X

THE ROAD TO KNOWLEDGE

(1) 'APODEIXIS' (DEMONSTRATION)

Preliminary note on the function of apodeixis

'The *Posterior Analytics* is a study of scientific method', wrote Ross, and so most of us thought until Jonathan Barnes proposed that

> the theory of demonstrative science was never meant to guide or formalise scientific research; it is concerned exclusively with the teaching of facts already won; it does not describe how scientists do, or ought to, *acquire* knowledge; it offers a formal model of how teachers should *present and impart* knowledge.[1]

This is to solve what he sees as 'a classical problem in Aristotelian exegesis', namely how to account for the fact that in his own philosophical and scientific work Aristotle does not put the method into practice.[2] The thesis is ably and methodically argued. Having rejected solutions hitherto proposed, and shown that *apodeixis* is sometimes introduced as pedagogic in intention, he passes to *equating* it with pedagogic arguments (p. 82), and almost traps the reader into suspecting him of arguing that because some A is B, all B is A (some instruction is imparted through *apodeixis*, therefore all *apodeixis* is pedagogic) before, with three quarters of the paper written, he turns to his positive evidence that *apodeixis* was not *also* a method of research.

He may be right, but I am not convinced. A primary method of teaching is dialectic, as the *Topics* makes clear. Is it only prejudice that makes it seem impossible that a man who had still so much of the Socratic in him as is there revealed should devise also, exclusively for educational purposes, a method so unlikely to develop the right teacher–pupil relationship? If, says Barnes, we are teaching a pupil by demonstrative means, 'we tell him a pair of

[1] 'A.'s Theory of Demonstration', in *Articles on A.* 1, 77. (Revised version of an article which first appeared in *Phron.* 1969.) His view was to some extent anticipated by Grote, *Arist.* II, 302 and 304, and briefly by von Fritz, 'Επαγωγή 28. For a recent alternative explanation see Mittelstrass in *Archive for History of Exact Sciences* 1965, 433f., and cf. Lesher, *Phron.* 1973, 57 n. 31. For a very full treatment consult M. Mignucci, *L'argomentazione dimostrativa in A.*, a commentary on the *Posterior Analytics*. Vol. 1, covering bk 1, appeared in 1975.

[2] The fact is noted by Düring (*Arist.*, 22), but does not seem to cause him great anxiety. Grene in her *Portrait of A.* (pp. 181f.) is even content to speak of 'Aristotle's method as set forth in tha *Posterior Analytics* and its application in the physical treatises'.

propositions which are to serve as premises; we then draw the conclusion.'[1] 'The question is,' he continues, 'Has the pupil acquired any new knowledge by our taking the last step?' More important, one might think, is the question whether a pupil educated by such a method will ever learn to think for himself. On p. 81 he actually mentions Socrates's conversation with the slave in Plato's *Meno* as a precursor of this sort of thing, whereas the two methods could hardly exhibit a greater contrast. If 'Aristotle was not telling the scientist how to conduct his research: he was giving the pedagogue advice on the most efficient and economic method of bettering his charges', I doubt if it would have been the best advice. Economy and efficiency recall the slogans of some modern educationists rather than of Aristotle. Where a passage sounds pedagogical, what is taught may be a method itself, not its results; as for instance *An. Post.* 97b7ff. on research (ζητεῖν). The teacher is not giving a history lesson about Alcibiades, Lysander and Socrates; he is offering a paradigm of how to conduct an enquiry.

At *An. Post.* 71b16–19 *apodeixis* is introduced in general terms as a method of acquiring knowledge; and if, as is said at *Met.* 1005b5–8, 'It is the part of the philosopher, surveyor of the nature of all that is, to investigate also syllogistic principles', these must be the principles of *apodeixis*: otherwise they would have no relevance to the study of reality. Again, when *apodeixis* is called a scientific or 'epistemonic syllogism, i.e. a syllogism to grasp which is to know' (*An. Post.* 71b17–19, and similarly with the epistemonic question at 77b36), it is natural to take this as referring to the actual acquisition of knowledge, not simply the imparting of knowledge already won. He has just said that *apodeixis* is at any rate one way of knowing (τοῦ ἐπίστασθαι τρόπος), and it is even a matter for future consideration whether there is any other. The same is true of other passages, e.g. the mention at 73a22–24 of 'what is known by apodeictic science, meaning by "apodeictic" the knowledge that we possess by having demonstration (*apodeixis*) of it'; and 81a40 'we learn either by induction or by demonstration'.

On p. 83 Barnes points out that according to Aristotle searches must precede demonstration; and he adds: 'This strongly implies that demonstrations cannot themselves be instruments of research.' Searches must certainly precede demonstrations. How else would the philosopher-scientist get his premises? But searching and its result (the amassing of facts) do not amount to knowledge, for as we shall soon see, genuine scientific knowledge (*epistêmê*) implies in Aristotle's eyes knowledge not only of the fact but also of its cause. The syllogizing procedure comes after the fact-finding stage, to turn

[1] P. 84. Cf. the mention on p. 79 of 'a teacher, and a pupil to whom he imparts knowledge in a formal manner'. B. occasionally writes as if μανθάνειν were used solely as the passive of διδάσκειν, which is not so.

it from experience into knowledge, and how much emphasis is laid on one or the other depends on the nature of a science and the stage it has reached. Perhaps Aristotle was not quite 'conceited to the point of fatuity', in spite of the passages referred to by Barnes on p. 85 (n. 88),[1] but admitted that in some sciences there was still quite a lot of fact-collecting to be done before the universal premises could be selected and the downward process begin. What may be readily granted, however, is that in Aristotle's mind the original acquisition of knowledge and its dissemination by teaching were more closely associated than they usually are with us. The criterion by which to distinguish the knower from the ignorant is his capacity to teach (*Met.* 981 b7), and 'all knowledge appears capable of being taught' (*EN* 1139 b25). Cf. also *Met.* 982 a28.

'Syllogism must be discussed before *apodeixis* because it is the more general: *apodeixis* is a species of syllogism, but not every syllogism is *apodeixis*' (*An. Pr.* 25 b28). We know now that Aristotle distinguished the formal correctness of an inference from its truth or falsehood when applied to concrete facts, calling the formal structure syllogism, and its epistemological or scientific application *apodeixis*, demonstration. The transition from one to the other is most clearly made in the *Posterior Analytics* bk 1 ch. 2. It begins:

We think we have knowledge of anything in the strict sense – not just an unscientific[2] and haphazard knowledge – when we believe ourselves to know the cause of the fact,[3] that it is the cause of that fact, and that it could not be otherwise than it is . . . The object of knowledge in the strict sense cannot be otherwise than it is.

Here and occasionally elsewhere[4] Aristotle talks as if science deals only with the necessary, subject to *invariable* laws, so that the premises of the apodeictic syllogism must be not only true but necessarily so. Here for the sake of emphasis he omits that other favourite conception

[1] These must be seen in context, and in the light of A.'s belief that all knowledge has been perfected many times over, and lost again in recurrent natural disasters. Cf. *Met.* 1074 b10–13, *Pol.* 1329 b25f., *Cael.* 270 b19f., *De phil.* fr. 8 and *Protr.* fr. 8 (Ross). See also p. 85 above.

[2] On τὸν σοφιστικὸν τρόπον I have followed Grote, *Arist.* 1, 313 n. *b*.

[3] Often, and rightly, brought into connexion with this is Plato *Meno* 98a: true opinions are converted into knowledge by 'working out the reason' (αἰτίας λογισμῷ).

[4] See 73 a21, *EN* 1139 b20. But note (and I have not seen it noted) that ἀναγκαῖον need not always mean 'necessary, absolutely and without exception', for A. uses the comparative form ἀναγκαιότερον, which can be replaced by ἀκριβέστερον. Cf. *Met.* 1025 b13 with 1064 a6. On the meanings of ἀκριβής see Grant, *Ethics* 1, 452, a ref. which I owe to Lesher in *Phron.* 1973, 63.

of his, what happens 'usually', 'as a rule' or 'for the most part' (ὡς ἐπὶ τὸ πολύ). This is commonly conjoined with 'always' or 'necessarily', and the two together are contrasted with what happens by chance, and so *neither* always *nor* for the most part. In the changing world of nature there may be exceptions to every rule. His full view is expressed later (87 b 19–22): 'What happens by chance cannot be known by demonstration, for it is neither necessary nor usual, and demonstration deals with what is *either* one *or* the other.'[1] Nevertheless it is only in view of their constancy, absolute or approximate, that things or events can be properly and scientifically known.

Untroubled by any Humian injunction to 'restrain the intemperate desire of searching into causes', Aristotle asserts that one does not know something *until* one knows its cause, and a later description of *apodeixis* calls it 'a syllogism demonstrating the cause, or why the fact is so' (85 b 23). This is why sensation cannot by itself impart knowledge, in spite of the direct acquaintance of individuals which it affords: 'the senses do not tell the reason, e.g. why fire is hot, but only that it is hot', whereas 'what it is and why it is are the same'. So too engineers and architects are wiser than their workmen, because they know the reason for what is being done, whereas the experienced workman knows only *that it works*.[2] Knowledge, being of the necessary, is also of the universal (*EN* 1140 b 31).

To continue with *An. Post.* bk 1 ch. 2, *apodeixis* is certainly one way of acquiring knowledge. The question of other possible ways is postponed, but it soon becomes plain that they must exist if science is to be possible, since the primary premises of all must be *anapodeikta*, not themselves reached by demonstration. 'There simply cannot be *apodeixis* of *everything*: the process would go on to infinity, so that there

[1] Fuller treatment at *Met.* 1026 b 27–27 a 28. Thus at 1027 a 20: 'Clearly there is no knowledge of the accidental, for all knowledge is of what occurs *either* invariably *or* usually' (repeated at 1064 a 4–5). What is 'for the most part' can be brought under a law, e.g. that a certain remedy will benefit a fever-patient, but the accidental never. Chance for its own sake is the subject of *Phys.* 2, chh. 4–6 (pp. 233ff. below).

