

KARL R. POPPER



THE
WORLD
OF
PARMENIDES

ESSAYS ON THE
PRESOCRATIC
ENLIGHTENMENT

Edited by ARNE F. PETERSEN

with the assistance of JØRGEN MEJER

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Karl R. Popper

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PREFACE

The present book contains various attempts to understand early Greek philosophy, on which I have worked for many years. I hope that these essays may illustrate the thesis that all history is, or should be, the history of problem situations, and that in following this principle we may further our understanding of the Presocratics and other thinkers of the past. The essays also try to show the greatness of the early Greek philosophers, who gave Europe its philosophy, its science, and its humanism.

The essays have not been arranged in the order in which they were written. After one of the oldest essays, 'Back to the Presocratics', which presents some early attempts at understanding the main interests and achievements of the Presocratics, there follow a number of essays on the central problems that Xenophanes and Parmenides may have worked on. These later essays have been rewritten many times during recent years, and only one of them (Essay 3) has been published before. They supersede in some respects 'Back to the Presocratics', though that essay does deal with problems partly different from the more recent ones. This should also explain why there are recurrent themes and repeated attempts at rendering the ancient Greek texts: different translations have been retained in this collection since the main themes appear in different contexts and light from essay to essay – light reflected from the splendour of Presocratic philosophy.

The longest of the unpublished essays (Essay 7), originally entitled 'Rationality and the search for invariants', dates back to the 1960s. It tries to show that Heraclitus ('everything changes') and Parmenides ('nothing changes') have been reconciled and combined in modern science, which looks for Parmenidean invariance within Heraclitean flux. (As Emile Meyerson pointed out, this is done in physics by differential equations.) The final title of this essay indicates that 'the search for invariants' may advantageously be replaced by a theory of understanding founded on Xenophanes' early ideas.

When as a 16-year-old student I first read Parmenides' wonderful poem,

P R E F A C E

I learnt to look at Selene (the Moon) and Helios (the Sun) with new eyes – with eyes enlightened by his poetry. Parmenides opened my eyes to the poetic beauty of the Earth and the starry heavens, and he taught me to look at them with a new searching look: searching to determine, as does Selene herself, the position of Helios below the Earth's horizon, by following the direction of her 'eager look'. None of my friends whom I told about my rediscovery of Parmenides' discovery had looked for this before, and I hoped that some of them liked it as much as I did. It was, however, only some seventy years later that I realized the full significance of Parmenides' discovery, and this made me realize what it must have meant for him, the original discoverer. I have tried since to understand and explain the importance of this discovery for the world of Parmenides, for his Two Ways, and its great role in the history of science, and especially of epistemology and of theoretical physics.

As mentioned, these essays overlap in a number of respects, showing repeated attempts to solve the problem of understanding the ideas of the Presocratics. I apologize to my readers if the repetition is sometimes excessive. I am grateful, though, to my friends, in particular Arne F. Petersen, for their determination in putting together and editing the essays, in spite of their knowing that I am not an expert in this field, that I am a mere amateur, a lover of the Presocratics. I think that the essays reveal that I love three cosmologists above all the others: Xenophanes, Heraclitus, and Parmenides.

Karl R. Popper
Kenley, 27 February 1993

ABBREVIATIONS

- C. & R.* Karl R. Popper, *Conjectures and Refutations*, London, 1963, 5th edn, 1989.
- DK* H. Diels & W. Kranz, *Fragmente der Vorsokratiker*, 10th edn, Berlin, 1960.
- L.d.F.* Karl R. Popper, *Logik der Forschung*, Vienna, 1934, 10th edn, 1994.
- L.Sc.D.* Karl R. Popper, *The Logic of Scientific Discovery*, London, 1959.
- O.K.* Karl R. Popper, *Objective Knowledge: An Evolutionary Approach*, Oxford, 1972, 2nd edn, 1979.
- O.S.* Karl R. Popper, *The Open Society and Its Enemies*, 6th edn, vols I and II, London, 1969.
- S.I.B.* Karl R. Popper, *The Self and Its Brain – An Argument for Interactionism*, Part I (Part II written by Sir John Eccles), Berlin–Heidelberg–New York, 1977, 3rd edn, 1990.

INTRODUCTION

Aristotle's invention of induction and the eclipse of Presocratic cosmology

With the sole exception, perhaps, of Protagoras, who seems to argue against it, all serious thinkers before Aristotle made a sharp distinction between *knowledge*, real knowledge, certain truth (*saptes, alētheia*; later: *epistēmē*), which is divine and only accessible to the gods, and *opinion* (*doxa*), which mortals are able to possess, and is interpreted by Xenophanes as guesswork that could be improved.

It seems that the first who revolted against this view was Protagoras. There exists the beginning of a book by him, where he says: 'We don't know anything about the gods – neither whether they exist, nor whether they don't exist.' I suggest that his *homo mensura* proposition – 'Man is the measure of all things' – is derived from this, and that his argument was as follows: 'About the gods we don't know anything, so we don't know what they know. Thus human knowledge must be taken as our standard, as our *measure*.' In other words, the *homo mensura* proposition of Protagoras is a criticism of his predecessor's distinction between mere human opinion and divine knowledge. 'Therefore we must take human knowledge as our standard or measure.'

Other thinkers held similar views, but all of them can be placed historically after Protagoras: for example Democritus, whose native city, like Protagoras', was Abdera; although Democritus was, according to Diogenes Laertius, the teacher of Protagoras, more reliable historical sources place them in the inverse order. Protagoras was most probably an empiricist revolting against Parmenides' rationalism. This point is stressed several times in the present book.

Yet after Protagoras – but only until Aristotle – most thinkers of importance continued to hold the view of Parmenides and his predecessors that only the gods have knowledge. This is perfectly clear in Socrates. It is even clearer in the much more dogmatic Plato, because Plato's dogmatism pertains mainly to the laws of the state; although he does not want these laws to be written down, they should be rigid and quite immutable. Concerning the field that we now describe as natural science, Plato says explicitly (in the *Timaeus*, for example, but also in other places) that all he

can tell us is at best only 'truthlike' and *not* the truth: it is, at best, *like* the truth. This term is usually translated by 'probable', but we have to make the distinction between probability in the *mathematical sense* and in the totally different sense of *truthlikeness*. I therefore break with the tradition of mixing up these two notions; and since we cannot hope to change what mathematicians mean by 'probability', I use the term 'truthlikeness', or 'verisimilitude', especially for theories. The word that Plato uses is really '*similar*', and sometimes he says 'similar to truth'; the word is also connected with '*pictorial similarity or likeness*', and this seems, indeed, to be the root of the meaning.¹ According to Plato, humans can have only this kind of knowledge; he rarely calls it opinion, which is the usual term used, for example by his contemporary Isocrates, who says 'We have only opinion.'

