratic Treatises*, 66 f., 115 f.). The idea that both theories, the encephalo-myelogenic and the pangenetic, were parts of a single general theory (thus J. Jouanna, 'La Naissance de la science de l'homme chez les médecins et les savants de l'époque d'Hippocrate: problèmes de méthode', in J. A. López Férez (ed.), *Tratados Hipocráticos* (Madrid, 1992), 107 f.; id., *Hippocrate*, 382 ff.), seems unconvincing.

[119] Cens. 5.2 = 24 A 13 = 59 A 107; 68 A 141. On this text see Lesky, 'Alkmaion'.

Alcmaeon's embryology was inevitably far more primitive than his physiology. The methods then available very rarely allowed one to achieve definite results. The naive rationalism and speculative nature of his embryological theories testify not only to Alcmaeon as a scientist and a physician, but also to the possibilities of ancient medicine, and pre-scientific medicine as a whole, which for centuries preserved and developed his views. Thus the notion of semen originating in the brain and spinal marrow, for example, survived in European science until the beginning of the eighteenth century. Alcmaeon's idea that there existed both male and female semen had an even longer life; from their union an embryo was formed, and the semen which prevailed determined the sex of the child.[120] This theory, which ran counter to traditional views,[121] took hold because it provided a more rational explanation of sex determination and the way a child inherited paternal and maternal traits. The theory of two types of semen was shared by Parmenides (B 18), Empedocles (B 63), and Democritus (A 142), all of whom enriched it by adding new features. The author of *On Generation* went further than others by stating that each parent possessed both male and female semen (6–9); in this way a Hippocratic was able to explain, for example, how a girl inherited her father's traits.[122] Alcmaeon's theory could not do this. The theory of female semen was criticized by Aristotle, but supported and developed by Galen, who handed it down to medieval and modern medicine. It was finally refuted by K. von Baer (1827), who used a microscope to investigate the female ovule.

[120] A 13–14. See W. Gerlach, 'Das Problem des "weiblichen Samens" in der antiken und mittelalterlichen Medizin', *Sudhoffs Archiv*, 30 (1937/8), 177–93; Lesky, *Zeugungs- und Vererbungslehren*, 24 f., 162 f, etc.; Lonie, *Hippocratic Treatises*, 125 ff.; G. E. R. Lloyd, *Science, Folklore and Ideology* (Cambridge, 1982), 86 ff.; P. van der Horst, 'Sarah's Seminal Emission: Hebrews 11:11 in the Light of Ancient Embryology', in *Hellenism-Judaism-Christianity: Essays on Their Interaction* (Leuven, 1998), 221–40. As van der Horst shows, in the pre-Greek, Jewish tradition in particular, this idea is unattested.

[121] They are reflected in Aeschylus' *Eumenides* (657 ff.), where Apollo asserts that only the father begets the child; the mother merely nourishes the foetus.

[122] This teaching is close to the way genetics explains sex determination by heredity (Lesky, *Zeugungs- und Vererbungslehren*, 82 f.; Lonie, *Hippocratic Treatises*, 125 ff.). See also W. Brunschön, 'Gleichheit der Geschlechter? Aspekte der Zweisamentheorie im Corpus Hippocraticum und ihrer Rezeption', in Chr. Brockmann et al. (eds.), *Antike Medizin im Schnittpunkt von Geistes- und Naturwissenschaften* (Berlin, 2009), 173–90.

The fragmentary information on Alcmaeon's views may sometimes be supplemented by relying on the theories of his younger contemporaries. Tradition has brought down to us the views of Parmenides, Empedocles, and Anaxagoras on children inheriting their father's and mother's traits; from this we may conclude that the question was posed by Alcmaeon. What answer he gave we do not know, but it seems most likely that his opinion was the one which Censorinus attributes to Anaxagoras: children most resemble the parent who supplies the most semen (6.8 = A 111); this was the way Alcmaeon explained the determination of the child's sex. Censorinus' report that Anaxagoras accepted the theory of female semen contradicts Aristotle and is unsupported by anything else,[123] and Alcmaeon was the author of that theory. It is clear that the same kind of confusion arose over the answer to the question of which part of the foetus took shape first. According to Aëtius, Alcmaeon believed that it was the head, which contained the *hegemonikon* (V,17,3 = A 13), but according to Censorinus, in the spirit of the sceptics, Alcmaeon withheld judgement (5.5), whereas Anaxagoras maintained that it was the brain, the seat of all sensation (6.1 = A 108). As we know, of all the Presocratics only Alcmaeon upheld this latter view. Further evidence of Anaxagoras' dependence on Alcmaeon is found in the coincidence of their views on another embryological matter: according to Aristotle, Alcmaeon believed that the white of eggs was milk, which served to feed the chick; Athenaeus ascribes the same view to Anaxagoras;[124] Aristotle himself held that the chick fed on the yolk.

Alcmaeon's interest in various aspects of embryology is demonstrated by some further evidence in Aëtius. The male mule is sterile as it has thin (λεπτός) and cold semen, while the female is barren because the womb 'does not open' (5,14,1 = B 3). Applied to the womb, ἀναχάσκω occurs regularly in the Hippocratic Corpus,[125] so here Alcmaeon was probably relying on the medical tradition. If he

[123] Cf. Cens. 5.4, 6.8 and Arist. *GA* 763b30 ff. = A 107 (Anaxagoras acknowledged only male semen). Thus Lesky, *Zeugungs- und Vererbungslehren*, 55. Cf. however O. Kember, 'Anaxagoras' Theory of Sex Differentiation and Heredity,' *Phronesis* 18 (1973), 1–14.

[124] Arist. *GA* 752b22 = 24 A 16; Athen. 57d = 59 B 22. Some believe that Anaxagoras and Alcmaeon have been confused here: D. Sider, *The Fragments of Anaxagoras*, 2nd edn. (Sankt Augustin, 2005), 169.

[125] *De superfet.* 29 (ἀναχανεῖται), 32 (bis), *De victu* 30; *Nat. mul.* 45, etc.

resorted to a quantitative principle in the heredity of sex and parental features (Lesky called it the 'principle of predominance', ἐπικράτεια), infertility was explained qualitatively: for normal conception the male semen should be thick (παχύς) and warm.[126] As for the way in which the foetus is nourished in the womb, Aëtius reports that it fed with its whole body, absorbing nutritious substances from its food, like a sponge, while the physician Rufus of Ephesus (first century AD), asserts that the foetus in the womb fed through its mouth.[127] A majority of scholars accepted Aëtius' version,[128] but a recently published papyrus, which mentions the theories of Alcmaeon and Democritus, lends more weight to Rufus' version.[129] This view is also supported by the fact that the opinion that the foetus fed through its mouth was shared by many in the fifth century, including Hippon,[130] whereas the idea that it fed with its whole body is found nowhere else. Hippon took over some embryological theories of Alcmaeon without changes, while modifying others in the monist spirit which was characteristic of him. Thus he thought that although the woman also possesses semen, it plays no part in the formation of the embryo because it does not reach the uterus (Aët. V,5,3 = A 13). Consequently, the sex of the child depends solely on the quality of the male semen: thick and potent semen gives boys, thin (λεπτός, ῥευστικός) and weak semen – girls (V,7,3; Cens. 6.4 = A 14). It is interesting that in the same chapter (V,7,7 = A 14) Aëtius reports another of Hippon's opinions on the same matter: a male child results when the semen prevails (κρατήσειεν), and a female child when food (τροφή) prevails.

126 Lesky, *Zeugungs- und Vererbungslehren*, 26. On strong and weak semen in the Hippocratic Corpus, see Lonie, *Hippocratic Treatises*, 126 f., 141.

127 Aët. V,16,3 = A 17: Ἀ. δι' ὅλου τοῦ σώματος τρέφεσθαι (τὰ ἔμβρυα)· ἀναλαμβάνειν γὰρ αὐτῷ ὥσπερ σπογγιᾷ τὰ ἀπὸ τῆς τροφῆς θρεπτικά. Rufus *ap.* Oribas. *Coll. med.* 38,9: οὐχ ὥσπερ Ἀ. οἴεται, ὅτι ἐν ταῖς μήτραις ὂν τὸ παιδίον ἤσθιε στόματι.

128 Olivieri, *Civiltà greca*, 136, proposed to read in Rufus σώματι instead of στόματι, which would harmonize both versions. This was accepted by Timpanaro Cardini, i. 164; Longrigg, *Greek Medicine*, 61, among others.

129 D. Manetti, 'Alcmaeon', *Corpus dei Papiri Filosofici Greci e Latini* I, I* (Florence, 1989), 149–51. See also L. Perilli, 'Democritus, Zoology and the Physicians', in A. Brancacci and P.-M. Morel (eds.), *Democritus: Science, the Arts, and the Care of the Soul* (Leiden, 2007), 160, 168. Among those who shared it earlier were C. Cumston, *An Introduction to the History of Medicine* (London, 1926), 84, and Guthrie, ii. 468 n. 2.

130 Hippon (A 17); Diogenes (A 25), Democritus (A 144); [Hipp.] *De carn.* 6,3. See Lonie, *Hippocratic Treatises*, 208. Many modern scientists (Harvey, Boerhaave, Haller) shared this view and the issue itself was debated until the 19th cent.

If we can trust this testimony, Hippon held to a traditional standpoint: the woman's role was reduced to nourishing the foetus. Lesky reconciles two apparently contradictory views in the following way: if the semen is thick and potent, it overcomes the material supplied by the mother, and the child becomes male, while thin and weak semen yields to that material.[131] Finally, Hippon explained the birth of twins by saying that in such cases there was more semen than was needed for a single child (A 18).

10.4 BOTANY

From the botanical works of Theophrastus we learn that at least two Pythagoreans, Menestor and Hippon, wrote about plants. That Alcmaeon also dealt with this subject became known from the Arabic translation of *On Plants* by the Peripatetic Nicolaus of Damascus (first century):

> The nutritive principle of plants comes from the earth and their generative principle from the sun – Anaxagoras, however, maintains that their seeds are carried down from the air – and therefore a man called Alcmaeon says that the earth is the mother of plants and the sun their father (I,2,44).[132]

Nicolaus made use of early Peripatetic material: Theophrastus, and possibly a lost work by Aristotle *On Plants*. In the *Enquiry into Animals*, Aristotle mentions the analogy between people and plants, drawn by Alcmaeon: by the age of 14 a youth achieves sexual maturity and begins to grow body hair, just as plants flower before they produce seeds.[133] It appears that in this case the source of information

[131] Lesky, *Zeugungs- und Vererbungslehren*, 28. The agonistic aspect of embryology may be seen in Parmenides too (Cens. 6.5 = A 53). See also Hippon A 13: the bones of the child are derived from the father, its flesh from the mother.

[132] H. J. Drossaart Lulofs and E. L. J. Poortman (eds.), *Nicolaus Damascenus, De plantis* (Amsterdam, 1989). See G. S. Kirk, 'A Passage in *De plantis*', *CR* 6 (1956) 5–6; A. Lebedev, 'Alcmaeon on Plants', *PdP* 48 (1993), 456–60. This evidence was not included in *DK* because, in the translation of *De plantis* then available, Alcmaeon's name could not be read.

[133] 591a12 = A 15. It seems more convincing to link with Alcmaeon not only the words ἀνθεῖν πρῶτον (*DK* I, 213.3), but the whole analogy (Zeller, i. 489 n. 2; Timpanaro Cardini, i. 144 n.), since it is known that he wrote about maturation.

on Alcmaeon was also Aristotle,[134] who had devoted a special work to him (D.L. V, 25) and often referred to his views in his treatises. Mention of the sun and the earth as father and mother of plants is more likely to have been part of an elaborate analogy between the animal and vegetable kingdoms than part of a special chapter on plants, as Lebedev supposed. Here too no direct connection can be discerned with the theory of opposite 'qualities' (hot, cold, moist, dry), just as it cannot in Alcmaeon's embryology, in particular (A 14). His explanations are varied and specific, and cannot be obtained deductively from a general theory.

Theophrastus refers to Hippon's view in the first book of the *Enquiry into Plants* (I,3,5); besides Hippon, in this book he mentions only Menestor (I,2,3). Discussing the division of plants into cultivated and wild, fructiferous and non-fructiferous, flowering and non-flowering, he notes:

> thus the distinction between wild and cultivated seems to be due simply to cultivation, since, as Hippon remarks, any plant may be either wild or cultivated according as it receives or does not receive attention (A 19; tr. Hort).

Theophrastus' further reasoning does not relate to Hippon, who in III,2,2 again appears in the same context: when he affirms that with nurture we obtain a cultivated plant, and without it a wild plant, Hippon is only partly right, since any plant that is neglected goes wild, but not everything that is nurtured becomes better. Having at first agreed with Hippon, Theophrastus then refines his opinion: plants not suited to domestication remain wild. We may note that, unlike Aristotle's dismissive appraisal of Hippon the philosopher,[135] *Enquiry into Plants* features him as an expert.

According to the evidence of the Platonic scholia (*Schol. Plat. Alc.* I, 121 E), we reach full maturity at the age of 14 (τέλειος λόγος; see Timpanaro Cardini, i. 145 n.), as Aristotle, Zeno, and Alcmaeon the Pythagorean report. The observation that by 14 males show 'signs of the onset of maturity' occurs in Solon (fr. 19 Diehl = fr. 23 G.-P., see below, 397 f.); in Alcmaeon it appears in a natural-philosophical context which is characteristic of him, in which man, animals and plants are seen as homogenous beings; see Senn, *Entwicklung*, 18 ff.

[134] Thus G. Wöhrle, 'Aristoteles als Botaniker', in W. Kullmann and S. Föllinger (eds.), *Aristotelische Biologie* (Stuttgart, 1997), 387–96, at 393; B. Herzhoff, 'Das Erwachen des biologischen Denkens bei den Griechen', in G. Wöhrle (ed.), *Geschichte der Mathematik und der Naturwissenschaften in der Antike: Biologie* (Stuttgart, 1999), 18.

[135] *Met.* 984a3; *De an.* 405b1; cf. below, 376 n. 115.

Menestor, the first known author of a special writing on plants, is mentioned more frequently than most others in the botanical works of Theophrastus. He does not appear in any other sources, including Theophrastus' *Opinions of the Physicists*, except the list of Pythagoreans. This leads one to suppose that Menestor was interested above all in the world of plants, and his book did not contain the sections which were usual in the writings of natural philosophers, and according to which the *Opinions of the Physicists* were later structured. However, in the little surviving evidence Menestor appears not as a learned agriculturist, but as a natural philosopher and naturalist competent in matters of agriculture, whom Theophrastus himself counted among οἱ παλαιοὶ τῶν φυσιολόγων (A 7). Menestor, as V. Capelle observed, enquired about the causes of all the phenomena he knew of in the vegetable kingdom, and tried to explain the visible states and phenomena through invisible processes taking place within the plants.[136] This programme is known to us from the investigations of Alcmaeon, who had much in common with Menestor. While Alcmaeon explained health through a balance of opposing 'qualities', primarily cold and hot, moist and dry, Menestor transferred this principle to plants, giving primacy to a dynamic equilibrium of internal and external properties which determined when they sprouted. He viewed moisture, or sap (ὀπός, A 1), as the bearer of life in plants;[137] by its nature this sap was warm (φύσει γὰρ καὶ ὁ ὀπὸς αὐτοῖς ὢν θερμός), so those plants with most moisture were warm, and those with least – cold.[138] Excessive cold or heat led to diminished moisture, which meant that a plant either froze or died. We may recall that Alcmaeon considered excessive cold or heat one of the main pathogenic factors; Hippon's theory, according to which a change in moisture due to excessive heat or cold was a cause of illness, is even closer to Menestor.[139]

136 Capelle, 'Menestor', 65 f.

137 Cf. ὑγρὸν ἔμφυτον in A 7; Hoppe, *Biologie*, 145 (ἔμφυτον is the conjecture of Heinsius).

138 'The warmest plants are those that live most in water, as rush, reed and galingale (which is why they do not freeze out in winter), the warmest of the rest being those best able to survive in cold localities, as silver fir, pine, prickly cedar, Phoenician cedar and ivy' (A 5, tr. Einarson).

139 See 24 B 4; 38 A 11. A passage of Theophrastus which goes back to Menestor (*CP* II,9,7, cf. I,21,7; Capelle, 'Menestor', 54 f.) speaks of a 'thickening of the sap' (πῆξίς τις γίνεται τοῦ ὀποῦ), under the influence of cold, as a cause for the leaf-fall. Cf. the thickening of moisture in Hippon's theory (A 11) and the thickening of the blood in Philolaus' theory (A 27).

Having divided plants into warm and cold, Menestor proceeded to establish their principal properties on the basis of this division. He claimed, first, that warm plants bore fruit, while cold ones did not. Secondly, warm plants could survive only in cold places, and cold plants in warm places: in matching localities they died of excess heat or cold, while in opposite conditions they survived, thanks to 'a certain moderation of temperature' (εὐκρασία). Thirdly, the warmest plants flowered soonest and bore fruit (a variant: the mulberry was a warm tree, but it blossomed late in a cold climate). Fourthly, evergreen plants retained their leaves because of their warmth, while those with insufficient warmth shed their leaves. Fifthly, the best fire-sticks were from naturally warm plants, such as ivy or mulberry, because they caught fire fastest and gave the strongest flames (A 3, 5). Although Theophrastus was consistent in his criticism of the criteria by which Menestor divided plants into warm and cold (*CP* I,22,1–7), he not only did not reject the division, but also assigned to the warm plants the same plants as Menestor.[140] Interestingly, Theophrastus' arguments in his dispute with Menestor are often even more speculative than those of the first Greek botanist.

The maintenance of equilibrium between internal and external warmth and cold was evidently central to Menestor's theory, but it was not the only point. Location apart, he included the soil in the list of external factors: 'Extremely fat soil is good for no plant, drying up more than is wanted, as Menestor says, fuller's earth, which is whitish in colour, being (he says) of this kind' (tr. Einarson) (*CP* II,4,3 = A 6). A little further on Theophrastus returns to this topic, adducing an extended analogy from Menestor: rich soil is good only for 'spare' plants, such as 'the fruits of Demetra' (cereals and vegetables), since those which were naturally 'sparer' needed rich food, which could also be seen in the nature of humans: thin people like rich food because it lent them colour and strength, while their bodies rejected dry and 'spare' food, which could cause them various illnesses, especially of the digestive tract.[141] This analogy brings with it another pair of opposites utilized by Menestor, rich and spare, and clearly shows

[140] Capelle, 'Zur Geschichte', 281; Steier, 'Menestor', 654; the dispute between Menestor and Theophrastus became the theme of one of Plutarch's learned table conversations: C. Viano, 'Théophraste, Ménestor de Sybaris et la συμμετρία de la chaleur', *REG* 105 (1992), 584–92.

[141] II,4,5–6. See Capelle, 'Menestor', 54 f.; Theophrastus, *De causis plantarum* 1–2. B. Einarson and G. K. K. Link, ed. and tr. (Cambridge, Mass., 1976), 227 n.

his closeness to medical dietetics. It seems that Menestor, like Alcmaeon, did not place any limit on the number of opposing properties by which he explained the phenomena of the vegetable kingdom. At any rate, he wrote of an infinite number of savours (*χυμοί*), found in plants and distributed in pairs: bitter and sweet, tart and rich, and so on; whatever the mixture of internal moisture in a plant, such was its taste.[142] Here too Theophrastus takes issue with Menestor, claiming, like Aristotle, that there are seven 'basic' savours, because the number seven is 'the most appropriate and natural'![143] On this question, paradoxically, Aristotle and Theophrastus occupy the position which Aristotle ascribed to the Pythagoreans and for which he criticized them (below, §11.2), while Menestor – a real, not an imaginary, Pythagorean! – is untouched by the magic of numbers.

Commenting on Menestor's idea that in matching localities plants die from excess heat or cold, while they survive in opposite conditions, Theophrastus adds:

> So Empedocles says of animals that the ones with an excess of fire are brought by their nature to water. Menestor too follows this view not only for animals but for plants as well, saying that the hottest plants are those that live most in water, as rush, reed and galingale (which is why they do not freeze in winter).[144]

Although it does not follow directly from the *συνηκολούθηκε* that Theophrastus considered Menestor to be Empedocles' junior,[145] this passage has usually been interpreted this way.[146] However, even if

[142] *CP* VI,3,5 = A 7; cf. *χυμοί* in Alcmaeon (A 5) and Empedocles (A 70).

[143] *καιριώτατος καὶ φυσικώτατος* (*CP* VI,4,1–2). Cf. Arist. *De sensu* 442a12–28: the number of saps corresponds to the number of flowers.

[144] *ὥσπερ καὶ Ἐμπεδοκλῆς λέγει περὶ τῶν ζῴων· τὰ γὰρ ὑπέρπυρα τὴν φύσιν ἄγειν εἰς τὸ ὑγρόν. συνηκολούθηκε δὲ ταύτῃ τῇ δόξῃ καὶ Μ. οὐ μόνον ἐπὶ τῶν ζῴων, ἀλλὰ καὶ ἐπὶ τῶν φυτῶν. θερμότατα γὰρ εἶναί φησι τὰ μάλιστα ἔνυγρα* . . . (*CP* I,21,5–6 = A 5, tr. Einarson).

[145] *LSJ*, s.v. *συνακολουθέω*, 3; above, 127 n. 97. In a parallel passage of Theophrastus (*DS* 72), where it is stated that Plato followed (*συνηκολουθηκέναι*) the opinion of the other 'physiologists', there are two chronological indications: the opinion itself is called *ἀρχαιοτάτη*, and those who upheld it – *οἱ παλαιοί*. In *CP* I,21,5 Theophrastus begins by setting out Menestor's theory of hot and cold plants, without naming him, then mentions Empedocles as a parallel, and only after that names Menestor (I,21,6). The seniority of Empedocles does not follow from this.

[146] See above, 126 n. 95. Capelle, who thought Menestor older than Empedocles, was influenced by Diels to change his position: Capelle, 'Zur Geschichte', 278; id., 'Menestor', 47 n 2.

Theophrastus really did view Menestor's opinion as dependent on Empedocles, this conclusion seems far from convincing. In Empedocles' treatment of plants (A 70) there are coincidences with the views of Menestor, but they are too general to serve as evidence of dependence. The opposition of cold and heat is well known from Alcmaeon, and acquires a systematic character in Parmenides,[147] so its presence in Empedocles and Menestor is more than natural. Menestor's notion of hot plants living in water follows logically from his own teaching, and does not imitate Empedocles' idea of hot animals. It is revealing that Menestor shows no trace of the theory of four elements, which lay at the basis of Empedocles' views on plants (A 70), and against which, above all, natural philosophy and medicine reacted in the fifth–fourth centuries.[148] Empedocles' animals are hot because of an excess of fire (*ὑπέρπυρα*, A 73), while Menestor, like Alcmaeon, speaks of qualities, whose number seems to be unlimited, not of elements. Empedocles' explanation of the endurance of evergreen trees included the symmetrical arrangement of their 'pores' (B 77). Menestor had no such theory; to Empedocles, the savours (*χυμοί*) depended on the soil (A 73), while to Menestor they depended on the mixture of internal moisture in the plant. Even if we are unable to define Menestor's chronology more closely, in the fragmentary material available to us there are no definite traces of the influence of Empedocles.

[147] 24 A 5, B 4; 28 A 35, 45, 46, 52.

[148] See Wright, *Empedocles*, 14 n. 67; Nutton, *Ancient Medicine*, 81 f.

11

Pythagorean Philosophies

11.1 THEORIES OF THE SOUL

The teachings of Alcmaeon, Menestor, and Hippon reviewed above reveal a common interest in those areas of natural philosophy and natural sciences which made a study of living nature. As a rule, the philosophies of the early Pythagoreans are closely bound up with their attempts to solve various problems in physiology, psychology, embryology, botany, and medicine. There are very few theories which go beyond this 'physiological' direction; they include Alcmaeon's astronomy and his teaching on the soul (A 4, 12, B 2). Alcmaeon's thesis that people can make judgements about things invisible only on a basis of evidence (B 1) was a reflection of his empiricist theory of perception and cognition: thought is based on perception through the senses (above, §10.2). Only two theses are known of the philosophy of Hippasus, who appears not to have left behind the work περὶ φύσεως: the first as set out by Aristotle and Theophrastus – *archē* of the world is fire;[1] the second as set out by Aëtius – the soul is by nature fiery.[2]

[1] Arist. *Met.* 984a7 = A 7. According to Theophrastus, Hippasus and Heraclitus believed that all things arise from fire through being either condensed or rarefied to decompose once again in fire (fr. 225 FHSG = A 7). It is difficult to decide whether this standard Peripatetic interpretation of monistic cosmogony relates to Hippasus. Central fire appears first in Philolaus' cosmogony (B 7, A 16–17); it is possible that this is a connection with Hippasus' fire.

[2] Parmenides, Hippasus, and Heraclitus regarded the soul as fiery (Aët. IV,3,4, *Dox.* 388 not. = 18 A 9). For Heraclitus this is not true (A 15, B 36 = fr. 66 Marcovich; R. Dilcher, *Studies in Heraclitus* (Hildesheim, 1995), 67 ff.; cf. *KRS*, 203 f.), and for Parmenides inaccurate; in the Way of Opinion the soul is presented as a mixture of 'fire' and 'earth' (A 45–6, B 16). All this does not lend reliability to the evidence on Hippasus; moreover there is nothing to compare it with. Hippasus is not named (nor Parmenides either) in Aristotle's *On the Soul,* although he mentions those who

The context of these theses is unknown. The sole fragment of Hippon (B 1), preserved by chance, says that fresh water is derived from the sea, the deepest of all waters. This may relate to cosmology, but there is no other trace of interest in this in Hippon.[3]

Given the affinity of interests of the early Pythagorean philosophers and the closeness of their views on many questions, general and particular, the individual differences of their philosophies, which cast doubt on the presence of any generally accepted doctrines in the school, stand out clearly.[4] Let us take, for example, the theories of the soul. The Presocratics usually understood ψυχή as the source of life and movement and/or the centre of sensation and feelings. Pythagoras, it would appear, had no philosophical teaching on the soul. Metempsychosis, which he borrowed from Orphism and transformed (above, §6.2), was a purely religious doctrine which had no tangible influence on the Pythagoreans' construction of philosophical notions of the soul, apart perhaps from Alcmaeon. However, in Alcmaeon, the sole Pythagorean philosopher to teach the immortality of the soul, there is no trace of a doctrine of its transmigration, either. In Orphism, ψυχή is the centre of personality and is preserved in the process of transmigration. Evidently Pythagoras also held this view, recalling his previous incarnations.[5] Alcmaeon was the first to connect the personality of a person with the brain, the centre of cognition and thought (above, §10.2). He understood ψυχή as the principle of life and movement; we have no information as to where he placed it. The immortality of the soul is shown by the fact that, like all divine heavenly bodies, it is in constant circular motion:[6] an argument

regarded the soul as fire, since in the first place it moves and imparts movement to everything else (405a4 f.), and in the second place it is the cause of nourishment and growth (416a9 ff.). It is unclear which of these causes was postulated by Hippasus.

[3] In Cratinus' comedy Hippon asserted that the sun is a brazier and people are coals (A 2). It is unknown whether this is a reflection of Hippon's teaching. In Aristophanes this idea is ascribed to Socrates.

[4] See above, 22, 109 f.

[5] The soul in Orphic tablets: Bernabé and Jiménez San Cristóbal, *Instructions*, 169 ff. In Xenophanes Pythagoras recognizes in the squeal of a puppy his friend's ψυχή (B 7). It is possible that Empedocles connected the intellectual capabilities of Pythagoras with his recollection of previous incarnations (B 129). Euphorbus as the first incarnation of Pythagoras: Her. Pont. fr. 89; Dic. fr. 36.