[2] *An. Post.* 85 b 23 (cf. *Met.* 983 a 25) and 90 a 15; *Met.* 981 b 10–13, 981 a 25. In her examples of 'What is . . .?' questions, Elizabeth Anscombe includes 'What is dreaming?' (*Three Phils.*, 11). This is a good illustration of A.'s point here. She comments on the questioner that 'in a sense he knows what dreaming is, but wants some sort of account of it' (λόγον διδόναι to use the Platonic phrase). He is well acquainted with the phenomenon of dreaming, and could describe it accurately; but he wants it explained or accounted for. In effect he is asking 'Why do we dream?'

would still be no *apodeixis*.'[1] *Apodeixis* is now defined as 'scientific syllogism', that is, 'one to grasp which is to know'.[2] An apodeictic syllogism, as opposed to a dialectical (or of course a merely formal) one, is a true *philosophema* (*Top.* 161a15). Here the opinions of the ordinary man count for nothing. 'Don't discuss geometry with a non-mathematician' (77b12): geometrical discussion (*logos*) must be based on geometrical principles and conclusions. To fulfil these conditions the premises of the apodeictic syllogism must not only be true and express the real cause, but also 'primary and immediate': a science must depend ultimately on premises which may be taken as self-evident, or we are landed with the infinite regress. Next they must be 'more knowable', a point to be explained later (pp. 198f.), and, as causes, prior to the conclusion.[3] Apart from the basic axioms or *summa genera* of science or *a* science, the premises in a chain of reasoning, leading to the fact demonstrated in the conclusion, must be logically prior to the fact, i.e. established as true before being used to prove it. They must, he adds, be causes of the conclusion. The point that only knowledge of causes is real knowledge was made emphatically a few lines above, and he now continues: 'for so the premises will be really appropriate to (οἰκεῖαι) what is being proved'. His present concern therefore is appropriateness or relevance, and those are doubtless right who take it to refer to the impossibility of proving theses in one science from premises appropriate to another, the 'transfer from another genus': 'you cannot prove geometrical truths by arithmetic', a question of continuous magnitudes through the science of number.[4]

[1] *Met.* 1006a7. Cf. *An. Post.* 71b26–29, 72b18–22, 84a30 ('If this is true, there must be starting-points (ἀρχαί) of demonstrations, and there cannot be *apodeixis* of everything'). A second view that A. ressonably rejected was that apodeictic knowledge could be attained by arguing in a circle, κύκλῳ γίνεσθαι τὴν ἀπόδειξιν καὶ ἐξ ἀλλήλων (72b15–18; but cf. H. W. Johnstone, p. 184 n. 5 below).

[2] Later in the book (79a17–32) he says that the most scientific syllogism will be in the first figure, 'for to infer the cause belongs either invariably or usually to this figure'.

[3] Cf. *Top.* 159b8 and 141a28, γνωρίζομεν δ'οὐκ ἐκ τῶν τυχόντων ἀλλ'ἐκ τῶν προτέρων καὶ γνωριμωτέρων. Prior and more knowable, he says at this point, have two senses. This will be explained on pp. 195f. below.

[4] 75a38ff., b14–17. Cf. Ross, *Analytics*, 55. That this is the reference is confirmed by 75b39, 76a5–7: It is not enough for the premises to be true, immediate and undemonstrated: everything must be demonstrated from *its own* ἀρχαί. (Moreau suggests a different explanation in *A. et son école*, 53.)

The relation between apodeixis *and definition.* According to the *Topics* a definition is a form of words which states the essence of its subject, and it is made up of genus and differentiae, which alone explain the being of anything because they exhibit its form. At the same time 'it is clear that there can be syllogism of a definition', i.e. it can be reached by syllogistic reasoning.[1] The relations between definition and the apodeictic syllogism appear strange and complex. As a part of logic definition is treated in *An. Post.* 2, chapters 2–13, where in ch. 2 to seek a definition is to look for a 'middle', i.e. the middle term which expresses the cause (p. 162 above). This suggests the syllogism, but just as in the *Metaphysics* (997a31) 'there does not seem to be *apodeixis* of substance (οὐσία, 'essence', Ross in O. Tr.)', so here ch. 4 argues that there can be no syllogism or *apodeixis* of the essence (τοῦ τί ἐστι, of what something is), and in ch. 8 the somewhat mysterious conclusion is reached (93b16) that

There is no syllogism or *apodeixis* of the essence, but nevertheless it is exhibited through syllogism and *apodeixis*,[2] if its cause is external to it. Our conclusion is that neither can the essence of anything be known without *apodeixis*, if its cause is external to it, nor can there be *apodeixis* of it.

Later, at 94a1, he says that 'plainly there is a sort of (οἷον, 'something like') *apodeixis* of the essence, differing from it in arrangement', and at 94a8 he mentions without qualification 'the *apodeixis* of the essence'. 84a11 says that '*apodeixis* is of what belongs essentially to things'. A definition may be one of three things (94a11): either an undemonstrable statement of the essence,[3] or a syllogistic inference from it, or thirdly the conclusion of an *apodeixis* of the essence. He has endeavoured to explain this in chapters 2 and 3, but a different approach, still based on his own text, may be clearer.

[1] *Top.* 153a15 and 23, 143b9. (Our phrase 'specific difference' goes heck to A.'s εἰδοποιὸς διαφορά at 143b8.) Definition as statement of the essence also at *Met.* 1017b21, 30a5, 31a12, 42a17.

[2] One can 'show' (δηλῶσαι) the essence by demonstration without demonstrating it (μὴ ἀποδείκνυντας) 93b25–28. Especially puzzling is the statement in ch. 7 (92b38) thet 'one cannot know the essence *either* by definition *or* by *apodeixis*'. In this chapter definition seems to be reduced to its least important nominal (ὀνοματώδης) form. It must he remembered, however, that ch. 7 is explicitly aporetic (as indeed are esrlier chapters), and ch. 8 makes a fresh start, promising to investigate which of the foregoing conclusions are sound and which not.

[3] And as such the ἀρχή of an apodeictic syllogism. Some truths must he indemonstrable, to avoid an infinite regress (pp. 173f. above), and these include at least some definitions (*An. Post.* 90a4, *De an.* 402b25–26).

There are two main kinds of definition, nominal and real (93b29ff.). The first simply enables one to connect the fact with the name, e.g. 'Thunder is a noise in the clouds'. Real or complete definition, as we know, includes a statement of the cause, which Aristotle equates with the essence,[1] e.g. 'Thunder is the noise of fire being quenched in the clouds'.[2] By expressing the cause this is in effect the same as *apodeixis*, though in form it is not.[3] Strictly speaking, *apodeixis* is the answer to the question 'Why does it thunder?', not 'What is thunder?'. Real definition is thus a kind of potted *apodeixis*, which packs in the middle term along with the major and minor in the same sentence. The implied syllogism may be set out thus:[4]

> Quenching of fire necessarily produces noise.
> In the clouds fire is being quenched.
> Therefore in the clouds there is noise.

So, as Aristotle points out (94a7), the conclusion of the apodeictic syllogism of the essence gives by itself the [nominal] definition of thunder as 'noise in the clouds'. *Apodeixis* is here called 'continuous' because being in syllogistic form it constitutes a *progress* from premises to conclusion. It is like a line, whereas definition is the same thing gathered up into a point. The lesson of the early part of *An. Post.* (bk 1 ch. 2) is undoubtedly that all scientific truth is arrived at (not merely expressed) by a process of syllogistic reasoning from self-evident premises, even if not usually presented in that form. The unnatural cumbrousness of this becomes even more evident if we take another of Aristotle's examples, the lunar eclipse. From what is said about it in *An. Post.* bk 2 ch. 2, together with passages already noted, one must conclude that to define it properly, giving its cause, presupposes an argument like this, whether to prove it (δεικνύναι) or simply to explain it (δηλοῦν):

[1] 90a14, 'In all these instances it is plain that what a thing is (its essence, τὸ τί ἐστι) and *why it is are the same*'; line 34, 'As I say, to know the essence is the same as knowing the cause.' Cf. *De an.* 413a13–20, where current definitions are dismissed as offering for the most part conclusions only.

[2] This theory about thunder was held in different forms by Empedocles and Anaxagoras, and is criticized by A. himself when writing on meteorology (*Meteor.* bk 2, 369b11).

[3] It differs θέσει or πτώσει (94a2 and 12).

[4] Based on Joachim, *Nic. Eth.*, 55.

Any body whose light being derived from the sun is blocked by the interposition of the earth loses its light.

The moon is a body whose light, derived from the sun, is thus blocked.

Therefore the moon loses its light.

The middle term does describe the real cause, but we should scarcely want to explain eclipses of the moon as if they were instances of a more general law. In this first attempt to devise a scientific method, Aristotle could only conceive of basing it on the subject-predicate relationship, and what we see as the *events* whose relationship science investigates appear in the guise of *properties* of the subjects to which they happen, attributes flowing from their essence.[1] Instead of tracing a sequence of causally connected events he thinks rather in terms of taking a subject and laying bare all its essential attributes.

This investigation of essence and properties is entirely appropriate to mathematics, and it might be that Aristotle's training in the Academy had led him to extend it unconsciously to all science. As an illustration he uses more than once the equivalence of the angles of a triangle to two right angles, a timeless mathematical truth. More probably it has deeper roots. Not only the Pythagoreans, who earlier saw the cosmos in mathematical terms, but the Presocratic natural philosophers in general, sought something static, the nature (*physis*) and inherent properties of things, rather than any sequences of cause and effect or laws of motion. So too with Aristotle. 'Tout le monde sait', in the words of Suzanne Mansion, 'que le but propre de la science d'après Aristote est la connaissance des essences, des qualités des choses.' But any influence from the Presocratics was certainly unconscious, for consciously he condemned the earlier neglect of the problems of motion as a fundamental error. Cornford in his inaugural lecture[2] quoted a twentieth-century scientist, N. R. Campbell, as observing that such 'timeless laws of associated properties' are not only, in an imperfect form, the earliest laws of science, but still retain their

[1] Cf. *An. Post.* 90a11 and 13 τι τῶν καθ' αὑτό . . . τὸ δὲ τὶ ἔκλειψιν ('a property, e.g. eclipse', Mure in Oxford trans.).

