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## **Explanation and Essence in *Posterior Analytics* II 16-17**

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**Abstract:** In *Posterior Analytics* II 16-17, Aristotle seems to claim that there cannot be more than one *explanans* of the same scientific *explanandum*. However, this seems to be true only for “primary-universal” demonstrations, in which the major term belongs to the minor “in itself” and the middle term is coextensive with the extremes. If so, several *explananda* we would like to admit as truly scientific would be out of the scope of an Aristotelian science. The secondary literature has identified a second problem in II 16-17: the

middle term of a demonstration is sometimes taken as the definition of the minor term (the subject), other times as the definition (or the causal part of the definition) of the major (the demonstrable attribute). I shall argue that Aristotle's solution to the first problem involves showing that certain problematic attributes, which appear to admit more than one explanation, actually fall into the privileged scenario of primary-universal demonstrations. In addition, his solution suggests a conciliatory way-out to our second problem (or so I shall argue): the existence of an attribute as a definable unity depends on its subject having the essence it has, which suggests that both the essence of subjects and the essence of demonstrable attributes can play explanatory roles in demonstrations.

**Keywords:** Aristotle, Explanation, Essence, Science.

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Few chapters of the *Posterior Analytics* (*APo*) are as elucidating as II 16-17. Aristotle spells out, with helpful examples, what kind of syllogism can be taken as a full-fledged demonstration – i.e. a demonstration of the “primary universal” (πρῶτον καθόλου; *APo* I 5, 74a4-6; II 17, 99a33-35) – and what kind of explanatory role definitions play in demonstrative arguments. However, these chapters also present us with at least two major difficulties.

(1) In *APo* II 16, Aristotle raises the question of whether a scientific *explanandum* always entails and is explained by the same *explanans* (98a35-98b2). The philosopher discusses two hypothetical scenarios, each of which leads to different answers to this question (98b25-28). In the first of them, different middle terms play the role of *explanans* depending on the subjects of which the *explanandum* attribute is predicated. Thus, the answer to the question raised in *APo* II 16 would be negative. In the second scenario, the demonstration is of the “primary universal”: the major and the minor terms of the syllogism are coextensive, which entails that the major (*explanandum*) and the middle term (*explanans*) also counterpredicate (since demonstrations of this kind are in *Barbara*). In *APo* II 17, the philosopher goes on to argue that in proper scientific

contexts – in which we demonstrate something “in itself” (καθ’ αὐτὸ) – there cannot be several *explanantia* of the same *explanandum*. Hence, only instances of the second scenario, in which the three terms of the syllogistic demonstration are coextensive, would be properly scientific. If so, Aristotelian demonstrations seem to be restricted to very specific kinds of phenomena, while certain *explananda* we would like to admit as truly scientific – some of which considered by Aristotle himself in *APo* II 17 – would be out of the scope of science.

(2) It has been argued that in *APo* II 16-17 Aristotle advances two different (and potentially incompatible) models of scientific explanation. Michael Ferejohn (2013, p. 149), for instance, claims that these chapters present “two alternative ways of explaining” the fact that certain plants shed their leaves. The author revives a long-standing and important question that has been neglected by interpreters of the *APo* for many years – see also Angioni (2014b, p. 103-107); Bronstein (2015; 2016, p. 48-50). Aristotelian demonstrations are based on definitions insofar as the primary explanatory factor of every demonstrable fact is some kind of essence (*APo* I 2, 72a18-25; I 4, 73a34-35; I 8, 75b30; II 2, 89b36-90a14; 90a31-35; II 3, 90b24; II 8, 93a31-33; II 17, 99a3-4, 21-23). However, is the *explanans* (the middle term) the essence (i) of the subject the *explanandum* attribute belongs to (minor term) or (ii) of the attribute itself (major term)? According to Ferejohn (2013, p. 104), lines 98a35-b4 favour option (i): broad-leaved plants are deciduous precisely because they “have broad leaves” (τὸ πλατέα ἔχειν τὰ φύλλα). This passage is in accordance with what he takes to be Aristotle’s “canonical” model of scientific explanation, according to which the demonstrable attributes of a given subject are explained by the subject’s essence. However, lines 98b36-8 and 99a23-29 support option (ii), which Ferejohn would take as a “non-canonical” model of explanation: the *explanans* (coagulation of sap) is the essence (or rather the causal or explanatory part of the essence) of the *explanandum* attribute (deciduousness).

In the following, I shall argue that Aristotle’s solution to the first problem involves showing that certain problematic attributes, which

appear to admit more than one explanation, actually fall into the privileged scenario of primary-universal demonstrations. In addition, his solution suggests a conciliatory way-out to our second problem (or so I shall argue): both the essence of subjects and the essence of demonstrable attributes can play explanatory roles in demonstrations. I shall indicate how these results are underpinned by two of Aristotle's views on essence and causation: (i) causal or explanatory connections have a three-fold configuration, which means that one cannot evaluate whether a feature  $x$  is the primary explanation of a feature  $y$  unless the relevant domain of objects for the occurrences of  $x$  and  $y$  is properly specified; (ii) the existence of a demonstrable attribute as a unified phenomenon (i.e. as having such and such essence) depends on its subject having the essence it has.

## Two Questions and the Uniqueness Requirement

Aristotle begins *APo* II 16 interested in knowing whether every “occurrence” of an attribute – the verb used is “ὑπάρχειν” – that can be scientifically explained involves the occurrence of its putative explanatory factor (*APo* II 16, 98a35-36). In other words, does the *explanandum* always entails its *explanans*? We can formalize the question in the following way:

Q1:  $\forall x \forall y ((x \text{ is explanatory of } y) \rightarrow (y \text{ occurs} \rightarrow x \text{ occurs}))$  [?]

In *APo* II 16, 98b2-4, a second question, apparently less controversial, is added. It concerns sufficient causality as it is usually conceived: given a certain cause, does its effect follow?

Q2:  $\forall x \forall y ((x \text{ is explanatory of } y) \rightarrow (x \text{ occurs} \rightarrow y \text{ occurs}))$  [?]

If affirmative answers are given to both questions, there will be a mutual entailment between *explanans* and *explanandum*: given a certain cause, its effect follows (affirmative answer to Q2) and, given

a certain effect, its putative explanation occurs as well (affirmative answer to Q1).<sup>1</sup>

The use of “ὑπάρχειν” without a dative in 98a35-b4 may suggest that, for Aristotle, causation (or “being explanatory of”) is a relation that takes place between events or processes. However, the next lines make it clear that “x is explanatory of y” is short for “x is explanatory of y for z” (see Barnes 1993, p.252) – that is to say, we have to consider not only the “cause” (αἴτιον) and “that of which it is cause” (οὗ αἴτιον) or “the thing caused” (τὸ αἰτιατόν), but also the subject or subjects “for which it is cause” (ᾧ αἴτιον).<sup>2</sup> In the same vein, an expression such as “x/y occurs” (ὑπάρχει) is short for “x/y holds of z” or “x/y is predicated of z” (ὑπάρχει plus dative). In fact, the introduction of a third item in the analysis of causal relations is a crucial part of Aristotle’s solution to the problems addressed in *APo* II 16-17. In 98a35-b24, for instance, the philosopher is concerned with the following difficulty: do affirmative answers to Q1 and Q2 entail that “being explanatory of” is a symmetrical relation? His tripartite analysis of causation allows him to approach the problem in syllogistic terms. If x and y entail each other, one can prove syllogistically that “x holds of z” from the premise “y holds of z” and vice-versa (98b4-5). Let us say, for instance, that being a broad-leaved plant is the reason why vines shed their leaves (regularly, under certain conditions, in a certain period of the year etc.). If Q1 and Q2 are answered affirmatively, one could formulate the following two syllogisms (98b5-16):

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<sup>1</sup> Barnes (1993, p. 252) notes that, in *APo* II 16, Aristotle is not interested in temporal relations between *explanans* and *explanandum* (like in *APo* II 12), but in logical relations.

<sup>2</sup> This is what Lucas Angioni calls “the triadic structure” of scientific explanations. For a systematic discussion of this notion – to which I am very much indebted – see, for instance, Angioni (2012; 2013; 2014a; 2014b). For a similar view, see Charles (2000, p. 204-209).

