

Introduction

Dante refers to Aristotle as “il maestro di color che sanno,” the master of those who know.¹ But Aristotle typically refers to the works that have come down to us as ‘inquiries’ or ‘investigations,’ and in the pages that follow, I will make a case for Aristotle as “il maestro di color che cercano,” the master of those who inquire. The chapters to follow attempt to get clarity on Aristotle’s conception of inquiry, insofar as the goal of inquiry is scientific knowledge (ἐπιστήμη).² Does Aristotle see inquiry, as he clearly sees explanation, as a process constrained by epistemic norms – norms of inquiry, as I am calling them? That is, given that Aristotle has clearly articulated ideas about what the goal of scientific inquiry looks like, does he also have clearly articulated norms that must be adhered to if one is to achieve that goal?

Typically, when scholars ponder where to find Aristotle’s views on that topic, they turn to the second book of the *Posterior Analytics* (*APo.*), which begins by characterizing four different objects of inquiry “equal in number to things we know” (ἴσα τὸν ἀριθμὸν ὅσαπερ ἐπιστάμεθα, 89b23-24). That discussion operates, however, on a rarefied plane of abstraction – so rarefied that Aristotle is at times happy to exemplify the same philosophical thesis by means of examples drawn from geometry and botany. What that discussion provides, I argue in the chapters that follow, is an *erotetic framework* – a ‘logic of questions and answers,’ as it were – for *any* inquiry aiming at achieving scientific knowledge. Every such inquiry must operate within the general guidelines provided by this framework, which in turn is

¹ *Inferno*, Canto 4, line 131 (Durling 1996, 77).

² How best to translate this term is a matter of longstanding dispute. A tradition going back at least to Kosman 1973, and endorsed and further defended by Burnyeat 1981, would render it ‘understanding’ and stress the centrality of the capacity to explain or demonstrate to its possession. Since Aristotle uses a variety of terms to designate weaker and stronger forms of knowing, another option, challenged by Burnyeat, is ‘scientific knowledge,’ to indicate that ἐπιστήμη, at least in its unqualified form, is the sort of knowledge that one who has mastered a science has.

shaped by the detailed characterization of scientific knowledge provided in *APo.* 1. However – and this is among my central themes – this turns out to be the wrong place to turn if one wants to understand Aristotle’s views about the *norms of inductive inquiry* that must guide research in distinct domains. Many, if not most, of these norms, Aristotle holds, are domain-specific – local, not global.

Where then does one look for Aristotle’s thoughts about substantive norms of inquiry? Historians of philosophy and science face an obvious difficulty in attempting to answer that question: we have no written reports from those who observed Aristotle the inquirer, telling us how he carried out different inquiries; nor do we have (as we do with so many researchers from the seventeenth century on) his ‘lab’ or ‘field’ notebooks either, assuming some fourth century BCE analogues of such things actually existed.³ All we have are treatises reporting the results of his inquiries. Does that mean it is impossible for us to investigate his views about the norms that ought to guide actual research and the methods by which it should be carried out?

Fortunately, no: there are at least three fruitful sources of information to which we can turn in order to answer this question. First, Aristotle wrote a great deal, at different levels of abstraction, about how inquiry in general, and different kinds of inquiry, *ought* to be carried out.⁴ In fact after you finish this book, you may well conclude that he was obsessed by this subject! Thus, if we make the charitable assumption that Aristotle at least attempted to practice what he preached, then these normative discussions of inquiry ought to be a rich source of information about how he actually carried out his inquiries – or perhaps about what he learned about the nature of inquiry while engaging in them. Much of what Aristotle has to say on this topic is to be found in self-consciously methodological introductions to his various inquiries – *De partibus animalium* (*PA*) 1, *De anima* (*de An.*) 1.1, and *Nicomachean Ethics* (*EN*) 1.1–6 are three familiar examples.

