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The Beginnings of Science and Philosophy in Archaic Greece

EDWARD HUSSEY

Homer and Hesiod: A Pre-scientific Conception of the World

Ancient Greek science and philosophy were radical innovations, but they did not emerge from a void.[1] This chapter will first look at the way in which the world was conceived and understood, around 800 BCE, in the poems of Homer and Hesiod. These poems soon came to be taken as canonical: in archaic Greece, and right down to the end of the fifth century, to know and understand Homer and Hesiod was the accepted test of an educated person. This canonical status was not created or enforced by political or economic power. Apart from their poetic achievement, the conception of the world and of human life that they provided was one that was found convincing, authoritative, and comprehensive by successive generations.

Their way of representing the world, and the god-given authority they claimed for their statements, constituted the established view, against which the Ionian proto-scientists of the sixth century were sharply reacting, but to which (not surprisingly) they were also indebted. There are no discontinuities in this kind of history, without accompanying partial continuities, which are also part of the story.

It makes sense to focus, at the outset, exclusively on Homer and Hesiod, but the reader should remember that they were not the products of a static or self-contained society. Archaic Greece was, on the contrary, constantly receiving and reacting to all kinds of stimuli from the older civilizations of the "Ancient Near East" (to use a convenient, though Eurocentric, and now almost unintelligible term).

There are two characteristic features of the Homeric-Hesiodic world-view that are of leading significance for a study of the "origins of science." These two features are connected, though one of them is very obvious and one rather less so. The obvious feature, overwhelmingly so to a modern reader, is the *centrality of anthropomorphic gods* (especially the Olympian gods) in the world. The less obvious feature is the *finitude* and the *vagueness about the limits* (spatial, temporal, and of other kinds) of the world. These characteristic features must now be examined.

The gods of Homer and Hesiod (many of whom were gods of actual Greek religious cults) were conceived of anthropomorphically. Though they were immortal, and had

1. I am much indebted to Hywel Clifford for his helpful comments on an earlier draft of this chapter.

superhuman powers, their nature was physically and psychologically like that of human beings. Hence the world of Homer and Hesiod is, in its essence and its details, a familiar one, closely related to ordinary human experience.

The centrality of the gods in the world is such that it can almost be said that the gods *are* the world. The principal and defining constituents of the body of the world are themselves ancient gods in Hesiod (Sky, Earth, Erebus, Tartarus, Sea: *Theog.* 117–132). Within this cosmic framework, other gods are active, of which the ruling dynasty is that of the Olympian gods under the leadership of Zeus. The rule of Zeus and the Olympians seems not guaranteed to be inevitable, and in theory could be challenged; but in practice Zeus' unequalled combination of power and wisdom means that he is *de facto* king of the world. (The difficulties Zeus encounters in Homer in putting his plans into effect are mostly due to the need to carry the rest of his family with him and to circumvent opposition from some of them on some particular matters.) Human beings, even when favored by the gods, are transient and marginal beings, subject to the will of the gods.

The gods are, therefore, central to the intelligibility of the world in a straightforward way: they are in fact the source and the explanation of any intelligibility it may have, both as a whole and as to particular objects or events. To understand anything is to know which god or gods are responsible for it; and that is usually the most that can be done. The gods themselves are not to be understood in terms of anything else, though some of them may be partly intelligible in terms of *other* gods.

The world as a whole, then, may be seen and partly understood as something shaped by the choices of various gods acting in an earlier stage of the world. The choices of gods may be understood in so far as they have motivations that make sense in human terms.

Hesiod offers the most ambitious attempt at providing, systematically, an intelligible world along these lines. His *Theogony* contains a vast genealogical scheme, which enables one to determine the exact kin-relationship of any god to any other. The knowledge of the gods' pedigrees and their interrelations is just as important for understanding their actions and wishes as the corresponding knowledge about human kings and princes is in Homer's epics.

Hesiod's *Theogony* is instructive because it so clearly aims to be an account of the world in terms of anthropomorphic gods that was as complete and coherent as its author could devise. The characteristic limitations of this way of thinking appear all the more clearly.

There is first of all the point that the world is essentially *finite* in all respects, because the gods are finite. Spatially, it does not extend further than the sky above and the murky region of Tartarus below, while the earth is encompassed by the circularly flowing Ocean. In time, it does not go back before the appearance of Chaos, the first god, of whom it is expressly said that it "came to be first of all" (*Theog.* 116). Nothing is said about the other end of time, but the stock epithet of the gods, "living always" (*aien eontes*), certainly need not imply an unending future. The power and knowledge of the gods themselves, though it is superhuman, is also finite, being intelligible only after the human pattern. Even within the finite world, there are things that are beyond the power of any gods to change or to prevent: not only the general nature of the world and the gods including himself, but certain matters that are impersonally "fated

to be," whether conditionally or absolutely (examples in Hesiod: *Theog.* 463–465, 475–476, 891–894). Nor do any of the gods appear to know anything about what may lie beyond the spatial and temporal boundaries mentioned. In this sense it may be said that the gods themselves have only a limited understanding of themselves and their own situation.

Finitude is not in itself a hindrance to intelligibility; rather the reverse. But it is a feature of the Homeric-Hesiodic world that though it is finite its limits are not only vaguely expressed, but are in themselves, apparently, indefinite; in any case, not to be precisely known. As a result, even the finitude of the world remains indefinite, and conceivably revisable.

