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Aristotle's Considered View of the Path to Knowledge

Two apparent discrepancies mar Aristotle's discussion of 'the path to knowledge'—i.e. the means by which one attains a complete and accurate grasp of a subject. First, while the account in the *Posterior Analytics* focuses on constructing the special kinds of syllogisms that qualify as demonstration, when we turn to Aristotle's scientific treatises, fully worked-out syllogisms are nowhere to be found.[i] Second, according to the *Analytics*, the path to knowledge begins from the perception of sensible particulars, advances through the formulation of universal concepts and principles, and ends in a grasp of the subject grounded in a knowledge of its ultimate or 'un-middle' principles. In Book I of the *Physics*, however, Aristotle speaks in just the opposite terms, describing the natural path toward knowledge as beginning *from universals* and advancing *toward particulars*.[ii] In what follows I argue that these inconsistencies in wording and practice reflect the existence of two distinct Aristotelian views of inquiry, one peculiar to the *Posterior Analytics* and the other put forward in the *Physics* and practiced in the *Physics* and in other treatises.[iii] Although the two views overlap to some degree (e.g. both regard a rudimentary understanding of the subject as an essential first stage), the view of the syllogism as the workhorse of scientific investigation and the related view of inquiry as a search for the 'missing middle terms' turn out to be ideas peculiar to the *Analytics*. Conversely, the techniques of analysis and differentiation highlighted in the *Physics* account receive only cursory attention in the *Analytics*. However, when we consider the character of Aristotle's own inquiries, on both scientific and

philosophical topics, it becomes clear that it is the *Physics* rather than the *Posterior Analytics* that gives us Aristotle's considered view the path to knowledge.

I The *Analytics* Account of Inquiry

In the *Posterior Analytics* Aristotle famously equated scientific knowledge (*epistêmê*) with demonstration (*apodeixis*), and defined the latter as a certain kind of syllogism:

> …the premises of demonstrated knowledge must be true, primary, immediate, better known than and prior to the conclusion, which is further related to them as effect to cause…Syllogism there may indeed be without these conditions, but such syllogisms, not being productive of scientific knowledge, will not be demonstration. (I, 2, 71b)

As I understand them, the phrases 'better known than', 'prior to the conclusion', and 'related as effect to cause' all zero in on a single requirement: in a scientific demonstration the premises must relate to the causes of things (e.g. the fact that the planets are near to us); while the conclusions must relate to their effects (the fact that the planets do not twinkle), rather than the other way around. The requirement that the premises of a demonstration be 'primary' and 'immediate' means that we do not know a thing in a scientific way until we are in a position to trace it back to its ultimate 'reason why'. In addition, for Aristotle, scientific explanations must: (1) take the form of universal generalizations rather than partial claims or statements about individuals (cf. *Meta* I, 2 and *Apo* I 24 and II 19); (2) assert necessary connections (*Apo* I 4, 73b 16ff.); and (3) and be organized around the first-figure syllogisms Medieval students of logic knew as 'Barbara' and 'Celarent' (*Apo* I, 14). To use one of Aristotle's stock examples: we can explain, and thereby come to know in a scientific way, why equilateral triangles possess 180 internal degrees by utilizing our knowledge that all equilateral triangles are, of necessity, triangles and that all triangles, of necessity, possess 180

interior degrees. And since we succeed in explaining the connection between our subject and predicate terms by supplying the appropriate middle term—the M—scientific inquiry may also be described as 'the search for the 'middle':

> We conclude that in all our inquiries we are asking either whether there is a 'middle', or what the 'middle' is: for the 'middle' here is precisely the cause, and it is the cause we seek in all our inquiries. (*Apo* II 1, 90a)[iv]

But while the process of acquiring knowledge centrally involves the construction of syllogisms that meet these formal requirements, this activity cannot go on for any length of time in an informational vacuum. In order for scientists (using the term 'scientists' in a way broad enough to include mathematicians, astronomers, biologists, as well as philosophers) to be able to construct their syllogisms, they must become aware of a sufficiently large number of subjects and attributes with which to create the premises of their demonstrations. And these items, so we are told at *Apr* I 30, 46a, they have to get from experience:

> The method is the same in all cases, in philosophy, and in any art or study. We must look for the attributes and the subjects of both our terms, and we must supply ourselves with as many of these as possible…consequently it is the business of experience to give the principles which belong to each subject. I mean for example that astronomical experience supplies the principles of astronomical science, for once the phenomena were adequately apprehended, the demonstrations of astronomy were discovered. Similarly with any other art or science. Consequently, if the attributes of the thing are apprehended, our business will be to exhibit readily the demonstrations. For if none of the true attributes of the thing had been omitted in the historical survey,

> we should be able to discover the proof and demonstrate everything which admitted of proof, and to make that clear whose nature does not admit of proof.[v]

The view of the sources and methods involved in the acquisition of scientific knowledge I have just sketched is not without its merits. As Jonathan Barnes noted[vi], it is a pioneering expression of the view of science as an axiomatic system, i.e. as a body of knowledge organized around the basic principles common to all sciences (e.g. the Law of Non-contradiction), as well as the specific axioms, postulates, and definitions appropriate to a particular discipline. Minus the syllogisms, it is also much the same vision of knowledge Plato articulated in *Republic* VI, when he spoke of the level of thought at which reason 'moves on through forms to forms and ends with forms' (511c). But Aristotle was able to explain, as Plato was not, how something so mutable and imperfect as sense perception can lead us to something so solid and reliable as knowledge: from many sensations of the same thing comes memory, and from many memories comes a single experience, and from many experiences arise the universal concepts and principles[vii] that constitute 'reasons why', the knowledge of which constitutes a correct scientific understanding of a given subject.

On the other hand, Aristotle's account faces a number of well-known difficulties. It ignores all forms of argumentation other than those that make use of one or more of the four basic categorical propositions—i.e. All S is P, No S is P, Some S is P, and Some S is not P. Even preserving the inferences Aristotle believed to hold among these four propositions (as displayed in what was later known as the Square of Opposition) requires that we make a blanket assumption concerning the existential import of all the subject and predicate terms

that appear in our propositions; i.e. that we assume that the things designated by our S, M, and P terms actually exist. But neither in science nor in daily life do we always wish to commit ourselves to the existence of all the items we are discussing (consider, for example, the point of asserting that 'all trespassers are subject to prosecution'). A syllogistic science, moreover, can handle only a small fraction of all the quantities the scientist will need to consider. An Aristotelian scientist can consider the consequences of all, some, or no S being P, but not the consequences of an S that weighs 6.5 grams, has an internal temperature of 100 degrees centigrade, or travels at 344 meters per second. Aristotle speaks, moreover, as though all a scientist needs to do in order to explain some phenomenon is to gather up enough subject and predicate terms with which to construct one or more explanatory syllogisms. What we miss here is some acknowledgement of how difficult it may be to identify the causally relevant attribute; e.g. what triggers a particular cell to begin unbridled growth, or which specific atmospheric conditions spawn tornadoes. It is also disconcerting to see Aristotle, at some point in the 4th century BCE, speaking of the time at which 'all the astronomical phenomena were adequately apprehended… and the demonstrations discovered.' Finally, one must ask, whatever became of the *Analytics'* vision of science on the axiomatic model? Why do we not find Aristotle assembling subjects and predicates and arranging them within the first-figure syllogism he identified as the workhorse of scientific inquiry and explanation? The answer to this question, I believe, lies in Book I of the *Physics*.[viii]

II The *Physics* Account of Inquiry

Aristotle opens his account of *ta phusika*, 'the things of nature' with a description of what he calls 'the natural path' to knowledge:

> The natural path (*pephuke…hê hodos*) starts from the things that are better known and clearer to us (*ek tôn gnôrimôterôn hêmin…saphesterôn*) and proceeds towards those that are clearer and better known by nature (*ta saphestera têi phusei kai gnôrimôtera*), for 'things known to us' and 'things known without qualification' are not the same. (*Physics* I 1, 184a)