### Syllogism I

*Deciduousness holds of all broad-leaved trees*

*Being a broad-leaved tree holds of all vines*

*Deciduousness holds of all vines*

### Syllogism II

*Being a broad-leaved tree holds of all deciduous trees*

*Deciduousness holds of all vines*

*Being a broad-leaved tree holds of all vines*

In this passage, Aristotle addresses the mistake of taking both I and II as demonstrative syllogisms. In demonstrations, the middle term explains why the major term is predicated of the minor. Hence, if I and II were both demonstrative syllogisms (in the strict sense of the term), the attributes *deciduousness* and *being a broad-leaved tree* would be “mutually explanatory” (αἴτια ἀλλήλων, 98b17). However, says Aristotle, “an explanation is prior to what it is explanatory of” (τὸ γὰρ αἴτιον πρότερον οὐ αἴτιον, 98b17). Since priority is an asymmetrical relation, the relation “being explanatory of” is also asymmetrical (*Cat.* 12, 14a29-35; 14b11-22; *Metaph.* V 11, 1019a1-4; VII 10, 1034b30-32; 1035b6-7). By arguing that explanatory relations are asymmetric, Aristotle points out that, in demonstrations, the priority of the premises over the conclusion goes beyond mere inferential connections between them: although the properties *being a broad-leaved tree* and *being deciduous* entail each other, the former is explanatory of the latter, but not the other way around, which means that only Syllogism I is of “the reason why” (τοῦ διότι ὁ συλλογισμός, *APo* I 13, 78a28-b4; II 16, 98b19-21).

As has been noted, in *APo* II 16-17, Aristotle takes Q2 as uncontroversial (see Barnes, 1993, p. 252). From 98b25, the focus is on Q1 or, more specifically, on a different (and in a certain way more relevant) problem related to it. Let us say that, in a given context  $c_1$ ,  $x$  is the putative *explanans* of the *explanandum*  $y$ . If there is a context

$c_2$  in which  $y$  occurs without  $x$  occurring, there must be a different item  $z$  which is explanatory of  $y$  in  $c_2$ . Thus, if Q1 is answered negatively, it follows that an *explanandum* can be explained by different *explanantia*. This motivates Aristotle to address the following requirement:

### Uniqueness Requirement (UR)

$\forall x \forall y ((x \text{ is explanatory of } y) \rightarrow \forall z (z \text{ is explanatory of } y \rightarrow z = x))$

Of course, Aristotle recognizes that a demonstration may be composed of several syllogistic inferences, which happens when one or more of the premises that contribute to explain the conclusion are themselves demonstrable (*APr* I 23, 41b18-20; *APr* II 18, 66a17-18; *APo* I 19-22). If so, all middle terms of such a syllogistic chain may be said to be “explanatory of” the conclusion in a certain sense. However, in *APo* II 16-17 Aristotle has a stronger explanatory connection in mind, in which the *explanans* is not something that merely contributes to explain the *explanandum*, but the determinant causal factor in virtue of which the *explanandum* is the case – or the “primary middle term” (τὸ πρῶτον μέσον, 99a25). In the rest of *APo* II 16-17, the philosopher argues that every phenomenon susceptible to scientific explanation has a “primary middle term” satisfying UR.<sup>3</sup> I shall examine Aristotle’s strategy in the next section.

## Two Scenarios in Posterior Analytics II 16

In the last part of *APo* II 16, Aristotle discusses UR in two hypothetical scenarios (98b25-28). In the first of them, the same *explanandum* attribute belongs to distinct subjects, each of which relates to distinct *explanantia* (*APo* II 16, 98b25-29). Let us call it the “multiple causes” scenario or “MC-scenario.” For instance, if a single attribute  $A$  is predicated of distinct subjects  $D$  and  $E$ , nothing

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<sup>3</sup> It is worth saying that UR is compatible with *APo* I 29, where Aristotle claims that “it is possible for there to be several demonstrations of the same thing” (87b5). As Barnes (1993, p. 191) argues, Aristotle shows, at best, that there can be several valid arguments for the same conclusion, which suggests that the term “ἀπόδειξις” is being used in a weaker sense.

prevents us from elaborating two demonstrative syllogisms with distinct middle terms, B and C respectively:

AaB	AaC
<u>BaD</u>	<u>CaE</u>
AaD	AaE

If C and B are incompatible but equally adequate explanations for the major term A, UR is not satisfied. Later on, in *APo* II 17 99b5-7, Aristotle seems to exemplify the MC-scenario: “the explanation of longevity for quadrupeds is their not having bile, while for birds it is their being dry (or something else)”:

### Syllogism III

*Longevity holds of absence of bile*  
*Absence of bile holds of quadrupeds*

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*Longevity holds of quadrupeds*

### Syllogism IV

*Longevity holds of having dry bodies*  
*Having dry bodies holds of birds*

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*Longevity holds of birds*

The longevity of quadrupeds cannot be explained by the same item used to explain longevity among birds.<sup>4</sup> Therefore, at least at first sight, none of these explanations satisfy UR.

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<sup>4</sup> I shall take for granted, as the intelligibility of the example requires, that the minor “quadrupeds” denotes all the objects for which longevity is a consequence of absence of bile. The example is problematic. First, this explanation would work only for *some* quadrupeds – perhaps blooded quadrupeds (see *PA* IV, 677a30-b10) or quadrupeds without gall bladders (see Ferejohn 2013, p. 104-105). Second, in *PA* IV 2, 677a30-35, Aristotle recognizes that also among dolphins longevity is caused by absence of bile. We should not assume that the examples express Aristotle’s own scientific views. In one of his best-known examples of scientific explanation, thunder is said to be caused by fire being extinguished in the clouds,



Next Aristotle discusses a second scenario in which the *explanandum* entails the occurrence of the same *explanans* – I shall call it the “one-cause scenario” or “OC-scenario”: “or if problems are universal, then must the explanation be some whole and what it is explanatory of be universal?” (*APo* II 16, 98b32-38). Aristotle brings up here the notion of “universal problem.” “Problem” translates the Greek “πρόβλημα” in its technical sense of *APo* II 14, i.e. the conclusion of a demonstrative syllogism whose premises provide its adequate explanation. The meaning of “universal” (καθόλου), on the other hand, is not as clear – at least not on a first reading. However, the general context of *APo* II 16-17, the contrast with the MC-scenario, and the examples Aristotle provides in *APo* II 16, 98b33-38 and II 17, 99a16-29, clearly point to the technical use of the term introduced in *APo* I 4, 73b25-27. What is particularly relevant in *APo* II 16-17 is that, among other intensional features (which I shall discuss later), the ‘universal’ attribute – in this technical sense – is coextensive with the subject it belongs to (see *APo* I 4, 73b32-39; II 17, 99a33-35). This use of the term should not be confused with the notion of something being “by nature predicated of several things” (*De Int.* 7, 17a39-40; *Metaph.* VII 13, 1038b11-12), neither with the universal affirmative type of sentence.<sup>5</sup> Actually, when Aristotle wants to stress the difference between this technical sense and other meanings of the term, he uses the expression “πρῶτον καθόλου” or “primary universal” (see *APo* I 5, 74a4-6; II 17, 99a33-35).<sup>6</sup> In order to avoid misunderstandings, I shall use the expressions “primary universal” and “primary universality” to refer to this concept.

Let us clarify the concept of primary-universality and its relevance to Aristotle’s argumentation in *APo* II 16-17. By

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which is not the view he advances in *Met.* II 9, 369a14-369b4. At any rate, the inadequacy of the example does not affect Aristotle’s philosophical discussion.

<sup>5</sup> Barnes (1993, p. 253-256), who identifies the universal problem mentioned in 98b 32 with the universal categorical sentence, fails to recognize any articulation between the occurrences of “καθόλου” in 98b32 and 99a33-35 and affirms, without relating them to *APo* I 4, that the uses of the term in 99a33-35 are “unique”.

