

# INTRODUCTION

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I. The Cosmological Character of Early Greek Philosophy IT was not till the traditional view of the world and the customary rules of life had broken down, that the Greeks began to feel the needs which philosophies of nature and of conduct seek to satisfy. Nor were those needs felt all at once. The ancestral maxims of conduct were not seriously questioned till the old view of nature had passed away; and, for this reason, the earliest philosophers busied themselves mainly with speculations about the world around them. In due season, Logic was called into being to meet a fresh want. The pursuit of cosmological inquiry had brought to light a wide divergence between science and common sense, which was itself a problem that demanded solution, and moreover constrained philosophers to study the means of defending their paradoxes against the prejudices of the unscientific. Later still, the prevailing interest in logical matters raised the question of the origin and validity of knowledge; while, about the same time, the break-down of traditional morality gave rise to Ethics. The period which

precedes the rise of Logic and Ethics has thus a distinctive character of its own, and may fitly be treated apart.<sup>1</sup>

II. The Traditional View of the World It must, however, be remembered that the world was already very old when science and philosophy began. In particular, the Aegean Sea had been the seat of a high civilisation from the Neolithic age onwards, a civilisation as ancient as that of Egypt or of Babylon, and superior to either in most things that matter. It is becoming clearer every day that the Greek civilisation of later days was mainly the revival and continuation of this, though it no doubt received certain new and important elements from the less civilised northern peoples who for a time arrested its development. The original Mediterranean population must have far outnumbered the intruders, and must have assimilated and absorbed them in a few generations, except in a state like Sparta, which deliberately set itself to resist the process. At any rate, it is to the older race we owe Greek Art and Greek Science.<sup>2</sup> It is a remarkable fact that every one of the men whose work we are about to study was an Ionian, except Empedokles of Akragas, and this exception is perhaps more apparent than real. Akragas was founded from the Rhodian colony of Gela, its *ὀβιστής* was himself a Rhodian, and Rhodes, though officially Dorian, had been a centre of the early Aegean civilisation. We may fairly assume that the emigrants belonged mainly to the older population rather than to the new Dorian aristocracy. Pythagoras founded his society in the Achaian city of Kroton, but he himself was an Ionian from Samos.

This being so, we must be prepared to find that the Greeks of historical times who first tried to understand the world were not at all in the position of men setting out on a hitherto untrodden path. The remains of Aegean art prove that there must have been a tolerably consistent view of the world in existence already, though we cannot hope to recover it in detail till the records are deciphered. The ceremony represented on the sarcophagus of Hagia Triada implies some quite definite view as to the state of the dead, and we may be sure that the Aegean people were as capable of developing theological speculation as were the Egyptians and Babylonians. We shall expect to find traces of this in later days, and it may be said at once that things like the fragments of Pherekydes of Syros are inexplicable except as survivals of some such speculation. There is no ground for supposing that this was borrowed from Egypt, though no doubt these early civilisations all influenced one another. The Egyptians may have borrowed from Crete as readily as the Cretans from Egypt, and there was a seed of life in the sea civilisation which was somehow lacking in that of the great rivers.

On the other hand, it is clear that the northern invaders have assisted the free development of the Greek genius by breaking up the powerful monarchies of earlier days and, above all, by checking the growth of a superstition like that which ultimately stifled Egypt and Babylon. That there was once a real danger of this is suggested by certain features in the Aegean remains. On the other hand, the

worship of Apollo seems to have been brought from the North by the Achaians,<sup>3</sup> and indeed what has been called the Olympian religion was, so far as we can see, derived mainly from that source. Still, the artistic form it assumed bears the stamp of the Mediterranean peoples, and it was chiefly in that form it appealed to them. It could not become oppressive to them as the old Aegean religion might very possibly have done. It was probably due to the Achaians that the Greeks never had a priestly class, and that may well have had something to do with the rise of free science among them.

III. Homer We see the working of these influences clearly in Homer. Though he doubtless belonged to the older race himself and used its language,<sup>4</sup> it is for the courts of Achaian princes he sings, and the gods and heroes he celebrates are mostly Achaian.<sup>5</sup> That is why we find so few traces of the traditional view of the world in the epic. The gods have become frankly human, and everything primitive is kept out of sight. There are, of course, vestiges of the early beliefs and practices, but they are exceptional.<sup>6</sup> It has often been noted that Homer never speaks of the primitive custom of purification for homicide. The dead heroes are burned, not buried, as the kings of the older race were. Ghosts play hardly any part. In the *Iliad* we have, to be sure, the ghost of Patroklos, in close connexion with the solitary instance of human sacrifice in Homer. There is also the *Nekyia* in the Eleventh Book of the *Odyssey*.<sup>7</sup> Such things, however, are rare, and we may fairly infer that, at least in a certain society, that of the Achaian princes for whom Homer sang, the traditional view of the world was already discredited at a comparatively early date,<sup>8</sup> though it naturally emerges here and there.

#### IV. Hesiod

When we come to Hesiod, we seem to be in another world. We hear stories of the gods which are not only irrational but repulsive, and these are told quite seriously. Hesiod makes the Muses say: "We know how to tell many false things that are like the truth; but we know too, when we will, to utter what is true."<sup>9</sup> This means that he was conscious of the difference between the Homeric spirit and his own. The old light-heartedness is gone, and it is important to tell the truth about the gods. Hesiod knows, too, that he belongs to a later and a sadder time than Homer. In describing the Ages of the World, he inserts a fifth age between those of Bronze and Iron. That is the Age of the Heroes, the age Homer sang of. It was better than the Bronze Age which came before it, and far better than that which followed it, the Age of Iron, in which Hesiod lives.<sup>10</sup> He also feels that he is singing for another class. It is to shepherds and husbandmen of the older race he addresses himself, and the Achaian princes for whom Homer sang have become remote persons who give "crooked dooms." The romance and splendour of the Achaian Middle Ages meant nothing to the common people. The primitive view of the world had never really died out among them; so it was natural for their first spokesman to assume it in his poems. That is why we find in Hesiod these old savage tales, which Homer disdained.

Yet it would be wrong to see in the *Theogony* a mere revival of the old superstition. Hesiod could not help being affected by the new spirit, and he became a pioneer in spite of himself. The rudiments of what grew into Ionic science and history are to be found in his poems, and he really did more than any one to hasten that decay of the old ideas which he was seeking to arrest. The *Theogony* is an attempt to reduce all the stories about the gods into a single system, and system is fatal to so wayward a thing as mythology. Moreover, though the spirit in which Hesiod treats his theme is that of the older race, the gods of whom he sings are for the most part those of the Achaians. This introduces an element of contradiction into the system from first to last. Herodotos tells us that it was Homer and Hesiod who made a theogony for the Hellenes, who gave the gods their names, and distributed among them their offices and arts,<sup>11</sup> and it is perfectly true. The Olympian pantheon took the place of the older gods in men's minds, and this was quite as much the doing of Hesiod as of Homer. The ordinary man would hardly recognise his gods in the humanised figures, detached from all local associations, which poetry had substituted for the older objects of worship. Such gods were incapable of satisfying the needs of the people, and that is the secret of the religious revival we shall have to consider later.

#### V. Cosmogony

Nor is it only in this way that Hesiod shows himself a child of his time. His *Theogony* is at the same time a Cosmogony, though it would seem that here he was following the older tradition rather than working out a thought of his own. At any rate, he only mentions the two great cosmogonical figures, Chaos and Eros, and does not really bring them into connexion with his system. They seem to belong, in fact, to an older stratum of speculation. The conception of Chaos represents a distinct effort to picture the beginning of things. It is not a formless mixture, but rather, as its etymology indicates, the yawning gulf or gap where nothing is as yet.<sup>12</sup> We may be sure that this is not primitive. Primitive man does not feel called on to form an idea of the very beginning of all things; he takes for granted that there was something to begin with. The other figure, that of Eros, was doubtless intended to explain the impulse to production which gave rise to the whole process. These are clearly speculative ideas, but in Hesiod they are blurred and confused.