The decisive break comes with Aristotle. Strangely enough, although Aristotle is a theist – he even has a kind of theology – he definitely breaks with the tradition of distinguishing between divine knowledge and human guesswork. *He believes that he knows*: that he himself has *epistēmē*, demonstrable scientific knowledge. This is the main reason why I do not like Aristotle: what to Plato is a scientific *hypothesis* becomes with Aristotle *epistēmē*, demonstrable knowledge. And for most epistemologists of the West, it has remained so ever since.

Thus Aristotle breaks with the reasonable tradition that says that we know very little. He thinks he knows a lot; and he tries to give a theory of *epistēmē*, of demonstrable knowledge; and being a clever man, and a good logician, he finds that his assumption that there is demonstrable knowledge involves him in an infinite regress, because this knowledge, if demonstrated, must be logically deduced from something else, which in turn must also be demonstrated knowledge, and therefore in its turn deduced from something else, and so on.

So he gets to the problem: how can this infinite regress be stopped? Or: what are the real original premises, and how do we make sure of their truth? He solves this fundamental problem of knowledge by the doctrine that the real original premises are statements of definitions. Here he invokes, at least sometimes, a kind of strange 'double thinking' or 'double talk'. Definitions, on the one hand, give to words a meaning by convention and are therefore certain (analytic, tautological). But if they are only conventional, and therefore certain, then all *epistēmē* is truth by convention and therefore certain. In other words, all *epistēmē* is tautological, deduced from our definitions. This conclusion Aristotle does not want, and he therefore proposes that there exist, on the other hand, also definitions that are not conventional and not certain. Yet he does not stress that they are not certain, only that they are the result of 'seeing the essence of a thing', and so synthetic; they are the result of induction.

This seems to have been the way in which induction entered into the theory of scientific method, of epistemology. According to Aristotle,

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induction is the procedure of leading the pupil (or the scholar in the sense of the learner) to a place, to an outlook, from which he can *see the essence* of the object of his interest. The description of this essence he then lays down by definition as one of his fundamental principles, the *archai*. In Aristotle these principles are definitions, and at the same time they become (I suggest by some kind of 'double talk') the certain truth that only conventional and tautological definitions can have.

Aristotle's method of induction is similar to the social initiation of a young man: it is the procedure of getting to an outlook from which you can actually see the essence of adult life. Inducing is a way of making definitions a rich source of knowledge. But definitions are in fact nothing like this: there cannot be such things as informative definitions.

Aristotle's theory of induction – the way we are led to see, to intuit, the essential property, the essence, the nature, of a thing – is double talk in another sense as well: it is achieved in part by regarding it critically from several sides (as in a Socratic discussion), and in part by considering many cases, many instances of it. The latter sense of induction leads to the construction of a kind of inductive syllogism. *Premises*: Socrates is mortal; Plato is mortal; Simmias is mortal; and so on. All these are men. *Conclusion* (which, Aristotle knows, is invalidly reached): All men are mortal. Or even the further conclusion, which goes to the essence of the problem: it is in the nature of every generated thing that it must decay and perish.

As just mentioned, Aristotle himself is perfectly clear that an inductive syllogism is invalid; but he does believe that we somehow arrive, by its help and by the intuition of the essences of things referred to, at statements that describe these essences, or some essential properties, and that these statements are, as definitions, true and certain and can serve as the ultimate premises of *epistēmē*, of demonstrated scientific knowledge.

I suspect that the logician Aristotle had a bad intellectual conscience when he introduced this theory. There are two arguments supporting this conjecture. One is that in spite of his generally very objectivist attitude, he becomes, in a strange way, a subjectivist in the theory of knowledge: he teaches that in knowing a thing, in intuiting it, the knower and his knowledge become one with the object known; a theory that may fairly be described as mysticism.² A theory that the knowing and the known are identical is, clearly, a form of subjectivism, and very different from the objectivism of demonstrable or syllogistic knowledge. But it helps somehow to get over the chasm across which induction offers a very insecure bridge.

The other indication that Aristotle had a bad conscience when he invented induction is that he projects his invention of induction on to Socrates, of all people. Yet Socrates would have been the last person to claim that he (or any man) possessed *epistēmē* that can be based upon such a procedure, simply because he always claims to have no *epistēmē*: *Socrates*

claims not to know, as Aristotle himself puts it – though what he says, more literally translated, is that Socrates *professes* (or *pretends*) not to know.

It seems very strange to burden Socrates, of all men, with the responsibility for inventing induction. The motive may be the thought that if Socrates, of all men, saw the need for induction, *then it could not be as the result of a bad argument*, an uncritical argument. But Aristotle has to get over two difficulties. He has to deny that Socrates *seriously* claims not to know; and, indeed, he suggests that Socrates' profession of ignorance is just ironical. (This is 'Socratic irony'.) The other difficulty is to interpret (or convert) the Socratic method – the *elenchus*, critical refutation by counterexamples – into a positive method of proof.

What Socrates attempts, with his *elenchus*, is to prove ignorant those who believe that they know. At the start, they believe that they know all about a subject (virtue, for example); and then Socrates shows them *with the help of concrete, experiential instances* – of counterexamples – that they do not. This method Aristotle now interprets as a method of searching for the essence by way of concrete evidence. Although this interpretation has a certain plausibility the conversion of the *elenchus* into an *epagōgē* (inductive proof) creates for Aristotle a need to invoke Socratic irony.

It is now understandable why Aristotle chooses Socrates as the person to be burdened with the responsibility for an invention that he, Aristotle, himself had made and for which he, as it were, does not dare to bear the responsibility. That seems to have been the situation: Aristotle *knows* that he knows (and that he knows that he knows makes him a bit similar to Protagoras, who was also an empiricist). However, Aristotle does not admit what Protagoras might have perhaps admitted – namely, that human knowledge is not certain. Protagoras might have admitted indeed that, even though we are the measure of all things and cannot do much better than we actually do, we can perhaps improve our knowledge a little, but not a great deal, and therefore we have to take human knowledge as the measure of all knowledge. This does not say, however, that he believed in *epistēmē* in the way that Aristotle did.

Aristotle was described admiringly by Dante as 'The master of all who know'. In my opinion this is a correct description, but he should not be admired for it, since knowledge in the Aristotelian sense is really not accessible to man. Xenophanes and Socrates (and Plato too, to the extent that he dealt with problems of natural science) are right in saying '*We do not know, we only guess.*' Aristotle was undoubtedly a great scientist (though not as great as Democritus, whom Aristotle appreciates but Plato never mentions and – according to certain traditions – is supposed to have hated); but he was pre-eminently a scholar and a great logician, whom we can thank for the invention of logic, and a great biologist. There are many things that speak in his favour, although his theories are all studies

INTRODUCTION

in dogmatism. Indeed Aristotle was the first real dogmatist – even Plato, though a political dogmatist, was not a dogmatist in epistemology.