<sup>6</sup> Even though Aristotle can be quite flexible with his vocabulary. See *APo* I 4, 73b25-74a3; I 24.

introducing this notion, the philosopher intends, among other things, to require scientific explanations to cover all instances of the attribute taken as an *explanandum*. Suppose that distinct subjects D and E are both members of a kind F and that A belongs not only to D and E, but to all Fs and nothing more. Thus, it is reasonable to seek for a single middle term explaining why all Fs are A. If there is such a term (let it be G), D and E would be A insofar as they are F or, put in Aristotelian terms, A would not belong “primarily” to D and E (see “πρώτῳ ὑπάρχον” in 98b27) but “primarily” to their common kind F. In this case, the *demonstranda* “AaD” and “AaE” would not fall into our MC-scenario, since a syllogistic proof of greater explanatory power would be available:

AaG

GaF

AaF

In *APo* I 4-5, Aristotle illustrates the “OC-scenario” with helpful examples. Let us say that a geometer finds out that all isosceles triangles have the sum of their internal angles equal to two right angles (from now on, “2R”). In these circumstances, her investigation would end up with a demonstration only for isosceles triangles. Thus, the middle term runs the risk of failing to cover all instances of 2R, since 2R “does not apply to isosceles universally, but extends further” (*APo* I 4, 74a1-2). Even if the geometer investigates explanations for the presence of 2R also in scalene and equilateral triangles, without unifying them under the same description, her knowledge would qualify only as an incidental (κατὰ συμβεβηκός) understanding of the 2R-theorem (*APo* I 5, 74a25-32; cf. I 2, 71b9-12). Unless the geometer tries to explain why “all triangles have 2R”, she will not have a scientific problem *par excellence*, i.e. a primary-universal problem.

Primary-universal demonstrations explain all occurrences of the *explanandum* attribute in a single syllogistic argument. If all its occurrences can be explained at once, there must be a single cause for all them. In this scenario, a simple syllogistic deduction can

establish a mutual entailment between *explanans* and *explanandum*. In *Barbara*, the sole syllogistic mood that proves universal affirmative sentences, co-extensiveness between major and minor terms entails co-extensiveness between the major and the middle (see *APr* II 5). Thus, in a demonstration with a primary-universal conclusion, in which major and minor terms counterpredicate, the major (*explanandum*) and the middle (*explanans*) counterpredicate as well. In *APo* II 16, Aristotle's example of this kind of syllogism runs as follows:

### Syllogism V

*Deciduousness holds of coagulation of sap*

*Coagulation of sap holds of all broad-leaved trees*

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*Deciduousness holds of all broad-leaved trees*

The conclusion of the syllogism states a primary-universal predication, i.e. the phenomenon of deciduousness is considered in all its instances (i.e. all broad-leaved trees), not only in vines or fig-trees (*APo* II 16, 98b5-10; II 17 99a23-26). In this case, the explanation is “some whole” (ὅλον τι, 98b32) or, as Ross (1949, p. 667) puts it, “the whole and sole cause of the effect.” That is to say, the middle term (*coagulation of sap at the connection of the seed*) holds of and (more importantly) explains all instances of the major. Predicates such as “2R” and “deciduousness” are, in Aristotle's words, “determined to some whole” (ὅλω τινὶ ἀφωρισμένον, 98b33), i.e. they are restricted to a domain of objects that can be grasped by a single kind-term (the  $\tilde{\omega}$  αἴτιον item), which clears the way for a single, unifying explanation (the αἴτιον).

As we have seen, Aristotle addresses Q1 and UR introducing a third item ( $\tilde{\omega}$  αἴτιον) in his analysis of causal connections: the subject (or subjects) to which the οὔ αἴτιον-attribute belongs *primarily* (πρώτῳ ὑπάρχει). At first sight, it seems that UR is satisfied or not depending on how the  $\tilde{\omega}$  αἴτιον-term (minor) relates to the other two, the αἴτιον (middle) and the οὔ αἴτιον (major). When the demonstration is of the πρώτον καθόλου – and minor ( $\tilde{\omega}$  αἴτιον) and

major terms (οὐ ἄττιον) are coextensive –, there is a single middle term (ἄττιον) which not only is coextensive with the major, but also (and more importantly) explains all its instances. On the other hand, when the relation between the major (οὐ ἄττιον) and the minor term (ῥῶ ἄττιον) is not one of primary-universality, nothing seems to prevent us from demonstrating the same *explanandum*/major term with two syllogisms with distinct middle terms as *explanantia*.

## Aristotle’s Answer and Two Models of Scientific Explanation

In *APo* II 17, Aristotle goes on to state the conditions under which UR is satisfied.

Can it or can it not be the case that what is explanatory of some feature is not the same for every item but different? If the conclusions have been demonstrated in themselves [καθ’ αὐτὸ], and not in virtue of a sign [κατὰ σημεῖον] or incidentally [συμβεβηκός], then perhaps the explanations cannot be different (for the middle term is the account of the extreme); but if they have not been demonstrated in this way, perhaps they can be different [*APo* II 17, 99a1-4; Barnes’ translation with changes].

An answer to the question raised in 99a1-2 depends on the way the *explanandum* attribute is demonstrated to belong to its subject. Can there be different explanations of the same item? If the conclusion is proved *in itself* (καθ’ αὐτὸ), the answer is negative. If it is demonstrated *in virtue of a sign* (κατὰ σημεῖον) or *incidentally* (κατὰ συμβεβηκός), nothing prevents the existence of several *explanantia* for the same attribute.

Now, Aristotle uses the expression “καθ’ αὐτὸ” to refer to authentic demonstrative knowledge, in opposition to the mere pretence of knowledge labelled as “κατὰ συμβεβηκός” (*APo* I 2, 71b9-12; I 4, 74a1-3; I 5, 74a25-32).<sup>7</sup> Is Aristotle claiming that only

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<sup>7</sup> Proofs “*in virtue of a sign*” are not properly explanatory, since they establish the truth of its *probandum* through one of its consequences (one that is more easily

phenomena falling into the OC-scenario are scientifically explainable? Would it not be possible to admit *explananda* such as longevity as properly scientific by arguing that, in those cases, there is a single *explanans* for them *in restricted domains* (quadrupeds in one case, birds in the other)? Could not we understand the minor terms as imposing a domain restriction in Syllogisms III and IV? After all, what is being sought is an explanation for longevity *in quadrupeds* in one case and *in birds* in the other. If there is a single item explaining longevity in each of those domains (*not having bile* and *being dry* respectively), would not be too demanding to say that here “something else will be explanatory” (*APo* II 16, 98b1-2)?

Answering these questions requires identifying what Aristotle takes to be the most determinant feature of authentic demonstrative knowledge. When the conclusion of a syllogism is demonstrated “καθ’ αὐτὸ”, says he, the middle term is the definition (λόγος) of the extreme (99a3-4). At this juncture, it is worth addressing a long-standing question, recently revived in the secondary literature (see Ferejohn, 2013; Angioni, 2014b, p. 103-107; Bronstein, 2015; 2016, p. 48-50): is the middle the λόγος of the major or of the minor term? Is the *cause* (αἴτιον) the essence of the attribute of *which it is cause* (οὗ αἴτιον) or of the subject *for which it is cause* (ᾧ αἴτιον)? Michael Ferejohn (2013) has argued that Aristotle does not answer this question consistently in the *APo*. According to the author, lines 98a35-b4 favour what he takes as Aristotle’s “canonical” model of scientific explanation: broad-leaved plants such as vines and fig-trees shed their leaves precisely because they are broad-leaved (τὸ πλατέα ἔχειν τὰ φύλλα). Thus, the αἴτιον would be the essence of the ᾧ αἴτιον-subject and the middle term, the definition of the minor term. Let us call it the “S-Model.” With “Def(x)” standing for the definition of x, the demonstration would run as follows:

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perceived than the *probandum* itself). See *APr* II 27. Ross (1949, p. 669) also quotes *APo* II 8, 93a37-b3 as providing an example of such a proof. While the expression “κατὰ σημεῖον” is usually absent from Aristotle’s most relevant accounts of scientific knowledge, the philosopher often characterizes the concept of “καθ’ αὐτὸ” in opposition to that of “κατὰ συμβεβηκός.” For more accurate accounts of this opposition, see Hasper (2006) and Angioni (2016).