We have records of great activity in the production of cosmogonies during the whole of the sixth century B.C., and we know something of the systems of Epimenides, Pherekydes,<sup>13</sup> and Akousilaos. If there were speculations of this kind even before Hesiod, we need have no hesitation in believing that the earliest Orphic cosmogony goes back to that century too.<sup>14</sup> The feature common to all these systems is the attempt to get behind the Gap, and to put Kronos or Zeus in the first place. That is what Aristotle has in view when he distinguishes the "theologians" from those who were half theologians and half philosophers, and who put what was best in the beginning.<sup>15</sup> It is obvious, however, that this process is the very reverse of scientific, and might be carried on indefinitely; so we

have nothing to do with the cosmogonists in our present inquiry, except so far as they can be shown to have influenced the course of more sober investigations.

## VI. General Characteristics of Greek Cosmology

The Ionians, as we can see from their literature, were deeply impressed by the transitoriness of things. There is, in fact, a fundamental pessimism in their outlook on life, such as is natural to an over-civilised age with no very definite religious convictions. We find Mimnermos of Kolophon preoccupied with the sadness of the coming of old age, while at a later date the lament of Simonides, that the generations of men fall like the leaves of the forest, touches a chord that Homer had already struck.<sup>16</sup> Now this sentiment always finds its best illustrations in the changes of the seasons, and the cycle of growth and decay is a far more striking phenomenon in Aegean lands than in the North, and takes still more clearly the form of a war of opposites, hot and cold, wet and dry. It is, accordingly, from that point of view the early cosmologists regard the world. The opposition of day and night, summer and winter, with their suggestive parallelism in sleep and waking, birth and death, are the outstanding features of the world as they saw it.<sup>17</sup>

The changes of the seasons are plainly brought about by the encroachments of one pair of opposites, the cold and the wet, on the other pair, the hot and the dry, which in their turn encroach on the other pair. This process was naturally described in terms borrowed from human society; for in early days the regularity and constancy of human life was far more clearly realised than the uniformity of nature. Man lived in a charmed circle of social law and custom, but the world around him at first seemed lawless. That is why the encroachment of one opposite on another was spoken of as injustice (*ἀδικία*) and the due observance of a balance between them as justice (*δίκη*). The later word *κόσμος* is based on this notion too. It meant originally the discipline of an army, and next the ordered constitution of a state.

That, however, was not enough. The earliest cosmologists could find no satisfaction in the view of the world as a perpetual contest between opposites. They felt that these must somehow have a common ground, from which they had issued and to which they must return once more. They were in search of something more primary than the opposites, something which persisted through all change, and ceased to exist in one form only to reappear in another. That this was really the spirit in which they entered on their quest is shown by the fact that they spoke of this something as "ageless" and "deathless."<sup>18</sup> If, as is sometimes held, their real interest had been in the process of growth and becoming, they would hardly have applied epithets so charged with poetical emotion and association to what is alone permanent in a world of change and decay. That is the true meaning of Ionian "Monism."<sup>19</sup>

## VII. Physis

Now, Ionian science was introduced into Athens by Anaxagoras about the time Euripides was born, and there are sufficient traces of its influence on him.<sup>20</sup> It is, therefore, significant that, in a fragment which portrays the blessedness of a life devoted to scientific research (ἱστορία)<sup>21</sup> he uses the very epithets "ageless and deathless" which Anaximander had applied to the one primary substance, and that he associates them with the term φύσις. The passage is so important for our present purpose that I quote it in full:

ὄλβιος ὅστις τῆς ἱστορίας  
ἔσχε μάθησιν, μήτε πολιτῶν  
ἐπὶ πημοσύνας μήτ' εἰς ἀδίκους  
πράξεις ὀρμῶν,  
ἀλλ' ἀθανάτου καθορῶν φύσεως  
κόσμον ἀγήρω, τίς τε συνέστη  
καὶ ὅπη καὶ ὅπως·  
τοῖς τοιούτοις οὐδέποτ' αἰσχρῶν  
ἔργων μελέτημα προσίξει.<sup>22</sup>

[Blessed is whoever has a knowledge of science, neither rushing headlong at freemen, causing them to suffer or commit unjust acts, but perceiving the ordering of immortal and ageless *physis* and who organized it, whence it came and how: the practice of shameful works never sits near such.—Tr. Anonymous, (Peithô's Web note)]

This fragment is clear evidence that, in the fifth century B.C., the name φύσις was given to the everlasting something of which the world was made. That is quite in accordance with the history of the word, so far as we can make it out. Its original meaning appears to be the "stuff" of which anything is made, a meaning which easily passes into that of its "make-up," its general character or constitution. Those early cosmologists who were seeking for an "undying and ageless" something, would naturally express the idea by saying there was "one φύσις"<sup>23</sup> of all things. When that was given up, under the influence of Eleatic criticism, the old word was still used. Empedokles held there were four such primitive stuffs, each with a φύσις of its own, while the Atomists believed in an infinite number, to which they also applied the term.<sup>24</sup>

The term ἀρχή, which is often used in our authorities, is in this sense<sup>25</sup> purely Aristotelian. It is very natural that it should have been adopted by Theophrastos and later writers; for they all start from the well-known passage of the *Physics* in which Aristotle classifies his predecessors according as they postulated one or more ἀρχαί.<sup>26</sup> But Plato never uses the term in this connexion, and it does not occur once in the genuine fragments of the early philosophers, which would be very strange on the assumption that they employed it.

Now, if this is so, we can understand at once why the Ionians called science Περί φύσεως ἱστορίη. We shall see that the growing thought which may be traced through the successive representatives of any school is always that which concerns the primary substance,<sup>27</sup> whereas the astronomical and other theories are, in the main, peculiar to the individual thinkers. The chief interest of all is the quest for what is abiding in the flux of things.<sup>28</sup>

#### VIII. Motion and Rest

According to Aristotle and his followers, the early cosmologists believed also in an "eternal motion" (ἀίδιος κίνησις) but that is probably their own way of putting the thing. It is not at all likely that the Ionians said anything about the eternity of motion in their writings. In early times, it is not movement but rest that has to be accounted for, and it is unlikely that the origin of motion was discussed till its possibility had been denied. As we shall see, that was done by Parmenides; and accordingly his successors, accepting the fact of motion, were bound to show how it originated. I understand Aristotle's statement, then, as meaning no more than that the early thinkers did not feel the need of assigning an origin for motion. The eternity of motion is an inference, which is substantially correct, but is misleading in so far as it suggests deliberate rejection of a doctrine not yet formulated.<sup>29</sup>

A more important question is the nature of this motion. It is clear that it must have existed before the beginning of the world, since it is what brought the world into being. It cannot, therefore, be identified with the diurnal revolution of the heavens, as it has been by many writers, or with any other purely mundane motion.<sup>30</sup> The Pythagorean doctrine, as expounded in Plato's *Timaeus*,<sup>31</sup> is that the original motion was irregular and disorderly, and we shall see reason for believing that the Atomists ascribed a motion of that kind to the atoms. It is safer, then, not to attribute any regular or well-defined motion to the primary substance of the early cosmologists at this stage.<sup>32</sup>

#### IX. The Secular Character of Ionian Science

In all this, there is no trace of theological speculation. We have seen that there had been a complete break with the early Aegean religion, and that the Olympian polytheism never had a firm hold

on the Ionian mind. It is therefore quite wrong to look for the origins of Ionian science in mythological ideas of any kind. No doubt there were many vestiges of the older beliefs and practices in those parts of Greece which had not come under the rule of the Northerners, and we shall see presently how they reasserted themselves in the Orphic and other mysteries, but the case of Ionia was different. It was only after the coming of the Achaians that the Greeks were able to establish their settlements on the coast of Asia Minor, which had been closed to them by the Hittites,<sup>33</sup> and there was no traditional background there at all. In the islands of the Aegean it was otherwise, but Ionia proper was a country without a past. That explains the secular character of the earliest Ionian philosophy.

