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Existence Claims in the Posterior Analytics

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I. Introduction

In the APo Aristotle discusses the nature of scientific knowledge and of science. A science (ἐπιστήμη) is an organized body of facts or propositions[1] which deals with a particular subject genus (γένος, ὑποκείμενον γένος) of existing things. The bulk of a science consists of syllogistic proofs or demonstrations which show that their conclusions hold and must be the case and also why they hold and must be the case. The most frequently cited specimen of a conclusion of a scientific demonstration is the fact or proposition that triangles have angles whose sum is equal to two right angles. Aristotle thinks of this fact as a relation or connection between a subject (triangle) and an attribute (having triangles whose sum is equal to two right angles). He argues[2] that a science must contain unprovable principles from which all the remaining facts are proved. He lists six properties of scientific principles: they are (a) true, (b) primary, (c) immediate, and (d) more intelligible than, (e) prior to, and (f) grounds for the conclusions.[3] Moreover, he has a good deal to say about the various types of principles.[4] In the first place, some, which he calls axioms, are common (κοιναί) in that they are used as principles in more than one science[5] and others, the "proper" principles (ἴδια) are restricted to a single science. Aristotle identifies two kinds of proper principles. One of these kinds is definitions, which state the essence of the subjects and attributes in the science's subject genus. The other kind of proper principle turns out to be assumptions of existence. In the present paper I shall discuss a number of features of these existence claims and shall attempt to make sense of them in the context of an Aristotelian demonstrative science.

In APo I.2 Aristotle identifies three kinds of scientific principles: axioms, definitions, and a third kind which he calls hypotheses and which he introduces in a way that leaves it an open question whether hypotheses are restricted to, or even include existence claims.

> "Among immediate deductive principles, I call a thesis one which it is not possible to prove, but is not necessary for a person to have if he is going to learn anything.... Among theses, one which assumes either of the members of a contradiction (i.e., I mean, that something exists or does not exist) is an hypothesis." (I.2 72a14-16, a18-20)

This passage can be taken in different ways, since the words

translated "i.e., I mean" (οἷον λέγω) can also be translated "e.g." (which would allow for more hypotheses than existence claims) and the word translated "exists" can also be rendered "is" and it can be taken simply as referring to any subject-predicate statement: "that something is (f) or is not (f)," or "that something is [the case] or is not [the case]."

I.2 is not definitive, but I.10 may be taken to be. Two kinds of proper principles are identified as needed for a science: assumptions what something is or what it signifies (τὸ ἐστι, τὸ σημαίνει) and that something is (ὅτι ἔστι, τὸ εἶναι, etc.). Moreover, there is nothing in I.10 or in the discussion of scientific per se predications and necessity (I.4-I.6) to suggest that there are any scientific propositions attributing an attribute to a subject which are not either definitional propositions or propositions deduced from definitions. Therefore there is no reason to think that the assumption that something is is anything more than a statement of existence.

This view is supported by II.1-2, which carefully distinguish questions whether something exists (εἰ ἔστι) from questions whether something has a given attribute (ὅτι).

The only further confirmation that could reasonably be demanded is an account of the role such assumptions play in a science, to show that they are needed by sciences and have a distinct function from the other two kinds of principles, and also to show that Aristotle might reasonably have supposed that these three kinds of principles he identifies are sufficient, that sciences as he conceives them do not need further kinds of principles. I shall not discuss the question of sufficiency in the present paper, but shall consider what existence assumptions are needed in an Aristotelian demonstrative science, the role they play in the structure of demonstrative sciences, and how well they meet the requirements Aristotle places on scientific principles. Afterwards I shall take up the difficult question whether scientific existence claims are necessary truths, since it is an issue which divides interpretations of APo and which threatens the very possibility of there being any demonstrative sciences.[6]

II. Existence Assumptions of Primitive Subjects

I.10 contains the primary passages for understanding what existence claims a demonstrative science needs.

> "Proper things are (a) those things which are assumed to exist, concerning which the science investigates the attributes which belong to them per se.... They assume that these exist and that they are this. (b) The per se attributes of these

> they assume what each signifies." (I.10 76b3-4, b5-7)

This view is repeated just below.

> "Every demonstrative science is concerned with three things, (a) as many things as are posited to exist (these are the genus whose per se attributes the science investigates)..., (c) the attributes, of which the science assumes what each signifies." (I.10 76b11-13, b15-16)

These passages agree that the distinction between subjects and attributes is mirrored in a distinction in the kinds of principles having to do with each. Definitions of both subjects and attributes are assumed, but the existence of only the subjects is assumed; that of the attributes is proved. How their existence is proved is no mystery. Their existence is adjectival and for an attribute to exist is for it to belong to a subject which exists. Since sciences deal with necessary, per se relations of subject and attribute, it is sufficient to prove that an existing subject has (per se) a given attribute. The existence of the attribute (in its appropriate adjectival way) follows.

The picture presented here is simple: assume the existence of all the subjects, prove that the subjects have their per se attributes, and that gives us the existence of the attributes. But elsewhere Aristotle is more sophisticated. Some subjects can be proved to exist, given the existence of others. Therefore it is necessary to assume the existence of only some subjects (primitive or primary subjects) and possible to prove the existence of the rest (derivative subjects).