[2] *The Laws of Motion in Ancient Thought* (1931), 22–4. Perhaps this 'Schriftchen' does less than justice to early Greek physics. So at least Wilhelm Nestle thought (*Phil. Woch.* 1936, 754).

significance alongside the laws of motion and of cause and effect which have come into prominence since Galileo and Newton. Campbell added something even more relevant to Aristotle. Laws which assert that 'there is such a thing as steel, considered as a group or system of constantly associated properties . . . form the content of the classificatory sciences, such as the older zoology, botany, mineralogy', which grouped their material according to resemblances and differences but were not concerned to discover laws governing 'the conjunction of *successive events*', which Dugald Stewart saw as the proper object of physics. It was in precisely the classificatory sciences that Aristotle so far surpassed his contemporaries and produced results which are still respected today.[1]

(2) THE 'ARCHAI'[2] OF KNOWLEDGE

> Our assent to the conclusion being grounded upon the truth of the premises, we never could arrive at any knowledge by reasoning, unless something could be known antecedently to all reasoning.
>
> J. S. Mill

> It must be the case that we are capable of knowing at least one proposition to be true, *without* knowing any other proposition whatever from which it follows.
>
> G. E. Moore

> It is foolish not to recognize what one should seek to demonstrate and what not. There cannot be demonstration of everything alike: the process would go on to infinity, so that there would still be no demonstration.
>
> Aristotle (*Met.* 1006a6)

[1] If I have failed to understand A. completely here (and on the relations between definition and demonstration I have certainly found him hard to follow), a reader may be helped by S. Mansion's *Le jugement de l'existence chez A.*, especially the second chapter of each of its two books; or by Moreau, *A. et son école*, 59–63. Barnes (*Articles on A.* 1, 82) says that according to A.'s arguments in *An. Post.* 2, 3–10, 'definitions, or statements of essence, cannot be demonstrated – they may, in a sense, be exhibited in an *apodeixis*, but they cannot occur as conclusions'. Exactly how the definitions can 'in a sense be exhibited' in the *apodeixis* is just what one would like to know, and his own conclusion from this, that 'essence is at best an accidental quarry of demonstration', does not altogether clear the matter up, nor does it take account of some other key passages, notably *Top.* 153a23 and *An. Post.* 84a11, 94a1–2.

[2] In this section at least it will be best to retain the Greek word. *Archē* means a beginning, starting-point, first principle or cause. In one place (*Met.* 1003b23–24) he says that ἀρχή and αἴτιον are μιὰ φύσις, and at 1013a17 that all αἴτια are ἀρχαί. In a physical sense it was applied to the primary substance and permanent ground of the universe postulated by the early natural philosophers – water, air, *apeiron* and so on (vol. 1, 57f.). In applied logic the *archai* are the ultimate, undemonstrable premises of apodeictic syllogism.

The 'archai' of knowledge

There need not be, are not, and *could* not be, any ultimate ἀρχαί of definition, explanation and demonstration.

Renford Bambrough

The last chapter of the *Posterior Analytics* is one of the most important in all Aristotle's works. It is a confession of his epistemological faith, a statement of the source from which in the last resort all knowledge springs, 'a magnificent account', as Ross put it, 'of the unbroken development from sense to reason'.[1] So far we have seen him describe the process of acquiring knowledge as syllogistic, i.e. deductive, reasoning downwards from certain basic propositions which he calls the *archai* of the scientific syllogism. These must be regarded as axiomatic or self-evident, being themselves *anapodeikta*, not subject to demonstration by the scientific syllogism. Without such primary, indemonstrable truths we should have either an infinite regress or a vicious circle and the advancement of knowledge would be impossible. Hence not all knowledge is by demonstration. If knowledge of the primary assumptions[2] were demonstrable, they would not be known until they had been demonstrated. Therefore in the case of the *archai* of knowledge one must not ask the reason why; each must carry conviction on its own. These assumptions or axioms[3] are admitted both

[1] There is a complementary account of this development at the opening of the *Metaphysics*, where emphasis is laid on the natural delight which we take in the exercise of the senses, especially sight.

The chapter in *An. Post.* has been subjected to a gruelling cross-examination by Hamlyn in *Phron.* 1976, 171ff., where A.'s account is described as 'crude', 'incoherent', 'not altogether perspicuous', 'not very plausible'. Some of his article I have failed to understand. He asks, for instance, on p. 179: 'Is it plausible to suppose that we differentiate men, say, from certain other objects, because we experience men more frequently? And as opposed to what objects – trees, for example?' Who is suggesting that our power of distinguishing one thing from another applies to men but not to trees? Again, 'Repetition itself seems an empty explanation' of the persistence of objects in the memory. Does it not rather refer us to an obviously relevant fact of experience. Hear a man's name once or twice, and you probably forget it. Meet it many times in different contexts (perhaps making his acquaintance, or reading of him in the news) and it will 'make a stand' in the mind.

A. M. Quinton, *The Nature of Things*, 121 describes A.'s first principles thus. They are 'logically intuitive basic statements which do not essentially require the support of other justified beliefs, and which are only inferable and testable in the light of their consequences'.

[2] In which at one time at least he included definitions. See p. 175 n. 3 above. For a modern opinion (Bambrough's) see p. 250 n. 2 below.

[3] At *An. Post.* 72a 14–16 an axiom is said to be something which, though it cannot be demonstrated, must be grasped before anything can be learned. 'There are some such truths', adds A. a trifle artlessly.

for philosophy in general and as applicable to a special science.[1] In general they are not so much premises as principles on which reasoning must be carried out. Foremost is the law of non-contradiction, that 'the same thing cannot at one and the same time and in the same respect both be and not be', described as a necessary truth about which one cannot be mistaken. It is 'the most certain of the *archai*' and 'by its nature *archē* also of all the other *archai* and axioms'.[2] Others are the law of excluded middle (*An. Post.* 71 a 14, 88 b 1) and the principle that if equals are taken from equals, equals remain.[3] As for the special sciences, 'in each separate kind I call *archai* the truths that cannot be demonstrated' (76 a 31). Here in *An. Post.* bk 1 he confines himself to mathematical examples such as the axioms of geometry and the definitions and existence of such things as unit, point, line, triangle, magnitude.[4] Studies with a practical end, like ethics, also provide examples (*EE* 1227 b 22). Virtue itself lays down the end, not the means, for the end is not determined by syllogism or taking thought, but must be accepted as an *archē*. Similarly medicine assumes that its end is health, and considers only the means thereto. In the natural sciences the *archai* are reached by experience based on repeated observation.

46 a 17–25. For instance astronomical experience provides the *archai* of astronomical science: it was after the phenomena were sufficiently grasped that astronomical *apodeixeis* were discovered. It is the same with every other art and science. Given the facts in each, it is in our power to expound the demonstrations.

Aristotle's two main classes of undemonstrated *archai* resemble the

[1] *An. Post.* 76 a 37–b 2, *Met.* 1005 a 23–27. Cf. Leszl, *Ontology*, 65 f., and for what A. meant by a single science see *An. Post.* 87 a 38–b 4.

[2] *Met.* 1005 b 5–34, 1011 b 13–14. On the necessity of the law of non-contradiction and its relation to earlier philosophies, especially those of Heraclitus and Protagoras, see Grote's discussion in *Arist.* II, 140–69.

[3] 76 a 41. A. expressly includes this among the κοινά, while pointing out that a particular science (in this case mathematics) uses a κοινόν for its own purposes so far as it applies to its own subject-matter. But to investigate the κοινά themselves belongs to first philosophy (*Met.* K, ch. 4).

[4] Ross commented that this was inevitable, because in A.'s time mathematics furnished the only developed science. Barnes says the same, but adds that this presented A. with a dilemma, because he was primarily interested in the natural sciences, which had not the compelling rigour of mathematics, but allowed for what occurs 'for the most part' as well as what was invariably true. (Ross, *Analytics*, 504 and 52; Barnes in *Articles on A.* 1, 74. Cf. p. 172 above.)

'hard' data which Russell distinguished from 'soft' in *Our Knowledge of the External World* (77f.): 'The hardest of hard data are of two sorts: the particular facts of science and the general truths of logic . . . Real doubt in these two cases would, I think, be pathological.' Ayer enunciated a similar unquestionable *archē* of his own when he condemned as nonsensical the assertion that the world of sense-experience is altogether unreal. Aristotle would agree, but not with the logical positivist's (as he was then) further claim that 'from empirical premises nothing whatsoever concerning the properties, or even the existence, of anything super-empirical can legitimately be inferred.' (See Ayer, *Language, Truth and Logic*, 2nd ed., pp. 39 and 33.)

The final chapter begins: 'It is now clear what syllogism and *apodeixis* are, and how they are produced, and likewise apodeictic knowledge, which is the same thing. How the *archai* become known, and by what faculty, will next be made clear, when we have first set out the problems.'[1]

If the *archai* are not deducible from prior truths, how *do* we know them to be true? This question of 'the *archai* of the syllogism' is the concern of the philosopher, 'the surveyor of all being' (*Met.* 1005 b 5–8). In the *Ethics*, three alternative, but closely related services are mentioned: induction, sensation, and 'a certain habituation'. The gist of what follows in the *Analytics* is that the basis of all knowledge is sensation, described as 'a congenital power of distinguishing one thing from another'. This is common to all animals, but only some have the capacity to go beyond sensation. In these the mental process ascends first to memory, then (in mankind only) to the making of a generalization.[2] We now have experience, which consists in seeing the single identity (concept in our minds, corresponding to the *eidos* in the particulars) behind the multiplicity of particular examples, and is the foundation in their respective spheres of practical skill and theoretical knowledge. In Aristotle's general philosophical terms, all men have

[1] διαπορήσασι πρῶτον, a reminder of his salutary advice at the beginning of *Met.* B. (p. 90 above).