We must not be misled by the use of the word θεός in the remains that have come down to us. It is quite true that the Ionians applied it to the "primary substance" and to the world or worlds, but that means no more and no less than the use of the divine epithets "ageless" and "deathless" to which we have referred already. In its religious sense the word "god" always means first and foremost an object of worship, but already in Homer that has ceased to be its only signification. Hesiod's *Theogony* is the best evidence of the change. It is clear that many of the gods mentioned there were never worshipped by any one, and some of them are mere personifications of natural phenomena, or even of human passions.<sup>34</sup> This non-religious use of the word "god" is characteristic of the whole period we are dealing with, and it is of the first importance to realise it. No one who does so will fall into the error of deriving science from mythology.<sup>35</sup>

We see this, above all, from the fact that, while primitive religion regards the heavenly bodies and the heavens themselves as divine, and therefore of a wholly different nature from anything on this earth, the Ionians from the very first set their faces against any such distinction, though it must have been perfectly familiar to them from popular beliefs. Aristotle revived the distinction at a later date, but Greek science began by rejecting it.<sup>36</sup>

## X. Alleged Oriental Origin of Philosophy

We have also to face the question of the nature and extent of the influence exercised by what we call Eastern wisdom on the Greek mind. It is a common idea even now that the Greeks in some way derived their philosophy from Egypt and Babylon, and we must therefore try to understand as clearly as possible what such a statement really means. To begin with, we must observe that the question wears a very different aspect now that we know the great antiquity of the Aegean civilisation. Much that has been regarded as Oriental may just as well be native. As for later influences, we must insist that no writer of the period during which Greek philosophy flourished knows anything of its having come from the East. Herodotos would not have omitted to say so, had he heard of it; for it would have confirmed his own belief in the Egyptian origin of Greek religion and civilisation.<sup>37</sup> Plato,

who had a great respect for the Egyptians on other grounds, classes them as a business-like rather than a philosophical people.<sup>38</sup> Aristotle speaks only of the origin of mathematics in Egypt<sup>39</sup> (a point to which we shall return), though, if he had known of an Egyptian philosophy, it would have suited his argument better to mention that. It is not till later, when Egyptian priests and Alexandrian Jews began to vie with one another in discovering the sources of Greek philosophy in their own past, that we have definite statements to the effect that it came from Phoenicia or Egypt. But the so-called Egyptian philosophy was only arrived at by a process of turning primitive myths into allegories. We are still able to judge Philo's Old Testament interpretation for ourselves, and we may be sure that the Egyptian allegorists were even more arbitrary; for they had far less promising material to work on. The myth of Isis and Osiris, for instance, is first interpreted according to the ideas of later Greek philosophy, and then declared to be the source of that philosophy.

This method of interpretation culminated with the Neopythagorean Noumenios, from whom it passed to the Christian Apologists. It is Noumenios who asks, "What is Plato but Moses speaking Attic?"<sup>40</sup> Clement and Eusebios give the remark a still wider application.<sup>41</sup> At the Renaissance, this farrago was revived along with everything else, and certain ideas derived from the *Praeparatio Evangelica* continued for long to colour accepted views.<sup>42</sup> Cudworth speaks of the ancient "Moschical or Mosaical philosophy" taught by Thales and Pythagoras.<sup>43</sup> It is important to realise the true origin of this prejudice against the originality of the Greeks. It does not come from modern researches into the beliefs of ancient peoples; for these have disclosed nothing in the way of evidence for a Phoenician or Egyptian philosophy. It is a mere residuum of the Alexandrian passion for allegory.

Of course no one nowadays would rest the case for the Oriental origin of Greek philosophy on the evidence of Clement or Eusebios; the favourite argument in recent times has been the analogy of the arts. We are seeing more and more, it is said, that the Greeks derived their art from the East; and it is urged that the same will in all probability prove true of their philosophy. That is a specious argument, but not at all conclusive. It ignores the difference in the way these things are transmitted from people to people. Material civilisation and the arts may pass easily from one people to another, though they have not a common language, but philosophy can only be expressed in abstract language, and can only be transmitted by educated men, whether by means of books or oral teaching. Now we know of no Greek, in the times we are dealing with, who could read an Egyptian book or even listen to the discourse of an Egyptian priest, and we never hear till a late date of Oriental teachers who wrote or spoke in Greek. The Greek traveller in Egypt would no doubt pick up a few words of Egyptian, and it is taken for granted that the priests could make themselves understood by the Greeks.<sup>44</sup> But they must have made use of interpreters, and it is impossible to conceive of philosophical ideas being communicated through an uneducated dragoman.<sup>45</sup>

But really it is not worth while to ask whether the communication of philosophical ideas was possible or not, till some evidence has been produced that any of these peoples had a philosophy to communicate. No such evidence has yet been discovered, and, so far as we know, the Indians were the only ancient people besides the Greeks who ever had anything that deserves the name. No one now will suggest that Greek philosophy came from India, and indeed everything points to the conclusion that Indian philosophy arose under Greek influence. The chronology of Sanskrit literature is an extremely difficult subject; but, so far as we can see, the great Indian systems are later in date than the Greek philosophies they most nearly resemble. Of course the mysticism of the Upanishads and of Buddhism was of native growth; but, though these influenced philosophy in the strict sense profoundly, they were related to it only as Hesiod and the Orphics were related to Greek scientific thought.

## XI. Egyptian Mathematics

It would, however, be another thing to say that Greek philosophy originated quite independently of Oriental influences. The Greeks themselves believed their mathematical science to be of Egyptian origin, and they must have known something of Babylonian astronomy. It cannot be an accident that philosophy originated just at the time when communication with these two countries was easiest, and that the very man who was said to have introduced geometry from Egypt is also regarded as the first philosopher. It thus becomes important for us to discover what Egyptian mathematics meant. We shall see that even here, the Greeks were really original.

The Rhind papyrus in the British Museum<sup>46</sup> gives us a glimpse of arithmetic and geometry as they were understood on the banks of the Nile. It is the work of one Aahmes, and contains rules for calculations both of an arithmetical and a geometrical character. The arithmetical problems mostly concern measures of corn and fruit, and deal particularly with such questions as the division of a number of measures among a given number of persons, the number of loaves or jars of beer that certain measures will yield, and the wages due to the workmen for a certain piece of work. It corresponds exactly, in fact, to the description of Egyptian arithmetic Plato gives us in the *Laws*, where he tells us that children learnt along with their letters to solve problems in the distribution of apples and wreaths to greater or smaller numbers of people, the pairing of boxers and wrestlers, and so forth.<sup>47</sup> This is clearly the origin of the art which the Greeks called λογιστική, and they probably borrowed that from Egypt, where it was highly developed; but there is trace of what the Greeks called ἀριθμητική, the scientific study of numbers.