This point is difficult to establish with certainty, because the attention of Hesiod or Homer is, naturally, mostly focused on the center of the world, the Olympian gods, and the events in recent history in the central region, in heaven and on earth. But, just because the gods are finite and central to the world, the limits of the world, and anything that might lie beyond, are beyond the gods' powers to affect, and beyond their knowledge. To say this, for Homer and Hesiod, is as good as to say that anything that is beyond the limits is unknowable, and cannot be considered as having any relevance to human life or divine beings.

This holds not only for the spatial and temporal limits; the same indefiniteness attaches to the limits of the gods' power, to the limits of intelligibility of the gods themselves, and to that of the world as a whole. For, as has been said, the gods are conceived of as "super-humans," who are not to be understood otherwise than by analogy with human nature as it is known in common experience. While this makes it easy to understand, in a general way, many aspects of their nature and their acts, it leaves it impossible to state with any precision how or why any one god will act in any one particular case. And intelligibility of the world as a whole depends directly, as has been said, on that of the gods.

To take a case directly affecting the observable regular order of the world: at *Odyssey* 12.377–388, the Sun, angered at the slaughter of his sacred cattle by Odysseus' men, threatens to go down into the underworld and shine among the dead. This threat is parried by Zeus with a promise to kill those responsible. So even the continuance of the Sun in his regular course, on which so much depends, is never absolutely guaranteed. In general it seems that the prevention of cosmic anarchy is entirely dependent on the continuing but finite watchfulness and resourcefulness of Zeus; so that there can be no absolute guarantee.

So far as can be seen, the Homeric-Hesiodic account of the world was the generally accepted one in archaic Greece. This is not to say that it was regarded as wholly unchallengeable, or was left wholly unchallenged. According to the Homeric-Hesiodic world-view itself, any *human* claim to know the truth about important matters concerning the gods, was in principle open to challenge. So Homer and Hesiod themselves had to explain how it was that they had better access to the truth than other human beings.

Their claim was that they were "inspired," that their stories were told them by the Muses, the goddesses who presided over memory and song; hence the source of their knowledge was, as it had to be, the gods themselves. But what supported the claim by any one particular poet to be so inspired? It could only be the public success of that

poet in poetically reproducing and enhancing traditional materials, in a way that was manifestly pleasing and convincing to most listeners.

At this point, then, there was necessarily an appeal to traditional beliefs and stories about the gods. The Homeric-Hesiodic reworking of these beliefs and stories imposed itself because it was found to be, ultimately, the most satisfying. If this is right, it follows that it was open to anyone (even to a character within the Homeric narrative itself) to doubt or to challenge the Homeric-Hesiodic account of things, on any one particular point, even a very important one. Thus, at *Odyssey* 24.351–352, it appears that Laertes, in his despair at Odysseus' failure to return, has been doubting whether the Olympian gods are still dispensing justice on Olympus. And there is evidence for myths discrepant from those of Homer and Hesiod being asserted by other poets, sometimes in what seems to be more or less free allegory; for example, Alcman's story of Poros and Tekmor (Alcman fr. 5 Davies).

But what it was not possible to do, was to doubt or to challenge the supporting substratum of traditional belief: above all, the belief that the beings central to the understanding of the world were the anthropomorphic gods of traditional Greek religion. When the whole Homeric-Hesiodic view finally came under systematic attack, the first serious critic of whom we know, Xenophanes of Colophon, centered his polemic precisely on the anthropomorphic gods.

It is clear then that the Homeric-Hesiodic view of the world was not and could not be a "free-standing" one, appealing to some intrinsic authority of its own. It was dependent on the tacit support of the "traditional substratum" of assumptions.

Thus this view of the world was clearly "pre-scientific." To say this, is not to deny that it represents the result of a great deal of intense reflection on the problems of understanding the world. Moreover, some of this reflection is recognizably concerned with questions that are typically philosophical. Thus, Aristotle (*Phys*. IV.1, 208b29–33) plausibly interprets Hesiod's introduction of Chaos as the temporally first god, as drawn from a recognition that some concept of *place* is necessary and antecedent to any account of material existence.

But, in spite of such interesting suggestions of proto-philosophical reflection, it has to be said that the Homeric-Hesiodic view was even in a certain sense "anti-scientific" (and "anti-philosophical"). This is meant as follows: it positively made impossible the development of any scientific thinking about the world as a whole, so long as it (or rather the "substratum" of supporting beliefs) retained any authority. It was recognition of this incompatibility that underlay what Plato later called "the ancient quarrel between philosophy and poetry" (*Rep*. X, 607b5–c4; the poets, Homer and Hesiod above all, being the principal exponents of the pre-scientific view).

What constitutes the division between "scientific" and "pre-scientific"is not the use of "gods" in explanations of the world. It all depends on the nature of the gods. As will be seen, the Milesian theorists also postulated intelligent "gods;" but these were *not* the traditional anthropomorphic ones.