We may say that the Aristotelian ideal of science is more or less an encyclopaedia full of concepts, the names of the essences. What is known about these essences defines the concepts, so that we can deduce everything about the concepts from their various definitions and their interconnections. This is the structure of a deductive encyclopaedia with all its concepts obtained by inductive procedures: the *archai* from which we can then derive everything else by means of logical deductions, the syllogisms.

Admittedly, Aristotle, by his theory of logical derivation, and by his theory of the four causes, or more precisely his third cause (the moving or proximate or efficient cause), achieved a considerable clarification of Plato's essentialism (which, for instance, made beauty the cause of the beautiful object).³

Nevertheless, I think that with Aristotle's theory, that science, *epistēmē*, is (demonstrable and therefore) *certain knowledge*, it may be said that the great enterprise of Greek critical rationalism came to an end. Aristotle killed the critical science to which he himself had made a leading contribution. The philosophy of nature, the theory of nature, the great original attempts in cosmology, broke down after Aristotle, owing mainly to the influence of his epistemology, which demanded *proof* (including inductive proof).

I think this is in brief the story of how epistemology as we know it came to be dominated by what Parmenides would have called a *wrong way*, the way of induction. This is also the main reason why these essays, which also contain a disproof of induction, have been collected under the title *The World of Parmenides: Essays on the Presocratic Enlightenment*. They are mostly about the three great Presocratics – Xenophanes, Heraclitus and Parmenides – but they also discuss Socrates and Plato, and what was later learnt and may still be learnt from the greatest and most inventive period in Greek philosophy; a period that came to an end with Aristotle's dogmatic epistemology, and from which even the most recent philosophy can be said hardly to have recovered.

Notes

- 1 See further Addenda 1 and 2 to Essay 1, below.
- 2 See *O.S.*, vol. I, p. 314.
- 3 For a detailed account of this improvement in the understanding and explanation of natural phenomena, see Svend Ranulf, *Der eleatische Satz vom Widerspruch*, Copenhagen, 1924. I am indebted to Dr Flemming Steen Nielsen for drawing my attention to this interesting work.

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ESSAY 1

BACK TO THE PRESOCRATICS

I

'Back to Methuselah' was a progressive programme, compared with 'Back to Thales' or 'Back to Anaximander': what Shaw offered us was an improved expectation of life – something that was in the air, at any rate when he wrote it. I have nothing to offer you, I am afraid, that is in the air today; for what I want to return to is the simple straightforward *rationality* of the Presocratics. Wherein does this much-discussed 'rationality' of the Presocratics lie? The simplicity and boldness of their questions is part of it, but my thesis is that the decisive point is the critical attitude which, as I shall try to show, was first developed in the Ionian School.

The questions which the Presocratics tried to answer were primarily cosmological questions, but there were also questions of the theory of knowledge. It is my belief that philosophy must return to cosmology and to a simple theory of knowledge. There is at least one philosophical problem in which all thinking men are interested: the problem of understanding the world in which we live; and thus ourselves (who are part of that world) and our knowledge of it. All science is cosmology, I believe, and for me the interest of philosophy, no less than of science, lies solely in its bold attempt to add to our knowledge of the world, and to the theory of our knowledge of the world. I am interested in Wittgenstein, for example, not because of his linguistic philosophy, but because his *Tractatus* was a cosmological treatise (although a crude one), and because his theory of knowledge was closely linked with his cosmology.

For me, both philosophy and science lose all their attraction when they

The Presidential Address, delivered before the meeting of the Aristotelian Society on 13 October 1958; first published in the Proceedings of the Aristotelian Society, N.S. 59, 1958–9. Footnotes were added to the reprint of the address in C. & R., 1963. (In the present collection, the address is reprinted without the appendix but with two addenda on verisimilitude that first appeared in C. & R., 1965 and 1969. Newly improved translations of Xenophanes' fragments (DK 21B23; 24; 25; 26; and DK B15; 16; 18; 34; and 35) have replaced the translations on p. 145 and on pp. 152–3 of the 5th edition of C. & R., 1989. Ed.)

give up that pursuit – when they become specialisms and cease to see, and to wonder at, the riddles of our world. Specialization may be a great temptation for the scientist. For the philosopher it is the mortal sin.

II

In this paper I speak as an amateur, as a lover of the beautiful story of the Presocratics. I am not a specialist or an expert: I am completely out of my depth when an expert begins to argue which words or phrases Heraclitus might, and which he could not possibly, have used. Yet when some expert replaces a beautiful story, based on the oldest texts we possess, by one which – to me at any rate – no longer makes any sense, then I feel that even an amateur may stand up and defend an old tradition. Thus I will at least look into the expert's arguments, and examine their consistency. This seems a harmless occupation to indulge in; and if an expert or anybody else should take the trouble to refute my criticism I shall be pleased and honoured.¹

I shall be concerned with the cosmological theories of the Presocratics, but only to the extent to which they bear upon the development of *the problem of change*, as I call it, and only to the extent to which they are needed for understanding the approach of the Presocratic philosophers to the problem of knowledge – their practical as well as their theoretical approach. For it is of considerable interest to see how their practice as well as their theory of knowledge is connected with the cosmological and theological questions which they posed to themselves. Theirs was not a theory of knowledge that began with the question, 'How do I know that this is an orange?' or, 'How do I know that the object I am now perceiving is an orange?' Their theory of knowledge started from problems such as, 'How do we know that the world is made of water?' or, 'How do we know that the world is full of gods?' or, 'How can we know anything about the gods?'

There is a widespread belief, somewhat remotely due, I think, to the influence of Francis Bacon, that one should study the problems of the theory of knowledge in connection with our knowledge of an orange rather than our knowledge of the cosmos. I dissent from this belief, and it is one of the main purposes of my paper to convey to you some of my reasons for dissenting. At any rate it is good to remember from time to time that our Western science – and there seems to be no other – did not start with collecting observations of oranges, but with bold theories about the world.

III

Traditional empiricist epistemology and the traditional historiography of science are both deeply influenced by the Baconian myth that all science

starts from observation and then slowly and cautiously proceeds to theories. That the facts are very different can be learnt from studying the early Presocratics. Here we find bold and fascinating ideas, some of which are strange and even staggering anticipations of modern results, while many others are wide of the mark, from our modern point of view; but most of them, and the best of them, have nothing to do with observation. Take, for example, some of the theories about the shape and position of the Earth. Thales said, we are told [A 15], 'that the Earth is supported by water on which it rides like a ship, and when we say that there is an earthquake, then the Earth is being shaken by the movement of the water'. No doubt Thales had observed earthquakes as well as the rolling of a ship before he arrived at his theory. But the point of his theory was to *explain* the support or suspension of the Earth, and also earthquakes, by the conjecture that the Earth floats on water; and for this conjecture (which so strangely anticipates the modern theory of continental drift) he could have no basis in his observations.

