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(*b*. Miletus, Ionia, 625 B.C. [?] *d*. 547 B.C. [?])

natural philosophy.

Thales is considered by Aristotle to be the “founder” (ἀϱχηγός) of Ionian natural philosophy.[1] He was the son of Examyes and Cleobuline, who were, according to some authorities, of Phoenician origin. But the majority opinion considered him a true Milesian by descent (ἰυαγενής Μιλήσιος), and of a distinguished family. This latter view is probably the correct one since his father’s name seems to be Carian rather than Semitic, and the Carians had at this time been almost completely assimilated by the Ionians. According to Diogenes Laèrtius, Apollodorus put Thales’ birth in Olympiad 35.1 (640 B.C.) and his death at the age of 78 in Olympiad 58 (548–545 B.C.). There is a discrepancy in the figures here; probably 35.1 is a mistake for 39.1 (624), since the confusion of ϵ̄ and ῡ is a very common one. Apollodorus would in that case characteristically have made Thales’ death correspond with the date of the fall of Sardis, his *floruit* coincide with the eclipse of the sun dated at 585 B.C.–which he is alleged to have predicted–and assumed his birth to be the conventional forty years before his prime.[2]

Even in antiquity there was considerable doubt concerning Thales’ written works. It seems clear that Aristotle did not have access to any book by him, at least none on cosmological matters. Some authorities declare categorically that he left no book behind. Others, however, credit him with the authorship of a work on navigation entitled “The Nautical Star Guide,” but in spite of a tradition suggesting that Thales defined the Little Bear and recommended its navigational usefulness to Milesian sailors,[3] it is extremely doubtful that he was the actual author of this work, since Diogenes Laërtius informs us that this book was also attributed to a certain Phokos of Samos. It is most unlikely that a work of Thales would have been ascribed to someone of comparative obscurity, but not the converse.

Much evidence of practical activities associated with Thales has survived, testifying to his versatility as statesman, tycoon, engineer, mathematician, and astronomer. In the century after his death he became an epitome of practical ingenuity.[4] Herodotus records the stories that Thales advised the Ionians to establish a single deliberative chamber at Teos and that he diverted the river Halys so that Croesus’ army might be able to cross. (Herodotus is skeptical about the latter explanation.)[5] Aristotle preserves another anecdote that credits Thales with considerable practical knowledge. According to this account, Thales, when reproached for his impracticality, used his skill in astronomy to forecast a glut in the olive crop, went out and cornered the market in the presses, and thereby made a large profit. Aristotle disbelieves the story and comments that this was a common commercial procedure that men attributed to Thales on account of his wisdom.[6] Plato, on the other hand, whose purpose is to show that philosophy is above mere utilitarian considerations, tells the conflicting anecdote that Thales, while stargazing, fell into a well and was mocked by a pretty Thracian servant girl for trying to find out what was going on in the heavens when he could not even see what was at his feet.[7] It is clear that these stories stem from separate traditions–the one seeking to represent the philosopher as an eminently practical man of affairs and the other as an unworldly dreamer.

Thales achieved his fame as a scientist for having predicted an eclipse of the sun. Herodotus, who is our oldest source for this story, tells us that the eclipse (which must have been total or very nearly so) occurred in the sixth year of the war between the Lydians under Alyattes and the Medes under Cyaxares, and that Thales predicted it to the Ionians, fixing as its term the year in which it actually took place.[8] This eclipse is now generally agreed to have occurred on 28 May 585 B.C. (–584 by astronomical reckoning). It has been widely accepted that Thales was able to perform this striking astronomical feat by using the so-called “Babylonian saros,” a cycle of 223 lunar months (18 years, 10 days, 8 hours), after which eclipses both of the sun and moon repeat themselves with very little change. Neugebauer, however, has convincingly demonstrated that the “Babylonian saros” was, in fact, the invention of the English astronomer Edmond Halley in rather a weak moment.[9] The Babylonians did not use cycles to predict solar eclipses but computed them from observations of the latitude of the moon made shortly before the expected syzygy. As Neugebauer says,

. . . there exists no cycle for solar eclipses visible at a given place; all modern cycles concern the earth as a whole. No Babylonian theory for predicting a solar eclipse existed at 600 B.C., as one can see from the very unsatisfactory situation 400 years later, nor did the Babylonians ever develop any theory which took the influence of geographical latitude into account.[10]

Accrodingly, it must be assumed that if Thales did predict the eclipse he made an extremely lucky guess and did not do so upon a scientific basis, since he had no conception of geographical latitude and no means of determining whether a solar eclipse would be visible in a particular locality. He could only have said that an eclipse was possible somewhere at some time in the (chronological) year that ended in 585 B.C. But a more likely explanation seems to be simply that Thales happened to be the *savant* around at the time when this striking astronomical phenomenon occurred and the assumption was made that as a savant he *must* have been able to predict it. There is a situation closely parallel to this one in the next century. In 468–467 B.C.

a huge meteorite fell at Aegospotami. This event made a considerable impact, and two sources preserve the absurd report that the fall was predicted by Anaxagoras, who was the Ionian *savant* around at that time.[11]