A second source of information that is helpful in exploring which norms were in play in distinct Aristotelian inquiries involves a sort of reverse engineering process – starting with the written results we possess

³ To anticipate a thought some readers might be having at this point, the *Historia animalium* (*HA*) decidedly is *not* an exception. On the place of the *HA* in Aristotle’s zoological inquiries, see Balme 1987a, Gotthelf 1988 [2012, ch. 14], and Lennox 1991 [2001b, ch. 2].

⁴ One could also take the attitude that this is all that is of philosophical significance anyway – whether Aristotle followed his own norms is perhaps an interesting historical question, but irrelevant to their epistemological virtues. For reasons that I will allow to gradually reveal themselves as the argument progresses, that is not the attitude I adopt here.

and then reflecting on the means by which those results could have been achieved. Now this would be a hopeless task if the treatises were written as axiomatically organized presentations of demonstrations – but they are not. Aristotle invariably refers to them as inquiries or investigations, and they are often organized in such a way as to model the investigation on which they are reporting – moving from what is clearer to the beginning investigator and more obvious to perception toward what is clearer in itself (i.e., toward the natures and causes of the phenomena in the domain under study). They often begin by reviewing previous research on the subject and the puzzles that emerge from subjecting that previous research to critical scrutiny. Aristotle's own considered answers are typically only presented late in the narrative, and are often presented in preliminary ways first – after which he will often declare that it is time for a fresh start!

I suspect that this mode of presentation is pedagogical in intent – but the primary focus is not on teaching scientific *content*, but on providing object lessons in *the methods and norms appropriate to specific inquiries*. And, as Part II of this book will show by means of a number of case studies, the lessons will vary from one domain of investigation to the next.

Finally, there is one other feature (already alluded to) of virtually all his treatises that is helpful in determining what Aristotle deems the proper norms of inquiry – the number of pages devoted to identifying the errors made by previous thinkers in investigating each domain; more often than not the errors are fundamentally *errors of method*. In many cases the errors are due to applying norms or standards that are appropriate in one domain to another, where they are inappropriate. In a well-known passage near the beginning of the *EN*, for example, Aristotle comments that “it is just as mistaken to demand demonstrations from a rhetorician as it is to accept [merely] persuasive arguments from a mathematician” (*EN* 1.3, 1094b25-27).

Here again it is rewarding to look at these critical discussions of the errors of his predecessors as pedagogical in character – not, again, primarily focused on teaching scientific *content* (i.e., the results of an investigation), but rather on instructing future investigators in the methods and norms appropriate (and *inappropriate*) to specific inquiries.

It is thus no accident that every treatise of Aristotle's opens with a methodological discussion of the norms that ought to govern inquiry into the subject to which it is devoted. It is to these discussions, I argue, that one needs to turn in order to understand Aristotle's epistemology of inquiry, the norms that must be followed if one is to stay ‘on track’ in the

quest for knowledge – and Part II of this book will be a study of a selection of those discussions.

But why, it is reasonable to ask, would Aristotle come to adopt this domain-specific approach to inquiry? After all, one could believe, as he does, that knowledge is hierarchically organized, differentiated into domains and sub-domains, and that at least some of the principles in each domain and sub-domain are distinctive to it, without concluding that the modes of inquiry that *lead to* those principles are also distinctive. As I see it, there are three grounds for Aristotle insisting that norms of inquiry are domain-specific.

