CHAPTER I., THE MILESIAN SCHOOL

1. Miletus and Lydia

IT was at Miletos that the earliest school of scientific cosmology had its home, and it is not, perhaps, without significance that Miletos is just the place where the continuity of Aegean and Ionian civilisation is most clearly marked.[1] The Milesians had come into conflict more than once with the Lydians, whose rulers were bent on extending their dominion to the coast; but, towards the end of the seventh century B.C., the tyrant Thrasyboulos succeeded in making terms with King Alyattes, and an alliance was concluded which secured Miletos against molestation for the future. Even half a century later, when Croesus, resuming his father's forward policy, made war upon and conquered Ephesos, Miletos was able to maintain the old treaty-relation, and never, strictly speaking, became subject to the Lydians at all. The Lydian connexion, moreover, favoured the growth of science at Miletos. What was called at a later date Hellenism seems to have been traditional in the dynasty of the Mermnadai, and Herodotos says that all the "sophists" of the time flocked to the court of Sardeis.[2] The tradition which represents Croesus as the "patron" of Greek wisdom was fully developed in the fifth century; and, however unhistorical its details may be, it must clearly have some foundation in fact. Particularly noteworthy is "the common tale among the Greeks," that Thales accompanied Croesus on his luckless campaign against Pteria, apparently in the capacity of military engineer. Herodotos disbelieves the story that he diverted the course of the Halys, but only because he knew there were bridges there already. It is clear that the Ionians were great engineers, and that they were employed as such by the eastern kings.[3]

It should be added that the Lydian alliance would facilitate intercourse with Babylon and Egypt. Lydia was an advanced post of Babylonian culture, and Croesus was on friendly terms with the kings of Egypt and Babylon. Amasis of Egypt had the same Hellenic sympathies as Croesus, and the Milesians possessed a temple of their own at Naukratis.

I. THALES

2. Origin

The founder of the Milesian school, and therefore the first man of science, was Thales;[4] but all we can really be said to know of him comes from Herodotos, and the Tale of the Seven Wise Men was already in existence when he wrote. He says that Thales was of Phoenician descent, a statement which other writers explained by saying he belonged to a noble house descended from Kadmos and Agenor.[5] Herodotos probably mentions the supposed descent of Thales simply because he was believed to have introduced certain improvements in navigation from Phoenicia.[6] At any rate, his father's name, Examyes, lends no support to the view that he was a Semite. It is Karian, and the Karians had been

almost completely assimilated by the Ionians. On the monuments we find Greek and Karian names alternating in the same families, while the name Thales is otherwise known as Cretan. There is therefore no reason to doubt that Thales was of pure Milesian descent, though he probably had Karian blood in his veins.[7]

3. The Eclipse Foretold by Thales

The most remarkable statement Herodotos makes about Thales is that he foretold the eclipse of the sun which put an end to the war between the Lydians and the Medes.[8] Now, he was quite ignorant of the cause of eclipses. Anaximander and his successors certainly were so,[9] and it is incredible that the explanation should have been given and forgotten so soon. Even supposing Thales had known the cause of eclipses, such scraps of elementary geometry as he picked up in Egypt would never have enabled him to calculate one. Yet the evidence for the prediction is too strong to be rejected off-hand. The testimony of Herodotos is said to have been confirmed by Xenophanes,[10] and according to Theophrastos Xenophanes was a disciple of Anaximander. In any case, he must have known scores of people who were able to remember what happened. The prediction of the eclipse is therefore better attested than any other fact about Thales whatsoever.

Now it is possible to predict eclipses of the moon approximately without knowing their true cause, and there is no doubt that the Babylonians actually did so. It is generally stated, further, that they had made out a cycle of 223 lunar months, within which eclipses of the sun and moon recurred at equal intervals of time.[11] This, however, would not have enabled them to predict eclipses of the sun for a given spot on the earth's surface; for these phenomena are not visible at all places where the sun is above the horizon at the time. We do not occupy a position at the centre of the earth, and the geocentric parallax has to be taken into account. It would only, therefore, be possible to tell by means of the cycle that an eclipse of the sun would be visible somewhere, and that it might be worth while to look out for it, though an observer at a given place might be disappointed five times out of six. Now, if we may judge from reports by Chaldaean astronomers which have been preserved, this was just the position of the Babylonians in the eighth century B.C. They watched for eclipses at the proper dates; and, if they did not occur, they announced the fact as a good omen.[12] To explain what we are told about Thales no more is required. He said there would be an eclipse by a certain date; and luckily it was visible in Asia Minor, and on a striking occasion.[13]

4. The Eclipse Foretold by Thales

The prediction of the eclipse does not, then, throw any light on the scientific attainments of Thales; but, if we can fix its date, it will give us an indication of the time at which he lived. Astronomers

have calculated that there was an eclipse of the sun, probably visible in Asia Minor, on May 28 (O.S.), 585 B.C., while Pliny gives the date of the eclipse foretold by Thales as Ol. XLVIII.4 (585/4 B.C.).[14] This does not exactly tally; for May 585 belongs to the year 586/5 B.C. It is near enough, however, to justify us in identifying the eclipse as that of Thales,[15] and this is confirmed by Apollodoros, who fixed his *floruit* in the same year.[16] The further statement in Diogenes that, according to Demetrios Phalereus, Thales "received the name of wise" in the archonship of Damasias at Athens, really refers to the Tale of the Seven Wise Men, as is shown by the words which follow, and is doubtless based on the story of the Delphic tripod; for the archonship of Damasias is the era of the restoration of the Pythian Games.[17]

5. Thales in Egypt

The introduction of Egyptian geometry into Hellas is ascribed to Thales,[18] and it is probable that he did visit Egypt; for he had a theory of the inundations of the Nile. Herodotos[19] gives three explanations of the fact that this alone of all rivers rises in summer and falls in winter; but, as his custom is, he does not name their authors. The first, however, which attributes the rise of the Nile to the Etesian winds, is ascribed to Thales in the *Placita*,[20] and by many later writers. Now, this comes from a treatise on the Rise of the Nile attributed to Aristotle and known to the Greek commentators, but extant only in a Latin epitome of the thirteenth century.[21] In this the first of the theories mentioned by Herodotos is ascribed to Thales, the second to Euthymenes of Massalia, and the third to Anaxagoras. Where did Aristotle, or whoever wrote the book, get these names? We think naturally of Hekataios; and this conjecture is strengthened when we find that Hekataios mentioned Euthymenes.[22] We may conclude that Thales really was in Egypt; and, perhaps, that Hekataios, in describing the Nile, took account, as was natural, of his fellow-citizen's views.

6. Thales and Geometry

As to the nature and extent of the mathematical knowledge brought back by Thales from Egypt, it must be pointed out that most writers have seriously misunderstood the character of the tradition.[23] In his commentary on the First Book of Euclid, Proclus enumerates, on the authority of Eudemos, certain propositions which he says were known to Thales,[24] one of which is that two triangles are equal when they have one side and the two adjacent angles equal. This he must have known, as otherwise he could not have measured the distances of ships at sea in the way he was said to have done.[25] Here we see how all these statements arose. Certain feats in the way of measurement were traditionally ascribed to Thales, and Eudemos assumed that he must have known all the propositions these imply. But this is quite illusory. Both the measurement of the distance of ships at sea, and that of the height of the pyramids, which is also ascribed to him,[26] are easy applications of the rule given by Aahmes for finding the *seqt*.[27] What the tradition really points to is that Thales applied this empirical

rule to practical problems which the Egyptians had never faced, and that he was thus the originator of general methods. That is a sufficient title to fame.

7. Thales as a Politician

Thales appears once more in Herodotos some time before the fall of the Lydian monarchy. He is said to have urged the Ionian Greeks to unite in a federal state with its capital at Teos.[28] We shall have occasion to notice more that once that the early schools of philosophy by no means held aloof from politics; and, there are many things, for instance the part played by Hekataos in the Ionian revolt, which suggest that the scientific men of Miletos took up a very decided position in the stirring times that followed the death of Thales. It is this political action which has gained the founder of the Milesian school his undisputed place among the Seven Wise Men; and it is owing to his inclusion among those worthies that the numerous anecdotes told of him in later days attached themselves to his name.[29]

8. Uncertain Character of the Tradition

So far as we know, Thales wrote nothing, and no writer earlier than Aristotle knows anything of him as a scientific man and a philosopher; in the older tradition he is simply an engineer and an inventor.[30] It is obvious, however, that the requirements of Milesian enterprise and commerce would necessarily turn his attention to problems which we should call astronomical. He was said, we saw, to have introduced the practice of steering a ship's course by *Ursa minor*;[31] and there is a remarkable persistence in the tradition that he tried to do something for the calendar, though the details are not sufficiently well attested to find a place here.[32] No doubt he constructed a παράπηγμα like those of much later date which have been discovered at Miletos.[33] The παράπηγμα was the oldest form of almanac, and gave, for a series of years, the equinoxes and solstices, the phases of the moon, the heliacal risings and settings of certain stars, and also weather predictions. Even Aristotle does not pretend to know how Thales arrived at the views he ascribes to him or by what arguments they were supported. This very reserve, however, makes it hard to doubt that he was correctly informed with regard to the few points about them he mentions, so we may venture on a conjectural restoration of his cosmology. This, of course, must be taken for just what it is worth.

9. The Cosmology of Thales

The statements of Aristotle may be reduced to three:

(1) The earth floats on the water.[34]
(2) Water is the material cause[35] of all things.
(3) All things are full of gods. The magnet is alive; for it has the power of moving iron.[36]

The first of these statements must be understood in the light of the second, which is expressed in Aristotelian terminology, but would undoubtedly mean that Thales had said water was the stuff of which all other things were transient forms. We have seen that this was the great question of the day.

10. Water

Aristotle and Theophrastos, followed by Simplicius and the doxographers, suggest several explanations of this doctrine. Aristotle gives them as conjectures; it is only later writers that repeat them as if they were quite certain.[37] The most probable view seems to be that Aristotle ascribed to Thales the arguments used at a later date by Hippon of Samos in support of a similar thesis.[38] That would account for their physiological character. The rise of scientific medicine had made biological arguments popular in the fifth century; but, in the days of Thales, the prevailing interest was not physiological, but meteorological, and it is from this point of view we must try to understand the theory.

Now it is not hard to see how meteorological considerations may have led Thales to adopt the view he did. Of all the things we know, water seems to take the most various shapes. It is familiar to us in a solid, a liquid, and a vaporous form, and so Thales may well have thought he saw the world-process from water and back to water again going on before his eyes. The phenomenon of evaporation naturally suggests that the fire of the heavenly bodies is kept up by the moisture they draw from the sea. Even at the present day people speak of "the sun drawing water." Water comes down again in rain; and lastly, so the early cosmologists thought, it turns to earth. This may have seemed natural enough to men familiar with the river of Egypt which had formed the Delta, and the torrents of Asia Minor which bring down large alluvial deposits. At the present day the Gulf of Latmos, on which Miletos used to stand, is filled up. Lastly, they thought, earth turns once more to water—an idea derived from the observation of dew, night-mists, and subterranean springs. For these last were not in early times supposed to have anything to do with the rain. The "waters under the earth" were regarded as an independent source of moisture.[39]

11. Theology

The third of the statements mentioned above is supposed by Aristotle to imply that Thales believed in a "soul of the world," though he is careful to mark this as no more than an inference.[40] The doctrine of the world-soul is then attributed quite positively to Thales by Aetios, who gives it in the Stoic phraseology which he found in his immediate source, and identifies the world-intellect with God.[41] Cicero found a similar statement in the Epicurean manual which he followed, but he goes a step further. Eliminating the Stoic pantheism, he turns the world-intellect into a Platonic *demiourgos*, and says that Thales held there was a divine mind which formed all things out of water.[42] All this is derived from

Aristotle's cautious statement, and can have no greater authority than its source. We need not enter, then, on the old controversy whether Thales was an atheist or not. If we may judge from his successors, he may very possibly have called water a "god"; but that would not imply any definite religious belief.[43]

Nor must we make too much of the saying that "all things are full of gods." It is not safe to regard an apophthegm as evidence, and the chances are that it belongs to Thales as one of the Seven Wise Men, rather than as founder of the Milesian school. Further, such sayings are, as a rule, anonymous to begin with, and are attributed now to one sage and now to another.[44] On the other hand, it is probable that Thales did say the magnet and amber had souls. That is no apophthegm, but more on the level of the statement that the earth floats on the water. It is just the sort of thing we should expect Hekataios to record about Thales. It would be wrong, however, to draw any inference from it as to his view of the world; for to say the magnet and amber are alive is to imply, if anything, that other things are not.