The Greeks themselves claim to have derived their mathematics from Egypt.[12] Eudemus, the author of the history of mathematics written as part of the systematization of knowledge that went on in the Lyceum, is more explicit. He tells us that it was "Thales who, after a visit to Egypt, first brought this study to Greece" and adds "not only did he make numerous discoveries himself, but he laid the foundations for many other discoveries on the part of his successors, attacking some problems with greater generality and others more empirically." Proclus preserves for us some of the discoveries that Eudemus ascribed to Thales, namely, that the circle is bisected by its diameter,[13] that the base angles of an isosceles triangle are equal,[14] and that vertically opposed angles are equal.[15] In addition he informs us that the theorem that two triangles are equal in every respect if they have two angles and one side respectively equal was referred by Eudemus to Thales with the comment that the latter's measuring the distance of ships out at sea necessarily involved the use of this theorem.[16]

From the above it can be seen that Eudemus credited Thales with full knowledge of the theory behind his discoveries. He also held that Thales introduced geometry into Greece from Egypt. Our surviving sources of information about the nature of Egyptian mathematics, however, give us no evidence to suggest that Egyptian geometry had advanced beyond certain rule–of–thumb techniques of practical mensuration. Nowhere do we find any attempt to discover why these techniques worked, nor anything resembling a general and theoretical mathematics. It seems most unlikely, then, that the Greeks derived their mathematics from the Egyptians. But could Thales have been the founder of theoretical mathematics in Greece, as Eudemus claimed? Here again the answer must be negative. The first three discoveries attributed to him by the Peripatetic most probably represent "just the neatest abstract solutions of particular problems associated with Thales."[17] Heath points out that the first of these propositions is not even proved in Euclid.[18] As for the last of them, Thales could very easily have made use of a primitive angle–measurer and solved the problem in one of several ways without necessarily formulating an explicit theory about the principles involved.

Van der Waerden, on the other hand, believes that Thales did develop a logical structure for geometry and introduced into this study the idea of proof.[19] He also seeks to derive Greek mathematics from Babylon. This is a very doubtful standpoint. Although Babylonian mathematics, with its sexagesimal place–value system, had certainly developed beyond the primitive level reached by the Egyptians, here too we find nowhere any attempt at proof. Our evidence suggests that the Greeks were influenced by Babylonian mathematics, but that this influence occurred at a date considerably later than the sixth century B.C. If the Greeks had derived their mathematics from Babylonian sources, one would have expected them to have adopted the much more highly developed place-value system. Moreover, the Greeks themselves, who are extremely generous, indeed overgenerous, in acknowledging their scientific debts to other peoples, give no hint of a Babylonian source for their mathematics.

Our knowledge of Thales' cosmology is virtually dependent on two passages in Aristotle. In the *Metaphysics* (A3, 983b6) Aristotle, who patently has no more information beyond what is given here, is of the opinion that Thales considered water to be the material constituent of things, and in the *De caelo* (B13, 294a28), where Aristotle expressly declares his information to be indirect, we are told that Thales held that the earth floats on water. Seneca provides the additional information (*Naturales quaestiones*, **III** , 14) that Thales used the idea of a floating earth to explain earthquakes. If we can trust this evidence, which seems to stemultimately from Theophrastus via a Posidonian source, the implication is that Thales displays an attitude of mind strikingly different from anything that had gone before. Homer and Hesiod had explained that earthquakes were due to the activity of the god Poseidon, who frequently bears the epic epithet "Earth Shaker," Thales, by contrast, instead of invoking any such supernatural agency, employs a simple, natural explanation to account for this phenomenon. Cherniss, however, has claimed that Aristotle's knowledge of Thales' belief that the earth floats on water would have been sufficient to induce him to infer that Thales also held water to be his material substrate.[20] But it is impossible to believe that Aristotle could have been so disingenuous as to make this inference and then make explicit conjectures as to why Thales held water to be his ἀρχή. Aristotle's conjectured reasons for the importance attached by Thales to water as the ultimate constituent of things are mainly physiological. He suggests that Thales might have been led to this conception by the observation that nutriment and semen are always moist and that the very warmth of life is a dampwarmth. Burnet has rejected these conjectures by Aristotle on the ground that in the sixth century interests were meteorological rather than physiological.[21] But, as Baldry has pointed out, an interest in birth and other phenomena connected with sex is a regular feature even of primitive societies long before other aspects of biology are thought of.[22] However this may be, it is noteworthy that, in view of the parallels to be found between Thales' cosmology and certain Near Eastern mythological cosmogonies,[23] there exists the possibility that Thales' emphasis upon water and his theory that the earth floats on water were derived from some such source, and that he conceived of water as a "remote ancestor" rather than as a persistent substrate. But even it Thales was influenced by mythological precedents[24] and failed to approximate to anything like the Aristotelian material cause, our evidence, sparse and controversial though it is, nevertheless seems sufficient to justify the claim that Thales was the first philosopher. This evidence suggests that Thales' thought shared certain basic characteristics with that of his Ionian successors. These Milesian philosophers, abandoning mythopoeic forms of thought, sought to explain the world about them in terms of its visible constitutents. Natural explanations were introduced by them, which took the place of supernatural and mystical ones.[25] Like their mythopoeic predecessors, the Milesians firmly believed that there was an orderliness inherent in the world around them. Again like their predecessors, they attempted to explain the world by showing how it had come to be what it is. But, instead of invoking the agency of supernatural powers, they sought for a unifying hypothesis to account for this order and, to a greater or lesser extent, proceeded to deduce their natural explanations of the various phenomena from it. Two elements, then, characterize early Greek philosophy, the search for natural as opposed to supernatural and mystical explanations, and secondly, the search for a unifying hypothesis. Both of these elements proved influential in paving the way for the development of the sciences, and it is in the light of this innovation that Thales's true importance in the history of science must be assessed.