The gods of Homer and Hesiod, and generally those of the traditional Greek belief, were too humanly credible, too straightforwardly similar to common human experience, to serve as elements of a scientific theory. They leave no room for any effort to rise above vagueness and ambiguity in understanding, and to develop a more detached and precise style of describing and understanding. As has been seen, the very

notion and limits of the "world" have to be left indeterminate, and not determinable even in principle. They therefore make a scientific effort to understand the world impossible, so long as they are taken to be indispensable.

Innovation at Miletus: Aristotle on Thales and His New Style of Cosmology

There is all too much we do not know about how people were thinking in the Greek world between 800 and 600 BCE. A few fragments of poets throw only an uncertain and indirect light here. While traditional political structures were crumbling and new ones appearing, it seems that nevertheless the Homeric-Hesiodic world-view, and the traditional religious beliefs and practices that underlay it, remained dominant. After 600 BCE, though, the picture becomes fuller, and other forms of religious belief and practice (particularly mystery-cults and occult beliefs) come into view.

One innovation that was surely of more than incidental significance was the introduction of Greek alphabetic writing. This made it possible, for one thing, to stabilize the texts of Homer and other poets in "canonical" versions. It made it possible also to reduce customary law to a standard, publicly available, and revisable written form. More than that, the ease of alphabetic writing, and the growth of literacy among the richer citizens, meant that any thinking involving more than the simplest kind of argumentation could now, for the first time, be exactly recorded and preserved by anyone literate, for consideration by anyone else who was literate and interested. It was no longer necessary to write metrically and to be dependent on surviving in enough memories. The mere possibility of committing one's thoughts to writing (not to mention the sheer pleasure of doing so) was itself an encouragement to any kind of speculation that went beyond the bounds of everyday experience.

An archaeological point is perhaps of interest here. Very little Greek writing, apart from inscriptions and graffiti, has been materially preserved from the archaic and classical centuries. Outstanding among the scanty finds are certain enigmatic texts dealing with occult religious matters: the gold plates found in Southern Italy, the Olbia bone-fragments, the Derveni papyrus.

Aristotle, whose testimony is our natural starting-point, ascribes to Thales of Miletus (active c. 600–550 BCE) the distinction of being the "founding father" (*archēgos*) of "natural science," or of a kind of "philosophy" (*Met.* A.3, 983a24–b27). It is clear enough what, in Aristotle's view, separated Thales and his successors from anything whatever that had preceded. For Aristotle, Thales was the first of those who "undertook proper examination of things that are" (*eis episkepsin tōn ontōn elthontas*), who "philosophized about reality" (*philosophēsantes peri tēs alētheias*), and was therefore trying to construct a science (*epistēmē*).

Aristotle is not here supposing that Thales produced anything like his (Aristotle's) own ideal of a science of nature. On the contrary, he forthrightly points out the defects, as he sees them, in the assumptions and methods of all the earlier theorists that he recognizes as forerunners. But his central point in *Metaphysics* A is that though they were fumbling beginners, they have an incontestable claim to be recognized as predecessors, as at least would-be scientists, because of the kind of explanations that they gave.

Thales apparently said that everything came out of, and was made of, water. This statement, taken on its own, could well be part of a creation myth of the kind familiar from some Ancient Near Eastern texts. But Aristotle interprets it (no doubt partly in the light of the better-attested theorizing of Thales' successors) as the provision of a "material cause." That is, he sees Thales as claiming that everything there is, its nature and behavior, can and must be understood exclusively in terms of the properties of water.

It is clear that this sort of general and abstract claim is not the kind of thing that one meets with, either expressed or latent, in Homer or Hesiod. It is characteristic of a theoretical enterprise. Aristotle elsewhere (e.g., *Met.* B.4, 1000a9–19; *Meteor.* II.1, 353a34–b5) contrasts with scientific explanations the explanations of those he calls "writers about gods" (*theologoi*), those who speak "in myths" (*muthikōs*), implying that they are incomplete, unsatisfactory and not worth wasting time on.

Whether or not we accept the Aristotelian account, it is important at least to understand what it does and what it does not imply. (The points made here apply also, and more clearly, to the better-documented successors of Thales.)

Above all, it does not imply that Thales was scientific because his theory was a "materialist" theory, or because it avoided explanations in terms of "gods." (Here I bypass questions about what was for Aristotle a "material" cause;[2] it is clear at least that Aristotle does not mean to attribute any well-developed concept of "matter" or "corporeality" to Thales.) Aristotle elsewhere (*Phys.* III.4, 203b3–15) implies that Thales' "water" was not just the water of ordinary everyday experience, as nowadays conceived, but a theoretically loaded version of the same, which was alive and intelligent, and could reasonably be entitled "the divine."

Aristotle himself disapproves of this sort of explanation, and finds it perhaps almost as archaic and bizarre as do most moderns. But that does not deter him from seeing it as being, at least in intention, a genuinely "scientific" explanation. The point, for Aristotle, is that, even if Thales' water is a "god," this is a very different kind of god from any of Homer and Hesiod's gods. It is an exceptionally well-defined god, of which the properties and powers could in principle be stated precisely in a finite list. Because of this theoretical precision, it can without absurdity be suggested as capable of giving a complete theoretical explanation of the universe.

The Theoretical Enterprise Unfolds: A Post-Aristotelian Interpretation

Aristotle's account of the beginnings of Greek science and philosophy is the unavoidable starting-point for any investigation. This is so for obvious reasons: Aristotle is by far the fullest, most coherent, most expert, and most intelligent witness we have. His conception of what happened is naturally hard to challenge; it has been accepted often enough, often without being very precisely understood.