> "I call principles in each genus those which it is not possible to prove that they exist. What both the primary and the derivative things signify is assumed, but it is necessary to assume that the principles exist and prove that the others do. For example, it is necessary to assume what unit signifies and what straight and triangle do, and that the unit and magnitude exist, but it is necessary to prove the rest." (I.10 76a31-6)

In the first sentence, "principles" (ἀρχάς) cannot be read in its normal meaning of unprovable premisses. It may refer to primitive (as opposed to derivative) subjects, and the examples of things whose existence is assumed may be understood as primitive subjects, as opposed to a derivative subject like triangle. Nevertheless, it is not certain that Aristotle intends the distinction between primitive and derivative subjects here. It is possible to read the passage simply as distinguishing subjects ("primary things") from attributes ("derivative things"). On the other hand, the distinction between primitive and derivative subjects occurs quite clearly at the beginning of

book II.

There we find a fourfold division of "things which are investigated." For our purposes most important is the distinction quoted above between determining whether something exists (εἰ ἔστι) and whether a subject has an attribute (ὅτι).

> "When we investigate ... whether the sun is eclipsing or not, we are investigating the fact (ὅτι). Evidence for this is that when we have found that it is eclipsing, our investigation is at an end... Some things we investigate in a different way, e.g., if a centaur or god is or is not. I mean 'if it is or is not' (εἰ ἔστιν ἢ μή) without qualification, not if it is white or not." (II.1 89b25-7, b31-3)

It is clear as can be that a statement that something "is without qualification" is distinguished from statements that something (some subject) has an attribute, and it is surely correct to see Aristotle intending the distinction between existence and predication by his distinction between complete (ἁπλῶς) and incomplete[7] uses of the verb 'to be' (εἶναι). Accordingly, I shall translate ἔστι as "exists."

Aristotle's doctrine in II.1-2 is complicated and its full explication demands a lengthy treatment. Here I shall set out only what is relevant to the present question. In II.2 Aristotle examines the relations among the four kinds of investigations identified in II.1. He gives further examples of things of which we might investigate whether they exist: the moon, earth, sun, or triangle[8] and identifies these as subjects.[9] He speaks of looking for "the middle," which is the grounds or explanation[10] He calls the middle and grounds/explanation the 'what it is' (τί ἐστι), by which he shows that he means the scientific definition. How a definition can be an explanation of something's existence is a problem I cannot discuss here, but for now it is sufficient to note that the presence of the notions of 'middle' and 'grounds/explanation' proves that Aristotle is thinking of a context of scientific demonstration. Just as when we know the fact (ὅτι) we proceed to look for its grounds by looking for a middle of a proof (i.e., the nexus of immediate relations that is founded on scientific principles) of which the given fact is a conclusion, so when we know that something exists, we proceed to look for the middle of a proof that that thing exists.

Thus, proofs of the existence of subjects take their place alongside proofs of <u>per se</u> relations between subjects and attributes. This entails the distinction between primitive and derivative subjects corresponding to that between unprovable (immediate) and provable (derivative) facts. Although this distinction complicates the structure of an Aristotelian demonstrative science beyond the simple picture presented above,[11] the result is significant. On this more sophisticated

view, the number of principles is reduced and we find that not all subjects are on an equal footing, but that some are superior to others from the point of view of priority and intelligibility. The principles that remain are correspondingly richer in content than they were on the simple picture, and there is no loss to the content of the science because the totality of its scientific propositions (its principles and conclusions taken ensemble) remains the same. The most important gain is the increased amount of order that is found in the science's subject genus.

III. The Role of Existence Assumptions

What role to the existence assumptions play in a demonstrative science? Someone might argue that sciences can do as well without them as with them. If the main interest of science is to prove per se relations between subjects and attributes, and if these depend on the definitions of the terms involved, existence is irrelevant. It follows from the definition of triangle (and other definitions) that all triangles per se have angles whose sum equals two right angles, and the proof does not require that there be triangles. In fact, Aristotle's distinction between per se facts and existence claims effectively makes existence claims useless in proofs. If the form of a demonstration is

> A belongs per se to B
> B belongs per se to C
> Therefore, A belongs per se to C

there simply is no need and no room for either primitive or derivative existence claims in demonstrations.

There are a number of possible responses to this attack. Perhaps the most obvious is that Aristotle's recognition of existence proofs requires conclusions of the form 'A's exist,' and so requires premisses of the same form. Thus, existence claims are not irrelevant and are in fact central to one of the main types of demonstrations recognized in APo.

More general considerations come out of Aristotle's views on essence, which is the basis for per se predication. To put the matter simply, things which do not exist do not have essences. Things which do not have essences do not have per se attributes. It follows that things which do not exist are irrelevant to science. There is no science of the non-existent. In order to be a satisfactory subject of a science, a subject must exist -- not only exist, we may add, but also be a subject in the subject genus of the science.

> "It is necessary for a person who knows what is (τί ἐστιν) man or anything else to know also that it exists. (For no one knows what the non-existent

> is, only what the formula or name signifies, when I say goat-stag. But it is impossible to know what a goat-stag is.)" (II.7 92b4-8)

The distinction between "what x signifies" (τὸ σημαίνει) and "what x is" (τὸ ἐστι) is that the latter can be known only when we know that x exists. The same words that express what a thing is can also express what it signifies. The difference is not in their form or content, but depends on whether they characterize an entity or a non-entity like a goat-stag. Aristotle implies that the same expression indicates "what it signifies" to one person and "what it is" to another, if the first does not know that x exists and the second does. Similarly, an expression that indicates "what it signifies" to someone at some time will later, after he has learned that it exists, indicate "what it is."