### Syllogism VI

*Deciduousness holds of Def(broad-leaved tree)*

*Def(broad-leaved tree) holds of all broad-leaved trees*

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*Deciduousness holds of all broad-leaved trees*

This interpretation is along the lines of Aristotle's use of the expression "καθ' αὐτὸ" in the *APo*. The syntax of the passages in which we find the formula "S is καθ' αὐτὸ P" indicates that the pronoun "αὐτὸ" refers to the subject S.<sup>8</sup> In support of the S-Model, one could argue that the pronoun "αὐτὸ" refers to S by introducing the essence of S, which would be the feature in virtue of which S is P. In several passages, Aristotle seems to claim that all demonstrable attributes are necessary properties (*APo* I 4, 73a21-25; I 6, 74b5-12; cf. I 2, 71b9-12, I 33, 89a6-10; *EN* VI 3, 1139b19-24; VI 6, 1140b31-32; *Metaph.* V 5, 1015b6-9; VII 15, 1039b31-1040a2), which in his theory implies that they belong to their subjects "in themselves" (καθ' αὐτὰ).<sup>9</sup> As has been repeatedly noted in the secondary literature, for Aristotle, necessary predicates are either part of the essence of the subject or follow from its essence (Barnes, 1993, p. 120; Charles, 2000, p. 203; Loux, 1991, p. 73; Malink, 2013, p. 124-126; Bronstein, 2015, p. 724-725). Thus, Aristotle's own characterisation of demonstrable properties invites us to accept something along the lines of the S-Model.

However, what predominates in book II of the *APo* is what Ferejohn (2013, p. 131-155) claims to be a "non-canonical" model of scientific explanation: the αἴτιον is the essence (or the causal part of the essence) of the οὗ αἴτιον-attribute (*APo* II 2, 89b36-90a14; 90a31-35; II 8, 93a31-33; *APo* II 16, 98b21-24; II 17 99a21-22, 25-

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<sup>8</sup> See *APo* I 4, 73b28-32. The pronoun is in the same gender and number of the subject-terms of the exemplified predications, "αὐτήν" with "γραμμή" and "αὐτὸ" with "τρίγωνον". Moreover, the "αὐτὸ" in the "ἢ αὐτὸ" formula is replaced in both cases by the respective subject-terms, "γραμμή" and "τρίγωνον."

<sup>9</sup> This controversial claim is stated in *APo* I 6, 74b11-12, without which the argument presented in 74b5-12 is invalid.

26). I shall call it the “A-model”.<sup>10</sup> Chapter II 17 is not an exception to this pattern. The following passage is particularly eloquent:

The middle term is an account [λόγος] of the first extreme [τοῦ πρώτου ἄκρου] (which is why all sciences come about through definitions). Shedding leaves both follows vine and exceeds it, and it follows fig and exceeds it – but it does not exceed all of them: rather, it is equal to them. If you take the primary middle term [τὸ πρῶτον μέσον], it is an account of deciduousness. For there will be first [πρῶτον] a middle term in the one direction [ἐπὶ θάτερα] (that all are such-and-such [ὅτι τοιαδί ἅπαντα]); and then [εἶτα] a middle term for this (that the sap coagulates, or something of the sort). What is deciduousness? – The coagulation of the sap at the connection of the seed [*APo* II 17, 99a21-29; Barnes’ translation, with changes].

Aristotle not only affirms that the middle term is the λόγος of the major term (τοῦ πρώτου ἄκρου), but claims that this is the reason why “all sciences come about through definitions” (διὸ πᾶσαι αἱ ἐπιστῆμαι δι’ ὀρισμοῦ γίνονται, 99a22-23). Quite emphatically, Aristotle seems to endorse the view that our Syllogism V (rather than Syllogism VI) is the one providing the primary explanation – the “primary middle term” (τὸ πρῶτον μέσον) – of the fact that all broad-leaved trees shed their leaves:

### Syllogism V

*Deciduousness holds of coagulation of sap*

*Coagulation of sap holds of all broad-leaved trees*

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*Deciduousness holds of all broad-leaved trees*

An important thesis of *APo* II corroborates the A-model. According to *APo* II 1, 89b23-4, the things we seek (ζητοῦμεν) and understand (ἐπιστάμεθα) are four:

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<sup>10</sup> The S-Model and the A-Model correspond to David Bronstein’s Model 1 and Model 2, respectively. See Bronstein (2016, p. 48-50). I am very much indebted to Bronstein’s views on this issue.

- (i) “the fact” (τὸ ὄντι)
- (ii) “the reason why” (τὸ διότι)
- (iii) “if something exists” (εἰ ἔστι)
- (iv) “what something is” (τί ἐστίν)

Aristotle notes that the knowledge of (i) is prior to (ii) in the order of inquiry, since we can only ask *why* something is the case when we already know *that* it is the case. Similarly, (iii) is epistemologically prior to (iv): in order to know *what* something is, we need to know in advance *that* it “is” or “exists”. Aristotle also argues that, at least in the case of attributes, the knowledge of (iii) is equivalent to the knowledge of (i), whereas knowing (iv) is equivalent to knowing (ii) – see *APo* II 2, 90a14-8. If so, the following equivalencies hold good:

- (i) Does P holds of S?  $\equiv$  (iii) Does P exist?
- (ii) Why does P holds of S?  $\equiv$  (iv) What is P?

An attribute is said to “exist” insofar as it is predicated of a subject. Knowing the existence of thunder is the same as knowing that the kind of noise we call “thunder” is predicated of certain clouds. On the other hand, there is some sort of isomorphism between the definition of an attribute and the explanation of its occurrence in the relevant subject. For instance, thunder is defined as a noise in the clouds caused by fire being extinguished. Correspondingly, we explain why this specific noise we call “thunder” holds of clouds through the middle term “extinction of fire” (*APo* II 8, 93a7-b14):

### Syllogism VII

*Thunder (or such-and-such noise) holds of extinction of fire*  
*Extinction of fire holds of clouds*

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*Thunder (or such-and-such noise) holds of clouds*

The definition of thunder (*APo* II 10, 94a5-6), in turn, is isomorphic to Syllogism VII:

Thunder is<sub>(df.)</sub> noise of fire being extinguished in the clouds.



Here we find in the *definiens* reference to the three items involved in explanatory relations: (i) a brief account of what the οὐδ' αἴτιον-term means (*noise*),<sup>11</sup> (ii) its proper subject or the ὅτι αἴτιον-term (*clouds*) and (iii) the αἴτιον, i.e. the basic factor explaining why the former (*noise*) belongs to the latter (*clouds*) (*APo* II 10, 93b 35-38). If this pattern is followed also in the case of deciduousness, its whole definition would be isomorphic to Syllogism V:

Deciduousness is<sub>(df.)</sub> the loss of leaves in broad-leaved trees because of coagulation of sap.

As we can see, the λόγος that plays the role of middle term in Syllogisms V and VII is not the entire definition of the major term, but the causal or explanatory element in it. Still, the middle term is a specification of the attribute's essence – in fact, of the most determinant element of its essence. Therefore, the A-Model is definition- or essence-based no less than the S-Model.<sup>12</sup>

Still in favour of the A-model, one could argue that there is no textual evidence for us to assume that Aristotle is committed to the S-model in *APo* II 16. When in 98a35-b4 Aristotle presents “having broad leaves” (τὸ πλατέα ἔχειν τὰ φύλλα) as the αἴτιον of deciduousness, he probably has in mind our Syllogism I, formulated in 98b5-10 – and not Syllogism VI as Ferejohn (2013, p. 104) supposes.

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<sup>11</sup> Aristotle sometimes does not use the *definiendum* attribute as the major term, but that item in its what-it-is that we described as “a brief account of its current meaning”. Hence, our syllogism could have “noise” as the major instead of “thunder” (see *APo* II 8, 93b8-14). With that syllogism in mind, Aristotle says that the correspondent *definiens* would be nothing more than a demonstration “differing in arrangement” (see the second type of ὁρισμός/ὅρος in *APo* II 10, 93b38-94a7). On the other hand, item (i), put together with (ii), is a merely nominal non-explanatory definition, corresponding to the first type of ὁρισμός/ὅρος in *APo* II 10, 93b 29-37 (and maybe also to the third one, in 94a7-9).