But our dependence on Aristotle is not absolute. A certain amount of independent evidence survives, particularly in the shape of brief or longer quotations from original

2. See Bodnár and Pellegrin, ARISTOTLE'S PHYSICS AND COSMOLOGY, in this volume.

works of the sixth and fifth centuries. This other evidence can often suggest ways in which Aristotle, like any other historian of science and philosophy, has oversimplified and distorted. Inevitably Aristotle, like everyone else, sometimes cannot free himself sufficiently from his own temporal and philosophical standpoint.

From the discussion of the "flagship" case of Thales, above, it seems that the core of Aristotle's view about the nature of his innovation can be accepted, even if we do not accept Aristotle's whole philosophy of science and scientific explanation. We can understand that the new cosmology was new, and was proto-scientific, because it was a self-consciously *theoretical* enterprise.

Against this view, it can be argued that the non-Aristotelian evidence does not support such an understanding. (Here I draw on Frede, 2000.) The argument is partly linguistic: before Plato, the word "philosophy" and its derived verb (*philosophia*, *philosophein*) are rarely attested and have no specialized sense. Nor are there any other words that are obviously used to designate the new approach to cosmology and its practitioners as something separate and distinct. In parallel to these linguistic points, it can be pointed out that in the surviving remarks of the "pre-Socratic philosophers," we find them comparing themselves with, and attacking or praising, not only others of the same narrow group but also a whole range of poets and sages.

Much must be conceded to these arguments. It is certainly probable that, right down to the end of the fifth century, there was no one word or phrase in use to denote, exclusively, those we now separate off as "pre-Socratics." It is also highly likely that both their admirers and their detractors made use of the general terms "sage" (*sophos*: usually approving) and "clever person" (*sophistēs*: ambiguous as between approval and disapproval). These terms covered a multitude of activities, but their import was a person of real or pretended general intelligence, applied to all sorts of matters, whose insights might well not endorse traditional views. It is Herodotus who provides, in his portraits of such men as Solon and Amasis and his vignettes of Thales and others, the clearest view of what a "sage" was expected to be. It was characteristic of the sage to present himself as confidently in opposition to the general mass of received opinion; and this is certainly the attitude and the tone we find, to give an outstanding instance, in the opening of Heraclitus' book:

> While this *logos* is always men always prove to have no understanding, both before they have heard it and when once they have heard it. For though all things come about according to this *logos* they are like people of no experience when they experience words and deeds such as I set forth, dividing each thing according to nature (*phusin*) and pointing out how it is. (Heraclitus DK 22B1, part)

Corresponding to the inclusivity of these terms, it is also highly likely that at least the earliest theoretical cosmologists did not see themselves *exclusively* as such. Thales even won a place among the "Seven Sages," and it is his practical wisdom, as well as his "prediction" of a solar eclipse, that is illustrated by Herodotus. Xenophanes and Heraclitus mingle moral, political, and religious exhortation, and social criticism with their cosmologies.

Yet, even when all this is conceded, it by no means follows that Aristotle was wrong, that there were no new theoretical enterprises or new methods in cosmology, or that

they were not seen as something new. Here one must take account of a certain linguistic conservatism, which can be seen in other instances too. The evidence suggests strongly that Greek geometry and arithmetic were already developing as theoretical sciences before the end of the fifth century BCE. And yet the terms always used to denote these theoretical activities were ones that did not distinguish them at all from the corresponding practical ones: "geometry" (*geōmetria*) means "land-measurement," i.e. land-surveying; and the words for number theory (*arithmētikē*, *logismoi*) mean "the art of counting" and "reckonings."[3]

One important mark of such an enterprise is that it deals primarily in what may, loosely and untechnically, be called "abstract" entities. More precisely, its explanatory terms refer to entities which are theoretically postulated, and which, though related to the objects of experience, are at some remove from them. Most importantly, they are "sanitized" to enable them to be handled with precision in general theoretical reasonings.

The abstractness of even the earliest theorists, the Milesians, can be seen even in the case of Thales, if we accept on Aristotle's testimony that his "water" was not just the "water" of the modern physicist; but it appears more clearly with his successor Anaximander. For Anaximander the ultimate theoretical entity was "the infinite" (*to apeiron*): a self-confessed abstract entity, but one that sustains the same central role assigned by Thales to "water." With later theories of the same sort it is equally clear, and by no means exclusively on Aristotle's evidence, that even when "water" or "air" or "fire" figure as ultimate theoretical terms, the meaning of these words is only partly to be understood from our ordinary experience of the corresponding everyday things.

Corresponding to the new abstractness of the explanations is a new precision about what is to be explained. We saw that an impenetrable vagueness hangs over all the limits of Hesiod's or Homer's world. There is no plausible way, within the Homeric-Hesiodic world-view, in which even the gods could have more precise knowledge about these limits and what might or might not lie beyond them. This being so, it may be meaningless and it is certainly pointless to ask for such knowledge.