A similar view, stated in terms of what is better known and *prior* rather than what is better known and *clearer*, appears at the outset of the *Posterior Analytics* (I 2, 72a):

> I call prior and better known in relation to us (*pros hêmas men protera kai gnôrimôtera*) what is nearer to perception (*ta egguteron aisthêseôs*), prior and better known *simpliciter* what is further away (*haplôs de protera kai gnôrimôtera ta porrôteron*). What is furthest away are the most universal things (*ta katholou malista*) and what is nearest are the particulars (*ta kath' hekasta*); and these are opposite (*antikeitai*) to each other. (*Apo* I 2, 72a)

Both of these ways of speaking of 'what is better known' square with the story we find at *Posterior Analytics* II 19 and in *Metaphysics* I: the path toward knowledge begins from our perception of the sensible particulars (*ta kath' hekasta*) and advances toward the grasp of the universal (*to katholou*), i.e. the universal concepts and principles with which scientists construct their demonstrations:

> So out of sense perception comes to be what we call memory, and out of frequently repeated memories of the same thing develops experience, for many memories constitute a single experience. And from experience, or rather[ix] from the whole

> universal established within the soul, the one beside the many which is a single identity within them all—originate skill and scientific knowledge (*archê technês kai epistêmê*), skill in the sphere of coming to be and scientific knowledge in the sphere of being. (*Apo* II 19, 100a)[x]

At this point, however, Aristotle proceeds to speak in precisely the opposite terms: that which lies nearer to sense perception is *to katholou*: 'the universal'[xi], and the natural path of inquiry is said to proceed from universals to the particulars:

> Now the things that are at first plain and clear to us are the rather confused masses (*ta sungkechumena mallon*), the elements and principles of which later become known by analysis (*diairousi*). Thus we must advance from the universals (*ek tôn katholou*) to the particulars (*epi ta kath' hekesta*), for it is the whole (*to holon*) that is best known to sense perception and the universal is a kind of whole (*to katholou holon ti esti*), since it comprehends many things as parts. (A 1, 184a-b)

This, it must be admitted, is not a crystal clear set of remarks. What, one must wonder, are the rather confused masses that are the wholes and universals; and what for that matter are the wholes and universals? What, moreover, are the elements and principles that are the particulars? By way of explanation Aristotle compares the inquiry that begins from the universal with the way in which we give an account or definition of a single term:

> Much the same thing happens in the relation of the name to the account. A name, e.g. 'circle' (*ho kuklos*) means vaguely a sort of whole, whereas its definition (*horismos*) analyzes it into its particulars (*ta kath' hekasta*). (A 1, 184b)

This explanation is itself puzzling since one would normally expect a definition of 'circle' to analyze it in terms of its *genus* ('plane figure') and *differentia* ('such that all points on its circumference are equidistant from a given point'), and these are not 'particulars' in any obvious sense. But, as W. D. Ross explains in his commentary:

> ...*ta kath hekasta* seems to have here an unusual meaning; i.e. to mean the various senses of an ambiguous term. Though it is essentially the business of definition to state the logical elements of a complex term, incidentally in doing this it will distinguish the various meanings of the term if this happens to be ambiguous.[xii]

And, in fact, the word *kuklos* is extremely well suited to make Aristotle's point. The standard Greek lexicon lists its various senses as 'ring', 'place of assembly', 'circle of people', 'wheel', 'circular dance', 'round shield', 'vault of the sky', 'disc of the sun', 'wall around the city', 'eye ball', 'orbit of the sun', and 'revolution of the seasons'.[xiii] So if inquiry involves 'much the same' sort of activity as the one we engage in when we set out the different definitions of a term then we should expect to engage in a process of analysis much like disambiguation, but focusing on the various elements, principles, and causes that constitute a thing's nature rather than on the various senses of an expression.