[6] Arist. *De an.* 405a29 = A 12: φησὶ γὰρ αὐτὴν ἀθάνατον εἶναι διὰ τὸ ἐοικέναι τοῖς ἀθανάτοις. On circular motion see above, 332.

subsequently developed by Plato.[7] We do not know the extent of Alcmaeon's analogy between the circular motion of the soul and that of the heavenly bodies, and what happened to the soul after death. Nor is his explanation of death capable of a definite interpretation: 'People die because they cannot join the beginning with the end.'[8] Some took this to be that life, as distinct from the soul, moves in a straight line; others that the 'line of life' is an arc of a circle. The latter seems more convincing.[9]

If Hippasus identified the nature of the soul with his cosmic principle, fire, then he followed the path of Anaximenes.[10] It is unknown whether Menestor wrote anything about the soul; the object of his interests, the plant world, did not suggest it. In Hippon, as in Hippasus, ψυχή is akin to his basic principle, ὑγρότης; it derives from moist semen, the source of which is the brain (A 3; above, §10.3). The soul as moisture is the principle of life and the senses and to all appearances is located in the head.[11] The soul is mortal, since, according to Hippon, it was the drying-up of moisture which was the cause of death (A 11). Philolaus' theory comprised practically the same elements as the teachings of Alcmaeon and Hippon, but set out

[7] 'That which is a conclusion from analogy in Alcmaeon becomes in Plato, through the idea of self-movement, a dialectical proof (*Phdr.* 245c)', Burkert, 296 n. 97; similarly Guthrie, i. 351. Aëtius' formulation, Ἀ. φύσιν αὐτοκίνητον κατ' ἀΐδιον κίνησιν καὶ διὰ τοῦτο ἀθάνατον αὐτὴν ὑπολαμβάνει (4,2,2 = A 12), includes Plato's idea of a self-moving soul and hence is unreliable. Skemp, *Theory of Motion*, 36 ff., brought Alcmaeon's and Plato's ideas too close together, Festugière, 'Mémoires', 429 ff., on the contrary, placed them too far apart.

[8] B 2. Review of interpretations see: Zeller-Mondolfo, i. 617 n. 4; Graeser, *Probleme*, 47.

[9] Cf. parallels in the Hippocratic Corpus: Μοὶ δοκέει ἀρχὴ μὲν οὖν οὐδεμία εἶναι τοῦ σώματος, ἀλλὰ πάντα ὁμοίως ἀρχὴ καὶ πάντα τελευτή· κύκλου γὰρ γραφέντος ἀρχὴ οὐχ εὑρέθη (*De locis in hom.* 1). Πλοκέες ἄγοντες κύκλῳ πλέκουσιν, ἀπὸ τῆς ἀρχῆς ἐς τὴν ἀρχὴν τελευτῶσι· τοῦτο περίοδος ἐν τῷ σώματι, ὁκόθεν ἄρχεται, ἐπὶ τοῦτο τελευτᾷ (*De victu*, I, 19). Cf. Hdt. I, 207; Arist. *Phys.* 223b24 f. In physiological terms Alcmaeon treated death as the total outflow of blood into the veins (above, 373). Whether these two explanations are compatible is unclear.

[10] A 9 (cf. above, 387 n. 2), Anaximenes: the soul is air (B 2, A 22–3, Aët. IV,3,2). So also Diogenes (A 20, B 4).

[11] ἐν ἡμῖν οἰκείαν εἶναι ὑγρότητα, καθ' ἣν καὶ αἰσθανόμεθα καὶ ᾗ ζῶμεν (A 11); τὴν δὲ ψυχὴν ποτὲ μὲν ἐγκέφαλον λέγει, ποτὲ δὲ ὕδωρ (A 3, 4. above, 376 n. 115). See also A 15. According to Aristotle (*De an.* 405b24 = A 10), those who believe that the soul is τὸ ψυχρόν derive ψυχή from breathing and cooling (κατάψυξις). Commenting on this passage, Philoponus asserted that its subject was Hippon (A 10), but this is just his conjecture. Hippon was mentioned by Aristotle above (405b1), but his moisture is not in itself cold (A 11) and bears no relation to breathing.

in a different order. Believing, following Alcmaeon (B 1a), that animals feel, but do not think, Philolaus placed reason in the brain, and the soul and senses (*ψυχὴ καὶ αἴσθησις*) in the heart. Hence the brain contains the principle of man, the heart that of an animal, the navel that of a plant, and the sex organ that of semen, from which everything grows.[12] This leads to the conclusion that *ψυχή*, which unites man and animals, but does not include reason and the senses, is the principle of life and movement, just like Alcmaeon's *ψυχή*.[13] There is nothing to indicate that Philolaus regarded the soul as immortal; when the heart stops, the living being dies and with it its soul.

The Pythagorean teaching that the soul is *ἁρμονία*, i.e. harmony, musical tune, or the attunement of the elements of the body, is indirectly connected with Philolaus. It was first attributed to him by Macrobius (fourth–fifth century AD). This is not particularly convincing,[14] but in Plato's *Phaedo* this point of view is expressed by Philolaus' pupils Simmias of Thebes and Echecrates of Phlius.[15] Contesting Socrates' arguments in favour of the immortality of the soul, Simmias says: our body is held together and tensioned by warmth, cold, dryness, and moisture, and other similar things, and the soul is their 'blending and harmony' (*κρᾶσιν καὶ ἁρμονίαν*). Once

[12] *καὶ τέσσαρες ἀρχαὶ τοῦ ζώου τοῦ λογικοῦ, ὥσπερ καὶ Φ. ἐν τῷ Περὶ φύσεως λέγει, ἐγκέφαλος, καρδία, ὀμφαλός, αἰδοῖον· 'κεφαλὰ μὲν νόου, καρδία δὲ ψυχᾶς καὶ αἰσθήσιος, ὀμφαλὸς δὲ ῥιζώσιος καὶ ἀναφύσιος τοῦ πρώτου, αἰδοῖον δὲ σπέρματος [καὶ] καταβολᾶς τε καὶ γεννήσιος. ἐγκέφαλος δὲ τὰν ἀνθρώπω ἀρχάν, καρδία δὲ τὰν ζώου, ὀμφαλὸς δὲ τὰν φυτοῦ, αἰδοῖον δὲ τὰν ξυναπάντων· πάντα γὰρ ἀπὸ σπέρματος καὶ θάλλοντι καὶ βλαστάνοντι'* (B 13).

[13] In the wider sense plants also live, but they possess neither movement, nor a heart, nor, in consequence, a soul. Aristotle included in the functions of the soul nutrition and reproduction (*De an.* II, 3–4), which Philolaus connected with the navel and the sexual organ.

[14] Macr. *Somn. Sc.* I,14,19 = A 23: Pythagoras and Philolaus regarded the soul as harmony. It has more than once been observed that this report could be based solely on an interpretation of the *Phaedo* (see n. 15, below).

[15] At *Phaed.* 61d–e Simmias and Cebes of Thebes are named as hearers of Philolaus. Unlike Echecrates (Aristox. fr. 18–19) there is no other information on this. Hence Ebert rejects their Pythagoreanism (*Platon*, 115 f.; on Echecrates, the Pythagoreans of Phlius, and their role in the *Phaedo*, ibid. 97 ff.). However, the absence of both the Thebans from Aristoxenus' catalogue may be connected with the absence from it of Thebes (above, 113). It seems strange that we know of none of the Theban pupils of Philolaus. Epaminondas was a pupil of Lysis (Aristox. fr. 18).

the body is mortal, then the soul, as a combination of bodily properties, is also mortal.[16] Aristotle criticized the theory of the soul as harmony without attributing it specifically to anyone; it was shared by Aristoxenus, who in his youth had heard Echecrates, and his colleague Dicaearchus.[17] This theory is frequently connected with one of the metaphysical principles of Philolaus, *ἁρμονία*, which unites *τὰ ἄπειρα* and *τὰ περαίνοντα* (B 6–7),[18] though this leaves out of consideration that the cosmic harmony, unlike the mortal soul as harmony, is eternal. That the theory of the soul as a harmony of bodily functions could derive from medicine seems more convincing. In particular this is indicated by its similarity with Alcmaeon's teaching of health as a balance of moisture, dryness, cold, heat, and other qualities, and of illness as a disruption of this balance.[19] Simmias asserted that illness immediately destroys the soul as harmony (*Phaed.* 86c), while Aristotle, criticizing this theory, insisted that it was not the soul which was harmony, but rather that harmony was health.[20] If my understanding of the Philolaus' *ψυχή* as the principle of movement is correct, then it is highly problematic to combine it with the idea of the soul as harmony; as was noted by Aristotle, 'to be the cause of movement is not characteristic of the harmony' (*De an.* 407b34). A lack of evidence makes it impossible to say with certainty whether Philolaus shared the theory of the soul as harmony; his pupils may have had their own notions about the soul.

The last Pythagorean from whom a teaching on the soul has come down to us, Ecphantus of Syracuse, was an eclectic who combined the

[16] 86b–d. Simmias says: *we* regard the soul as harmony (86b6–7), which could apply to Philolaus' entire circle. Echecrates confirms: I have long been of that opinion (88d3–4). The thesis that this theory was invented, not by the Pythagoreans, but by Plato himself (H. B. Gottschalk, 'Soul as Harmonia', *Phronesis* 16 (1971), 179–98) has found no support: Ebert, *Platon*, 288 f.; V. Gaston, 'Dicaearchus' Philosophy of Mind', Fortenbaugh and Schütrumpf (eds.), *Dicaearchus*, 175–93.

[17] See Aristotle's dialogue *Eudemus* (fr. 45 = 7 Ross); *De an.* 407b27–408a30; *Pol.* 1340b18 f. Aristox. fr. 118–21; Dic. fr. 5–12; L. Zhmud, 'Dikaiarchos aus Messana', in Flashar (ed.), *Philosophie der Antike* 3, 569 f.

[18] Huffman, *Philolaus*, 328 ff.; Sedley, 'Dramatis Personae', 22 ff.

[19] Burnet, 295 f.; Zeller-Mondolfo, i. 370; Wehrli, *Dikaiarch*, 45 f.; Guthrie, i. 313; Burkert, 272; Ebert, *Platon*, 284.

[20] *ἡ ἁρμονία ἄρα ὑγίεια καὶ ἰσχὺς καὶ κάλλος· ψυχὴ δὲ οὐδέν ἐστι τούτων* (Philop. *In De an.*, 145.4 f. = fr. 45); *ἁρμόζει δὲ μᾶλλον καθ' ὑγιείας λέγειν ἁρμονίαν, καὶ ὅλως τῶν σωματικῶν ἀρετῶν, ἢ κατὰ ψυχῆς* (*De an.* 408a1).

traditions of various schools.[21] Following the atomists, he taught that the world consists of indivisible bodies and the void (A 1–2), but these bodies are moved 'not by weight nor impact but by a divine power which he calls mind and soul' (A 1).[22] The latter idea recalls the theory of Anaxagoras, with, however, the difference that his *νοῦς* provided only the primal impulse to the cosmos, while *ψυχή* had the meaning simply of 'life' and played no independent role (B 12, A 99–100). Combining the mind and the soul, Ecphantus, like Democritus,[23] makes them the force which constantly moves both the atoms and the whole cosmos. There is another opinion of the soul as the source of constant movement, possibly connected with Ecphantus, which Aristotle ascribes to anonymous Pythagoreans. The doxographical overview in *On the Soul* (I, 2) begins with those who believed that the soul is first and foremost something which moves and is moved, i.e. with the atomists, the Pythagoreans, and Anaxagoras, who are followed by Plato and the Platonists. Democritus and Leucippus believed that the soul consists of particularly mobile spherical atoms, which a living being breathes in from outside. They resemble the specks of dusts in the air (*ἐν τῷ ἀέρι τὰ καλούμενα ξύσματα*) which are visible in the sun's rays (403b31 f.). The Pythagoreans evidently had similar notions: some of them regarded the soul as specks of dust (*ξύσματα*) floating in the air, others as that which set them in motion – even when there is no wind at all they are in constant motion (404a17–20).[24] Of the Pythagoreans known to us, Ecphantus was closest to the views of the atomists. That in later doxography he always follows them must be a reflection of his position in Theophrastus' list of 'physicists' and thus of his views.[25]

[21] Zeller, i. 604; Guthrie, i. 323 ff.; Mansfeld, *Heresiography*, 37. There is no reason to believe that the material about Ecphantus in Hippolytus does not go back to Theophrastus.

[22] *κινεῖσθαι δὲ τὰ σώματα μήτε ὑπὸ βάρους μήτε πληγῆς, ἀλλ' ὑπὸ θείας δυνάμεως, ἣν νοῦν καὶ ψυχὴν προσαγορεύει* (Hippol. *Ref.* I, 15 = A 1). The expression *θεία δύναμις* does not of course belong to Ecphantus, nor does the Stoic *πρόνοια* in A 4.

[23] According to Aristotle, Democritus made no distinction between *νοῦς* and *ψυχή* (*De an.* 404a27 = A 101, *De resp.* 471b30 f. = A 106).

[24] See R. Polansky, *Aristotle's 'De anima': A Critical Commentary* (Cambridge, 2007), 67 f. Specks of dust dancing in the air have more than once been used to explain physical phenomena, see Anaxagoras A 74; [Arist.] *Probl.* 903a7 f.

[25] See Aët. I,3,19 (after Leucippus, Democritus, Metrodorus of Chios, and Epicurus); II,3,3 (after Leucippus, Democritus, and Epicurus); Hippol. I, 15 = *Dox.* 566 (after Leucippus, Democritus, Xenophanes, and Metrodorus); Theodoret. IV, 11 = *Dox.* 286 not. (after Democritus, Metrodorus, and Epicurus). See Mansfeld,

In *On the Soul*, but outside the doxographical review, Aristotle makes a passing mention of another Pythagorean opinion of the soul, clearly regarding it as unworthy of philosophical analysis. One should not join the soul to a body, he says, without giving any explanation to that body, as if any soul could be clothed in any body, as in the Pythagorean myths.[26] It is clear that Aristotle was not inclined to ascribe metempsychosis to any of the philosophers named above only because they were Pythagoreans; the question whether any one of them believed in the Pythagorean myths remains open. But we are interested rather in what the Pythagoreans taught than in what they believed. It is known that Empedocles had two different teachings on the soul, one belonging to natural philosophy and one to religion. The Pythagorean philosophers could in principle have had something similar. Judging by the fact that none of them became the author of a religious poem, as did Empedocles,[27] nor are in any way associated in our sources with metempsychosis, this possibility remained unrealized.

Hence practically all the Pythagorean theories of the soul known to us, from Alcmaeon to Ecphantus, are different. Only Simmias and Echecrates, the pupils of Philolaus, held identical views. The similarity among some of these theories can sometimes be explained by direct influence (Alcmaeon and Hippon, Alcmaeon and Philolaus), but most often by the fact that many Pythagoreans shared the interpretation of the soul as the source of motion, which was the most widespread view amongst the Presocratics. Hippasus, Hippon, Simmias, and Echecrates held other views; no evidence has survived of the teachings on the soul of Menestor, Archytas, or Hicetas. Only one Pythagorean, Alcmaeon, taught of the immortality of the soul; his

Heresiography, 37. It is interesting that Theodoretus, relying on Aëtius, defined atoms as tiny particles jumping in the sun's rays (IV, 10), adding: *τούτοις* [i.e. Democritus and others] *Ἔκφαντος ὁ Συρακούσιος ὁ Πυθαγόρειος ἠκολούθησε*. Unlike Diels (*Dox.*, 45 n. 2), Luria was inclined to associate this definition with Aëtius (Dem. fr. 200–1 Luria with comm.). If this is so, then it is highly probable that Ecphantus also referred to specks of dust.

[26] *ὥσπερ ἐνδεχόμενον κατὰ τοὺς Πυθαγορικοὺς μύθους τὴν τυχοῦσαν ψυχὴν εἰς τὸ τυχὸν ἐνδύεσθαι σῶμα* (407b22 f.). As Philoponus notes, Aristotle expresses himself quite sharply, *μυθώδη φησὶ καὶ οὐκ ἄξια λόγου τὰ ὑπ' αὐτῶν λεγόμενα* (*In De An.*, 140.5). The adjective *Πυθαγορικός* is not found again in Aristotle's corpus. It is likely that he intentionally used it here instead of his usual *Πυθαγόρειος*.

[27] On Cercops and Brontinus see above 116, 120.

theory, however, has no direct connection with Pythagoras' doctrine of the transmigration of souls.

11.2 ALL IS NUMBER?

The nature of the soul is one of the very few philosophical problems on which we have at our disposal a representative sample of the opinions of the ancient Pythagoreans. The variety of these opinions could be connected with the absence of a philosophical theory of the soul in Pythagoras himself, if we did not observe the same picture in his teaching on principles. In this area we have grounds, far from incontestable though they are, to take back to Pythagoras the doctrine that the cosmos inhales air, identified with the infinite void which surrounds it. This air-void demarcates the space between individual things, thus giving them beginning of existence.[28] In the generation of those who could have listened to Pythagoras himself, the range of different voices is particularly revealing. There is no evidence at all of the doctrine of principles in Alcmaeon, whereas Hippasus' *archē*, fire, shows him as a monist, in contrast to the dualism of most Italian philosophers after Pythagoras (above, §10.2). The philosophy of the actual Pythagoreans once more is found to be far from the unanimity projected onto it, the emblem of which, the expression αὐτὸς ἔφα, first appeared in the neo-Pythagorean milieu (above, §4.3e).

In the light of these facts, the very existence in ancient Pythagoreanism of a common philosophical doctrine seems implausible, even if it were to have solid empirical foundations. In a strange way the history of philosophy, following Aristotle, cast in this role a thesis which is more than distant from the data of experience: the world arose from and consists of numbers, or corporeal units. This situation becomes particularly paradoxical, since it is this thesis which gives rise to a consensus very rare amongst the students of Pythagoreanism. Both those who believe that, before Philolaus, the Pythagoreans did not go beyond quasi-philosophical arithmological speculations, and those who take Pythagorean number metaphysics seriously, consider that the maxim 'all is number' correctly conveys the

[28] See above, 31 n. 17.

fundamental philosophical doctrine of early Pythagoreanism, which in one way or another derives from Pythagoras. 'What Anaximander called the "unlimited" (materially conceived), Anaximenes "air", Xenophanes "water and earth", and Heraclitus "fire" is for the Pythagoreans – and with them presumably also for Pythagoras himself – number: the original material out of which everything was created and of which it still consists.'[29] The interpretation of Pythagorean number doctrine[30] encounters great difficulties; for one thing, it is doubly a reconstruction. The history of philosophy reconstructs it on the basis of Aristotle's often contradictory assertions (frequently adding to them later sources known to be unreliable). Aristotle in turn reconstructed it on the basis of written and oral accounts relating to different times, authors, and contexts, in each of which he perceived an expression of a teaching common to the Pythagoreans. Does, however, the likening of justice to reciprocity and thus to the number four indeed reflect a theory that things originated from and consist of numbers? And why did Aristotle not once produce an example of such a thing? If, for the sake of argument, one were to accept number doctrine as a given, the consequence is that the question of its origin then arises. Who was its author? Who actually shared it? Are there sources on it which are independent of Aristotle?

The theory dominant among the Pythagoreans, if one existed, had to derive from Pythagoras; nevertheless in the early tradition there is not so much as a hint of a teaching on numbers. Nor is Pythagoras in Aristotle associated with speculations on numbers, apart from a passage from *Magna Moralia*, the authorship of which, as before, is highly debatable.[31] Here lies the principal distinction between Aristotle's and the contemporary view. The numbers discussed in Aristotle's and Xenocrates' fragments on Pythagoras relate to *mathēmata*, not to philosophy or arithmology; to be sure, Aristoxenus, speaking of Pythagoras' study of arithmetic, adds that he likened

[29] Riedweg, *Pythagoras*, 80.

[30] A reminder that I use the term 'number doctrine' for a theory in which number is an ontological principle (above, 13 n. 30), distinguishing it both from other directions of the philosophy of number and from number symbolism and arithmology.

[31] Pythagoras referred virtues to numbers, saying that justice is a square number (*MM* 1182a12 f.; see above, 58 ; H. Flashar, 'Aristoteles', in id. (ed.), *Philosophie der Antike*, iii. 227 f.). In all other cases Aristotle associated such likenings with the Pythagoreans, not with Pythagoras (see above, 58 nn. 117, 199 n. 116), erroneously considering them to be philosophical definitions (see below, 407 n. 75, 437 n. 96).

πάντα τὰ πράγματα to numbers.[32] Heraclides put into his mouth the idea that 'knowledge of the perfection of numbers is happiness of the soul';[33] however, this is not at all what we are seeking. The authorship of the theory that numbers are the principle of things was attributed to Pythagoras only in the Hellenistic age, when everything which Aristotle and his colleagues in the Academy and the Lyceum ascribed to the Pythagoreans, and even more, came to be attributed to him.[34] Such an evolution is fully understandable, the more so since Aristotle nowhere disclosed the names of those Pythagoreans who asserted that things are made of numbers. Who were these anonymous bearers of the number doctrine, and can they be identified with any one Pythagorean known to us?

According to Aristotle, *Πυθαγόρειοι* lived at the same time as Leucippus and Democritus and before them (*Met.* 985b24 f., 1078b21 f.). Their acme was then in the middle and the second half of the fifth century. Several times Aristotle makes it clear that in *Πυθαγόρειοι* he envisaged the later philosophical school which immediately preceded Plato.[35] Chronologically the best candidates are Philolaus and his pupil Eurytus, but, if we identify Aristotle's *Πυθαγόρειοι* with them, we immediately encounter new difficulties. It seems strange that the author of the theory commonly accepted among the Pythagoreans was Philolaus. But if he modified an already existing doctrine of the number as the first principle, why was this not reflected in the views of the early Pythagoreans known to us? After all, Alcmaeon, Hippasus, Menestor, Theodorus, and Hippon either say nothing about numbers or say something quite different from what we expect. Their *archai* are typical for Presocratics: fire in Hippasus, moisture in Hippon. *Archai* are not found in Alcmaeon and Menestor: only 'qualities' and 'juices' (above, §§10.1 and 4), which cannot be considered the material substratum of the world. Hippasus and Theodorus dealt with numbers in mathematics. The philosophy of Theodorus, if it existed, has not come down to us. Numbers as an

[32] Arist. fr. 191 (above, 260 n. 72); Xenocr. fr. 87 (above, 258 n. 65); Aristox. fr. 23 (above, 261 n. 77); Eud. fr. 133 (above, 263 ff).

[33] Her. Pont. fr. 44; below, 430 f.

[34] See e.g. Aët. I,3,8 and below, 423 n. 34.

[35] See *Met.* 987a4, a10: πρῶτοι and οἱ Ἰταλικοί; 987a28: οἱ πρότεροι and οἱ ἄλλοι; 1002a8, a11: οἱ πρότερον and οἱ ὕστεροι (the Pythagoreans and the Platonists are seen in the latter group: Ross, i. 248; Burkert, 46 n. 100). On the Pythagoreans whose principles were ten opposites (*Met.* 986b22 f.), see above, 123.

ontological principle are absent from the teachings of the early Pythagoreans, as indeed is any philosophy of numbers.

Certainly, in a number of cases, we find in their texts significant numbers, for example the seven. The particular significance of the seven in Greek culture was evident already in the myths, the cult of Apollo, and Homer's epic. In the early sixth century it was reflected in Solon's elegy on the ten seven-year periods into which a man's life is divided.[36] One of the early responses to this subsequently canonical text has come down from Alcmaeon, who, agreeing with Solon, stated that young men achieve sexual maturity at the age of twice seven.[37] To this division of life into periods of seven years, the medicine of the fifth century added analogous notions regarding the development of the foetus. We encounter them for the first time in Empedocles; the formation of the organs of the foetus began from the thirty-sixth day (after the fifth week) and was completed from the forty-nineth day (at the end of the seventh week). A woman can give birth to a viable child from the seventh to the tenth month.[38] Such embryological calendars are found in Hippon, in treatises of the Hippocratic Corpus, in the renowned fourth-century doctor Diocles of Carystus, and in Aristotle.[39] Hippon, like certain Hippocratics (*De carn.*, *Oct.*), combines the embryological calendar with the division of life into periods of seven. In an attempt to take into consideration data derived from experience, in his calculations, apart from the seven, he makes use of the still more significant number three:

[36] Fr. 19 Diehl = fr. 23 G.-P. Sevens in myth and cult: W. Roscher, 'Die Hebdomadenlehre der griechischen Philosophen und Ärzte', *AKSGW* 24/6 (1906), 7 ff. (the treatment of the Pythagoreans is flawed).

[37] This view was shared also by Aristotle, who cited it (*HA* 581a12 = A 15). Solon's elegy in ancient number symbolism: J. Mansfeld, *The Pseudo-Hippocratic Tract ΠΕΡΙ ʽΕΒΔΟΜΑΔΩΝ Ch. 1–11 and Greek Philosophy* (Assen, 1971), 161 ff. Aristotle cited Solon approvingly (*Pol.* 1335b31 ff.) and included some of his ideas (1335a-b) in his own system (Mansfeld, *Pseudo-Hippocratic Tract*, 174 n. 103). The number seven in Aristotle: Roscher, 'Hebdomadenlehre', 90 ff. (greatly exaggerated); cf. Mansfeld, *Pseudo-Hippocratic Tract*, 176 f.

[38] A 75, 83, B 153a; H. N. Parker, 'Greek Embryological Calendars', 522 f. Euryphon of Cnidus, who wrote on gynaecology, rejected the viability of 7-month-old infants (Cens. 7,5 = test. 34 Grensemann).

[39] See [Hipp.] *De carn.* 12, 13.4, 19; *Oct.* 1; *Epid.* II 3,17; *De victu*, I, 26; Diocles fr. 45–6 (= Strato of Lampsacus, fr. 97–8), 48d (= Cens. 7,2–6); Arist. *HA* VII. See K. Deichgräber, *Hippokrates über Entstehung und Aufbau des menschlichen Körpers (Peri sarkōn)* (Leipzig, 1935) 43 f.; H. Grensemann, *Hippokrates über Achtmonatskinder* (Berlin, 1968), 104 ff.; Mansfeld, *Pseudo-Hippocratic Tract*, 174 ff.; H. N. Parker, 'Greek Embryological Calendars', 524 ff.

> Hippon of Metapontum estimated that babies could be born any time from the seventh to the tenth month. The foetus, he said, was already mature in the seventh month, since the nnmber seven has the greatest power over everything. For we are formed in seven months, after another seven months, we begin to stand upright; After the seventh month, our teeth begin to emerge and then they fall out in the seventh year; And we usually begin adolescence in the fourteenth year. But this maturity which begins in the seventh month is prolonged to the tenth, because the same natural law applies to everything, so that three months or years are added to the original seven months or years to bring things to completion. So the child's teeth are formed in the seventh month but not completed until the tenth; the first teeth fall out in the seventh year, the last in the tenth; most have reached puberty after fourteen years, but everyone has by seventeen.[40]

This embryological calendar, like the calendar of Empedocles, relies on medical tradition;[41] otherwise Hippon makes use of Solon's periodization. His calculations do not presuppose a special Pythagorean philosophy of numbers or number symbolism. The number three acquired its special significance before and apart from any philosophy.[42] Individual Pythagoreans could have a preference for the seven or the three, but such preferences are not in themselves Pythagorean: Aristotle, for example, had a predilection for both these numbers.[43] In turn the predilection of one or another philosopher for significant numbers is not evidence of Pythagorean influence. If, in the case of Ion of Chios, it is at least chronologically possible, the theories of Anaximander and Pherecydes exclude it.[44]

Hence, in the hundred years separating Pythagoras from Philolaus, we do not find in the Pythagorean tradition so much as a trace of the doctrine that the world arose from and consists of numbers, nor

[40] Cens. 7.2 = A 16, tr. H. N. Parker.