By contrast, the new-style cosmology has questions of limits, or their absence, at the forefront; and the subject for theoretical inquiry is not just the observable world-system (*kosmos*), but the universe, all that there is (*to pan*, *to holon*, *ta onta*). The Milesians, and many others later in the same tradition, opted for what was then the easiest solution, a spatially and temporally infinite universe. Hence one of their central theoretical tasks was to account for the existence of one or more finite world-systems (*kosmoi*) within the basically uniform universe. (In this connection, it is regrettable that so little is known about the early development of mathematics as an exact science in Greece. It is hard to believe that the advent of theoretical cosmology and that of theoretical arithmetic and geometry were not causally connected.)

Part of the point of this new kind of theoretical entity is that it lends itself to unrestricted general reasonings. This raises the question of the relevance of the concepts of *reason* and *rationality* to the innovations of the sixth century.

3. On the development of Greek mathematics, see Mueller, GREEK MATHEMATICS TO THE TIME OF EUCLID, in this volume.

It would be a mistake to assume that the Homeric-Hesiodic world-view did not allow the application of reasoned argument to large questions about the nature of the world. Apart from the intrinsic implausibility of supposing that before around 600 BCE people were somehow "not rational" (at least on non-practical matters), but that thereafter they became so, there is actually no need to suppose any such thing. What we should say is, rather, that the Homeric-Hesiodic account of the world represents a favorable example of what human reason could produce, when working under the restrictive condition of not having yet discovered the possibility of a purely theoretical enterprise.

The problem (from a post-Milesian point of view) is that if one starts, not from theoretical entities specially postulated, but simply from things one takes to be directly and wholly given in experience, then, however rational one is, the possible power and reach of one's reasonings is severely limited. First, no Milesian-style reductions are possible: for example, stones, animals, and water are all given in experience as different things, so none of them can be theoretically "reduced" to anything else. All must stand side-by-side, equally primary, in any catalog of the contents of the world. Nor will counter-factual reasoning, that great weapon in the theoretical armory, be possible; for it will have no Archimedean point from which to exert leverage. To ask, about some feature of the world, "what if X were not as it in fact is?" is meaningless, if X is something that is wholly given by experience alone. For, in that case, one can have no grasp whatever of what it might mean for X *not* to be as it is. In short, while the theoretical enterprise is not to be identified with rationality *per se*, it is characteristic of the theoretical approach that it is needed to release the full power of which reasoned argument is capable.

Conversely, it is characteristic of the pre-theoretical approach that it is *necessarily* at the mercy of some generally accepted assumptions. We may see Homer and Hesiod as trying to make the best sense they could out of certain universally accepted assumptions of their time: above all, that the world was dominated by a group of anthropomorphic gods who were, by and large, friendly towards humankind and gave them information. (The fact that these particular assumptions have few adherents nowadays, and are indeed widely considered absurd and irrational, is not relevant to the point being made here, though it may have contributed to the confusions about the relevance of "rationality.")

It is only a purely theoretical approach that can give the necessary leverage to reveal generally accepted assumptions as what they are, namely mere assumptions. For generally accepted assumptions, a theoretical approach substitutes as its postulates other assumptions, which are claimed to be both intrinsically more acceptable and more successful at giving explanations of the experienced world.

Aristotle rightly saw the giving of certain types of explanation as an essential part of a science. The new style of cosmology was characterized and almost constituted by a new style of explanations. As Aristotle suggests, pre-theoretical explanations in the style of Homer and Hesiod are always essentially incomplete. At best they present an outline of a possible way of *understanding* the explanandum in outline, within a context of generally accepted assumptions; they do not and cannot show that it follows of necessity from the nature of things. By contrast, the new-style cosmology based its claim to attention precisely on its supposed ability to deliver an account of the

universe that not only agreed with experience but also followed of necessity from the stated principles.

Thus the postulates from which the whole enterprise started had to be not only true without exception, but also capable in principle of delivering a theory covering the whole of the universe in a coherent and unified way. Any suggestion of anything introduced *ad hoc*, to meet a particular difficulty, would be fatal to their plausibility. Everything about the universe had to be seen to flow of necessity from what it essentially *was*. Around this time the term *phusis*, usually translated "nature," began to become current to indicate the object of the new-style theorizing. As has been shown by Holwerda (1951), in archaic and early classical Greek *phusis* served as the noun corresponding to the verb *einai* "be" in most senses.

These theoretical demands naturally lead to a particular style of theorizing. Observable things have to be *reduced* to combinations of primary constituents; and their powers and interactions have to be *subsumed* as special cases under more general truths about the powers and interactions of the primary constituents. In particular, apparently abnormal and paradoxical phenomena must be shown to be naturally and convincingly explicable in the terms of the theory.

Instead of the chaos of accepted opinions, the new aesthetic of theoretical explanation requires structural unity and the maximum of symmetry and essential uniformity to be displayed in the universe. The principle later formulated as the "Principle of Sufficient Reason" seems to be implicit in this approach, and there are already signs of its conscious use in Anaximander's explanation of why the earth remains at rest (it is symmetrically placed with regard to the rest of the *kosmos*).

Theoretical Reflections on the Limits and Presuppositions of Cosmology: The Origins of Greek Philosophy

Like every other real revolution, the revolution in cosmology was irreversible. This was not because the new theoretical approach was self-evidently or provably truer in its results, and still less because of any impact on practical life (it had none), but because it was in itself obviously and incontestably an advance in the technology of reasoning. As with every revolution, there were those who tried to ignore or resist it ("they pluck the fruit of wisdom when it is unripe" complained Pindar (fr. 209 Snell) about the new style of cosmology); and those who fruitlessly attempted compromise between the old ways and the new, such as Pherecydes of Syros (on whom see Schibli, 1990).