The geometry of the Rhind papyrus is of a similar character, and Herodotos, who tells us that Egyptian geometry arose from the necessity of measuring the land afresh after the inundations, is

clearly far nearer the mark than Aristotle, who says it grew out of the leisure enjoyed by the priestly caste.<sup>48</sup> The rules given for calculating areas are only exact when these are rectangular. As fields are usually more or less rectangular, this would be sufficient for practical purposes. It is even assumed that a right-angled triangle can be equilateral. The rule for finding what is called the *segt* of a pyramid is, however, on a rather higher level, as we should expect. It comes to this. Given the "length across the sole of the foot," that is, the diagonal of the base, and that of the *piremus* or "ridge," to find a number which represents the ratio between them. This is done by dividing half the diagonal of the base by the "ridge," and it is obvious that such a method might quite well be discovered empirically. It seems an anachronism to speak of elementary trigonometry in connexion with a rule like this, and there is nothing to suggest that the Egyptians went any further.<sup>49</sup> That the Greeks learnt as much from them is highly probable, though we shall see also that, from the very first, they generalised it so as to make it of use in measuring the distances of inaccessible objects, such as ships at sea. It was probably this generalisation that suggested the idea of a science of geometry, which was really the creation of the Pythagoreans, and we can see how far the Greeks soon surpassed their teachers from a remark attributed to Demokritos. It runs (fr. 299): "I have listened to many learned men, but no one has yet surpassed me in the construction of figures out of lines accompanied by demonstration, not even the Egyptian *arpedonaptis*, as they call them."<sup>50</sup> Now the word *ἀρπεδονάπτῆς* is not Egyptian but Greek. It means "cord-fastener,"<sup>51</sup> and it is a striking coincidence that the oldest Indian geometrical treatise is called the *Sulvasutras* or "rules of the cord." These things point to the use of the triangle of which the sides are as 3, 4, 5, and which has always a right angle. We know that this was used from an early date among the Chinese and the Hindus, who doubtless got it from Babylon, and we shall see that Thales probably learnt the use of it in Egypt.<sup>52</sup> There is no reason for supposing that any of these peoples had troubled themselves to give a theoretical demonstration of its properties, though Demokritos would certainly have been able to do so. As we shall see, however, there is no real evidence that Thales had any mathematical knowledge which went beyond the Rhind papyrus, and we must conclude that mathematics in the strict sense arose in Greece after his time. It is significant in this connexion that all mathematical terms are purely Greek in their origin.<sup>53</sup>

## XII. Babylonian Astronomy

The other source from which the Ionians were supposed to have derived their science is Babylonian astronomy. It is certain, of course, that the Babylonians had observed the heavens from an early date. They had planned out the fixed stars, and especially those of the zodiac, in constellations.<sup>54</sup> That is useful for purposes of observational astronomy, but in itself it belongs rather to mythology or folklore. They had distinguished and named the planets and noted their apparent motions. They were well aware of their stations and retrograde movements, and they were familiar with the solstices and

equinoxes. They had also noted the occurrence of eclipses with a view to predicting their return for purposes of divination. But we must not exaggerate the antiquity or accuracy of these observations. It was long before the Babylonians had a satisfactory calendar, and they kept the year right only by intercalating a thirteenth month when it seemed desirable. That made a trustworthy chronology impossible, and therefore there were not and could not be any data available for astronomical purposes before the so-called era of Nabonassar (747 B.C.). The oldest astronomical document of a really scientific character which had come to light up to 1907 is dated 523 B.C., in the reign of Kambyses, when Pythagoras had already founded his school at Kroton. Moreover, the golden age of Babylonian observational astronomy is now assigned to the period after Alexander the Great, when Babylon was a Hellenistic city. Even then, though great accuracy of observation was attained, and data were accumulated which were of service to the Alexandrian astronomers, there is no evidence that Babylonian astronomy had passed beyond the empirical stage.<sup>55</sup>

We shall see that Thales probably knew the cycle by means of which the Babylonians tried to predict eclipses (§ 3); but it would be a mistake to suppose that the pioneers of Greek science had any detailed knowledge of Babylonian observations. The Babylonian names of the planets do not occur earlier than the writings of Plato's old age.<sup>56</sup> We shall find, indeed, that the earliest cosmologists paid no attention to the planets, and it is hard to say what they thought about the fixed stars. That, in itself, shows that they started for themselves, and were quite independent of Babylonian observations, and the recorded observations were only made fully available in Alexandrian times.<sup>57</sup> But, even if the Ionians had known them, their originality would remain. The Babylonians recorded celestial phenomena for astrological purposes, not from any scientific interest. There is no evidence that they attempted to account for what they saw in any but the crudest way. The Greeks, on the other hand, made at least three discoveries of capital importance in the course of two or three generations. In the first place, they discovered that the earth is a sphere and does not rest on anything.<sup>58</sup> In the second place, they discovered the true theory of lunar and solar eclipses; and, in close connexion with that, they came to see, in the third place, that the earth is not the centre of our system, but revolves round the centre like the planets. Not much later, certain Greeks took, at least tentatively, the final step of identifying the centre round which the earth and planets revolve with the sun. These discoveries will be discussed in their proper place; they are only mentioned here to show the gulf between Greek astronomy and everything that had preceded it. On the other hand, the Greeks rejected astrology, and it was not till the third century B.C. that it was introduced among them.<sup>59</sup>

We may sum up all this by saying that the Greeks did not borrow either their philosophy or their science from the East. They did, however, get from Egypt certain rules of mensuration which, when generalised, gave birth to geometry; while from Babylon they learnt that the phenomena of the

heavens recur in cycles. This piece of knowledge doubtless had a great deal to do with the rise of science; for to the Greek it suggested further questions such as no Babylonian ever dreamt of.<sup>60</sup>

### XIII. The Scientific Character of the Early Greek Cosmology

It is necessary to insist on the scientific character of the philosophy we are about to study. We have seen that the Eastern peoples were considerably richer than the Greeks in accumulated facts, though these facts had not been observed for any scientific purpose, and never suggested a revision of the primitive view of the world. The Greeks, however, saw in them something that could be turned to account, and they were never as a people slow to act on the maxim, *Chacun prend son bien partout où il le trouve*. The visit of Solon to Croesus which Herodotos describes, however unhistorical it may be, gives us a good idea of this spirit. Croesus tells Solon that he has heard much of "his wisdom and his wanderings," and how, from love of knowledge (*φιλοσοφῆων*), he has travelled over much land for the purpose of seeing what was to be seen (*θεωρίης εἶνεκεν*). The words *θεωρίη*, *φιλοσοφίη*, and *ἱστορίη*, are, in fact, the catchwords of the time, though they had, no doubt, a somewhat different meaning from that they were afterwards made to bear at Athens.<sup>61</sup> The idea that underlies them all may, perhaps, be rendered in English by the word *Curiosity*; and it was just this great gift of curiosity, and the desire to see all the wonderful things--pyramids, inundations, and so forth--that were to be seen, which enabled the Ionians to pick up and turn to their own use such scraps of knowledge as they could come by among the barbarians. No sooner did an Ionian philosopher learn half-a-dozen geometrical propositions, and hear that the phenomena of the heavens recur in cycles, than he set to work to look for law everywhere in nature, and, with an audacity almost amounting to *ὕβρις*, to construct a system of the universe. We may smile at the medley of childish fancy and scientific insight which these efforts display, and sometimes we feel disposed to sympathise with the sages of the day who warned their more daring contemporaries "to think the thoughts befitting man's estate" (*ἀνθρώπινα φρονεῖν*). But we shall do well to remember that even now it is just such hardy anticipations of experience that make scientific progress possible, and that nearly every one of these early inquirers made some permanent addition to positive knowledge, besides opening up new views of the world in every direction.