We must not forget that the function of the Baconian myth is to explain why scientific statements are *true*, by pointing out that observation is the '*true source*' of our scientific knowledge. Once we realize that all scientific statements are hypotheses, or guesses, or conjectures, and that the vast majority of these conjectures (including Bacon's own) have turned out to be false, the Baconian myth becomes irrelevant. For it is pointless to argue that the conjectures of science – those which have proved to be false as well as those which are still accepted – all start from observation.

However this may be, Thales' beautiful theory of the support or suspension of the Earth and of earthquakes, though in no sense based upon observation, is at least inspired by an empirical or observational analogy. But even this is no longer true of the theory proposed by Thales' great pupil, Anaximander. Anaximander's theory of the suspension of the Earth is still highly intuitive, but it no longer uses observational analogies. In fact it may be described as counter-observational. According to Anaximander's theory [A 11],

The Earth . . . is held up by nothing, but remains stationary owing to the fact that it is equally distant from all other things. Its shape is . . . like that of a drum. . . . We walk on one of its flat surfaces, while the other is on the opposite side.

The drum, of course, is an observational analogy. But the idea of the Earth's free suspension in space, and the explanation of its stability, have no analogy whatever in the whole field of observable facts.

In my opinion this idea of Anaximander's is one of the boldest, most revolutionary, and most portentous ideas in the whole history of human thought. It made possible the theories of Aristarchus and Copernicus. But the step taken by Anaximander was even more difficult and audacious than

the one taken by Aristarchus and Copernicus. To envisage the Earth as freely poised in mid-space, and to say 'that it remains motionless because of its equidistance or equilibrium' (as Aristotle paraphrases Anaximander), is to anticipate to some extent even Newton's idea of immaterial and invisible gravitational forces.²

IV

How did Anaximander arrive at this remarkable theory? Certainly not by observation but by reasoning. His theory is an attempt to solve one of the problems to which his teacher and kinsman Thales, the founder of the Milesian or Ionian School, had offered a solution before him. I therefore conjecture that Anaximander arrived at his theory by criticizing Thales' theory. This conjecture can be supported, I believe, by a consideration of the structure of Anaximander's theory.

Anaximander is likely to have argued against Thales' theory (according to which the Earth was floating on water) on the following lines. Thales' theory is a specimen of a type of theory which if consistently developed would lead to an infinite regress. If we explain the stable position of the Earth by the assumption that it is supported by water – that it is floating on the ocean (Okeanos) – should we not have to explain the stable position of the ocean by an analogous hypothesis? But this would mean looking for a support for the ocean, and then for a support for this support. This method of explanation is unsatisfactory: first, because we solve our problem by creating an exactly analogous one; and also for the less formal and more intuitive reason that in any such system of supports or props, failure to secure any one of the lower props must lead to the collapse of the whole edifice.

From this we see intuitively that the stability of the world cannot be secured by a system of supports or props. Instead Anaximander appeals to the internal or structural symmetry of the world, which ensures that there is no preferred direction in which a collapse can take place. He applies the principle that where there are no differences there can be no change. In this way he explains the stability of the Earth by the equality of its distances from all other things.

This, it seems, was Anaximander's argument. It is important to realize that it abolishes, even though not quite consciously, perhaps, and not quite consistently, the idea of an absolute direction – the absolute sense of 'upwards' and 'downwards'. This is not only contrary to all experience but notoriously difficult to grasp. Anaximenes ignored it, it seems, and even Anaximander himself did not grasp it completely. For the idea of an equal distance from all other things should have led him to the theory that the Earth has the shape of a globe. Instead he believed that it had the shape of a drum, with an upper and a lower flat surface. Yet it looks as if the

remark, 'We walk on one of its flat surfaces, while the other is on the opposite side' [A 11], contained a hint that there was no absolute upper surface, but that on the contrary the surface on which we happened to walk was the one we might *call* the upper.

What prevented Anaximander from arriving at the theory that the Earth was a globe rather than a drum? There can be little doubt: it was *observational experience* which taught him that the surface of the Earth was, by and large, flat. Thus it was a speculative and critical argument, the abstract critical discussion of Thales' theory, which almost led him to the true theory of the shape of the Earth; and it was observational experience which led him astray.

V

There is an obvious objection to Anaximander's theory of symmetry, according to which the Earth is equally distant from all other things. The asymmetry of the universe can be easily seen from the existence of Sun and Moon, and especially from the fact that Sun and Moon are sometimes not far distant from each other, so that they are on the same side of the Earth, while there is nothing on the other side to balance them. It appears that Anaximander met this objection by another bold theory – his theory of the hidden nature of the Sun, the Moon, and the other heavenly bodies.

He envisages the rims of two huge chariot wheels rotating round the Earth, one 27 times the size of the Earth, the other 18 times its size. Each of these rims or circular pipes is filled with fire, and each has a breathing-hole through which the fire is visible. These holes we call the Sun and the Moon respectively. The rest of the wheel is invisible, presumably because it is dark (or misty) and far away. The fixed stars (and presumably the planets) are also holes on wheels which are nearer to the Earth than the wheels of the Sun and the Moon. The wheels of the fixed stars rotate on a common axis (which we now call the axis of the Earth) and together they form a sphere round the Earth, so the postulate of equal distance from the Earth is (roughly) satisfied. This makes Anaximander also a founder of the *theory of the spheres*. (For its relation to the wheels or circles see Aristotle *De Caelo* 289b10–290b10.)

VI

There can be no doubt whatever that Anaximander's theories are critical and speculative rather than empirical: and considered as approaches to truth, his critical and abstract speculations served him better than observational experience or analogy.

But, a follower of Bacon may reply, this is precisely why Anaximander was not a scientist. This is precisely why we speak of early Greek *philosophy*

rather than of early Greek *science*. Philosophy is speculative: everybody knows this. And as everybody knows, science begins only when the speculative method is replaced by the observational method, and when deduction is replaced by induction.

This reply, of course, amounts to the thesis that, by definition, theories are (or are not) *scientific* according to their origin in observations, or in so-called 'inductive procedures'. Yet I believe that few, if any, physical theories would fall under this definition. And I do not see why the question of origin should be important in this connection. What is important about a theory is its explanatory power, and whether it stands up to criticism and to tests. The question of its origin, of how it is arrived at – whether by an 'inductive procedure', as some say, or by an act of intuition – may be extremely interesting, especially for the biographer of the man who invented the theory, but it has little to do with its scientific status or character.