II. ANAXIMANDER

12.The Life of Anaximander

Anaximander, son of Praxiades, was also a citizen of Miletos, and Theophrastos described him as an "associate" of Thales.[45] We have seen how that expression is to be understood (§ XIV).

According to Apollodoros, Anaximander was sixty-four years old in Ol. LVIII.2 (547/6 B.C.); and this is confirmed by Hippolytos, who says he was born in Ol. XLII. 3 (610/9 B.C.), and by Pliny, who assigns his great discovery of the obliquity of the zodiac to Ol. LVIII.[46] We seem to have something more here than a combination of the ordinary type; for, according to all the rules, Anaximander should have "flourished" in 565 B.C., half-way between Thales and Anaximenes, and this would make him sixty, not sixty-four, in 546. Now Apollodoros appears to have said that he had met with the work of Anaximander; and the only reason he can have had for mentioning this must be that he found in it some indication which enabled him to fix its date. Now 547/6 is just the year before the fall of Sardeis, and we may perhaps conjecture that Anaximander mentioned what his age had been at the time of that event. We know from Xenophanes that the question, "How old were you when the Mede appeared?" was considered an interesting one in those days.[47] At all events, Anaximander was apparently a generation younger than Thales.[48]

Like his predecessor, he distinguished himself by certain practical inventions. Some writers credited him with that of the *gnomon*; but that can hardly be correct. Herodotos tells us this instrument came from Babylon, and Thales must have used it to determine the solstices and equinoxes.[49]

Anaximander was also the first to construct a map, and Eratosthenes said this was the map elaborated by Hekataios. No doubt it was intended to be of service to Milesian enterprise in the Black Sea. Anaximander himself conducted a colony to Apollonia,[50] and his fellow-citizens erected a statue to him.[51]

13. Theophrastus on Anaximander's Theory of the Primary Substance

Nearly all we know of Anaximander's system is derived in the last resort from Theophrastos, who certainly knew his book.[52] He seems once at least to have quoted Anaximander's own words, and he criticised his style. Here are the remains of what he said of him in the First Book:

Anaximander of Miletos, son of Praxiades, a fellow-citizen and associate of Thales,[53] said that the material cause and first element of things was the Infinite, he being the first to introduce this name of the material cause. He says it is neither water nor any other of the so-called[54] elements, but a substance different from them which is infinite; from which arise all the heavens and the worlds within them.—*Phys. Op.* fr. 2 (*Dox.* p. 476; R. P. 16).

He says that this is "eternal and ageless," and that it "encompasses all the worlds."—Hipp. *Ref.* i. 6 (R. P. 17 a).

And into that from which things take their rise they pass away once more, "as is meet; for they make reparation and satisfaction to one another for their injustice according to the ordering of time," as he says[55] in these somewhat poetical terms.—*Phys. Op.* fr. 2 (R. P. 16).

And besides this, there was an eternal motion, in which was brought about the origin of the worlds.—Hipp. *Ref.* i. 6 . (R. P. 17 a).

He did not ascribe the origin of things to any alteration in matter, but said that the oppositions in the substratum, which was a boundless body, were separated out —Simpl. *Phys.* p. 150, 20 (R. P. 18).

14. The Primary Substance is Not One of the Elements

Anaximander taught, then, that there was an eternal, indestructible something out of which everything arises, and into which everything returns; a boundless stock from which the waste of existence is continually made good. That is only the natural development of the thought we have ascribed to Thales, and there can be no doubt that Anaximander at least formulated it distinctly. Indeed, we can still follow to some extent the reasoning which led him to do so. Thales had regarded water as the most likely thing to be that of which all others are forms; Anaximander appears to have

asked how the primary substance could be one of these particular things. His argument seems to be preserved by Aristotle, who has the following passage in his discussion of the Infinite:

Further, there cannot be a single, simple body which is infinite, either, as some hold, one distinct from the elements, which they then derive from it, or without this qualification. For there are some who make this (*i.e.* a body distinct from the elements) the infinite, and not air or water, in order that the other things may not be destroyed by their infinity. *They are in opposition one to another*—air is cold, water moist, and fire hot—and therefore, *if any one of them were infinite, the rest would have ceased to be by this time.* Accordingly they say that what is infinite is something other than the elements, and from it the elements arise.—Arist. Phys. Γ. 204 b 22 (R. P. 16 b).

It is clear that Anaximander is here contrasted with Thales and with Anaximenes. Nor is there any reason to doubt that the account given of his reasoning is substantially correct, though the form is Aristotle's own, and in particular the "elements" are an anachronism.[56] Anaximander started, it would seem, from the strife between the opposites which go to make up the world; the warm was opposed to the cold, the dry to the wet. These were at war, and any predominance of one over the other was an "injustice" for which they must make reparation to one another at the appointed time.[57] If Thales had been right in saying that water was the fundamental reality, it would not be easy to see how anything else could ever have existed. One side of the opposition, the cold and moist, would have had its way unchecked, and the warm and dry would have been driven from the field long ago. We must, then, have something not itself one of the warring opposites, something more primitive, out of which they arise, and into which they once more pass away. That Anaximander called this something by the name of φύσις is the natural interpretation of what Theophrastos says; the current statement that the term ἀρχή was introduced by him appears to be due to a misunderstanding.[58] We have seen that, when Aristotle used the term in discussing Thales, he meant what is called the "material cause,"[59] and it is hard to believe that it means anything else here.

15. Aristotle's Account of the Theory

It was natural for Aristotle to regard this theory as an anticipation or presentiment of his own doctrine of "indeterminate matter,"[60] and that he should sometimes express the views of Anaximander in terms of the later theory of "elements." He knew that the Boundless was a body,[61] though in his own system there was no room for anything corporeal prior to the elements; so he had to speak of it as a boundless body "alongside of" or "distinct from" the elements (παρὰ τὰ στοιχεῖα). So far as I know no one has doubted that, when he uses this phrase, he is referring to Anaximander.

In a number of other places Aristotle speaks of some one who held the primary substance to be something "intermediate between" the elements or between two of them .[62] Nearly all the Greek commentators referred this to Anaximander also, but most modern writers refuse to follow them. It is, no doubt, easy to show that Anaximander himself cannot have said anything of the sort, but that is no real objection. Aristotle puts things in his own way regardless of historical considerations, and it is difficult to see that it is more of an anachronism to call the Boundless "intermediate between the elements" than to say that it is "distinct from the elements." Indeed, if once we introduce the elements at all, the former description is the more adequate of the two. At any rate, if we refuse to understand these passages as referring to Anaximander, we shall have to say that Aristotle paid a great deal of attention to some one whose very name has been lost, and who not only agreed with some of Anaximander's views, but also used some of his most characteristic expressions.[63] We may add that in one or two places Aristotle certainly seems to identify the "intermediate" with the something "distinct from" the elements.[64]

There is even one passage in which he speaks of Anaximander's Boundless as a "mixture," though his words may perhaps admit of another interpretation.[65] But this is of no consequence for our interpretation of Anaximander. It is certain that he cannot have said anything about "elements," which no one thought of before Empedokles, and no one could think of before Parmenides. The question has only been mentioned because it has given rise to a lengthy controversy, and because it throws light on the historical value of Aristotle's statements. From the point of view of his own system, these may be justified; but we shall have to remember in other cases that, when he seems to attribute an idea to some earlier thinker, we are not bound to take what he says in an historical sense.[66]

16. The Primary Substance is Infinite

Anaximander's reason for conceiving the primary substance as boundless was, no doubt, as indicated by Aristotle, "that becoming might not fail."[67] It is not clear, however, that these words are his own, though the doxographers speak as if they were. It is enough for us that Theophrastos, who had seen his book, attributed the thought to him. And certainly his view of the world would bring home to him the need of a boundless stock of matter. The "opposites" are, we have seen, at war with one another, and their strife is marked by "unjust" encroachments on either side. The warm commits "injustice" in summer, the cold in winter, and this would lead in the long run to the destruction of everything but the Boundless itself, if there were not an inexhaustible supply of it from which opposites might continually be separated out afresh. We must picture, then, an endless mass, which is not any one of the opposites we know, stretching out without limit on every side of the world we live in.[68] This mass is a body, out of which our world once emerged, and into which it will one day be absorbed again.

17. The Innumerable Worlds

We are told that Anaximander believed there were "innumerable worlds in the Boundless,"[69] and we have to decide between the interpretation that, though all the worlds are perishable, there are an unlimited number of them in existence at the same time, and Zeller's view that a new world never comes into existence till the old one has passed away, so that there is never more than one world at a time. As this point is of fundamental importance, it will be necessary to examine the evidence carefully.

In the first place, the doxographical tradition proves that Theophrastos discussed the views of all the early philosophers as to whether there was one world or an infinite number, and there can be no doubt that, when he ascribed "innumerable worlds" to the Atomists, he meant coexistent and not successive worlds. Now, if he had classed two such different views under one head, he would have been careful to point out in what respect they differed, and there is no trace of any such distinction. On the contrary, Anaximander, Anaximenes, Archelaos, Xenophanes, Diogenes, Leukippos, Demokritos, and Epicurus are all mentioned together as holding the doctrine of "innumerable worlds" on every side of this one,[70] and the only distinction is that, while Epicurus made the distances between these worlds unequal, Anaximander said all the worlds were equidistant.[71] Zeller rejected this evidence[72] on the ground that we can have no confidence in a writer who attributes "innumerable worlds" to Anaximenes, Archelaos, and Xenophanes. With regard to the first two, I hope to show that the statement is correct, and that it is at least intelligible in the case of the last.[73] In any case, the passage comes from Aetios,[74] and there is no reason for doubting that it is derived from Theophrastos, though the name of Epicurus has been added later. This is confirmed by what Simplicius says:

Those who assumed innumerable worlds, e.g. Anaximander, Leukippos, Demokritos, and, at a later date, Epicurus, held that they came into being and passed away *ad infinitum*, some always coming into being and others passing away.[75]

It is practically certain that this too comes from Theophrastos through Alexander.

We come next to a very important statement which Cicero has copied from Philodemos, the author of the Epicurean treatise on Religion found at Herculaneum, or perhaps from the immediate source of that work. "Anaximander's opinion was," he makes Velleius say, "that there were gods who came into being, rising and passing away at long intervals, and that these were the innumerable worlds";[76] and this must clearly be taken along with the statement of Aetios that, according to Anaximander, the "innumerable heavens" were gods.[77] Now it is much more natural to understand the "long intervals" as intervals of space than as intervals of time;[78] and, if that is right, we have a perfect agreement among our authorities.

It may be added that it is very unnatural to understand the statement that the Boundless "encompasses all the worlds" of worlds succeeding one another in time; for on this view there is at a given time only one world to "encompass." Moreover, the argument mentioned by Aristotle that, if what is outside the heavens is infinite, body must be infinite, and there must be innumerable worlds, can only be understood in one sense, and is certainly intended to represent the reasoning of the Milesians ; for they were the only cosmologists who held there was a boundless body outside the heavens.[79] Lastly, we happen to know that Petron, one of the earliest Pythagoreans, held there were just one hundred and eighty-three worlds arranged in a triangle,[80] which shows at least that the doctrine of a plurality of worlds was much older than the Atomists.