There is no justification either for the idea that Greek science was built up by more or less lucky guesswork, instead of by observation and experiment. The nature of our tradition, which mostly consists of *Placita*--that is; of what we call "results"--tends, no doubt, to create this impression. We are seldom told why any early philosopher held the views he did, and the appearance of a string of "opinions" suggests dogmatism. There are, however, certain exceptions to the general character of the tradition; and we may reasonably suppose that, if the later Greeks had been interested in the matter, there would have been many more. We shall see that Anaximander made some remarkable discoveries

in marine biology, which the researches of the nineteenth century have confirmed (§ 22), and even Xenophanes supported one of his theories by referring to the fossils and petrifications of such widely separated places as Malta, Paros, and Syracuse (§ 59). This is enough to show that the theory, so commonly held by the earlier philosophers, that the earth had been originally in a moist state, was not purely mythological in origin, but based on biological and palaeontological observations. It would surely be absurd to imagine that the men who could make these observations had not the curiosity or the ability to make many others of which the memory is lost. Indeed, the idea that the Greeks were not observers is ludicrously wrong, as is proved by the anatomical accuracy of their sculpture, which bears witness to trained habits of observation, while the Hippokratean corpus contains models of scientific observation at its best. We know, then, that the Greeks could observe well, and we know that they were curious about the world. Is it conceivable that they did not use their powers of observation to gratify that curiosity? It is true that they had not our instruments of precision; but a great deal can be discovered by the help of very simple apparatus. It is not to be supposed that Anaximander erected his *gnomon* merely that the Spartans might know the seasons.<sup>62</sup>

Nor is it true that the Greeks made no use of experiment. The rise of the experimental method dates from the time when the medical schools began to influence the development of philosophy, and accordingly we find that the first recorded experiment of a modern type is that of Empedokles with the *klepsydra*. We have his own account of this (fr. 100), and we can see how it brought him to the verge of anticipating Harvey and Torricelli. It is inconceivable that an inquisitive people should have applied the experimental method in a single case without extending it to other problems.

Of course the great difficulty for us is the geocentric hypothesis from which science inevitably started, though only to outgrow it in a surprisingly short time. So long as the earth is supposed to be in the centre of the world, meteorology, in the later sense of the word, is necessarily identified with astronomy. It is difficult for us to feel at home in this point of view, and indeed we have no suitable word to express what the Greeks at first called an οὐρανός. It will be convenient to use the term "world" for it; but then we must remember that it does not refer solely, or even chiefly, to the earth, though it includes that along with the heavenly bodies.

The science of the sixth century was mainly concerned, therefore, with those parts of the world that are "aloft" (τὰ μετέωρα) and these include such things as clouds, rainbows, and lightning, as well as the heavenly bodies.<sup>63</sup> That is how the latter came sometimes to be explained as ignited clouds, an idea which seems astonishing to us.<sup>64</sup> But even that is better than to regard the sun, moon, and stars as having a different nature from the earth, and science inevitably and rightly began with the most obvious hypothesis, and it was only the thorough working out of this that could show its inadequacy. It is just

because the Greeks were the first people to take the geocentric hypothesis seriously that they were able to go beyond it. Of course the pioneers of Greek thought had no clear idea of the nature of scientific hypothesis, and supposed themselves to be dealing with ultimate reality, but a sure instinct guided them to the right method, and we can see how it was the effort to "save appearances"<sup>65</sup> that really operated from the first. It is to those men we owe the conception of an exact science which should ultimately take in the whole world as its object. They fancied they could work out this science at once. We sometimes make the same mistake nowadays, and forget that all scientific progress consists in the advance from a less to a more adequate hypothesis. The Greeks were the first to follow this method, and that is their title to be regarded as the originators of science.

#### XIV. Schools of Philosophy

Theophrastos, the first writer to treat the history of Greek philosophy in a systematic way,<sup>66</sup> represented the early cosmologists as standing to one another in the relation of master and scholar, and as members of regular societies. This has been regarded as an anachronism, and some have even denied the existence of "schools" of philosophy altogether. But the statements of Theophrastos on such a subject are not to be lightly set aside. As this point is of great importance, it will be necessary to elucidate it before we enter on our story.

In almost every department of life, the corporation at first is everything and the individual nothing. The peoples of the East hardly got beyond this stage; their science, such as it is, is anonymous, the inherited property of a caste or guild, and we still see clearly in some cases that it was once the same among the Greeks. Medicine, for instance, was originally the "mystery" of the Asklepiads. What distinguished the Greeks from other peoples was that at an early date these crafts came under the influence of outstanding individuals, who gave them a fresh direction and new impulse. But this does not destroy the corporate character of the craft; it rather intensifies it. The guild becomes what we call a "school," and the disciple takes the place of the apprentice. That is a vital change. A close guild with none but official heads is essentially conservative, while a band of disciples attached to a master they revere is the greatest progressive force the world knows.

It is certain that the later Athenian schools were legally recognised corporations, the oldest of which, the Academy, maintained its existence as such for some nine hundred years, and the only question we have to decide is whether this was an innovation made in the fourth century B.C., or rather the continuance of an old tradition. Now we have the authority of Plato for speaking of the chief early systems as handed down in schools. He makes Sokrates speak of "the men of Ephesos," the Herakleiteans, as forming a strong body in his own day,<sup>67</sup> and the stranger of the *Sophist* and the *Statesman* speaks of his school as still in existence at Elea.<sup>68</sup> We also hear of "Anaxagoreans,"<sup>69</sup> and no

one, of course, can doubt that the Pythagoreans were a society. In fact, there is hardly any school but that of Miletos for which we have not external evidence of the strongest kind; and even as regards it, we have the significant fact that Theophrastos speaks of philosophers of a later date as having been "associates of the philosophy of Anaximenes."<sup>20</sup> We shall see too in the first chapter that the internal evidence in favour of the existence of a Milesian school is very strong indeed. It is from this point of view, then, that we shall now proceed to consider the men who created Greek science.

1. It will be observed that Demokritos falls outside the period thus defined. The common practice of treating this younger contemporary of Socrates along with the "Pre-Socratics" obscures the historical development altogether. Demokritos comes after Protagoras, and he has to face the problems of knowledge and conduct far more seriously than his predecessors had done (see Brochard, "Protagoras et Démocrite," *Arch.* ii. p. 368).

2. See Sir Arthur Evans, "The Minoan and Mycenaean Element in Hellenic Life" (*J.H.S.* xxxii. 277 *sqq.*), where it is contended (p. 278) that "The people whom we discern in the new dawn are not the pale-skinned northerners--the 'yellow-haired Achaeans' and the rest--but essentially the dark-haired, brown-complexioned race . . . of whom we find the earlier portraiture in the Minoan and Mycenaean wall-paintings." But, if the Greeks of historical times were the same people as the "Minoans," why should Sir Arthur Evans hesitate to call the "Minoans" Greeks? The Achaeans and Dorians have no special claim to the name; for the Graes of Boiotia, who brought it to Cumae, were of the older race. I can attach no intelligible meaning either to the term "pre-Hellenic." If it means that the Aegean race was there before the somewhat unimportant Achaian tribe which accidentally gave its name later to the whole nation, that is true, but irrelevant. If, on the other hand, it implies that there was a real change in the population of the Aegean at any time since the end of the Neolithic age, that is untrue, as Sir Arthur Evans himself maintains. If it means (as it probably does) that the Greek language was introduced into the Aegean by the northerners, there is no evidence of that, and it is contrary to analogy. The Greek language, as we know it, is in its vocabulary a mixed speech, like our own, but its essential structure is far liker that of the Indo-Iranian languages than that of any northern branch of Indo-European speech. For instance, the augment is common and peculiar to Sanskrit, Old Persian, and Greek. The Greek language cannot have differed very much from the Persian in the second millennium B.C. The popular distinction between *centum* and *satem* languages is wholly misleading and based on a secondary phenomenon, as is shown by the fact that the Romance languages have become *satem* languages in historical times. It would be more to the point to note that Greek, like Old Indian and Old Persian, represents the sonant *n* in the word for "hundred" (ἑκατόν=*satam*, *satem*) by *a*, and to classify it with them as a *satem* language on that ground.