VII

As to the Presocratics, I assert that there is the most perfect possible continuity of thought between their theories and the later developments in physics. Whether they are called philosophers, or pre-scientists, or scientists matters very little, I think. But I do assert that Anaximander's theory cleared the way for the theories of Aristarchus, Copernicus, Kepler, and Galileo. It is not that he merely 'influenced' these later thinkers; 'influence' is a very superficial category. I would rather put it like this: Anaximander's achievement is valuable in itself, like a work of art. Besides, his achievement made other achievements possible, among them those of the great scientists mentioned.

But are not Anaximander's theories false, and therefore non-scientific? They are false, I admit; but so are many theories, based upon countless experiments, which modern science accepted until recently, and whose scientific character nobody would dream of denying, even though they are now believed to be false. (An example is the theory that the typical chemical properties of hydrogen belong only to one kind of atom – the lightest of all atoms.) There were historians of science who tended to regard as unscientific (or even as superstitious) any view no longer accepted at the time they were writing; but this is an untenable attitude. A false theory may be as great an achievement as a true one. And many false theories have been more helpful in our search for truth than some less interesting theories which are still accepted. For false theories can be helpful in many ways; they may, for example, suggest some more or less radical modifications, and they may stimulate criticism. Thus Thales' theory that the Earth floats on water reappeared in a modified form in Anaximenes, and in more recent times in the form of Wegener's theory of

continental drift. How Thales' theory stimulated Anaximander's criticism has been shown already.

Anaximander's theory, similarly, suggested a modified theory – the theory of an Earth globe, freely poised in the centre of the universe, and surrounded by spheres on which heavenly bodies were mounted. And by stimulating criticism it also led to the theory that the Moon shines by reflecting light; to the Pythagorean theory of a central fire; and ultimately to the heliocentric world-system of Aristarchus and Copernicus.

VIII

I believe that the Milesians, like their oriental predecessors who took the world for a tent, envisaged the world as a kind of house, the home of all creatures – our home. Thus there was no need to ask what it was for. But there was a real need to inquire into its architecture. The questions of its structure, its ground-plan, and its building material constitute the three main problems of Milesian cosmology. There is also a speculative interest in its origin, the question of cosmogony. It seems to me that the cosmological interest of the Milesians far exceeded their cosmogonical interest, especially if we consider the strong cosmogonical tradition, and the almost irresistible tendency to describe a thing by describing how it has been made, and thus to present a cosmological account in a cosmogonical form. The cosmological interest must be very strong, as compared with the cosmogonical one, if the presentation of a cosmological theory is even partially free from these cosmogonical trappings.

I believe that it was Thales who first discussed the architecture of the cosmos – its structure, ground-plan, and building material. In Anaximander we find answers to all three questions. I have briefly mentioned his answer to the question of structure. As to the question of the ground-plan of the world, he studied and expounded this too, as indicated by the tradition that he drew the first map of the world. And of course he had a theory about its building material – the 'endless' or 'boundless' or 'unbounded' or 'unformed' – the *apeiron*.

In Anaximander's world all kinds of *changes* were going on. There was a fire which needed air and breathing-holes, and these were at times blocked up ('obstructed'), so that the fire was smothered: ³ this was his theory of eclipses, and of the phases of the Moon. There were winds, which were responsible for the changing weather.⁴ And there were the vapours, resulting from the drying up of water and air, which were the cause of the winds and of the 'turnings' of the Sun (the solstices) and of the Moon.

We have here the first hint of what was soon to come: of the *general problem of change*, which became the central problem of Greek cosmology, and which ultimately led, with Leucippus and Democritus, to a *general theory of change* that was accepted by modern science almost up to the

beginning of the twentieth century. (It was given up only with the breakdown of Maxwell's models of the ether, a historic event that was little noticed before 1905.)

This *general problem of change* is a philosophical problem; indeed in the hands of Parmenides and Zeno it almost turns into a logical one. *How is change possible* – logically possible, that is? How can a thing change, without losing its identity? If it remains the same, it does not change; yet if it loses its identity, then it is no longer that thing which has changed.

IX

The exciting story of the development of the problem of change appears to me in danger of being completely buried under the mounting heap of the minutiae of textual criticism. The story cannot, of course, be fully told in one short paper, and still less in one of its many sections. But in briefest outline, it is this.

For Anaximander, our own world, our own cosmic edifice, was only one of an infinity of worlds – an infinity without bounds in space and time. This system of worlds was eternal, and so was motion. There was thus no need to explain motion, no need to offer a *general* theory of change (in the sense in which we shall find a general problem and a general theory of change in Heraclitus; see below). But there was a need to explain the well-known changes occurring in our world. The most obvious changes – the change of day and night, of winds and of weather, of the seasons, from sowing to harvesting, and of the growth of plants and animals and men – all were connected with the contrast of temperatures, with the opposition between the hot and the cold, and with that between the dry and the wet. 'Living creatures came into being from moisture evaporated by the Sun', we are told [A 11]; and the hot and the cold also administer to the genesis of our own world edifice. The hot and the cold were also responsible for the vapours and winds, which in their turn were conceived as the agents of almost all other changes.

Anaximenes, a pupil of Anaximander and his successor, developed these ideas in much detail. Like Anaximander he was interested in the oppositions of the hot and the cold and of the moist and the dry, and he explained the transitions between these opposites by a theory of condensation and rarefaction. Like Anaximander he believed in eternal motion and in the action of the winds; and it seems not unlikely that one of the two main points in which he deviated from Anaximander was reached by a criticism of the idea that what was completely boundless and formless (the *apeiron*) could yet be in motion. At any rate, he replaced the *Apeiron* by *Air* – something that was almost boundless and formless, and yet, according to Anaximander's old theory of vapours, not only capable of motion, but the main agent of motion and change. A similar unification of ideas was

achieved by Anaximenes' theory that 'the Sun consists of earth, and that it gets very hot owing to the rapidity of its motion' [A 6]. The replacement of the more abstract theory of the unbounded *Apeiron* by the less abstract and more common-sense theory of air is matched by the replacement of Anaximander's bold theory of the stability of the Earth by the more common-sense idea that the Earth's 'flatness is responsible for its stability; for it . . . covers like a lid the air beneath it' [A 20]. Thus the Earth rides on air as the lid of a pot may ride on steam, or as a ship may ride on water; Thales' question and Thales' answer are both reinstated, and Anaximander's epoch-making argument is not understood. Anaximenes is an eclectic, a systematizer, an empiricist, a man of common sense. Of the three great Milesians he is least productive of revolutionary new ideas; he is the least philosophically minded.