[41] Mansfeld, *Pseudo-Hippocratic Tract*, 175. See esp. *De carn.* 19.

[42] See detailed overview: R. Mehrlein, 'Drei', *RAC* 4 (1959) 269–310.

[43] See above, 384 n. 143, 397 n. 37, and below, 403.

[44] Ion: *πάντα τρία καὶ οὐδὲν πλέον ἢ ἔλασσον τούτων τῶν τριῶν* (B 1, cf. A 6). In Anaximander the diameter and height of the earth were in the ratio 3:1, and the distance from the earth to the stars, the moon, and the sun a multiple of 3 and 9 (A 10–11, 21–2); cf. Hes. *Th.* 720 f. The three principles of the theo-cosmogony of Pherecydes: Zeus, Chronos, and Chthonia (B 1, A 8 = Eud. fr. 150). Ion on Pherecydes: above, 38 f. Three plays an important role in Hippodamus of Miletus (*DK* 39), who should not be accounted a Pythagorean (see above, 118 n. 56).

indeed of number philosophy as such. It is possible that, alongside the early Pythagoreans known to us, there were also some unknown to us who, in anonymous and entirely vanished writings, developed the number philosophy set out in Aristotle. It is possible that we should presume the existence of an oral doctrine, carefully preserved, which oddly became available to Aristotle and to no one but him. However, if we do not have recourse to such extravagant hypotheses, our most natural conclusion is that in early Pythagoreanism there was no number doctrine. Hence Pythagoras had none either; the doctrine is in fact attributed to him in the first place because it is considered to be the foundation of the philosophy of the Pythagoreans, not because it is shown by reliable sources. As Gigon observed half a century ago, 'the system of number philosophy does not in fact belong to ancient Pythagoreanism. Before the second half of the fifth century we have not a single reliable testimony on it'.[45] Do they appear after the mid-fifth century and is it possible to perceive in them, not simply numbers which figure in the most varied context, but a philosophical system?

Let us turn once again to Philolaus. On the sole occasion when Aristotle names him, he cites his saying 'there are thoughts which are stronger than us' (*EE* 1225a30). This was one of the main arguments for Philolaus' book being unknown to Aristotle and hence a later fabrication. Nevertheless Philolaus the philosopher was known to Plato (*Phaed.* 61d–e), Theophrastus (A 9, 16–21), and Menon (A 27–8). Whatever might have been the motives leading Aristotle to deny Philolaus authorship and attribute his teaching to anonymous *Πυθαγόρειοι*, he certainly knew his book.[46] In particular, Philolaus' astronomical system with Hestia and counter-earth, described briefly in *De caelo* 293a–b, occurs regularly in Aristotle's polemic with number doctrine in the *Metaphysics* and in the monograph *Against the Pythagoreans*. With this system Aristotle links simultaneously several significant numbers: first, ten as a 'perfect' number, for the sake of which Philolaus introduced counter-earth; second, seven as the sun's number (it was in seventh place, counting from the periphery);[47] third, one as the number of the centre (Hestia);

[45] Gigon, *Ursprung*, 142.

[46] For instances of correspondence between Philolaus' and Aristotle's material see Burkert, 234 n. 83.

[47] *Met.* 986a10 f.; Alex. *In Met.*, 38.20 f., 40.27 f. = fr. 13 Ross. See below, 405 and n. 68.

fourth, two, placed following it. For the Pythagoreans declared, says Aristotle, that a particular number is proper to each location in the cosmos: thus to the centre one is proper (for it is the first here); after the centre comes two etc.; the number rises as distance from the centre increases.[48] The fragment of Philolaus' cosmogony, τὸ πρᾶτον ἁρμοσθέν, τὸ ἕν, ἐν τῷ μέσῳ τᾶς σφαίρας ἑστία καλεῖται (B 7), was evidently the text which led Aristotle to treat Hestia as the numerical unit, insisting that the Pythagoreans' units are corporeal and extensive, that they generate numbers, and that the entire universe is composed of corporeal numbers.[49] Aristotle, however, 'confuses the cosmogony with the number theory', since Hestia of Philolaus is not a unit with a spatial magnitude, but the One (τὸ ἕν), which is the first thing 'fitted together' from the opposites, and is located in the centre of the world (cf. A 16).[50] It is ἄπειρα and περαίνοντα, combined by ἁρμονία (B 1–2), from which Philolaus' cosmos arose and of which it consists; these things he takes to be ἐστώ and φύσις of the world and of all it contains (B 1–2, 6). He has no other principles. As Huffman demonstrated, the genuine fragments and evidence of Philolaus do not signify that things are made up of numbers and they in turn of corporeal units. This notion is the fruit of Aristotle's tendentious interpretation.[51] Philolaus' material, preserved in the doxography

[48] τῆς δὲ τούτων κατὰ τὴν τάξιν τὴν τοιαύτην συστάσεως ἀπόδειξιν ἔφερον ὅτι τούτων μὲν ἕκαστον τοῦ ἀριθμοῦ ἐστιν, ἑκάστῳ δὲ τόπῳ ἐν τῷ κόσμῳ οἰκεῖός τίς ἐστιν ἀριθμός. τῷ μὲν γὰρ μέσῳ τὸ ἕν (πρῶτον γάρ ἐστιν ἐνταῦθα), μετὰ δὲ τὸ μέσον τὰ δύο, ἃ δόξαν τε ἔλεγον καὶ τόλμαν· καὶ οὕτως ἀεὶ ἀφισταμένων ἀπὸ τοῦ μέσου πλείονα τὸν ἀριθμὸν γίγνεσθαι τῶν συνισταμένων (Alex. *In Met.*, 74.9 ff. = fr. 163 Gigon). See below, 405 and n. 68.

[49] Number is the principle of everything; the elements of number are the even and the odd; the One (τὸ ἕν) proceeds from both of these (for it is both even and odd), and number from the One (*Met.* 986a15–21). The Pythagoreans recognize one kind of number, mathematical, but construct the whole universe out of monads with spatial magnitude. However they seem unable to explain how the first one having magnitude was constructed (1080b16–21). The One is the element and principle of things; numbers have magnitude (1080b30–3). 'Whether the Pythagoreans attribute generation to eternal things (i.e. numbers – *L. Zh.*) or not cannot be in any doubt, for they clearly say that once the One (τὸ ἕν) had been constructed..., immediately the nearest part of the unlimited began to be drawn in and limited by the limit' (1091a12–18). Hence and hereinafter it follows that the question is one of cosmogony, not the generation of the unit; see also Arist. fr. 204.

[50] Cherniss, *Criticism*, 39 f.; Huffman, *Philolaus*, 204 f., 226 f. Aristotle's treatment is defended by H. S. Schibli, 'On "The One" in Philolaus, Fragment 7', *CQ* 46 (1996), 114–30; Kahn, 28. For criticism of Schibli see Zhmud, 'Some Notes', 255 f.

[51] Huffman, *Philolaus*, 72 ff., 172.

going back to Theophrastus, confirms this conclusion: numbers as principles are absent from it.

Parmenides and Zeno took from Pythagorean mathematics the technique of deductive proof and made use of it to solve philosophical problems (above, §7.2), but in them we find no reflection on the subject of their borrowed methods. The logic and epistemology of the Eleatics substantially influenced Philolaus.[52] The other important source of his epistemology was the exact sciences,[53] the successes of which made highly attractive the methods of cognition adopted in them. Educated within the framework of the mathematical quadrivium (Vitruvius mentioned him among experts in *mathēmata*, A 6), Philolaus became the first Pythagorean and one of the first Presocratics to introduce *mathēmata* into a philosophical work and make its results and methods an object of discussion and analysis.[54] In the words of Sextus Empiricus, he saw as the criterion of truth λόγος, which derives from *mathēmata* (A 29; the very question of the criterion of truth was posed in Hellenistic philosophy); geometry he called the 'principle' and 'motherland' of *mathēmata* (A 7a).[55] Philolaus built a highly original, if in many things speculative, system of astronomy. He was the first to introduce into philosophical tradition a calendar scheme of the luni-solar year, the cycle of fifty-nine years with twenty-one intercalary months and a solar year of 364½ days (A 22).[56] Naturally he also touched on specifically Pythagorean *mathēmata*, arithmetic and harmonics: B 5 deals with even and odd numbers; B 6 sets out a mathematical theory of the division of the octave; A 24 refers to 'musical' proportion. Philolaus' notion that animals on the moon are fifteen times larger than those on earth,

[52] Reinhardt, *Parmenides*, 65; Zeller and Mondolfo, i. 378; Burkert, 260 f.; M. Nussbaum, 'Eleatic Conventionalism and Philolaus on the Conditions of Thought', *HSCP* 83 (1979), 83 ff., 92 f.; Huffman, *Philolaus*, 67 ff; Kahn, 24 ff.; P. Curd, *The Legacy of Parmenides: Eleatic Monism and Later Presocratic Thought* (Princeton, 1998), 218 ff.

[53] Huffman, *Philolaus*, 72 ff., 172.

[54] On the tradition of Democritus' mathematics and the philosophy related to it see: Luria, *Democritea*, 46 f. On mathematics among the Sophists see: Zaicev, 178 f.

[55] Detailed analysis of A 7a and A 29: Huffman, *Philolaus*, 193 f., 199 f.

[56] Oenopides was the first to propose a calendar scheme of 59 years (730 months), see above, 333 n. 72–3. Evidently it was adopted and modified by Philolaus (Heath, *Aristarchus*, 102 n. 3; Burkert, 314 n. 79, 322; Huffman, *Philolaus*, 276 f.). It was usually the astronomers who concerned themselves with such schemes – Meton, Euctemon, Eudoxus, Callippus—but Democritus also wrote about the 'great year' (B 11–12).

since the lunar day (i.e. half the period taken by the moon to revolve about its centre) is fifteen times longer than on earth, indicates his enthusiasm for numbers.[57]

It is against this background that Philolaus' epistemology should be examined. 'For if all things are unlimited, there will be nothing knowable at all' (B 3).[58] This fragment evidently served as a link between his epistemology and ontology. The eternal *ἀρχαί*, 'limit', 'unlimited', and 'harmony' are accessible only to divine knowledge, yet things originating from their union are knowable also by humans (B 6). Once the world surrounding us is knowable, while what is unlimited in number, magnitude, or form cannot be known, then that means that a limiting principle is active in the world. It supposes a limit to things and brings into the world determinacy, making it possible to calculate and measure something, to find its number, i.e. to know it. 'And indeed all the things that are known have number (*καὶ πάντα γα μὰν τὰ γιγνωσκόμενα ἀριθμὸν ἔχοντι*). For without it we can neither understand nor know anything' (B 4). What then does the expression 'to have number' mean? Nussbaum asserts that between Philolaus and Aristotle there is no essential difference in understanding it: *ἀριθμὸν ἔχειν* means 'to be countable', since 'number or that which has number is countable'.[59]

> As Aristotle remarks at *Physics* 219b5–9, there are two senses of the Greek word *arithmos*: that with which we count (*arithmos hōi*

[57] John Lydus says that Philolaus called the seven 'motherless' (B 20). Diels related this testimony to *Dubia*; Burkert (249) and Huffman (*Philolaus*, 334 f.) rehabilitate it, noting that according to Aristotle the Pythagoreans called the seven Athena (fr. 203). This last evidence is however doubtful (see below, 447). John derived his information from pseudo-Pythagorica through Philo (Runia, *Philo of Alexandria*, 298 f.), who ascribed to Philolaus a monotheistic thesis (*De opif.* 100). This tradition is not to be trusted.

[58] *ἀρχὰν γὰρ οὐδὲ τὸ γνωσούμενον ἐσσεῖται πάντων ἀπείρων ἐόντων.* Burkert and Nussbaum relate B 3 to epistemology, Schofield and Huffman to ontology, the former taking *τὸ γνωσούμενον* as passive, 'that which is known' (Burkert, 260 n. 107; Nussbaum, 'Eleatic Conventionalism', 84 f.; Böckh, Diels, and others read it in the same way), while the latter read it as active, 'that which knows' (*KRS*, 325; Huffman, *Philolaus*, 113 f., 116 f.). I prefer the first variant, but, independent of whether one speaks of an object or subject of cognition, Philolaus has cognition depend on the limiting principle.

[59] *ἀριθμητὸν γὰρ ὁ ἀριθμὸς ἢ τὸ ἔχον ἀριθμόν* (*Phys.* 204b7, *Met.* 1066b25). And the number, whatever it is, is always a number of something (*Met.* 1092b19). Verse is better recalled than prose, since it 'has number by which it is measured' (*Rhet.* 1409b4–8).

> *arithmoumen*) and that which gets counted (*arithmos arithmoumenos*). It is the second sense which predominates by far in Aristotle's own usage and, even more obviously, in earlier writers. The most general sense of *arithmos* in ordinary Greek of the fifth century would be that of an ordered plurality or its members, a countable system or its countable parts.[60]

Thus, Nussbaum concludes, number in Philolaus makes a knowable thing calculable. Schofield understands B 3 similarly, while Huffman believes that 'to have number' is 'to have structure which can be described mathematically'.[61]

In several of Aristotle's passages with the expression 'have number', the question is not of any number, but of significant numbers; here we can see the similarity of his views to those of the Pythagoreans. Every body is given in three dimensions and there are no other dimensions,

> For, as the Pythagoreans say, the world and all that is in it is determined by the number three, since beginning and middle and end give the number of an 'all', and the number they give is the triad. And so, having taken these three from nature as (so to speak) laws of it, we make further use of the number three in the worships of the Gods . . . And in this, as we have said we do but follow the lead which nature gives (268a10–20, tr. Stocks).

Whether it was Philolaus who wrote of the triad as the number of 'all' we do not know, yet Aristotle clearly attached great importance to that notion, believing that behind it stood, not only number speculations, but a significant natural regularity which we must follow in our life and researches. Of course, from the fact that the world and all in it is defined by three, also that beginning, end, and middle 'have' the number three, in no way does it follow that *all* is three or that all is *number*. Nevertheless Aristotle sometimes was prepared, in order to defer to number symbolism, to disregard phenomena, while himself accusing the Pythagoreans of doing so. So, for example, when describing the colours of the rainbow (*Mete.* 371b33 f.), he asserts: 'Each of them [*sc.* two rainbows] is three-coloured; the colours are the same

[60] Nussbaum, 'Eleatic Conventionalism', 89 f.

[61] *KRS*, 327: Philolaus 'probably means to claim that if things are countable, we cannot think of them nor be acquainted with them'; Huffman, *Philolaus*, 71, cf. 176.

in both and their number is the same' (καὶ ἴσα τὸν ἀριθμὸν ἔχουσιν ἀλλήλαις). Further he notes:

> No further change is visible, but three completes the series of colours (as we find three does in most other things), and the change into the rest is imperceptible. Hence also the rainbow appears with three colours (374b32 f., tr. Webster).

To reduce seven colours of the rainbow to three (red, green, violet) Aristotle obviously violates the φαινόμενα: he reduces red and orange to one colour; blue, dark blue, and violet also to one, further he treats green as a primary colour (although it can be produced by mixing yellow and blue) and the appearance of the yellow in the rainbow as an optical illusion, for 'the rainbow necessarily (ἀνάγκη) has three colours, and these three and no others'. Similarly the number of colours, tastes, and vowels necessarily equals seven.[62] Theophrastus adds odours to colours and tastes, calling the number seven καιριώτατος καὶ φυσικώτατος (*CP* VI,4,1–2). The Pythagoreans also connected καιρός with the seven, making use of the same traditional notions as Aristotle and Theophrastus.[63]

As a rule, Aristotle regarded the Pythagoreans as going too far in their predilection for numbers. Representing them in the *Metaphysics*, he asserts:

> Since the number ten is considered to be perfect (τέλειος) and to comprise the whole nature of numbers, they also assert that the bodies which revolve in the heavens are ten; and there being only nine that are visible, they make the counter-earth the tenth (986a8–12).

Indeed: it is one thing to limit the colours of the rainbow to three, and the number of tastes to seven, and quite another to devise an invisible

[62] *De sensu* 442a19 ff., 446a19. Cf. 'The senses making up an odd number, and an odd number having always a middle unit, the sense of smell occupies in itself as it were a middle position between the tactual senses, i.e. touch and taste, and those which perceive through a medium, i.e. sight and hearing' (*De sensu* 445a4–8, tr. Beare). Syrianus observes that, when Aristotle is not in the heat of argument, he himself admits the natural power of numbers and follows the theory of the Pythagoreans (*In Met.*, 192.15–29). As an example Syrianus cites the passage on the three from *De caelo* and on the seven from *De sensu*.

[63] See above, 8 f. The passage stating that the lives of certain animals 'have a number by which they are distinguished', i.e. are measured by a certain period, is evidently connected with the seven (Arist. *De gen. et corr.* 336b10–15). This is mainly about the maturation period of the foetus, in which seven played an important part; see Arist. *HA* VII and above, 397 n. 39.

planet for the sake of a round figure! Arithmology does not normally invent things, but fits them into numbers or derives numbers from things available, of which there are always sufficient to produce the desired combination. Does this mean that Philolaus in his ardour for numbers surpassed all others? An unprejudiced analysis shows that this is by no means so. To begin with, Philolaus introduced *two* invisible heavenly bodies: Hestia and counter-earth, which revolved with the earth around Hestia. Had he wished to bring the number of heavenly bodies to ten, he could have stopped with Hestia, which was the tenth. For the cosmogony and astronomy of Philolaus, Hestia is far more important than counter-earth; without it his system is impossible. Counter-earth could only appear in his system after Hestia, hence being the eleventh heavenly body![64] Certainly Aristotle speaks of ten *rotating* bodies, leaving the stationary Hestia out of the ten. However, one who is moved by a love of numbers himself decides what and how he is to count. If Philolaus had wished to count Hestia too, that it was motionless would hardly have stopped him. By the way, it is the sphere of the fixed stars that was most likely motionless in his system, since the function of daily rotation passed from it to the earth.[65] Even if we do not take into account that contradiction, one thing is immediately obvious: in one and the same work Aristotle counts Philolaus' heavenly bodies first from the periphery to the centre and then in reverse order. Counting from the sphere of the fixed stars, the sun is in seventh place and counter-earth in the tenth. In reverse, one is proper to the centre, two comes after the centre, and so on.[66] In that case Hestia is in first place, counter-earth

[64] Kingsley, *Ancient Philosophy*, 174, seems to have been the first to draw attention to this, but his reconstruction of Philolaus' astronomy is on the whole fanciful. See C. Huffman, 'Philolaus and the Central Fire', in S. Stern-Gillet and K. Corrigan (eds.), *Reading Ancient Texts, I: Presocratics and Plato, Essays in Honour of Denis O'Brien* (Leiden, 2007), 57–94.

[65] Huffman, *Philolaus*, 254 ff. Although the motion of the sphere of the fixed stars clearly contradicts the earth's rotation around Hestia, more than one attempt has been made to salvage Aristotle's words, postulating, for example, a *very* slow and hence imperceptible motion of the stars. 'It is to be feared that a convincing solution of the puzzle will never be found', Heath, *Aristarchus*, 101 f., 104; cf. Dicks, *Astronomy*, 68 f. It is suggestive that Hicetas (A 1–2) and Ecphantus (A 1.5) modified Philolaus' system in the same direction: they replaced an apparent motion of the stars by the earth's rotation about its own axis. Cicero's report on Hicetas (A 1) is erroneous: not all heavenly bodies stand still – only the stars.

[66] See above, 399.

in second,[67] the sun in fifth, and the sphere of the fixed stars in eleventh! If this contradiction derives from the Pythagoreans, then Aristotle is repeating it without noticing. However it is most likely that we have here retrospective interpretations of Philolaus' system in the spirit of number doctrine.[68]

Explaining the introduction of counter-earth by the 'perfect', or 'complete' (τέλειος) number ten, Aristotle refers to his earlier works.[69] Meanwhile, at *De caelo* 293a15–28, where he criticizes the introduction of counter-earth, no number is mentioned; he speaks only of the Pythagoreans making phenomena fit their own preconceived opinions. Those who deny the central position of the earth, Aristotle goes on, make it rotate about the centre together with counter-earth, with some even thinking that there are several such invisible bodies rotating about the centre. This, they say, accounts for the fact that lunar eclipses occur more often than solar eclipses (293b21–5). From Alexander onwards these ἔνιοι were considered to be the Pythagoreans;[70] even if that is not so, their hypothesis is closely linked to the hypothesis of counter-earth. The author of the lemma in Aëtius also seemed to see in Aristotle's ἔνιοι the Pythagoreans: 'Some of the Pythagoreans, according to Aristotle's account and the statement of Philip of Opus, say that eclipse of the moon is

[67] Doxography also counts thus: in the centre is Hestia, in second place counter-earth, in third the earth (Aët. III,11,3 = A 17).

[68] The tradition connecting numbers (and concepts) with different parts of the cosmos is confused and its interpretations are contradictory: Zeller, i. 497 n. 1; Burnet, 291 n. 5; Ross, i. 184 f.; Guthrie, i. 302 f.; Burkert, 40 n. 64; Huffman, *Philolaus*, 283 ff. *Met.* 990a18 ff. speaks only of two and seven without linking them to a definite place. The remaining information is given by Alexander, using the monograph *Against the Pythagoreans* (see *In Met.*, 75.15–17 = fr. 1). Compared with Rose, Ross and Gigon ascribed a lot of new material to it (cf. fr. 203 Rose = Alex. *In Met.*, 40.27–41.2 and fr. 13 Ross = fr. 162 Gigon = *In Met.* 38.8–41.15; fr. 202 Rose = fr. 12 Ross = *In Met.*, 75.15–17 and fr. 163 Gigon = *In Met.* 74.3–75.17), but in no way does everything here derive from Aristotle (cf. above, 341 n. 105, and 343), and far from all that he reports belongs to the Pythagoreans (cf. below, 446 f.). Although the connection of one with the centre, i.e. with Hestia, and of the sun with seven (the sun is the seventh of *ten*) indicates that the projection of numbers onto the cosmos was based on Philolaus' system, it is very doubtful that he himself was involved (see Huffman, *Philolaus*, 288). This looks rather like a reinterpretation of his system, possibly by the Pythagoreans, but more probably by the Platonists with the participation of Aristotle.

[69] *Met.* 986a12, cf. Alex. *In Met.*, 41.1 = fr. 203: λέγει δὲ περὶ τούτων καὶ ἐν τοῖς Περὶ οὐρανοῦ καὶ ἐν ταῖς τῶν Πυθαγορικῶν δόξαις ἀκριβέστερον.

[70] See Simpl. *In Cael.*, 515.25; Burnet, 306 n. 1; Guthrie, i. 283 n. 1; cf. T. L. Heath, *Greek Astronomy* (London, 1932), p. xxxvii.

due to the interposition sometimes of the earth, sometimes of the counter-earth.'[71] The name of Philip, the astronomer, the list of whose works includes *On Eclipses of the Moon*, lends additional weight to this evidence; an account of eclipses through the action of counter-earth cannot be dismissed as an elementary error.[72] Inasmuch as counter-earth also shaded the earth from the central fire, rendering it invisible, an astronomical explanation of Philolaus' motives is much more persuasive than an arithmological.[73]

If the ten in the eyes of the Pythagoreans had such magic power that for its sake Philolaus invented a new planet, this belief should have left numerous traces, similar to those left by the three and the seven. Nevertheless there is absolutely nothing about this in the tradition on Philolaus, apart from Aristotle's commentary on counter-earth and sources which rely on it. What grounds do we actually have for believing that the Pythagoreans attached particular significance to the decad?[74] As a rule, Pythagorean number symbolism came down to likening numbers to some concept or other: four is justice, seven is καιρός etc. All these likenings, or analogies are known to us from Aristotle, who wrongly saw in them philosophical definitions.[75] The ten, which he mentions separately from them, clearly stands out from this series. Among the Pythagoreans the role of 'complete' number was played by the three, symbolizing the completeness and perfection of 'all'.[76] Late sources expressly call it τέλειος ἀριθμός, and their explanations refer us back to the passage on the three from *De Caelo*.[77] It is of still more intrinsic importance that, unlike the three, the four, or the seven, the ten is not a symbol of a

[71] II,29,4 = 58 B 36 = fr. 16 Ross. Among many others, Ross attributes this evidence, not to *De caelo*, but to Aristotle's monograph on the Pythagoreans.

[72] This was asserted by Dicks, *Astronomy*, 66 f., referring to counter-earth's rotation between the earth and Hestia, not between the earth and the sun; he is followed by Burkert, 344; Huffman, *Philolaus*, 246 f. However Philolaus' sun is a glass-like body that shines with light reflected from Hestia (A 19), clearly by analogy with the moon. Hence counter-earth could well have shaded Hestia's light from the moon.

[73] Heath, *Aristarchus*, 99, 119; id., *History*, 164 f.; Burnet, 305 f.; Cherniss, *Criticism*, 199; Ross, i. 146; Dicks, *Astronomy*, 67. Guthrie, i. 285, 288, believed that the two motives were compatible.

[74] The fragments on the decad of Philolaus (A 11–13, B 11) and Archytas (B 5) are pseudo-Pythagorean. On the tetractys see above, 199 n. 115, 300 f. It is closely connected to the number ten, see below, 425 f.

[75] See above, 199 n. 116, and below, 437 n. 98, 446.

[76] τὸ πᾶν καὶ τὰ πάντα (Arist. *Cael.* 268a11), τὰ πάντα καὶ τὸ πᾶν καὶ τὸ τέλειον (a20).

[77] See above, 403. Theon. *Exp.*, 46.14–19; *Theol. ar.*, 16.9–16 and 78.15 f.

particular thing or notion. Its completeness consists of embracing 'the entire nature of numbers', while, beyond the world of numbers, a new heavenly body has to be invented for it! This is no longer simply traditional number symbolism, familiar from Solon and the Hippocratic Corpus, which 'rationally' ordered physical and conceptual reality.[78] This is philosophically tinted arithmology,[79] the source of which should be sought where such notions flourished, *viz.* in the Academy.

In Plato's dialogues *τέλειος ἀριθμός* does not yet denote decad, it refers in one case to the so-called nuptial number, and in the other to the complete, or great year.[80] This suggests that *before* Plato there was hardly any doctrine on the decad as *τέλειος ἀριθμός*. At any rate, we have no evidence to their effect. But Plato, with his theory of ten ideal numbers, or Forms-Numbers, played a decisive role in its formation.[81] It is worth noting that Aristotle does not speak of the Pythagorean *origin* of this doctrine; rather, he refers to the already existent theory that is supported also by the Pythagoreans.[82] In the other references to this theory in the *Metaphysics*, he obviously has Plato in mind,[83] and in the *Physics* 206b27–33 he directly refers to Plato (*μέχρι γὰρ δεκάδος ποιεῖ τὸν ἀριθμόν*). This confirms that Aristotle knew of it not from the Pythagorean but from the Academic sources. One of them must have been Plato's oral teaching, including his lecture *On the*

[78] See above, 397 f., Aristoxenus, probably, also had it in mind, fr. 23 (above, 396 n. 32).

[79] On the difference between number symbolism and arithmology see above, 300 n. 51.