3. See Farnell, *Cults of the Greek States*, vol. iv. pp. 98 *sqq.*

4. This is surely a simpler hypothesis than that of Sir Arthur Evans, who postulates (*loc. cit.* p. 288) "an earlier Minoan epic taken over into Greek." The epic dialect has most points of contact with Arcadian and Cypriote, and it is wholly improbable that the Arcadians came from the North. There are sufficient parallels for the prowess of the conqueror being celebrated by a bard of the conquered race (Ridgeway, *Early Age of Greece*, vol. i. p. 664). Does this explain the name Ὀμηρος "hostage"?

5. Professor Ridgeway (*Early Age of Greece*, i. p. 674) points out that the specifically Achaian names, such as Achilles, Odysseus, Aiakos, Aias, Laertes and Peleus cannot be explained from the Greek language, while the names of the older race, such as Herakles, Erichthonios, Erysichthon, etc., can. No doubt Agamemnon and Menelaos have Greek names, but that is because Atreus owed his kingship to the marriage of Pelops with a princess of the older race. It is an instance of the process of assimilation which was going on everywhere.

6. There are traces of cosmogonical ideas in the Διὸς ἀπάτη (*Il.* xiv.).

7. *Od.* xi. has been referred to a late date because it is supposed to contain Orphic ideas. In the light of our present knowledge, such a hypothesis is quite unnecessary. The ideas in question are primitive, and were probably generally accepted in the Aegean. Orphicism was essentially a revival of primitive beliefs.

8. On all this, see especially Rohde, *Psyche*<sup>2</sup>, i. pp. 37 *sqq.* (= *Ps.*<sup>1</sup> pp. 34 *sqq.*).

9. Hes. *Theog.* 27 (the words are borrowed from *Od.* xix. 203). The Muses are the same as those who inspired Homer, which means that Hesiod wrote in hexameters and used the Epic dialect.

10. There is great historical insight here. It was Hesiod, not our modern historians, who first pointed out that the "Greek Middle Ages" were a break in the normal development.

11. Herod. ii. 53.

12. The word χάος certainly means the "gap" or "yawn," the χάσμα πελώριον of the Rhapsodic Theogony (fr. 52). Grimm compared it with the Scandinavian *Ginnunga-Gap*.
13. For the remains of Pherekydes, see Diels, *Vorsokratiker*, 71 B, and the interesting account in Gomperz, *Greek Thinkers*, vol. i. pp. 85 *sqq.*
14. This was the view of Lobeck with regard to the so-called "Rhapsodic Theogony" described by Damaskios.
15. Arist. *Met.* N, 4. 1091b 8.
16. See Butcher, "The Melancholy of the Greeks," in *Some Aspects of the Greek Genius*, pp. 130 *sqq.*
17. This is well brought out by Prof. J. L. Myres in a paper entitled "The Background of Greek Science" (*University of Chicago Chronicle*, vol. xvi. No. 4). There is no need to derive the doctrine of the "opposites" from a "religious representation" as Mr. Cornford does in the first chapter of *From Religion to Philosophy*. In Greece these force themselves upon our attention quite apart from anything of the sort. Of course they are also, important in agrarian magic for practical reasons.
18. Ar. *Phys.* Γ, 4. 203 b 14 ἀθάνατον γὰρ καὶ ἀνώλεθρον (sc. τὸ ἄπειρον), ὡς φησιν Ἀναξίμανδρος καὶ οἱ πλείστοι τῶν φυσιολόγων Hipp. *Ref.* i. 6, 1 φύσιν τινὰ τοῦ ἀπείρου . . . ταύτην δ' αἰδίων εἶναι καὶ ἀγήρω. The epithets come from the Epic, where ἀθάνατος καὶ ἀγήρω is a standing phrase to mark the difference between gods and men.
19. As it has been suggested that the Monism ascribed by later writers to the early cosmologists is only based on Aristotle's distinction between those who postulated one ἀρχή and those who postulated more than one (*Phys.* A, 2. 184 b 15 *sqq.*), and is not therefore strictly historical, it will be well to quote a pre-Aristotelian testimony for it. In the Hippokratian Περὶ φύσιος ἀνθρώπου (Littre, vi. 32) we read φασὶ τε γὰρ ἓν τι εἶναι ὅτι ἔστι, καὶ τοῦτ' εἶναι τὸ ἓν καὶ τὸ πᾶν, κατὰ δὲ τὰ ὀνόματα οὐκ ὁμολογεῖσσι· λέγει δ' αὐτῶν ὁ μὲν τις φάσκων ἄερα εἶναι τοῦτο τὸ ἓν καὶ τὸ πᾶν, ὁ δὲ πῦρ, ὁ δὲ ὕδωρ, ὁ δὲ γῆν, καὶ ἐπιλέγει ἕκαστος τῷ ἑωυτοῦ λόγῳ μαρτύριά τε καὶ τεκμήρια ἃ γε ἔστιν οὐδέν.
20. See below, [§ 123](#).
21. Cf. Plato, *Phaedo*, 96 a 7 ταύτης τῆς σοφίας ἦν δὴ καλοῦσι περὶ φύσεως ἱστορίαν This is the oldest and most trustworthy statement as to the name originally given to science. I lay no stress on the fact that the books of the early cosmologists are generally quoted under the title Περὶ φύσεως, as such titles are probably of later date.
22. Eur. fr. inc. 910. The word κόσμος here means, of course, "ordering," "arrangement," and ἀγήρω is genitive. The object of research is *firstly* what is "the ordering of immortal ageless φύσις," and *secondly*, how it arose. Anaxagoras, who introduced Ionian science to Athens, had belonged to the school of Anaximenes ([§ 122](#)). We know from Aristotle (*loc. cit.* p. 9 n. 1) that not only Anaximander, but most of the φυσιολόγοι, applied epithets like this to the Boundless.
23. Arist. *Phys.* A, 6. οἱ μίαν τινὰ φύσιν εἶναι λέγοντες τὸ πᾶν, οἷον ὕδωρ ἢ πῦρ ἢ τὸ μεταξὺ τούτων, B, I. 193 a 21 οἱ μὲν πῦρ, οἱ δὲ γῆν, οἱ δ' ἄερα φασίν, οἱ δὲ ὕδωρ, οἱ δ' ἓνα τούτων, (Parmenides), of οἱ δὲ πάντα ταῦτα (Empedokles) τὴν φύσιν εἶναι τὴν τῶν ὄντων.
24. For the history of the term φύσις, see [Appendix I](#).
25. Professor W. A. Heidel has shown that the cosmologists might have used ἀρχή in a sense different from Aristotle's, that, namely, of "source," "store," or "collective mass," from which particular things are derived (*Class. Phil.* vii. pp. 217 *sqq.*). I should be quite willing to accept this account of the matter if I could find any evidence that they used the term at all. It is only in the case of Anaximander that there is even a semblance of such evidence, and I believe that to be illusory ([p. 54, n. 2](#)). Moreover, Diels has shown that the first book of Theophrastos's great work dealt with the ἀρχή in the Aristotelian sense, and it is very unlikely that the word should have been used in one sense of Anaximander and in another of the rest.
26. *Phys.* A, 2. 184 b 15 *sqq.* It is of great importance to remember that Theophrastos and his followers simply adopted the classification of this chapter, which has no claim to be regarded as historical.
27. I am conscious of the unsatisfactory character of the phrase "primary substance" (πρῶτον ὑποκείμενον), but it is hard to find a better. The German *Urstoff* is less misleading in its associations, but the English "stuff" is not very satisfactory.
28. The view of O. Gilbert (*Die meteorologischen Theorien des griechischen Altertums*, Leipzig, 1907) that the early cosmologists started from the traditional and popular theory of "the four elements" derives all its plausibility from the ambiguity of the term "element." If we only mean the great aggregates of Fire, Air, Water and Earth, there is no doubt that these were distinguished from an

early date. But that is not what is meant by an "element" (στοιχεῖον) in cosmology, where it is always an irreducible something with a φύσις of its own. The remarkable thing really is that the early cosmologists went behind the theory of "elements" in the popular sense, and it was only the accident that Empedokles, the first to maintain a plurality of elements, selected the four that have become traditional that has led to the loose use of the word "element" for the great aggregates referred to.