Now Aristotle's doctrine of per se predication is closely related with the notion of "what it is." To put it briefly, a per se predication is either a predication which is stated in a definition or is implied by other per se predications which are stated in definitions, and definitions are statements of essence, of "what it is."[12] A, or the, work of a science is to investigate per se relations among the subjects and attributes it treats.[13] But in order for something to have any per se relations, it must exist, since only so will it have a "what it is" as opposed to a "what it signifies."

Thus the distinction between "what it is" and "what it signifies," in combination with Aristotle's notion of per se predication shows the significance of the basic existence claims of a science. A science is the study of things that exist; there can be no scientific knowledge of things that do not. As Aristotle says in another context, the various sciences "cut off some part of what is and investigate its attributes."[14]

Existence claims are needed to guarantee the science. They are the existential underpinning that gives the definitions a grip on reality. Even if they did not appear in any proofs as premisses, they would be presupposed in proofs, since without them the science might be a science of the non-existent, and therefore not a science at all. The links are straightforward: science deals in the per se, the per se depends on "what it is," and the "what it is" entails and presupposes existence. Therefore, some existence-claims are needed.

It is possible to think of a body of knowledge organized into demonstrative form as a kind of evolutionary story, beginning with the simplest, primitive facts and showing how more complex facts emerge. "In the beginning" there are the indemonstrable principles and subsequently there develops the balance of the science.[15] A slightly different way of seeing this situation is to consider what materials are available for use in proofs at the beginning: the axioms, the existence of the primitive subjects, and their definitions which state "what it is." The derivative

subjects cannot be used, since they are not yet known to exist. Their definitions at this stage have only the status of saying "what it signifies" and only after a derivative subject's existence is proved is its "what it signifies" promoted to "what it is." Likewise for the attributes. Given that a subject exists, the science has to prove that it has certain per se attributes, and thus that the attributes exist. Only at that point do the definitions of the attributes qualify as indicating "what it is."

Aristotle's careful choice of words in I.10 shows that he was sensitive to this issue.

> "Proper things are (a) those things which are assumed to exist... They assume that these exist and that they are this. (b) The per se attributes of these they assume what each signifies." (I.10 76b3, b5-7)

"That they are this" is best taken as an emphatic way of saying that this is their definition ("what it is").[16]

Briefly stated, the function of the existence claims is to introduce things into the realm of discourse of the science, to introduce them as subjects for per se predications. The primitive existence claims, which are scientific principles, introduce the primitive subjects and then in the course of its progress the science proves the existence of the derivative subjects, i.e., establishes derivative existence claims, which therefore entitle the derivative things to be subjects of their own per se attributes.

IV. The Nature of Existence Assumptions

At this point, the question arises whether the form and force of the existence claims is unrestricted ("so and so exists") or restricted to the subject genus of the science in question (e.g., "so and so exists as a spatial magnitude"). Aristotle speaks as if the existence claims are unrestricted in form, but we may wonder whether their force is unrestricted: in asserting that lines exist, does the geometer mean just that there are lines in the world, or that there are lines which are subjects of geometry? In a geometrical context it is reasonable to suppose that an existence claim of unrestricted form is intended to be understood in the restricted way, with the implicit specification that lines do not just exist, but that they exist in the way that is relevant to geometry, i.e., that they occupy a place in the subject genus of geometry.

Two objections can be made to this suggestion. First, it violates the separation of existence claims from definitions. If

"lines exist" is to be taken as "lines are spatial magnitudes," the existence claim becomes a specification of a genus of the subjects, which is either mentioned explicitly in the subject's definition or is implied by it. Either way, it is a per se relation, and so is related to the "what it is" and therefore to the definition of the subject. Second, a claim that a subject exists must not simply locate it in a subject genus. Its main function is to assert that there are things in reality to which the subject applies, to guarantee that the science has as its object a division of things that are. The things that are are divided up variously and treated variously by the different sciences, but all sciences are rooted in the same reality. It is the existence claims that provide these roots.

These objections are useful correctives, but they go too far. An existence claim is not to be taken as simply asserting that a subject belongs to the subject genus of the science, but rather that there is such a thing in reality. But at the same time it is to be understood that that existing thing is a subject of the science. The scientist is not idly calling attention to the existence of certain things in the world when he says that they exist, but is calling them to our attention as the basic subjects of his science. The subject genera of sciences are genera of things that are, and so there is no inconsistency in asserting that something exists and positing it as a basic subject of a science.

The happy result of this discussion is that the separation of existence claims from definitions is preserved, and both maintain their own functions which are jointly sufficient for the purpose of introducing subjects into a science. The existence claim simply states that the subject exists; the definition informs us what kind of subject it is. Together they identify the subject as a member of the genus of the science and locate it in the genus. The assertions that lines exist or tigers exist do not tell us what sciences study those subjects, to what subject genera they belong. The definitions do this much and more. Being told only that lines exist, we do not yet know what discipline we are confronting, what context of discourse we are in. But when we are told further that a line is "magnitude continuous in one direction,"[17] we know both the subject genus (spatial magnitude) and the specific nature of lines.[18]

V. Existence Assumptions as Scientific Principles

The next topic is to see how well primitive existence claims satisfy the requirements on scientific principles enumerated in I.2. As we have seen, principles are said to be true, primary, immediate, more intelligible than, prior to, and grounds for the conclusions. There is no doubt that the first three conditions are satisfied by the primitive existence claims. If there is a

demonstrative science and it has existence claims which are principles, they must be true. Primary and immediate mean unprovable, and by requiring that only primitive existence claims be principles, we have ruled out the possibility that they could be proved on the basis of other more primitive existence claims. In addition, their form and function are such that they cannot be proved from the definitions, since definitions will not mention existence and in fact per se predication presupposes existence. As indemonstrable principles, insofar as they are used as premisses of demonstrations they will qualify as more intelligible than, prior to, and grounds for the conclusions. More specifically, the primitive subjects can reasonably be described as prior to, more intelligible than and grounds for the derivative subjects whose existence is shown to follow from theirs. There therefore appears to be no difficulty in saying that basic existence claims qualify as principles on Aristotle's criteria.