18. "Eternal Motion" and the Dinê

The doxographers say it was the "eternal motion" that brought into being "all the heavens and all the worlds within them." We have seen (§ VIII.) that this is probably only the Aristotelian way of putting the thing, and that we must not identify the primordial motion of the Boundless with any purely mundane movement such as the diurnal revolution. That would be quite inconsistent, moreover, with the doctrine of innumerable worlds, each of which has, presumably, its own centre and its own diurnal revolution. As to the true nature of this motion, we have no definite statement, but the term "separating off" (ἀπόκρισις) rather suggests some process of shaking and sifting as in a riddle or sieve. That is given in Plato's *Timaeus* as the Pythagorean doctrine,[81] and the Pythagoreans followed Anaximander pretty closely in their cosmology (§ 54). The school of Abdera, as will be shown (§ 179), attributed a motion of the same kind to their atoms, and they too were mainly dependent on the Milesians for the details of their system. This, however, must remain a conjecture in the absence of express testimony.

When, however, we come to the motion of the world once it has been "separated off," we are on safer ground. It is certain that one of the chief features of early cosmology is the part. played in it by the analogy of an eddy in water or in wind, a δίνη (or δῖνος),[82] and there seems to be little doubt that we are entitled to regard this as the doctrine of Anaximander and Anaximenes.[83] It would arise very naturally in the minds of thinkers who started with water as the primary substance and ended with "air," and it would account admirably for the position of earth and water in the centre and fire at the circumference, with "air" between them. Heavy things tend to the centre of a vortex and light things are forced out to the periphery. It is to be observed that there is no question of a sphere in revolution at this date; what we have to picture is rotary motion in a plane or planes more or less inclined to the earth's surface.[84] It is in favour of the conjecture given above as to the nature of the primordial motion

that it provides a satisfactory dynamical explanation of the formation of the δίνη, and we shall find once more (§180) that the Atomists held precisely this view of its origin.

19. Origin of the Heavenly Bodies

The doxographers also give us some indications of the process by which the different parts of the world arose from the Boundless. The following statement comes ultimately from Theophrastos:

He says that something capable of begetting hot and cold out of the eternal was separated off at the origin of this world. From this arose a sphere of flame which fitted close round the air surrounding the earth as the bark round a tree. When this had been torn off and shut up in certain rings, the sun, moon and stars came into existence.—Ps.-Plut. *Strom.* fr. 2 (R. P. 19).[85]

We see from this that, when a portion of the Boundless was separated off from the rest to form a world, it first differentiated itself into the two opposites, hot and cold. The hot appears as flame surrounding the cold; the cold, as earth with air surrounding it. We are not told here how the cold was differentiated into earth, water and air, but there is a passage in Aristotle's *Meteorology* which throws some light on the question. After discussing the views of the "theologians" regarding the sea, he says:

But those who are wiser in the wisdom of men give an origin for the sea. At first, they say, all the terrestrial region was moist; and, as it was dried up by the sun, the portion of it that evaporated produced the winds and the turnings back of the sun and moon,[86] while the portion left behind was the sea. So they think the sea is becoming smaller by being dried up, and that at last it will all be dry. *Meteor*, B, 1. 353 b 5.

And the same absurdity arises for those who say the earth too was at first moist, and that, when the region of the world about the earth was heated by the sun, air was produced and the whole heavens were increased, and that it (the air) produced winds and caused its (the sun's) turnings back.[87]—*Ib.* 2. 355 a 21 (R. P. 20 a).

In his commentary on the passage, Alexander says this was the view of Anaximander and Diogenes, and cites Theophrastos as his authority for the statement. This is confirmed by Anaximander's theory of the sea as given by the doxographers (§ 20). We conclude, then, that after the first separation of the hot and the cold by the δίνη, the heat of the flame turned part of the moist, cold interior of the world into air or vapour—it is all one at this date—and that the expansion of this mist broke up the flame itself into rings. We shall come back to these rings presently, but we must look first at what we are told of the earth.

20. Earth and Sea

The origin of earth and sea from the moist, cold matter which was "separated off" in the beginning is thus described:

The sea is what is left of the original moisture. The fire has dried up most of it and turned the rest salt by scorching it. - Aet. iii. 16, 1 (R. P. 20 a).

He says that the earth is cylindrical in form, and that its depth is as a third part of its breadth.—Ps.-Plut. *Strom* fr. 2 (R. P. *ib.*).

The earth swings free, held in its place by nothing. It stays where it is because of its equal distance from everything. Its shape is hollow and round, and like a stone pillar. We are on one of the surfaces, and the other is on the opposite side.[88]—Hipp. *Ref.* i. 6 (R. P. 20).

Adopting for a moment the popular theory of "elements," we see that Anaximander put fire on one side as the hot and dry, and all the rest on the other as the cold, which is also moist. This may explain how Aristotle came to speak of the Boundless as intermediate between fire and water. And we have seen also that the moist element was partly turned into "air" or vapour by the fire, which explains how Aristotle could say the Boundless was something between fire and air, or between air and water.[89]

The moist, cold interior of the world is not, in fact, water. It is always called "the moist" or "the moist state." That is because it has to be still further differentiated under the influence of heat into earth, water, and vapour. The gradual drying up of the water by the fire is a good example of what Anaximander meant by "injustice."

Thales had said that the earth floated on the water, but Anaximander realised that it was freely suspended in space (μετέωρος) and did not require any support. Aristotle has preserved the argument he used. The earth is equally distant from the circumference of the vortex in every direction, and there is no reason for it to move up or down or sideways.[90] The doctrine of innumerable worlds was inconsistent with the existence of an absolute up and down in the universe, so the argument is quite sound. The central position of the earth is due to the δίνη; for the greater masses tend to the centre of an eddy.[91] There is good evidence that Anaximander made the earth share in the rotary movement.[92] It is not, however, a sphere, so we must not speak of an axial revolution. The shape given to the earth by Anaximander is easily explained if we adopt the view that the world is a system of rotating rings. It is just a solid ring in the middle of the vortex.

21. The Heavenly Bodies

We have seen that the flame which had been forced to the circumference of the vortex was broken up into rings by the pressure of expanding vapour produced by its own heat. I give the statements of Hippolytos and Aetios as to the formation of the heavenly bodies from these rings.

The heavenly bodies are a wheel of fire, separated off from the fire of the world, and surrounded by air. And there are breathing-holes, certain pipe-like passages, at which the heavenly bodies show themselves. That is why, when the breathing-holes are stopped, eclipses take place. And the moon appears now to wax and now to wane because of the stopping and opening of the passages. The wheel of the sun is 27 times the size of (the earth, while that of) the moon is 18 times as large.[93] The sun is the highest of all, and lowest are the wheels of the stars. —Hipp. *Ref.* i. 6 (R. P. 20).

The heavenly bodies were hoop-like compressions of air, full of fire, breathing out flames at a certain point through orifices.Aet. ii. 13, 7 (R. P. 19 a).

The sun was a wheel 28 times the size of the earth, like a chariot-wheel with the felloe hollow, full of fire, showing the fire at a certain point through an orifice, as through the nozzle of a pair of bellows.—Aet. ii. 20, i (R. P. 19 a).

The sun was equal to the earth, but the wheel from which it breathes out and by which it is carried round was 27 times the size of the earth.—Aet. ii. 21, 1.

The sun was eclipsed when the orifice of the fire's breathing-hole was stopped.—Aet. ii. 24., 2.

The moon was a wheel 19 times the size of the earth, like a chariot-wheel with its felloe hollow and full of fire like that of the sun, lying oblique also like it, with one breathing-hole like the nozzle of a pair of bellows. [It is eclipsed because of the turnings of the wheel.][94] —Aet. ii. 25, 1.

The moon was eclipsed when the orifice of the wheel was stopped.—Aet. ii. 29, 1.

(Thunder and lightning, etc.) were all caused by the blast of the wind. When it is shut up in a thick cloud and bursts forth with violence, then the tearing of the cloud makes the noise, and the rift gives the appearance of a flash in contrast with the blackness of the cloud.—Aet. iii. 3, 1.

Wind was a current of air (*i.e.* vapour), which arose when its finest and moistest particles were stirred or melted by the sun.—Aet. iii. 7, 1.

There is a curious variation in the figures given for the size of the wheels of the heavenly bodies, and it seems most likely that 18 and 27 refer to their inner, while 19 and 28 refer to their outer circumference. We may, perhaps, infer that the wheels of the "stars" were nine times the size of the earth; for the numbers 9, 18, 27 play a considerable part in primitive cosmogonies.[95] We do not see the wheels of fire as complete circles; for the vapour or mist which formed them encloses the fire, and forms an outer ring except at one point of their circumference, through which the fire escapes, and that is the heavenly body we actually see.[96] It is possible that the theory of "wheels" was suggested by the Milky Way. If we ask how it is that the wheels of air can make the fire invisible to us without becoming

visible themselves, the answer is that such is the property of what the Greeks at this date called "air." For instance, when a Homeric hero is made invisible by being clothed in "air," we can see right through both the "air" and the hero.[97] It should be added that lightning is explained in much the same way as the heavenly bodies. It, too, was fire breaking through condensed air, in this case storm clouds. It seems probable that this was really the origin of the theory, and that Anaximander explained the heavenly bodies on the analogy of lightning, not *vice versa*. It must be remembered that meteorology and astronomy were still undifferentiated,[98] and that the theory of "wheels" or rings is a natural inference from the idea of the vortex.

So far we seem to be justified, by the authority of Theophrastos, in going; and, if that is so, certain further inferences seem to be inevitable. In the first place, Anaximander had shaken himself free of the old idea that the heavens are a solid vault. There is nothing to prevent us from seeing right out into the Boundless, and it is hard to think that Anaximander did not believe he did. The traditional cosmos has given place to a much grander scheme, that of innumerable vortices in a boundless mass, which is neither water nor air. In that case, it is difficult to resist the belief that what we call the fixed stars were identified with the "innumerable worlds" which were also "gods." It would follow that the diurnal revolution is only apparent; for the stars are at unequal distances from us, and can have no rotation in common. It must, then, be due to the rotation of the cylindrical earth in twenty-four hours. We have seen that the earth certainly shared in the rotation of the δίνη. That gets rid of one difficulty, the wheel of the "stars," which is between the earth and the moon; for the fixed stars could not be explained by a "wheel" at all; a sphere would be required. What, then, are the "stars" which are accounted for by this inner wheel? I venture to suggest that they are the morning and the evening stars, which, we have seen (p. 23, *n.* 1), were not recognised yet as a single luminary. In other words, I believe that Anaximander regarded the fixed stars as stationary, each rotating in its own vortex. No doubt this involves us in a difficulty regarding the rotation of the sun and the moon. It follows from the nature of the vortex that they must rotate in the same direction as the earth, and, on the assumption just made, that must be from west to east, and it must be a slower rotation than that of the earth, which is inconsistent with the fact that the circumference of a vortex rotates more rapidly than the centre. That, however, is a difficulty which all the Ionian cosmologists down to Demokritos had to face. Holding, as they did, that the whole rotation was in the same direction, they had to say that what we call the greatest velocities were the least. The moon, for instance, did not rotate so rapidly as the sun, since the sun more nearly keeps up with the fixed stars.[99] That Anaximander failed to observe this difficulty is not surprising, if we remember that he was the first to attack the problem. It is not immediately obvious that the centre of the vortex must have a slower motion than the circumference. This serves to explain the origin of the theory that the heavenly bodies have a rotation of their own in the opposite direction to the diurnal revolution which we shall see reason for attributing to Pythagoras (§ 54).