<sup>12</sup> Cf. Ferejohn (2013, p. 155), who seems to assume that only the “canonical” model is essence-based or definition-based, whereas the “non-canonical” or “causal” model would at best “generate definitions.”

## Syllogism I

*Deciduousness holds of all broad-leaved trees*

*Being a broad-leaved tree holds of all vines*

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*Deciduousness holds of all vines*

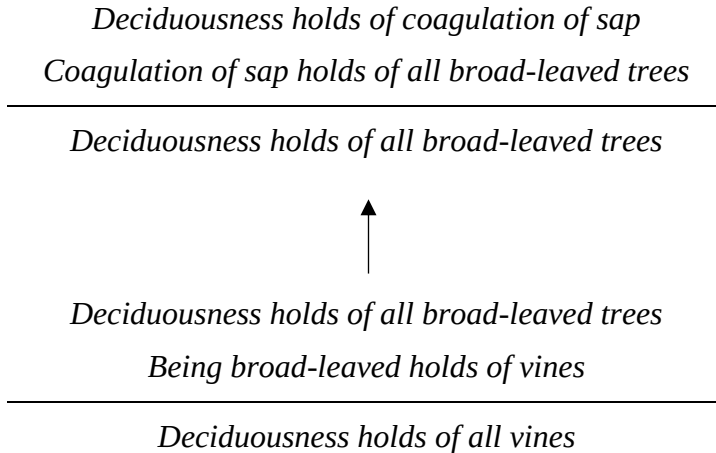
Syllogisms of this sort have been called “application arguments.”<sup>13</sup> One way of approaching these arguments is to take them not as properly explanatory, but as mere classificatory inferences meant to “upgrade” non primary-universal problems into primary-universal ones. The deciduousness example is an instance of the OC-scenario. Since a problem with coextensive terms such as “*deciduousness* holds of all *broad-leaved plants*” is available, sentences like “*deciduousness* holds of all *vines*” or “*deciduousness* holds of all *fig-trees*” are not “primary *demonstranda*” – i.e. sentences in which the predicate belongs *primarily* (πρώτῳ ὑπάρχει) to the subject. In *APo* II 18, Aristotle generalises a rule that was already implied in *APo* II 17, 99a21-29 (quoted above): it would be wrong to demonstrate a non-primary-universal conclusion such as “*deciduousness* holds of all *vines*” with the λόγος of deciduousness as the middle term. Aristotle begins the chapter affirming that not all scientific problems are explainable directly by “atomic” (i.e. immediate) premises (εἰς τὸ ἄτομον μὴ εὐθὺς ἔρχονται, 99b7). As we know, demonstrations may be composed of several syllogistic inferences and contain premises that are themselves demonstrable. Therefore, in the deciduousness example, the *first* deductive step of the demonstration (πρῶτον, 99a26) – “first” in the “analytic” or “proof-search” order, i.e. from the conclusion to the premises –, subsumes “vine” under the wider kind “broad-leaved tree” (ὅτι τοιαδὶ ἅπαντα, 99a26-27). Hence, the major premise of this first inference would state a primary-universal *demonstrandum* (“*deciduousness* holds of all *broad-leaved plants*”) and only then (εἶτα, 99a27) the

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<sup>13</sup> See McKirahan (1992, p. 177-187); Ferejohn (2013, p. 122-131). Application arguments are called “type A” syllogisms by Lennox (1987).

“primary middle term” (τὸ πρῶτον μέσον, 99a25) – the λόγος of deciduousness – becomes part of the demonstration:

**(Extended) Syllogism (I + V)**



Not only is the presence of the S-Model in *APo* II 16-17 questionable, but also the A-model appears to serve the purpose of these chapters more successfully. From *APo* II 8, it is clear that Aristotle takes the *definiendum* and the causal part of its *definiens* as coextensive.<sup>14</sup> Thus, if the *explanans* is the causal element in the *definiens* of the *explanandum* attribute, affirmative answers to Q1 and Q2 are just mere corollaries of this definitional tie. Moreover, the A-model is part of Aristotle’s reply to those willing to take coextensive middle and major terms as reciprocally explanatory (see *APo* II 16, 98b4-16): if x is part of the definition of y (and if the definition of y avoids circularity), x and y cannot be mutually explanatory, x being used to clarify what it is to be y, but not vice-versa (see *APo* II 16, 98b21-24).

<sup>14</sup> Or at least within a restricted domain, determined by the minor term. See Barnes (1993, p. 253). The major premises in syllogisms such as V and VII and the corresponding definitions yield this result: every plant that sheds its leaves undergoes coagulation of sap (from the definition of deciduousness) and every plant that suffers coagulation of sap sheds its leaves (major premise of Syllogism V).

Therefore, at first sight, our problem (2) does not seem to be that challenging. At least in *APo* II 16-17 – letting aside the question of whether this is the case in respect of the *APo* as a whole –, Aristotle seems to be committed not to two alternative models of explanation, but only to the A-model. However, this is just an apparent solution. Even if an “application argument” such as Syllogism I is implied in 98a35-b4, Ferejohn is right in recognising the presence of the S-Model in the passage (or, at least, some modified version of it). Let us spell this out.

The question of whether or not a predicate holds *primarily* of a given subject (πρῶτῳ ὑπάρχει) cannot be decided in purely extensional terms. If the scientist arbitrarily selects a  $\tilde{\phi}$  ἄτιον-term that counterpredicates with the οἷ ἄτιον-term, the *demonstrandum* does not immediately qualify as a πρῶτον καθόλου problem. In *APo* I 5, 74a25-32, Aristotle argues that the mere extensions of the terms involved in a demonstrative syllogism are not enough to warrant its scientific status. Let us say, for instance, that 2R is predicated of two different subjects: a simple one (“triangle”) and a disjunctive complex one (“everything that is either equilateral or isosceles or scalene”). The extension of the subject “everything that is either equilateral or isosceles or scalene” would cover all instances of 2R only “in number” (κατ’ ἀριθμόν, *APo* I 5, 74a31): although the disjunction exhausts the desired extension (*extensional* grasp), the objects it denotes are not described as members of a cohesive kind (*intensional* grasp), e.g. *being a triangle* (see Lennox, 1987, p. 91).

This intensional requirement becomes perfectly understandable if we assume that something along the lines of the S-Model underlies the notion of primary-universality. The reason why “triangle” – and not some other coextensive term – is the proper subject-term for the predicate “2R” may lie with the fact that the definition of triangle plays an important role in explaining the 2R-theorem. Whatever has the attribute 2R has it independently of having two, three or none of its sides equal to one another (i.e. independently of being an equilateral, an isosceles or a scalene figure): a given figure may have the property 2R without being an isosceles (negative answer to Q1),

which means that something else in this case must be explanatory (see Kosman, 1973, p. 375; Hasper, 2006; Angioni, 2014b, p. 97-98; 2016; Zuppolini, 2018, p. 130-132). Rather, the demonstration of the 2R-theorem is meant to show how 2R is explanatorily related to a specific property (or cluster of properties) common to all objects that happen to have 2R: being a three-sided rectilinear closed figure, i.e. being a triangle. If being a triangle is actually explanatory of certain figures having 2R, application arguments are not meant to promote minor classificatory adjustments.

In fact, Aristotle's vocabulary makes it clear that the kind of upgrade accomplished by arguments such as Syllogism I are truly explanatory rather than merely taxonomic. Aristotle affirms that 2R belongs to triangle "in itself" in the sense that whatever has the property 2R has it "in virtue of" (διὰ) triangle, whereas triangle has 2R "not in virtue of something different" (οὐκέτι δι' ἄλλο; *APr* I 35, 48a33-36)<sup>15</sup> – in other passages, the same idea is expressed with a "κατὰ" or an explanatory "ὅτι" instead of "διὰ" (*APo* I 5, 74b2-4; I 24, 85b5-13; see Angioni, 2016, p. 96-100). Therefore, one may argue that the reason why (αἴτιον) triangles have 2R is not something different from what it is to be a triangle, i.e. the essence of triangle.