VI. Is Existence Necessary?

A. The Problem

Finally, are existence claims necessary truths? Is there anything in the theory of science to require that the subjects of science exist of necessity? Nowhere in APo does Aristotle make this demand in so many words. Being necessary is not one of the requirements of principles listed in I.2. Nevertheless, it is introduced as a condition for the conclusions of demonstrations[19] and from this it is inferred to be a condition for the principles.[20] Since primitive existence claims are principles, it would follow that they are necessary. Another way to the same conclusion begins with proofs of the existence of derivative subjects. If the existence of a derivative subject is a conclusion of a proof, and if conclusions of demonstrations are necessary, then it is a necessary truth that the derivative subject exists. Since the existence of a derivative subject depends on the existence of one or more primitive subjects, it can be argued that the existence of the primitive subjects is necessary too.[21]

To leave the matter at this stage is to endanger Aristotle's whole enterprise in the theory of demonstrative science. If the objects of science exist of necessity, then precious few disciplines can qualify as knowledge. Even for Aristotle, astronomy and theology, if they can be reduced to demonstrative form, will be the only secure sciences, since the stars and god exist eternally and therefore of necessity.[22] The sublunary world can be squeezed in only by special pleading. For example, biology might be allowed on the grounds that it is the species of animals that exist eternally and of necessity, not the individuals. Geometry does not fare any better, since the existence of spatial magnitudes depends on the existence of

things with certain shapes, and most things can perish. The problems this interpretation raises for us today are much worse than the ones it does for Aristotle, since we no longer believe in the eternity of species. Even those who dispute the evolution of species must admit that species may become extinct. And the eternal existence of stars and planets is no longer tenable. On this view, there may be no scientific disciplines left as serious contenders for being Aristotelian demonstrative sciences.

Before abandoning the theory to eternal uselessness, it will be worth our while to look more closely at the chain of reasoning that leads to this uncomfortable result. Conclusions of demonstrations are necessary, therefore scientific principles are necessary. Whatever is necessary (necessarily true) is eternal (eternally true). Therefore scientific principles are eternally true. Primitive existence claims are scientific principles, therefore they are necessary and eternally true. Therefore the primitive subjects of an Aristotelian demonstrative science exist eternally and of necessity.

B. A Solution

I do not propose to attack the Aristotelian view that necessary implies eternal and necessarily true implies eternally true. What bears investigation is the first premiss: conclusions of demonstrations are necessary. The only source of necessity Aristotle identifies for scientific propositions is the definitions. Necessary propositions are *per se* propositions,[23] which depend on "what it is." Scientific necessity is definitional necessity, necessity which depends on essence. This account is valuable for understanding what kind of attributes subjects have. Given that triangles exist, it is necessary that they have 2R. Indeed, this is the sort of use of necessity Aristotle is principally concerned with in *APo* I -- that a subject *x* must have attribute *f per se*, not that subject *x* must exist. Further, since necessity is connected specifically with the *per se* and with definitions, it seems that there is special reason *not* to think that the existence claims are necessary. At least they are not *per se*, and therefore the arguments relating the necessity appropriate to principles with the nature of principles as *per se* predications[24] do not apply to them.

There are two basic kinds of proofs in sciences: a proof that an attribute belongs to a subject *per se* and a proof that a derivative subject exists. It was suggested above that for the former kind of proof an assertion that the subject exists may well not appear as a premiss. It is a presupposition of the demonstration, but the premisses as well as the conclusions can be expected to be *per se* predications of the subject. The form of the argument will be:

A belongs *per se* to B,

B belongs per se to C,
Therefore, A belongs per se to C.

If the conclusion is necessary and the argument is a demonstration, then the premisses are necessary. But that says nothing about the assertion that C's exist. That serves as an ontological prop for the argument, but no more. Since existence claims introduce subjects for per se predications and do not assert any attribute to be true of them per se, the role they play in science is very special and quite distinct from the function of definitions. It is therefore plausible to suppose that in concentrating on the premisses and conclusions of this type of demonstration (which is the only kind of demonstration clearly envisaged in APo I) Aristotle did not intend his assertions to go beyond the necessity that is found in and dependent on definitions. And so, if there is a philosophically respectable way for a subject to have necessary attributes without itself existing of necessity, the problem is solved, at least for this class of proofs.

But what of the other kind of proof? If the conclusions of all demonstrations are necessary, and some conclusions prove that subjects exist, we have to do with things that exist of necessity and therefore eternally. The most straightforward way to deal with this argument is to deny the first premiss. The conclusions of only some demonstrations are necessary, namely the demonstrations which prove that one attribute belongs to another per se. This move may seem crude, but it is justified by the discussion of necessity in APo I.6, which shows that a proposition is necessary if and only if it is per se. And since existence claims are separate from definitions, existence cannot belong to anything per se.