22. Animals

We have, in any case, seen enough to show us that the speculations of Anaximander about the world were of an extremely daring character. We come now to the crowning audacity of all, his theory of the origin of living creatures. The Theophrastean account of this has been well preserved by the doxographers:

Living creatures arose from the moist element as it was evaporated by the sun. Man was like another animal, namely, a fish, in the beginning.—Hipp. *Ref.* i. 6 (R. P. 22 a).

The first animals were produced in the moisture, each enclosed in a prickly bark. As they advanced in age, they came out upon the drier part. When the bark broke off,[100] they survived for a short time.[101]—Aet. v. 19, 4 (R. P. 22).

Further, he says that originally man was born from animals of another species. His reason is that while other animals quickly find food by themselves, man alone requires a lengthy period of suckling. Hence, had he been originally as he is now, he would never have survived.—Ps.-Plut. *Strom.* fr. 2 (R. P. *ib.*).

He declares that at first human beings arose in the inside of fishes, and after having been reared like sharks,[102] and become capable of protecting themselves, they were finally cast ashore and took to land.—Plut. *Symp. Quaest.* 730 f (R. P. *ib.*).

The importance of these statements has sometimes been overrated and still more often underestimated. Anaximander has been called a precursor of Darwin by some, while others have treated the whole thing as a mythological survival. It is therefore important to notice that this is one of the rare cases where we have not merely a *placitum*, but an indication of the observations on which it was based. It is clear from this that Anaximander had an idea of what is meant by adaptation to environment and survival of the fittest, and that he saw the higher mammals could not represent the original type of animal. For this he looked to the sea, and he naturally fixed upon those fishes which present the closest analogy to the *mammalia*. The statements of Aristotle about the *galeus levis* were shown by Johannes Müller to be more accurate than those of later naturalists, and we now see that these observations were already made by Anaximander. The way in which the shark nourishes its young furnished him with the very thing he required to explain the survival of the earliest animals.[103]

III. ANAXIMENES

23. The Life of Anaximenes

Anaximenes of Miletos, son of Eurystratos, was, according to Theophrastos, an "associate" of Anaximander.[104] Apollodoros said, it appears, that he "flourished" about the time of the fall of Sardeis

(546/5 B.C.), and died in Ol. LXIII. (528/525 B.C.).[105] In other words, he was born when Thales "flourished," and "flourished" when Thales died, and this means that Apollodoros had no definite information about his date. He perhaps made him die in the sixty-third Olympiad because that gives just three generations for the Milesian school.[106] We cannot therefore say anything positive as to his date, except that he must have been younger than Anaximander.

24. His Book

Anaximenes wrote a book which survived until the age of literary criticism; for we are told that he used a simple and unpretentious Ionic,[107] very different, we may suppose, from the poetical prose of Anaximander.[108] The speculations of Anaximander were distinguished for their hardihood and breadth; those of Anaximenes are marked by the opposite quality. He appears to have thought out his system carefully, but he rejects the more audacious theories of his predecessor. The result is that, while his view of the world is less like the truth than Anaximander's, it is perhaps more fruitful in ideas that were destined to hold their ground.

25. Theory of the Primary Substances

Anaximenes is one of the philosophers on whom Theophrastos wrote a special monograph;[109] and this gives us an additional guarantee for the trustworthiness of the tradition. The following[110] are the passages which contain the fullest account of the central feature of his system:

Anaximenes of Miletos, son of Eurystratos, who had been an associate of Anaximander, said, like him, that the underlying substance was one and infinite. He did not, however, say it was indeterminate, like Anaximander, but determinate; for he said it was Air.—*Phys. Op.* fr. 2 (R. P. 26).

From it, he said, the things that are, and have been, and shall be, the gods and things divine, took their rise, while other things come from its offspring.—Hipp. *Ref.* i. 7 (R. P. 28).

"Just as," he said, "our soul, being air, holds us together, so do breath and air encompass the whole world."—Aet. i. 3, 4 (R. P. 24).

And the form of the air is as follows. Where it is most even, it is invisible to our sight; but cold and heat, moisture and motion, make it visible. It is always in motion; for, if it were not, it would not change so much as it does.—Hipp. *Ref.* i. 7 (R. P. 28).

It differs in different substances in virtue of its rarefaction and condensation.—*Phys. Op.* fr. 2 (R. P. 26).

When it is dilated so as to be rarer, it becomes fire; while winds, on the other hand, are condensed Air. Cloud is formed from Air by felting;[111] and this, still further condensed, becomes water.

Water, condensed still more, turns to earth; and when condensed as much as it can be, to stones.—Hipp. *Ref.* i. 7 (R. P. 28).

26. Rarefaction and Condensation

At first, this looks like a falling off from the more refined doctrine of Anaximander to a cruder view; but this is not really the case. On the contrary, the introduction of rarefaction and condensation into the theory is a notable advance.[112] In fact, it makes the Milesian cosmology consistent for the first time; since a theory which explains everything as a form of a single substance is clearly bound to regard all differences as quantitative. The only way to save the unity of the primary substance is to say that all diversities are due to the presence of more or less of it in a given space. And when once this step has been taken, it is no longer necessary to make the primary substance something "distinct from the elements," to use Aristotle's inaccurate but convenient phrase; it may just as well be one of them.

27. Air

The air Anaximenes speaks of includes a good deal that we should not call by the name. In its normal condition, when most evenly distributed, it is invisible, and it then corresponds to our "air"; it is the breath we inhale and the wind that blows. That is why he called it πνεῦμα. On the other hand, the old idea that mist or vapour is condensed air, is still accepted without question. It was Empedokles, we shall see, who first discovered that what we call air was a distinct corporeal substance, and not identical either with vapour or with empty space. In the earlier cosmologists "air" is always a form of vapour, and even darkness is a form of "air." It was Empedokles who cleared up this point too by showing that darkness is a shadow.[113]

It was natural for Anaximenes to fix upon "air" as the primary substance; for, in the system of Anaximander, it occupied an intermediate place between the two fundamental opposites, the ring of flame and the cold, moist mass within it (§ 19). We know from Plutarch that he fancied air became warmer when rarefied, and colder when condensed. Of this he satisfied himself by a curious experimental proof. When we breathe with our mouths open, the air is warm; when our lips are closed, it is cold.[114]

28. The World Breathes

This argument brings us to an important point in the theory, which is attested by the single fragment that has come down to us.[115] "Just as our soul, being air, holds us together, so do breath and air encompass the whole world." The primary substance bears the same relation to the life of the world as to that of man. Now this was the Pythagorean view;[116] and it is also an early instance of the argument

from the microcosm to the macrocosm, and so marks the beginning of an interest in physiological matters.

29. The Parts of the World

We turn now to the doxographical tradition concerning the formation of the world and its parts:

He says that, as the air was felted, the earth first came into being. It is very broad and is accordingly supported by the air.— Ps.-Plut. *Strom.* fr. 3 (R. P. 25).

In the same way the sun and the moon and the other heavenly bodies, which are of a fiery nature, are supported by the air because of their breadth. The heavenly bodies were produced from the earth by moisture rising from it. When this is rarefied, fire comes into being, and the stars are composed of the fire thus raised aloft. There were also bodies of earthy substance in the region of the stars, revolving along with them. And he says that the heavenly bodies do not move under the earth, as others suppose, but round it, as a cap turns round our head. The sun is hidden from sight, not because it goes under the earth, but because it is concealed by the higher parts of the earth, and because its distance from us becomes greater. The stars give no heat because of the greatness of their distance.—Hipp. *Ref.* i. 7, 4-6 (R. P. 28).

Winds are produced when air is condensed and rushes along under propulsion; but when it is concentrated and thickened still more, clouds are generated; and, lastly, it turns to water.[117] -Hipp. *Ref.* i. 7, 7 (*Dox.* p. 561).

The stars [are fixed like nails in the crystalline vault of the heavens, but some say they] are fiery leaves, like paintings.[118]—Aet. ii. 14, 3 (*Dox.* p. 344).

They do not go under the earth, but turn round it.—*Ib.* 16, 6 (*Dox.* p. 348).

The sun is fiery.—Ib. 20, 2 (*Dox.* p. 348).

It is broad like a leaf.—*Ib.* 22, 1 (*Dox.* p. 352).

The heavenly bodies turn back in their courses[119] owing to the resistance of compressed air.—*Ib.* 23, 1 (*Dox.* p. 352).

The moon is of fire.—*Ib.* 25, 2 (*Dox.* p. 356).

Anaximenes explained lightning like Anaximander, adding as an illustration what happens in the case of the sea, which flashes when divided by the oars—*Ib.* iii. 3, 2 (*Dox.* p. 368).

Hail is produced when water freezes in falling; snow, when there is some air imprisoned in the water.—Aet. iii. 4, 1 (*Dox.* p. 370).

The rainbow is produced when the beams of the sun fall on thick condensed air. Hence the anterior part of it seems red, being burnt by the sun's rays, while the other part is dark, owing to the predominance of moisture. And he says that a rainbow is produced at night by the moon, but not

often, because there is not constantly a full moon, and because the moon's light is weaker than that of the sun.—*Schol,. Arat.*[120] (*Dox.* p. 231).

The earth was like a table in shape.—Aet. iii. 10, 3 (*Dox.* p. 377).

The cause of earthquakes was the dryness and moisture of the earth, occasioned by droughts and heavy rains respectively. —*Ib.* 15, 3 (*Dox.* p. 379).

We have seen that Anaximenes was justified in going back to Thales in regard to the nature of primary substance; but the effect upon the details of his cosmology was unfortunate. The earth is once more imagined as a table-like disc floating on the air. The sun, moon, and stars are also fiery discs which float on the air "like leaves"; an idea naturally suggested by the "eddy" (δίνη). It follows that the heavenly bodies cannot go under the earth at night, as Anaximander must have held, but only round it laterally like a cap or a millstone.[121] This view is also mentioned in Aristotle's *Meteorology*,[122] where the elevation of the northern parts of the earth, which makes it possible for the heavenly bodies to be hidden from sight, is referred to. This is only meant to explain why the stars outside the Arctic circle appear to rise and set, and the explanation is fairly adequate if we remember that the world is regarded as rotating in a plane. It is quite inconsistent with the theory of a celestial sphere.[123]

The earthy bodies, which circulate among the planets, are doubtless intended to account for eclipses and the phases of the moon.[124]

30. Innumerable Worlds

As might be expected, there is much the same difficulty about the "innumerable worlds" ascribed to Anaximenes as there is about those of Anaximander. The evidence, however, is far less satisfactory. Cicero says that Anaximenes regarded air as a god, and adds that it came into being.[125] That cannot be right. Air, as the primary substance, is certainly eternal, and it is quite likely that Anaximenes called it "divine," as Anaximander did the Boundless; but it is certain that he also spoke of gods who came into being and passed away. These arose, he said, from the air. This is expressly stated by Hippolytos,[126] and also by St. Augustine.[127] These gods are probably to be explained like Anaximander's. Simplicius, indeed, takes another view; but he may have been misled by a Stoic authority.[128]

31. Influence of Anaximenes

It is not easy for us to realise that, in the eyes of his contemporaries, and for long after, Anaximenes was a much more important figure than Anaximander. And yet the fact is certain. We shall see that Pythagoras, though he followed Anaximander in his account of the heavenly bodies, was far more indebted to Anaximenes for his general theory of the world (§ 53). We shall see further that

when, at a later date, science revived once more in Ionia, it was "the philosophy of Anaximenes" to which it attached itself (§ 122). Anaxagoras adopted many of his most characteristic views (§ 135), and so did the Atomists.[129] Diogenes of Apollonia went back to the central doctrine of Anaximenes, and made Air the primary substance, though he also tried to combine it with the theories of Anaxagoras (§ 188). We shall come to all this later; but it seemed desirable to point out at once that Anaximenes marks the culminating point of the line of thought which started with Thales, and to show how the "philosophy of Anaximenes" came to mean the Milesian doctrine as a whole. This it can only have done because it was really the work of a school, of which Anaximenes was the last distinguished representative, and because his contribution to it was one that completed the system he had inherited from his predecessors. That the theory of rarefaction and condensation was really such a completion of the Milesian system, we have seen (§ 26), and it need only be added that a clear realisation of this fact will be the best clue at once to the understanding of the Milesian cosmology itself and to that of the systems which followed it. In the main, it is from Anaximenes they all start.