But, also like every other real revolution, the revolution in cosmology tended in some sense to devour its own children. For it quickly became apparent that the shared program of theoretical investigation of the universe might lead equally intelligent theorists in different directions. This awkward fact is already evident within the Milesian group. All were monists, but each chose a different fundamental constituent and gave different mechanisms for the production of *kosmoi*.

Any one theorist, therefore, was likely to be in conflict not only with traditional ideas but with all other theorists as well. How was the new paradise of theoretical

reasoning to be secured from internal disagreements? And what universally acceptable reasons could be found for preferring one theory to another?

Once these questions had been raised, they too could not be erased from the general awareness. They can be seen as the founding questions of Greek philosophy. The supporters of the theoretical approach in cosmology were forced henceforward to apply that same approach to higher-order questions, about knowledge, about reasoning and reasonableness, about the epistemic status of the theoretical approach itself.

The first person whom our evidence shows unambiguously to have been concerned with these problems, is Xenophanes of Colophon (active before and around 500 BCE). It is Xenophanes, then, who has the best claim to the title of "the first Greek philosopher."

Xenophanes raises the question of human knowledge directly and explicitly, and makes the fundamental point that truth is not a sufficient condition for knowledge. He concludes that on the central questions (the general nature of the universe as a whole, and the nature of the gods) no knowledge is to be had, for human beings at least: "And as for the certain truth, no man has known or ever will know that, concerning the gods and all the other things I speak of; for even if one should chance to say what is fully correct, still one does not *know*; it is *opinion* that is constructed about all these matters" (DK 21B34).

The natural supposition is that for Xenophanes knowledge is gained from first-hand experience only. Yet he himself went beyond that limit, as he indicates in these lines. And another remark (DK 21B18) expresses optimism about the possibility of human beings to "find out something better" without the help of the gods. How better "opinion" should be constructed on the basis of limited experience is indicated directly: "let these things be taken as opinions that resemble the truth" (DK 21B35). Indirectly, the prescription to be followed is indicated by the reports about Xenophanes' own ontologically parsimonious cosmology. Here his guiding principle is to assume that the parts of the universe inaccessible to direct human experience are essentially similar to the accessible parts. No unobserved constituents or forces are postulated.

In offering this cosmology, Xenophanes seems, at first sight, to have jettisoned one of the principal aims of the theoretical enterprise: that of giving a convincingly *unified* overall explanation of the universe. Xenophanes' universe, as revealed by his cosmology, hardly has much unity. But it turns out that Xenophanes has a second branch to his theorizing; the universe that is a subject for empirical cosmology, is *not* the whole universe. Beyond and behind it, there is a supreme god.[4]

Though our knowledge of this theology is tantalizingly incomplete (and Aristotle, who had read it entire, found it "unclear" at certain vital points), it seems that it was based on the principle that a god, or at least a supreme god, must be in every possible respect complete and perfect. It must therefore be a unity in some strong sense, and must also in some sense contain the rest of the universe. The desired overall unity of explanation, denied by the cosmology, is therefore restored by the theology. The principle of "perfection" on which it was based can hardly have been seen as something given in human experience; Xenophanes therefore must have taken it as something like an *a priori* truth.

4. On Xenophanes' theology, see also Betegh, GREEK PHILOSOPHY AND RELIGION, in this volume.

This conclusion is borne out to some extent by the evidence. First, Xenophanes made bitter attacks on the traditional, Homeric-Hesiodic religious opinions. These he lampooned as showing all traditional supposed "gods" to be theoretically unfit to be considered gods: they were morally vicious, limited by contingent circumstances, and were conceived of anthropomorphically, and according to the prevailing human physical type of each society. The implicit appeal is to some unvarying and absolute standard of divinity, implying (at least) moral and other kinds of superhuman perfection, in opposition to the various and confused conceptions of imperfect, "human" gods current in the tradition.

Also, Xenophanes' positive statements show the results of this appeal, and contain some statements directly indicating the standard being appealed to. "One god is greatest among gods and humankind, not like mortals either in bodily form or in thought." "It is as a whole that he sees, as a whole that he thinks, as a whole that he hears." "Always he stays still in the same place, not stirring at all; nor is it fitting for him to move about hither and thither (DK 21B23, B24, B26).

The most obscure part of Xenophanes' theology is the question of this god's relation to the observable universe. It is here that Aristotle (*Met*. A.5, 986b21–25) complains of "unclarity," but tells us at least that in some sense the supreme god *is* the whole universe, or the unity of the whole universe. The most natural way to make sense of this may be to take the supreme god as containing the rest of the universe in much the same way that a mind contains its contents. That at least would explain how the god "without effort, sways all things by the thought of his mind" (DK 21B25).

It is striking that Xenophanes, the first recognizable philosopher, thus stands at the beginning of two Greek philosophical traditions which are usually thought of as naturally opposed, and frequently were: the empiricist tradition and the tradition of *a priori* metaphysics.