[80] *Res.* 546b–d; *Tim.* 39d3–4; Heath, i. 312 f.; Burkert, 471 n. 76. In mathematics *τέλειος ἀριθμός* is equal to the sum of all its divisors, e.g. 6 = 1 + 2 + 3, but before Euclid (VII, def. 22, IX, 36) this meaning does not occur. Though such numbers were discovered before Euclid, an attempt to find them in Plato seems unconvincing: F. Acerbi, 'A Reference to Perfect Numbers in Plato's *Theaetetus*', *AHES* 59 (2005) 319–48.

[81] On Plato's teaching on decad, see e.g. K. Gaiser, *Platons ungeschriebene Lehre* (Stuttgart, 1963), 115 ff. and nr. 24–5, 61–2; Dillon, *Heirs*, 19 ff.; M. Erler, 'Platon', *Grundriss der Geschichte der Philosophie. Die Philosophie: der Antike*, 2/2 (Bern, 2007), 427 f.

[82] 986a8–10: *ἐπειδὴ τέλειον ἡ δεκὰς εἶναι δοκεῖ . . . , καὶ τὰ φερόμενα κατὰ τὸν οὐρανὸν δέκα μὲν εἶναί φασιν* (note *δοκεῖ*, but *φασίν*).

[83] 1073a17–22: adherents of the Forms *περὶ δὲ τῶν ἀριθμῶν ὁτὲ μὲν ὡς περὶ ἀπείρων λέγουσιν ὁτὲ δὲ ὡς μέχρι τῆς δεκάδος ὡρισμένων*; 1084a12–b2: *πειρῶνται δ' ὡς τοῦ μέχρι τῆς δεκάδος τελείου ὄντος ἀριθμοῦ* (a31); 1088b10–11: *κἂν πολὺ ἁπλῶς εἴη, οἷον ἡ δεκὰς πολύ*. See Frank, 257 n. 1; Ross, ii. 445 ff.; J. Annas, *Aristotle's Metaphysics. Books M and N* (Oxford, 1976), comm. ad loc.

Good that, according to Aristotle's testimony, dealt mostly with *μαθήματα* and *ἀριθμούς*.[84] The other significant source was Speusippus' treatise *On Pythagorean Numbers*, half of which was devoted to the marvellous properties of the decad (fr. 28). Speusippus is important as a most natural link between the Pythagoreans and the Platonists (at least, for this specific theory), all the more as his influence is discernible also in the table of the *ten* opposites.[85] Speusippus probably mentioned Philolaus in this treatise,[86] so it might have been he who counted the number of the heavenly bodies in Philolaus' system up to ten.

Are there traces of number doctrine in Pythagoreans after Philolaos? Eurytus, his pupil and teacher of the last Pythagoreans, left no written works. One of his ideas is known from an account by Archytas, whose story was preserved in Aristotle and Theophrastus through the Academy.[87] Eurytus was the only Pythagorean connected with number philosophy to be named by Aristotle and Theophrastus, though he appears in the context of criticism of the number theories of Plato and the Platonists. In the *Metaphysics M–N*, on this actual subject, Aristotle refers to Eurytus, discussing whether numbers can be the causes of things:

> Once more, it has not been determined at all in which way numbers are the causes of substances and of being – whether as boundaries (as points are of spatial magnitudes). This is how Eurytus decided what was the number of what (e.g. one of man and another of horse), viz. by imitating the figures of plants with pebbles, as some people bring numbers into the forms of triangle and square.[88]

[84] See e.g. Aristox. *Harm.* 2, 30–1, p. 40.1= Arist. *De bono*, test. 1 Ross; Alex. *In Met.* 55. 20–57 = Arist. *De bono*, fr. 2 Ross.

[85] Frank, 239 ff., Burkert, 51 f.; see below, 434 f., 449 f.

[86] Tarán, *Speusippus*, 260 f.; contra: Burkert, 246; Huffman, *Philolaus*, 361 f. I do not see any reason why Speusippus could not mention Philolaus.

[87] Ross, ii. 494; Burkert, 47; Huffman, *Archytas*, 593. Theophrastus makes it clear that Archytas' account was oral: *ὅ περ Ἀρχύτας ποτ' ἔφη* (*Met.* 6a19 f. = A 2). Cf. M. van Raalte, *Theophrastus: Metaphysics* (Leiden, 1993), 256.

[88] *οὐθὲν δὲ διώρισται οὐδὲ ὁποτέρως οἱ ἀριθμοὶ αἴτιοι τῶν οὐσιῶν καὶ τοῦ εἶναι, πότερον ὡς ὅροι (οἷον αἱ στιγμαὶ τῶν μεγεθῶν, καὶ ὡς Εὔρυτος ἔταττε τίς ἀριθμὸς τίνος, οἷον ὁδὶ μὲν ἀνθρώπου ὁδὶ δὲ ἵππου, ὥσπερ οἱ τοὺς ἀριθμοὺς ἄγοντες εἰς τὰ σχήματα τρίγωνον καὶ τετράγωνον, οὕτως ἀφομοιῶν ταῖς ψήφοις τὰς μορφὰς τῶν φυτῶν) ἢ ὅτι [ὁ] λόγος ἡ συμφωνία ἀριθμῶν, ὁμοίως δὲ καὶ ἀνθρώπος καὶ τῶν ἄλλων ἕκαστον;* (*Met.* 1092b8–15, tr. after Ross).

The very posing of the question of causes belongs to Aristotle, as does the comparison with those who composed triangular and square numbers out of *psephoi*. This practice goes back to early Pythagorean arithmetic (above, §7.3). In the fourth century it was used also by the Platonists;[89] Aristotle presumes that it is well known. Theophrastus praises Eurytus for pursuing his research to the end, whereas Plato, postulating the One and the indefinite dyad as first principles, did not go so far as to explain through them individual things:

> For this is the characteristic of an accomplished and sensible person, to do exactly what Archytas once said that Eurytus did by arranging certain pebbles. For he reports that Eurytus would say that this is the number of man, this of horse, this of something else (*Met.* 6a19–22, tr. Huffman).

Of course this preference for Eurytus (Theophrastus does not even mention his principles!) over Plato was ironic,[90] and his manipulations were hardly likely to be taken seriously by Aristotle.[91] It is believed that Eurytus, drawing a silhouette, placed pebbles along the outline and by this means determined the number of a man or a horse. Meanwhile, Aristotle and Theophrastus cite no numbers, and those given by Pseudo-Alexander, 250 and 360, are taken *exempli gratia*.[92] Further, to make use of man and horse in explanatory examples is a favourite device of Aristotle, one which he evidently took from Plato; it does not occur in the Presocratics.[93] This makes it

[89] See Speus. fr. 28 with comm. and above 282 n. 157.

[90] Thus W. D. Ross, and F. H. Fobes (eds.), *Theophrastus: Metaphysics* (Oxford, 1929), 49; Burkert, 47 n. 197; J. Dillon, 'Theophrastus' Critique of the Old Academy in the *Metaphysics*', in W. W. Fortenbaugh, and G. Wöhrle (eds.), *On the Opuscula of Theophrastus* (Stuttgart, 2002), 180 n. 18. Against: A. Laks, and G. W. Most (eds.), *Théophraste: Métaphysique* (Paris, 1993), 43; Huffman, *Archytas*, 67. Cf. van Raalte. *Theophrastus*, 257.

[91] Annas, *Aristotle's Metaphysics*, 218. H. G. Zekl, *Aristoteles: Metaphysik* (Würzburg, 2003), 572, also takes Aristotle's words to be sarcasm.

[92] *Κείσθω λόγου χάριν* (Ps.-Alex. *In Met.*, 826.35 f = A 3). A. Bélis, 'Le Procédé de numération du pythagoricien Eurytos', *REG* 96 (1983), 64–75, places too much reliance on this late testimony.

[93] Here are only examples from the *Analytics*: 25b5, 26a7, 28a31, 34b11, 37b3, b7, b31, 39b4, 40a36, 54a31, 55b18, 68b19, 88a28, 98a7; there are many more in the *Metaphysics*. Cf. Pl. *Phaed.* 78d10, 96d9; *Crat.* 385a6; *Prot.* 334a4; *Tht.* 195d5; *Pol.* 267d9; Hermodor. fr. 7 (on Plato's lecture *On the Good*). A. Laks, 'Four Notes on Theophrastus' *Metaphysics*', in W. W. Fortenbaugh, and R. W. Sharples (eds.), *Theophrastean Studies* (New Brunswick, 1998), 251 n. 47. This device possibly derives from Socrates' dialectic, cf. Xen. *Symp.* 2,10, 5,3; *Mem.* 4,2,25.

possible to explain why Aristotle says οὕτως ἀφομοιῶν ταῖς ψήφοις τὰς μορφὰς τῶν φυτῶν, although man and horse are mentioned earlier: Eurytus outlined plants with pebbles, and οἷον ὁδὶ μὲν ἀνθρώπου ὁδὶ δὲ ἵππου should be read as Aristotle's parenthetic remark.[94] However this be, it should not follow from Eurytus' story that he regarded numbers as the principles of things, or compiled things out of corporeal units, or that he was interested in specific numbers. οἷον αἱ στιγμαὶ (ὅροι) τῶν μεγεθῶν implies a line, a one-dimensional magnitude, the ends (limits) of which are points marked by *psephoi*.[95] The outline of a plant was composed of these lines. It is not clear what he meant by this; possibly it was a not altogether successful interpretation of Philolaus' thesis 'all that is knowable has number'.

The outstanding geometrician and arithmetician Archytas to an extent even greater that Philolaus introduced *mathēmata* into his philosophical works, the subject matter of which often intersected with his mathematical works. Archytas perceived all the sciences of the quadrivium from an epistemological standpoint (B 1) and declared in particular that arithmetic surpassed all other τέχναι, including geometry, in ἐναργεια, i.e., clearness, evidence, and obviousness, which makes it, in comparison, more demonstrative (B 4).[96] Apart from the fact that arithmetic is more exact than geometry, it is also useful socially, and even capable of improving the moral qualities of people (B 3). Archytas' philosophy of mathematics influenced Plato, yet in him we do not find a philosophy of *numbers*. It was not found by Aristotle either, who mentioned Archytas more than once in his treatises and wrote *On the Philosophy of Archytas* in three books[97] – otherwise we would know something about it. It is unlikely

[94] Thus also Zekl, *Aristoteles*, 572: 'Belegen lässt sich aus dem Text nur, daß Eurytos *Pflanzen* mit Steinchen dargestellt hat'. The problem here was perceived long ago. Christ proposed the reading <ζῴων καὶ> φυτῶν, Diels accepted this conjecture. Ross, ii. 494, believed that φυτόν means here 'living being', with examples from Plato, but not from Aristotle. Theophrastus attributed the example with the man and horse to Archytas, though he could have heard the story, not from Archytas, but from Aristotle or read it in *On the Philosophy of Archytas*.

[95] By Euclid's definition, γραμμῆς δὲ πέρατα σημεῖα (I, def. 3). Aristotle treated πέρατα and ὅροι as synonyms. See Heath, *Euclid*, i. 155 ff., 165 f., 182.

[96] Epistemology in B 1: Huffman, *Archytas*, 126 f., 149 f. On B 4 see also Zhmud, *Origin*, 61 ff., 71 ff.

[97] The presence of this work does not mean that 'Aristotle clearly distinguished Archytas from the rest of the Pythagoreans, since he treated them in separate books and never calls Archytas a Pythagorean' (Huffman, *Archytas*, 586). 1) Aristotle called

that Archytas developed the doctrine of principles and physics in general; in any case he is absent from Theophrastus' *Opinions of the Physicists*.

Ecphantus, one of the last Pythagoreans, united in his physics the theories of the atomists and of Anaxagoras (above, §11.1). According to the doxography in Hippolytus (A 1), which is more complete and reliable than in Aëtius (A 2, 4), Ecphantus' principles were ἀδιαίρετα σώματα, differing in size, form, and power, which moved through the action of 'mind and soul'. The short lemma in Aëtius on the principles of Ecphantus, indivisible bodies and the void (I,3,19 = A 2), has this note attached to it: 'for he was the first to declare the Pythagorean monads corporeal' (τὰς γὰρ Πυθαγορικὰς μονάδας οὗτος πρῶτος ἀπεφήνατο σωματικάς). This note raises grave doubts. The Pythagorean monads greatly interested Aristotle, who regarded them as corporeal and extensive,[98] but for some reason he failed to notice Ecphantus' idea, which so successfully confirmed his thesis. It is uncertain whether it was noticed by Theophrastus; monads are absent in Hippolytus and the other testimonies of Aëtius. Theophrastus sometimes noted the first discoverers of ideas and concepts,[99] but the note in Aëtius contradicts the logic and chronology of Aristotle: his Pythagoreans constructed the world out of corporeal units, whereas Plato and the Platonists accepted numbers composed of abstract units, μοναδικοὶ ἀριθμοί (*Met.* 1080b16 f., b30 f.). In Aëtius, Ecphantus, a contemporary of Plato, appears as the first to declare

no one at all a Pythagorean. 2) The fragments of his writings about the Pythagoreans contain not one name of a Pythagorean. 3) He devoted a separate work to Alcmaeon also (D.L. V, 25), who was an actual Pythagorean, unlike the authors of the table of opposites with whom Aristotle compared him (above, 122 f., below, 449 f.). 4) In the sole fragment of a work on Archytas, it is not he who is referred to, but Pythagoras, to whom the Platonic theory of matter is attributed: 'Aristotle in his work on Archytas relates that Pythagoras, too, called matter "other", as being in flux and always becoming different' (fr. 207, tr. Ross). Huffman's proposal to replace Pythagoras with Pythagoreans is based only on the fact that 'in the extant writings Aristotle does not refer to Pythagoras himself' (*Archytas*, 588). Yet we do have before us a fragment of one of Aristotle's *lost* works, in which Pythagoras is named several times (fr. 75, 191–5, 611.32, *Protr.* fr. 18, 20 etc.). As for those preserved, the mention of Pythagoras in *Met.* 986a30 may be subject to doubt, but not in *Rhet.* 1398b14 or in *MM* 1182a12 (see above, 44, 58), and, if Huffman believes that in *MM* also not Pythagoras, but the Pythagoreans, should be read (*Archytas*, 590), then this looks like a vicious circle.

[98] Above, 400 n. 49; below, 439.

[99] Zhmud, *Origin*, 161, 256.

units corporeal, as if hitherto they had been incorporeal![100] It is much more likely that the first to declare ἀδιαίρετα σώματα 'the Pythagorean monads' was a Hellenistic doxographer interpreting the atomism of Ecphantus in the spirit of number doctrine.

It is appropriate here to mention number atomism, which Tannery and particularly Cornford attributed to the early Pythagoreans, perceiving it to be the object of criticism of Zeno.[101] The hypothesis that mathematical atomism was the precursor and, in some sense, the forefather of physical atomism has long been refuted, but is slow to die.[102] Ecphantus' role in it has undergone interesting changes. Tannery believed him to be a figure invented by Heraclides Ponticus and hence did not connect him with number atomism. Cornford saw in the account of Ecphantus' corporeal monads confirmation that number atomism was not an original doctrine, but arose in the first third of the fifth century. Asserting that Ecphantus' dates were unknown, Cornford turned him from a contemporary of Plato into a contemporary of Parmenides. Criticizing number atomism, Vlastos and Burkert reasonably noted that Ecphantus' 'reform' belongs to the fourth century, not to early Pythagoreanism.[103] Knorr, who believed Ecphantus' ideas to be 'the single potential confirmation of the thesis of Pythagorean "number-atomism"', treated this theory, not as the subject of Zeno's criticism, but as a reaction to it.[104] Accordingly he placed Ecphantus later than Zeno (450s), but before the discovery of irrationality (430s), since Ecphantus' naive view of units-atoms and physical magnitudes is incompatible with the discovery which showed that the diagonal and the side of a square are incommensurable. This date for Ecphantus is just as arbitrary as the date of the discovery of irrationality:[105] it implies that Ecphantus was older than Democritus and was developing his theories precisely when the young Philolaus (whose astronomy he modified) was settling down

[100] Cf. Guthrie, i. 323 ff.

[101] See above, 328 n. 51.

[102] History of the question: Burkert, 285 n. 38; Guthrie, ii. 83 ff. For criticism of number atomism see e.g. Heidel, 'Pythagoreans', 21 ff.; G. Vlastos, 'Raven's *Pythagoreans and Eleatics* (1953)', in his *Studies in Greek Philosophy* (Princeton, 1996), 180–8; Burkert, 41 f., 285 ff.; D. J. Furley, *Two Studies in Greek Atomists* (Princeton, 1967), 44 ff.; KRS, 277 f.

[103] Vlastos, 'Raven's *Pythagoreans and Eleatics*', 184 n. 4; Burkert, 41.

[104] Knorr, 43 f.

[105] Theodorus of Cyrene (b. about 475/470), relying on Hippasus' discovery, demonstrated the irrationality of magnitudes from $\sqrt{3}$ to $\sqrt{17}$ (see above, §7.5).

in Thebes! I am sure that the number atomism of Ecphantus will share the fate of this entire theory.

So, reaching the lowest limit of ancient Pythagoreanism, we have found in it neither a clear formulation of number doctrine, nor tangible examples of it. It transpires that the theory which was taken to be the essence of Pythagorean philosophy, a theory backed by the authority of Aristotle as the source and as a historian of philosophy, is, like many other elements of the ancient tradition about the Pythagoreans, a retrospective projection.[106] The monolithic basis of Pythagorean philosophy breaks down into numerous splinters unconnected with philosophy (the number symbolism of Hippon), with early Pythagoreanism (the epistemology of Philolaus, the pebbles of Eurytus), or with any reality at all (the perfect number ten of Philolaus, the monads of Ecphantus). What then remains? The tetractys belongs to the Hellenistic pseudo-Pythagorica; closely connected to the number ten, it arose under the influence of Speusippus.[107] The 'harmony of the spheres', which led Aristotle to assert that, for the Pythagoreans, *τὸν ὅλον οὐρανὸν ἁρμονίαν εἶναι καὶ ἀριθμόν* (*Met.* 986a2), is not philosophical ontology, but astronomical theory.[108] Pythagorean number symbolism has a pre-philosophical character and frequently coincides with non-Pythagorean.[109] Where philosophical concepts, such as *νοῦς* or *δόξα*, come to be mixed with it, we see the influence of the Academy.[110] Number ontology and philosophical arithmology were born in the Academy. It was there they were moulded into the forms in which succeeding generations adopted them. Pythagorean number doctrine is one of these forms.

106 On other pseudo-historical constructs, such as the Pythagorean communal property, the secrecy of their doctrines, the oral nature of their teachings, the vow of silence, or the division into *mathematici* and *acusmatici* see above, §§4.3, 5.1–3.

107 See above, 199 n. 115, 300 ff, and below, 425 f.

108 The theory that the velocities of the heavenly bodies, proportional to their distances from the earth, have the ratios of consonances, was an extrapolation to the heavenly bodies of laws discovered by Pythagoras and Hippasus in harmonics (above, §9.3).

109 On the seven as *καιρός*, see above, 397 f.; on the three, above, 403.

110 Below, 448 f.

12

Pythagorean Number Doctrine in the Academy and Lyceum

12.1 PYTHAGOREANISM AND THE ACADEMY

Estimates of how great was the contribution of the Pythagoreans to Plato's philosophy diverge substantially, varying across the range from 'decisive' to 'insignificant'. Plato himself is very reserved on this topic: if indeed he is indebted to the Pythagoreans for a great deal, his dialogues cleverly conceal it.[1] Plato's Pythagoras established a particular way of life (*Res.* 600a–b), from which it does not directly follow that he was a philosopher. Cebes heard from Philolaus something vague about a ban on suicide (*Phaed.* 61e); Simmias and Echecrates shared a materialist theory of the soul which was refuted by Socrates (above, §11.1). Hippasus, Alcmaeon, Hippon, Archytas, Eurytus and the later Pythagoreans are absent from the dialogues. Theodorus, the mathematician, and his discoveries would be the only one to find reflection here (*Tht.* 147d), perhaps because he did not engage in philosophy (165a1–2). In the only place where Plato mentions the Pythagoreans, he concurs with them (i.e. with Archytas) that harmonics and astronomy are kindred sciences, while criticizing them for inability to rise to the investigation of real problems (*Res.* 530d–531c). There is a perception that the Seventh Letter attempts to prove that Archytas is much weaker than Plato in philosophy and therefore could not have any influence on him.[2] Plato's Timaeus of Locri is seen

[1] See above, 28, 53 f., 299. Burkert, 83, puts it mildly: 'Plato's dialogues do not suggest strongly that Pythagoreanism was the determinative influence upon him.'

[2] G. E. R. Lloyd, 'Plato and Archytas in the Seventh letter', *Phronesis* 35 (1990), 159–73.

usually as a tribute to the Pythagoreans, but let us not lose sight of the fact that, in order to set out the 'Pythagorean' doctrines, Plato chooses a fictitious character from a city which produced not a single Pythagorean philosopher or scientist,[3] while the actual Italian and Sicilian Pythagoreans are not even mentioned in the dialogue.[4] That Phaedo converses with Echecrates at Phlius, and Socrates before his death with students of Philolaus, is also seen as a tribute to the Pythagoreans, although it is Socrates who teaches the immortality of the soul to sceptically minded Pythagoreans, and not vice versa;[5] it is he who explains to them the difference between even and odd as such and specific numbers (*Phaed.* 104a–105b). Clearly only a reader *independently* familiar with the philosophy and science of the Pythagoreans could recognize Pythagorean influence on Plato. Against this background hypotheses that Plato in the Academy affirmed respect for Pythagoras as the founder of number metaphysics,[6] or projected onto him his own ideas, appear implausible. There is no direct evidence for this; indirect confirmation is sought between the lines of Plato's dialogues, in various vague indications and hints, taking, for example, words about Prometheus giving to people the dialectical method (*Phil.* 16c5 ff.) as an allusion to Pythagoras.[7] Plato is indisputably a master

[3] See the list of Pythagoreans from Locri in Aristoxenus' catalogue (*DK* I, 447.4 f.). The birthplace of Timaeus calls to mind rather the well-known doctor Philistion of Locri (Frank, 129 and n. 375; Burkert, 84). The physiology and medicine of the *Timaeus* owe much to Philistion. It is also material that he reworked Empedocles' doctrine of the four elements, which is so important in the *Timaeus* (Longrigg, *Greek Medicine*, 106 f.).

[4] In particular the Syracusans Hicetas and Ecphantus (*DK* 50–1), who studied physics and astronomy. Heraclides made use of the astronomy of Ecphantus and other Pythagoreans; see below, 428 n. 59.

[5] Plato probably took metempsychosis from Orphism (see above, 228 f., 230 nn. 103–4), the centre of which in his time was Magna Graecia. Therefore it is natural that the *Gorgias* (493a5) mentioned *τις μυθολογῶν κομψὸς ἀνήρ* from Italy or Sicily. Empedocles and Pindar lived and worked in Sicily (see above, 225); Plato quotes the latter with reference to metempsychosis (*Men.* 81a–c). On Pythagorean metempsychosis see above, 393 f.

[6] 'The Academy's cult of Pythagoras, one the most remarkable examples of religious auto-suggestion there have ever been, was the projection of the Academy itself and its number-metaphysics into the half-mythical personality of Pythagoras, whom the Platonists venerated as a the founder of "the theoretical life", and whom they soon freely credited with the views of their own time and school' (Jaeger, *Aristotle*, 97).

[7] Ancient commentators perceived in this passage, which mentions *πέρας καὶ ἀπειρίαν*, the influence of Philolaus (see Burkert, 86 n. 14). Modern commentators also agree (cf. however: A. Barker, 'Plato's *Philebus*: The Numbering of a Unity', *Apeiron* 29 (1996), 143–64, esp. 152); the question is whether Plato made use of his

of allusions and hints. It is quite probable that some of them point to the Pythagoreans,[8] but no obvious trace in them of Pythagoras, the philosopher and scientist, can be found.

Two waves of influence of Pythagoreanism on Plato are usually identified. The first is linked to his journey to Magna Graecia in 388/7: meeting Archytas and his circle provided the impulse for the dialogues of the middle period, in which mathematics, scarcely mentioned before, comes to the fore (*Meno*) and becomes the path to mastering the dialectic (the *Republic*); the Pythagoreans also appear, together with mathematics (*Phaedo*).[9] The second wave is perceived in the later Plato's philosophy: in the mathematization of the cosmos (*Timaeus*) and of the dialectic (*Philebus*), and especially in the mathematization of the theory of Forms, reflected in the unwritten doctrine of principles. The influence on Plato of the Pythagorean *mathēmata* is incontestable; Philolaus and Archytas were the first to make *mathēmata* and numbers a subject of philosophy; to Archytas belongs the idea, so precious to Plato, of the beneficial effect of mathematics on the soul.[10] Nevertheless it would be too straightforward to perceive in the mathematization of Plato's philosophy its Pythagorization. Plato's relations with various Pythagoreans, the presence in his dialogues of mathematics and its changing role, the mathematics of Archytas and the number metaphysics of the late Plato – all these things are by no means necessarily or unambiguously linked one with another. Plato's subjective assessment of what it is he owes to the Pythagoreans is another question. The framework of this book does not allow me to delve into this set of problems; I can only dwell briefly on certain aspects. Aristotle regarded Plato and the Platonists as continuing the Pythagorean number philosophy: does

terminology or his method; cf. E. E. Benitez, *Forms in Plato's Philebus* (Assen, 1989), 51 f.; D. Frede, *Platon. Philebos* (Göttingen, 1997), 130 f.; C. A. Huffman, 'The Philolaic Method: The Pythagoreanism Behind the *Philebus*', in A. Preus (ed.), *Before Plato: Essays in Ancient Greek Philosophy*, vol. vi (Albany, NY, 2001), 67–85, esp. 70 f.; C. Meinwald, 'Plato's Pythagoreanism: Philolaus and the Program of the "Philebus" ', *AncPhil* 22 (2002), 87–101.

8 See above, 53 n. 96.

9 G. Vlastos, 'Elenchus and Mathematics: A Turning-Point in Plato's Philosophical Development', *AJP* 109 (1988), 362–96.

10 See Zhmud, *Origin*, 71 f., 109 f. Cf. M. F. Burnyeat, 'Plato on Why Mathematics Is Good for the Soul', *PBA* 103 (2000), 1–81.

that mean that 'Plato and his pupils saw themselves as continuators of Pythagoreanism'?[11]

When the 40-year-old Plato set off for Magna Graecia, he was no novice in mathematics. Although *mathēmata* are mentioned much less frequently in the early dialogues than in the middle and later ones, there is no doubt that Plato was familiar with the subject.[12] His teacher in mathematics was Theodorus, a coeval of Socrates, who lived in Athens at the end of the fifth century and taught there all the sciences of the quadrivium.[13] Theodorus appears as a character in the late dialogues, *Theaetetus*, the *Sophist*, and the *Republic*, forty to fifty years after his appearance in Plato's life. The mathematics of the early dialogues is simple, but Plato's familiarity with more complicated mathematics discussed in the late dialogues, let us say the irrational numbers of Theodorus (*Tht.* 147d) or the five regular solids of Theaetetus (*Tim.* 47e–57c), still relates to the youth, not the old age, of the philosopher.[14] It should not be thought that Plato each time set out in his dialogues what he had recently learnt; as a rule, they reflect the level of mathematics of the fifth century. His favourite mathematical example, even and odd numbers, goes back to early Pythagorean arithmetic; the famous doubling of the square in the *Meno* (82b ff.) to the application of areas, also Pythagorean.[15] There are few examples of more contemporary theories, some of them highly contentious.[16] The mathematics of the unwritten doctrine is rudimentary and not entirely (or not at all) mathematical.[17] It is also important that Plato's

[11] Burkert, 92; see also Kahn, 14; Dillon, *Heirs*, 153. Jaeger included here Aristotle himself (*Aristotle*, 97, see above, 416 n. 6).