[2] A.'s own word here is λόγος. Exactly as in Plato (*Phdr.* 249; vol. IV, 404 and 427), men proceed from many sensations to a unity embraced by thought. (But not for A. any question of knowledge recollected from a pre-natal state.) In the *Phil.* too Plato's attempt to bridge the gap between sense and reason bears a resemblance to A.'s, notably in the origin of *doxa* from sensation and memory at 38 b. See also Allan in Stenzel's *PMD*, xxxiv–vi. Lesher (*Phron.* 1973, 59 n. 37 *ad fin.*) may well be right in suggesting that ἢ at 100 a 6 may mean 'or rather', not 'i.e.'.

the potentiality of knowledge,[1] and this is how it is actualized; i.e. by the familiar process of abstracting the single *eidos* informing all the particulars. Without the conceptually separable form, *apodeixis*, and hence knowledge, would be impossible.[2] The upshot is that knowledge is not innate in us in a determinate form (Plato), nor is it derived from other, prior states of knowledge, but originates entirely from sensation. The process is illustrated by a vivid simile: it is as in a battle, when an army has been routed, if one man has the courage to turn and make a stand, his example fires another and then another, until their original order (*archē*) is restored.[3] From our earliest years we are bombarded with a confused mass of sensations.[4] A great many we forget at once: they slip away and flee from us. But there comes a time when one remains in our memory, then more and more. Gradually we are becoming experienced. Finally, being creatures possessed of reason, we become aware of the *archē*, which is nothing more or less than the 'one beside the many',[5] a universal of which all the separately remembered particulars are examples, and are enabled to produce that definition which is one of the *archai* of the scientific or apodeictic syllogism (90b24).

[1] δύναμιν 99b33; 'the mind is such as to be capable of (δύνασθαι) undergoing this process' (100a13). Perhaps this still remains all than can be said about the question. Chomsky has something similar in his Bertrand Russell lecture at Cambridge in 1971: 'Intrinsic principles of mental organization permit (cf. ἡ ψυχὴ ὑπάρχει τοιαύτη οὖσα οἵα δύνασθαι) the construction of rich systems of knowledge and belief on the basis of scattered evidence. Such principles . . . constitute an essential part of human nature.' (*Problems of Knowledge and Freedom*, 45.) This may be relevant to Hamlyn's complaint at the end of his article in *Phron.* 1976 (p. 183 n. 2 below) that A. did not ask 'what it is that must be the case about human beings and their psychical capacities' to make ἐπαγωγή possible and useful.

[2] Cf. 77a5–8: '*Apodeixis* does not necessitate the existence of [Platonic] Forms, a One apart from (παρά) the many, but it is necessary to affirm the truth that there is a unity covering [or predicated of, κατά] many. Without this there will be no universal, and if no universal then no middle term and so no *apodeixis*.'

[3] The play on this word, which in addition to 'beginning' means 'rule, authority or command' (*Met.* 1013a10–13), cannot well be reproduced in English. The army has recovered its original state, and what has been restored in discipline and control. In both these senses it belongs to the simile alone, but A. has ingeniously reminded us that *archai* are also his own theme.

[4] αἰσθητά, that is, particular physical objects of which sensation makes us aware. A. has not here in mind any distinction between these and what are now called sense-data, though perfectly capable of distinguishing when he wished between τὸ λευκόν as a colour and as a coloured thing.

[5] ἓν παρὰ τὰ πολλά. Separable of course only in our minds (pp. 219f. below). Owen has pointed out (*Symp. Ar. III*, 124) how readily the familiar Platonic terminology flows from A.'s pen. At 77a5 he rejected this expression in favour of κατὰ πολλῶν (n. 2 above), but here and at 100a7 he himself uses it of the universal.

After the simile he restates the matter to make it clearer. First, one of the particulars[1] makes a stand in the mind (memory). He adds an observation vital to his doctrine, that 'although we perceive the individual, perception itself is of the universal, e.g. of man, not just of Callias *a* man'. In petceiving, say, Callias we perceive not only the indefinable traits in which he differs from Socrates but also the attributes common to them both as men, though we do not recognize them as belonging to the *eidos* until experience (memory plus *logos*) has enabled us to abstract and unite them.[2] With the first or lowest universal etablished, 'a new stand is made on that level' and so the philosopher continues, from the definable species dog, elephant, man to the genus animal, upwards till he reaches the *summa genera* common to all sciences, the ultimate categories of substance, quality and the rest, 'the unshakeable *archai* of all that exists, *qua* existing' (*Met.* 1005 b 10).[3] Immediately he continues: 'Clearly then for us the *archai* of knowledge must be reached by induction, for that is the way in which sensation itself can implant the universal.'[4] Consideration of the alternatives still open brings him finally to the conclusion that the possibility of knowledge must depend in the last resort on a kind of intellectual intuition (for so it is natural to translate *nous*).[5] The argument is this (100 b 5):

There are only two thinking states which invariably produce truth,

[1] Called here by A. ἀδιάφορα, indiscriminables, which logically speaking they are (p. 144 above).

[2] (There has been occasion to mention this doctrine in vol. IV, 415.) A. might have been on Plato's side when Antisthenes made his notorious remark: 'I see a horse but I don't see horseness' (vol. III, 214).

[3] Here A. reaches his own ἀνυπόθετος ἀρχή (*ib.* 14), as Plato's was the Form of the Good (*Rep.* 510b). The use of the word (surely deliberate allusion; it occurs nowhere else in A.) brings out both the resemblances and the differences between their two philosophies. *Ultim*ate certainty was the demand of both. A. calls the *summa genera* ἀμερῆ as not divisible into genus and *differentiae*. Trendelenburg in his ed. of *De an.*[2] (1877) says (p. 146): 'Haec vero cur dicitur? Quo quid magis generale est, eo plures species subiectas tenet, eo pauciores vero in se ipso notas complectitur.' Ross compares *Met.* 1014 b 6 ff. For the contrast between Plato and A. here see vol. V, 432f.

[4] Thus A. offers poor evidence for the common modern verdict that, as expressed by N. Griffin (*Scientia 1969*, 251), 'Although it was the ancient Greeks who first recognized induction, they failed to recognize its importance and placed the whole weight of scientific enquiry upon deduction.' Griffin's article gives a useful short survey of the present position of what has been known since Hume as 'the problem of *induction*'.

[5] Barnes in his translation (Oxford 1975) prefers 'comprehension', which A. W. Price calls 'vacant' instead of the 'misleading' 'intuition' (*CR* 1978, 87). But cf. also pp. 192–4 below.

scientific knowledge (*epistēmē*) and *nous*. All *epistēmē* is discursive,[1] i.e. based on reasoning, in which the premises or first principles must be known before the conclusion. How then can there be knowledge of the primary premises of all? They cannot be the subject of *apodeixis*, since there are no prior premises from which to deduce them, yet if the whole body of science is to be true, they must be the most indubitably known of all. Now besides *epistēmē* only *nous* infallibly gives truth, therefore *nous* is the source of all knowledge, the *archē* of the *archai*.[2]

What is this *nous*? Consideration of scientific method has brought us to induction, and it will be appropriate to introduce *nous* in this connexion (pp. 192ff. below). Aristotle is seeking his own explanation of a fact with which scientists have been faced in all ages: that in the last resort the assumptions on which their whole edifice is based – the so-called laws of nature, involving belief in the constancy of nature – are reached by a sheer leap in the dark.

Aristotle's views on the *archai* can be criticized on more than one ground. He is hot for certainty, and demands 'necessary truths'. Philosophic and scientific knowledge must be based on valid reasoning from first premises impossible to doubt. To the modern scientist, science is and will always be something tentative and subject to constant revision.[3] There is no final goal, nor need every discussion proceed from assumptions or hypotheses which are themselves beyond argument.[4] One may even accept the infinite regress so repugnant to common sense, and deny not only the necessity but the possibility of primary and indubitable first premises.[5] No *archē* can be assigned to

[1] μετὰ λόγου γὰρ ἡ ἐπιστήμη, *EN* 1140b33.

[2] Cf. *EN* 1140b31–41a8, ending λείπεται νοῦν εἶναι τῶν ἀρχῶν. In this sense νοῦς is infallible (1100b7–8). Unfortunately our incorrigible philosopher sometimes uses νοῦς as a more general term for reasoning (ᾧ διανοεῖται τε καὶ ὑπολαμβάνει ἡ ψυχή, *De an.* 429a23), which may erroneously unite incompatible notions (430b1–6).

[3] A.'s choice of astronomy to exemplify a subject where the facts are sufficiently known (p. 180 above), now affords a rotten pathetic object-lesson.

[4] 'In our search for truth, we have replaced scientific certainty by scientific progress' (Popper, *O.S.* II, 11). Cf. Popper's *C. and R.*, 66 and *O.S.* II, 270: The idea of teaching science as a body of knowledge 'is about to disappear and science can be taught as a quickly developing growth of bold hypotheses, controlled by experiment, and by *criticism*'. Popper may sometimes be controversial, but few scientists would disagree with this. I omit here his criticism of A. as an 'essentialist', which will be found in ch. 11 of *O.S.*

[5] Philosophical arguments, i.e. those justifying first principles, are never formally valid, but either analytic or circular, according to H. W. Johnstone (as quoted by R. J. Burke in *Philos. and Phenom. Res.* 1966–7, 393).

knowledge, no starting-point to our thinking life, and there is something hypothetical about even the most elementary data of consciousness. Knowledge by intuition is a myth.[1] Again, for Aristotle what are now known as the laws of nature (to which no Greek expression corresponds) were generalizations, or deductions from generalizations, based on separate data perceived individually by the senses. Until recently this might have been generally agreed, as it was by men like Eddington and Whitehead, but it is a leit-motif of Stephen Toulmin's book on the philosophy of science that 'to treat laws of nature on the pattern of generalizations is positively misleading'.[2] He also denies that inferences in the physical sciences are of syllogistic type (pp. 33, 84). It is the familiar point: Aristotle saw the world in terms of substance and property, whereas, 'we are not seriously interested in enumerating the common properties of sets of objects, but are concerned with relations of other kinds' (*o.c.*, 33).

Aristotle's empirical tendencies might have taken him much further had there been no Plato. A very similar account of the progress from sensation to knowledge through memory and *doxa* 'coming to rest' in the mind is given in the *Phaedo*,[3] in which Plato also explains that recognition of the Forms is first stimulated by sense-perception.[4] The activity by which this is accomplished, *dianoia*, is one stage below *nous*, which grasps the *archē* and sees the Forms in the light of that – a downward path, not an upward one from particulars. Once the philosopher has seen the *archē* of all things, namely the Form of the Good, then is the time to start the reasoning or syllogistic[5] process from the ultimate premise that it is the cause of all good, truth and understanding, and no man can conduct himself wisely without a glimpse of it. For

[1] So for instance C. S. Peirce the pragmatist. See the chapters on his theory of knowledge in Gallie's book, especially pp. 68ff. (The intuitional theory against which Peirce is arguing is that of Descartes.)

