


AN ESSAY BY ANDREW TORGESEN

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ARISTOTELIAN SCIENCE: REVIEW AND  
EVALUATION

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A decorative calligraphic signature of Andrew Torgesen, featuring elegant, flowing cursive script with a horizontal line through the middle of the text.

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Aristotle's conception of science is to develop a body of demonstrable knowledge, united by common principles, to explain observed phenomena. The scientific principles derived by Aristotle have been very influential throughout history, though some of his ideas have fallen out of favor as secure grounds for scientific knowledge. In this paper, I aim to describe Aristotle's method for acquiring scientific, theoretical knowledge, then provide a personal evaluation of its epistemological usefulness in modern times.

Unlike his teacher, Plato, Aristotle sees sense observation as the highest indicator of what is ultimately real. Scientific knowledge, operating in a secondary capacity, is mankind's tool for providing an explanation for what is observed. Thus, scientific knowledge must depend entirely on what is perceived through the senses. To arrive at scientific knowledge from observation, Aristotle advocates for the formulation of a deductive argument in the form of syllogism. He also refers to the process of deduction as demonstration. Demonstration must begin with a set of principle premises. The premises must be indemonstrable because if they were demonstrable, then all demonstration would suffer from infinite regression, never arriving at a first cause, or principle. Rather, the premises must be evident through observation alone. There are two types of principle premises which form the bedrock for scientific knowledge: postulates and axioms.

Postulates are basic assertions of the existence of entities which have been observed and cannot be expressed in terms of other entities. The entities described by postulates can have attributes attributed to them, though only through observation. Closely related to postulates are definitions. A definition is not strictly an affirmation of existence. Rather, it articulates what it means to be a certain object through comparison with other objects. A definition begins by placing the object to be defined, called a species, within a more general classification of object, called a genus. A meaningful definition of the species is then attained by articulating the key factor which differentiates the species from everything else within the genus. This factor is referred to as the differentia, or essence, of the species. As an example, the species of mankind is defined as a member of the genus animals, with its differentiating essence being the ability to reason abstractly. It is interesting to note that the chosen essence may not be found in every particular instance of the species. Aristotle claims, however, that the essence need only represent what is normally found to be true of a species. In this sense, a definition can be considered universal. Definitions ultimately group all observed entities into a tree-like structure which has usefulness in formulating an explanation. It is also important to note that species need not only have their essence associated with them as qualifiers. Aristotle conjectures that there are many categories, aside from substances, which can be attached to substances as abstract attributes. Such attributes may involve quantity, quality, location, or any other descriptor of the substance as a subject.

Axioms, according to Aristotle, are self-evident truths which are available to any rational thinker. Within the realm of theoretical knowledge, there are many different fields, each

with their own fundamental principles. Such fields include psychology, mathematics, physics, biology, etc. While scientific knowledge in one field cannot usually be described in terms of another field's principles, a sense of consistency must still be maintained between all the fields for them to be considered knowledge. This consistency is examined and maintained through the field of metaphysics, which utilizes the axioms as tools to search for contradictions and validate relationships. A rational thinker uses the axioms to pinpoint relationships between particulars and generate abstract knowledge. In modern language, axioms can be referred to as logical principles. An example of an axiom would be that if A is equal to B, and B is equal to C, then A is equal to C.

With postulates, definitions, categories, and axioms established, the framework of demonstration can be built. This is done through a process that Aristotle refers to as the order of knowing. The order of knowing begins with a particular, observed phenomenon. The next step is to express the phenomenon as an attribute of a substance which belongs to a species. This species is then connected to its more general genus through a middle term, or common attribute that is relevant to explaining the phenomenon. The process continues, connecting species to more general ones using middle terms. The order of knowing finally ends when one arrives at a species which has no genus: a postulate, or principle. Once the principle has been identified, then the phenomenon has been satisfactorily explained through a valid chain of causality leading all the way back to a principle which is known to be true (and unchanging) through observation. If every premise along the syllogistic chain of explanation is to be trusted, then the explanation is sound. In stark contrast to what Plato teaches about the doctrine of recollection, Aristotle formulates a conception of knowledge which begins and ends with observation. Aristotle asserts that there are four kinds of causes of a phenomenon which can be demonstrated. The four kinds of causes are the material cause, the formal cause, the efficient cause, and the teleological cause. The material cause provides an explanation based on the attributes of the constituent materials. The formal cause derives its explanation from having new properties arise out of a constitutive structure or arrangement. The efficient cause refers to an external agent which has acted to cause what was observed. The teleological cause appeals to an ultimate sense of purpose, or end-directed course, to explain characteristics and behavior. These four causes can ultimately be used as a criterion for how thoroughly a phenomenon has been explained. Thus far, I've described Aristotle's method of doing science in terms of first principles. One of the main strengths of Aristotelian science, I believe, is the primacy that it gives to what is observed. If a scientific theory, after it has been derived from first principles, is ever contradicted by a subsequent observation, then it is the theory that must be thrown out. I agree with Aristotle that of all the possible bases for ontological affirmation, observation is the one in which we can put the most trust. Similarly, our attributions of abstract characteristics to a substance are more likely to be fallible than the existence of the substance itself. Due to this pattern of prioritization, it is reasonable to assume that Aristotelian science is still capable of incremental progress as increasingly exotic observations are made. However, there are other aspects of the science which, I believe, hinder and even limit such progress. I will now proceed to highlight those aspects.

Aristotle extolls impartial observation as the basis for all scientific knowledge. Despite

this, he seems to allow his observations of order in the universe to lead him to project unnecessary constraints on the attributes of substances. One good example of this is his assertion that objects have natural and unnatural states, and that knowledge of an object can only be gained if it is found in a natural state. Such a perspective rules out any form of controlled experimentation, which is a necessary tool for overcoming limitations in our own ability to observe and isolate possible causes. Another example of unnecessary constraint is found in the process of creating definitions and categories. These, as Aristotle formulates them, are dependent on the linguistic subject-predicate structure, and cannot express any other kind of relationship. Moreover, definitions and categories for a species must be based on an attribute which is not necessarily universally applicable to all instances of the species. Basing a definition of a species on a norm is useful for everyday classifications of objects. Its relative imprecision, however, glosses over details and possible sources of insight when an abnormal observation is made, hindering the development of impartial knowledge. When attaining knowledge from scratch, it is important to place as few constraints on the universe as we can, though we will probably never be able to be perfect in this. Though we observe a certain order to the universe, we have no good reason to be certain that phenomena, or what is, should necessarily conform to any of our notions of what ought to be, based on our sense of concision and coherence.

Another case of the problem of imposed constraints is found in Aristotle's insistence that phenomena can be explained in terms of their end-driven purpose, or teleological cause. Aristotle is well-known as claiming that the universe is full of purpose, even if it doesn't happen to have a grand architect or creator. This premise for knowledge is problematic because it automatically forces models of the universe to presuppose the existence of purpose. Purpose is not observable, but rather a product of conjecture. Nor is it self-evident. It could be argued that teleological explanations exist today in the study of evolutionary biology, with the ultimate end-driven behavior being that of survival for living organisms. However, even this paradigm is based in conjecture, and its use as a fundamental tenet of knowledge is certainly not warranted, in my view. While Aristotelian science has the ability to incrementally improve its knowledge base given new observations, I believe that the knowledge which it seeks is fatally constrained by anthropocentric notions of inclination, homogeneity, and purpose. It can go far in refining its premises, categories, and definitions. However, it has too many blind spots to be considered a reliable epistemological paradigm today.