NOTES

1.*Metaphysics*, A3, 983b17 ff. (DK, 11A12).

2. These datings are now approximately in accordance with the figures given by Demetrius of Phalerum, who placed the canonization of the Seven Sages (of whom Thales was universally regarded as a member) in the archonship of Damasias at Athens (582–581 B.C.).

3. Callimachus, *Iambus*, 1, 52 f. 191 Pfeiffer (DK, 11A3a).

4. See Aristophanes, *Birds* 1009; *Clouds* 180.

5. Herodotus, I, 170; I, 75 (DK, 11A4, 11A6).

6.*Politics*, A11, 1259a6 (DK, 11A10).

7.*Theaetetus*, 174A (DK, 11A9). It is odd that Plato should have applied this story to someone as notoriously practical in his interests as Thales. It makes one think that there may be at least a grain of truth in the story. See my review of Moraux's Budé edition of the *De caelo*, in *Classical Review*, n.s., **20** (1970), 174, and M. Landmann and J. O. Fleckenstein, "Tagesbeobachtung von Sternen in Altertum." in *Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich*, **88** (1943), 98, notwithstanding Dicks' scornful dismissal of their suggestion. Certainly the motive for this story is clear, but it could have been Thales' practice that determined its form. In general Dicks is far too skeptical in his treatment of the stories told of Thales and relegates them to the status of "the famous story of the First World War about the Russians marching through England with 'snow on their boots.'" But on this latter story see Margo Lawrence, *Shadow of Swords* (London, 1971), in which she reveals that soldiers from Russia, wearing Russian uniform, carrying balalaikas, and singing Slavonic songs, did in fact disembark in 1916 at Newcastle upon Tyne. Admittedly the snow on their boots must be left to folklore.

8. I, 74 (DK, 11A5).

9. O. Neugebauer, The Exact Sciences in Antiquity, 141.

10.*Ibid*., 142.

11. See Diogenes Laërtius, II, 10 (DK, 59A1), and Pliny, *Historia naturalis*, **II** , 149 (DK, 59A11), See also Cicero, *Dedivinatione*, **I** .50.112 (DK, 12A5a), and Pliny, *ibid*., **II** , 191, for a sixth–century parallel, where Anaximander is alleged to have predicted an earthquake.

12. See Herodotus, **II** , 109, who believes that geometry originated from the recurrent need to remeasure land periodically flooded by the Nile: Aristotle, *Metaphysics*, A3, 98Ib20–25, who believes that mathematics evolved in a highly theoretical way as the invention of a leisured class of Egyptian priests: and Eudemus, who, in spite of being a Peripatetic, sides with Herodotus rather than with Aristotle (see Proclus, *Commentary on Euclid's Elements*, I, 64, 16 "Friedlein")

13.*Commentary on Euclid's Elements*, 157.10 (DK, 11A20)

14.*Ibid*., 250.20.

15.*Ibid*., 299.1.

16.*Ibid*., 352.14.

17. G. S. Kirk, *The Presocratic Philosophers*, 84.

18. T. L. Heath, *Greek Mathematics*, **I** , 131.

19. B. L. van der Waerden, *Science Awakening*, 89.

20. H. Cherniss, "The Characteristics and Effects of Presocratic Philosophy," in *Journal of the History of Ideas*, **12** (1951), 321.

21. J. Burnet, *Early Greek Philosophy*, 48.

22. H. C. Baldry, "Embryological Analogies in Early Greek Philosophy," in *Classical Quarterly*, **26** (1932), 28.

23. For an excellent account of Egyptian and Mesopotamian cosmogonies, see H. Frankfort, ed., *Before Philosophy* (Penguin Books, London, 1949), pub. orig. as *The Intellectual Adventure of Ancient Man* (Chicago, 1946).

24. Aristotle, it may be noted, cites the parallel in Greek mythology of Oceanus and Tethys, the parents of generation (*Metaphysics*, A3, 983b27ff. [DK,1B10]). But the Greek myth may itself be derived from an oriental source.

25. The gods of whom Thales thought everything was full (see Aristotle. *De anima*, A5, 411a7 [DK, 11A22]) are manifestly different from the personal divinities of traditional mythology.

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