Aristotle next likens inquiry to the way in which a child 'begins by calling all men fathers and all women mothers but later distinguishes each of these' (A 1, 184b); i.e. at some point a child uses the terms 'father' and 'mother' in connection with men and women who are neither his father nor mother and only later learns the correct, more restricted scope of the terms.[xiv] The lesson, evidently, is that in all our inquiries we naturally begin with a somewhat vague understanding of some (complex) item and move toward knowing what it is by

analyzing into its component elements, principles, and causes. The end result is a clear sense of what a thing is, what different forms it may take, and how it differs from other things with which it might easily be confused or mistaken. We might characterize such a process of inquiry as 'the pursuit of knowledge through analysis into constituent and defining elements, followed by differential description in the light of the results of that analysis'.

We can get a clearer sense of the process Aristotle has in mind here by reviewing the account he proceeds to offer in the *Physics*. In *Physics* I he reviews the accounts given by earlier inquirers into nature, clarifying in the process the sense in which things can be said to be 'one', since 'the most pertinent question with which to begin will be this: In what sense is it asserted that all things are one' (I 2, 185a). He then distinguishes the different ways in which earlier thinkers had spoken of things either as one (e.g. either as one in substance, underlying substrate, quantity, or quality, and as either continuously or discontinuously one), or as more than one (e.g. as multiple elements or as contraries). In *Physics* I 7 he states his own view:

> We shall now give our own account, approaching the question first with reference to coming to be in the widest sense (*peri pasês geneseôs*): for we shall be following the natural order (*kata phusin*) if we speak first of common characteristics (*ta koina*), and then investigate the characteristics of special cases (*ta peri hekaston idia*). (189b)

After distinguishing between the coming into being of a substance and mere qualitative coming into being, he identifies the three principles essential to both—the two contrary states present before and after the change, and a third thing, the substratum which persists throughout the process, explaining in passing how this tripartite framework avoids the

difficulties that beset the views of Parmenides and other early thinkers who claimed it was impossible for anything to come to be from 'what is not'. Book II begins with an analysis of the concepts of nature, by nature, and according to nature, before turning to distinguish between the different ways in which we speak of the causes of physical change. 'Chance' and 'spontaneity' require discussion in so far as they are counted among the causes of change, as do 'necessity' and things that act 'for the sake of something'. Since 'nature' has been defined as 'a principle of motion and change' it is clear that we must distinguish among the kinds of motion and change, '…since there are as many types of motion or change as there are meanings of the word "is"' (III 1, 201a). Later books of the *Physics* take up and resolve other issues related to motion—the nature of place, the void, and time, distinguishing along the way finite from infinite motion, and continuous from discontinuous motion. An apt subtitle for the work might be: '*ta phusika*: an analysis of the ways in which we speak and think about the things that come into being, move about, and change, informed by a review of the opinions of earlier thinkers, with specific attention paid to the particular principles, elements, and causes that serve to distinguish the different kinds of coming into being, movement, and change from each other.'

The account of the soul in the *De Anima* follows along the same lines. After reviewing earlier accounts which had plausibly associated the soul with the capacities for movement, sensation, and perception, and less plausibly with harmony and the idea of a self-moving number, Aristotle sets out his preferred definition of the soul using two of his favorite explanatory notions, potentiality and actuality: the soul is 'the first actuality of a natural body

having life potentially in it' (*De Anima* 412a-413a). In a passage strongly reminiscent of the methodological remarks in Book I of the *Physics* he explains that:

> Since what is clear and theoretically better known (*to saphes kai kata ton logon gnôrimôteron*) emerges from what is in itself obscure but more observable to us (*ek tôn asaphôn kai phanerôterôn*), we must reconsider our results from this [observational] point of view (413a).

Since what is evident to us from observation is that the things believed to possess soul are living beings endowed with the capacity for, or 'first actuality' of, self-nutrition, sensation, thought, and movement, we must survey the ways in which these capacities are distributed among different kinds of animate beings. Giving an exact account, he explains, will require focusing on the souls of plants, animals, and human beings in particular (414b-415a). To put it very briefly, the remainder of the *De Anima* consists of a series of accounts of the identifiable 'first actualities' or organized capacities of nutrition, sensation, thought, and movement, with each of these analyzed into their constitutive elements. In the discussion of sensation, for example, Aristotle examines the different sense faculties, the objects peculiar to each, and 'the common sensibles' [things perceived by more than one sense], with the general finding that in each case sensation involves reception within the sense organ of the sensible form without the matter. An apt subtitle for the work might be; '*peri psuchês*: an analysis of the ways in which we speak and think about living creatures, informed by a review of the opinions expressed by earlier thinkers, with specific attention paid to the principles, elements, or causes that serve to distinguish the different psychic capacities from each other.'