[12] Arithmetic and/or logistics in the early dialogues: *Euthyd.* 290b; *Charm.* 165e; *Gorg.* 450d–451c, 453e; *Ion* 531e3, 537e7; *Hip. min.* 366c–367c; *Phdr.* 274c; geometry: *Charm.* 165e; *Euthyd.* 290b; *Gorg.* 450d–e, 465b, 508a; *Hip. min.* 367e; *Prot.* 318e; astronomy: *Euthyd.* 290b; *Gorg.* 451c; *Hip. min.* 367e; *Prot.* 318e; *Symp.* 188b; even and odd numbers: *Charm.* 165e–166a, *Euthyphr.* 12c–d; *Gorg.* 451a–c, 453e, 460e; *Prot.* 356e–357a; the group of three *mathēmata*: *Euthyd.* 290b, *Gorg.* 450d–451c, *Hip. min.* 366c–367e.

[13] See above, 128.

[14] According to the most likely chronology, Theaetetus lived *c.*430–*c.*390; see Zhmud, *Origin*, 94.

[15] On even and odd numbers see above, 262 f.; they were mentioned by Epicharmus (B 2) and Philolaus (B 5). Application of areas see above, 247 f., 279 f.

[16] Thus the construction in *Men.* 86e–87d has generated many interpretations: Heath, i. 298 ff.; R. S. Bluck, *Plato's Meno* (Cambridge, 1964), 322 f., 441–61; Knorr, 71 f.; sceptically J. Klein, *A Commentary on Plato's Meno* (Chapel Hill, NC, 1965), 205 ff.

[17] Ideal numbers are not mathematical numbers: first, they end at ten; second, they are inassociable, i.e. they cannot be added, subtracted, divided, or multiplied, since the

attitude to mathematics and mathematicians in one essential aspect remained unchanged. In the early *Euthydemus* (290c) we read: since the geometricians, arithmeticians, and astronomers do not know how to make use of their discoveries, those of them who are not utter blockheads must hand these discoveries over to the dialecticians, who will find proper use for them. In the *Republic* (528b–c), the definition of the solid geometry, ἔστι δέ που τοῦτο περὶ τὴν τῶν κύβων αὔξην καὶ τὸ βάθους μετέχον, clearly refers back to the problem of doubling the cube, which, we know, was brilliantly solved by Archytas (Eud. fr. 141). Plato, however, asserts that this area, because of its complexity, has not been studied, and hence 'the investigators need a director, without whom they will hardly discover anything'! In the role of such an epistates he saw a dialectician, most probably himself.[18] Echoing the *Euthydemus*, the late *Philebus* (58a) firmly asserts the primacy of dialectic over mathematics: all who have a grain of intelligence will admit that dialectic is the truest of all the sciences![19] A philosopher convinced of his ability to see further and penetrate more deeply than any of those whose knowledge he made use of could hardly consider himself the continuer of Pythagorean mathematics. Nor could he see himself as the continuer of Pythagorean number doctrine, of which there is no trace before him or in himself.

Developing Plato's attitude to mathematics and mathematicians, the Academics represented him in the role of 'architect of science', setting scientists the most important problems and pointing out appropriate means of solving them. According to the Academic legend of the mid-fourth century, the famous problem of doubling the cube (the Delian problem) was solved by the 'Academic mathematicians' Archytas, Eudoxus, and Menaechmus, working under instructions from Plato and under his control.[20] A contemporary Academic source, quoted in Philodemus' *History of the Academy*, ascribes an even more significant role to him:

units making up the two differ from the units of the three etc. See Arist. *Met.* 1080a15 f., 1080b37 ff. with the commentaries of Ross and Julia Annas; I. Mueller, 'Forms and Numbers', in A. Pierris (ed.), *Aristotle on Plato: The Metaphysical Question* (Patras, 2004), 109–32.

[18] Zhmud, *Origin*, 106 f.

[19] See H. Cherniss, 'Plato as Mathematician' (1951), in L. Tarán (ed.), *Harold Cherniss, Selected Papers* (Leiden, 1977), 222–52, at 223.

[20] See Zhmud, *Origin*, 82 ff. (with a bibliography of the question).

> He says that at this time *mathēmata* were also greatly advanced, with Plato being the architect of this development; he set problems to the mathematicians, who in turn eagerly studied them. In this way, the general theory of proportions (*μετρολογία*) and research on definitions reached their peak, as Eudoxus and his students completely revised the old theory of Hippocrates [of Chios]. Great progress was made in geometry, as [at that time] the methods of analysis and of diorism were discovered and overall geometry greatly <advanced>.[21]

Not a continuer of Pythagoreanism, but a sovereign thinker and organiser of science, to whom mathematics owes its highest achievements: that was how Plato was seen by his faithful pupils.[22] On the other hand Plato's dependence on the Pythagoreans is affirmed in tradition critical of him, in Aristotle and the Peripatetics, or openly hostile, in stories of his plagiarism from the Pythagoreans.[23]

The Academics belonged to those of Plato's readers who knew the works of the Pythagoreans and were personally acquainted with some of them,[24] and did nothing to hide their interest in Pythagoreanism. *On Pythagorean Numbers* of Speusippus, *Πυθαγόρεια* of Xenocrates (in one book), *On the Pythagoreans* of Heraclides of Pontus and his dialogues *Abaris* and *On the Woman who Stopped Breathing*, a character in both of which was Pythagoras, *On the Pythagoreans*, *Against the Pythagoreans*, *Against Alcmaeon*, and *On the Philosophy of Archytas* (in three books) of Aristotle: all the significant pupils of Plato found it necessary to devote to this current one or more works. However the significance of Pythagorean topics for the Platonists should not be overestimated; in the incomplete catalogue of the works of Speusippus there are some thirty titles, of Xenocrates seventy-six, of Heraclides of Pontus fifty-two (D.L. IV, 4–5; IV, 11–14;

[21] *PHerc* 1021, col. Y, text: Dorandi, *Filodemo*, 126 f. There are no grounds for ascribing this extract to Dicaearchus (as Gaiser, *Philodems Academica*, 76 f., 97 f., 342 f.). Whoever was the author, he belonged to the Academy. In more detail see Zhmud, *Origin*, 87 f.

[22] On the sources of these notions see Zhmud, *Origin*, 104–8.

[23] See above, 55 n. 106; Dörrie, *Platonismus*, ii. 30 ff. On plagiarism see above, 159 f. Note that, not Pythagoreans, but Sophists and Socratics figure in the first accusations of plagiarism against Plato (Theopomp. *FGrHist* 115 F 259; Aristox. fr. 67; Dörrie, *Platonismus*, ii. 12 ff., 20 ff.)

[24] Speusippus and Xenocrates travelled with Plato to Syracuse; Hermodorus was born there; Heraclides 'heard' the Pythagoreans (fr. 3, cf. below, 428 n. 59). Philip came from Medma in southern Italy or lived there (Krämer, 'Ältere Akademie', 81; Lasserre, *Leodamas*, 593 f.; Dillon, *Heirs*, 179 f.). Aristotle while still in the Academy studied various aspects of Pythagoreanism.

V, 86–9). It is suggestive that Aristotle wrote more on this subject than all the Platonists together; certainly, unlike them, he had a critical attitude to the *Πυθαγόρειοι*. To judge by the few surviving fragments of works of the Platonists, in some of them Pythagorean notions stand alongside Academic and Platonic notions. Thus, in the first part of *On Pythagorean Numbers* (fr. 28), Speusippus deals with, not only figured numbers, but also the five regular solids which figured in the *Timaeus* (47e–57c). In the second, setting out his variant of the Academic doctrine of the decad, he examines the same types of triangles as in the *Timaeus* (54a–d). Heraclides' story of the invention by Pythagoras of the word *φιλόσοφος* (fr. 88), so important for the Academy, relies on the early tradition, but contains also Platonic elements: for example, the theory of three types of life and the ideal of *bios theorētikos*. According to another testimony by him, Pythagoras taught that knowledge of the perfection of numbers is the happiness of the soul (fr. 44). Behind *τελειότης τῶν ἀριθμῶν* it is possible, but not obligatory, to perceive Plato's *τέλειος ἀριθμός* and Academic arithmology.[25] Note that Aristotle in the *Protrepticus* also projects onto Pythagoras his own view of philosophy, and in *On the Philosophy of Archytas* ascribes to Pythagoras the Platonic notion of matter.[26] In the surviving treatises Aristotle very insistently and, unlike his fellow pupils, *explicitly* emphasizes the similarities of the Pythagoreans to Plato. In fact his interest in the Pythagoreans was above all as precursors of Academic number philosophy.

Here we approach an important point. To Burkert belongs the now commonly accepted theory of two lines in the interpretation of Pythagorean philosophy: 1) the Platonic, projecting Academic teachings onto Pythagoras and the Pythagoreans; 2) the Aristotelian, reflecting the number doctrine of the Pythagoreans in a historically credible manner.[27] The second part of this theory is quite traditional: in the nineteenth century Aristotle was regarded as one of the most reliable sources on Pythagoreanism; the credibility of Philolaus' fragments was assessed from the point of view of their conformity to Aristotle ('was Aristotelischen Angaben widerspricht, ist unecht'), and for those who rejected it Aristotle was in practice the sole

[25] See above, 404 f. and below, 430 f.

[26] On Protr. fr. 18 see above, 56. On fr. 207 see above, 411 n. 97, cf. *Met.* 1087b26; Simpl. *In Phys.*, 503.12 f. = Arist. *De bono*, test, p. 112 Ross; Burkert, 80 n. 164.

[27] Burkert, 81.

source.[28] Frank seems to be the first who, while rejecting Philolaus, expressed doubts about Aristotle also.[29] Frank's valuable observations were, unfortunately, built into an impossible construction: the so-called Pythagoreans of Aristotle were Archytas and Eudoxus; Archytas' philosophy proceeded from Democritus; Plato took his physics from Archytas; the teachings of 'Philolaus', 'Hicetas', and 'Ecphantus' were created by the Academics; Aristotle, under the influence of Speusippus, took the Academic theories to be Pythagorean. It was not difficult to overturn Frank's construction. Cherniss, who supported in principle his criticism of Aristotle, observed, 'It is not, however, likely that he merely adopted the theories of Speusippus as Pythagorean, for everywhere he distinguished sharply between Pythagoreans and Platonists.'[30] Burkert proved the authenticity of part of the fragments of Philolaus, and attempted to restore the reputation of Aristotle, undermined by Cherniss, as a source on Pythagoreanism, emphasizing precisely what Cherniss had noted: Aristotle distinguishes between Pythagoreans and Platonists. The first part of Burkert's theory, on Pythagorizing Platonists, goes back to Frank and makes use of many of his arguments. Burkert, however, on the one hand separated Aristotle from the Platonists and made Philolaus his main source, and on the other linked to the Platonists the late Hellenistic tradition which ascribed to Pythagoras and the Pythagoreans Academic theories, in particular Plato's unwritten doctrine of principles. Thus there came into being the theory of two fundamentally differing lines, only one of which can be historically correct.

Attractive as this theory may be, it must be said that it is incorrect. There is no reliable evidence that 'Speusippus, Xenocrates, and Heraclides equate the doctrine of their master Plato, and therewith also their own philosophical positions with the wisdom of Pythagoras'.[31] That thesis implies that Speusippus and Xenocrates were the fathers

[28] Schaarschmidt, *Die angebliche Schriftstellerei*, 84; A. Rothenbücher, *Das System der Pythagoreer nach den Angaben des Aristoteles* (Berlin, 1867), 2, 60.

[29] 'In dem, was Aristoteles über die Pythagoreer zu sagen hat, ist also wirklich nichts, was aus den anderen Quellen als aus den pythagoreisierenden Werken der Platoniker seiner Zeit geschöpft sein müsste. [...] Jedenfalls darf man die Zeugnisse des Aristoteles nicht wie bisher als eine unantastbare, streng historische Quelle für die Philosophie der pythagoreischen Schule verwenden' (Frank, 259–60).

[30] Cherniss, *Criticism*, 391. 'The Platonic cast given to much of the Pythagorean material is probably Aristotle's own work' (ibid.). On the table of opposites, see below, 449 f.

[31] Burkert, 82.

of neo-Pythagoreanism.[32] However the tendency to attribute to the Pythagoreans and (much less frequently) to Pythagoras the Platonic teaching of the One and the indefinite dyad first appears in pseudo-Pythagorean literature of the first century and in neo-Pythagoreanism.[33] Zeller referred it to the turn of the first century, and that dating remains the most convincing.[34] The late origin of that tradition follows from its transformation, under the influence of Stoicism, of the dualistic teaching of Plato in the spirit of monism: the One (the monad) generates the dyad;[35] in Aëtius, for brevity of

[32] They are so treated by, for example: Dillon, *Middle Platonists*, 38; id., 'Plotinus, Speusippus and the Platonic *Parmenides*', *Kairos* 15 (2000) 61–74, at 69; id., *Heirs*, 204.

[33] Pseudo-Pythagoreans: Alexander Polyhistor's *Memoirs* (D.L. VIII, 25 = p. 234.18 f. Thesleff); Anonymus Photii (p. 237.17 f., 238.8 ff.); Brontinus (*De intell.* fr. 2); Callicratides (fr. 1; p. 103.11); Pythagoras (*Hieros logos* in Doric prose, fr. 2, p. 104.24); Archytas (*De princ.*, p. 19 f.). Neo-Pythagoreans: Eudorus (Simpl. *In Phys.*, 181.10 ff.); Moderatus (ibid., 230.34 f.); Numenius (fr. 52 Des Places). Doxography: Aët. I,3,8 (= *Dox.*, 281.6–12) and I,7,18 (relies on pseudo-Pythagorica); Anonymus in Sextus Empiricus (*Adv. math.* 10, 261–2; cf. similarity of D.L. VIII, 25 and *Adv. math.* 10, 282); Anonymus in Hippolitus (*Ref.* 1,2,2, 2,6; 4,43,4–4,44,3, 4,51,1–5, 5,13,6, 6,23,1–2, 6,52,2). Cf. Iren. *Adv. haeres.* II,14,6.

[34] Zeller, i. 464 ff; iii. 2, 103 ff. The pseudo-epigraphs of Brontinus, Callicratides, Pythagoras, and Archytas are dated rather to the 1st cent. AD than a century earlier (see the discussion between Burkert and Thesleff, above, 5 n. 11), Anonymus Photii to the 1st cent. AD (above, 72 n. 48). The key question is the dating of the earliest of the pseudo-epigraphs, *Memoirs* (see above, 10 n. 18, 71 n. 44), particularly its doctrine of principles (D.L. VIII, 25). Like Zeller, Jacoby (IIIa, 293 f.) dated *Memoirs* to the turn of the 1st century, Festugière ('Memoires', 428 f.; id., *La Révélation d'Hermès Trismégiste*, iv (Paris, 1954), 28) to the 2nd cent.; similarly C. de Vogel, *Greek Philosophy*, iii. (Leiden, 1973), 341 ff.; ead., *Pythagoras*, 206 f., and Mansfeld, *Pseudo-Hippocratic Tract*, 98 n. 163 f., pointing to the monism of the doctrine of principles (n. 35, below) and the influence of Stoicism. Burkert, 'Hellenistische Pseudopythagorica', 24 ff., dated this text to the end of the 3rd cent., joining it to the letter of Lysis. This combination was rejected (Thesleff, 'On the Problem', 78; Du Toit, *Theios Anthropos*, 234 n. 83); the letter of Lysis is now dated to the 1st cent. AD (see above, 189 n. 79).

[35] See A. Schmekel, *Die Philosophie der mittleren Stoa* (Berlin, 1892), 403 ff., 436 f.; Festugière, *Révélation*, 18 ff., 43 ff., 49 f., 307 ff.; J. M. Rist, 'The Neoplatonic One and Plato's Parmenides', *TAPA* 93 (1962), 389–401; id., 'Monism: Plotinus and Some Predecessors', *TAPA* 69 (1965), 329–44, at 333 f.; W. Theiler, 'Einheit und unbegrenzte Zweiheit von Plato bis Plotin' (1964), in *Untersuchungen zur antiken Literatur* (Berlin, 1970), 462–83; Ph. Merlan, 'The Pythagoreans', in A. H. Armstrong (ed.), *The Cambridge History of Later Greek and Early Medieval Philosophy* (Cambridge, 1967), 84 ff.; de Vogel, *Pythagoras*, 207 ff.; ead., *Rethinking Plato and Platonism* (Leiden, 1986), 130 f., 196 f.; Mansfeld, *Heresiography*, 168 ff. Cf. Dillon, *Middle Platonists*, 344; Kahn, 79 f.

expression, this idea is omitted, but can easily be restored.[36] As for the second line, it was Aristotle and (on one occasion) Theophrastus who projected some elements of the Platonic *Prinzipienlehre* onto the Pythagoreans.[37] In the age of Hellenism this interpretation was unknown: Aristotle's *Metaphysics* was discovered only in the mid-first century, and Theophrastus' *Metaphysics* still later. On some important issues Aristotle drew a distinction between the *Πυθαγόρειοι* and Plato and the Platonists; the point is, however, that most of the theories of these 'Pythagoreans' are the fruit of his polemical interpretations. Hence there are no grounds for asserting that his depiction of the Pythagorean number doctrine is more historical than the evidence of the Platonists – that, of course, which actually belongs to them.

Speusippus. The *Kronzeuge* of the theory of Pythagorizing Platonists is the Latin translation of Proclus' commentary on *Parmenides*, made by William of Moerbeke; it quotes Speusippus' words about the 'ancients'.[38] According to Burkert, Speusippus attributes to the 'ancients', in whom the Pythagoreans and even Pythagoras himself should be seen, a typically Platonic pair, the One and the indefinite dyad. Thus 'Plato's nephew and successor claimed that the basic thought of the Platonic doctrine of ideal numbers was Pythagorean'.[39] Both editors of Speusippus' fragments, L. Tarán and M. Isnardi Parente, and also Proclus' editor C. Steel, came out against this widely accepted interpretation.[40] They are unanimous in stating that

[36] *μονάς = τὸ ποιητικὸν αἴτιον καὶ εἰδικόν, ὅπερ ἐστὶ νοῦς ὁ θεός, ἀόριστος δυάς = τὸ παθητικόν τε καὶ ὑλικόν, ὅπερ ἐστὶν ὁ ὁρατὸς κόσμος* (Aët. I,3,8 = *Dox.*, 281a6–12; I,7,1). We have before us Stoicized Platonism; cf. Zeno's principles (I,3,25). Posidonius, in whose school the doxography of Pythagoras was created (see above, 302 f.) was familiar with the pseudo-Pythagorica.

[37] See below, 453 f. It is interesting that Festugière (*Révélation*, 28 f., 49 f.), one of the few to try to find the sources of (neo)-Pythagorean monism in the fourth century, relied on the evidence of Aristotle and Theophrastus (greatly overvaluing them), not the Academics.

[38] C. G. Steel and L. van Campe (eds.), *Procli in Platonis Parmenidem commentaria. T. III, libros VI–VII* (Oxford, 2009), 288 f. For convenience I quote the editor's reverse translation into the Greek: *Τὸ γὰρ ἓν κρεῖττον τοῦ ὄντος ἡγούμενοι καὶ ἀφ' οὗ τὸ ὄν, καὶ τῆς κατ' ἀρχὴν σχέσεως αὐτὸ ἀπήλλαξαν. ὑπολαμβάνοντες δὲ ὅτι, εἴ τις τὸ ἓν αὐτὸ χωρὶς καὶ μόνον διανοούμενος ἄνευ τῶν ἄλλων καθ' αὐτὸ τιθείη, μηδὲν ἕτερον στοιχεῖον αὐτῷ προσθείς, οὐδὲν ἂν γένοιτο τῶν ἄλλων, τὴν ἀόριστον δυάδα τῶν ὄντων ἀρχὴν εἰσ‹ή›γαγον.*

[39] Burkert, 64.

[40] Tarán, *Speusippus*, 350 ff; id., 'Proclus on the Old Academy', in J. Pépin and H. D. Saffrey (eds.), *Proclus: Lecteur et interprète des Anciens* (Paris, 1987), 227–76,

'Speusippus' ascribes to the Pythagoreans an entirely Neoplatonic doctrine of the One, which is beyond Being and has no relation to it; 'they delivered it even from the relation a principle has', so that the One is not even a principle. This doctrine was unknown in the Old Academy, and Speusippus could not therefore ascribe it to the Pythagoreans: we are dealing with a Neoplatonic fabrication. We have no other evidence that Speusippus projected the Platonic doctrine of principles onto the Pythagoreans or moreover that he did so onto Pythagoras, who does not figure in his fragments. Philolaus was possibly named in *On Pythagorean Numbers*,[41] yet it does not follow from the title of the work (*if* it came from the author), and the text accessible to us, that Speusippus considered the doctrines he was expounding to be Pythagorean: it was the numbers which were Pythagorean![42] Figured, prime, even, and odd numbers, multiple and epimoric ratios, proportions and progressions – all these things discussed by Speusippus do actually go back to Pythagorean arithmetic and harmonics.[43] Three regular solids were constructed by the Pythagoreans, the other two by Theodorus' pupil Theaetetus.[44] Speusippus had reason to perceive in the Pythagoreans his predecessors, at least as regards the mathematical material which he used for his own paramathematical purposes.[45] However his reasoning on the perfection of the decad derives, not from mathematics or arithmology of the Pythagoreans, but from the number ontology of late Plato.[46] The

at 228 ff.; M. Isnardi Parente, 'Speusippo in Proclo', *Elenchos* 5 (1984), 293–310; ead., *Speusippo: Testimonianze e frammenti* (Rome, 2005)^2 (Internet), comm. ad fr. 30; C. Steel, 'A Neoplatonic Speusippus?', in M. Barbanti et al. (eds.), *Unione e Amicizia: Omaggio a Fr. Romano* (Catania, 2002), 469–76.

[41] See above, 409 n. 86.

[42] '[H]e uses Pythagorean notions in the course of putting forward his own mathematical and metaphysical doctrines; and these doctrines are not only at variance with early Pythagorean notions but often incompatible with them' (Tarán, *Speusippus*, 260, see 109, 269 f., 275 f., on the title: 262). Cf. Isnardi Parente, *Speusippo*^{2}, comm. ad fr. 94. Philolaus and the Pythagoreans are not mentioned in the quotation from Speusippus, and his book 'shows only very general ties to early Pythagoreanism' (Huffinan, *Philolaus*, 361).

[43] See above, 262, 264, 272, 295.

[44] See above, 264 n. 87.

[45] Asserting, for example, that in the decad there are equal numbers of prime (1, 2, 3, 5, 7 – *L. Zh.*) and composite (2, 4, 6, 8, 10) numbers, he makes the one a prime number, although in that case all the other numbers become composite (see Euc. VII, def. 12, 14). Beside this he asserts that in an equilateral triangle in a certain sense there is one side and one angle!

[46] See above, 408 n. 81.

sequence point–line–plane–solid and the 'magical' transformation of the tetrad into the decad (1 + 2 + 3 + 4 = 10) also relate to this.[47] In late Hellenism, when Pythagoreanism merged inextricably with Platonism, the Academic tetrad became the Pythagorean tetractys.[48] It is unlikely, however, that the contemporaries of Speusippus were misled by his exposition of the Academic doctrines in *On Pythagorean Numbers*. Aristotle, discussing counter-earth, connects the decad as *τέλειος ἀριθμός* with the Pythagoreans; if in this he did rely on Speusippus,[49] then we have merely a forced interpretation of the astronomy of Philolaus, not a projection of Plato's *Prinzipienlehre* onto Pythagoras. In the remaining instances Aristotle distinguishes the number symbolism of the Pythagoreans and the arithmology of Speusippus.[50] We shall return to the table of the ten opposites.

Xenocrates. Burkert believed that Xenocrates' testimony on Pythagoras as the discoverer of mathematical harmonics was related to his interpretation of the *Timaeus*. Since, going further, late doxography attributes Xenocrates' definition of the soul as a 'self-moving number' to Pythagoras, and this definition in turn relies on the *Timaeus*, the Academic supposedly interpreted the ideas of Plato's dialogue as the teaching of Pythagoras. That interpretation is unconvincing, as was shown above.[51] Evidence of Pythagoras' discovery of the numerical expression of concords is taken, not from an interpretation of the *Timaeus*, but, most probably, from a special book on harmonics (*Πυθαγόρεια* is also possible). Since Xenocrates, making use of the unwritten doctrines of his mentor, tried to demonstrate that Plato in the *Timaeus* believed the World Soul to be a self-moving number,[52] it

[47] Aristotle on Plato: 'the Animal itself (*αὐτὸ μὲν τὸ ζῷον*) is compounded of the Idea itself of the One together with the primary length, breadth, and depth (i.e. 1, 2, 3, 4), everything else being similarly constituted. Again, he puts his view in yet other terms: Mind is the monad, knowledge the dyad (because it goes undeviatingly from one point to another), opinion the number of the plane, sensation the number of the solid' (*De an.* 404b19–24 = *De philos.* fr. 11 Ross). See also the teaching of Xenocrates: Arist. *Met.* 1090b21f = fr. 38.

[48] See above, 300 f.

[49] See above, 409.

[50] He mentions the tetrad exclusively when discussing Plato and the Platonists (*Met.* 1081a 23, b15–22; 1082 a12–34, 1084a23; 1090b23). As for the tetractys, this 'kernel of Pythagorean wisdom' (Burkert, 72) remained unknown to him. On the table of ten opposites see below, 449 f.

[51] See above, 55 n. 103, 258 f.

[52] Plut. *De an. procr.* 1012 D–F = fr. 188. See: H. Cherniss, *The Riddle of the Early Academy* (Berkeley, 1944), 45 f.; Tarán, 'Proclus', 250 f.

is highly implausible that he attributed that very definition to Pythagoras. There is no evidence that he or Speusippus treated the *Timaeus* as a Pythagorean dialogue, or that he equated the doctrine of Plato, and therewith also his own philosophical positions, with the wisdom of Pythagoras. The idea, known as early as the third century, that Plato in the *Timaeus* was following the Pythagoreans[53] becomes a sort of dogma in the first century, and, if the neo-Pythagoreans and the Platonists had been able to reinforce it with the authority of Speusippus, Xenocrates, or Crantor, they would have done so. The demonology of Xenocrates, as was long ago shown by Heinze, owes its origin to Plato (as does the demonology of Philip in the *Epinomis*) and is unrelated to Pythagoreanism.[54] Attempts to demonstrate the contrary are based on arbitrary propositions: if in a late text Pythagoras appears beside Xenocrates in a list, 'what is meant here is really "Pythagoras as cited by Xenocrates"'![55] It is also groundless to suggest that in *ἀέναος*, 'ever-flowing', 'everlasting', as Xenocrates designated one of his two principles (*συνεστάναι τὸ πᾶν ἐκ τοῦ ἑνὸς καὶ τοῦ ἀενάου*), one should perceive a reference to the Pythagorean oath (*παγὰν ἀενάου φύσεως*).[56] *ἀέναος* is abundantly evidenced before Xenocrates, both in poetry and prose, in Plato amongst others, and to connect it with a pseudo-Pythagorean oath first cited by Aëtius is quite pointless.[57] It is highly probable that Xenocrates in *Πυθαγόρεια* interpreted Pythagoreanism in his own, i.e. Platonic, spirit, as did the other Academics, but no reliable evidence of this remains.

Heraclides. The least systematic of the elder Platonists wrote on Pythagoras and the Pythagoreans more frequently than the others. The accounts of Pythagoras' introduction of a meat diet for athletes and of the Pythagoreans eating the meat of sacrificial animals possibly

[53] See above, 159 ff. This idea is of an anti-Platonic nature.