1. See Introd. § II. Ephoros said that Old Miletos was colonised from Milatos in Crete at an earlier date than the fortification of the new city by Neleus (Strabo, xiv. p. 634), and recent excavation has shown that the Aegean civilisation passed here by gradual transition into the early Ionic. The dwellings of the old Ionians stand on and among the *débris* of the "Mycenean" period. There is no "geometrical" interlude.

2. Herod. i. 29. See Radet, La Lydie et le monde grec au temps des Mermnades (Paris, 1893).

3. Herod. i. 75. It is important for a right estimate of Ionian science to remember the high development of engineering in these days. Mandrokles of Samos built the bridge over the Bosporos for King Dareios (Herod. iv. 88), and Harpalos of Tenedos bridged the Hellespont for Xerxes when the Egyptians and Phoenicians had failed in the attempt (Diels, *Abh. der Berl. Akad.*, 1904, p. 8). The tunnel through the hill above Samos described by Herodotos (iii. 60) has been discovered by German excavators. It is about a kilometre long, but the levels are almost accurate. On the whole subject see Diels, "Wissenschaft und Technik bei den Hellenen" (*Neue Jahrb.* xxxiii. pp. 3, 4). Here, as in other things, the Ionians carried on "Minoan" traditions.

4. Simplicius quotes Theophrastos as saying that Thales had many predecessors *Dox.* p. 475, 11). This need not trouble us; for the scholiast on Apollonios Rhodios (ii. 1248) tells us that he made Prometheus the first philosopher, which is merely an application of Peripatetic literalism to a phrase of Plato's (*Phileb.* 16 c 6). Cf. Note on Sources, § 2.

5. Herod. i. 170 (R. P. 9 d); Diog. i. 22 (R. P. 9). This is no doubt connected with the fact mentioned by Herodotos (i. 146) that there were Kadmeians from Boiotia among the original Ionian colonists. Cf. also Strabo, xiv. pp. 633, 636; Pausan. vii. 2, 7. These, however, were not Semites.

6. Diog. i. 23, Καλλίμαχος δ' αὐτὸν οἶδεν εὑρετὴν τῆς ἄρκτου τῆς μικρᾶς λέγων ἐν τοῖς Ἰάμβοις οὕτως—

καὶ τῆς ἁμάξης ἐλέγετο σταθμήσασθαι

τοὺς ἀστερίσκους, ἣ πλέουσι Φοίνικες.

7. See Diels, "Thales ein Semite?" (*Arch.* ii. 165 *sqq.*), and Immisch, "Zu Thales Abkunft" (*ib.* p. 515). The name Examyes occurs also in Kolophon (Hermesianax, *Leontion*, fr. 2, 38 Bgk.), and may be compared with other Karian names such as Cheramyes and Panamyes.

8. Herod. i. 74.

9. For the theories held by Anaximander and Herakleitos, see *infra*, §§ 19, 71.

10. Diog. i. 23, δοκεῖ δὲ κατά τινας πρῶτος ἀστρολογῆσαι καὶ ἡλιακὰς ἐκλείψεις καὶ τροπὰς προειπεῖν, ὥς φησιν Εὔδημος ἐν τῇ Περὶ τῶν ἀστρολογουμένων ἱστορίᾳ, ὅθεν αὐτὸν καὶ Ξενοφάνης καὶ Ἡρόδοτος θαυμάζει. The statement that Thales "predicted"

solstices as well as eclipses is not so absurd as has been thought. Eudemos may very well have meant that he fixed the dates of the solstices and equinoxes more accurately than had been done before. That he would do by observing the length of the shadow cast by an upright (γνώμων), and we shall see (p. 47) that popular tradition ascribed observations of the kind to him. This interpretation is favoured by another remark of Eudemos, preserved by Derkyllides (*ap.* Theon. p. 198, 17 Hiller), that Thales discovered τὴν κατὰ τὰς τροπὰς αὐτοῦ (τοῦ ἡλίου) περίοδον, ὡς οὐκ ἴση ἀεὶ συμβαίνει. In other words, he discovered the inequality of the four seasons which is due to the solar anomaly.

11. It is wrong to call this the *Saros* with Souidas; for *sar* on the monuments always means 60^2=3600, the number of the Great Year. The period of 223 lunations is, of course, that of the retrograde movement of the nodes.

12. See George Smith, *Assyrian Discoveries* (1875), p. 409. The inscription which follows was found at Kouyunjik:—

"To the king my lord, thy servant Abil-Istar.

. . .

"Concerning the eclipse of the moon of which the king my lord sent to me; in the cities of Akkad Borsippa, and Nipur, observations they made, and then in the city of Akkad, we saw part . . . . The observation was made, and the eclipse took place.

. . .

"And when for the eclipse of the sun we made an observation, the observation was made and it did not take place. That which I saw with my eyes to the king my lord I send." See further R. C. Thomson, *Reports of the Magicians and Astrologers of Nineveh and Babylon* (1900).

13. Cf. Schiaparelli, "I primordi dell' Astronomia presso i Babilonesi" (*Scientia*, 1908, p. 247). His conclusion is that "the law which regulates the circumstances of the visibility of solar eclipses is too complex to be discovered by simple observation," and that the Babylonians were not in a position to formulate it. "Such a triumph was reserved to the geometrical genius of the Greeks."

14. Pliny, *N.H.* ii. 53. It should be noted that this date is inconsistent with the chronology of Herodotos, but that is vitiated by the assumption that the fall of the Median kingdom synchronised with the accession of Cyrus to the throne of Persia. If we make the necessary correction, Cyaxares was still reigning in 585 B.C.

15. The words of Herodotos (i. 74), οὖρον προθέμενος ἐνιαυτὸν τοῦτον ἐν τῷ δὴ καὶ ἐγένετο, mean at first sight that he only said the eclipse would occur before the end of a certain year, but Diels suggests (*Neue Jahrb*. xxxiii. p. 2) that ἐνιαυτός has here its original sense of "summer solstice" (cf. Brugmann, *Idg. Forsch.* xv. p. 87). In that case Thales would have fixed the date within a month. He may have observed the eclipse of May 18, 603 B.C. in Egypt, and predicted another in eighteen years and some days, not later than the solstice.

16. For Apollodoros, see Note on Sources, §21. The dates in our text of Diogenes (i. 37; R. P. 8) cannot be reconciled with one another. That given for the death of Thales is probably right; for it is the year before the fall of Sardeis in 546/5 B.C., which is one of the regular eras of Apollodoros. It no doubt seemed natural to make Thales die the year before the "ruin of Ionia" which he foresaw. Seventy-eight years before this brings us to 624/3 B.C. for the birth of Thales, and this gives us 585/4 B.C. for his fortieth year. That is Pliny's date for the eclipse, and Pliny's dates come from Apollodoros through Nepos.

17. Diog. i. 22 (R. P. 9), especially the words καθ' ὃν καὶ οἱ ἑπτὰ σοφοὶ ἐκλήθησαν. The story of the tripod was told in many versions (cf. Diog. i. 28-33 ; *Vors*. i. p. 226 *sqq.*). It clearly belongs to the Delphian Tale of the Seven Wise Men, which is already alluded to by Plato (*Prot.* 343 a, b). Now Demetrios of Phaleron dated this in the archonship of Damasias at Athens (582/1 B.C.), and the Marmor Parium dates the restoration of the ἀγὼν στεφανίτης at Delphoi in the same year, and also identifies it with that of Damasias (cf. Jacoby, p. 170, *n.* 12).

18. Proclus, in *Eucl.* I. p. 65, Friedlein (from Eudemos).

19. Herod. ii. 20.

20. Aet. iv. 1.1 (*Dox.* p. 384).

21. *Dox*. pp. 226-229. The Latin epitome will be found in Rose's edition of the Aristotelian fragments.

22. Hekataios, fr. 278 (*F.H.G.* i. p. 19).

23. See Cantor, *Vorlesungen über Geschichte der Mathematik*, vol. i. pp. 12 *sqq*.; Allman, "Greek Geometry from Thales to Euclid" (*Hermathena,* iii. pp. 164-174).

24. Proclus, *in Eucl.* pp. 65, 7; 157, 10; 250, 20; 299, 1; 352, 14 (Friedlein). Eudemos wrote the first histories of astronomy and mathematics, just as Theophrastos wrote the first history of philosophy.

25. Proclus, p. 352, 14, Εὔδημος δὲ ἐν ταῖς γεωμετρικαῖς ἱστορίαις εἰς Θαλῆν τοῦτο ἀνάγει τὸ θεώρημα (*Eucl.* 1.26) τὴν γὰρ τῶν ἐν θαλάττῃ πλοίων ἀπόστασιν δι' οὗ τρόπου φασὶν αὐτὸν δεικνύναι τούτῳ προσχρῆσθαί φησιν ἀναγκαῖον.

26. The oldest version of this story is given in Diog. i. 27, ὁ δὲ Ἱερώνυμος καὶ ἐκμετρῆσαί φησιν αὐτὸν τὰς πυραμίδας, ἐκ τῆς σκιᾶς παρατηρήσαντα ὅτε ἡμῖν ἰσομεγέθης ἐστίν.. Cf. Pliny, *H. Nat.* xxxvi. 82, *mensuram altitudinis earum deprehendere invenit Thales Milesius umbram metiendo qua hora par esse corpori solet.* (Hieronymos of Rhodes was contemporary with Eudemos.) This need imply no more than the reflexion that the shadows of all objects will be equal to the objects at the same hour. Plutarch (*Conv. sept. sap.* 147 a) gives a more elaborate method, τὴν βακτηρίαν στήσας ἐπὶ τῷ πέρατι τῆς σκιᾶς ἣν ἡ πυραμὶς ἐποίει γενομένων τῇ ἐπαφῇ τῆς ἀκτῖνος δυοῖν τριγώνων, ἔδειξας ὃν ἡ σκιὰ πρὸς τὴν σκιὰν λόγον εἶχε, τὴν πυραμίδα πρὸς τὴν βακτηρίαν ἔχουσαν.

27. See Gow, Short History of Greek Mathematics, § 84.

28. Herod. i. 170 (R. P. 9 d).

29. The story of Thales falling into a well (Plato, *Theaet.* 174 a) is nothing but a fable teaching the uselessness of σοφία; the anecdote about the "corner" in oil (Ar. *Pol.* A, 11. 1259 a 6) is intended to inculcate the opposite lesson.

30. Cf. Aristophanes, *Clouds* 180 (after a burlesque description of how Sokrates provided himself with a cloak) τί δῆτ' ἐκεῖνον τὸν Θαλῆν θαυμάζομεν; *Birds* 1009 (of Meton's town-planning, ἄνθρωπος Θαλῆς). Plato's way of speaking is remarkable. Cf. *Rep*. 600a ἀλλ' οἷα δὴ εἰς τὰ ἔργα σοφοῦ ἀνδρὸς πολλαὶ ἐπίνοιαι καὶ εὐμήχανοι εἰς τέχνας ἤ τινας ἄλλας πράξεις λέγονται, ὥσπερ αὖ Θάλεώ τε πέρι τοῦ Μιλησίου καὶ Ἀναχάρσιος τοῦ Σκύθου.