When we turn to the biological treatises we find less attention devoted to 'the ways in which we speak and think about things' and more to the internal and external organs, faculties, modes of reproduction, courses of development, and ways of life that serve to distinguish different species of animals from one another. While the *Historia Animalium* focuses on identifying the parts possessed by different kinds of animals, the *Parts of Animals* undertakes to explain why animals have the particular parts they do. But in both accounts there is a general movement from generalities to specifics, from wholes to parts. In Book I of the *Historia Animalium*, after providing a lengthy survey of various ways in which animals differ from one another (e.g. some animals produce live offspring while others lay eggs), Aristotle comments:

> These preceding statements have been put forward as a kind of foretaste of the number of subjects and of the properties that we have to consider in order that we may first get a clear notion of their actual differences and common properties, By and by we shall discuss these matters with greater precision. (*HA* I 6, 490b)

At the outset of the *Parts of Animals* he similarly states:

> …the true method is to state what the definitive characters are that distinguish the animal as a whole; to explain what it is both in substance and form, and to deal after the same fashion with its several organs; in fact to proceed in exactly the same way as we should do if we were giving a complete description of a couch. (*PA* I 1, 641a)

The two biological inquiries have different objectives in view—detailed description of parts in the first case, and development of causal explanations in the second—but both illustrate the general method of analysis and differential description set out in *Physics* I. Without passing judgment on the merits of each of these individual accounts, it seems clear that this

set of techniques enabled Aristotle to develop a set of detailed and attractive accounts on a wide range of topics.

III One Account or Two?

We have seen how in the *Prior* and *Posterior Analytics* Aristotle held that we come to have knowledge of a subject in an unqualified way when we able to establish that all S is necessarily P on the basis of our knowledge that all S is necessarily M and all M is necessarily P. In all our inquiries, so we are told, it is the task of experience to supply us with the middle terms that enable us to link subjects with their predicates, and it is our task to move toward a more adequate grasp of essential natures by packing in more and more 'middles' until we reach the ultimate or 'un-middled' principles of explanation. We have also seen how, according to *Posterior Analytics* II 19, the path of inquiry begins from the perception of sensible particulars and ends in the grasp of universal concepts and principles. In the *Physics*, however, Aristotle states that the natural path to knowledge starts from a somewhat confused awareness of some item and concludes with a precise understanding of its essential nature in the light of its particular principles, elements, and causes. How should we understand the relation between these two accounts?

At *Historia Animalium* I 7 Aristotle links the analytic process described in the *Physics* with the construction of demonstrative syllogisms described in the *Analytics* by characterizing demonstration as a stage of inquiry that naturally *follows upon* the detailed analysis of wholes into parts:

> After this [i.e. after identifying the parts of animals] we shall pass on to the discussion of causes. For to do this when the investigation of the details is complete is the natural method (*kata phusin*), for from them the subjects and the premises of our demonstration (*peri hôn te gar kai ex hôn einai dei tên apodeixin*) become clear. (Revised Oxford translation of 491a)

Similarly, in *De Anima* I, 1, he describes inquiry as a process in which we first develop an account of a thing's essential nature and then construct demonstrations that link up its characteristics with one another:

> …when we are able to give an account conformable to experience of all or most of the properties of a substance, we will be in a position to say the best things (*legein kallista)* about the essential nature of that subject; in all demonstration a definition of the essence is required as a starting point, so that definitions that do not enable us to discover the derived properties, or fail to facilitate even a conjecture about them, must obviously, one and all, be dialectical and futile. (402b)

In short: once we have identified the attributes which constitute a thing's essential nature, and made use of those attributes in order to formulate a definition of that nature, we can then demonstrate the necessary presence or absence of other attributes by reference to those in the initial set. To cite just one small example: once Aristotle has defined the 'what-ness of the soul' as 'the first grade of actuality of a natural body having life potentially in it' (412a) he then comments on:

> …the rightness of the view that the soul cannot exist without a body, while it cannot be a body; it is not a body but something relative to a body. That is why it is in a body and a body of definite kind. (414a).