The three Milesians all looked on our world as our home. There was movement, there was change in this home, there was hot and cold, fire and moisture. There was a fire in the hearth, and on it a kettle with water. The house was exposed to the winds, and a bit draughty, to be sure; but it was home, and it meant security and stability of a sort. But for Heraclitus the house was on fire.

There was no stability left in the world of Heraclitus. 'Everything is in flux, and nothing is at rest.' *Everything* is in flux, even the beams, the timber, the building material of which the world is made: earth and rocks, or the bronze of a cauldron – they are all in flux. The beams are rotting, the earth is washed away and blown away, the very rocks split and wither, the bronze cauldron turns into green patina, or into verdigris: 'All things are in motion all the time, even though . . . this escapes our senses', as Aristotle expressed it. Those who do not know and do not think believe that only the fuel is burned, while the bowl in which it burns (cp. DK A1) remains unchanged; for we do not see the bowl burning. And yet it burns; it is eaten up by the fire it holds. We do not *see* our children grow up, and change, and grow old, but they do.

Thus there are no solid bodies. Things are not really things, they are processes, they are in flux. They are like fire, like a flame which, though it may have a definite shape, is a process, a stream of matter, a river. All things are flames: *Fire* is the very building material of our world; and the apparent stability of things is merely due to the laws, the measures, which the processes in our world are subject to.

This, I believe, is Heraclitus' story; it is his 'message', the 'true word' (the *logos*), to which we ought to listen: 'Listening not to me but to the true account, it is wise to admit that all things are one': they are 'an everlasting fire, flaring up in measures, and dying down in measures'.

I know very well that the traditional interpretation of Heraclitus' philosophy here restated is not generally accepted at present. But the critics have put nothing in its place – nothing, that is, of philosophical

interest. I shall briefly discuss their new interpretation in the next section. Here I wish only to stress that Heraclitus' philosophy, by appealing to thought, to the word, to argument, to reason, and by pointing out that we are living in a world of things whose changes escape our senses, though we *know* that they do change, created two new problems: *the problem of change* and *the problem of knowledge*. These problems were the more urgent as his own account of change was difficult to understand. But this, I believe, is due to the fact that he saw more clearly than his predecessors the difficulties that were involved in the very idea of change.

For all change is the change of something: change presupposes something that changes. And it presupposes that, while changing, this something must remain the same. We may say that a green leaf changes when it turns brown; but we do not say that the green leaf changes when we substitute for it a brown leaf. It is essential to the idea of change that the thing which changes retains its identity while changing. And yet it must become something else: it was green, and it becomes brown; it was moist, and it becomes dry; it was hot, and it becomes cold.

Thus every change is the transition of a thing into something with, in a way, opposite qualities (as Anaximander and Anaximenes had seen). And yet, while changing, the changing thing must remain identical with itself.

This is the problem of change. It led Heraclitus to a theory which (partly anticipating Parmenides) distinguishes between reality and appearance. 'The real nature of things loves to hide itself. An unapparent harmony is stronger than the apparent one' [B 123]. Things are *in appearance* (and for us) opposites, but in truth (and for God) they are the same.

Life and death, being awake and being asleep, youth and old age, all these are the same . . . for the one turned round is the other and the other turned round is the first. . . . The path that leads up and the path that leads down are the same path. . . . Good and bad are identical. . . . For God all things are beautiful and good and just, but men assume some things to be unjust, and others to be just. . . . It is not in the nature or character of man to possess true knowledge, though it is in the divine nature [B 88, 60, 58, 102, 78].

Thus in truth (and for God) the opposites are identical; it is only to man that they appear as non-identical. And all things are one – they are all part of the process of the world, the everlasting *Fire*.

This theory of change appeals to the 'true word', to the *logos*, to reason; nothing is more real for Heraclitus than change. Yet his doctrine of the oneness of the world, of the identity of opposites, and of appearance and reality threatens his doctrine of the reality of change.

For change is the transition from one opposite to the other. Thus if in truth the opposites are identical, though they appear different, then change

itself might be only apparent. If in truth, and for God, all things are one, there might, in truth, be no change.

This consequence was drawn by Parmenides, the pupil (*pace* Burnet and others) of the monotheist Xenophanes, who said of the one God (DK B23; 26; 25; and 24):

One God, alone among gods and alone among men is the greatest.
 Neither in body nor in mind does he resemble the mortals.
 Always in one place he remains, without ever moving,
 Nor is it fitting for him to wander now hereto now thereto.
 Effortless he swings the All, by mere thought and intention.
 All of him is sight; all is knowledge; and all is hearing.

Xenophanes' pupil Parmenides taught that the real world was one, and that it always remained in the same place, never moving. It was not *fitting* that it should go to different places at different times. It was in no way similar to what it appeared to be to mortal men. The world was one, an undivided whole, without parts, homogeneous and motionless: motion was impossible in such a world. In truth there was no change. The world of change was an illusion.

Parmenides based this theory of an unchanging reality on something like a logical proof; a proof which can be presented as proceeding from the single premise, 'What is not is not'. From this we can derive that the nothing – that which is not – does not exist; a result which Parmenides interprets to mean that the void does not exist. Thus the world is full: it consists of one undivided block, since any division into parts could only be due to separation of the parts by the void. (This is 'the well-rounded truth' which the goddess revealed to Parmenides, B1: 29.) In this full world there is no room for motion.

Only the delusive belief in the reality of opposites – the belief that not only *what is* exists but also *what is not* – leads to the illusion of a world of change.

Parmenides' theory may be described as the first hypothetico-deductive theory of the world. The atomists took it as such; and they asserted that it was refuted by experience, since motion does exist. Accepting the formal validity of Parmenides' argument, they inferred from the falsity of his conclusion the falsity of his premise. But this meant that the nothing – the void, or empty space – existed. Consequently there was now no need to assume that 'what is' – the full, that which fills some space – had no parts; for its parts could now be separated by the void. Thus there are many parts, each of which is 'full': there are full particles in the world, separated by empty space, and able to move in empty space, each of them being 'full', undivided, indivisible, and unchanging. Thus what exists is *atoms and the void*. In this way the atomists arrived at a *theory of change* – a theory

that dominated scientific thought until 1900. It is the theory that *all change, and especially all qualitative change, has to be explained by the spatial movement of unchanging bits of matter – by atoms moving in the void.*

The next great step in our cosmology and the theory of change was made when Maxwell, developing certain ideas of Faraday's, replaced this theory by a theory of changing intensities of fields.