There is a further difficulty. If the middle term of demonstrative syllogisms is always the λόγος of the major term, a phenomenon such as longevity does not seem to be scientifically explainable, or even properly definable. When it occurs in quadrupeds, longevity is explained by absence of bile, whereas its presence in birds is explained by their bodies being dry or something similar. Since one and the same item cannot have two alternative and incompatible definitions, attributes such as longevity would not be scientifically definable or explainable. However, why would Aristotle – who devoted a whole treatise to the topic: *On Length and Shortness of Life*

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<sup>15</sup> In *APr* I 35, Aristotle argues that one should not think that a primary *demonstrandum* is an immediate proposition just because the subject-term is the most appropriate one for the predicate in question. Although there is no subject-term for the predicate 2R that is explanatorily prior to "triangle", a complex expression could be used as a middle term to explain why all triangles have 2R.

– exclude an attribute such as longevity from the scope of science? This question brings us back to our problem (1). Since Aristotle’s solution to it sheds some light on (2) as well, I shall first concentrate on (1), which is the topic of our next section.

## **The appearance of “multiple causes”: “in-a-kind” and homonymous explananda**

In order to understand Aristotle’s solution to our problem (1), it is worth mentioning some of the views set out in *APo* II. As we have seen, in *APo* II 1-2, Aristotle claims that a question of the form (i) “does P holds of S?” is equivalent to (iii) “does P exist?”, whereas a question like (ii) “why does P holds of S?” is equivalent to (iv) “what is P?” In *APo* II 2, 90a6-7, the philosopher goes on to claim that looking for an answer to these four questions is equivalent to seeking for a cause (αἴτιον), which later on is identified with the “middle term” (τὸ μέσον, 90a5-6):

When we seek the fact or if something is without qualification, we are seeking whether or not there is a middle term for it; and when, having come to know either the fact or if it is – either partially or without qualification –, we seek the reason why or what it is, we are seeking what the middle term is [*APo* II 2, 89b37-90a1; Barnes 1993, with changes].

One of Aristotle’s claims here is that questions (i) and (iii) are reducible to a question about the existence of a middle term:

(i\*/iii\*) Is there an M such that PaM, MaS ⊢ PaS & M is the reason why PaS?

On the other hand, we answer questions (ii) and (iv) by finding out what that middle term is:

(ii\*/iv\*) What is M such that PaM, MaS ⊢ PaS & M is the reason why PaS?

In a context where μέσον is identified with αἴτιον, asking about the existence of a middle term for a given categorical proposition is

asking whether this proposition can be scientifically explained (see Barnes, 1993, p. 205). At this point, the inquirer is not looking for a middle term that simply establishes the truth of the conclusion, but “the actual ground in reality of the fact to be explained” (Ross, 1949, p. 611). Inquiring into the existence of such a ground is to examine whether the phenomenon in question presents the kind of regularity and consistency that suggests the presence of an underlying causal structure (Charles, 2000, p. 71). Asking what that middle term is, on the other hand, is asking what that actual ground is after all.

Therefore, asking question (iii) – “Does P exist?” – is equivalent to asking about the existence of a middle term M which could be used not only to explain why P belongs to its subject S, but also to formulate a unifying, causal definition of P. Extinction of fire explains why, under certain conditions, the particular kind of noise we call “thunder” occurs in the clouds. The causal component in the *definiens* of *thunder* is what makes the definition a “unified” account of what thunder is. In Aristotle’s words, the λόγος of thunder is “one” (εἷς) not just “by linking together” (συνδέσμῳ) *noise* and *clouds* in an artificial way, but by showing, through the middle term *extinction of fire*, that *noise* belongs to *clouds* “non-incidentally” (μὴ κατὰ συμβεβηκός; *APo* II 10, 93b35-7; see Charles, 2000, p. 40-41; p. 203). Therefore, question (iii) does not ask whether thunder *exists* without further qualification, but whether it exists *as a definable unity* or a *genuine kind*.

That being said, let us analyse the solution Aristotle offers to our problem (1):

You can inquire incidentally [κατὰ συμβεβηκός] both about what is explanatory of and about what is explanatory for – but such things are not thought to count as problems. Otherwise [εἰ δὲ μή], the middle term will have a similar character [ὁμοίως ἕξει τὸ μέσον] – if the items are homonymous [ὁμώνυμα], the middle terms will be homonymous; and if they are in a kind [ὡς ἐν γένει], the middle terms will have a similar character [*APo* II 17, 99a4-8].

In this context, to investigate something “incidentally” (σκοπεῖν κατὰ συμβεβηκός, 99a5) is to approach a scientific problem inappropriately, as if it were a case of the MC-scenario. If, on the other hand, the scientist investigates something “non-incidentally”, (εἰ δὲ μή, 99a6), “the middle term will have a similar character” (ὁμοίως ἔξει τὸ μέσον).<sup>16</sup> In order to clarify the point, let us consider two syllogisms with non-coextensive extreme terms:

AaB	AaC
<u>BaD</u>	<u>CaE</u>
AaD	AaE

Aristotle’s examples suggest that the obscure phrase “ὁμοίως ἔξει τὸ μέσον” refers to two types of apparent (but not real) cases of the MC-scenario – and therefore two apparent (but not real) counterexamples to the validity of UR (99a7-15).<sup>17</sup>

- If A holds of D and E *in a kind* (ὡς ἐν γένει), so A holds of B and C *in a kind*.
- If A holds of D and E *as homonymous* (ὁμώνυμα), so A holds of B and C *as homonymous*.

The first of these two situations is exemplified by the following problem: “why do proportionals alternate?” (99a8).<sup>18</sup> Someone may

<sup>16</sup> I here follow Ross (1949, p. 669), who argues, against most commentators, that “εἰ δὲ μή” in 99a6 means “if we study *not* κατὰ συμβεβηκός the οὐδ’ αἴτιον or the ᾧ αἴτιον.” I take the future “ἔξει” as consequential: a scientist who is dealing with an apparent case of the MC-scenario infers that the middle term has “a similar character” as soon as she starts investigating the problem “non-incidentally.” For a defence of the common reading, see Hasper (2006, p. 268).

<sup>17</sup> In *APo* II 17, 99a4-8, Aristotle also mentions a third case: explanations “by analogy” (κατ’ ἀναλογίαν). Analogical explanations are neither about one attribute predicated of two subjects of the same kind, nor about two different attributes called by the same name (see Ross, 1959, p. 670). The terms “bone” and “fish-spine” refer to quite different things, which nonetheless play the same function (or analogous functions) in the animals in which they are found (*APo* II 14, 98a20-23). These *explananda* do not threaten the validity of UR as homonymous *explananda* do, which explains why Aristotle mentions them very briefly without a proper discussion. See *APo* II 14, 98a20-23.

<sup>18</sup> That is to say: “why is the case that if W is to X as Y is to Z, then W is to Y as X is to Z?” See Ross (1949, p. 525).



commit the mistake of thinking that the explanation depends on the subjects considered: proportional *numbers* and proportional *lines* “alternate” for different reasons (see *APo* I 5, 74a17-24; I 14, 85a36-b1). Aristotle believes, however, that a single explanation could be reached if numbers and lines were treated as members of a common kind (ὡς ἐν γένει), i.e. not *qua* numbers or *qua* lines, but *qua* items having such-and-such ratio (ἢ δ’ ἔχον αὐξησιν τοιανδί, 99a10). The mistake consists in “investigating the  $\tilde{\alpha}$  αἴτιον incidentally”: minor terms D and E were mistaken for subjects to which A belongs “primarily” (πρώτῳ), when in fact D and E are A not in themselves, but as members of a wider-kind F, which is A “not in virtue of something different” (οὐκέτι δι’ ἄλλο; *APo* I 5, 74a25-32; cf. I 2, 71b9-12). If so, the conclusions “AaD” and “AaE” can be upgraded, by application arguments, into a single *demonstrandum* with coextensive terms: “AaF.” Moreover, if two subjects D and E are A “in a kind”, the respective middle terms B and C can also be replaced by a unifying middle term G: ὁμοίως ἔξει τὸ μέσον. For instance, deciduousness belongs to vines and fig-trees “in a kind” (ὡς ἐν γένει). Hence, we should obtain a primary-universal *demonstrandum* in the major premise of an application argument such as Syllogism I before trying to propose a unifying explanation for the major term “deciduousness.” Thus, any causal story about fig-trees being deciduous that does not work for vines as well can and should be improved by a wider explanation covering all instances of deciduousness (i.e. all broad-leaved trees), like in Syllogism V. Therefore, the violation of UR is merely apparent.