While he does not explicitly make this point in the form of a syllogism (e.g. that all souls must exist within a body since all souls are first actualities of a body, and all first actualities of a body must exist within a body), he does nevertheless supply an explanation for a derivative property in the light of an established definition of the soul's nature. These two passages link up the account of inquiry given in the *Physics* with the one given in the *Analytics* in so far as they depict the process of analysis that leads to the formulation of a definition of essence as a stage preliminary to the construction of the special sorts of syllogisms that constitute demonstration.

It is also possible to regard the process of moving from the particular to the universal described in the *Analytics* and the process of moving from the universal to the particular described in the *Physics* as stages within a single larger process. [xv] It is one thing, for example, for a child to become familiar through repeated experience with the phenomenon of thunder as something like 'the loud noise in the sky' (what both the *Physics* and *Analytics* speak of as grasping 'the whole or entire universal'), and quite another for a scientist to achieve a detailed understanding of the phenomenon of thunder as, to put it in Aristotelian terms, 'the noise produced in the heavens by the quenching of fire'. Once we realize that it is one thing to advance from sense perception to a rudimentary understanding of what a thing is and quite another to move from that rudimentary understanding to being able to define a thing's essential nature in virtue of its constituent elements and causes, the apparent inconsistency between the two ways of speaking vanishes.[xvi] Thus, by drawing on comments made in different settings we can construct a single, logically consistent Aristotelian view of inquiry as a process comprising four distinct (though related) stages: (1) acquiring a

rudimentary conception of what a thing is as a consequence of repeated perception of individual instances (= 'grasping the whole universal'); (2) developing a detailed understanding of what it is to be a thing of this sort through the identification of its specific principles, elements and causes; (3) formulating a definition of a thing's essential nature in terms of the principles, elements, and causes just identified in stage (2); and (4) producing demonstrations (at least some of which might be put in syllogistic form) setting out the relationships that hold among the thing's essential attributes, as well as the connections that hold between those attributes and others, based on the definition formulated in stage (3).

This picture of inquiry, however, remains sharply at odds with two basic features of the *Analytics* account. Even though Aristotle is prepared to speak of demonstration in connection with a process of analysis and differentiation, it is clear that in these settings demonstration functions not as the framework for inquiry in its entirety, as the unqualified descriptions given in *Analytics* would lead one to suppose, but merely as its final, largely summative phase.[xvii] In addition, according to the *Analytics*, we advance toward complete mastery of a subject by identifying and inserting into our syllogisms a series of newly acquired middle terms. Nowhere in the *Physics*, *De Anima*, or any of the biological treatises, does Aristotle characterize the process of inquiry in such terms. Indeed, so far as I have been able to determine, outside the logical works there are only three occurrences of *to meson* in the sense of 'the middle term of a syllogism' in the entire Aristotelian corpus, and in none of those three passages is Aristotle discussing inquiry.[xviii] This striking pattern of distribution suggests that while Aristotle may have always had *some* role in mind for demonstration, it was only during the period when he was writing the *Analytics* that he conceived of inquiry as

a process in which we search for, find, and insert a series of middle terms into our syllogisms. While it is difficult to be sure about the course of his intellectual development, it seems plausible to suppose that at some point Aristotle began to move away from the syllogism-based understanding of the nature of inquiry set forth in the *Analytics* and toward the process of analysis and differentiation described in *Physics* I 1.[xix] Given the close correspondence between the *Physics* account and many of the inquiries Aristotle actually carried out, on both scientific and more broadly philosophical topics, it seems clear that it is the *Physics*, and not the *Posterior Analytics*, that presents us with Aristotle's considered view of the path to knowledge.[xx]

FOOTNOTES

[i] Hankinson (1995: 113) comments: '…one can trawl the whole of Aristotle's considerable scientific oeuvre without netting a single instance of a fully worked-out syllogism…Aristotle's commentators sometimes trouble to reformulate his arguments in syllogistic form—but Aristotle himself does not do so.'