In its process of development, philosophy gradually separated itself from the purely cosmological enterprise and the more specialized areas of study (astronomy, mathematics, medicine, biology) that had developed their own theoretical impetus partly in interaction with cosmology. But for both of the two great philosophers of the pre-Socratic period, Heraclitus of Ephesus (active c. 490 BCE) and Parmenides of Elea (active c. 470 BCE; not discussed in this chapter),[5] cosmology was still an integral part of their enterprise.

In his theory of the observable *kosmos*, Heraclitus maintained a Xenophanean empiricism, and a similar ontological parsimony, not postulating any unobserved but in principle observable entities (or forces or mechanisms). The observed and observable forces at work are therefore just the hot and the cold, the wet and the dry, engaged as forces in unending struggle among themselves, and embodying themselves in fire, water, and other manifest constituents of the *kosmos*.

But this cosmic struggle, warlike and yet also lawlike in its regular changes, is for Heraclitus only one particular example of an abstract schematism ("unity-in-opposites") which he found in all aspects of pre-theoretical human experience, and postulated as fundamental in all the underlying structures of the universe:

5. On Parmenides, see Curd, PARMENIDES AND AFTER, in this volume.

> A road: uphill downhill one and the same. (DK 22B59)
>
> Sea: water purest and most impure, for fishes drinkable and life-saving, for people undrinkable and deadly. (DK 22B61)
>
> On those who step into the same rivers, other and other waters flow. (DK 22B12)

From these particular examples Heraclitus proceeded to a first attempt to conceptualize the notion of "structure" (*harmoniē*), and the assertion that "latent structure is master of visible" (DK 22B54).

So the understanding of the universe requires the uncovering of non-obvious "structures" which are determinative of everything else. This is a thought that would seem to have been implicit in the theoretical enterprise all along; in formulating it explicitly, Heraclitus comes to stand at the beginnings of the philosophy of science.

Rather less easy to decipher is another key concept of Heraclitus, "the *logos*" (or "this *logos*"), the introduction of which has already been cited. No even approximate equivalent of "*logos*", as used by Heraclitus, exists in English (or in any other modern language, so far as I know). The many uses of this word in ordinary Greek ("word", "story", "account", "reckoning", "selection", "proportion", "reasoning" are the most usual) are systematically exploited and theoretically united by Heraclitus. The details, and the upshot, are controversial; it is at least arguable that here we have, among other things, the beginnings of philosophical engagement with the concept of *reason*. "Though the *logos* is public, the many live their lives as though they had a private source of understanding" (DK 22B2).

But the *logos* is certainly not only the shared reason that enables human beings to understand the universe. Heraclitus sees it also as the reason that controls that same universe, on the principle that what reason can grasp must also be produced by reason. This active reason is traceable in the patterns of "unity-in-opposites" embedded in the observable universe: "When one listens not to me but to the *logos* it is wise to agree (*homologein*) that all things are one" (DK 22B50).

How the direction of the universe by the *logos* is to be conceived of, is perhaps the obscurest question in interpreting Heraclitus; but it seems that like Xenophanes he postulated a supreme and unifying deity, whose mind served as the carrier of the cosmic *logos*.

Xenophanes and Heraclitus can be seen as seeking, through philosophical reflection, to locate the cause and the cure of the troubles besetting the new theoretical cosmology. A rather different reaction, perhaps, was that of Pythagoras of Samos (active before and around 500 BCE), another personage of this period, and one mentioned with some contempt by both Xenophanes and Heraclitus.

Pythagoras, so far as one can penetrate the fog of legend that surrounds his life, presented himself to his contemporaries primarily as a magician, a wonder-worker, a mystagogue of charismatic personality. But he clearly also laid some claim to the all-round knowledge and the revealing insights of the "sage." It seems fairly certain that the "Pythagorean way of life" he imposed upon his followers included the study of mathematics and of music and astronomy, seen as exhibiting mathematical structures. At least this was a central point in the intellectual activity of many who saw themselves as "Pythagoreans" in the fifth century. A "Pythagorean" program of "reducing everything to numbers" was current then; and may possibly go back to

Pythagoras himself. If so, it is yet another example of the emergence in this period of thoughts that were to have a long subsequent history in the practice and philosophy of science.

Questions and Disputes

The previous part of this chapter has outlined an interpretation of certain texts from the archaic and classical periods of ancient Greece. It will already be obvious that the evidence for many points is fragmentary and miscellaneous; and that, even though some complete texts survive (notably the poems of Homer and Hesiod), these texts never tell us unambiguously and fully all that we want to know. Interpretations on such matters are always open to dispute.

It is also clear that any interpreter must necessarily, knowingly or not, take up positions on some fundamental matters of method and approach. It cannot be said that there is a great deal of agreement on any of these matters in recent scholarship; nor is that a fact to be regretted. In this final section I offer a brief survey of some of the more fundamental disputes, in the light of some recent scholarly works.

One question that causes trouble is that of "teleology" in the understanding of the history of science and philosophy. In this chapter I have been professedly concerned with the "beginnings of science and philosophy," and have therefore been taking as a starting-point and a guide some *modern* notions of what constitutes "science" and "philosophy" respectively. Such a procedure is exposed to obvious dangers: one must constantly be aware of the all the ways in which the archaic Greek "beginnings" were significantly *unlike* modern science and philosophy, as well as all the ways in which they were significantly *like* them. But that is just one way of formulating all the central questions about the subject-matter.