[54] Heinze, *Xenokrates*, 79 ff., 87, 89 ff. For an analogous interpretation see M. Baltes, 'Zur Theologie des Xenokrates', in *ΔΙΑΝΟΗΜΑΤΑ*: *Kleine Schriften zu Platon und zum Platonismus* (Stuttgart, 1999), 191–226; a 'Pythagorean trace' is not even discussed here.

[55] Thus Burkert, 73.

[56] Aët. I,3,23 = Xenocr. fr. 101; oath: Aët. I,3,8. First suggested by Zeller, i. 505 n. 1, ii/1. 1014 n. 3; contra Heinze, *Xenokrates*, 14, pro H. Cherniss, *Aristotle's Criticism of Plato and the Academy* (New York, 1962), 484 f., 571; Burkert, 72 ('it is tempting to believe that the verse on the tetractys was known to [Xenocrates]'); Dillon, *Heirs*, 100.

[57] See *LSJ*, s.v. *ἀέναος*; Crit. 88 B 18.1–2; Pl. *Leg.* 996e2 (*ἀέναος οὐσία*). On the oath above, 301 f.

belong to his historical work *On the Pythagoreans*.[58] Other evidence of the Pythagoreans relates to cosmology and astronomy. Heraclides believed that 1) the universe was infinite; 2) each planet was an independent cosmos surrounded by air, the moon probably being inhabited; 3) the earth rotated on its own axis. The first theory he shared with Archytas; the second is partly reminiscent of Philolaus; the third is taken from Ecphantus.[59] There is no evident intention here of attributing to the Pythagoreans the views of others.

The evidence on Pythagoras goes back as a rule to the dialogues of Heraclides, in which, inter alia, he systematized the legendary tradition of the prophecies and metamorphoses of the sage of Samos, associating him with the other renowned 'wonder-workers'.[60] The dialogue *On the Woman Who Stopped Breathing*, the main hero of which, Empedocles, cures a woman in a coma, introduces a fictitious conversation between Pythagoras and Leon, the tyrant of Phlius. In the course of the conversation Pythagoras calls himself *φιλόσοφος*. This conversation is passed on by Cicero (the fullest version, and directly from Heraclides), Sosicrates in Diogenes Laertius, and once more briefly by Diogenes himself.[61] Replying to Leon's question—who are philosophers? – Pythagoras likens life to the Olympic Games: some compete for the sake of fame, others have come to trade profitably, and the most worthy to observe it all. So too in this life, to which we have come from another life and nature (*ex alia vita et natura*): some serve fame, others money, but those few who, despising all this, ardently contemplate the nature of things (*rerum naturam studiose intuerentur*), call themselves lovers of wisdom, i.e. philosophers.[62] The Platonic explanation of the word 'philosopher' cited by Diogenes –

[58] Fr. 40. On fr. 41 see above, 237 n. 132.

[59] *Ἡρακλείδης καὶ οἱ Πυθαγόρειοι ἕκαστον τῶν ἀστέρων κόσμον ὑπάρχειν γῆν περιέχοντα ἀέρα τε ἐν τῷ ἀπείρῳ αἰθέρι* (Aët. II,13,15 = fr. 113a). Archytas on the infinite universe: A 24; Huffman, *Archytas*, 540 f. On the moon see fr. 113, 115, cf. Philolaus on life on the moon: A 20; Huffman, *Philolaus*, 270 f. *Ἡρακλείδης ὁ Ποντικὸς καὶ Ἔκφαντος ὁ Πυθαγόρειος κινοῦσι μὲν τὴν γῆν, οὐ μήν γε μεταβατικῶς, ἀλλὰ τρεπτικῶς* (Aët. III,13,3 = fr. 104). Cf. Hicetas (A 1) and Ecphantus (A 1). Heraclides' astronomy: Gottschalk, *Heraclides*, 58 ff., 82 f.; P. T. Keyser, 'Heliocentrism In or Out of Heraclides', in Fortenbaugh and Pender (eds.), *Heraclides* 205–35. It was apparently set out in his work *περὶ τῶν ἐν οὐρανῷ α'*, about which nothing definite is known.

[60] See above, 12, 52 n. 95, 115, 232 n. 115, and fr. 89, 90, 92.

[61] Cic. *Tusc.* 5,3; Sosicrates without reference to Heraclides (D.L. VIII, 8; cf. above, 71 n. 43); D.L. Prooem. 12. See also: Aët. I,3,8; Diod. X,10.1; Iamb. *VP* 44, 58, 159.

[62] Cic. *Tusc.* 5.3.8–9 = Her. Pont. fr. 88.

'for no one is wise except God' (cf. *Phdr.* 278d) – is absent in Sosicrates and Cicero and does not belong to Heraclides.[63] With it fails Burkert's main argument supporting 'dass Herakleides Platons und nur Platons Gedanken Pythagoras in den Mund gelegt hat'.[64] There is a close parallel to Heraclides' story: Aristotle's *Protrepticus*, which contains a comparison of life with the Olympic Games, and (separately) Pythagoras' reply to the question why he was born: 'To observe the heavens'.[65] Pythagoras, who called himself θεωρὸς τῆς φύσεως, is as little a creation of Plato as is Anaxagoras, into whose mouth Aristotle puts similar words.[66] The tradition which lies behind the choice of Pythagoras as the model, and in Heraclides also the archegetes of philosophy, understood as περὶ φύσεως ἱστορία, goes back to the fifth century.[67] *Φιλοσοφία* is first mentioned in *Ancient Medicine* in reference to Empedocles;[68] φιλόσοφος first in Heraclitus: χρὴ γὰρ εὖ μάλα πολλῶν ἵστορας φιλοσόφους ἄνδρας εἶναι (B 35); here φιλόσοφος is associated with ἱστορία, which, like πολυμαθία, was in the eyes of Heraclitus the distinguishing trait of Pythagoras.[69] In the pre-Platonic period φιλόσοφος and φιλοσοφία figure in various contexts, as a rule retaining their initial connection with the cognitive activity.[70] It was in this, according to early tradition, that the sage Pythagoras manifested

[63] Here he only authenticates the origin of Leon of Phlius: φιλοσοφίαν δὲ πρῶτος ὠνόμασε Πυθαγόρας καὶ ἑαυτὸν φιλόσοφον, ἐν Σικυῶνι διαλεγόμενος Λέοντι τῷ Σικυωνίων τυράννῳ ἢ Φλειασίων, καθά φησιν Ἡρακλείδης ὁ Ποντικὸς ἐν τῇ περὶ τῆς ἄπνου· μηδένα γὰρ εἶναι σοφὸν ἀλλ' ἢ θεόν (D.L. Prooem. 12). See de Vogel, *Philosophia*, 81 f.; Gottschalk, *Heraclides*, 26 f., 35 f.; Riedweg, 'Zum Ursprung', 154 f.

[64] Burkert, 'Platon oder Pythagoras', 166. Similarly, earlier Jaeger, *Aristotle*, 97 f., 431 f.

[65] Fr. 18, 44. See above, 56 f. It is unclear whether Heraclides influenced Aristotle or vice versa, or whether they made use of one and the same tradition (Gottschalk, *Heraclides*, 29; Riedweg, 'Zum Ursprung', 160 f.).

[66] Fr. 19. See R. Joly, 'Platon ou Pythagore? Héraclide Pontique, fr. 87–88 Wehrli', in *Hommage à Marie Delcourt* (Brussels, 1970), 136–48. On the whole the *Protrepticus* defended Plato's position, but the ideal of the philosopher as θεωρὸς τῆς φύσεως belongs to Aristotle (Düring, *Aristoteles*, 430 f.). Jaeger greatly exaggerated the Platonism of the young Aristotle, see Flashar, 'Aristoteles', *Philosophie der Antike*, iii. 169 ff.

[67] Cf. περὶ φύσεως and τὸ περὶ τῶν φυσικῶς ἀπορουμένων of Heraclides himself (fr. 22, 68).

[68] *Τείνει δὲ αὐτέοισιν ὁ λόγος ἐς φιλοσοφίην, καθάπερ Ἐμπεδοκλῆς ἢ ἄλλοι οἳ περὶ φύσιος γεγράφασιν* . . . (*VM* 20).

[69] B 40, 129; see above, 33 f. Unlike other editors, Marcovich, *Heraclitus*, 25 f., excludes φιλοσόφους ἄνδρας from B 35. Cf. Riedweg, 'Zum Ursprung', 169 f.

[70] A.-M. Malingrey, *'Philosophia': Étude d'un groupe de mots dans la littérature grecque* (Paris, 1961), 29 ff.; M. Dixsaut, *Le Naturel Philosophe* (Paris, 1985), 45 ff., 367 f. *Φιλοσοφία* developed from φιλόσοφος: P. Cipriano, *I composti greci con*

himself.[71] Meanwhile φιλόσοφος and φιλοσοφία are not attested with the Pythagoreans; hence the final stroke in the portrait of Pythagoras the philosopher evidently belongs to Heraclides. The real Pythagoras did not resemble a pure contemplative observer of nature (nor did Thales),[72] but that Heraclides and Aristotle portray him as such cannot be explained by their attachment to Platonism.[73]

Πυθαγόραν δὲ ὁ Ποντικὸς Ἡρακλείδης ἱστορεῖ τὴν ἐπιστήμην τῆς τελειότητος τῶν ἀριθμῶν τῆς ψυχῆς εὐδαιμονίαν εἶναι παραδεδωκέναι (fr. 44). How should this testimony be understood: 'knowledge of the perfection of numbers is the happiness of the soul' or 'knowledge of the perfection of the numbers of the soul is happiness'? Wehrli (comm. ad loc.) believed that τῆς ψυχῆς εὐδαιμονίαν was a pleonasm (cf. Democritus B 170), and though the parallel in Theodoretus supports the first variant,[74] the second is preferable, since 'the numerical structure of the soul is a Pythagorean doctrine'. Wehrli cited in support the interpretation of the Pythagorean oath in Ps.-Plutarch: *καὶ ἡ ἡμετέρα ψυχή, φησίν ἐκ τετράδος σύγκειται· εἶναι γὰρ νοῦν ἐπιστήμην δόξαν αἴσθησιν* (Aët. I,3,8). To this it should be objected that the oath is a pseudo-Pythagorean text in which ψυχᾷ (Ps.-Plutarch) alternates with κεφαλᾷ (Stobaeus);[75] that not one of the Pythagorean theories of the soul examined above mentions number

ΦΙΛΟΣ (Viterbo, 1990). On the φιλοσοφία of Pythagoras as seen by Isocrates see above, 48.

[71] Above, §1.2. In Isocrates, Pythagoras acquires from the Egyptians philosophy (*Bus.* 28), which had the power to legislate, to investigate the nature of reality, and to engage in astronomy, arithmetic, and geometry (21–3). His pupil Theopompus claimed that Pythagoras' philosophy was merely a cover for his aspiration towards tyranny (*FGrHist* 115 F 72). According to *Dissoi logoi*, the Pythagoreans and the Anaxagoreans taught σοφία and ἀρετή (see above, 47).

[72] Plato passes on the anecdote of his contemplative life (*Tht.* 174a4); Heraclides that he lived as a hermit in isolation (D.L. I,25 = fr. 45). Both rely on 5th-cent. tradition.

[73] On the predecessors of the Academic ideal of *bios theorētikos* see e.g. Joly, 'Platon ou Pythagore'; T. B. Eriksen, *Bios theoretikos* (Oslo, 1976), 14 ff.; Gottschalk, *Heraclides*, 26 f., 35 f.; Zaicev, 132 f.; Riedweg, 'Zum Ursprung', 162 ff.

[74] *Πυθαγόρας τὴν τελεωτάτην τῶν ἀριθμῶν ἐπιστήμην ἔσχατον ὑπέλαβεν ἀγαθόν* (*Graec. affect. cur.* XI, 8). There is no ψυχή here and the subject is not happiness, but an ultimate good (the 11th book is entitled *Περὶ τέλους καὶ κρίσεως*; cf. beside it: *Ἀναξαγόρας τὴν θεωρίαν τοῦ βίου καὶ τὴν ἀπὸ ταύτης ἐλευθερίαν, φιλοσόφῳ δὴ πρέποντα ὁρισάμενος ὅρον*).

[75] See above, 301 and n. 53.

(above, §11.1);[76] and that the theory associating the four capacities of the soul with the first four numbers is not Pythagorean, but Platonic.[77] Cherniss, De Vogel, and Gottschalk preferred the first variant; Burkert initially the first, then the second; the number structure of the soul finally turned out to be an Academic theory based on the *Timaeus* which Heraclides attributed to Pythagoras.[78] τέλειος ἀριθμός[79] and the number structure of the World Soul are indeed in Plato, but they relate to different things. Further, among the numbers constituting the soul in the *Timaeus* (35a–b) there is no decad; no one among the Academics wrote of the 'perfection of the numbers of the soul'; and they saw εὐδαιμονία in something quite different.[80] On the contrary, 'knowledge of the perfection of numbers' (hardly of some specific numbers – rather of numbers in general), or, in Theodoretus' version, 'perfect knowledge of numbers', as the highest aspiration and the greatest good of man is an idea which Heraclides could certainly in one of his dialogues put into the mouth of Pythagoras.[81] Pythagoras was linked with numbers both in the Academy and the Lyceum.[82] Although the exact meaning of Heraclides' words can hardly be restored, it is likely that they also relate to his propaganda of the Academic ideal of the contemplative life.[83]

So we see that the Platonists were characterized by a benevolent attitude to Pythagoras and the Pythagoreans and an interest in their scientific, philosophical, and religious theories. Number is found in the testimonies of all three Platonists, but there is in them no picture

[76] Among things which the Pythagoreans likened to numbers, Aristotle once names the soul: ὅτι τὸ μὲν τοιονδὶ τῶν ἀριθμῶν πάθος δικαιοσύνη τὸ δὲ τοιονδὶ ψυχή τε καὶ νοῦς ἕτερον δὲ καιρός (*Met.* 985b29 f.), but it does not again figure as such. Alexander, relying on Aristotle's monograph *On the Pythagoreans*, reports that the Pythagoreans likened the mind to the one, and that Aristotle used ψυχή in the sense of νοῦς: νοῦν δὲ καὶ οὐσίαν ἔλεγον τὸ ἕν· τὴν γὰρ ψυχὴν ὡς τὸν νοῦν εἶπε (*In Met.*, 39.13 f. = Arist. fr. 13 Ross); see Burkert, 467 n. 4; cf. Mansfeld, *Heresiography*, 169 n. 46. νοῦς as τὸ ἕν is the doctrine of Plato (see above, 426 n. 47) and Xenocrates (fr. 213), which Aristotle projects onto the Pythagoreans, and Aëtius onto Pythagoras (I,3,8 = *Dox.* 281a8–b6; 282a13 f.; I,7,8). See below 448 f.

[77] Arist. *De an.* 404b16 f. See above, 426 n. 47.

[78] Cherniss, *Selected Papers*, 100 n. 2; de Vogel, *Philosophia*, 79; Gottschalk, *Heraclides*, 114; Burkert, 65, cf. id., 'Platon oder Pythagoras', 162.

[79] See above, 408 n. 80.

[80] See e.g. Speus. fr. 77–9; Xenocr. fr. 232.

[81] Fr. 44 of Heraclides is taken to belong to his περὶ εὐδαιμονίας, which is not at all evident. Only the title of this work has survived.

[82] Above, 396 n. 32.

[83] Thus Gottschalk, *Heraclides*, 114 and n. 90.

of a Pythagorean philosophy even remotely reminiscent of number doctrine; this does not speak in favour of Aristotle. The Platonists reacted, not to a common Pythagorean doctrine, but to various theories of Pythagoras and his successors: Philolaus, Archytas, Ecphantus and Hicetas, et al. Speusippus relied on the mathematics of the Pythagoreans; Heraclides on their astronomy (developing at the same time the legendary tradition on Pythagoras); Xenocrates evidently made use of harmonics. If theories which appeared 300 or even 500 years after the death of Plato are not to be attributed to the Platonists, the thesis that they projected his unwritten doctrine onto Pythagoras hangs in mid-air. Plato himself slurred over his dependence on the Pythagoreans: why should the Platonists understate the originality of their teacher? Naturally, they interpreted Pythagorean theories from their own standpoint and for their own purposes, but it would be odd to expect from them anything different. The artificiality of the theory of two lines is shown in particular by the fact that Heraclides and Aristotle in parallel portray Pythagoras as a contemplative observer of nature. If one bears in mind that Anaxagoras played the same role in Aristotle and Thales a similar role in Heraclides,[84] it becomes obvious that Pythagoras was for them only one of the forefathers of the type of philosophy engaged in at the Academy. For Aristotle, as the founder of the history of philosophy, the search for precursors, his own and Plato's, was particularly important; not infrequently it led him to very strange historiographical constructions. Thus to Thales, as the forefather of natural philosophy, he attributed the doctrine of water as the principle of all things, which Thales did not hold, and reinforced his choice of water with arguments borrowed from the Pythagorean Hippon, about whom he made very unflattering remarks.[85] Plato as a successor of the Pythagoreans is a construction of Aristotle, not of his colleagues in the Academy. To all appearances he considered the unwritten doctrine of Plato to be a modification of Pythagorean doctrine. There is, however, too much which suggests that number doctrine is a modification of Plato's *Prinzipienlehre,* created by Aristotle on a basis of Pythagorean and Academic material.

[84] See above, 429 n. 66, 430 n. 72.
[85] See above, 27 n. 6, 376 n. 115, 381 n. 135.

12.2 ARISTOTLE AND THE *Πυθαγόρειοι*

Aristotle's reports on the Pythagoreans in his surviving works may be divided into several groups according to their origins and the degree of authenticity. At times these groups partially coincide. Information on individual Pythagoreans derives from their writings, or an oral tradition, and does not in itself pose particular problems. The ones mentioned most often are Alcmaeon and Archytas, to whom he devoted separate works; Hippon is mentioned twice, and Hippasus, Philolaus, and Eurytus once each.[86] Aristotle's reports on specific Pythagoreans are far less informative than his presentation of general Pythagorean philosophy. Nevertheless, we learn of Alcmaeon's qualitative opposites, and of the principles of Hippasus (fire) and Hippon (water). In Eurytus and Archytas no doctrine of principles is attested (they are absent from the *Opinions of the Physicists*), while Aristotle attributes Philolaus' principles, 'limit' and 'unlimited', to anonymous Pythagoreans, along with all of his teaching. In spite of statements that the Pythagoreans said nothing about corporeal principles (*Met.* 989b30 f., 990a16), Aristotle affirms that the natural philosophy of the Pythagoreans known to him was based on precisely corporeal principles or qualities. It is striking that, when he mentions these thinkers by name, he not once calls them Pythagoreans, and, when speaking of Pythagorean number doctrine, adduces not so much as one name.[87] Thus the individual and the collective Pythagoreans, as bearers of number doctrine, turn out to be two non-intersecting groups.

The second group of *testimonia* reports the cosmological and astronomical teachings of anonymous Pythagoreans, for example, on the infinite void which exists outside the cosmos, on the rotation of the celestial sphere round its pole from right to left, on celestial harmony, on a system with Hestia at its centre and the earth and counter-earth rotating round it, and on the origin of the Milky Way, comets, etc.[88] These teachings correspond to the level of Presocratic natural philosophy; although Aristotle does not tell us the names of

[86] Alcmaeon (*Met.* 986a27-b3; *De an.* 405a29; *HA* 492a14, 581a16; *GA* 752b25); Hippasus (*Met.* 984a7); Hippon (*Met.* 984a4; *De an.* 405b2); Philolaus (*EE* 1225a30); Eurytus (*Met.* 1092b10); Archytas (*Met.* 1043a21; *Rhet.* 1412a12; *Pol.* 1340b25).

[87] Apart from Eurytus, but he is mentioned in the context of criticism of Academic theories; see above, 409 f.

[88] *Cael.* 284b6, 285a10. b24, 290b12–291a9, 293a19. b1; *Phys.* 203a3, 204a32, 213b22; *Mete.* 342b29, 345a13.

their authors, they undoubtedly belong to real Pythagoreans. Some physical opinions also belong here, those held by anonymous Pythagoreans who called a surface 'colour' (χρόα), thought that animals fed on odours, and believed that the soul consisted of particles suspended in the air.[89] Aristotle uses some of the *testimonia* of this group, on celestial harmony or Philolaus' system, for example, in his polemics against number doctrine. In other cases, his criticism is of a natural-philosophical nature. He calls the anonymous Pythagoreans *οἱ Πυθαγόρειοι, οἱ καλούμενοι Πυθαγόρειοι, οἱ Ἰταλικοί* and even *οἱ περὶ τὴν Ἰταλίαν, καλούμενοι δὲ Πυθαγόρειοι* (*Cael.* 293a19), without making any distinction between these designations. From his reports it emerges that the Italians included Philolaus (*Cael.* 293a21, *Met.* 987a10), who was born in Tarentum but spent most of his life in Thebes. Eurytus apart, there were no Italians among his pupils. Since Aristotle did not call Zeno or Parmenides Italians, we may take it that *Ἰταλικοί* was a designation of the Pythagoreans common in the Academy and probably first referred to Archytas and his circle. Why Aristotle sometimes called the Pythagoreans *οἱ καλούμενοι*, and exactly what qualification he intended by it, remains unclear.[90]

The third and largest group of *testimonia*, most of them coloured by polemics, relate to the general Pythagorean number doctrine in its two fundamental variants: the main one, that numbers are principles of things (*Met.* 985b23–986a21), and a subsidiary one, that the principles are ten pairs of opposites: limit and unlimited, odd and even, one and plurality, right and left, male and female, at rest and moving, straight and crooked, light and darkness, good and bad, square and oblong (986a22–b8). Aristotle presents the table of ten opposites as the teaching of a separate group of Pythagoreans (*ἕτεροι δὲ τῶν αὐτῶν τούτων*), but it does not follow from this that he had in mind any real group or individual. We are dealing with a separate theory, which defined a specific number and set of opposites and was at the same time linked with the main doctrine. Thus identification of the pair 'limit–unlimited' with 'odd–even' is the cornerstone of number doctrine, making it possible to proceed from numbers to physical things (986a17–21), while the identification of 'male–female' with 'odd–even' underlies the interpretation of the number five as

[89] *De sensu* 439a29 f., 445a16 f. (It is possible that Alcmaeon was meant here); *De an.* 404a17 f.

[90] See above, 17 n. 44.

marriage (fr. 13 Ross). The connection between other components of number philosophy is less apparent. It is clear that as a unified whole it existed only in the mind of Aristotle, who interpreted material relating to various areas in the same vein, as he viewed in it differing manifestations of one and the same teaching.

In setting forth this teaching, Aristotle points to a number of fundamental premises, which the Pythagoreans relied upon in concluding that things consist of numbers (*Met.* 985b23–986a13). They are set out more systematically by Alexander, who supplied a commentary on this passage of *Metaphysics*, using Aristotle's monograph *Against the Pythagoreans.*[91] To begin with, having been brought up in *mathēmata*, in which numbers are by nature first, the Pythagoreans regarded the principles of numbers as the principles of everything. Secondly, as their point of departure they took resemblances, or similarities (ὁμοιώματα) between numbers and things that exist and come into being. Aristotle does not name any sensible things, all his examples point to similarities between numbers and certain *concepts.* Later he specifies that the Pythagoreans explained only a few things by means of numbers, for example, opportunity, justice, or marriage (1078b21–3). However, he sometimes permitted himself to amplify the Pythagorean material by drawing on Academic material. Thirdly, they saw that ratios of concords were also composed of numbers or in accordance with numbers (the octave, Alexander explains, is the ratio 2:1, the fifth 3:3, the fourth 4:3). Fourthly and finally, relying on correspondences (ὁμολογούμενα) between numbers and harmonies on the one hand, and with the cosmos and all its parts on the other, they judged that 'all the heavens are harmony and number', or consist of numbers. The following examples confirm this view: celestial harmony, counter-earth as the tenth celestial body; the teaching connecting numbers with different parts of the cosmos.[92] The premises led to conclusions: on the basis of all of this, the Pythagoreans supposed that number is the first principle, ἀρχή, and that the elements (στοιχεῖα) of numbers are the elements of everything that exists (985b33–986a3, b15–21).

[91] *In Met.* 38.8 ff = fr. 13 Ross = fr. 162 Gigon.

[92] See above, 399 f. The same examples are set out in more detail by Alexander (39.23 ff.).

> They hold that the elements of number are the even and the odd, and that of these the latter is limited, and the former unlimited; and that the one proceeds from both of these (for it is both even and odd), and number from the one; and that the whole heaven, as has been said, is numbers.[93]

Such a multi-levelled construction – (1) elements to which two pairs of opposing features are inherent, (2) the one, (3) number, (4) a world consisting of numbers – has no precedent in early Greek philosophy. This construction most closely resembles the system of derivations of Plato's doctrine of principles: *ἕν* and *ἀόριστος δυάς* generate ideal numbers, which in their turn generate Forms and so on right up to *τὰ αἰσθητά*. This similarity is no accident, of course. The overwhelming majority of Aristotle's *testimonia* on number doctrine are linked in one way or another with his interpretation of Plato's doctrine of principles and the kindred theories of the Platonists.[94] In a historiographical survey of the development of notions of the four causes (*Met. A* 3–7), the Pythagoreans are placed immediately before Plato. Earlier philosophers knew only a material and an active cause; the Pythagoreans also knew two (987a13), namely a material and a formal cause (like Plato), since to them number was both the material substance of which things consisted and their form.[95] More precisely, the Pythagoreans only approached an understanding of the formal cause: being the first to define essence (*περὶ τοῦ τί ἐστιν ἤρξαντο μὲν*

[93] *τοῦ δὲ ἀριθμοῦ στοιχεῖα τό τε ἄρτιον καὶ τὸ περιττόν, τούτων δὲ τὸ μὲν πεπερασμένον τὸ δὲ ἄπειρον, τὸ δ' ἓν ἐξ ἀμφοτέρων εἶναι τούτων (καὶ γὰρ ἄρτιον εἶναι καὶ περιττόν), τὸν δ' ἀριθμὸν ἐκ τοῦ ἑνός, ἀριθμοὺς δέ, καθάπερ εἴρηται, τὸν ὅλον οὐρανόν* (986a17–21, tr. Ross).

[94] *Phys.* 203a3 f.; *Cael.* 300a14 f.; *Met.* 987a31, 987b10. b22. 29, 990a30–4, 996a6, 1001a9, 1002a11, 1028b16–19; 1036b15, 1053b10, 1078b30, 1080b15, b30, 1083b8–15, 1090a20–35, 1091a12 f.; cf. *MM* 1182a11: Pythagoras as a precursor of Plato. See also *On the Good* (test. and fr. 2 Ross = fr. 87 Gigon) and *Against the Pythagoreans* (fr. 13 Ross = fr. 162 Gigon). Speusippus and the Pythagoreans: *Met.* 1072b30 = fr. 42, *EN* 1096b5–8 = fr. 47. Number doctrine is very seldom featured independently (*Cael.* 268a11, cf. Pl. *Parm.* 145a5–8). As already noted (above, 57), Aristotle had said practically everything that he wanted to say about it before the death of Plato.

[95] Number is the principle *καὶ ὡς ὕλην τοῖς οὖσι καὶ ὡς πάθη τε καὶ ἕξεις* (986a17), where *πάθη* (properties) and *ἕξεις* (states) must relate to form. On the Pythagoreans in connection with *causa formalis*, see: Zeller, i. 448 f.; Ross, i. 147 f., 156; Cherniss, *Criticism*, 224 f.; A. Burns, 'The Fragments of Philolaus and Aristotle's Account of Pythagorean Theories', *Metaphysics A*, *CeM* 25 (1964) 93–128, at 123; O. Gigon, 'Die *ἀρχαί* der Vorsokratiker bei Theophrast und Aristoteles', in I. Düring (ed.), *Naturphilosophie bei Aristoteles und Theophrast* (Heidelberg, 1969), 121; Mansfeld, *Studies*, 76 n. 99.