C. Eternal Existence of Scientific Universals and Eternal Existence of Particulars. Two Arguments.

This interpretation has some hurdles to jump before it can be accepted. In particular, there is Aristotle's assertion in APo I.8 that the conclusions of scientific demonstrations are eternal[25] and his claim in I.31 that the objects of science are universals, which are "always and everywhere."[26] Does this not prove that the subjects of scientific demonstrations must exist always? For unless there is always a subject for the attribute to belong to, how can the per se predications which the science proves be eternal?

By way of rebutting this argument it is important to notice that these passages in I.8 and I.31 do not declare explicitly that the subjects of sciences are eternal. They are found in discussions of the view that the premisses and conclusions of scientific proofs are universal. What is said to be universal in I.8 is scientific propositions, not subjects,[27] and so when

Aristotle speaks there about demonstration and knowledge not being "of perishables,"[28] it is conclusions of proofs, not subjects, that he is calling perishable. A perishable conclusion is one which states a perishable fact, one which does not hold at all times and places, but only occasionally.[29] Aristotle's example is lunar eclipse, which he conceives as a connection between the (eternal) subject moon and the attribute loss of light, and which can be treated by a scientific demonstration even though lunar eclipses are not always taking place.[30] Much of what he says in I.31 can be taken to apply to universal terms as well as propositions, but the examples he gives are propositions which can be conclusions of proofs (that the triangle has angles whose sum is equal to two right angles, lunar eclipse, and the passage of light through a burning-glass.[31] Here as well as in I.8 there is no clear statement that the subjects of science must be eternal.

The context of Aristotle's assertions of the eternity of the premisses and conclusions also helps us to understand what he intends. In I.31 he contrasts scientific knowledge and demonstration with perception on the grounds that we perceive a particular [fact] (i.e., a fact about a particular subject) in a particular place at a particular time,[32] but the universal [fact], which is the object of science and demonstration, is not subject to these temporal and spatial specifications.[33] In contrast to particulars, which are "this, here and now," universals apply "to all"[34] and are "always and everywhere."[35] Further, the universal reveals the grounds/explanation.[36]

What is important for now is the statement that the universal is "always" (ἀεί). This is not argued for, but appears as an unsupported premiss in an argument to show that the universal, which applies "to all," is incapable of being perceived.[37] Aristotle simply remarks "we say that that which is always and everywhere is universal." We need to discover how to understand this assertion, to ascertain whether it means any more than that the universal applies "to all" individual cases which fall under it, whenever and wherever they occur. If it does not, then a possible solution to the problem of the eternity of scientific subjects is indicated.

The Greek word ἀεί can mean "on each occasion," (I shall call this the "distributive" meaning) as well as "always." On one reading, then, Aristotle could mean that the universal propositions of science hold "on each occasion" that an appropriate individual subject exists. Thus the relation between triangle and having angles whose sum is equal to two right angles holds whenever there exists a triangle. In support of this reading is the statement that the universal is "always and everywhere." If we turn our attention to the second half of this claim, we see how odd it is. It is absurd to take Aristotle as maintaining that the universal is in all places, particularly since he does not argue for this striking view, but simply observes that "we say that that which is always and everywhere is

universal," as if this were an obvious or commonly accepted view. It is far more reasonable to take "everywhere" (παντα χοῦ) distributively: the universal is found everywhere that there is a particular. And likewise "always" (ἀεί) may be taken distributively. Aristotle is simply contrasting the particular, which is uniquely locatable in space and time, with the universal, which is not uniquely locatable, since it applies to all the particulars, whenever (ἀεί) and wherever (παντα χοῦ) they may be.

Will the same interpretation apply to I.8? It works just as well for one of the two passages in question:

> "Demonstrations and scientific knowledge of things which occur repeatedly,[38] such as lunar eclipse, are always (ἀεί), insofar as they [demonstrations and scientific knowledge] are of something of a certain kind, but are partial[39] insofar as they [the things which occur repeatedly] are not always." (I.8 75b33-35)

Aristotle tells us that eclipses occur "repeatedly," but not always. And there is demonstration and scientific knowledge of eclipses even so, and such demonstration and knowledge holds "always." The knowledge and proof concerned with such things apply to all cases, whenever they occur, and insofar as science treats individual cases, it holds of them with appropriate restrictions.

The other passage in I.8 uses the word "eternal" (ἀΐδιον) rather than "always" (ἀεί). This may appear more difficult to gloss in the required way.

> "It is also clear that if the premisses on which the deduction depends are universal, also the conclusion of such a demonstration, i.e., unqualified demonstration, must be eternal." (I.8 75b21-4)

But ἀΐδιον is an adjective formed from ἀεί, and if the context demands, it may admit the same distributive use. In fact three points of similarity between I.8 and I.31 encourage taking it in this way. First, the context in which the present passage occurs argues that universal premisses yield an eternal conclusion and so there is no strict demonstration or scientific knowledge of particular facts,[40] but the universal conclusion applies to particulars only at a particular time and in a way.[41] This is the same point about particulars and universals as is made in I.31.[42]

Second, both chapters speak of particulars as belonging to kinds or sorts[43] and contrast the nature of the particulars with that of the sorts:

> "Insofar as they [demonstration and scientific

knowledge] are of something of a certain kind, they are always, but insofar as they [the particular instances of the kind] are not always, they [demonstration and scientific knowledge] are partial."
(ἡ μὲν τοιοῦδ' εἰσίν, ἀεὶ εἰσίν, ἢ δ' οὐκ ἀεί, κατὰ μέρος εἰσίν (I.8 75b34-5))

"Even if perception is of what is of a certain kind and not of an individual, still it is necessary to perceive an individual here and now."
(εἰ γὰρ καὶ ἔστιν ἡ αἴσθησις τοῦ τοιοῦδε καὶ μὴ τοῦδέ τινος, ἀλλ' αἰσθάνεσθαί γε ἀναγκαῖον τόδε τι καὶ ποὺ καὶ νῦν (I.31 87b28-30))

Both passages point to differences between treating particulars as particulars[44] and as things of a certain kind, i.e., as instances of a certain universal.