X

I have sketched the story, as I see it, of the Presocratic theory of change. I am, of course, well aware of the fact that my story (which is based on Plato, Aristotle, and the doxographic tradition) clashes at many points with the views of some experts, English as well as German, and especially with the views expressed by G. S. Kirk and J. E. Raven in their book *The Presocratic Philosophers*, Cambridge, 1957. I cannot, of course, examine their arguments in detail here, and especially not their minute exegeses of various passages, some of which are relevant to the differences between their interpretation and mine. (See, for example, Kirk and Raven's discussion of the question whether there is a reference to Heraclitus in Parmenides; cp. their note 1 on pp. 193f., and note 1 on p. 272.) But I wish to say that I have examined their arguments and that I have found them unconvincing and often quite unacceptable.

I will mention here only some points regarding Heraclitus (although there are other points of equal importance, such as their comments on Parmenides).

The traditional view, according to which Heraclitus' central doctrine was that all things are in flux, was attacked forty years ago by Burnet. His main argument (discussed by me at length in note 2 of ch. 2 of my *Open Society*) was that the theory of change was not new, and that only a new message could explain the urgency with which Heraclitus speaks. This argument is repeated by Kirk and Raven when they write (pp. 186f.): 'But all Presocratic thinkers were struck by the predominance of change in the world of our experience.' About this attitude I said in my *Open Society*: 'Those who suggest . . . that the doctrine of universal flux was not new . . . are, I feel, unconscious witnesses to Heraclitus' originality, for they fail now, after 2,400 years, to grasp his main point.' In brief, they do not see the difference between the Milesian message, 'There is a fire in the house', and Heraclitus' somewhat more urgent message, 'The house is on fire.' An implicit reply to this criticism can be found on p. 197 of the book by Kirk and Raven, where they write: 'Can Heraclitus really have thought that a rock or a bronze cauldron, for example, was invariably undergoing invisible changes of material? Perhaps so; but nothing in the extant fragments suggests that he did.' But is this so? Heraclitus' extant fragments about the *Fire* (Kirk and Raven, fragm. 220–2) are interpreted by

Kirk and Raven themselves as follows (p. 200): 'Fire is the archetypal form of matter.' Now, I am not at all sure what 'archetypal' means here (especially in view of the fact that we read a few lines later, 'Cosmogony . . . is not to be found in Heraclitus'). But whatever 'archetypal' may mean, it is clear that once it is admitted that Heraclitus says in the extant fragments that all matter is somehow (whether archetypally or otherwise) fire, he also says that all matter, like fire, is a process; which is precisely the theory denied to Heraclitus by Kirk and Raven.

Immediately after saying that 'nothing in the extant fragments suggests' that Heraclitus believed in continuous invisible changes, Kirk and Raven make the following methodological remark: 'It cannot be too strongly emphasized that [in texts] before Parmenides and his apparent proof that the senses were completely fallacious . . . gross departures from common sense must only be accepted when the evidence for them is extremely strong.' This is intended to mean that the doctrine that bodies (of any substance) constantly undergo invisible changes represents a gross departure from common sense, a departure which one ought not to expect in Heraclitus.

But to quote Heraclitus: 'He who does not expect the unexpected will not detect it: for him it will remain undetectable, and unapproachable' (DK B18). In fact Kirk and Raven's last argument is invalid on many grounds. Long before Parmenides we find ideas far removed from common sense in Anaximander, Pythagoras, Xenophanes, and especially in Heraclitus. Indeed the suggestion that we should test the historicity of the ideas ascribed to Heraclitus – as we might indeed test the historicity of those ascribed to Anaximenes – by standards of 'common sense' is a little surprising (whatever 'common sense' may mean here). For this suggestion runs counter not only to Heraclitus' notorious obscurity and oracular style, confirmed by Kirk and Raven, but also to his burning interest in antinomy and paradox. And it runs counter, last but not least, to the (in my view quite absurd) doctrine which Kirk and Raven finally attribute to Heraclitus (the italics are mine): 'that natural changes of all kinds [and thus presumably also earthquakes and great fires] are regular *and balanced*, and *that the cause of this balance is fire, the common constituent of things that was also termed their Logos*'. But why, I ask, should fire be 'the cause' of any balance – either 'this balance' or any other? And where does Heraclitus say such things? Indeed, had this been Heraclitus' philosophy, then I could see no reason to take any interest in it; at any rate, it would be much further removed from common sense (as I see it) than the inspired philosophy which tradition ascribes to Heraclitus and which, in the name of common sense, is rejected by Kirk and Raven.

But the decisive point is, of course, that this inspired philosophy is *true*, for all we know.⁵ With his uncanny intuition Heraclitus saw that things are processes, that our bodies are flames, that 'a rock or a bronze cauldron

... was invariably undergoing invisible changes'. Kirk and Raven say (p. 197, note 1; the argument reads like an answer to Melissus): 'Every time the finger rubs, it rubs off an invisible portion of iron; yet when it does not rub, what reason is there to think that the iron is still changing?' The reason is that the wind rubs, and that there is always wind; or that iron turns invisibly into rust – by oxidation, and this means by slow burning; or that old iron looks different from new iron, just as an old man looks different from a child (cp. DK B88). This was Heraclitus' teaching, as the extant fragments show.

I suggest that Kirk and Raven's methodological principle 'that gross departures from common sense must only be accepted when the evidence for them is extremely strong' might well be replaced by the clearer and more important principle that *gross departures from the historical tradition must only be accepted when the evidence for them is extremely strong*. This, in fact, is a universal principle of historiography. Without it history would be impossible. Yet it is constantly violated by Kirk and Raven: when, for example, they try to make Plato's and Aristotle's evidence suspect, with arguments which are partly circular and partly (like the one from common sense) in contradiction to their own story. And when they say that 'little serious attempt seems to have been made by Plato and Aristotle to penetrate his [i.e. Heraclitus'] real meaning', then I can only say that the philosophy outlined by Plato and Aristotle seems to me a philosophy that has real meaning and real depth. It is a philosophy worthy of a great philosopher. Who, if not Heraclitus, was the great thinker who first realized that men are flames and that things are processes? Are we really to believe that this great philosophy was a 'post-Heraclitean exaggeration' (p. 197), and that it may have been suggested to Plato, 'in particular, perhaps, by Cratylus'? Who, I ask, was this unknown philosopher – perhaps the greatest and the boldest thinker among the Presocratics? Who was he, if not Heraclitus?

XI

The early history of Greek philosophy, especially the history from Thales to Plato, is a splendid story. It is almost too good to be true. In every generation we find at least one new philosophy, one new cosmology of staggering originality and depth. How was this possible? Of course one cannot explain originality and genius. But one can try to throw some light on them. What was the secret of the ancients? I suggest that it was a *tradition – the tradition of critical discussion*.