λέγειν καὶ ὁρίζεσθαι), they did it superficially (987a19 f.). In Aristotle's understanding, the form of a thing was an explanatory definition (λόγος) of its essence (τὸ τί ἦν εἶναι); thus the formal cause of an octave was the ratio (λόγος) 2:1 and number in general (1013a 29). In spite of the last words, Aristotle saw a fundamental difference between the ratio of numbers and number as such: only λόγος could be essence, that is, form, whereas number is not any one of the four causes (1092b14–25). The error of the Pythagoreans resided in the fact that they did not discern this distinction. Everything indicates that Aristotle took statements such as 'Justice is 4, because it returns like for like' seriously, as philosophical definitions, in spite of their obviously metaphorical nature.[96]

Πλάτων δὲ καὶ ἐν τούτοις πυθαγορίζει, – whoever first uttered these pithy words, it is easy to put them into Aristotle's mouth,[97] for it was he who insistently pointed out the kinship between the doctrines of Plato and the Pythagoreans, while noting their *differentia specifica*. Plato, wrote Aristotle, had much in common with his predecessors, but his teaching also differed from the philosophy of the Pythagoreans. Thanks to the influence on him in his youth of Cratylus, Heraclitus, and Socrates, he decided that common definitions should apply not to τὰ αἰσθητά, but to that which is beyond sensibles.[98] Sensibles are linked with this kind of being, which he called Forms, by 'participation' (μέθεξις). This, however, is merely a new name for an old view: according to the Pythagoreans things exist by 'imitation' (μίμησις) of numbers, while in Plato they exist by 'participation'. Precisely what these concepts signify they did not explain (*Met.* 986a29–b14). There was much debate about the term 'mimesis',

[96] See e.g. *Δοκεῖ δέ τισι καὶ τὸ ἀντιπεπονθὸς εἶναι ἁπλῶς δίκαιον, ὥσπερ οἱ Πυθαγόρειοι ἔφασαν· ὡρίζοντο γὰρ ἁπλῶς τὸ δίκαιον τὸ ἀντιπεπονθὸς ἄλλῳ* (*EN* 1132b21 f.). 'It is curious that Aristotle should regard such identifications as definitions' (Heidel, 'Pythagoreans', 10 n. 19). As Annas, *Aristotle's Metaphysics*, 214, commented on the interpretation of Plato's good in *Met.* 1091b20–a5, 'Aristotle's approach in the present passage is presumably another example of his insistence on taking metaphor in philosophy literally'. See below, 437 n. 98.

[97] See Burkert, 52.

[98] In a brief doublet of this passage in *Met. M* 4 the Pythagoreans also figure in connection with the problem of ὁρίζεσθαι: 'Socrates ... became the first to raise the problem of universal definition ... while the Pythagoreans had before this treated of a few things, whose definitions – e.g. those of opportunity, justice, or marriage – they connected with numbers' (*Met.* 1078b16–23, tr. Ross). See also *MM* 1182a12–14: Pythagoras traced the virtues to numbers, but justice is not a square number (Socrates follows). See above, 395 n. 31.

because it implies that things and numbers belong to different levels of being, which casts doubt on Plato's originality and contradicts the main variant of number doctrine.[99] Aristotle usually asserted that the Pythagoreans recognized only one kind of number, mathematical number, without separating it, however, from the sensible world (987b28, 1080b16, 1083b11, 1086b16). Since μίμησις is absent in the Pythagorean tradition and is not found again in Aristotle's *testimonia* on the Pythagoreans, there is hardly need to attach particular significance to it. Μίμησις as a term (like the doctrine of 'imitation') belongs to Plato, where, like μέθεξις, it describes relations between things and Forms.[100] Evidently this is an unsuccessful attempt by Aristotle to find a suitable term for the resemblances discerned by the Pythagoreans, between numbers and things.[101] Why he selected one Platonic concept for this purpose and set it against another is unclear. What is clear is that, to Aristotle, Plato's *Prinzipienlehre* acquires its historical meaning only against the background of the Pythagorean teaching. Like the Pythagoreans, Plato believed that the elements of Forms are the elements of all things. 'Great-and-small', that is, the indefinite dyad, which replaced the Pythagoreans' ἄπειρον, constitutes the material cause,[102] and the One (τὸ ἕν) – the formal cause. Like the Pythagoreans, Plato regarded the One as a substance (οὐσία), and not the predicate of something else, and saw in numbers the causes of the essence of all other things. He differed from the Pythagoreans in separating the One and numbers from things and, being engaged in investigating concepts, introduced Forms, whereas the Pythagoreans knew no dialectic (987b18–33).

It is very probable that to Aristotle the basic function of Pythagorean number doctrine lay in serving as a background to Plato's unwritten doctrine of principles. That which he presents in concentrated form in his historical portrait of Plato the metaphysician is reproduced

[99] See Burkert, 43 f. with references to earlier interpretations.

[100] Things 'imitating' Forms first occur in the *Phaedo* (W. D. Ross, *Plato's Theory of Ideas* (Oxford, 1951), 24 f.). Plato uses various concepts to express this relation (ibid. 228 f.); μίμησις is presented with particular clarity in the *Timaeus*: 38a, 39e, 48e–f, 50c.

[101] Thus Zeller, i. 451 f.; Burkert, 44. Cherniss, *Criticism*, 386 f., on the other hand, emphasized the contradictions between different versions of number doctrine. For a general critique of *Met.* A 6, in which Aristotle outlines the development of Plato's philosophy, see C. H. Kahn, *Plato and the Socratic Dialogue* (Cambridge, 1996), 80 f.

[102] For more detail, see below, 445.

in one form or another in virtually all his references to number philosophy.[103] As L. Tarán observed with regard to one such passage,

> Here and elsewhere Aristotle conflates Pythagoreanism and Platonism and yet distinguishes between them concerning the question of magnitudes because he wishes to discover in the former the origin of certain Platonistic doctrines and because he puts forward his own view of mathematicals as an intermediate one between the conceptions of the two other schools. For him mathematicals exist neither apart from the sensibles nor actually in them, but are potentially in the sensibles and can only be separated and actualized in thought.[104]

The Pythagorean view of number, at once mathematical and corporeal, seemed to many 'primitive' and 'archaic'. The fact that it did not accord with the concepts of Aristotelian philosophy was seen as a guarantee of its authenticity and 'Presocratic' nature.[105] Others, like Zeller and Ross, saw an Aristotelian interpretation in material number.[106] But do we possess anything on the Pythagorean ontology of number besides Aristotle's various interpretations, from which everybody may select according to taste? The Pythagorean *mathematical* definition is well known: number is a collection of units; for arithmetic nothing more was needed.[107] And why, exactly, should number be corporeal if not a single thing consisted of it? After all, no corporality was required for justice or opportunity! We must acknowledge that the Pythagoreans' corporeal number was no archaic remnant, but the primitivizing antithesis of Plato's *ἀριθμὸς κεχωρισμένος*, number separated from the things. Yes, Aristotle distinguished the *Πυθαγόρειοι* from Plato and the Platonists, but he also distinguished humans from centaurs (*APost* 89b 31–5), which did not lend any

[103] See above, 436 n. 94.

[104] L. Tarán, 'Aristotle *Metaphysics Z* 2, 1028 b 13–19' (1979), in *Selected Papers* (Leiden, 2001), 411. See also Cherniss, *Aristotle's Criticism of Plato*, 132 n. 82.

[105] Burnet, 99 ff., 307 ff.; Philip, 73; Burkert, 32: 'The Pythagoreans did not differentiate between number and corporeality, between corporeal and incorporeal being. Like all the Presocratics, these Pythagoreans take everything that exists in the same way, as something material.'

[106] Zeller, i. 486 ff.; O. Gilbert, 'Aristoteles' Urteile über die pythagoreische Lehre', *AGPh* 22 (1909), 22–48, 145–165, at 40 f.; Ross, *Plato's Theory*, 217; Burns, 'Fragments', 112 ff.; *KRS*, 333.

[107] Aristox. fr. 23. This definition coincides with that of Euclid (VII, def. 2). As to everybody else before Plato, to the Pythagoreans number was not an independent essence (a hypostatized abstraction), but always a number of something. See above, 402 f.

reality to the latter. The Pythagoreans' number doctrine is just such a centaur, assembled partly from data of the Pythagorean tradition, and partly from Aristotelian notions of what Plato's predecessors must have looked like.[108]

There is a certain irony of history in the fact that, of the two theories that Aristotle compared, it was the Platonic theory, not the Pythagorean, which gave rise to profound doubts – doubts which more than once caused it to be either dismissed or ignored.[109] Plato's unwritten doctrine was seen to be vulnerable because it was not reflected in the dialogues (although it is now clear that this was not so),[110] and because, being schematic and dogmatic, it was contrary to the openness of Plato's philosophy. And yet Aristotle spent twenty years in the Academy, and the pungency and intensity of his polemics against the *Prinzipienlehre* are fully comparable with the far-reaching influence of this teaching on the philosophical systems of Plato's heirs, Speusippus and Xenocrates. While recognizing Aristotle's right to be mistaken, it is far more natural to see an error not in the fact that his report of Plato's famous lecture on the Good is a gross distortion of it – for this report is confirmed by the accounts of other Academicians who were present – but rather in the fact that here too we encounter Aristotle's Pythagoreans, ubiquitous but invisible to everybody except him:

> Both Plato and the Pythagoreans assumed numbers to be the principles of the existing things, because they thought that that which is primary and incomposite is a first principle, and that planes are prior to bodies . . . , and on the same principle lines are prior to planes, and points (which mathematicians call *semeia* but they called units) to lines, being completely incomposite and having nothing prior to them; but units are numbers; therefore numbers are the first of existing things.[111]

[108] Cf. Cherniss, *Criticism*, 36 f., 391; see above, 422 n. 30.

[109] For the history of the interpretation of the *agrapha dogmata* see e.g. J. Wippern, (ed.), *Das Problem der ungeschriebenen Lehre Platons* (Darmstadt, 1972); de Vogel, *Rethinking Plato*; Erler, Platon, 406 ff. In the past half-century the exaggerations of the Tübingen school have often called forth an intemperate reaction, which has hampered a balanced approach to the problem.

[110] See e.g. Frede, *Philebos*, 403 ff.

[111] Alex. *In Met.*, 55.20–27 = *De bono*, fr. 2, tr. Ross. Alexander was the last commentator of Aristotle to read his work *On the Good*. Simplicius (*In de An.*, 28.7 f.) and Philoponus (*In de An.*, 75.34 f.), to whom it was accessible through Alexander, assert that it set forth the views of Plato and the Pythagoreans on first

Of course, the derivation point (or indivisible line) – line – plane – body belongs to Plato and the Platonists,[112] yet Aristotle repeatedly presents the conclusion based upon it, that numbers are by nature first, as a premise of Pythagorean number philosophy. If Pythagorean number doctrine is unthinkable without Plato's, to which Aristotle had direct access, there can be only one answer to the question, which of them possesses more reality.

Criticizing the Academic theory of ideal numbers, Aristotle comments: 'To the sages of today, *mathēmata* have become a philosophy, although they say that *mathēmata* should be studied for another reason' (*Met.* 992a31). Aristotle also perceived the origin of Pythagorean philosophy in the fact that the Pythagoreans were brought up in mathematical sciences (985b23 f.). In relation to Philolaus, he was perhaps not far from the truth,[113] but whereas Philolaus regarded number from the perspective of its cognitive possibilities (B 3), Aristotle took no interest whatever in the epistemology of the Pythagoreans as a whole or of Philolaus in particular. Although he returned dozens of times to the theories of the Pythagoreans, he never once touched on that topic.[114] He thought that the result of their mathematical studies, as with the Platonists, was number ontology: the principles of *mathēmata* are the principles of everything, and numbers are by their nature the first of those principles, and therefore the elements of numbers were the elements of all the things. All this applies rather to Platonism than to mathematics and Philolaus. What is meant, for example, by *ἀρχαὶ τῶν μαθημάτων*? In mathematics there is no such concept, and when Philolaus called geometry *ἀρχὴ καὶ μητρόπολις* of the other *mathēmata* (A7a), he did not mean the ontological priority of its objects compared with other sciences.[115]

principles. On the attribution of this fragment, see P. Wilpert, 'Reste', 376 f.; id., *Zwei Aristotelische Frühschriften über die Ideenlehre* (Regensburg, 1949), 121 ff.

[112] See J. Philip, 'The "Pythagorean" Theory of the Derivation of Magnitudes', *Phoenix* 20 (1966), 32–50.

[113] See above, 401 f.

[114] Cf. Burkert, 261. The passage of Iamblichus on Pythagorean epistemology (*Comm. Math.*, 78.8–18), which Burkert took to be a fragment of Aristotle (Burkert, 49 f., 447 f.; followed by Barnes, *Presocratic Philosophers*, 380; Huffman, *Philolaus*, 70 f., 114 f., id., *Archytas*, 552 ff.; M. Burnyeat, 'Archytas and Optics', *Science in Context*, 18 (2005), 35–53, at 38 ff.), does not in fact belong to the latter, see: L. Zhmud, 'Mathematics *vs* Philosophy: An Alleged Fragment of Aristotle in Iamblichus', *Hyperboreus* 13 (2007), 77–88.

[115] See Huffman, *Philolaus*, 193 f.

This, however, is precisely what Aristotle meant, when, like Plato, he put arithmetic in first place. Arithmetic is prior to geometry and more precise, as it relies on a smaller number of simple elements: 'a unit is substance without position, while a point is substance with position', i.e., the latter contains an additional property.[116] According to the Academic doctrine, ontological priority resides with that which can exist without another: body is less substance than plane, plane than line, and line than unit or point.[117] Thus, numbers are by nature first. Usually Aristotle ascribes this idea to Plato and the Platonists, but it is also one of the main premises of Pythagorean number doctrine.[118] Is it necessary to prove that it bears no relation to either the Pythagoreans or to mathematics?

Further, in mathematics there are no *στοιχεῖα* of numbers (*στοιχεῖα* in geometry are its basic propositions). A Greek mathematician would be extremely surprised to learn that the even and the odd are *elements* of numbers, while the one comprises both, because it is both even and odd. In themselves, *τὸ ἄρτιον* and *τὸ περιττόν* are not mathematical concepts. Mathematics knew only even and odd *numbers*, of which the first are 2 and 3; in other words, evenness and oddness are properties of number, not its elements. Since in Greek mathematics number is a multitude made up of units, the one was not considered a number. Both the Pythagoreans and Aristotle defined it as a principle (*ἀρχή*) of number, which could therefore never be even–odd;[119] the later popularizers of mathematics, Nicomachus and Theon, said the same.[120] Revealingly, the idea of the even–odd unit is found only among Aristotle's Pythagoreans, and nowhere else,

[116] *APost* 87a34 f. See also *Met.* 982a26–8.

[117] *Met.* 1002a4–8, 1019a1–4; 1017b6–21, etc. and above, 440. See Ross, i. 316; J. Cleary, *Aristotle and Mathematics* (Leiden, 1995), 148 ff.

[118] Pythagoreans: *Met.* 985b26, 986a1; Alex. *In Met.*, 40.11 f. = fr. 13 Ross (above, 435). Cf. on Speusippus: *τὰ δὲ μαθηματικὰ εἶναι καὶ τοὺς ἀριθμοὺς πρώτους τῶν ὄντων* (Arist. *Met.* 1083a23 = Speus. fr. 34); 1075b37 f. = fr. 30; 1080b11 f. = fr. 33.

[119] Aristox. fr. 23: *μονὰς μὲν οὖν ἐστιν ἀρχὴ ἀριθμοῦ, ἀριθμὸς δὲ τὸ ἐκ τῶν μονάδων πλῆθος συγκείμενον. τῶν δὲ ἀριθμῶν ἄρτιοι μέν εἰσιν οἱ εἰς ἴσα διαιρούμενοι, περισσοὶ δὲ οἱ εἰς ἄνισα καὶ μέσον ἔχοντες* (see above, 262 n. 79). Cf. Arist. *Phys.* 220a27: *Ἐλάχιστος δὲ ἀριθμὸς ὁ μὲν ἁπλῶς ἐστὶν ἡ δυάς*. Evenness and oddness as attributes of number: *Top.* 123a12; *APost* 73b18; *Met.* 1004b9, etc. The one: *Top.* 108b25, 141b5; *Met.* 1016b18: *τὸ δὲ ἑνὶ εἶναι ἀρχῇ τινί ἐστιν ἀριθμοῦ εἶναι*; 1021a12–14, 1052b15–24. Cf. J. Klein, *Greek Mathematical Thought and the Origin of Algebra* (Cambridge, Mass., 1968), 46 ff., 51 f.

[120] Nicom. *Ar.* I,7.2–3, 8.2; Theon. *Exp.*, 19.21, 21.22; Iamb. *In Nic.*, 12.11.

not even the Neoplatonists.[121] Aristotle explains it thus: the one is inherent in the nature of both the odd and the even because, when added to an even number it makes an odd, and when added to an odd number, an even.[122] This argument transfers to the one, which is *not* a number, the property of any odd number: added to an even number, it produces an odd number, and vice versa, which does not, of course, mean that three is an even–odd number![123] Corresponding propositions (not for addition, but for subtraction) appear in the early Pythagorean theory of odd and even numbers.[124] Its crowning proof of the fact that the diagonal of a square is incommensurable with its side (Euc. X, app. 27) uses *reductio ad absurdum*: one and the same number cannot be both even and odd. How is it that the very thing which the Pythagorean mathematicians and Aristotle himself (*APr* 41a24 f., 50a37 f.) considered *ἀδύνατον* and *ἄτοπον* turns out to be intrinsic to the one of Aristotle's Pythagoreans? It appears that they were not, after all, brought up in mathematics, but in Academic number metaphysics.

Pythagorean arithmetic, dividing numbers into even and odd, further identified four kinds of 'mixed' numbers from the point of view of their divisibility (Euc. VII, def. 8–11): even–even (for example 8), even–odd (6), odd–even (12), and odd–odd (9).[125] Plato in the *Parmenides* (143d–144a), concerned to produce a complete classification, names all four mixed kinds, Philolaus only one of them:

[121] See *Theol. ar.*, 1.10 f. (from Iamblichus), in which the monad is endowed with almost all the properties of numbers, as also in Procl. *In Parm.*, 1085.5 f. Although Speusippus sometimes treated the one *as if it were* an odd number (fr. 28 with commentary), this does not mean, *pace* Tarán, that he had a special doctrine about it (see above, 425 n. 45); see: I. Mueller, 'On Some Academic Theories of Mathematical Objects', *JHS* 106 (1986), 111–20, at 119. From Xenocrates' 'table of opposites' (fr. 213), *μονὰς–δυάς, περιττὸν–(ἄρτιον)*, it seems to emerge that the one was odd (Huffman, *Archytas*, 487), but the same conclusion also follows from the Pythagorean table: *περιττὸν–ἄρτιον, ἕν–πλῆθος*.

[122] Theon. *Exp.*, 22.5 f. = Arist. fr. 199 = Archyt. A 21; Alex. *In Met.* 40.20 f., 41.15 f. = fr. 13 Ross.

[123] Guthrie, i. 224; G. E. R. Lloyd, *Polarity and Analogy* (Cambridge, 1966), 95 n. 1. Cf. Huffman, *Archytas*, 487.

[124] Euc. IX, 25–7; see above, 262 f., 272 f., 282 f.

[125] Heath, i. 70 ff.

> Number, indeed, has two kinds peculiar to it, odd and even, and a third derived from the mixture of the two, even–odd. Each of the two kinds has many forms, which each thing itself indicates.[126]

Since Philolaus is discussing kinds of numbers, ἀρτιοπέριττον have traditionally been seen as even numbers consisting of odd halves,[127] rather than the one, which was not a number, much less a special kind of number.[128] In recent decades an interpretation has spread, according to which Philolaus was implying what Aristotle wrote about, that is, the One.[129] But in order to read into B 5 an exotic doctrine which runs counter to mathematics and left no trace in the Pythagorean tradition itself, one must have serious grounds, which I cannot see. On the contrary, the fragment of Aristotle on 'harmony' from Ps.-Plutarch's *De musica*, which demonstrates an indisputable Pythagorean influence, and in particular the influence of Philolaus,[130] assigns ἀρτιοπέρισσον to the even–odd numbers, making clear at the same time why Philolaus confined himself to three kinds of numbers. The ἁρμονία-octave and all its parts, we learn here, consists by its nature of the even, the odd, and even–odd. The ἁρμονία-octave itself is even, as it comprises four parts, and those parts, expressed in numbers, are even, odd, and even–odd: 12 is even, 9 odd, 8 even, and 6 even–odd.[131] In the

[126] ὅ γα μὰν ἀριθμὸς ἔχει δύο μὲν ἴδια εἴδη, περισσὸν καὶ ἄρτιον, τρίτον δὲ ἀπ' ἀμφοτέρων μειχθέντων ἀρτιοπέριττον· ἑκατέρω δὲ τῶ εἴδεος πολλαὶ μορφαί, ἃς ἕκαστον αὐταυτὸ σημαίνει (B 5, tr. KRS). The meaning of the last part of the fragment is not completely clear. See Huffman, *Philolaus*, 177 ff.

[127] Cf. Philo, *Περὶ ἀριθμῶν*, fr. 34b, 36a; Nicom. *Ar.* I,9; Theon. *Exp.*, 25.19 f.

[128] Thus Böckh, *Philolaos*, 59; Zeller, i. 445 n. 1; Tannery, *Science*, 381; Heath, i. 70 f.; Klein, *Greek Mathematical Thought*, 58; Lasserre, *Plutarque*, 169; Barker, *Science*, 332.

[129] M. E. Hager, 'Philolaus and the Even-Odd', *CR* 12 (1962), 1–2; Knorr, 163 n. 18; Burkert, 264; Huffman, *Philolaus*, 186 f.; id., *Archytas*, 486 f.; Schibli, 'On "The One"', 117 f. Becker, *Denken*, 46, offered both interpretations without expressing a preference, while Timpanaro Cardini, ii. 202 f., believed that among the Pythagoreans both co-existed.

[130] See the beginning: '*Harmonia* is celestial, and its nature is divine, beautiful and wonderful. In potential it is four-fold, and it has two means, the arithmetic and the harmonic; and its parts and magnitudes are revealed in accordance with number and equal measure; for melodies acquire their structure in two tetrachords' ([Plut.] *De mus.* 23 = fr. 47 Rose = *De philos.* fr. 25 Ross; tr. Barker). See M. Timpanaro Cardini, 'Il frammento musicale di Aristotele', 47, Rose, *PdP* 17 (1962), 300–12; Lasserre, *Plutarque*, 168 f.; Barker, *Science*, 331 ff. It is indicative that this extended fragment does not mention the harmony of the spheres, which is absent from Philolaus as well.

[131] συνέστηκε δὲ φυσικώτατα ἔκ τε τῆς ἀπείρου καὶ περαινούσης καὶ ἐκ τῆς ἀρτιοπερίσσου φύσεως καὶ αὐτὴ καὶ τὰ μέρη αὐτῆς πάντα. αὐτὴ μὲν γὰρ ὅλη ἀρτία ἐστὶ τετραμερὴς οὖσα τοῖς ὅροις, τὰ δὲ μέρη αὐτῆς καὶ οἱ λόγοι ἄρτιοι καὶ περισσοὶ καὶ

more complete classification, 12 is odd–even, but in this instance preference was accorded to a simpler and clearer division.

Philolaus treated his principles, *ἄπειρα* and *περαίνοντα*, separately from even and odd numbers, and without any appeal whatever to mathematics.[132] Aristotle's Pythagoreans *identified* 'limit' and 'unlimited' with the odd and the even. Despite the fact that this thesis, bringing together the world of things and numbers by identifying their principles, is by its nature fundamental, its only explanation adduced by Aristotle is obscure, artificial, and unconvincing. The Pythagoreans and Plato consider *ἄπειρον* to be a substance, not the predicate of anything else, and the Pythagoreans locate it both beyond the cosmos and in sensible things (because they do not separate number from things), while Plato locates it in Forms and sensibles.

> The Pythagoreans say moreover that the unlimited is the even, for this when it is enclosed and limited by the odd, provides the unlimited element in existing things. This is illustrated by what happens when gnomons are placed around numbers: when they are placed round the one, and without the one, in the one case the figure produced varies continuously, whereas in the other it is always the same (*Phys.* 203a3–16, tr. Guthrie).

This refers to the familiar construction of figured numbers with the aid of a gnomon: the addition of odd numbers produces a square number, which preserves its form, while the addition of even numbers produces an oblong number, whose sides always differ by one.[133] Leaving aside the fact that this illustration is not quite precise from

ἀρτιοπέρισσοι· τὴν μὲν γὰρ νεάτην ἔχει ἀρτίαν ἐκ δώδεκα μονάδων, τὴν δὲ παραμέσην περισσὴν ἐξ ἐννέα μονάδων, τὴν δὲ μέσην ἀρτίαν ἐξ ὀκτὼ μονάδων, τὴν δ' ὑπάτην ἀρτιοπέρισσον ἐξ μονάδων οὖσαν (n. 24). 12:9 = 8:6 is a Pythagorean 'musical' proportion (see above, 271). The similarity with Philolaus is underlined by the fact that at the beginning of Chapter 24 *ἔκ τε τῆς ἀπείρου καὶ περαινούσης φύσεως* is used in the sense of the even and the odd. The attribution of these words to Aristotle has been disputed. Thus Ross (fr. 25, p. 93) accepted Volkmann's conjecture *ἔκ τε τῆς ἀρτίας καὶ περισσῆς*; cf., however: Lasserre, *Plutarque*, 122.21; Burkert, 80, 253; Barker, *GMW* i. 231 and n. 164.

132 B 1–3. Huffman, *Philolaus*, 179 ff., allows parallelism in Philolaus' treatment of these two pairs, but not their identification as one and the same.

133 See above, 282 f. and Fig. 7.3. This interpretation, now generally accepted, was proposed only at the beginning of the 20th cent.: Burnet, 102 f., 288 f.; Heath, i. 82 f.; Becker, *Denken*, 40. For ancient interpretations, see W. D. Ross, *Aristotle's Physics. A Revised Text with Intr. and Comm.* (Oxford, 1936), 541 ff.; Burkert, 33 n. 27.

an arithmetical point of view (a gnomon retains the shape of an oblong number unchanged; only the ratios of the sides change: 2:3, 3:4, 4:5), it is clearly secondary and could not provide a basis for the identification of the two pairs of principles. However, Aristotle knew no other explanation, and neither do we.[134] Square and oblong (number) complete the table of ten opposites (*Met.* 986a22–b8); his recourse to them may have been inspired by a wish to demonstrate the correlation between all its pairs. Aristotle himself observed more than once that individual pairs in the table are united by shared features: the bad belongs to the class of the unlimited; the good to the limited (*EN* 1106b30); odd, straight, and square number (τὸ ἰσάκις ἴσον) belong to the column τοῦ καλοῦ (*Met.* 1093b12–14); the Pythagoreans placed τὸ ἕν (*EN* 1096b6–7) in the same column (τῇ τῶν ἀγαθῶν συστοιχίᾳ). However, any attempt to prove the sameness of all pairs inevitably leads into a blind alley: ἕν will turn out to be odd; πλῆθος – even, and so on. Since the table is a product of systematization undertaken by the Platonists, it is highly probable that the illustration showing, by means of the last pair, that the first two pairs are identical also belongs to the Academy.[135] Aristotle had already mentioned in the early *Categories* that a gnomon placed round a square increased it without changing it (15a29–33). This is precisely the kind of elementary mathematics which was used in the Academy to illustrate philosophical problems.[136] Without this mathematics, another fundamental premise of Pythagorean number doctrine remains suspended in mid-air.