However, not only the  $\tilde{\alpha}$  αἴτιον but also the οὔ αἴτιον-term can be investigated “incidentally” (σκοπεῖν κατὰ συμβεβηκός, 99<sup>a</sup> 5). In this case, a scientist may falsely believe that the conclusions “AaD” and “AaE” fall into the MC-scenario not because she did not realize that D and E are subspecies of a common kind F, but because D and E appear to be subjects of the same attribute, whereas in fact “A” is an ambiguous term and holds of D and E *homonymously*. In the *Categories*, Aristotle defines homonymy as follows: “when things have only a name in common and the definition of being which corresponds to the name is different, they are called *homonymous*”

(*Cat. I* 1, 1a1-2; translation by Ackrill, 1963). Aristotle's notion of homonymy is not that of equivocality or ambiguity, though the former may be derived from the latter. Homonymy is a property of things in relation to a certain expression, while equivocality (or ambiguity) is a feature of expressions themselves (see Ackrill, 1963, p. 71-72). Two subjects D and E are homonymous in relation to a certain expression "A" when "A" applies to both of them but each application is associated with different definitions of "A". Consequently, "A" must be an ambiguous word if it applies homonymously to D and E.

However, homonymy can obtain at different levels. In cases of what has been called "strong homonymy", the expression "A" has associated with it totally unrelated definitions, as when we apply the word "bank" to disparate types of thing such as a riverbank and a financial institution (Wedin, 2000, p. 13). On the other hand, "weak homonymy" occurs when the distinction between the different definitions of "A" is more subtle. In this case, the two homonymous items D and E may share a property in virtue of which they are both called "A" and consequently the corresponding definitions may also have something in common – though the complete definitions must obviously remain distinct if weak homonymy is to be case of homonymy at all.<sup>19</sup> Aristotle's example in *APo* II 17 suggests that he has in mind this second and weaker kind of homonymy: "similar" signifies different things when applied to figures and colours (*APo* II 17, 99a11-15). Between figures, similarity means "having proportional sides and equal angles" (99a13-14), while between colours it means "the fact that perception of them is one and the same" (99a14-15). Hence, figures and colours are homonymous in relation to the expression "similar" and hence "similar" is an equivocal term. However, there is no equivocality at the level of ordinary parlance, since the word currently means, regardless the items it applies to, a likeness or resemblance of a certain sort. Therefore, similarity is a case of weak homonymy.

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<sup>19</sup> See Wedin (2000, p. 13-14). See also Zingano (2013), for a detailed discussion of what he calls "attenuated homonymy".

Scientific definitions are explanatory and involve more than a brief account of the current meaning of the *definiendum* term. At a scientific level of analysis, similarity in figures and in colours relates to very different sets of truth-conditions and explanatory factors. Thus, part of the process of defining something in contexts of weak homonymy is to realize that there is no single attribute to be defined (similarity without qualification), with two (or more) competing explanatory accounts, but actually two (or more) different attributes (similarity in figures and similarity in colours) with their own definitions and explanations. Apparently, the same diagnosis applies to the case of longevity.<sup>20</sup> Aristotle believed that the phenomenon of longevity is realized in very different manners depending on the group of living-beings considered, in such a way that it becomes impossible for us to come up with a single explanation for all its instances (*Long.* 1, 464b22-464b25; 4, 466a1-466a8). Being long-lived for quadrupeds is so different from what being long-lived is for birds that we have different middle terms for the major “longevity” in each case: “absence of bile” and “being dry” respectively. If the middle term is the causal part of the definition of the major, the term “longevity” gets one definition when predicated of quadrupeds and another when predicated of birds. Therefore, longevity holds of quadrupeds and birds homonymously. Consequently, the respective middle terms “absence of bile” and “being dry”, as long as they refer to very distinct ways of being long-lived, also have “longevity” predicated of them in the respective major premises homonymously: ὁμοίως ἔξει τὸ μέσον.

Again, this reasoning does not entail that “longevity” is an equivocal term at the level of ordinary language. Rather, homonymy comes up only when we find out that there is no such thing as *longevity without qualification* that could be object of scientific definition. Rather, what can be defined in a scientific way are quite distinct attributes: *longevity-for-quadrupeds* (or *Q-longevity*) and *longevity-for-birds* (or *B-longevity*):

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<sup>20</sup> I am indebted to Lucas Angioni and David Bronstein on this point.

*Q-longevity* is<sub>(df.)</sub> quadrupeds living long because of absence of bile.

*B-longevity* is<sub>(df.)</sub> birds living long because of their bodies being dry.<sup>21</sup>

If this interpretation is correct, longevity is not an *explanandum* that fails to satisfy UR. What appears to be a single *explanandum* attribute at the level of ordinary language gives way to two different attributes (*Q-longevity* and *B-longevity*), each of which holds of its subject (quadrupeds and birds) *primarily* (πρώτῳ) and relates to one single item as its proper explanation (absence of bile and dryness respectively). If so, what appears to fall into the MC-scenario is actually an instance of the OC-scenario. Once we restrict the domains of the demonstrations in order to disambiguate the major term, what appeared to exemplify the MC-scenario turns out to be a case of the OC-scenario and no longer threatens the validity of UR.

In other words, *longevity* (without any disambiguation) does not exist as a *definable unity* or a *genuine kind*, but *Q-longevity* and *B-longevity* do. As Aristotle makes it clear since the beginning of *APo* II, when a scientist attempts to define an attribute such as longevity, she does not seek for a vague and abstract account of the term “longevity” covering all its (standard) uses in ordinary speech. Rather, she is interested in knowing whether these uses refer to a single homogenous phenomenon, i.e. whether they are all associated with one and the same underlying cause. If not, it is possible to look for unifying causes in more restricted domains than the one assumed in ordinary language. In this case, either there will not be restricted domains in which UR is satisfied (and the phenomenon is not scientifically explainable) or the scientist will find herself dealing with several scientific *explananda* – instead of just one as everyday discourse makes it appear.

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<sup>21</sup> These definitions avoid circularity precisely because the *definienda* are specific kinds of longevity, “living long” being an expression that accounts for what *Q-longevity* and *B-longevity* have in common (since this is a case of weak homonymy).

Now, I shall explain how this picture invites us to pursue a conciliatory solution to our problem (2).

## A Conciliatory Solution

As we have seen in *APo* II 16, 98b21-24, the priority of the *explanans* over the *explanandum* is illustrated in terms of an asymmetric relation of definitional dependence: *thunder* (*explanandum* attribute) cannot be defined without mentioning *extinction of fire* (*explanans*), whereas *extinction of fire* can be defined without mentioning *thunder*.<sup>22</sup> However, definitions of attributes contain reference not only to its *explanans* (e.g. extinction of fire), but also to its proper subject (e.g. clouds). *Thunder* cannot be defined without mentioning *clouds*, but *cloud* can be defined without reference to *thunder*. Can this definitional priority of subjects tell us something about which role their essences play in Aristotelian demonstrations?

We know Aristotle believes that attributes (non-substance entities) are somehow ontologically dependent on their proper subjects (substances or substance-like entities).<sup>23</sup> In treatises such as the *Categories* and the *Topics*, the question “what is x?” is equally applied to substance and non-substance entities. Even when x is a non-substance being, a sentence stating what x is would have the form “x is y”, in which x and y belong in the same category, without a reference to x’s proper subject. However, in the *APo* and the *Metaphysics*, Aristotle adopts the view that definitions of attributes (i.e. non-substantial beings) must somehow account for their status as dependent entities (*Metaph.* VII 1, 1028a35-36; VII 5, 1030b23-

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<sup>22</sup> The example in the passage is the lunar eclipse, but the two cases are strictly parallel.