I will try to put the problem more sharply. In all or almost all civilizations we find something like religious and cosmological teaching, and in many societies we find schools. Now schools, especially primitive schools, all have, it appears, a characteristic structure and function. Far from being places of critical discussion they make it their task to impart a

definite doctrine, and to preserve it, pure and unchanged. It is the task of a school to hand on the tradition, the doctrine of its founder, its first master, to the next generation, and to this end the most important thing is to keep the doctrine inviolate. A school of this kind never admits a new idea. New ideas are heresies, and lead to schisms; should a member of the school try to change the doctrine, then he is expelled as a heretic. But the heretic claims, as a rule, that his is the true doctrine of the founder. Thus not even the inventor admits that he has introduced an invention; he believes, rather, that he is returning to the true orthodoxy which has somehow been perverted.

In this way all changes of doctrine – if any – are surreptitious changes. They are all presented as restatements of the true sayings of the master, of his own words, his own meaning, his own intentions.

It is clear that in a school of this kind we cannot expect to find a history of ideas, or even the material for such a history. For new ideas are not admitted to be new. Everything is ascribed to the master. All we might reconstruct is a history of schisms, and perhaps a history of the defence of certain doctrines against the heretics.

There cannot, of course, be any rational discussion in a school of this kind. There may be arguments against dissenters and heretics, or against some competing schools. But in the main it is with assertion and dogma and condemnation rather than argument that the doctrine is defended.

The great example of a school of this kind among the Greek philosophical schools is the Italian School founded by Pythagoras. Compared with the Ionian School, or with that of Elea, it had the character of a religious order, with a characteristic way of life and a secret doctrine. The story that a member, Hippasus of Metapontum, was drowned at sea because he revealed the secret of the irrationality of certain square roots is characteristic of the atmosphere surrounding the Pythagorean School, whether or not there is any truth in this story.

But among Greek philosophical schools the early Pythagoreans were an exception. Leaving them aside, we could say that the character of Greek philosophy, and of the philosophical schools, is strikingly different from the dogmatic type of school here described. I have shown this by an example: *the story of the problem of change which I have told is the story of a critical debate, of a rational discussion*. New ideas are propounded as such, and arise as the result of open criticism. There are few, if any, surreptitious changes. Instead of anonymity we find a history of ideas and of their originators.

Here is a unique phenomenon, and it is closely connected with the astonishing freedom and creativeness of Greek philosophy. How can we explain this phenomenon? *What we have to explain is the rise of a tradition*. It is a tradition that allows or encourages critical discussions between various schools and, more surprisingly still, within one and the same school. For

nowhere outside the Pythagorean School do we find a school devoted to the preservation of a doctrine. Instead we find changes, new ideas, modifications, and outright criticism of the master.

(In Parmenides we even find, at an early date, a most remarkable phenomenon – that of a philosopher who propounds *two* doctrines, one which he says is true, and one which he himself describes as false. Yet he makes the false doctrine not simply an object of condemnation or of criticism; rather he presents it as the best possible account of the delusive opinion of mortal men, and of the world of mere appearance – the best account which a mortal man can give.)

How and where was this critical tradition founded? This is a problem deserving serious thought. This much is certain: Xenophanes, who brought the Ionian tradition to Elea, was fully conscious of the fact that his own teaching was purely conjectural, and that others might come who would know better. I shall come back to this point again in my next and last section.

If we look for the first signs of this new critical attitude, this new freedom of thought, we are led back to Anaximander's criticism of Thales. Here is a most striking fact: Anaximander criticizes his master and kinsman, one of the Seven Sages, the founder of the Ionian School. He was, according to tradition, only about fourteen years younger than Thales, and he must have developed his criticism and his new ideas while his master was alive. (They seem to have died within a few years of each other.) But there is no trace in the sources of a story of dissent, of any quarrel, or of any schism.

This suggests, I think, that it was Thales who founded the new tradition of freedom – based upon a new relation between master and pupil – and who thus created a new type of school, utterly different from the Pythagorean School. He seems to have been able to tolerate criticism. And what is more, he seems to have created the tradition that one ought to tolerate criticism.

Yet I like to think that he did even more than this. I can hardly imagine a relationship between master and pupil in which the master merely tolerates criticism without actively encouraging it. It does not seem to me possible that a pupil who is being trained in the dogmatic attitude would ever dare to criticize the dogma (least of all that of a famous sage) and to voice his criticism. And it seems to me an easier and simpler explanation to assume that the master encouraged a critical attitude; possibly not from the outset, but only after he was struck by the pertinence of some questions, asked by the pupil perhaps without any critical intention.

However this may be, the conjecture that Thales actively encouraged criticism in his pupils would explain the fact that the critical attitude towards the master's doctrine became part of the Ionian School tradition. I

like to think that Thales was the first teacher who said to his pupils: 'This is how I see things – how I believe that things are. Try to improve upon my teaching.' (Those who believe that it is 'unhistorical' to attribute this undogmatic attitude to Thales may again be reminded of the fact that only two generations later we find a similar attitude consciously and clearly formulated in the fragments of Xenophanes.) At any rate, there is the historical fact that the Ionian School was the first in which pupils criticized their masters, in one generation after the other. There can be little doubt that the Greek tradition of philosophical criticism had its main source in Ionia.

It was a momentous innovation. It meant a break with the dogmatic tradition which permits only *one* school doctrine, and the introduction in its place of a tradition that admits a *plurality* of doctrines which all try to approach the truth by means of critical discussion.

It thus leads, almost by necessity, to the realization that our attempts to see and to find the truth are not final, but open to improvement; that our knowledge, our doctrine, is conjectural; that it consists of guesses, of hypotheses, rather than of final and certain truths; and that criticism and critical discussion are our only means of getting nearer to the truth. It thus leads to the tradition of bold conjectures and of free criticism, the tradition which created the rational or scientific attitude, and with it our Western civilization, the only civilization which is based upon science (though, of course, not upon science alone).

In this rationalist tradition bold changes of doctrine are not forbidden. On the contrary, innovation is encouraged, and is regarded as success, as improvement, if it is based on the result of a critical discussion of its predecessors. The very boldness of an innovation is admired; for it can be controlled by the severity of its critical examination. This is why changes of doctrine, far from being made surreptitiously, are traditionally handed down together with the older doctrines and the names of the innovators. And the material for a history of ideas becomes part of the school tradition.

To my knowledge the critical or rationalist tradition was invented only once. It was lost after two or three centuries, perhaps owing to the rise of the Aristotelian doctrine of *epistēmē*, of certain and demonstrable knowledge (a development of the Eleatic and Heraclitean distinction between certain truth and mere guesswork). It was rediscovered and consciously revived in the Renaissance, especially by Galileo Galilei.

XII

I now come to my last and most central contention. It is this. The rationalist tradition, the tradition of critical discussion, represents the only practicable way of expanding our knowledge – conjectural or hypothetical knowledge, of course. There is no other way. More especially,