Third, in the contexts of I.8 in which the words occur ἀΐδιον does the same work as ἀεί. In context the statement that the conclusion of unqualified demonstration is ἀΐδιον amounts to the same as the statement that demonstrations and scientific knowledge are ἀεί. Both passages contrast proper scientific knowledge of universals with the qualified scientific knowledge which can be had of perishable particulars on the grounds that when applied to particulars scientific demonstrations and their conclusions are taken not in their full generality, but with the qualifications needed to adapt them to the limited circumstances of the particulars in question. Unqualified demonstrations, conclusions of demonstrations, and scientific knowledge are described as being ἀΐδιον or ἀεί in order to contrast them with their limited applicability to a given perishable particular. Accordingly, in I.8 the conditions for use of ἀΐδιον appear to be identical to those for ἀεί, and also the same as those for ἀεί in I.31.

The discussion so far points to the conclusion that Aristotle did not require the subjects of his sciences to be eternal. In fact, the passages from I.8 and I.31 examined above say clearly that the particulars to which scientific propositions apply are <u>not</u> eternally existent. The universals, which are the proper objects of demonstration and scientific knowledge, are described as being "always and everywhere," and the contexts of these statements permit them to be read as saying only that universals apply to all their individual cases, not that there are individual cases of them in all places and at all times. On this interpretation, scientific existence claims need not be eternal truths, but must hold only as long as the appropriate kinds of individuals exist. Demonstrations prove that the individuals that fall under the universal must have certain attributes as long as they fall under the universal. The universal must always have those attributes too, but "always" here simply means "in all

cases, whenever a case occurs."

This interpretation of the "eternity" of universals stresses the ontological dependency of universals on the existence of individuals of the appropriate kinds. Insofar as universals are parasitic on particulars, the "eternity" of scientific proofs, conclusions and knowledge must somehow be grounded in the temporary existence of perishable particulars. On the other hand, APo makes it clear that scientific knowledge is primarily of universals and only derivatively of particulars. From the epistemological point of view, particulars are parasitic on universals. The reversal of priority can be expected to cause difficulties for Aristotle, and the problem of the "eternity" of the subjects of sciences is a clear example of such a difficulty.

Another approach to the problem is suggested by Aristotle's discussion in Physics IV.12 of what it is to be in time.[45]

> "Things which are always (τὰ ἀεὶ ὄντα), insofar as they are always, are not in time, for they are not contained by time, nor is their existence measured by time.... Now it is also clear that not everything that does not exist will be in time, e.g., all those which cannot be otherwise [sc. than non-existent], as the diagonal [of a square] is commensurable with the side.... Non-existent things include all things whose opposites are always, e.g., that the diagonal is incommensurable with the side is always, and this will not be in time." (Phys. IV.12 221b3-5, b23-5, 222a3-6)

It is the conclusion of a scientific proof that the diagonal of a square is incommensurable with its side, and this conclusion is said not to be in time. We may take this as holding generally for per se relations. These are contrasted with perishable particulars.

> "All things that are perishable and generable and in general existing at some times and not at others must be in time." (Phys. IV.12 221b28-30)

This interpretation of the assertion that universals are always suggests a corresponding interpretation of the assertion that they are everywhere: universals are not in space.[46] These are consequences of the view of universals as abstract entities. We move from individuals to universals by a process of abstracting the incidental attributes of the universals. What is not incidental depends on what aspect of the individuals is being considered. Different sciences will abstract different attributes.[47] But certain attributes are incidental for all sciences -- attributes which concern the individual qua individual. Foremost among these are those which locate the individuals in space and time.[48] The universal which results from this abstraction is timeless, where "-less" is a true privative:

temporal considerations have been set aside and we are left with an entity which exists irrespective of time.

On this interpretation, universals are "always and everywhere" in that considerations of time and space are irrelevant. Science treats individuals timelessly. Scientific demonstrations are at the level of universals and so they prove attributes to belong timelessly in that they belong to universals as such. A proof applies only secondarily and incidentally to the particulars which fall under the universal which is its subject. Scientific existence claims are eternal truths in the way Aristotle characterizes them in the Physics: they are not in time. Thus there is no need to require infinitely long lasting particulars as objects of scientific knowledge, or even infinitely long lasting universals. What makes a subject suitable for science is for it to be introduced into the discourse of the science without reference to time, and this is what existence claims are called upon to do. On this account there is nothing in the nature of Aristotelian demonstrative science to demand that the subjects exist of necessity, only that given their (timeless) existence, the attributes which are proved to belong to them belong per se and of necessity.