[2] Toulmin, *Phil. of Sci.*, 105. Cf. 77, 99, and ch. III in general, also 110, 145. T. is writing primarily of physics, and relegates empirical generalization (with some disdain?) to 'natural history', which is something different (pp. 74, 77, 82, 85). That A. was a superb natural historian is undoubted and not necessarily to his discredit. At the same time his characterization of natural events as events which happen ἢ ἀεὶ ἢ ὡς ἐπὶ τὸ πολύ bears some resemblance to a law. Exceptions, however, he simply regards (in this *less* optimistic than the scientists) as due to chance or nature's failure to master her material.

[3] 96 b. Cf. also p. 181 n. 2 above.

[4] 74 b. Cf. also *Rep.* 510c–11 d; vol. IV, 345 and 510.

[5] ἀφθέγγτα δὲ συλλογιστέα, *Rep.* 517 c.

Aristotle a transcendent Form of goodness made no sense (*EN* 1095 a 26–28, pp. 340ff. below), and it was simply through inductive generalization that *nous* by itself apprehended the forms, which were still there though immanent. Moreover *nous* for both philosophers was not a purely human faculty, but a link between man and divinity, for pure *nous* is God, as we shall see.[1]

(3) INDUCTION[2]

In the *Topics* (105 a 13), a practical manual of debate, Aristotle defines induction (*epagōgē*) as we should, as the advance from particulars to universals. From examples, e.g. that the skilled navigator is the best and the skilled charioteer is the best, we conclude that the best in any occupation is the one who has learned his job ('the one who knows').[3] Here, as often outside mathematics, his 'particulars' are in fact species, the smallest definable units. There is a remarkably Philebus-like passage at 109 b 14: 'One must look species (*eidos*) by species, not among the infinite multitudes . . . beginning the investigation from the primary groups [widest genera] and proceeding to the atomic', where 'atomic' must refer to atomic forms,[4] as Alexander said. Elsewhere, however, he shows induction starting, as in practice it must, from awareness of genuine individuals. It is so for example in the account in the first book of the *Metaphysics*, already referred to, of the upward

[1] In Met. Λ and Plato's *Timaeus*. As hinted earlier (p. 100), one sometimes longs to explain the whole of A.'s philosophy in a single burst, like a rocket from which all the coloured stars flash out together. It has an essential unity. Unfortunately it is impracticable to deal simultaneously with physics, ontology, psychology, theology, cosmology and ethics, so we must be content with frequent reminders of their shared foundations. Meanwhile something about *nous* will be found in vol. II, 18f. and vol. IV, 253.

[2] Vol. III, 425ff., may be compared, and for the word ἐπαγωγή *ib.* 426 n. 2, Ross, *Analytics*, 481–5 and Bourgey, *L'observation et l'expérience chez A.*, 56f. An excellent introduction to the topic for readers of German is von Fritz, 'Die Ἐπαγωγή bei A.', *S. B. Bayr. Ak.* 1964, 3, which includes discussion of the work of Bochenski, Sigwart, Joseph, Kneale, Carnap and Stegmüller. (See Bibliography for details of these.)

[3] Cf. the opening of *An. Post.* bk I. The actual example is obviously only an incomplete mnemonic note. A. credited Socrates with the introduction of inductive arguments into philosophy (*Met.* 1078 b 27; vol. III, 425) and he chooses a Socratic illustration, the argument for the thesis that ἀρετή is ἐπιστήμη. It was also Socratic, as Richard Robinson noted (*PED*, 42), that the cases cited should be themselves universals.

[4] As at Plato *Soph.* 229 d; cf. *Phil.* 16 c–e. *Top.* 109 b 14 is not of course describing inductive argument, but simply illustrates A.'s inherited tendency to regard *infimae species* as atomic. But when he likes he uses ἄτομα of genuine individuals, as of ὁ τῆς ἀνθρώπος at 121 a 37f.

progress from sensation to knowledge. So in practical matters, he says there, those with experience are more likely to succeed than those who have the theory of an art without it.

981 a 15. The reason is that experience is knowledge (γνῶσις) of individuals, art of universals, and all action and production are concerned with the individual. A doctor does not cure 'man', except incidentally, but Callias or Socrates or someone else with a proper name who happens to be a man.[1] Therefore if someone has the theory without the practice, knowing the general rule but not the individual case which falls under it, his treatment will often fail, for it is the individual whom he has to treat.

Here Aristotle the empiricist breaks through his Platonic shell. He is speaking, of course, of the application of knowledge to action, not of the philosopher's pursuit of knowledge for its own sake, but the same need was clear to him in both: all knowledge alike depends in the last resort on the correct interpretation of that direct acquaintance with individuals which is furnished by the senses.

In comparison with syllogism, or deduction, Aristotle notes as general characteristics of induction that it is more persuasive and clear, more easily learned through the senses, and more readily available to the mass of men; the syllogism is more compelling and more efficacious against contentious people.

So he speaks when his subject is the actual practice of argument in living controversy: induction and syllogism (or *apodeixis*) stand opposed as the two opposite types of reasoning.[2] In the *Prior Analytics*, however, as already mentioned (p. 149), he attempts to unify the various kinds of inference by reducing them all to syllogistic form. There, in spite of having just distinguished syllogism and induction as

[1] (Similarly at *EN* 1097 a 11–13, 1180 b 8–10.) Neither therefore 'man' nor 'a disease'. In the present century Sir Henry Cohen remarked (*Philos.* 1952, 157) that there are no diseases, only sick people, no two of whom have exactly the same symptoms. Cf. F. G. Crookshank's essay in Ogden and Richards, *Meaning of Meaning*, Suppl. II, and an anonymous specialist writing in the *Sunday Times* for 22 June 1958: 'Nothing is more abstract than a disease . . . There is in fact no such *thing* as a disease. Strictly speaking, the only thing that we can actually observe is a person reacting to a set of noxious stimuli, some of which come from outside, and some from within.' Both the resemblances and the contrasts to A. in this attitude are worth pondering. Without his philosophical training by Plato he might have been the first great figure in the empirical tradition. It should be added that in *EN* 10 (80 b 7–23) he deals more fully and cautiously with the question how far the medical practitioner should be concerned with the individual patient and how far with general principles.

[2] Often, e.g. at *An. Pr.* 42 a 3, *An. Post.* 71 a 5.

the two alternative sources of belief, he goes on to describe induction as the source of a syllogism: 'induction', he says 'or rather the syllogism that originates an induction'.[1] This he illustrates with the example of the animals that have no gall.[2] As an ordinary inductive argument it would run: 'This gall-less animal and this one and this one are observed to be long-lived, from which we conclude that all gall-less animals are long-lived.' As a syllogism this is plainly invalid. It is of the third figure, in which the middle term is subject in both premises and narrower in extent than either the major or the minor, and can only yield a particular conclusion ('Some gall-less animals . . .'). This is shown up formally if we apply the Aristotelian test of conversion to first figure, turning 'M–P and M–S therefore S–P' into 'M–P and S–M, therefore S–P', where M stands for man–horse–mule (Aristotle's instances), S for gall-less and P for long-lived. Man, horse and mule have no gall and are long-lived, therefore all animals without gall are long-lived. This follows necessarily only if one can guarantee that man, horse and mule are the only gall-less species. The permanent weakness of induction, considered as a purely rational form of argument, becomes apparent as soon as it is forced into the rational framework of the syllogism. To justify the universal conclusion, it must be possible to add the proposition 'Man, horse and mule make up the whole class of gall-less animals'. So Aristotle is forced to qualify his description of induction as an argument syllogistic in form with the proviso 'If then C [the particular long-lived animals] is convertible with B [gall-less]' and 'But one must imagine C as composed of all the particulars, for the induction is carried out by going through all the cases' (68b23 and 28).

This is so-called perfect induction, in which the universal conclusion is not drawn until every relevant individual has been examined. It does not of course represent the way in which inductive argument is ordinarily applied, either by ourselves or by Aristotle. Is it, we may ask, either (*a*) practicable or (*b*) any use?

(*a*) In the great majority of scientifically interesting cases, it is

[1] By retaining the 'or rather' of the Oxford translation here, I do not mean to question Hamlyn's interpretation in *Phron.* 1976, 169. It means 'or, as one should rather say' ('to put it more precisely').

[2] Any who are interested in the biology as well as the logic of this example are referred to the additional note on pp. 194–5 below.

impossible to examine every instance before drawing a conclusion. It can be done, of course, for certain artificial communities like schools or clubs, and conversely there are some fields of knowledge in which even a single example suffices to prove the law. This applies not only to mathematics, as Aristotle knew (*An. Pr.* 67b24 etc.), but also, it appears, to certain chemical laws of which he could know nothing.[1] Nevertheless the common use of inductive technique to justify the attribution of a certain characteristic to all members of a natural species (like the notorious 'All swans are white') cannot be based on exhaustive examination of individuals. 'Who', as Bertrand Russell pertinently asked, 'can enumerate all the members of the class of earwigs?' (Even if our list of gall-less species had been exhaustive, it could not have been reached by examining every member of each.) If on the other hand one is treating *infimae species* as the units and proceeding from them to higher generalizations, it may be possible, before forming a judgement about a genus, to examine all of its constituent species; and in formal logic Aristotle did prefer to take species as the units (p. 146 above), because anything more individual was indefinable and not a suitable object of discursive thought. Hence in his formal treatment Aristotle may have felt justified (though the justification could only be partial) in speaking of perfect induction as a possible goal.[2]

(*b*) But it is worth while? Have we made any inference at all? If after observing only a few thousand human beings, my reason tells me I have the right to pronounce 'All men are tailless', I may justly believe that I have used my reason to add to my knowledge. But suppose I have observed that the three species of animal which lack gall are long-lived, and suppose for the sake of argument that I know these to be the only species thus lacking. If I then say 'These gall-less species are

[1] C. Sigwart, quoted by von Fritz, 'Επαγωγή, 10. Cohen and Nagel (*Introd. to Logic*, 178) give as *example of a universal proposition* established by examining *all its* instances 'All known planets revolve around the sun'. But does not the introduction of 'known' suggest a suspicion of cheating?