<sup>23</sup> The qualification “substance-like” is meant to account for basic subjects in mathematical sciences (such as number, line, surface, figure etc.), which are studied independently of the material elements in which they inhere in the real world. My point is that attributes such as *odd* and *straight* are ontologically dependent of *numbers* and *lines*, even if numbers and lines are not substances in the strict sense of the term.

24; *APo* I 4 73a37-b5; II 2, 90a14-18; II 10, 93b38-94a7). Therefore, at least in these later treatises, ontological priority of subjects over their attributes would have definitional priority as its linguistic counterpart.

In order to explain this correlation, some authors have rendered the notion of ontological priority in existential terms, but with important qualifications. According to them, Aristotle understands existence with some sort of essentialism in the background: to be is always to be with regard to a certain nature; to exist for *x* is being a member of a certain kind that states what *x* is (Loux, 1991, p. 3-6; p. 27-28; p. 34-35; Irwin & Fine, 1995, p. 569; Zillig, 2010, p. 41). Others have argued that the ontological correlate of definitional priority is not correctly depicted by an existential construal. Rather, *x* would be ontologically prior to *y* whenever *x* is *what it is* independently of *y* being *what it is*, the converse not being the case (Peramatzis, 2011).<sup>24</sup> Either way, the relevant concept of ontological priority would be intrinsically connected to the notion of essence. In Aristotle's vocabulary, *x*'s essence is "what being is for *x*" (τὸ + noun in the dative + εἶναι). That is to say, the philosopher talks of essence as a *way of being* (Loux, 1991, p. 85; Peramatzis, 2011, p. 3-4; Charles, 2011) – either in the sense of *existing as something of a certain kind* or in the sense of *being what something is*. Therefore, an attribute *P* (a non-substance entity) is ontologically dependent on the relevant subject *S* (a substance or substance-like entity) in the sense that *P* does not have the essence it has (i.e. cannot perform the *way of being* that distinguishes it as such) independently of *S* having the essence it has.

The way Aristotle deals with problem (1) corroborates this approach. After all, his solution involves arguing that a single term "A" may stand for two (or more) different attributes, with different causal definitions, depending on the subjects of which it is predicated. In other words, attributes are not what they are and do not get the definitions they get independently of the subjects to which

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<sup>24</sup> Cf. Fine (1995, p. 275) and his notion of ontological dependence.

they belong “primarily.” Their identity is partially fixed by these subjects, on which their status as definable unities ultimately depends. For that reason, the definitions of Q-longevity, B-longevity and deciduousness should mention quadrupeds, birds and broad-leaved trees respectively. If quadrupeds were not the sort of animals they are, their longevity would not have absence of bile as its primary explanation (and, consequently, as the causal part of its definition). Similarly, if broad-leaved plants had not the essences they have, they would not undergo coagulation of sap, which is the process that makes deciduousness the unified phenomenon it is. Therefore, given that the essence of subjects is prior to the essence of attributes, guaranteeing a place for definitions of attributes in demonstrative sciences and denying one for the definitions of their proper subjects seems, at best, uncongenial to Aristotle’s philosophy.

In fact, the structure of demonstrations allows definitions of subjects (as much as definitions of attributes) to play the role of explanatory middle term. As we have seen in our analysis of *APo* II 17, 99a16-9, a complete demonstration may have the form of an extended argument with several syllogistic inferences. Moreover, the passage is clear that it is not in every deductive step that the middle term is the λόγος of the major term. The demonstration may involve (as it does when it contains application arguments) further syllogistic steps in which the middle term is not definitionally connected to the major. In Syllogism V, for instance, the definitional connection between *coagulation of sap* and *deciduousness* makes the major premise “immediate” (cf. *APo* II 8, 93a35-36). Nevertheless, the relation between *coagulation of sap* and *broad-leaved tree* in the minor premise remains demonstrable. Therefore, in a complete demonstration, this branch of the demonstration would go on until it reaches a middle term “immediately” connected to *broad-leaved tree*, i.e. the λόγος of *broad-leaved tree*. Otherwise, the demonstration would proceed *ad infinitum*, since it would always contain at least one demonstrable premise. If a complete demonstration of the phenomenon of deciduousness is as we have

just stated, the pieces of textual evidence in favour of the A- and the S-Model are not incompatible, but complementary.<sup>25</sup>

The same pattern holds true *mutatis mutandis* for other examples. In the major premise of Syllogism VII, *thunder* is said to follow the causal part of its definition, namely, *extinction of fire*. The minor premise, in turn, introduces a new *demonstrandum*: why do clouds undergo extinction of fire? *Extinction of fire* is what explains why *thunder* holds of *clouds* “non-incidentally”, i.e. why there is a regular connection between *thunder* and *clouds*. However, this could hardly be the case if *extinction of fire* were “incidentally” connected to *clouds*. Thus, it would not be surprising if the nature of clouds were what directly or indirectly explains why, under certain conditions, fire is regularly extinguished in them. In other of Aristotle’s favourite examples, the occurrence of the *lunar eclipse* in the *moon* is explained by the middle term *earth screening* (see *APo* II 8, 93b3-7). Whereas the connection between *eclipse* and *earth screening* (the causal part of its definition) is “immediate” (93a35-36), the link between *earth screening* and *moon*, on the other hand, requires further explanation. According to Aristotle’s cosmology, having the earth interposed between the moon and the sun is caused by the moon’s natural movement and its position in the composition of the celestial spheres, features the philosopher would probably take either as essential to the moon or as properties following from its essence.

Finally, a combination of the A-Model and S-Model is especially attractive in contexts of weak homonymy. In the major premise of Syllogism III, for instance, the middle term *absence of bile* and the major *longevity* (which here stands for Q-longevity) are definitionally connected, whereas the connection between *absence of bile* and *quadrupeds* requires further premises in order to be fully understood. According to Aristotle, bile is a residue of impure blood that affects the conditions of the liver, which is a vital organ to

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<sup>25</sup> This solution has been recently defended, with different arguments, by David Bronstein (2016, p. 48-51).



quadrupeds in virtue of their being essentially blooded animals.<sup>26</sup> Therefore, in an extended version of Syllogism III, absence of bile in quadrupeds may be explained, directly or indirectly, by one or more of their essential features.

This new perspective also allows us to explain the intensional aspect of primary-universality. As we have seen, a disjunction of all deciduous trees (“everything that is vine or fig trees or oak...”), despite covering (extensionally) the desired domain, would not work (intensionally) as a minor term in a primary-universal demonstration. The reason is the following: the essence or *way of being* on which the essence of *deciduousness* depends is the one picked up by the definition of *broad-leaved tree*. In other words, what ultimately explains why coagulation of the sap occurs to all deciduous trees is the essence displayed by a definition whose *definiendum* is neither “vine” nor an exhausting disjunctive term, but “broad-leaved tree”. For the same reason, we cannot explain why “all isosceles triangles have 2R” with the definition of 2R as the middle term without first subsuming “isosceles triangle” to the wider term “triangle”. “Triangle” is the sole term apt to occur as subject in the primary-universal *demonstrandum* because what is part of the demonstration of the 2R-theorem is the definition of triangle, not the definition of any of its subspecies.

Ferejohn (2013, p. 151) rejects this kind of conciliatory solution on the grounds that it does not get support from Aristotle’s texts. The philosopher never combines Syllogisms V and VI to formulate a complete demonstration, and this is what we would expect him to do if the S-Model and the A-Model were complementary to each other. However, Aristotle’s aim in *APo* II 16-17 is to deal with problem (1), whose formulation and solution is under the influence of what can be taken as the main topic of *APo* II: the isomorphism between definitions of attributes (such as thunder and deciduousness) and their

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<sup>26</sup> *PA* IV 2, 677a30-677b10. In this passage, Aristotle mentions very specific kinds of quadrupeds (and also dolphins). On the inadequacy of Aristotle’s example, see n.4 above. Nevertheless, we believe the philosophical point we attribute to him remains solid.

respective syllogistic demonstrations. In this context, the essence of attributes is under the spotlight, which explains why the A-Model stands out in comparison to the S-Model. Problem (2), on the other hand, does not seem to bother Aristotle, which suggests he endorsed both models as parts of the same coherent doctrine. We have tried to show how his own solution to problem (1) leads to the same result.<sup>27</sup>

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