This second approach to the problem of the "eternity" of scientific universals stresses the epistemological priority of universals and their timelessness which is one basis for this priority, whereas the first approach emphasized their ontological dependency on particulars. The two approaches can be combined to give a plausible overall solution to the problem. The first approach gives ontological legitimacy to a demcnstrative science, assuring that the universal terms and propositions with which the science deals are grounded in and do not go beyond existent particulars. The truths of a science do not apply to particulars when there are no particulars for them to apply to. Without actually existing particulars which fall under the universal, there is no way in which the universal can properly be said to exist, and so there will be no essence and no per se attributes for it.

On the other hand, a science treats its subject matter timelessly. Accidental considerations of "when" and "where" are not relevant to science and have no place in scientific proofs and propositions. The timeless universals are reached by abstraction from individuals existing in time and space. The process of abstracting spatial and temporal properties is needed to ensure their legitimacy as subjects of science. Thus, although the universal does not exist except when there are particular instances of it in existence, science treats the universal without reference to the spatio-temporal constraints of its particulars.

But what happens when there are no particulars for them to apply to? Do they wink cut of existence? The question here is not about centaurs and goat-stags, but about eclipses when there

is no eclipse taking place. Surely scientific knowledge of eclipses does not exist only during eclipses. Surely scientific propositions about eclipses do not cease to be true in between eclipses.

Aristotle is helpful here because he considers this case in a passage already discussed.[49] He allows there to be demonstrations and scientific knowledge concerned with lunar eclipses because they can be considered as a "such," a thing of a certain kind. It is timelessly true that the earth's screening the sun's light produces[50] a lunar eclipse and this timeless truth is what applies to and explains each lunar eclipse when it occurs. If eclipses of the moon never occurred, there would be nothing to be explained or applied to, and the proposition would be science fiction, not a scientific fact. It would not be a _per se_ relation and could not be proved.[51]

There may be a residual doubt based on the possibility of the extinction of species. It is likely that California condors or some other endangered species will become extinct. While any members of a species survive, it is reasonable to suppose that there can be Aristotelian demonstrative science of that species. The question is how the status of the scientific facts about that species is affected when the species becomes extinct. Does the universal wink out of existence when the last member of the species does? Do the necessary, _per se_ truths about that species become false or unscientific? Is there no scientific knowledge of dodo birds, dinosaurs, or the Big Bang?

There is nothing to show that Aristotle considered this question or that he had any reason to think that it might arise. But it would be another step towards showing that his conception of science is useful and not bound to his special scientific beliefs if it could be shown that the study of dinosaurs etc. can qualify as scientific.

The key to the solution is the existential commitment of timeless universals. Must there always be one or more individuals existent in time and space for scientific facts about the corresponding universal to enjoy their timeless existence? The answer is surely no. The evidence, again, is the assertion that even though there is not always a lunar eclipse taking place, still there is demonstration and scientific knowledge of eclipses. They qualify as objects of scientific knowledge because they are "of a kind," and so in that way they are always, i.e., timelessly. The case of dodos and dinosaurs is relevantly the same. Dodos formed a kind, and scientific facts about that kind are timelessly true. The fact that there are no dodos now is on the same footing as the fact that no lunar eclipse is now taking place. The fact that there will be no dodos again is perhaps unfortunate, but does not affect the issue. The same holds true for all the kinds of dinosaurs and presumably also for the Big Bang, although special difficulties are likely to be raised by the uniqueness of that event and by the question of its

location in space and time.

I have suggested two interpretations of the claim that the universal scientific facts are "always and everywhere." On the first, it means that they apply to all the particulars that fall under them: a scientific fact about rabbits applies to all rabbits. On the second, it means that they are timelessly true. Aristotle would agree with both: the universals science deals with are timeless and also apply in all relevant cases.

The existence claims for subjects of a science satisfy both these demands. They are grounded in the relevant individual cases,[52] and they introduce the subject into scientific discourse as a timeless universal which is the only kind of subject appropriate for necessary, per se predications.

The foregoing arguments show that there is no need to attribute to Aristotle the view that subjects of a demonstrative science exist necessarily and eternally. They also support the position that a subject can have necessary attributes without itself existing of necessity and show that Aristotle's assertions that premisses and conclusions of demonstrations express necessary truths apply only to per se predications, not to existence claims. By doing so they have rebutted one challenge to the viability of Aristotelian demonstrative science.