[2] In the passage just quoted (*My Philosophical Development*, 87), Russell continues immediately: 'Nevertheless, we can *make statements* (*true* or *false*) *about* all *earwigs*, and we do this in virtue of the intension by which the class is defined.' In this sentence 'intension [or connotation] by which the class is defined' corresponds to the Aristotelian εἶδος. Elsewhere, however, he warned that 'if an induction is worth making it may be wrong' (*Outline*, 83). The black swan may turn up at any moment.

long-lived, and from this I infer that all gall-less species are long-lived', have I done anything but uselessly repeat, in a more cumbrous form, what I already knew? Yes. To have in our minds the concept of a class is an advance from acquaintance with individuals as such, even if our acquaintance had been with every member of the class in isolation. In Aristotle's terminology (*An. Post.* 74a31), we knew them all numerically (κατ' ἀριθμόν), but now we know them by their form, or specifically (κατ' εἶδος). The advance is twofold:

(i) We are a step nearer to the discovery of causes. He who knows only that man is gall-less and long-lived, horse ditto and mule ditto, without coordinating his knowledge further, is unlikely to establish an essential connexion between lacking gall and being long-lived. But when he has explicitly drawn the conclusion 'All gall-less animals are long-lived', it immediately suggests that there may be some causal connexion between lack of gall and longevity (which was in fact a question that interested Aristotle and his medical contemporaries). So 'the universal', as he says, 'is valuable because it reveals the cause'; and only that, in his view, amounts to *knowledge* of the fact itself.[1]

(ii) Once established in the mind as a single concept, the universal becomes the basis for higher generalizations, which it could not do so long as it was seen simply as a series of disconnected instances. In the terms of his own epistemology, we have now in our souls the 'first universal', and 'a new stand is made on that level'.[2]

Once again we are seeing the familiar, all-important operation of abstracting (better 'extracting') the form (*eidos*) from particulars, separating from their matter the set of common qualities which mark off those particulars from the rest of nature as belonging to the same species (*eidos* again). Without this 'one over the many', discernible in the flux of becoming, science would be impossible. So far Aristotle reasons as a Platonist, but he sees no need to suppose it a transcendental unity *outside* the world. It is in the world but discernible by the

[1] *An. Post.* 88a5. Cf. 85b26 and the beginning of *An. Post.* 1 ch. 2 (p. 172 above).

[2] *An. Post.* 2 ch. 19, p. 183 above. With πάλιν ἐν τούτοις ἵσταται (100b1) he is continuing the language of the battle simile. When one man by standing his ground has encouraged another and then another, first a platoon may re-form, then a company and so on. A platoon is more than its separate members.

philosopher who has fashioned the appropriate tools and techniques for its discovery.[1]

So much for the formal treatment of induction within the framework of analytics. But as commonly used induction 'leads from the particular to the universal *and from the known to the unknown*' (*Top.* 156a5). As Aristotle showed in the last chapter of the *Posterior Analytics*, he was fully aware that the search for knowledge cannot start from perfect induction. Our understanding of the natural world must begin from observation of the innumerable things and creatures around. Hence his statement that sensation itself conveys our first awareness of the universal. By what stages this develops into knowledge, both theoretical and practical, he has described in that passage, and in the *Ethics* he says: 'Induction is the *archē* of the universal itself, whereas syllogism is derived from the universal' (1137b28). Aristotle emphasizes equally, and with perfect consistency, that sensation does not of itself yield knowledge and that it is an indispensable precondition of it. From many possible passages two from the *Posterior Analytics* will serve to illustrate this.

(i) 87b28. Sensation does not yield knowledge. Even if it conveys the 'such', not just the 'this here' [cf. 'We see not only Callias but Callias the man', p. 183], its object must be singular, here and now. We cannot *perceive* the universal which covers all cases. It is not 'this' or 'now', or it would not be universal, a term which we apply to what is always and everywhere. Since therefore demonstrations (*apodeixeis*) are universal and universals cannot be perceived, sensation clearly cannot yield knowledge[2] . . . Sensation is of the individual, but knowledge implies recognition of the universal . . . The universal is valuable because it reveals the cause. *First principles however are another matter.*

(ii) 81a38. It is also clear that the loss of a sense necessitates a corresponding loss of knowledge, for (1) we learn either by induction or by *apodeixis*, (2) *apodeixis* is achieved through universals and induction through particulars, (3) it is impossible to grasp the universal except by induction . . . (4) induction is impossible without sensation.[3]

[1] See ch. VI for this.

[2] A little lower, at 88a10, he says: 'Knowledge of anything demonstrable cannot be acquired by sensation.'

[3] The idea that the common *eidos* is a reality, of which sensation itself makes us aware in a rudimentary way, has its parallel in twentieth-century science. W. H. Thorpe writes in *Biology*

As a vehicle of truth and knowledge, then, induction cannot be formally perfect, and Aristotle believed that the intellectual disposition[1] called *nous* (with its action *noein*, and *noēsis*) was capable of acting as a kind of intuition. It gives one a sense of recognition (ὥσπερ ἀναγνωρίζοντας) which he likens to the *anamnesis* of Plato's *Meno* (*An. Pr.* 67a21–24). By its means, after examining a number[2] of particular specimens or cases we can say we know that there is a common form or universal law underlying them which will hold good of all the unexamined instances of the same kind. The close association of *nous*, form and causation constitutes Aristotle's justification for claiming that future instances will resemble those already known,[3] an assumption commonly made by scientists and by others in everyday thinking. If I observed a creature looking in other respects like a man but waving a large, bushy tail, I should say to myself (if fraud was excluded) 'This cannot be a man' rather than 'Since I have not myself, and know no-one who has, examined all the men in the world, I am in no position to say whether or not there are men with tails.' *Nous* is Aristotle's answer to the question by which Hume confessed himself baffled, how to reconcile the two principles '*that all our distinct perceptions are distinct*

and the Nature of Man (1962), 86f.: 'But this is not to suggest that [a baby] is building up a picture of the external world from entirely random unordered stimulation. This is not so. The world that actually meets our senses is not a world of things about which we are invited to discover facts. The world of pure sensation is so complex and full that more sensitivity to stimuli would result only in confusion. Out of this bedlam, *our sense-organs must select certain predominant forms* if they are to make reports of things and not, as Langer says, merely of dissolving sensa. *An object is not a datum but a form*, which is experienced as a living individual thing, as a symbol for a concept. To quote her: "this *unconscious appreciation of form* is the primitive root of all abstraction, the keynote of rationality, which lies deep in our pure animal experience." And it is *our constructive* powers of perception which supply a humble but essential element for the building of the moral as well as the intellectual and aesthetic aspects of our mental natures.' The reference is to S. Langer's *Philosophy in a New Key*. Italics are mine.

[1] At 100b5ff. ἐπιστήμη and νοῦς, along with δόξα and λογισμός, are called περὶ τὴν διάνοιαν ἕξεις. ἕξεις is a difficult word to translate, but I do not think 'faculty' (usually δύναμις) would be very misleading. Perhaps the best comparison is with *Top.* 156b39 πιστεύοντες τῇ ἕξει, where the ἕξις that gives the boastful disputants their confidence is a state of readiness for (or facility in) argument.

[2] A. does not face the unanswerable question how many observations may be necessary before one can be certain of having isolated the essential properties that make up the form. It will obviously differ in different cases, but in the *PA* he does envisage the danger of premature generalization. (See additional note, on pp. 194f. and *GC* 316a6ff. quoted on p. 197). Natural endowment and practice would no doubt develop in a scientist, as they do today, the flair for this which is *nous*.

[3] Cf. Owens, *Doctrine of Being*, 81, 84.

existences, and *that the mind never perceives any real connexion between distinct existences'*.[1] Occasionally it is at least verbally equated with sensation in Aristotle's notes: 'Universals are reached from particulars, and of particulars one must have sensation, i.e. *nous*.'[2] If we were on the moon when it suffered eclipse, we should not ask either whether or why eclipses occur, 'but it would be immediately clear, for we should be able to know[3] the universal through sensation. The eclipse itself being now visible, sense-perception would also tell us that the earth is now blocking the sun's light, and from this would arise the universal rule.'

All this was made natural to Aristotle by contemporary and historical usage of '*nous*' and '*noēsis*'. As far back as Homer it means seeing *and recognizing*, or suddenly grasping, through an act of sensation, the realities of a situation. (See vol. II, 17f.) *Nous* was for Aristotle as for all Greeks the highest of our faculties. Since it is that by which we are first enabled to pick out the universal in the particulars, seeing the one through the many, it is in the last resort that on which depends our knowledge of the basic principles or *archai* of deductive science – the highest generalizations and the axioms from which scientific reasoning

[1] Appendix to the *Treatise*, Everyman ed., 319 (italics Hume's). This is mentioned by Grene *Portrait of A.*, 45, who, to the question what A. made of the puzzle, answers: 'He never saw it', Whatever may be thought of his answer (and the views of Thorpe and Langer suggest there is something in it), this statement is surely astonishing. For A. it was simply untrue that 'the mind never perceives any real connexion between distinct existences'. It perceives their formal or specific unity, which is a real one. If it is objected that to suppose him aware of Hume's dilemma is anachronistic, I would reply that since he himself states categorically *both* that the objects of sensation are unknowable *and* that sensations provide the first step towards knowledge, it or a very similar question cannot have been absent from his mind.

[2] *EN* 1143b5; cf. *Met.* 1036a6. How often is A.'s terminology confusing, but his thought perfectly clear! At *De an.* 432a2 (using his psychological terminology according to which the human *psychē* is the form of the living, sentient and thinking body, pp. 282ff. below) he contrasts νοῦς as the 'form of forms' with sensation as the 'form of sensibles'. This does as well as the equation of the two to make the single point that the essential object of sensation is the sensible individual, though νόησις gives us at the same time a glimpse of its specific form.

[3] *An. Post.* 90a26–30. A loose use of εἰδέναι, not at all surprising in A. As an insufficient but necessary condition of knowledge, sensation gives a 'sort of' knowledge (*Phys.* 247b6 in Ross's text): the knower ἐπίσταται πως τὰ καθόλου τῷ ἐν μέρει. With the above passage cf. 88a12: 'In some cases if we could witness ["see" in its literal sense] the event we should stop enquiring, not as knowing by the act of seeing but as having, through seeing, got at the universal.' He adds an example from a contemporary theory about burning-glasses. If we could see the perforations in the glass, and the light streaming through, it would be clear to us why it burns, through seeing each case individually and intuiting (νοήσει) simultaneously that it is the same in all. Νοῦς and sensation are analogous in that each bears the same immediate relation to its object. 'Νοῦς corresponds in the soul to sight in the eye' (*Top.* 108a9–11).

in any subject must start. 'By *nous* I mean the original source (*archē*) of scientific knowledge' (*An. Post.* 88b36).