1. He rejects two forms of reductionism that would encourage one to think that one global set of norms should be sufficient. One of these is mathematical, stemming either from a broadly Pythagorean perspective or from Platonism – or from some combination of the two.⁵ The other alternative is some form of materialism: insofar as true knowledge is possible, it is knowledge of fundamental material elements – atoms, one or more of the four elements, and so on – which are eternal, changeless, and underlie and explain the appearances. If one supposes the objects of knowledge are all of one kind, or at least explicable by reference to one kind of principle, as either form of reductionism encourages you to believe, it is plausible to suppose there is a single path to knowledge. Aristotle, however, denies that our knowledge is restricted to mathematical or formal entities; and as far as natural objects are concerned, while they have certain features in common,⁶ that turns out to be insufficient information to determine how they ought to be investigated, because nature is, to use a metaphor of Nancy Cartwright's, "dappled."⁷ Some natural substances – namely, the heavenly spheres – are constituted of a material that does not partake of any change other than eternal, circular locomotion, and thus the objects studied by cosmology and astronomy are natural and eternal. Others – animals and plants – have souls, are constituted of uniform and nonuniform parts, undergo a complex process of development that is goal-directed and governed by a distinctive kind of necessity, are perishable, and must constantly engage in a complex and coordinated set of activities in order to remain alive. Still others – the subject matter of meteorology – are more unstable and ephemeral, such as rain, hail, frost, clouds, thunder, lightning, or rainbows. In short, the subjects to be investigated differ in

⁵ These alternatives are discussed in some detail in *Metaphysics* (*Metaph.*) A.6 and 9, and M–N.

⁶ For example, they are composite unities of matter and form, they have within them their own sources of motion and rest, and they are perceptible. I discuss general norms of natural inquiry in Chapter 5.

⁷ Cartwright 1999.

fundamental ways that require distinctive norms of inquiry. And when we leave the natural realm, either in the direction of mathematics and theology or in the direction of ethics, politics, rhetoric, or poetics, the norms become even more distinctive.

2. Our *epistemic access* to the objects of investigation will vary from one domain to the next. A little reflection on the examples I just reviewed will make this apparent. In *De caelo* (*Cael.*) Aristotle regularly laments the limited nature of the phenomena he must depend on in reaching conclusions about the nature of the heavenly bodies or the principles governing their motions, a point he reiterates in *PA* 1.5 when he notes that while the objects studied by the cosmologist and astronomer are noble, animals and plants offer the natural inquirer far more in the way of opportunities for study, and if contemplated philosophically, “take the prize with respect to *scientific knowledge* (ἐπιστήμη)” (645a1–4). The objects investigated by the meteorologist provide obvious problems of accessibility of a different sort, as do those of mathematics or ethics. Such limitations must be taken into account in deciding how an inquiry should be conducted and what counts as staying on track. One can only imagine what Aristotle would have said about Spinoza’s attempt to apply the methods of geometry to ethics.

3. Finally, there is an ineliminable *perspectival* aspect to every scientific inquiry. To take just one example: consider the rainbow. Aristotle argues that certain features of rainbows can only be understood by taking into account the natural interactions between water droplets in the air and light from the sun. This is to take the perspective of the natural scientist, and the norms in play would be those of the meteorologist. To understand certain features of the *shapes* of rainbows, however, one must adopt the perspective of geometric optics, as he does in *Mete.* 111.5–6. The same object is being investigated from two very different perspectives, and different norms will be in play depending on the perspective one takes.

These, then, are three reasons for Aristotle insisting on certain norms of inquiry being domain-specific. A concept that is central in his presentation of such norms, and to the discussion to follow, is μέθοδος. An oddity of Aristotelian scholarship over the last few decades is that, while there has been a great deal of discussion about Aristotle’s philosophical and scientific methods, that discussion has all but ignored Aristotle’s deployment of this concept. Of course, there is no a priori reason why a Greek word that happens to be the etymological root (via Latin transliteration) of our English word ‘method’ should have a close semantic connection to it – but in this instance the connections are in fact complex and rich. The concept’s distribution in the corpus attests to its importance for my

argument. It appears in the first few lines of virtually every treatise reporting on one of Aristotle's inquiries – that is, in those methodological introductions that discuss the norms of inquiry important for each work. In stark contrast, it is entirely absent from the *Posterior Analytics*. I will make the case in Chapter 3 that it is Aristotle's concept for the domain-specific manner in which one ought to inquire – or for an inquiry when considered from the perspective of its distinctive mode of inquiry.

