EARLY GREEK WORLD; the PRE-SOCRATIC PHILOSOPHERS

For reasons which are not at all clear, the roots of modern science really lie in the philosophical schools which developed in Ancient Greece, and which in turn led to a remarkable flowering of mathematics at this time. Not all of the essential ingredients of modern science were then available (in particular, it was to be another 2000 yrs before the importance of experiment was to be realised), but many of the most important ones were. Probably the most important contribution of the Greek philosophers was to divorce speculative inquiry from religion, to emphasize the open-ended nature of this kind of inquiry, and to develop a methodology of inquiry which is still the basis of much of modern science. Note that technological accomplishment was in no way important for this- indeed, the example of Chinese civilisation (which for 3,000 yrs was many centuries ahead of the West in most technological spheres) shows this very clearly. What was crucial in the development of Greek philosophy and early science and mathematics was the idea of unfettered theoretical speculation.

(i) REMARKS on ANCIENT GREEK SOCIETY

These remarks will be very brief. After the end of the Mycenean civilisation (around 1200 BC) a kind of "Dark Age", about which we know little, came down on the emergent Greek (Dorian and Ionian) peoples, from which they began to emerge some time before Homer (c. 750 BC). Amongst the most important features of this re-emergence were a history of slow expansion of the Greeks over the period from 800-500 BC, to colonize large areas around the Mediterranean and in the Black Sea coastline (cf Map on slides). These can be thought of as small trading centres, and small city states- although some of them became quite big (eg., Miletus, Chalcius, Eritrea, Corinth, Megara, Phocaea, etc). At the time of Thales (c. 580 BC), Miletus was an important city-state. Many of these are still extant and have even grown to great cities (eg., Byzantium, Syracusa, or Massilia (Marseilles) or Neapolis (Naples)). Thus by 550 BC important colonies existed in Sicily and Southern Italy (Magna Grecia), Thrace, and the "Exxine Sea" (Black Sea), and even beyond. This coastline civilisation lived alongside the trading civilisation of the Phoenicians, based initially in the Middle East (Tyre, Sidon, etc), and later in Carthage and the Cartheginian empire (founded 810 BC).

Around 500 BC the rise of the Persian empire created a threat to many of the Mediterranean civilisations. After initial defeats (eg., at the famous battle of Thermopylae), the Greeks actually succeeded in beating off the Persians. After this the great 'Golden Age' in Athenian history. However in 431 BC the Pelopponesian War between Sparta and Athens began, and raged until the victory of Sparta in 404 BC. After this the power and influence of Athens was eclipsed. It might well have been forgotten if not for Alexander the Great, who by conquering vast stretches of the Middle East and Asia as far as India, would vastly extend Greek influence and knowledge of Greek ideas, and ensure that Hellenistic ideas did not completely die out after the fall of the Greek and Roman empires.

The Greek religion was heavily mystical, and prehistoric in origin. Each city had its local gods and other deities, and there were many local cults, with their attendant myths, oracles, and rituals (including ritual human or animal sacrifice). There was no concept of SIN as modern Christians know this- the worst possible fault was excessive pride (HUBRIS), which was punishable by NEMESIS. The Greeks admired, amongst other things-

-Competition (games, sport, etc), in the right spirit (cf. 1st Olympiad in 776 BC- which ran every 4 yrs until 385 AD; to be revived again 1896 AD)
-Courage and Enterprise
-Music (cf the Orphic cult beginning 7th Century BC)
-Learning and Wisdom (cf Apollonian cult)
-Mystic Insight (this is seen in many aspects of Greek life and legend)

The relationship between the Apollonian ideal of wisdom and the Dionysian mystical and orgiastic cult was well embodied in the myths and cult surrounding the oracle at Delphi. By legend this began when Apollo killed the god Python, and established the oracle. Delphi was supposed to mark the spot where the "Omphalos" (navel stone) or exact centre of the World was situated. On the 7th day of every month the high priestess (Pythia) of the oracle would sit on a tripod above a gaseous chasm in a cave, and in a trance would await enquiries. This oracle had a major influence on Greek events for many centuries. Some held that Apollo only held sway in the summer, relinquishing Delphi for the winter to Dionysius.

The feeling of a "Greek identity" dates from the Persian wars, which occured initially during the reign of Cyrus the Great (from 558-529 BC). The battles of Marathon (490 BC), and Thermopylae (480 BC) are described in great detail in Greek history and theatre, sometimes by participants (eg., Aeschylus, who fought at Marathon). The ideals

supposed to be Greek were of Liberty, freedom, and democracy (NB- note that these were ideals applying to the small free fraction of the population, ie., not the slaves or any visiting "barbarians"). The period between the end of these wars and the murderous Peloponnesian war (mainly between Athens and Sparta), from 431-404 BC, is sometimes called the "Golden Age" of Athens. Note that a young Plato lived through this war, and an old Socrates was executed at the end of it.