So much for *nous* in relation to induction. In Aristotle's psychology it had a network of related meanings, and will recur elsewhere.[1]

BIOLOGICAL NOTE: THE GALL-LESS ANIMALS

Light is thrown on Aristotle's choice of this example by *PA* 4 ch. 2, where he discusses the claim of some older physiologists that lack of gall or bile was conducive to longevity. The three species mentioned in the logical works do not correspond to those in the biological. *HA* 506a21–b5 lists deer, roe, horse, mule, donkey, seal, some kinds of pigs, elephant and dolphin. In a similar list at *PA* 676b28–77a3 he remarks that the camel has no separate gall-bladder, but 'what might rather be called "veins of bile"'. Some men have it, others not, and the same is true of sheep and goats (676b29–31. 'In men its absence is rare', Peck *ad loc.* in Loeb ed.). 'This', he continues, 'has caused a dispute about the species as a whole, for the observer assumes that whatever be the condition of the specimens he has happened to meet is the condition of all' – a warning against premature generalization.[2] F. H. A. Marshall in his foreword to the Loeb edition adds (p. 5): 'In the section on the gall-bladder, as in so many other passages in his works on natural history, it is truly remarkable how correct Aristotle is in his statements. He points out that the gall-bladder is not found either in the horse and ass or in the deer and roe, but is generally present in the sheep and goat.'

Von Fritz ('Επαγωγή, 45) obtained further information from his colleague the Professor of Zoology and Comparative Anatomy at Münich, which clears up a possible confusion.

'All animals mentioned by Aristotle as lacking gall do in fact produce it but except for man have no gall-bladder. The gall flows direct from the liver, where it is produced, to the digestive system where it is used. The 'sweetness' of the liver noted by Aristotle in the gall-less animals [677a22–25] is explained by the fact that when a beast is slaughtered the glycogen stored in the liver is transformed into sugar. Conversely the observed bitterness of the liver in animals which have gall-bladders is the result of gall from the gall-bladder entering the liver by osmosis, which cannot happen in animals without the bladders. Thus Aristotle's example depends on genuine observation, though inadequate in two respects: first, the absence of

[1] Pp. 308f. below. An amusing example of another use is Plutarch's anecdote about A.'s comment on Callisthenes, executed by Alexander: 'He was a powerful talker, but had no *nous*' (p. 38 above).

[2] Such premature generalization is possible if one confuses a συμβεβηκός with a καθ' αὑτό predicate. See pp. 147f. above.

a gall-bladder was mistakenly equated with the absence of the gall itself;[1] secondly, it was mistakenly believed that man had no gall-bladder [? 676 b 29–33, W.K.C.G.], which was probably partly due to the fact that human anatomy was at that time very little studied.'

I include this note, which may seem out of proportion, as a reminder that biology, and especially zoology, was one of Aristotle's leading interests and made great progress under his and his colleagues' hands. In a general work this fact must inevitably receive less attention than it deserves, especially in its details; yet anyone wishing to understand the motivation of his philosophy must keep it constantly in mind.

(4) SYLLOGISM, INDUCTION AND THE QUEST FOR KNOWLEDGE

> Let us not forget that arguments from the *archai* and to the *archai* are different. Plato did well to raise the question whether progress is from or towards them . . . We must begin from what is known, but that is ambiguous; some things are better known to us, others absolutely. Presumably we must begin from what is known to us.
>
> *EN* 1095 a 30–b 4.

A brief recapitulation may not be superfluous. In his account of syllogism, or deductive inference, Aristotle showed the progress of science (ἐπιστήμη) as consisting of argument downwards from certain primary premises (προτάσεις πρῶται, ἄμεσοι) or widest generalities to particular conclusions. The conclusions therefore are reached by a process of discursive reasoning (ἐπιστήμη ἅπασα μετὰ λόγου) from premises logically prior or better known (προτάσεις πρῶται, ἄμεσοι). Since no progress can be made by going back for ever seeking further premises from which to deduce our premises, we must assume a set of propositions or principles which are logically *prime*. These are, for a particular science like zoology the widest genera with their definitions, for mathematics the axioms and the admission and definition of certain fundamental concepts like number and extension and for science in general – what Aristotle calls *epistēmē* and we might call the philosophy

[1] Peck regularly translates χολή by gall-*bladder*, except where the sense makes it quite impossible (even at 677 a 21–22, where though it is not repeated, it has to be rendered first 'gall-bladder' and then 'gall').

of science – (*a*) the categories, substance, quality etc., into which any object of knowledge must fall, and (*b*) a few logical axioms whose acceptance he demanded, such as the laws of contradiction and excluded middle.[1]

These primary postulates are evidently not known by deductive reasoning from prior premises, which *ex hypothesi* there cannot be. How we know them was stated in the last chapter of the *Posterior Analytics*. 'It is clear then that it is by induction that we come to know the first principles, for by this means sensation itself implants the universal.' The human *psyche* is such as to be capable of an argument of this type: *a*, *b* and *c* are particulars possessing the same essential form *f*; *a*, *b* and *c* can be observed to possess the attribute *p*; hence it may be inferred that all members of the species *f* possess the attribute *p*. It was inductive inference that led to the abstraction of the common form *f* in the first place, and induction again that led to the inference that all members of that form or species possess the attribute *p*. When therefore we start to reason syllogistically from the premises 'All *f*'s are *p*', the way we arrived at the premise itself is the way of induction.

So much for recapitulation. It is still sometimes said that the methods advocated by Aristotle are deductive rather than inductive.[2] This is natural if great attention is paid to his formal logic, in which he tried to reduce all argument to syllogistic form. We also saw that, within the strictly formal limits, the feat was not impossible. But it becomes impossible as soon as the attempt is made to apply logic to the scientific search for truth, because it provides no means of making the first generalizations from the mass of unordered facts by which we are

[1] A. is at an interesting stage in the history of knowledge. The several scientific disciplines are still a part of philosophy, and indeed fall within the province of the same philosopher; but at the same time it is with A. that one can see the first signs of future breakaway and specialization, notably in this idea that each separate science has its own ἀρχαί as well as those common to ἐπιστήμη or φιλοσοφία as a whole. Complete separation was long in coming. The title 'Professor of Natural Philosophy' at Cambridge is doubtless only an interesting fossil, but it must have meant more when in 1795 one Charles Hutton produced a Dictionary of 'the several subjects comprized under the headings Mathematics, Astronomy, and Philosophy both natural and experimental'.

[2] Cf. p. 183 n. 4 above. But doubtless some will still agree with Grote that his practice was not up to his preaching (*Arist.* II, 264): 'While A. thus declares Induction to be the source from whence Demonstration in these separate sciences draws its first principles, we must at the same time acknowledge that his manner of treating science is not always conformable to this declaration, and that he often seems to forget Induction altogether.'

surrounded. And it is hardly an exaggeration to say that to do this was Aristotle's chief philosophical aim.

I spoke earlier of what I called his 'commonsense realism'. This is manifested in his distrust of any argument which he could stigmatize as *logikon*, 'abstract'. A constant complaint against his predecessors is that they argued 'abstractly' (*logikōs*) rather than 'according to nature' (*physikōs*). This applied notably to Parmenides, but is especially frequent in his criticism of Plato's Forms.

Met. 987b9: To make unity and numbers exist apart from sensible things (in which he differed from the Pythagoreans), and the introduction of the Forms, resulted from the abstract nature of his investigations.[1]
Met. 1069a26: The moderns [*sc.* Platonists] regard universals as substances, for the genera are universals, and these they prefer to call principles and substances owing to the abstract nature of their enquiries.
GC 316a6–14 gives both sides of the contrast:
Therefore those who are better acquainted with natural phenomena are better able to posit the kind of principles which will hold together over a wide area, whereas those who as a result of much abstract discussion have lost sight of the facts are too ready to give an opinion based on inadequate observation. The present subject [of indivisible magnitudes] shows up the difference between investigating *logikōs* and *physikōs*. The one [Platonic] school says there must be indivisible magnitudes because otherwise the ideal triangle will be many, but Democritus would appear to have relied on more relevant arguments drawn from nature.[2]

[1] διὰ τὴν ἐν τοῖς λόγοις σκέψιν. Cf. Plato's own confession in the *Phaedo* (99e): εἰς τοὺς λόγους καταφυγόντα ἐν ἐκείνοις σκοπεῖν τῶν ὄντων τὴν ἀλήθειαν. To A. it was indeed a 'running away' – from reality. A.'s expression here has elicited a remarkable variety of renderings: 'the study of things in propositions' (Taylor), 'enquiries in the region of definitory formulae' (Ross, similarly 'definitions' Owens, Wedberg), 'la considération des notions logiques' (Tricot), 'seine dialektischtheoretische Denkweise' (Düring, *Arist.*, 249; and on 250, 'seine spekulative Denkweise'), 'enquiring into the truth of things by arguments' (Evans), 'interest in dialectic' (Warrington, Hope). The idea reappears at *Cael.* 293a29: those who do not put the earth at the centre of the universe 'rely on *logoi* rather than phenomena'.

I cannot agree with Owen (*Symp. Ar.* I, 176 n. 4) that because A. says at 1029b13 πρῶτον εἰπωμέν τινα περὶ αὐτὰ λογικῶς ('first let us make some abstract linguistic remarks', Ross), 'this describes his own method'. For the different use of it in the *Analytics*, where it is opposed to ἀναλυτικῶς, see 82b35–6, 84a7–8, with Ross's notes. λογικόν, like λόγος itself, has a host of meanings, and the context must decide.

[2] It is interesting to speculate how A. would have turned out if he had known the work of Democritus but not Plato's. Needham, generously for one of his views, suggests (*Hist. of Embryol.*, 59) that 'Perhaps A. would not have made so many great discoveries if he had been more of a Democritus. For teleology is, like other varieties of common sense, useful from time to time.'