31. See p. 41, *n.* 2.

32. If he tried to introduce the year of 360 days and the month of 30 days, he may have learnt that in Egypt.

33. For the Milesian παραπήγματα see Rehm, *Berl. Sitzungsber.*, 1893, p. 101 *sqq.*, 752 *sqq.*

34. Ar. *Met.* A, 3. 983 b 21 (R. P. 10); *De caelo*, B, 13. 294 a 28 (R. P. 11).

35. Met. A, 3. 983 b 21 (R. P. 10). We must translate ἀρχή here by "material cause," for τῆς τοιαύτης ἀρχῆς means τῆς ἐν ὕλης εἴδει ἀρχῆς (b 7). The word, then, is used here in a strictly Aristotelian sense. Cf. Introd. p. ii, *n.* 3.

36. Arist. *De an.* A, 5. 411 a 7 (R. P. 13); *ib.* 2. 405 a 19 (R. P. 13 a). Diog. i. 24 (R. P. *ib.*) adds amber.

37. Met. A, 3. 983 b 22 ; Aet. i. 3, 1 ; Simpl. *Phys*. p. 36, 10 (R. P. 10, 12, 12 a). The last of Aristotle's explanations, that Thales was influenced by cosmogonical theories about Okeanos and Tethys, has strangely been supposed to be more historical than the rest, whereas it is merely a fancy of Plato's taken literally. Plato says (*Theaet.* 180 d 2; *Crat.* 402 b 4) that Herakleitos and his predecessors (οἱ ῥέοντες) derived their philosophy from Homer (*Il*. xiv. 201), and even earlier sources (Orph. frag. 2, Diels, *Vors.* 66 B 2). In quoting this suggestion, Aristotle refers it to "some"—a word which often means Plato—and he calls the originators of the theory παμπαλαίους, as Plato had done (*Met.* A, 3. 983 b 28; cf. *Theaet.* 181 b 3). This is how Aristotle gets history out of Plato. See Note on Sources, § 2.

38. Compare Arist. *De an.* A, 2. 405 b 2 (R. P. 220) with the passages referred to in the last note. We now know that, though Aristotle declines to consider Hippon as a philosopher (*Met.* A, 3. 984 a 3; R. P. 219 a), he was discussed in the Peripatetic history of medicine known as Menon's *Iatrika*. See §185.

39. The view here taken most resembles that of the "Homeric allegorist" Herakleitos (R. P. 12 a). That, however, is also a conjecture, probably of Stoic, as the others are of Peripatetic, origin.

40. Arist. *De an.* A, 5. 411 a 7 (R. P. 13).

41. Aet. i. 7, 11=Stob. i. 56 (R. P. 14). On the sources here referred to, see Note on Sources, §§ 11, 12.

42. Cicero, *De nat. d.* 1. 25 (R. P. 13 b). On Cicero's source, see *Dox.* pp. 125, 128. The Herculanean papyrus of Philodemos is defective at this point, but it is not likely that he anticipated Cicero's mistake.

43. See Introd. § IX.

44. Plato refers to the saying πάντα πλήρη θεῶν in *Laws*, 899 b 9 (R. P. 14 b), without mentioning Thales. That ascribed to Herakleitos in the *De part. an.* A, 5. 645 a 7 seems to be a mere variation on it. In any case it means only that nothing is more divine than anything else.

45. R. P. 15 d. That the words πολίτης καὶ ἑταῖρος, given by Simplicius, *De caelo*, p. 615, 13, are from Theophrastos is shown by the agreement of Cic. *Acad.* ii. 118, *popularis et sodalis*. The two passages represent independent branches of the tradition. See Note on Sources, §§ 7, 12.

46. Diog. ii. 2 (R. P. 15); Hipp. *Ref.* i. 6 (*Dox.* p. 560); Plin. *N.H.* ii. 31.

47. Xenophanes, fr. 22 (= fr. 17 Karsten; R. P. 95 a).

48. The statement that he "died soon after" (Diog. ii. 2; R. P. 15) seems to mean that Apollodoros made him die in the year of Sardeis (546/5), one of his regular epochs.

49. For the gnomon, see Introd. p. 26, *n.* 1; and cf. Diog. ii. 1 (R. P. 15); Herod. ii. 109 (R. P. 15 a). Pliny, on the other hand, ascribes the invention of the gnomon to Anaximenes (*N.H.* ii. 187).

50. Aelian, *V.H.* iii. 17. Presumably Apollonia on the Pontos is meant.

51. The lower part of a contemporary statue has been discovered at Miletos (Wiegand, *Milet*, ii. 88), with the inscription ΑΝ]ΑΞΙΜΑΝΔΡΟ. It was not, we may be sure, for his theories of the Boundless that Anaximander received this honour; he was a statesman and an inventor, like Thales and Hekataios.

52. In this and other cases, where the words of the original have been preserved by Simplicius, I have given them alone. On the various writers quoted, see Note on Sources, §§ 9 *sqq.*

53. Simplicius says "successor and disciple" (διάδοχος καὶ μαθητής) in his *Commentary on the Physics*; but see above, p. 50, *n.* 4.

54. For the expression τὰ καλούμενα στοιχεῖα, see Diels, *Elementum*, p. 25, n. 4.

55. Diels (*Vors*. 2, 9) begins the actual quotation with the words ἐξ ὧν δὲ ἡ γένεσις . . . The Greek practice of blending quotations with the text tells against this. Further, it is safer not to ascribe the terms γένεσις and φθορά in their technical Platonic sense to Anaximander, and it is not likely that Anaximander said anything about τὰ ὄντα.

56. See p. 12, *n.* 2.

57. The important word ἀλλήλοις is in all the MSS. of Simplicius, though omitted in the Aldine. This omission made the sentence appear to mean that the existence of individual things (ὄντα) was somehow a wrong (ἀδικία) for which they must be punished. With ἀλλήλοις restored, this fanciful interpretation disappears. It is *to one another* that whatever the subject of the verb may be make reparation and give satisfaction, and therefore the injustice must be a wrong which they commit against one another. Now, as δίκη is regularly used of the observance of an equal balance between the opposites hot and cold, dry and wet, the ἀδικία here referred to must be the undue encroachment of one opposite on another, such as we see, for example, in the alternation of day and night, winter and summer, which have to be made good by an equal encroachment of the other. I stated this view in my first edition (1892), pp. 60-62, and am glad to find it confirmed by Professor Heidel (*Class. Phil*. vii., 1912, p. 233 *sq.*).

58. The words of Theophrastos, as given by Simplicius (Phys. p. 24, 15: R. P. 16), are ἀρχήν τε καὶ στοιχεῖον εἴρηκε τῶν ὄντων τὸ ἄπειρον, πρῶτος τοῦτο τοὔνομα κομίσας τῆς ἀρχῆς, the natural meaning of which is "he being the first to introduce this name (τὸ ἄπειρον) of the material cause." Hippolytos, however, says (*Ref.* i. 6, 2) πρῶτος τοὔνομα καλέσας τῆς ἀρχῆς, and this has led most writers to take the words in the sense that Anaximander introduced the term ἀρχή. Hippolytos, however, is not an independent authority (see Note on Sources, § 13), and the only question is what Theophrastos wrote. Now Simplicius quotes Theophrastos from Alexander, who used the original, while Hippolytos represents a much more indirect tradition. Obviously, καλέσας is a corruption of the characteristically Peripatetic κομίσας, and the omission of τοῦτο is much more likely than its interpolation by Alexander or Simplicius. But, if τοῦτο is genuine, the ὄνομα referred to must be τὸ ἄπειρον, and this interpretation is confirmed by Simpl. *De caelo* 615, 15, ἄπειρον δὲ πρῶτος ὑπέθετο. In another place (p. 150, 23) Simplicius says πρῶτος αὐτὸς ἀρχὴν ὀνομάσας τὸ ὑποκείμενον, which must mean, as the context shows, "being the first to name the substratum of the opposites as the material cause,"

which is another point altogether. Theophrastos is always interested in noting who it was that "first" introduced a concept, and both ἄπειρον and ὑποκείμενον were important enough to be noted. Of course he does not mean that Anaximander used the *word* ὑποκείμενον. He only infers that he had the idea from the doctrine that the opposites which are "in" the ἄπειρον are "separated out." Lastly, the whole book from which these extracts were taken was Περὶ τῶν ἀρχῶν, and the thing to note was who first applied various predicates to the ἀρχή or ἀρχαί.

59. See p. 47 *n.* 6 and Introd. p. 11 *n.* 3.

60. Arist. *Met.* Λ, 2. 1069 b 18 (R. P. 16 c).

61. This is taken for granted in *Phys.* Γ, 4. 203 a 16; 204 b 22 (R. P. 16 b), and stated in Γ, 8. 208 a 8 (R. P. 16 a). Cf. Simpl. *Phys.* p. 150, 20 (R. P. 18).

62. Aristotle speaks four times of something intermediate between Fire and Air (*Gen. Corr.* B, 1. 328 b 35; *ib.* 5. 332 a 21; *Phys.* A, 4. 187 a 14; *Met.* A, 7. 988 a 30). In five places we have something intermediate between Water and Air (*Met.* A, 7. 988 a 13; *Gen. Corr.* B, 5. 332 a 21; *Phys.* Γ, 4. 203 a 18; *ib.* 5. 205 a 27; *De caelo*, Γ, 5. 303 b 12). Once (*Phys.* A, 6. 189 b 1) we hear of something between Water and Fire. This variation shows at once that he is not speaking historically. If any one ever held the doctrine of τὸ μεταξύ, he must have known which "elements" he meant.

63. Arist. *De caelo*, Γ, 5. 303 b 12, ὕδατος μὲν λεπτότερον, ἀέρος δὲ πυκνότερον, ὃ περιέχειν φασὶ πάντας τοὺς οὐρανοὺς ἄπειρον ὄν.

64. cf. *Phys.* Γ, 5. 204 b 22 (R. P. 16 b), where Zeller rightly refers τὸ παρὰ τὰ στοιχεῖα to Anaximander. Now, at the end (205 a 25) the whole passage is summarised thus: καὶ διὰ τοῦτ' οὐθεὶς τὸ ἓν καὶ ἄπειρον πῦρ ἐποίησεν οὐδὲ γῆν τῶν φυσιολόγων, ἀλλ' ἢ ὕδωρ ἢ ἀέρα ἢ τὸ μέσον αὐτῶν. In *Gen. Corr.* B, 1. 328 b 35 we have first τι μεταξὺ τούτων σῶμά τε ὂν καὶ χωριστόν, and a little further on (329 a 9) μίαν ὕλην παρὰ τὰ εἰρημένα. In B, 5. 332 a 20 we have οὐ μὴν οὐδ' ἄλλο τί γε παρὰ ταῦτα, οἷον μέσον τι ἀέρος καὶ ὕδατος ἢ ἀέρος καὶ πυρός.

65. *Met.* Λ, 2. 1069 b 18 (R. P. 16 c). Zeller (p. 205, *n.* 1) assumes an "easy zeugma."

66. For the literature of this controversy, see R. P. 15. Professor Heidel has shown in his "Qualitative Change in Pre-Socratic Philosophy" (*Arch.*, xix. p. 333) that Aristotle misunderstood the Milesians because he could only think of their doctrine in terms of his own theory of ἀλλοίωσις. That is quite true, but it is equally true that they had no definite theory of their own with regard to the transformations of substance. The theory of an original "mixture" is quite as unhistorical as that of ἀλλοίωσις. Qualities were not yet distinguished from "things," and Thales doubtless said that water turned into vapour or ice without dreaming of any further questions. They all believed that in the long run there was only one "thing," and at last they came to the conclusion that all apparent differences were due to rarefaction and condensation. Theophrastos (*ap.* Simpl. *Phys.* 150, 22) says ἐνούσας γὰρ τὰς ἐναντιότας ἐν τῷ ὑποκειμένῳ . . . ἐκκρίνεσθαι. I do not believe these words are even a paraphrase of anything Anaximander said. They are merely an attempt to "accommodate" his views to Peripatetic ideas, and ἐνούσας is as unhistorical as the ὑποκείμενον.