To live in Greece then was to live in a region dominated by the sea, by a harsh landscape, and by weather unremittedly sunny in the summer but with occasionally violent storms in the winter. Even now the light in the Greek islands is famous for its clarity, and the sea for its limpidity. The land was forested (pines, poplars) in mountainous areas (of which there were many), but deforestation was a big problem even then. Olives, grapes, etc., were cultivated along with goats. If one can imagine California scattered into islands, or the Gulf Islands and Vancouver Island moved quite a way south, this gives a vague idea.

LITERATURE: Although Homer did not write the first Epics (Gilgamesh from Assyria was earlier), the Iliad and Odysseus are certainly crucial to the development of Western literature. A whole slew of poets followed: Hesiod (c. 700 BC), Xenophanes (c. 570-480) Sappho (612-), Pindar (518-438) Simonides (556-468), Theocritus (300-260), etc. Poetry and Music were intimately connected- a common instrument was the 7-stringed lyre. Great playwrights such as Aeschylus (525-456 BC), Sophocles (496-406 BC), and Europedes (480-406 BC) founded the modern theatre as we know it,more or less. Thus was tribal myth and legend, plus a dose of history, politics, and tragedy, turned to dramatic art and literature. Comedy emerged in, eg., the work of Aristophanes (450-385 BC).

Connected with all of this was the development of a tradition, both in the theatre and in oratory, which we now associate with the Greeks (so that when Humanism emerged during the Renaissance, with people like Erasmus, they looked to the Greeks for inspiration and guidance). This tradition was also emergent in the art of Rhetoric- which was associated with a profession in those days, as well as written guides by people like Corax of Syracuse or Demosthenes (384-322 BC). Rhetoric was employed in courts and political assemblies- and to the dislike of Athenians, by Socrates in his philosophical teaching.

ART and ARCHITECTURE: For some of this see the slides. The development of sculpture was quite extraordinary, so that by the 3rd century BC one sees "naturalistic" sculpture in full flow, with the problems of dynamic form largely solved, and quite extraordinary compositions. These appeared in bronze (almost none of this is left, except a few rare finds), in stone and in pottery, and the occasional frieze or wall-painting. You are referred to books for more details on all of this. The same is true of architecture- it is clear that this embodied not only a remarkable engineering expertise, but also ideas about the aesthetic quality of certain forms that were developed partly in conjunction with mathematical ideas (cf., the Golden Mean). For details go to books.

(ii) REMARKS on PRE-SOCRATIC PHILOSOPHERS

For our purposes the most important thing about the pre-Socratics is the extent to which they anticipated both the later Greek ideas (indeed, the ideas of Plato started from those of some of these, notably from Heraclitus and Parmenides on the philosophical side, and the earlier Greek work in mathematics). Since much has been written on this I merely summarize what is of relevance to us.

(1) THALES and EMPEDOCLES: The important idea that has survived from these two is that of "elements" (they both had many other achievements to their credit). For Thales everything in the material world was some form of water. Empedocles on the other hand required 4 fundamental elements- fire, earth, water, and air. The motivating force that brought combinations of these together or drove them apart were "Love" and "Strife". Both ideas still have their adherents today!

The question is what led them to this important idea. Thales (and later pre-Socratics such as Anaximenes, who wanted air instead of water) searched for a single fundamental element, presumably in a search for some kind of all-embracing unity. On the other hand Empedocles proceeded from the observation (i) that one could put, eg., water and air together without them mixing (NB- not entirely true!), and (ii) one had somehow to explain how one could get so many different materials and forms (often by mixing them), that the natural hypothesis was that there were several elements. The choice of fire, water, earth, and air was presumably made on the basis of observations of different changes taking place.

The interesting thing, from our point of view, is that one is dealing with empirical propositions based to some extent on a observations about the world. Thus we are talking about the act of "hypothesizing" about the world, in a pre-scientific way.

Other interesting ideas to come from Empedocles included the hypothesis that the earth was a sphere (or a drum-head) in shape.

(2) HERACLITUS: Almost nothing original survives from Heraclitus, but the crucial idea we are interested in is his attempt to deal with the obvious fact that in the world we are aware of, everything seems to be changing in one way or another. Heraclitus regarded this dynamic quality as fundamental rather than illusory- in some sense it showed that instability was basic to the world. He then argued that if there was a fundamental "stuff" it was fire- and this apparently because it was the means by which things were transformed from one form to another. The ideas are difficult because expressed in the form of aphorisms, such as "All things come out of the one, and the one out of all things"; or as paraphrased by Plato, "nothing ever is, everything is becoming". The basic point, however, is to explain how there can be a fundamental and unchanging stuff if we have no evidence for it.