Notes

1. Aristotle does not always distinguish clearly between facts and propositions and feels free to move back and forth between the formal and the material mode of expression.
2. APo I.3.
3. APo I.2 71b20-2.
4. Especially APo I.2 and I.10.
5. In places Aristotle says or implies that an axiom is found in all sciences (e.g., APo I.2 72a16-17), and this is true for the law of non-contradiction and the law of the excluded middle, which Aristotle frequently mentions as common principles. It is not true, however, for Aristotle's other standard example of a common principle: if equals are subtracted from equals, the remainders are equal. This axiom holds only for quantities and therefore has no place in non-quantitative sciences. On the other hand, it does have a place in more than one quantitative science, and in fact it does in all the quantitative sciences known to Aristotle. The characterization of common principles as those found in more than one science does not give a full account of common principles, but at least it picks out the common principles from the rest. (Even here allowance must be made for the special case of the "subalternate sciences" in which the principles and conclusions of one science have a use in another science. See my paper "Aristotle's Subordinate Sciences," British Journal for the History of Science, 11 (1978), 197-220.
6. There are other serious obstacles as well, some having to do with large scale Aristotelian doctrines, such as his belief in real essences and real definitions, his assertion that scientific demonstrations are syllogistic, his belief that some facts are naturally more intelligible than others, and his views on how we come to know scientific principles. It is beyond the scope of the present paper to discuss these issues.
7. Cf. II.2 90a3-4: εἰ γάρ ἐστι τὶ ἢ μὴ ἔστι τί, ἐν τοῖς τοιούτοις ζητοῦμεν· ἁπλῶς δ', εἰ ἔστιν ἢ μὴ σελήνη ἢ νύξ.
8. 90a12-13.
9. τὸ ὑποκείμενον (90a12).
10. τὸ μὲν γὰρ αἴτιον τὸ μέσον (90a5-6).
11. p.3.
12. I refer only to the two types of per se predication Aristotle says are specially relevant to demonstrative sciences. These are the first two of the four types of per se relations identified at APo I.4 73a34-b24. They are singled out because of the close connection they have to necessary predications (73b16-24). Both these types of per se predications are characterized in terms of essence (τί ἐστι) and definition (ὁ λόγος ὁ λέγων τί ἐστι) (73a34-b1).
13. APo I.10 76b3-4, b6-10, b13.
14. Met. Γ.1 1003a24-6, cf. APo I.32 88b1-2.
15. Obviously, development over time is not intended by this metaphor.
16. At 76a32-3 he says "what both the primary and the derivative things signify is assumed." This preferable to saying that what they are is assumed. Neither expression is quite correct, but

given that Aristotle is going to use the same expression to apply to both, his choice is reasonable.
17. Cf. Met. Δ.13 1020a11-14.
18. Appropriate cautions must be provided to cover subjects in whose definition the subject genus term does not appear. One suggestion is that the subject genus will appear as a term in at least the definitions of primitive subjects and that derivative subjects for which this does not happen will be defined in terms of one or more primitive subjects, or derivative subjects for which this does happen, or derivative subjects for which this does not happen but which are themselves defined in terms of primitive subjects or derivative subjects for which this happens.... Aristotle, however, does not state this view or provide a basis for proving it.
19. APo I.2 71b9-12.
20. APo I.4 73a21-4, I.6 74b13 ff.
21. An argument to this effect can be constructed along the lines of APo I.6 74b26-32, which argues generally that the principles of scientific demonstrations are necessary, since the conclusions are necessary and the principles are the grounds of knowing why (not only that) the conclusion holds of necessity.
22. Met. Λ.7-8, Gen. et Corr. II.11 337b35-338a2.
23. It follows from APo I.6 74b5-12 that all and only necessary connections are per se.
24. Notably the argument at APo I.6 74b5-12.
25. 75b22-3.
26. 87b32-3, cf. b38-9.
27. προτάσεις, συμπέρασμα (75b21-2, cf. b27-8).
28. 75b24-5.
29. οὐ καθ' ὅλου αὐτοῦ ἐστιν ἀλλὰ ποτὲ καὶ πῶς (75b25-6).
30. I.8 75b33-5.
31. 87b35-6, b39-88a2, 88a14-16.
32. αἰσθάνεσθαί γε ἀναγκαῖον τόδε τι καὶ ποὺ καὶ νῦν (87b29-30).
33. οὐ γὰρ τόδε οὐδὲ νῦν· οὐ γὰρ ἂν ἦν καθόλου (87b31-2).
34. ἐπὶ πᾶσιν (87b31).
35. ἀεὶ καὶ πανταχοῦ (87b32).
36. δηλοῖ τὸ αἴτιον (88a5-6).
37. 87b30-3.
38. πολλάκις (75b33) is more effectively rendered by "repeatedly" than by "frequently" or "often." What is relevant is that they happen more than once, not how often they occur. The adverbial ending -άκις means "times" as in δεκάκις, "ten times."
39. "Partial" (κατὰ μέρος) means "not fully general." It covers both the contrast between universal and particular and that between more general and less general. For this use of the expression κατὰ μέρος, see APo I.24.
40. In the sense defined on p.12.
41. 75b21-6.
42. I.31 speaks of particulars as locatable in place as well as in time (ποὺ καὶ νῦν (87b30)), whereas I.8 speaks of the demonstration applying to particulars at a particular time and in a way (ποτὲ καὶ πῶς (75b26)). I see no reason think that all three qualifications (time, place, and manner) do not apply to both discussions.

43. This assertion applies to both particular subjects and particular facts.
44. I.31 makes it clear that as such they are locatable in time and space.
45. 220b32-222a9.
46. This claim is not Aristotelian, since he does not have a clear concept of space. On the other hand, his doctrine of place in Phys. IV.1-5 entails that universals are not in any place.
47. For example, geometry considers the spatial aspect of such things as have spatial extension and all attributes of those things that are irrelevant to their spatial extension are incidental to geometry. Similarly, biology considers those features of living things that are relevant to them qua living and disregards any other features they may possess.
48. Cf. APo I.31 87b30, etc.
49. APo I.8 75b33-5.
50. This verb should be understood in the "timeless present" tense.
51. The nature of lunar eclipses is perhaps too complicated for straightforward exposition, since it has to do with three bodies and the behavior of light. The point can be seen more simply for the relation between triangle and the attribute of having angles whose sum is equal to two right angles.
52. Aristotle sketchy account of how we come to know the principles of sciences (APo II.19) makes it clear that this indemonstrable knowledge (νοῦς) ultimately stems from our perception of particulars. Presumably this account is intended to apply to all the kinds of scientific principles, including existence assumptions.