[ii] Bolton (1991: 4) comments: 'However, in the passage in the *Analytics* such items [i.e. what is most accessible to perception] are said to be most opposed to and furthest from what is *katholou* (i.e. universal). This flatly contradicts what is said in *Phys*. I.1 unless, as most commentators reasonably conclude, the use of the term *katholou* in *Phys*. I. 1 is peculiar…'

[iii] Although the question of chronology is not vital to my argument, I believe that Aristotle conceived the view of inquiry presented in the *Analytics* prior to conceiving the view presented in the *Physics*. Certainly the *Analytics'* focus on knowledge as an axiomatic system is what one would expect to find in a work written early on in Aristotle's career, with a Plato-inspired regard for the importance of achieving a systematic understanding still part of his philosophical outlook. But the important point is to recognize the existence of contrasting views of inquiry, in whichever order they were conceived. For a set of informative if not decisive discussions of 'the developmental question' see Wians 1996.

[iv] Similarly, *Apo* I 6, 75a; I 8, 76a; I 11, 77a; and I 21, 82b. A somewhat different view is suggested by *Apo.* I, 12, 78a: 'A science expands not by the interposition of fresh middle

terms, but by the apposition of fresh extreme terms', but this may mean only that while a science is *completed* by the insertion of middle terms it is expanded or extended by means of additional extreme terms (see further Ross 1949: 550).

[v] This passage reveals Aristotle commitment to syllogism and demonstration in the context of the process of discovery, thereby providing reason to reject the view held by G. E. L. Owen that the theory of the syllogism 'plays small part in his scientific and philosophical inquiries just because it is not a model for inquiry but for subsequent exposition of the results of inquiry' (Owen 1975: 27), as well as the thesis defended by Jonathan Barnes that 'the theory was never meant to guide or formalize scientific research; it was 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' (Barnes 1975: 77). For a detailed critique of Barnes' thesis, see Wians 1989.

[vi] Barnes 1975: xiii.

[vii] My phrase 'universal concepts and principles' reflects one of the more salient difficulties in the discussion of the path from sensation to knowledge of first principles in *Apo*. II, 19. Aristotle there announces that he will explain how we come to know first principles and concludes that he has done so. But what he actually explains is only how we come to form universal concepts as a consequence of the repeated perception of sensible particulars. Perhaps the best way to handle this discrepancy is to believe that Aristotle thought that developing a (scientific) concept of X involved essentially the same set of activities as identifying the attributes that can be truly and universally ascribed to their subjects, hence

furnish the requisite universal principles. (A solution along these lines is suggested in Barnes 1975: 259-260).

[viii] Several attempts have been made to link the syllogism-based approach set out in the *Analytics* with Aristotle's actual practice in his biological treatises (see the studies by Bolton 1987, Lennox 1987, and Gotthelf 1987). While I accept the thesis that in these treatises Aristotle develops the ingredients with which syllogisms could be constructed, the fact remains that, so far as we can tell, he never actually constructs them. As I see it, the most plausible step to take in the light of this discrepancy between 'Aristotle's theory' and his practice is to revisit the assumption that it is the account in the *Analytics* that represents Aristotle's considered view of the nature of inquiry.

[ix] My 'or rather' reading of Aristotle's *ê* is justified by the distinction between 'experience' and the grasp of the universal that is characteristic of art and knowledge, as set out in *Metaphysics* I, 1. For one attempt to explain Aristotle's epistemology without the 'rather', see the discussion in Turnbull 1976.

[x] Similarly at *Apo* I 8, I 18, and I 31, scientific knowledge is said to consist in the grasp of the universal discovered by means of induction from the perception of sensible particulars.