Some would, perhaps, reject any such procedure at the outset, as irredeemably "teleological." In this context the word "teleology" is often used as a convenient term of abuse, and like many such terms it serves to cover a multitude of different things, which need to be distinguished.

"Teleology", in the broadest sense of studying the ancient world in the light of a modern understanding of things, may be not wholly desirable (because of the dangers already mentioned), but is in any case completely inevitable. It is absurd to suppose that the ancient texts alone could generate for us a purely "ancient" way of understanding them.

More properly "teleology" implies the understanding of historical developments by seeing them as moving towards some, supposedly somehow pre-ordained, goal. Here we must distinguish different suppositions about the goal involved. Science and philosophy are of their very nature directed towards goals: the better knowing and understanding of human experience, and of the world as given in experience. Hence *if* any progress towards these goals is in fact possible, and *if* human minds collectively are capable of learning from the results of repeated trial and error, then there will be a kind of "teleology" inherent in the history of science and philosophy, without which no sort of understanding of it is possible. But to say this is not to say that such progress is always possible, still less that progress will always be made.

Above all, to say this is not at all to discount the importance, both historical and philosophical, of what appear from a modern point of view as "dead-ends" and "failures." To take a striking example from this period: in the development of archaic Greek theorizing, the "cosmo-theology" of the Milesians, described above, is such a "dead-end," an evolutionary curiosity having no living descendants. Yet it was, of course, of the greatest possible importance in the development of both science and philosophy.

Even if it is admitted that we may reasonably look for "the beginnings of science and philosophy" in the archaic period of ancient Greece, there is still room for disputes about the nature of the developments in that period. For a start, the value of Aristotle's evidence may be questioned. The attempt by Cherniss (1964) at a root-and-branch destruction of Aristotle's credibility as a witness, no longer commands much assent. Yet one may still reasonably suspect that Aristotle does not always avoid, or even notice, the dangers inherent in his way of seeing things. And it would certainly be wholly unjustified to assume that Aristotle always tells us all that we wish to know about the earlier theorists. In any particular case, the question is a complex one, and there is no room for sweeping generalizations. (For an example of moderate and well-based skepticism about Aristotle's evidence on one important point, and how it might be answered, see page 9.)

There are always those who emphasize continuity in human history, at the expense of discontinuity; and conversely those who emphasize discontinuity at the expense of continuity. It is better to admit at once that in any line of development there are always both continuities and discontinuities to be found. That does not help us to answer any specific questions: for example, was Hesiod already "scientific?" were the Milesians still "pre-scientific?" Reasons for saying "no" to both questions have been given above. They depend essentially on a particular view about which aspects of science (as at present understood) are essential and which are not. In general, any particular understanding of "early Greek science and philosophy" inevitably involves some general conception of *science* and of *philosophy*. It is hardly surprising, given the contestability of any such conceptions, that many different kinds of answer to these two questions are to be found in recent scholarship.

There are those who seek to show that, for example, the cosmology of Hesiod is of essentially the same kind as that of the earliest "pre-Socratics." The strong cultural influence of the "Ancient Near East" on archaic Greece is often invoked in this connection. One notable representative of this view is Martin West, whose book *Early Greek philosophy and the Orient* (West, 1971) goes further than most in claiming the essential dependence of early Greek science and philosophy on the "Ancient Near East;" while claims along the same lines are made, for example, by Burkert (1999) and Hölscher (1968).

If one accepts that there is indeed a qualitative difference between the Homeric-Hesiodic world view and that of the Milesian cosmologists, there is still scope for disagreement about the ultimate nature of this difference. The most favored view, until recently, was that Hesiod's and similar cosmologies were not "rational" but "mythical;" whereas the new theoretical enterprise was "rational" (see, for example, Barnes, 1979; Kirk, Raven, and Schofield, 1983; Vernant, 1983). This view has lost popularity recently, perhaps because it is now generally perceived that, at best, without further

explanation of what is meant by "rationality," it merely rephrases the problem rather than giving any insight into it. As argued above, there is *no* obvious sense in which Hesiod's cosmogony was not the result of rational thought; yet there is something important that is half-concealed in this view, and needs to be brought out.

Another type of view places the emphasis on changing conceptions of "truth;" but here it is doubtful whether we can make sense of a conception of truth that is as flexible as seems to be required. (See Detienne, 1996; and Williams, 2002.) As argued above, there is certainly a most important difference between the *sources* of authoritative truth, as conceived of by the Homeric-Hesiodic view and by the sixth-century theorists. But whether this was the cause or the consequence of the different conceptions of reality, is another question.

There are also questions, hardly touched on in this chapter, about the circumstances (political, economic, social, and cultural) in which Greek science and philosophy began, and which may have helped or hindered their development. Some have pointed to political changes: the decay of the traditional political authority of kings and princes, and the development of new political structures with more widespread participation of citizens in the political process. (On all this, see Lloyd, 1987; Vernant, 1983.) Here I have suggested, following many others, that the spread of an alphabetic script and hence of a degree of literacy in Greece may well have been important, at least as a catalyst. (For other views on this question, see, for example, Lloyd, 1979; Osborne, 1997.)

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