29. This way of thinking is often called Hylozoism, but that is still more misleading. No doubt the early cosmologists said things about the world and the primary substance which, from our point of view, imply that they are alive; but that is a very different thing from ascribing a "plastic power" to "matter." The concept of "matter" did not yet exist and the underlying assumption is simply that everything, life included, can be explained mechanically, as we say, that is, by body in motion. Even that is not stated explicitly, but taken for granted.

30. It was Aristotle who first took the fateful step of identifying the "eternal motion" with the diurnal revolution of the heavens.

31. Plato, *Tim.* 30 a.

32. As I understand him, Prof. W. A. Heidel regards the "eternal motion" as a rotary or vortex motion (δίνη), on the ground that it is hazardous to assume that an early thinker, such as Anaximenes, "distinguished between the primordial motion of the infinite Air and the original motion in the cosmos" (see his article, "The δίνη in Anaximenes and Anaximander," *Classical Philology*, i. p. 279). It seems to me, on the other hand, that any one who held the world had come into being must have made such a distinction, especially if he also held the doctrine of innumerable worlds. As will be seen later, I adopt Prof. Heidel's view that the "original motion of the cosmos" was a rotary one in the earliest cosmological systems, but it was certainly not "eternal," and I do not think we can infer anything from it as to the pre-mundane motion, except that it must have been of such a nature that it could give rise to the δίνη.

33. See Hogarth, *Ionia and the East*, pp. 68 sqq.

34. No one worshipped Okeanos and Tethys, or even Ouranos, and still less can Phobos and Deimos be regarded as gods in the religious sense.

35. This is, I venture to think, the fundamental error of Mr. Cornford's interesting book, *From Religion to Philosophy* (1912). He fails to realise how completely the old "collective representations" had lost their hold in Ionia. We shall see that his method is more applicable when he comes to deal with the western regions, but even there he does not recognise sufficiently the contrast between Ionian science and the old tradition.

36. The importance of this point can hardly be exaggerated. See Prof. A. E. Taylor, *Aristotle*, p. 58.

37. All he can say is that the worship of Dionysos and the doctrine of transmigration came from Egypt (ii. 49, 123). We shall see that both these statements are incorrect, and in any case they do not imply anything directly as to philosophy.

38. In *Rep.* 435 e, after saying that τὸ θυμοειδές is characteristic of the Thracians and Scythians, and τὸ φιλομαθές of the Hellenes, he refers us to Phoenicia and Egypt for τὸ φιλοχρημάτων. In the *Laws* he says (747 b 6) that arithmetical studies are valuable only if we remove all ἀνελευθερία and φιλοχρηματία from the souls of the learners. Otherwise, we produce πανουργία instead of σοφία, as we can see that the Phoenicians, the Egyptians, and many other peoples do.

39. Arist. *Met.* A, 1. 981 b 23.

40. Noumenios, fr. 13 (R. P. 624) Τί γάρ ἐστι Πλάτων ἢ Μωσῆς ἀττικίζων;

41. Clement (*Strom.* i. p. 8, 5, Stählin) calls Plato ὁ ἐξ Ἑβραίων φιλόσοφος.

42. Exaggerated notions of Oriental wisdom were popularised by the *Encyclopédie*, which accounts for their diffusion and persistence. Bailly (*Lettres sur l'origine des sciences*) assumed that the Orientals had received fragments of highly advanced science from a people which had disappeared, but which he identified with the inhabitants of Plato's Atlantis!

43. We learn from Strabo (xvi. p. 757) that it was Poseidonios who introduced Mochos of Sidon into the history of philosophy. He attributes the atomic theory to him. His identification with Moses, however, is a later *tour de force* due to Philon of Byblos, who published a translation of an ancient Phoenician history by Sanchuniathon, which was used by Porphyry and afterwards by Eusebios.

44. Herod. ii. 143 (where they boast to Hekataios of their superior antiquity); Plato, *Tim.* 22 b 3 (where they do the same to Solon).

45. Gomperz's "native bride," who discusses the wisdom of her people with her Greek lord (*Greek Thinkers*, vol. i. p. 95), does not convince me either. She would probably teach her maids the rites of strange goddesses; but she would not be likely to talk theology with her husband, and still less philosophy or science.