[xi] I translate *katholou* throughout as 'universal' in part because Aristotle here suggests that the universal is merely 'a kind of whole' (*to de katholou holon ti esti*) and not literally a whole. It must be admitted, however, that Aristotle speaks here in a decidedly unhelpful manner—using the same term to speak of a perceptible compound that he elsewhere uses to speak of an entity that can be present 'in the soul' (cf. *Apo*. II, 19, 100a16: *proton men en têi psuchêi katholou*). Perhaps the best explanation for this peculiar behavior is that Aristotle understood the root meaning of *katholou* as 'that which is *kath holou*; i.e. 'on the whole', and

believed that there were various ways in which things could be spoken of as 'on the whole'. Thus in a sense *katholou* means the same thing in *Physics* I, 1, as it does in *Apo*. II, 19; namely: 'something on the whole'—either an observable whole, or an attribute that applies to an entire class of subjects. Wieland holds that '*katholou* here, of course, does note designate anything general in the sense of a class, but something general in the sense of *indeterminate*, something not yet differentiated into its factors' (1975:131). But while it is true to say that the compound is about to be analyzed into its factors, it is not plausible to suppose that *katholou* here *means* 'indeterminate'.

[xii] Ross 1936: 457.

[xiii] Liddell and Scott. 1976, s.v. *kuklos*.

[xiv] As Konstan (1975: 242) explains, this does not mean that children unable to distinguish their fathers from other men, or their mothers from other women: '[Aristotle] says only that they do not know that fathers and mothers are something different from men and women generally'.

[xv] I follow Reeve in crediting Aristotle with a distinction between the 'first or whole universals' and the 'well-understood or analyzed universals' (Reeve 2000: 18-20). I do not, however, agree with his view that the process by which the scientist comes to an understanding 'is itself inductive' (p. 20). That is indeed the story told in the *Posterior Analytics* II, 19, but not the one told in *Physics* I.

[xvi] The account I present here represents one of several possible ways out reconciling these two ways of speaking of 'universals' and 'particulars'. For other approaches, see Konstan, 1975, Turnbull 1976, Bolton 1987, and Angioni 2001. Without passing judgment on the merits of each of these approaches, it is important to see that establishing the consistency of

the *Physics* and *Analytics* accounts *on this point* does not establish that Aristotle had a monolithic view of the nature of inquiry. Similarly Modrak1996 shows how on a number of specific points Aristotle's practice as a scientific investigator is consistent with the general theory of knowledge he set out in the *Posterior Analytics*. But she does not discuss whether Aristotle remained committed to demonstration as the framework for scientific investigation in its entirety and to view of inquiry as the search for the missing middle term. In the light of these differences it does not appear to be correct to say that 'all of Aristotle's methodological discussions endorse the central tenets of the *Analytics* picture' (p. 170).

[xvii] Ferejohn 1991 argues that in the *Analytics* Aristotle conceives of inquiry as admitting of at least two stages—an initial 'framing', definitional stage and syllogism proper. This seems correct, but various remarks Aristotle makes in the *Analytics* make it clear that he sees demonstration as the main task of the investigator, with definition playing an ancillary role (see the somewhat labored discussion of definition and its relation to demonstration in *Apo*. II, 3-10).

[xviii] *De Anima* I 3, 407a29, *Metaphysics* V 3, 1014b2, and *Nicomachean Ethics* VI 9, 1142b24. For a full listing see Bonitz 1870: 456-457, s.v. *mesos*. Forms of *mesos* occur often in various settings (e.g. in the doctrine of the mean). *To meson* occurs twelve times in the *Physics*, but it there designates the mid-point of a movement or period of time (219a, 227a, 229b, 245a, 245b, 251b, 262a, and 264b). Similarly, *meson* appears four times in the *De Anima* but in connection with the view of sense perception as a mean between opposite qualities (423b, 424a) and with a line that is a mean between two unequal sides of a triangle (413a).

[xix] Otherwise we must conclude either that Aristotle simultaneously held two inconsistent views of the nature of inquiry or that he first developed a powerful set of analytic techniques and then abandoned them in favor of a syllogism-based approach to inquiry—which he never fully put into practice.

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