Chapter 4 concludes Part I by considering the consequences of Aristotle insisting on domain-specificity *within* the science of nature. The evidence is reasonably conclusive that Aristotle thought of all these inquiries as contributions to a single, integrated science of nature. Much of the literature on Aristotle's science (or philosophy) of nature does not face the difficult consequences of the fact that there are nevertheless many self-consciously autonomous natural investigations, at several levels of abstraction and approached from a variety of different perspectives. To understand these various inquiries as contributions to a single *epistêmê*, we must consider what sort of integration Aristotle thinks is possible and how successful he is at achieving it. In this chapter we look at what Aristotle has to say about what differentiates the science of nature from that of the two other theoretical modes of inquiry, first philosophy and mathematics. By a careful study of Aristotle's discussions of that subject, we can develop a picture of what *every* natural inquiry must have in common, *qua* natural. That picture will turn out to be a valuable asset to have in hand as we turn to thinking about the domain-specific norms governing the inquiries to be investigated and how Aristotle conceives of the interconnections among the various natural investigations, the subject of Part II.

Part II thus opens, in Chapter 5, with a study of what Aristotle refers to as the *methodos* of nature – that is, the general norms that must guide any natural inquiry *qua* natural. That natural objects are unities of matter and form – that their natures are 'dual,' as he sometimes puts it, and that this dualism grounds distinctive inherent sources of change, has more far-reaching implications for natural inquiry than is typically acknowledged, and drawing out those implications will be a primary task of this chapter.

One theme of Chapter 4, however, was that even within the study of nature, there is considerable methodological variability, and the remaining chapters are explorations of the distinctive norms that are to be found in a number of Aristotle's natural inquiries. Chapter 6 explores the distinctive norms of zoological inquiry outlined in the first book of *De partibus animalium* and shows those norms at play in a number of specific inquiries. One question raised in *PA* I.1 is whether it is appropriate for the natural

scientist to investigate all aspects of the soul, or only some – and Aristotle appears to conclude that an inquiry into the capacity of reason and its activity is outside the scope of the science of nature, which in turn raises questions about whether the *De anima* in whole or in part, should be considered part of natural science or not. In Chapter 7, principally through a careful investigation of *de An.* I.1, we consider what Aristotle has to say about the form of inquiry appropriate for the soul, and how the norms governing that inquiry are related to those governing zoological inquiry.

In Chapters 8 and 9, I rely on two pieces of previous research to shed new light on an old question: how did Aristotle (as opposed to later editors and commentators) conceive of the interrelationships among his various inquiries? Are the many cross-references simply editorial additions, do they tell us about Aristotle's preferred order in which treatises should be read or studied, or does Aristotle have discernible views about *the order in which inquiries ought to be carried out* – a distinctive category of norm of inquiry? In Chapter 8, I explore this question by looking at the dependence of a particular inquiry reported in *Cael.* II.2 on conclusions reached in *De incessu animalium* (*IA*) 2–6. In the following chapter the same question is explored by investigating the dependence of his zoological investigations on the generation and existence of uniform (homoeomerous) parts on his theory of the emergence of differential powers of uniform materials presented in *Meteorology* (*Mete.*) IV. These chapters provide compelling evidence that for Aristotle it is not just that the treatises should be *studied* in a certain order, but that the inquiries on which they report have a preferred order as well. Of course, Aristotle may only have come to realize this after the fact – that is, while engaged in a biological investigation of uniform parts he may have decided he needed to have a better understanding of the differences between uniform materials and embarked on such an inquiry. But that could very well lead him to a conclusion about the dependence of one inquiry on another, and to formulate views about how inquiries ought to be ordered based on such dependence relations.

I've chosen a rather unorthodox strategy for the conclusion of this volume. I apply the lessons learned from the previous chapters to a quite focused and delimited scientific inquiry, one that had a very significant impact on the history of anatomy, physiology, and biochemistry: Aristotle's attempt to understand why respiration is (obviously) so vitally important to those animals that breathe. The conclusion serves to demonstrate the value of Aristotle's epistemology of inquiry by showing that epistemology of inquiry in action.