67. *Phys.* Γ, 8. 208 a 8 (R. P. 16 a). Cf. Aet. i. 3, 3 (R. P. 16 a). The same argument is given in *Phys.* Γ, 4. 203 b 18, a passage where Anaximander has just been named, τῷ οὕτως ἂν μόνον μὴ ὑπολείπειν γένεσιν καὶ φθοράν, εἰ ἄπειρον εἴη ὅθεν ἀφαιρεῖται τὸ γιγνόμενον. I cannot, however, believe that the arguments at the beginning of this chapter (203 b 7; R. P. 17) are Anaximander's. They bear the stamp of the Eleatic dialectic, and are, in fact, those of Melissos.

68. I have assumed that the word ἄπειρον means *spatially infinite*, not *qualitatively indeterminate*, as maintained by Teichmüller and Tannery. The decisive reasons for holding that the sense of the word is "boundless in extent" are as follows: (1) Theophrastos said the primary substance of Anaximander was ἄπειρον and contained all the worlds, and the word περιέχειν everywhere means "to encompass," not, as has been suggested, "to contain potentially." (2) Aristotle says (*Phys.* Γ, 4. 203 b 23) διὰ γὰρ τὸ ἐν τῇ νοήσει μὴ ὑπολείπειν καὶ ὁ ἀριθμὸς δοκεῖ ἄπειρος εἶναι καὶ τὰ μαθηματικὰ μεγέθη καὶ τὰ ἔξω τοῦ οὐρανοῦ· ἀπείρου δ' ὄντος τοῦ ἔξω, καὶ σῶμα ἄπειρον εἶναι δοκεῖ καὶ κόσμοι. The mention of σῶμα shows that this does not refer to the Atomists. (3) Anaximander's theory of the ἄπειρον was adopted by Anaximenes, and he identified it with Air, which is not qualitatively indeterminate.

69. Cf. [Plut.] *Strom.* fr. 2 (R. P. 21 b).

70. Aet. ii. 1, 3 (*Dox.* p. 327). Zeller seems to be wrong in understanding κατὰ πᾶσαν περιαγωγήν here of revolution. It must mean "in every direction we turn," as is shown by the alternative phrase κατὰ πᾶσαν περίστασιν. The six περιστάσεις are πρόσω, ὀπίσω, ἄνω, κάτω, δεξιά, ἀριστερά (Nicom. *Introd.* p. 85, 11, Hoche).

71. Aet. ii. 1, 8 (*Dox.* p. 329), τῶν ἀπείρους ἀποφηναμένων τοὺς κόσμους Ἀναξίμανδρος τὸ ἴσον αὐτοὺς ἀπέχειν ἀλλήλων, Ἐπίκουρος ἄνισον εἶναι τὸ μεταξὺ τῶν κόσμων διάστημα.

72. He supposed it to be only that of Stobaios. The filiation of the sources had not been traced when he wrote.

73. For Anaximenes see § 30; Xenophanes, § 59; Archelaos, § 192.

74. This is proved by the fact that the list of names is given also by Theodoret. See Note on Sources, § 10.

75. Simpl. *Phys.* p. 1121, 5 (R. P. 21 b). Cf. Simpl. *De caelo*, p. 202, 14, οἱ δὲ καὶ τῷ πλήθει ἀπείρους κόσμους, ὡς Ἀναξίμανδρος . . . ἄπειρον τῳ μεγέθει τὴν ἀρχὴν θέμενος ἀπείρους ἐξ αὐτοῦ τῷ πλήθει κόσμους ποιεῖν δοκεῖ.

76. Cicero, *De nat. d.* i. 25 (R. P. 21).

77. Aet. i. 7, 12 (R. P. 21 a). The reading of Stob., ἀπείρους οὐρανούς, is guaranteed by the ἀπείρους κόσμους of Cyril, and the ἀπείρους νοῦς (*i.e.* ουνους) of the pseudo-Galen. See *Dox.* p. 11.

78. It is natural to suppose that Cicero found διαστήμασιν in his Epicurean source, and that is a technical term for the *intermundia*.

79. Arist. *Phys.* Γ, 4. 203 b 25, ἀπείρου δ' ὄντος τοῦ ἔξω (sc. τοῦ οὐρανοῦ), καὶ σῶμα ἄπειρον εἶναι δοκεῖ καὶ κόσμοι (ἄπειροι). The next words—τί γὰρ μᾶλλον τοῦ κενοῦ ἐνταῦθα ἢ ἐνταῦθα—show that this refers to the Atomists as well; but the ἄπειρον σῶμα will not apply to them. The meaning is that both those who made the Boundless a body and those who made it a κενόν held the doctrine of ἄπειροι κόσμοι in the same sense.

80. See below, § 53. Cf. Diels, *Elementum*, pp. 63 *sqq*.

81. Plato, *Tim.* 52 e. There the elemental figures (which have taken the place of the "opposites") "being thus stirred (by the irregular motion of the τιθήνη), are carried in different directions and separated, just as by sieves and instruments for winnowing corn the grain is shaken and sifted; and the dense and heavy parts go one way, while the rare and light are carried to a different place and settle there.

82. Aristophanes, referring to the Ionian cosmology, says (*Clouds*, 828) Δῖνος βασιλεύει τὸν Δι' ἐξεληλακώς, which is nearer the truth than the modern theory of its religious origin.

83. I gratefully accept the view propounded by Prof. W. A. Heidel ("The δίνη in Anaximenes and Anaximander," *Class. Phil.* i. 279), so far as the cosmical motion goes, though I cannot identify that with the "eternal motion." I had already done what I could to show that the "spheres" of Eudoxos and Aristotle must not be imported into Pythagoreanism, and it strengthens the position considerably if we ascribe a rotary motion in a plane to Anaximander's world.

84. This is the plain meaning of Aet. ii. 2, 4, οἱ δὲ τροχοῦ δίκην περιδινεῖσθαι τὸν κόσμον, which is referred to Anaximander by Diels (*Dox.* p. 46). Zeller's objections to the ascription of the δίνη to Anaximander are mainly based on an inadmissible rendering of the word τροπαί (p. 63 *n.* 2). Of course, the rotations are not all in the same plane; the ecliptic, for instance, is inclined to the equator, and the Milky Way to both.

85. This passage has been discussed by Heidel (*Proceedings of the American Academy*, xlviii. 686). I agree that ἀπὸ τοῦ ἀπείρου must be supplied with ἀποκριθῆναι, and I formerly thought that ἐκ τοῦ αἰδίου might be equivalent to that, and might have been displaced if the order of words was too harsh. I cannot believe that it means "from eternity," as Heidel thinks. On the other hand, he is clearly right in his interpretation of περιφυῆναι and ἀπορραγείσης. He also points out correctly that "the *sphere* of flame" is an inaccuracy. The comparison to the bark of a tree distinctly suggests something annular.

86. Zeller (p. 223, *n.* 5) asks what can be meant by τροπαὶ τῆς σελήνης, but his difficulty is an imaginary one. The moon has certainly a movement in declination and therefore τροπαί. In other words, the moon does not always rise at the same point of the horizon any more than the sun. This is admitted by Sir T. L. Heath (*Aristarchus*, p. 33, *n.* 3), though he has unfortunately followed Zeller in supposing that τροπαί here means "revolutions." This seems to me impossible; for τρέπεσθαι means "to turn back" or "to turn aside," never "to turn round," which is στρέφεσθαι. It is conceivable, indeed, that τροπαὶ ἠελίοιο in *Od.* xv. 404 means the place where the sun sets and turns *back* from west to east, though it is not very likely, as Hesiod already uses τροπαὶ ἠελίοιο of the winter and summer solstices (*O.D.* 479, 564, 663). Zeller's statement (repeated by Heath) that Aristotle speaks of τροπαί of the fixed stars in *De caelo,* B, 14. 296 b 4, is erroneous. What Aristotle does say is that, if the earth is in motion, there ought to be πάροδοι (movements in 1atitude) and τροπαί of the fixed stars, *which there are not*. The passage is correctly rendered by Sir T. L. Heath himself in a subsequent chapter (p. 241). For the other passages referred to, see p. 64, *n.* 1, and p. 76, *n.* 3.

87. From the whole context it is plain that τὰς τροπὰς αὐτοῦ means τὰς τοῦ ἡλίου τροπάς, and not τὰς τοῦ οὐρανοῦ, as Zeller and Heath say. The "air" in this passage answers to "the portion that evaporated" (τὸ διατμίσαν) in that previously quoted, and τοῦτον must therefore refer to it. Cf. the paraphrase of Alexander (p. 67, 3 from Theophrastos, *Dox.* p. 494). τὸ μέν τι τῆς ὑγρότητος ὑπὸ τοῦ ἡλίου ἐξατμίζεσθαι καὶ γίνεσθαι πνεύματά τε ἐξ αὐτοῦ καὶ τροπὰς ἡλίου τε καὶ σελήνης (see last note). In this chapter of the *Meteorology*, Aristotle is discussing the doctrine that the sun is "fed" by moisture and the relation of that doctrine to its τροπαί at the solstices, and we must interpret accordingly.

88. The MSS. of Hippolytos have ὑγρὸν στρογγύλον, and so has Cedrenus, a writer of the eleventh century who made extracts from him. Roeper read γυρὸν [στρογγύλον], supposing the second word to be a gloss on the first. Diels (*Dox.* p. 218) holds that the first applies to the surface of the earth; while the second refers to its circuit. Professor A. E. Taylor has pointed out to me, however, the great improbability of the view that γυρόν means convex. The Ionians down to Archelaos (§ 192) and Demokritos (Aet. iii. 10, 5, κοίλην τῷ μέσῳ) regularly regarded the surface of the earth as concave, and γυρός can just as well mean that. The next words are also of doubtful meaning. The MSS. of Hippolytos have χίονι λίθῳ, while Aetios (iii. 10, 2) has λίθῳ κίονι. Diels doubtfully conjectures λίθῳ κίονι, which he suggests might represent an original λιθέῃ κίονι (*Dox.* p. 219). In any case the pillar seems genuine, and the general sense is guaranteed by the Plutarchean *Stromateis* (*loc. cit.*), ὑπάρχειν . . . τῷ μὲν σχήματι τὴν γῆν κυλινδροειδῆ.

89. See above, p. 55, *n.* 4.

90. Arist. *De caelo*, B, 13. 295 b 10 εἰσὶ δέ τινες οἳ διὰ τὴν ὁμοιότητά φασιν αὐτὴν (τὴν γῆν) μένειν, ὥσπερ τῶν ἀρχαίων Ἀναξίμανδρος· μᾶλλον μὲν γὰρ οὐθὲν ἄνω ἢ κάτω ἢ εἰς τὰ πλάγια φέρεσθαι προσήκειν τὸ ἐπὶ τοῦ μέσου ἱδρυμένον καὶ ὁμοίως πρὸς τὰ ἔσχατα ἔχον. One point of the δίνη is no more "down" than another. Apparently, the Pythagoreans adopted this reasoning; for Plato makes Sokrates in the *Phaedo* say (108 e) [Perseus 109a] ἰσόρροπον γὰρ πρᾶγμα ὁμοίου τινὸς ἐν μέσῳ τεθὲν οὐχ ἕξει μᾶλλον οὐδὲ ἧττον οὐδαμόσε κλιθῆναι. From this it appears that ὁμοιότης means something like "indifference." There is nothing to differentiate one radius of a circle from another.