Aristotle would probably have maintained, unlike the modern scientist or philosopher of science, that the observations should be recorded with a completely open mind, and any hypothesis be based on them – a situation impossible even if it were desirable. (See pp. 110–11 above.) For him everything starts from induction, which with syllogism should be seen as two stages of the same process. The emphasis laid on each may vary, but they cannot properly be regarded as separate, contrasting methods. The formal perfection of the syllogism may give an impression of infallibility and make it more 'compelling' (βιαστικώτερον, *Top.* 105 a 18), and one is tempted to see the upward, inductive process as lacking in finality because based on an incomplete examination of particulars. In fact, however, the major premise of the syllogism is just such an inductive generalization, and the upward process has preceded the downward in every case. Here Aristotle acknowledges his debt to Socrates: 'One may justly accord two things to Socrates', he says (*Met.* 1078 b 27), 'inductive arguments and general definitions, both of which are concerned with the *archē* of knowledge; but Socrates did not allow separate existence to universals or definitions.' Socrates's attempts to make his interlocutors abstract the *eidos* from the various examples with which they first presented him (e.g. at *Meno* 78 c) constituted an early attempt at the inductive method as understood by Aristotle.[1] But whereas Socrates had been interested in applying it to moral questions (*Met.* 987 b 1), Aristotle sought to apply it to the whole field of knowledge. Science, he claimed, depends on statements of cause which 'could not be otherwise'; but our knowledge of these necessary truths (truths about forms and essences) is derived by induction from sense-perception.

This point he expresses by his distinction between what is nearer and more easily known to ourselves and what is more knowable, in its own nature, and to this we must now return. (Cf. p. 174 above).

An. Post. 71 b 33–72 a 5: The terms prior and more knowable are used in two senses, for it is not the same thing to be prior in nature and prior in relation to us, nor more knowable[2] in nature and more knowable to us. By

[1] On Socrates and induction see vol. III, 425–30.

[2] Barnes may be right to say (*An. Post.*, p. 100) that 'known' is better than 'knowable' here; but it will hardly do to avoid the difficulty of finding a comparative form for 'known' by substituting 'familiar'. The γνωριμώτερα ἁπλῶς are certainly not 'more familiar'.

prior and more knowable in relation to us I mean those things which are nearest to sense-perception, by prior and more knowable in an absolute sense, those which are further from sensation. Now the things which are furthest from sensation are the universals, and those that are nearest are the individuals.

Met. 1018b32–34: Logically speaking universals are prior, but in sensation individuals precede them.

Met. 1029b4–12: Learning proceeds like this for everyone, from what is less knowable by nature to what is more so. Just as in conduct the task is to start from what is good for each and make what is good in general good for each, so now the task is to start from what is knowable to oneself and make what is knowable by nature known to oneself. What is known and primary to people individually can often be known only to a slight extent, and contains little or no reality.[1] Nevertheless from what is poorly known but known to oneself one must try to understand what is knowable in the universal sense, passing, as has been said, by way of just those things that one understands.

This distinction determines the scientist-philosopher's programme. Starting from perception of individuals, and respecting the primary and indemonstrable *archai*, he forms by induction concepts of increasing generality. These give a truer kind of knowledge – knowledge of what is logically prior – which he uses to form the premises of demonstrations ('scientific syllogisms').

Is the progress of knowledge from particular to general or vice versa? So far the answer seems obvious. We must start from the evidence of our senses, which makes us directly aware of the particular, and proceed from that to general concepts. Yet here as in other matters Aristotle's expression, as he singlemindedly pursues one train of thought or another, is such as to have misled scholars into accusing him of doubt or inconsistency. The trouble arises from his statement at the opening of the *Physics*:

Every branch of knowledge and understanding which has principles (*archai*) causes and elements, develops through acquaintance with these. That is what we mean by knowing a thing, namely knowing its primary causes and principles down to its simplest elements. Evidently then in the case of

[1] Individuals – the 'primary substances' – have little or no reality? This will have to wait until the next chapter.

natural philosophy itself we must begin by trying to determine its principles. The natural progress is from what is more knowable and plain to us to what is plainer and more knowable by nature,[1] for what is knowable relatively to us is not the same as what is more knowable absolutely. That is why the method must be to advance from what is naturally more obscure but plainer to us to what is clearer and more knowable by nature. Now what at first appears to us clearly and vividly is rather what is confused, the elements and principles of which become known later as we analyse the mass. *Hence we must advance from generalities to particulars*,[2] for the whole is more accessible to sensation, and the universal is a kind of whole, embracing many part-like elements. The relationship is something like that between name and *logos*: a name, for instance 'circle', signifies an undifferentiated whole, but the definition analyses it into its various components.[3] Similarly children begin by calling all men 'daddy' and all women 'mummy', but later distinguish each one.

The italicized words look at first like a flat contradiction of the method elsewhere advocated, depicting the advance of knowledge as from the particular (sensible object) to the universal (definition, law or axiom), and so we have such verdicts as 'Aristotle appears to be in some doubt on this point' (Evans). But he is simply looking at the subject from another angle. The key lies in the mention of the linguistic behaviour of children, their primitive erroneous generalization. 'The general' or 'universal'[4] refers to something different in each account. In the *Analytics* it signifies the properly thought-out and defined concept of a specific or generic form which the mind has

[1] So again at *De an.* 413a11–12, ἐκ τῶν ἀσαφῶν μὲν φανερωτέρων δὲ γίνεται τὸ σαφὲς καὶ κατὰ τὸν λόγον γνωριμώτερον.

[2] διὸ ἐκ τῶν καθόλου ἐπὶ τὰ καθ'ἕκαστα δεῖ προιέναι, 184a23.

[3] I hardly think that A. could have spoken of the relation between ὄνομα and λόγος, using the example of a circle, without having Plato in mind. (Cf. *Ep.* 7, 342b; vol. v, 404.) Partly for this reason, of the two alternatives mentioned by Ross (*Phys.*, 457f.), I would suppose him to mean by καθ'ἕκαστα the separate components of the definition (ὁρισμός 184b2), i.e. genus and differentiae. This suits the context well. What the philosopher has to do is διαιρεῖν or διορίζειν τὰ συγκεχυμένα, take the confused crowd of dogs, trees etc. and extract definitions of them, as of their genera and sub-species. The distinction between being knowable to us and knowable absolutely reappears in connexion with definition at *Top.* 141b3ff. Genus and differentiae are more knowable than and prior to species in the absolute sense because if they are abolished the species disappears too. (The note here sounds like an afterthought: notice τρόπον τινά, there is 'a kind of analogy'.)

[4] I have translated the same expression τὸ καθόλου as both. Quite literally it means 'the "as a whole"'. It must be emphasized that its application here to τὰ συγκεχυμένα is most unusual. For the definition of its standard use see *An. Post.* 73b26f.

abstracted by analysing the individual objects of sense, the result of a completed process of induction. Here in the *Physics* it means the first unanalysed flood of impressions which strikes our senses continuously. The *Analytics* maintained that when we see Callias we are made aware for the first time, in a rudimentary way, of the form of man, of which repeated experience plus intellectual activity can give us knowledge. But in the course of an ordinary day we may see dozens if not hundreds of men. A rational creature just arrived from another planet, having pointed at Callias and been told 'Callias', might say to himself, 'Ah, more Calliases', like the child who calls the visitors 'Daddy'. Nor will our senses have been bombarded only with men, but with trees, dogs, houses and many other kinds of object. These confused impressions (συγκεχυμένα) are what he refers to in the *Physics* as 'the general', what presents itself 'as a whole' (καθόλου), from which, to gain knowledge, the seeker must learn to identify and define each sort separately.

Thus when Aristotle says that knowledge advances from particular to general, he means from the perception of a single individual like Callias, via the sight and sound of other individual men, to an understanding of the concept 'man'; by the advance from general to particular he means that from a confused mass of immediate sensations, an infinite plurality of which no real knowledge is possible,[1] we advance to each single concept, the ἕν κατὰ πολλῶν, the unity which pervades and is predicated of every member of a definable class.

A final note: potential and actual knowledge. We are familiar with Aristotle's steadfast belief that though the foundations of knowledge are laid by sensation, sensation, for reasons expounded in the *Posterior Analytics*, is not itself knowledge. To know x is to know its cause, and only the universal supplies the cause (p. 173 above). In the last chapter of *Met.* M he has given some interpreters a shock in tackling what has struck him as a difficult problem for himself as well as the Platonists. If, he says (evidently with the Platonic Forms in mind), one denies that real substances (οὐσίαι) exist separately in the way we say that individuals do, substance as we understand it is abolished. If on

[1] The *apeiron* of Plato, *Phil.* 16 d–e. The whole passage 16c5–17a5 offers a foretaste of A.'s methods. Cf. also *Met.* 1018b32–34 with *EN* 1095b3–4.

the other hand one grants them separate existence, what becomes of their elements and principles? It is not the problem that is of interest at the moment (for that see the judicious discussion by Annas in *Met. M and N*, 188–92), but a remark which he makes in suggesting a solution. He first repeats (1086 b33), with reasons, what one expects, that knowledge is of the universal, then proceeds at 1087 a15 as follows:

> This presents the greatest difficulty of all, but it is true in one sense and not in another. Knowledge, like the act of knowing, is twofold, potential and actual. The potentiality, as matter, is universal and indefinite, and so is its object, but the actuality, being definite, has a definite object, *this* knowledge of *this* thing. The eye sees *colour* incidentally, because *this* colour which it sees is colour, just as the letter a which the reader looks at is *an* a. Evidently knowledge is in one way universal, and in another way not.

This is another example of the sort of thing for which I tried to prepare the reader in ch. v. We are not dealing with works prepared for publication, but with notebooks, and faced with different problems Aristotle is always ready to try out an *ad hoc* solution. Apparent obscurity or inconsistency may reveal nothing more substantial than a variation in terminology. One thing certain is that 'universal *and indefinite* (ἀόριστος)' cannot describe the object of definition, the articulated concept of the form, which gives the knowledge of which perception provided the new material. In that sense sensation itself was potential knowledge, actualized by induction. (Cf. p. 182.) The 'indefinite universal' as potential knowledge must be the first awareness of, say, man evoked by the sight of a single individual (p. 183 above; the example of colour here is precisely parallel). There is a sense in which 'sensation itself implants the universal', and his expression here does not affect the kernel of his epistemology.