As examples of number doctrine, Aristotle often likens certain concepts – usually justice and καιρός – to numbers.[137] Let us consider these examples in more detail. Only once does Aristotle indicate a particular number: three, 'the number of everything' (*Cael.* 268a10–15); the number three also appears in the same light in Plato (*Parm.* 145a5–8). The other numbers are passed on by Alexander, relying on the

[134] Cf. Zeller, i. 490 ff.; W. A. Heidel, '*Peras* and *apeiron* in the Pythagorean Philosophy', *AGPh* 14 (1901), 384–99 (the identification of the two pairs came later); A. E. Taylor, 'Two Pythagorean Philosophemes', *CR* 40 (1926), 149–51; Guthrie, i. 241 f.; Philip, 104 n. 14; Burkert, 34; Huffman, *Philolaus*, 179 ff.

[135] Cf. above, 409 n. 85, and below, 449 f.

[136] That a gnomon around the one is associated with the immutable, and around the two with the mutable is suspiciously reminiscent of Plato's doctrine of the monad and the indefinite dyad. In Xenocrates the pair of highest principles, μονάς and δυάς, is matched by another pair, περιττόν and ἄρτιον (fr. 213). See below, 448 n. 143.

[137] *Met.* 985b29–30, 990a23, 1078b21–3; *EN* 1132b23; *MM* 1182a11.

monograph *Against the Pythagoreans*.[138] All the indications are that some of these analogies are drawn from the Pythagorean tradition; what period they belong to is unknown. Among the Pythagoreans themselves, in Hippon in particular, we find only the three and the seven, which are characteristic of Greek number symbolism,[139] and which he did not connect with any concepts at all. It would be wrong to suppose that Alexander used *only* Aristotle's material, and that Aristotle in his turn had access to an authoritative source on Pythagorean number symbolism, a source which enabled him to distinguish it from Academic arithmology. Thus, when he reports that justice is the first square number, Alexander adds: some believed that it is four, the first square number, while others thought it is nine, the first square of an odd number (*In Met.* 38.14–16). It is highly probable that he was thinking not of the Pythagoreans, but of their later interpreters. An accumulation of interpretations, one on top of another, is noticeable already in Aristotle, especially in the case of seven (ibid. 38.16–39.8). First Alexander adduces arguments which repeat Hippon's reasoning (A 16): birth, the emergence of teeth, puberty, etc. are related to the number seven. The physiological series is followed by a cosmological series, based on Philolaus' system. Since the sun, as Aristotle says, is the cause of the seasons (*αἴτιος εἶναι τῶν καιρῶν*), the Pythagoreans believe that it is situated in the same place as the number seven, which they called *καιρός*; after all, of the ten bodies which revolved round Hestia, the sun occupied seventh place.[140] The third interpretation is even more artificial: the Pythagoreans identified seven with Athena, the motherless maiden, because she alone among the numbers of the decad does not produce other numbers and is not born of them. It is clear that this view was the product of Academic arithmology, which studied the miraculous properties of the first ten numbers; thus Speusippus claimed that seven was neither a quotient nor a divisor (fr. 28, l. 30). There is nothing to confirm the presence of arithmology of this kind among the Pythagoreans,[141] and without it the link between seven and Athena loses all meaning.

[138] *In Met.* 38.8–39.19 = fr. 13 Ross = fr. 162 Gigon.

[139] See above, 397 f.

[140] See above, 405 f.

[141] See above, 407 f.

Marriage is the five, Alexander goes on, because it joins the female and male; even is female, and odd is male; the first even number is two, and the first odd number is three.[142] The identification of even numbers with the female principle, and of odd with male, is known in various cultures, in China, for example. Within the framework of Greek culture, however, we find the closest parallel in Xenocrates, who assigned such predicates as *ἄρρεν–θῆλυ* and *περιττὸν–(ἄρτιον)* to his principles *Μονάς* and *Δυάς*.[143] Aristoxenus, who in his book *On Arithmetic* passes on the Pythagorean teaching on even and odd numbers (fr. 23), makes no mention of their sexual differentiation.[144] It is unlikely that this differentiation goes back to an ancient tradition. At least, we have no evidence of this. The odd–even and male–female pairs, however, appear in the table of opposites, whose Academic provenance is not in doubt.[145] It is even more apparent in Alexander's last two examples:

> Reason and substance they identified with the One. [. . .] Because it was unchanging, alike everywhere, and a ruling principle they called reason monad, or one; but they also applied these names to substance, because it is primary. Opinion they identified with the number 2 because it can move in two directions; they also called it movement and *epithesis*.[146]

According to Aristotle himself, the matching of various types of cognitive activity to numbers (*νοῦς* 1, *ἐπιστήμη* 2, *δόξα* 3, *αἴσθησις* 4) is owed to Plato, who put forward these types themselves.[147] Xenocrates, following Plato, identified *νοῦς* with *τὸ ἕν* (fr. 213) and distinguished *two* types of *δόξα*, the true and the false (fr. 83). *Οὐσία*

[142] *In Met.*, 39.8–13 = fr. 13 Ross = fr. 162 Gigon. An analogous but more detailed interpretation in Plutarch (*Quaest. Rom.* 264a, 288c–d; *De E* 388b–c) evidently also goes back to Aristotle (Burkert, 29 n. 5, 34).

[143] Aët. I,7,30 = fr. 213, *ἄρτιον* is omitted in the text; see Zeller, ii 1. 1014; Baltes, 'Theologie', 192 ff.; Dillon, *Heirs*, 99 ff.

[144] See below, 456.

[145] See below, 449 f. On the differing variants of correlation between its individual pairs, see above, 446.

[146] *νοῦν δὲ καὶ οὐσίαν ἔλεγον τὸ ἕν· ‹ . . . ›. διὰ τὸ μόνιμον δὲ καὶ τὸ ὅμοιον πάντῃ καὶ ἀρχικὸν τὸν νοῦν μονάδα τε καὶ ἓν ἔλεγον· ἀλλὰ καὶ οὐσίαν, ὅτι πρῶτον ἡ οὐσία. δόξαν δὲ τὰ δύο διὰ τὸ ἐπ' ἄμφω μεταβλητὴν εἶναι· ἔλεγον δὲ καὶ κίνησιν αὐτὴν καὶ ἐπίθεσιν* (*In Met.*, 39.16–22 = fr. 13 Ross = fr. 162 Gigon, tr. Ross). Ross interprets *ἐπίθεσις* as the 'addition' of 1 to 1.

[147] See above, 426 n. 47. On types of cognition in Plato: *Phaed.* 96b, *Parm.* 142a, 151e, 164a, *Tim.* 37b–c, *Phil.* 21b; in Aristotle: *APost* 88b34 f., 100b4 f.; *De an.* 428a3; *Met.* 1074b34 f.

is a typically Platonic, and later Peripatetic term. Plato contrasted οὐσία, immutable essence, to becoming and motion; in the *Cratylus* (411c5), μόνιμον is used in this same sense; Eudemus reports that Plato identified κίνησις with 'great-and-small', that is, with the indefinite dyad.[148] According to Aristotle, the Pythagoreans and Plato considered τὸ ἕν a substance, rather than an attribute.[149] Whatever the route which led Aristotle to this conclusion, the only thing in the Pythagorean tradition which corresponds to his reasoning is Philolaus' one (τὸ πρᾶτον ἁρμοσθέν, τὸ ἕν, B 7), composed of 'limit' and 'unlimited'; it is not a numerical unit, of course.[150] Even if the 'Pythagorean' definitions do not fully coincide with those of Plato (to him, opinion was 3, not 2), it is clear that we are dealing with an Academic type of arithmology.

Burkert called the table of ten opposites ascribed by Aristotle to a distinct group of Pythagoreans 'a continuous transition between Pythagorean and Platonic'.[151] This description, correct in principle, requires refinement. A methodical comparison of the table with Pythagorean and Academic material shows that it contains far more of the latter than the former. Is it in any case possible to imagine a Presocratic with ten pairs of principles, including ethical, physical, and mathematical concepts? Of the early Greek thinkers, none went beyond two pairs of physical principles (Empedocles). Everything points to the fact that what we have is a compilation whose author had set himself the goal of raising the number of paired principles to precisely ten. This number, which to Platonists was the perfect number, is not attested in the Pythagorean tradition itself, it appears only in the interpretations of Speusippus and Aristotle.[152] Dualism, in the sense of a theory of opposite qualities or elements, was characteristic of the philosophy of Alcmaeon, Menestor, Philolaus, Simmias, and Echecrates,[153] but such pairs as warm and cold, dry and wet, sweet and

[148] *Tim.* 29c: ὅτιπερ πρὸς γένεσιν οὐσία, τοῦτο πρὸς πίστιν ἀλήθεια; *Soph.* 232c, *Leg.* 966e. Eud. fr. 60.

[149] *Met.* 987a18, b22–3. To the Eleatics, the One was immovable: τὸ ἓν ἀκίνητόν φασιν εἶναι (*Met.* 984a 31); cf. ὅμοιον πάντῃ ἀκίνητον εἶναι τὸ ἕν ([Arist.] *De Melisso* 974a15) – like the νοῦς of the Pythagoreans.

[150] See above, 444.

[151] See above, 434 f.; Burkert, 51.

[152] See above, 404 f., 407 f., 425.

[153] On the theory of the soul as harmony among the pupils of Philolaus, see above, 390 f.

bitter, typical of the Pythagoreans and the Presocratics in general, are absent from the table. True, it begins with the pair limit–unlimited, but is that sufficient to guarantee its Pythagorean origin as a whole?

The connection between the right, the male, and the good, and between the left, the female, and the bad, is traditional in nature and has nothing specifically Pythagorean about it.[154] Even and odd and square and oblong numbers go back to early Pythagorean arithmetic; the first of these pairs is mentioned in Philolaus in a mathematical context, linked with harmonics, as the parallel in Aristotle shows.[155] At the same time, the even and the odd are found in abundance in Plato, who also has square and oblong numbers,[156] and these same types of numbers were treated by Speusippus (fr. 28). The combination of even and odd with left and right first appears in Plato's *Laws*.[157] According to Aristotle, the pairs at rest and moving, and good and bad, are typically Platonic, being derived from his *ἀρχαί*, the One and the indefinite dyad.[158] One and plurality are not only a Platonic principle; they constitute the cornerstone of Speusippus' philosophy. The male–female pair was significant to Xenocrates, who linked it to another pair, even–odd. It is known that Speusippus and Xenocrates had series of opposites similar to those of the Pythagoreans.[159] Aristotle twice links Speusippus with

[154] Parmenides (B 17) and Anaxagoras (A 107) linked the sex of a child, male or female, with right and left; see G. E. R. Lloyd, 'Right and Left in Greek Philosophy', *Methods and Problems*, 27–48, at 38 ff.

[155] See above, 444 f.

[156] See above, 418 n. 12; *Phaed.* 105a7, 106b5–c5, *Tht.* 185d1–3, 198a6, *Res.* 510c3, *Leg.* 946a4. *τετράγωνος-ἑτερόμηκες* (or *πρόμηκες*): *Tht.* 148a–b, *Res.* 510c3–5.

[157] The Athenian suggests allocating even and left to the honours rendered to the chthonic gods, and odd and right to the Olympian gods (717a–b). This is not confirmed by the actual practice of the ritual, see R. Hägg (ed.), *Greek Sacrificial Ritual: Olympian and Chthonian* (Stockholm, 2005); after Plato, this idea is found in Plutarch (*Numa* 14.3; *Quaest. Rom.* 15), who refers directly to the *Laws* (*De Isid.* 361a), then in Porphyry (*VP* 38). See Burkert, 474 n. 56; *Platon, Nomoi IV–VII*. K. Schöpsdau, tr. and comm. (Göttingen, 2003), 213 f. Plato's innovation is usually taken to be an echo of Pythagorean teaching, but it is more likely that the real influence flowed in the opposite direction.

[158] *Met.* 1084a35, cf. *Phys.* 201b16 ff.; Eud. fr. 60; Ross i, 450 f.; Gaiser, *Ungeschriebene Lehre*, 536 f. For Hermodorus' report on Plato's *agrapha dogmata*, see below, 453.

[159] Speusippus: Arist. *Met.* 1085b5, 1087b4, b25; 1092a35; Tarán, *Speusippus*, 32 ff. For Xenocrates one could reconstruct the following table of opposites: *μονὰς–δυάς*, *ἄρρεν-θῆλυ*, *Ζεὺς–μήτηρ θεῶν*, *περιττὸν–ἄρτιον*, *νοῦς–ψυχή* (fr. 213); see above, 448 n. 143.

the Pythagorean table.[160] Aristotle himself evidently thought in terms of a universal table of opposites, of which the Pythagorean table was a particular instance. Sometimes he mentions it as if it were Academic.[161]

The opposites in every series are akin to one another and ethically coloured; odd, square, right, etc. correspond to even, oblong, and left, etc., and cannot be transposed from the 'good' series to the 'bad'.[162] Alcmaeon's and Menestor's opposites, however, can easily be combined crosswise: warm and wet, cold and dry, as was done to the full extent in the humoral theory of the Hippocratics. In Philolaus, ἄπειρα and περαίνοντα have no ethical colouration, and when he discussed spatial concepts (B 17), he insisted that 'up' and 'down' were relative, not absolute![163] Among Aristotle's Pythagoreans, things are the other way round: 'They called right, up and forward "good", and left, down and backward "bad".'[164] Is it accidental that these ethical coordinates coincide with those of Plato's eschatological myth in the *Republic* (614c3–d1), where after judgement the souls of the righteous go to the right and upwards, carrying their sentences in front of them, while the souls of the sinners go to the left and downwards, holding their sentences behind their backs? However much in its detail the table ultimately derives from the Pythagorean tradition, in its final form of the *ten pairs of distinct kindred opposites*, it was created by somebody very well versed in the teaching of Plato and the Platonists. But if there is nothing in the table for which *we* could not find an immediate correspondence in the Academic doctrines, what made Aristotle believe that it is Pythagorean? Most likely it was presented in the Academy as a systematization of Pythagorean teaching. It is usually

[160] *Met.* 1072b30 = fr. 42, *EN* 1096b5–8 = fr. 47.

[161] See e.g. *Phys.* 189a1 ff., 201b21 ff.; *Met.* 1004b27 ff., 1093b11 f. From the works on physics by Aristotle himself, 'we can piece together a Table of Opposites comparable to that of the Pythagoreans' (G. E. R. Lloyd, *Polarity and Analogy* (Cambridge, 1966), 63 f.); see *PA* 670b17 ff.

[162] See above, 446 f.

[163] Burkert, 268; Huffman, *Philolaus*, 215 f.

[164] Simpl. *In Cael.* 386.9 f. = fr. 200 Rose = fr. 10 Ross. From this it follows that some opposites which Aristotle treated as Pythagorean were not included in the table. At *Cael.* 285a11 f. he rebukes the Pythagoreans for omitting the other coordinates when they talk of right and left. For evidence of this, and analysis, see Huffman, *Philolaus*, 222 ff.

supposed that Aristotle learned of it through Speusippus,[165] but our sources do not permit us to establish whether Plato's nephew was its author.

12.3 NUMBER DOCTRINE AT THE LYCEUM?

Were number doctrine a historically attested philosophical theory set out in written or oral form by actual Pythagoreans, it would have found reflection, not only in Aristotle's polemical interpretations, but also in his pupils' works. It would also be natural to expect its appearance in a context independent of Platonic teaching. The Peripatetic tradition does not bear out these expectations. As has been pointed out, Aristotle's pupils adopted from him (certainly not from the Academics!) a tendency to see Plato as the pupil and follower of the Pythagoreans. Thus the words of Dicaearchus that Plato combined in his teaching Pythagoras and Socrates (fr. 41) are a direct echo of the description of Plato in the *Metaphysics*.[166] The expression familiar to us 'the Pythagoreans and Plato' is also found in Eudemus' *Physics*. Defining what is movement in *Phys*. III.2, Aristotle as usual turns to his predecessors. Some 'identify motion with 'difference' or 'inequality' or 'not being'; but such things are not necessarily moved'; the reason for this is that motion 'is thought to be something indefinite, and the principles of the second column are indefinite because they are privative' (201b27 f., tr. Ross). 'Difference', 'inequality', and 'not being' point unmistakably to Plato, but the reference to 'principles of the second column' compelled both ancient and modern commentators to give thought also to the Pythagorean table,[167] though far from every mention of the two columns of opposites leads to that. Commenting on this place, Simplicius cites a parallel passage from Eudemus' *Physics*:

> 'Plato says that motion is the great and small and not-being and the uneven and as many things as have the same force as these. But it seems

[165] Frank, 254 ff.; Cherniss, *Criticism*, 391; Burkert, 52. Tarán, *Speusippus*, 334 f., 348 f., does not rule out the possibility that Speusippus could have referred to the Pythagoreans.

[166] See above, 437 f.

[167] See Ross, *Physics*, 538 f.

> paradoxical to say that motion is just this [. . .]. It is better to say that these are causes (of motion) just as Archytas does'. And a little later 'The Pythagoreans and Plato are right, he says, to apply indefinite to motion (indeed no one else has spoken about it). For it is not definite, and incomplete and what is not. For it (motion) comes to be, and insofar as it is coming to be, it is not.'[168]

Archytas' idea that the causes of motion are ἄνισον and ἀνώμαλον has more to do with mechanics than metaphysics;[169] Eudemus compares it with Plato's *Prinzipienlehre*, with his preference going to Archytas. In the second quotation Eudemus, on the other hand, praises the Pythagoreans and Plato for relating ἀόριστον to motion. Do the two quotations of Eudemus relate to the same subject? Huffman believes that, in the second instance, Eudemus, like Aristotle, had in mind, not Archytas, but the Pythagorean table of opposites, 'because of the indefinite nature of the second column in the table'.[170] It seems more probable that Aristotle had in mind here the general principle of the organization of opposites discussed at the Academy.[171] As Hermodorus reports in his overview of the doctrine of principles (fr. 7), Plato said that some things exist by themselves (man, horse), and others in relation to other things. Of the latter some relate to opposites (good and bad), others to something else, and of these some are definite and others indefinite. Things which allow of more and less, for example unequal, moving, and unarranged, belong to the indefinite, while equal, permanent, and arranged, which do not admit a difference of degree, belong to the definite. Hermodorus' text corresponds much better than the table of ten opposites to what Aristotle writes and Eudemus after him. It is nevertheless possible that Eudemus meant the pair at rest—moving from the Pythagorean table. In any case it is clear that the Πυθαγόρειοι to which he refers in the context of Plato's doctrine of principles are a duplicate of Aristotle's Pythagoreans, not independent evidence of the theories of actual thinkers.

Theophrastus' *Metaphysics* has preserved an analogous, but much better known testimony. Taking issue with the teleological principle,

[168] Simp. *In Phys.* 431.4 f. = fr. 60 = Archyt. A 23, tr. Huffman.

[169] Zhmud, *Origin*, 97 f., 176.

[170] Huffman, *Archytas*, 510 f.

[171] See e.g. *Met.* 1004a26 ff.: 'Again, in the list of contraries one of the two columns is privative, and all contraries are referred to being and nonbeing, and to unity and plurality, as for instance rest belongs to unity and movement to plurality' (tr. Ross).

according to which everything in the world aspires to the better, Theophrastus examines it on various examples, in particular touching on Speusippus' theory that good is found more rarely than bad (32). Then he turns to our heroes (33):

> Plato and the Pythagoreans [hold] the distance to be a great one, seeing that all things wish to imitate [the good]. Still for them, as they posit something like an opposition between the One and the indefinite dyad (on which rest both unlimited and the unordered, and, practically speaking, all shapelessness as such), it is altogether impossible that the nature of the whole should exist without the latter; it could only have (so to speak) an equal share or even exceed the other; this is how ‹they say that› the principles are contrary to each other.[172]

Plato's doctrine of *ἕν* and *ἀόριστος δυάς* had figured earlier in the *Metaphysics*. Theophrastus contrasted it with the position of Eurytus, who did not stop at deriving intermediate essences from first principles, but went as far as physical bodies.[173] In the given passage Plato and the Pythagoreans together represent the following views: the distance between the good (the One) and everything else is great; all things aspire to imitate the good. The antithesis of the One (the good) is the indefinite dyad, which they believe to be an equal principle responsible for all that is indefinite in the world. In the 'Pythagorean' table one is opposite plurality, and good is opposite bad, but Theophrastus' source is Plato's unwritten doctrine. Note how unremarkable it is for the Pythagoreans once again to appear in that context. Theophrastus does not project into the past typically Platonic theories and does not contest their authorship. He merely places the Pythagoreans alongside Plato, as Aristotle did regularly; if they were to be removed, absolutely nothing would change.[174] It is true that Aristotle, at least in the surviving tradition, never connected the Pythagoreans with the doctrine of *ἕν* and *ἀόριστος δυάς*. However they figured so

[172] *Πλάτων δὲ καὶ οἱ Πυθαγόρειοι μακρὰν τὴν ἀπόστασιν, ἐπεὶ μιμεῖσθαι γ' ἐθέλειν ἅπαντα. καίτοι καθάπερ ἀντίθεσίν τινα ποιοῦσιν τῆς ἀορίστου δυάδος καὶ τοῦ ἑνός (ἐν ᾗ καὶ τὸ ἄπειρον καὶ τὸ ἄτακτον καὶ πᾶσα ὡς εἰπεῖν ἀμορφία καθ' αὑτήν) ὅλως οὐχ οἷόν τε ἄνευ ταύτης τὴν τοῦ ὅλου φύσιν, ἀλλ' οἷον ἰσομοιρεῖν ἢ καὶ ὑπερέχειν τῆς ἑτέρας· ᾗ καὶ τὰς ἀρχὰς ἐναντίας* (11a27–b7, text and trans. van Raalte, who accepts the reading *ἐπεὶ μιμεῖσθαι* instead of the manuscript *ἐπιμιμεῖσθαι* (thus Laks and Most (eds.), *Théophraste*, 86). See also Burkert, 62 n. 57.

[173] 6a14 f. See above, 410 f.

[174] Theophrastus paid no attention to Aristotle's words that Plato had replaced the Pythagoreans' *μίμησις* with *μέθεξις*, see above, 437 f.

often in his work in connection with other aspects of Plato's unwritten doctrine, including the latter's lecture on the Good,[175] that it was easy for Theophrastus to take the next step in that direction, unaware of its revolutionary nature.[176] (It is obvious that Theophrastus, like Eudemus, followed his teacher here, and not Speusippus.[177]) In effect this remark of Theophrastus had no serious consequences. By the time his *Metaphysics* had once again become accessible to a philosophical audience, a quite different doctrine, on the generation by the monad of the indefinite dyad, was considered to be Pythagorean.[178]

What Theophrastus does not say is no less important than what he does say. In his *Opinions of the Physicists*, we find the teachings of individual Pythagoreans from Alcmaeon to Hicetas and Ecphantus, but, as was to be expected, not a trace of a general Pythagorean number doctrine with which Aristotle polemized.[179] Usually attentive to the doxographical remarks of his teacher, in this instance Theophrastus could not identify number doctrine with the teaching of any of the Pythagorean philosophers known to him. If Theophrastus could not do so, can we have any hope of success? Not only were the Pythagoreans as a group absent from the *Opinions of the Physicists*, but Pythagoras also. Evidently Theophrastus followed Aristotle in not regarding him as a 'physicist'. Pythagoras and the *Πυθαγόρειοι* were included in the doxography by the author of the *Vetusta placita*, a follower of Posidonius, who in the middle of the first century revised Theophrastus' compendium in accordance with the notions of his school and his times.[180]

[175] See above, 440 and n. 111.

[176] 'Once Aristotle said that Plato took over some of his fundamental doctrines from the Pythagoreans, this obviously was used as an excuse to attribute anything said by Plato to them', Merlan, 'Pythagoreans', 86.

[177] *Pace* Burkert, 57 ff., 62 ff. Cf. above, 421 f.

[178] See above, 422 f.

[179] On the corporeal monads of Ecphantus see above, 413 f.

[180] See Zhmud, *Origin*, 295 f.; id., 'Doxographische Tradition', 167 f. An abridged version of the *Vetusta placita* is the compendium of Aëtius (*c.* AD 100) reconstructed by Diels. On the late origin of the doxography of Pythagoras in Aëtius see *Dox.*, 181; Zeller, I. 467 f.; Burkert, 62. In the chapter *On Principles* (I,3,8 = 58 B 15) teachings are ascribed to him the sources of which were Heraclides of Pontus (fr. 87): the invention of the word 'philosophy' (280a17–281a2; see above, 428 f.); Aristotle: principles are number and harmony (281a2–6); pseudo-Pythagorica: the principles of the Pythagoreans are monad and indefinite dyad (281a6–12;cf. above, 424 n. 36); Speusippus (fr. 28): the doctrine of the decad (281a12–282a5; cf. above, 303 n. 61); pseudo-Pythagorica: the Pythagorean oath and the tetractys (282a5–13; see above, 300 f.);

The sole Peripatetic to mention one of the aspects of number doctrine was Aristoxenus, who knew the Pythagorean tradition well. The testimony set out above is taken from his work *On Arithmetic*: 'Pythagoras more than anybody else seems to have valued the science of numbers and to have advanced it, separating it from the merchants' business and likening (ἀπεικάζων) all things to numbers. For number contains all things as well, and there is a ratio (λόγος) between all the numbers to each other.'[181] Aristoxenus speaks of similarities, or analogies, well known to us, between numbers and 'things', which are the most tangible example of Pythagorean number symbolism. While Aristotle treated ὁμοιώματα between numbers and 'things' in an ontological sense, the mention of λόγος, which exists among all numbers, indicates that Aristoxenus understood the link between things and numbers in an epistemological sense, as did Philolaus, who declared, 'all the things that are known have number'.[182] This is emphasized also by the link between odd numbers and medical prognostics, mentioned at the end of Aristoxenus' fragment: 'It is considered, therefore, that crises and changes in illnesses relating to their beginning, peak, and end occur on odd days, since an odd number has a beginning, a middle and an end' (fr. 23). This contention, related to the thesis that three is 'the number of everything', with which Aristotle concurred (*Cael.* 268a10 f.), does not at all mean that illness *is* a number, or that it *consists* of numbers, or that the *principles* of number and illness are identical. Aristoxenus' example can be understood only in the sense of a similarity between odd numbers and the stages of an illness: since both have a beginning, a peak, and a conclusion, then changes in illness occur precisely on odd-numbered days. The doctrine of critical days, most often (but not necessarily) odd-numbered, was widespread in Hippocratic medicine, from which it evidently found its way into the Pythagorean tradition.[183] Aristoxenus' evidence bears no relation to the number metaphysics which Aristotle foisted on the Pythagoreans.

finally Plato in Aristotle's interpretation (*De an.* 404b16 f.): the likening of 1, 2, 3, and 4 to νοῦς, ἐπιστήμη, δόξα, and αἴσθησις (282a13–283a9; see above, 426 n. 47, 448 n. 147).

[181] Fr. 23; see above, 261 f.; more detail see Zhmud, *Origin*, 218 f.

[182] B 4; see above, 402 f.

[183] See Jouanna, *Hippocrate*, 475 f. and above, 349 n. 5. Cf. e.g. 'One must be specially cautious of odd-numbered days, since those days are decisive in one way or another' (*De victu acut.* [Appendix] 9; *Epid.* I, 12; *De sept. partu*, 9.

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