91. Arist. *De caelo*, B, 13. 295 a 9 (ἡ γῆ) συνῆλθεν ἐπὶ τὸ μέσον φερομένη διὰ τὴν δίνησιν· ταύτην γὰρ τὴν αἰτίαν πάντες λέγουσιν ἐκ τῶν ἐν τοῖς ὑγροῖς καὶ περὶ τὸν ἀέρα συμβαινόντων· ἐν τούτοις γὰρ ἀεὶ φέρεται τὰ μείζω καὶ τὰ βαρύτερα πρὸς τὸ μέσον τῆς δίνης. διὸ δὴ καὶ τὴν γῆν πάντες ὅσοι τὸν οὐρανὸν γεννῶσιν ἐπὶ τὸ μέσον συνελθεῖν φασιν.

92. This was expressly stated by Eudemos (ap. Theon. Smyrn. p. 198, Ἀναξίμανδρος δὲ ὅτι ἐστὶν ἡ γῆ μετέωρος καὶ κινεῖται περὶ τὸ μέσον. Anaxagoras held the same view (§ 133).

93. I assume with Diels (*Dox.* p. 56o) that something has fallen out of the text, but I have made the moon's circle 18 and not 19 times as large, as agreeing better with the other figure, 27. See p. 68, *n.* 1.

94. There is clearly some confusion here, as Anaximander's real account of lunar eclipses is given in the next extract. There is also some doubt about the reading. Both Plutarch and Eusebios (*P.E.* xv. 26, 1) have ἐπιστροφάς, so the τροπάς of Stob. may be neglected, especially as the *codex Sambuci* had στροφάς. It looks as if this were a stray reference to the theory of Herakleitos that eclipses were due to a στροφή or ἐπιστροφή of the σκάφη (§ 71). In any case, the passage cannot be relied on in support of the meaning given to τροπαί by Zeller and Heath (p. 63, *n.* 2).

95. See Tannery, *Science hellène*, p. 91; Diels, "Ueber Anaximanders Kosmos" (*Arch.* x. pp. 231 *sqq.*).

96. The true meaning of this doctrine was first explained by Diels (*Dox.* pp. 25 *sqq.*). The flames issue *per magni circum spiracula mundi*, as Lucretius has it (vi. 493). The πρηστῆρος αὐλός, to which these are compared, is simply the mouthpiece of the smith's bellows, a sense the word πρηστήρ has in Apollonios of Rhodes (iv. 776), and has nothing to do with the meteorological phenomenon of the same name (see Chap: III. § 71), except that the Greek sailors very likely named the fiery waterspout after the familiar instrument. It is not necessary now to discuss the earlier interpretations of the phrase.

97. This is not so strange a view as might appear. An island or a rock in the offing may disappear completely when shrouded in mist (ἀήρ), and we seem to see the sky beyond it.

98. See above, p. 27.

99. Lucretius, v. 619 *sqq.*

100. This is to be understood in the light of what we are told about γαλεοί below. Cf. Arist. *Hist. An.* Z, l0. 565 a 25, τοῖς μὲν οὖν σκυλίοις, οὓς καλοῦσί τινες νεβρίας γαλεούς, ὅταν περιρραγῇ καὶ ἐκπέσῃ τὸ ὄστρακον, γίνονται οἱ νεοττοί.

101. The true reading is ἐπ' ὀλίγον χρόνον μεταβιῶναι, the omission of χρόνον by Diels in *Vors.*[1] and *Vors.*[2] being apparently a slip. In the Index to *Dox.*, Diels *s.v.* μεταβιοῦν says "mutare vitam [cf. μεταδιαιτᾶν]," and I followed him in my first edition. Heidel well compares Archelaos, *ap.* Hipp. *Ref.* i. 9, 5 (of the first animals) ἦν δὲ ὀλιγοχρόνια.

102. Reading ὥσπερ οἱ γαλεοί for ὥσπερ οἱ παλαιοί with Doehner, who compares Plut. *De soll. anim.* 982 a, where the φιλόστοργον of the shark is described.

103. On Aristotle and the *galeus levis*, see Johannes Müller, "Ueber den glatten Hai des Aristoteles" (*K. Preuss. Akad.*, 1842), to which my attention was directed by my colleague, Professor D'Arcy Thompson. The precise point of the words τρεφόμενοι ὥσπερ οἱ γαλεοί appears from Arist. *Hist. An.* Z, l0. 565 b 1, οἱ δὲ καλούμενοι λεῖοι τῶν γαλεῶν τὰ μὲν ᾠὰ ἴσχουσι μεταξὺ τῶν ὑστερῶν ὁμοίως τοῖς σκυλίοις, περιστάντα δὲ ταῦτα εἰς ἑκατέραν τὴν δικρόαν τῆς ὑστέρας καταβαίνει, καὶ τὰ ζῷα γίνεται τὸν ὀμφαλὸν ἔχοντα πρὸς τῇ ὑστέρᾳ, ὥστε ἀναλισκομένων τῶν ᾠῶν ὁμοίως δοκεῖν ἔχειν τὸ ἔμβρυον τοῖς τετράποσιν. It is not necessary to suppose that Anaximander referred to the further phenomenon described by Aristotle, who more than once says that all the γαλεοί except the ἀκανθίας "send out their young and take them back again" (ἐξαφιᾶσι καὶ δέχονται εἰς ἑαυτοὺς τοὺς νεοττούς, *ib.* 565 b 23), for which compare also Ael. i. 17; Plut. *De amore prolis* 494 c ; *De soll. anim.* 982 a. The placenta and umbilical cord described by Johannes Müller will account sufficiently for all he says.

104. Theophr. *Phys. Op.* fr. 2 (R. P. 26).

105. This follows from a comparison of Diog. ii. 3 with Hipp. *Ref.* i. 7 (R. P. 23) and Souidas (*sv.*). In Hippolytos we must, however, read τρίτον for πρῶτον with Diels. The suggestion in R. P. 23 a that Apollodoros mentioned the Olympiad without giving the number of the year is inadequate; for Apollodoros did not reckon by Olympiads, but Athenian archons.

106. Jacoby (p. 194) brings the date into connexion with the *floruit* of Pythagoras, which seems to me less probable.

107. Diog. ii. 3 (R. P. 23).

108. Cf. the statement of Theophrastos above, § 13.

109. On these monographs, see *Dox.* p. 103.

110. See the conspectus of extracts from Theophrastos given in *Dox.* p. 135.

111. "Felting" (πίλησις) is the regular term for this process with all the early cosmologists, from whom Plato has taken it (*Tim.* 58 b 4; 76 c 3).

112. Simplicius, *Phys.* p. 149, 32 (R. P. 26 b), says that Theophrastos spoke of rarefaction and condensation in the case of Anaximenes *alone*. It should be noted, however, that Aristotle, *Phys.* A, 4. 187 a 12, seems to imply that Anaximander too had spoken of rarefaction and condensation, especially if ὅ ἐστι πυρὸς μὲν πυκνότερον ἀέρος δὲ λεπτότερον is referred to him. On the other hand, at 20, οἱ δ' ἐκ τοῦ ἑνὸς ἐνούσας τὰς ἐναντιότητας ἐκκρίνεσθαι, ὥσπερ Ἀναξίμανδρός φησι seems to be opposed to a 12, οἱ μὲν κτλ. As I have indicated already, it looks as if we were dealing here with Aristotle's own inferences and interpretations, which are far from clear. They are outweighed by the definite statement quoted by Simplicius from Theophrastos, though Simplicius himself adds δῆλον δὲ ὡς καὶ οἱ ἄλλοι τῇ μανότητι καὶ πυκνότητι ἐχρῶντο. That, however, is only his own inference from Aristotle's somewhat confused statement.

113. For the meaning of ἀήρ in Homer, cf. e.g.. *Od.* viii. 1, ἠέρι καὶ νεφέλῃ κεκαλυμμέναι; and for its survival in Ionic prose, Hippokrates, Περὶ ἀέρων, ὑδάτων, τόπων, 15, ἀήρ τε πολὺς κατέχει τὴν χώρην ἀπὸ τῶν ὑδάτων.. Plato is still conscious of the old meaning; for he makes Timaios say ἀέρος (γένη) τὸ μὲν εὐαγέστατον ἐπίκλην αἰθὴρ καλούμενος, ὁ δὲ θολερώτατος ὁμίχλη καὶ σκότος (*Tim.* 58 d). For the identification of ἀήρ with darkness, cf. Plut. *De prim. frig.* 948 e, ὅτι δ' ἀὴρ τὸ πρώτως σκοτεινόν ἐστιν οὐδὲ τοὺς ποιητὰς λέληθεν· ἀέρα γὰρ τὸ σκότος καλοῦσιν. My view has been criticised by Tannery, "Une nouvelle hypothèse sur Anaximandre" (*Arch.* viii. pp. 443 *sqq.*), and I have slightly altered my expression of it to meet these criticisms. The point is of fundamental importance for the interpretation of Pythagoreanism.

114. Plut. *De prim. frig.* 947 f (R. P. 27), where we are told that he used the term τὸ χαλαρόν for the rarefied air.

115. Aet. i. 3, 4 (R. P. 24).

116. See Chap. II. § 53.

117. The text is very corrupt here. I retain ἐκπεπυκνωμένος, because we are told above that winds are condensed air.

118. See below, p. 77, *n.* 4.

119. This can only refer to the τροπαί of the sun, though it is loosely stated of τὰ ἄστρα generally. It occurs in the chapter Περὶ τροπῶν ἡλίου, and we cannot interpret it as if it were a detached statement.

120. The source of this is Poseidonios, who used Theophrastos. *Dox.* p. 231.

121. Theodoret (iv. 16) speaks of those who believe in a revolution like that of a millstone, as contrasted with one like that of a wheel. Diels (*Dox.* p. 46) refers these similes to Anaximenes and Anaximander respectively. They come, of course, from Aetios (Note on Sources, § 10), though they are given neither by Stobaios nor in the *Placita.*

122. B, 1. 354 a 28 (R. P. 28 c).

123. For this reason, I now reject the statement of Aetios, ii. 14, 3 (p. 76), Ἀναξιμένης ἥλων δίκην καταπεπηγέναι τῷ κρυσταλλοειδεῖ. That there is some confusion of names here is strongly suggested by the words which immediately follow, ἔνιοι δὲ πέταλα εἶναι πύρινα ὥσπερ τὰ ζωγραφήματα, which is surely the genuine doctrine of Anaximenes. I understand ζωγραφήματα of the constellations (cf. Plato, *Tim.* 55c). To regard the stars as fixed to a crystalline sphere is quite inconsistent with the far better attested doctrine that they do not go under the earth.

124. See Tannery, *Science hellène*, p. 153. For the precisely similar bodies assumed by Anaxagoras, see below, Chap. VI. § 135. See further Chap. VII. § 151.

125. Cic. *De nat. d.* i. 26 (R. P. 28 b).

126. Hipp. *Ref.* i. 7, 1 (R. P. 28).

127. Aug. *De civ. D.* viii. 2: "Anaximenes omnes rerum causas infinito aëri dedit: nec deos negavit aut tacuit; non tamen ab ipsis aërem factum, sed ipsos ex aëre ortos credidit" (R. P. 28 b).

128. Simpl. *Phys.* p. 1121, 12 (R. P. 28 a). The passage from the *Placita* is of higher authority than this from Simplicius. It is only to Anaximenes, Herakleitos, and Diogenes that successive worlds are ascribed even here. For the Stoic view of Herakleitos, see Chap. III. § 78; and for Diogenes, Chap.X. §188. That Simplicius is following a Stoic authority is suggested by the words καὶ ὕστερον οἱ ἀπὸ τῆς Στοᾶς.

129. In particular, both Leukippos and Demokritos adhered to his theory of a flat earth. Cf. Aet. iii. 10, 3-5 (Περὶ σχήματος γῆς), Ἀναξιμένης τραπεζοειδῆ (τὴν γῆν). Λεύκιππος τυμπανοειδῆ. Δημόκριτος δισκοειδῆ μὲν τῷ πλάτει, κοίλην δὲ τῷ μέσῳ. And yet the spherical form of the earth was already a commonplace in circles affected by Pythagoreanism.