46. I am indebted for most of the information which follows to Cantor's *Vorlesungen über Geschichte der Mathematik*, vol. i. pp. 46-63. See also Gow's *Short History of Greek Mathematics*, §§ 73-80; and Milhaud, *La Science grecque*, pp. 91 *sqq.* The discussion in the last-named work is of special value because it is based on M. Rodet's paper in the *Bulletin de la Société Mathématique*, vol. vi., which in some important respects supplements the interpretation of Eisenlohr, on which the earlier accounts depend.
47. Plato, *Laws*, 819 b 4 μῆλων τέ τινων διανομαὶ καὶ στεφάνων πλείοσιν ἅμα καὶ ἐλάττωσιν ἀρμοττόντων ἀριθμῶν τῶν αὐτῶν, καὶ πυκτῶν καὶ παλαιστῶν ἐφεδρείας τε καὶ συλλήξεως ἐν μέρει καὶ ἐφεξῆς καὶ ὡς πεφύκασι γίγνεσθαι. καὶ δὴ καὶ παίζοντες, φιάλας ἅμα χρυσοῦ καὶ χαλκοῦ καὶ ἀργύρου καὶ τοιούτων τινῶν ἄλλων κεραυνῶντες, οἱ δὲ καὶ ὅλας πῶς διαδιδόντες.
48. Herod ii. 109; Arist *Met.* A, 1. 981 b 23.
49. For a fuller account of this method see Gow, *Short History of Greek Mathematics*, pp. 127 *sqq.*; and Milhaud, *Science grecque*, p. 99.
50. R. P. 188. It should be stated that Diels now considers this fragment spurious (*Vors.*<sup>3</sup> ii. p. 124). He regards it, in fact, as from an Alexandrian forgery intended to show the derivative character of Greek science, while insisting on its superiority. However that may be the word ἀρπεδονάπται is no doubt a real one, and the inference drawn from it in the text is justified.
51. The real meaning of ἀρπεδονάπτης was first pointed out by Cantor. The gardener laying out a flower-bed is the true modern representative of the "arpedonapts."
52. See Milhaud, *Science grecque*, p. 103.
53. Cf. *e.g.* κύκλος, κύλινδρος. Very often these terms are derived from the names of tools, *e.g.* γνῶμων, which is the carpenter's square, and τομεύς, "sector," which is a cobbler's knife. The word πυραμῖς is sometimes supposed to be an exception and has been derived from the term *piremus* used in the Rhind papyrus, which, however, does not mean "pyramid" (p. 19); but it too is Greek. Πυραμῖς (or πυραμοῦς) means a "wheat-cake," and is formed from πυροί on the analogy of σησαμῖς (or σησαμοῦς). The Greeks had a tendency to give jocular names to things Egyptian. Cf. κροκόδειλος, ὄβελίσκος, στρουθός, καταράκτης (lit. "sluice"). We seem to hear an echo of the slang of the mercenaries who cut their names on the colossus at Abu-Simbel.
54. That is not quite the same thing as dividing the zodiac into twelve signs of 30° each. There is no evidence of this before the sixth century B.C. It is also to be noted that, while a certain number of names for constellations appear to have reached the Greeks from Babylon, most of them are derived from Greek mythology, and from its oldest stratum, which became localised in Crete, Arkadia, and Boiotia. That points to the conclusion that the constellations were already named in "Minoan" times. The disproportionate space occupied by Andromeda and her relatives points to the time when Crete and Philistia were in close contact. There is a clue here which has been obscured by the theory of "astral mythology."
55. All this has been placed beyond doubt by the researches of Father Kugler (*Sternkunde und Sterndienst in Babel*, 1907). There is a most interesting account and discussion of his results by Schiaparelli in *Scientia*, vol. iii. pp. 213 *sqq.*, and vol. iv. pp. 24 *sqq.*, the last work of the great astronomer. These discussions were not available when I published my second edition, and I made some quite unnecessary concessions as to Babylonian astronomy there. In particular, I was led by some remarks of Ginzel (*Klio*, i. p. 205) to admit that the Babylonians might have observed the precession of the equinoxes, but this is practically impossible in the light of our present knowledge. There is a good note on the subject in Schiaparelli's second article (*Scientia*, iv. p. 34). The chief reason why the Babylonians could have no records of astronomical records from an early date is that they had no method of keeping the lunar and the solar year together, nor was there any control such as is furnished by the Egyptian Sothis period. Neither the ὀκταετηρίς or the ἐννεακαιδεκατηρίς was known to them till the close of the sixth century B.C. They are purely Greek inventions.
56. In classical Greek literature, no planets but Ἑσπερος and Ἐωσφόρος are mentioned by name at all. Parmenides (or Pythagoras) first identified these as a single planet (§ 94). Mercury appears for the first time by name in *Tim.* 38 e, and the other divine names are given in *Epin.* 987 b *sq.*, where they are said to be "Syrian." The Greek names Φαίνων, Φαέθων, Πυροίς, Φωσφόρος, Στίλβων, are no doubt older, though they do not happen to occur earlier.
57. The earliest reference to them is in Plato's *Epinomis*, 987 a. They are also referred to by Aristotle, *De caelo*, B, 12. 292 a 8.
58. The view of Berger (*Erdkunde*, pp. 171 *sqq.*) that the sphericity of the earth was known in Egypt and Babylon is flatly contradicted by all the evidence known to me.
59. The earliest reference to astrology among the Greeks appears to be Plato, *Tim.* 40 c 9 (of conjunctions, oppositions, occultations, etc.), φόβους καὶ σημεῖα τῶν μετὰ ταῦτα γενησομένων τοῖς οὐ δυναμένοις λογίζεσθαι πέμπουσιν. That is quite general, but Theophrastus was more definite. Cf. the commentary of Proclus on the passage: θαυμασιωτάτην εἶναι φησιν ἐν τοῖς κατ' αὐτὸν χρόνοις τὴν τῶν Χαλδαίων θεωρίαν τὰ τε ἄλλα προλέγουσαν καὶ τοὺς βίους ἐκάστων καὶ τοὺς θανάτους καὶ οὐ τὰ κοινὰ μόνον. The Stoics, and especially Poseidonios, were responsible for the introduction of astrology into Greece, and it has recently been shown

that the fully developed system known in later days was based on the Stoic doctrine of εἰμαρμένη. See the very important article by Boll in *Neue Jahrb.* xxi. (1908), p. 108.

60. The Platonic account of this matter is to be found in the *Epinomis*, 986 e 9 *sqq.*, and is summed up by the words λάβωμεν δὲ ὡς ὅτιπερ ἂν Ἑλληνας βαρβάρων παραλάβωσι, κάλλιον τοῦτο εἰς τέλος ἀπεργάζονται (987 d 9). The point is well put by Theon (Adrastos), *Exp.* p. 177, 20 Hiller, who speaks of the Chaldaeans and Egyptians as ἄνευ φυσιολογίας ἀτελεῖς ποιούμενοι τὰς μεθόδους, δέον ἅμα καὶ φυσικῶς περὶ τούτων ἐπισκοπεῖν ὅπερ οἱ παρὰ τοῖς Ἑλλησιν ἀστρολογήσαντες ἐπειρώντο ποιεῖν, τὰς παρὰ τούτων λαβόντες ἀρχὰς καὶ τῶν φαινομένων τηρήσεις. This gives the view taken at Alexandria, where the facts were accurately known.

61. Still, the word θεωρία never lost its early associations, and the Greeks always felt that the θεωρητικὸς βίος meant literally "the life of the spectator." Its special use and the whole theory of the "three lives" seem to be Pythagorean. (See [§ 45.](#))

62. As we saw, the word γνώμων properly means a carpenter's square ([p. 21, n. 1](#)), and we learn from Proclus (*in Eucl.* I. p. 283, 7) that Oinopides of Chios used it in the sense of a perpendicular (κάθετος) The instrument so called was simply an upright erected on a flat surface, and its chief use was to indicate the solstices and the equinoxes by means of its shadow. It was not a sundial; for it afforded no means of dividing the day into equal hours, though the time of day would be approximately inferred from the length of the shadow cast by it. For the geometrical use of the term, see below, [p. 103, n. 1](#).

63. The restricted sense of μετεωρολογία only arose when Aristotle introduced for the first time the fateful distinction between the οὐρανός and the "sublunary" region, to which it was now confined. In so far as they make no such distinction, the early cosmologists were more scientific than Aristotle. Their views admitted of correction and development; Aristotle's theory arrested the growth of science.

64. It is well, however, to remember that Galileo himself regarded comets as meteorological phenomena.

65. This phrase originated in the school of Plato. The method of research in use there was for the leader to "propound" (προτείνειν, προβάλλεσθαι) it as a "problem" (πρόβλημα) to find the simplest "hypothesis" (τῶν ὑποτεθέντων) on which it is possible to account for and do justice to all the observed facts (σφάζειν τὰ φαινόμενα). Cf. Milton, *Paradise Lost*, viii. 81, "how build, unbuild, contrive | To save appearances."

66. See [Note on Sources, § 7.](#)

67. *Theaet.* 179 e 4, αὐτοῖς . . . τοῖς περὶ τὴν Ἑφεσον. The humorous denial that the Herakleiteans had any disciples (180 b 8, Ποίους μαθηταῖς, ὧ δαίμονε;) implies that this was the normal and recognised relation.

68. *Soph.* 242 d 4, τὸ . . . παρ' ἡμῖν Ἑλεατικὸν ἔθνος. Cf. *ib.* 216 a 3, ἑταῖρον δὲ τῶν ἀμφὶ Παρμενίδην καὶ Ζήγωνα [ἑταίρων], (where ἑταίρων is probably interpolated, but gives the right sense); 217 a 1, οἱ περὶ τὸν ἐκεῖ τόπον.

69. *Crat.* 409 b 6, εἴπερ ἀληθῆ οἱ Ἀναξαγόρειοι λέγουσιν. Cf. also the Δισσοὶ λόγοι (Diels, *Vors.*<sup>3</sup> ii. p. 343) τί δὲ Ἀναξαγόρειοι καὶ Πυθαγόρειοι ἦεν; This is independent of Plato.

70. Cf. [Chap. VI. § 122.](#)