(3) PARMENIDES: The important argument for us is that leading to the idea that the universe is "One", an indivisible and infinite which is present everywhere (NB: this idea was expressed in verse, in a poem called "On Nature"). The basic Metaphysical argument leading to this is that anything that can be thought of must exist- that the objects of all our ideas must be real. Moreover, since we can think of them at any time, they must always exist. Thus there can be no change, since this would involve objects coming and going. By the same argument one thing cannot change into another. From this point of view change must be illusory.

Parmenides went further than this by noting that "nothing" could not exist- this then leads to the conclusion that there can be no void anywhere, and that all of space must be filled. Apparently he thought that this was consistent with the idea of no change, in that the filling of all space prevented movement (NB, in one sense this is incorrect- an incompressible fluid can move).

The idea that all reality was One appears to have then proceeded from the observation that the world of "appearances" seems to be in a constant state of flux (cf Heraclitus). To solve this one supposes that all changes must then be apparent changes in some underlying "One". It is not a great linguistic jump to see in this the idea of an indestructible "substance".

The importance of all of this lies in the argumentation- an attempt to derive general properties of the world through logical argument. Nowadays we might wish to call into question the attempt to extrapolate from the structure of language to statements about the nature of the world- just because we think of something is not perhaps a good argument for its existence.

(4) THE ATOMISTS: Atomists like Democritus and Leucippus before him did a number of things (eg., Democritus made some mathematical discoveries) but the idea for which they are most important is that of atoms. Briefly, this philosophy argues that the world was made of atoms, which moved in empty space. There were apparently an infinite number of them, which differed in size and shape (although this argument is not completely clear). They were physically indivisible (but, apparently, not geometrically indivisible- this is the part that is unclear). They were also indestructible and unchanging. They moved but it is not clear if the Greeks made the connection to heat (certainly Aristotle did not, since he felt that different atoms were at different temperatures according to their shape). Whether they had weight is unclear in the original theory (Aristotle gave them this as well); apparently Democritus said that there was no up or down in the void, comparing the motion of atoms to that of dust in a sunbeam.

Interestingly, collections of atoms were supposed to interact via collisions, and their collective motion could form vortices. It is clear that the Atomists must have had a sophisticated idea of how one could build up complex structures using collections if atoms, including crystalline solids. They believed that thought and perception are both mechanical processes involving atomic motions. Moreover qualities like colour, warmth, etc., were not intrinsic properties of objects but depended also on our sense perceptions; whereas apparently hardness, weight, etc., depended on how the atoms were arranged, ie., on the atoms themselves.

This theory is quite remarkable for several reasons. There were obvious problems for other philosophers- in its attempt to bridge the gap between plural theories like those of Empedocles and the monism of Parmenides, they offended everyone, by substituting an idea which contradicted all of the others, and did not apparently answer any of the questions raised by them. Their answer to the problem of apparent change was to introduce a void, which Parmenides had specifically denied, for reasons given above. However the theory was able to explain many details of the behaviour of the surrounding world. It had another interesting feature- it was deterministic and seemed not to require any kind of motivating force or "cause" to (eg., Love + Strife) to drive things along. This led to the criticism that it did not explain why things happened. That a more limited "mechanical" explanation could be given of details did not impress those like Aristotle and Plato who felt that they could get to the problem of ultimate causes. The ideas of Aristotle later led western thought down a 1500 year path which attempted to find teleological explanations for the world. There is no doubt that Greek religion and mysticism played a role in this, just as the later influence of the Catholic and other Christian dogmas also sought teleological rather than mechanical explanations.

Democritus et al were surely aware of this defect (the lack of an explanation of "initial causes" or any other kind of cause). But they had found a new way of inquiry- to look for explanation of the details in a *hypothesis* about the structure of the world of appearances. And the style of inquiry was crucial- pursue the hypothesis IN SPITE OF the obvious philosophical problems (eg, the presence of a void), to see how far one could get. Thus they attempted a more

limited goal than that of ultimate truth- their goal was an explanation of the processes in the sensible world around them. From a modern point of view the accuracy of some of their conclusions, even in the details, was quite incredible, and shows that the Greeks were not prevented from arriving at these by any limitations on the experimental methods or tools available to them. Interestingly, Democritus was a thorough-going sceptic when it came to popular religion, and was not convinced of any underlying purpose in the universe.