IS ARISTOTLE'S BIOLOGY A "POSTERIOR ANALYTICS' SCIENCE"?

Introdução e justificativa

The idea of studying the different sort of inquiry in zoological treatises and their interrelation with *Posterior Analytics* is part of a wider research program which take place in Venice:

"Le projet s'inscrit, du point de vue de l'équipe de Venise, dans le cadre d'un projet de recherche sur la théorie de la causalité chez Aristote dont le but ultime est de revenir sur le statut de la causalité volontaire chez Aristote. Le travail de recherche de Barbara Botter constitue un des éléments du volet physique et logique de cette enquête.

Bien que la biologie aristotélicienne passe pour résolument finaliste, et qu'elle le soit certainement si l'on considére la prééminence explicative de la cause finale, si l'on suit certaines déclarations programmatiques d'Aristote on ne peut que constater que les explications particulières font une place importante à des explications de type mécaniques. L'explication par les causes matérielle et parfois motrice est fondamentale. Il existe aussi une série de passages théoriques où s'esquissent une articulation entre les deux niveau d'analyse. Barbara Botter se propose d'examiner de ce point de vue les passages pertinents du corpus zoologique du point de vue physique et logique. Cette question permet à son tour de poser à un niveau plus général le problème de la multiplicité des axes étiologiques et explicatives qui la constituent (théorie des quatre causes)[1]."

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[1] Nous n'avons pas distingué "cause" et "explication". Voir à ce propos: Frede 1980; Moravcsick 1991; Freeland 1991.

Plano de trabalho e objetivos

Aristotle was the first Greek thinker to articulate a taxonomy of scientific pursuits. He distinguishes theoretical, practical and productive areas of knowledge. Theoretical knowledge is divided into mathematics, second philosophy, that is the study of natural objects, and first philosophy, that is the study of being *qua* being. In addition, the four books of *Analytics* present a theory of scientific knowledge. Aristotle presents us a rigorous account of what a body of propositions must be like in order to count as a theoretical science. But Aristotle was also the originator of "special sciences". In fact, there is a subset of Aristotle's treatises which we usually refer to as his biology or zoology. Aristotle himself occasionally mentions the investigation of animals and plants, but not in a way that marks it off clearly from the study of coming to be and passing away in general[2]. When we turn to these works, a number of questions arise. A longstanding problem about Aristotle's philosophy of science is to understand if there is a conflict between the account of scientific explanation in the *Posterior Analytics* and the investigations reported in treatises such as the *Historia Animalium, Parts of Animals, Generation of Animals*[3].

The main problem:

In his famous and still influential treatment of this problem, Werner Jaeger saw in what he took to be the empiricism of the biological works the final step in Aristotle's emancipation from the platonic view of scientific knowledge found in the *Analytics*[4]. Now it is clear that this general account of Aristotle's progress away from platonism is untenable. But it is still supposed that Jaeger was right that there are empirical elements

[2] Aristotle, *Mete.* 339a5-8, 390b19-22; *PA* I 4, 644b22-645a10.
[3] Cf. Barnes 1975, and 1981.
[4] Jaeger 1948, pp. 337-41.

in the method practiced in biological works to which no role is given in the *Analytics*[5].

There has also developed in recent years the view according to which there is a more basic discrepancy between the account of the path to scientific knowledge found in the *Posterior Analytics* and the path actually followed in all the scientific writings including the biological. The *Analytics* restricts knowledge to what has been demonstrated from self-evident first principles. The biological works seem to secure their results without such demonstrations. Aristotle's biological practice presents a theoretical explanation of why animals have parts they have, develop and behave as they do. Yet it looks nothing like the prescriptions for theoretical science in *Analytics.* There are not axioms, nor definitions, nor theorems or proofs. The whole discourse of the natural science resists to the formal language that the *Organon* desiderates[6]. G. E. R. Lloyd has been especially critical of attemps to bring the practices displayed in the biological works in line with the scientific knowledge found in *Posterior Analytics (A Po).* In fact, it appears to be enigmatic on how the prescriptions of *Analytics* would apply to a natural science. In this work Aristotle never mentions the distinction between matter and form; never raises the question of whether a proper definition of a natural object include reference to its material nature; never mentions conditional necessity, even in the discussion of natural processes[7]. Yet many of the examples in the *A Po* are drawn from meteorology, botany and zoology, and are discussed side by side with mathematical examples.

The prevailing view in Anglo-American scholarship was that the *Posterior Analytics* provides us with an austere, formal, deductive model of explanatory proof, while biological treatises are a set of informal explorations.

The strongest evidences against the suggestion that there are affinities between the theory of explanation in the *A Po* and the zoological treatises are that:

[5] See Düring 1943, pp. 22-3; Lloyd 1968, pp. 71-80, 301; Bourgey 1955, pp. 121-2.
[6] See Lloyd 1991, p. 394, and 1996.
[7] Aristotle, *A Po* 94b27-95a9.

1) Aristotle introduces in the biological treatises concepts and distinctions that are absent from the *Analytics*; for example there are special forms of necessity and of demonstration operative.

2) *A Po* recommends a picture of science at the stage of providing explanations, which has not correspondence with the structure of explanation found in the biology.

3) How much of the model of science found in the *Analytics* remains once you introduce such ideas as that organisms are active, goal-oriented unities of matter and form?

4) does syllogistic remain?

I agree that in biological works there are explorations, physical observations, lists of facts and of phenomena which have not correspondence with the model of science found in the *Analytics,* but as Wolfgang Kullmann writes, "Aristoteles' Ziel war es nicht nur, möglichst viele Beobachtungen in der Natur zu machen und Fakten zu sammeln, sondern aus diesen Beobachtungen Aufschluss über die Ursachen von Gestalt und Funktion der Lebewesen und ihrer Organe zu gewinnen. Die Fakten sollten in einem Nachschlagwerk zusammengefasst und die Ursachen in anschliessenden Abhandlungen wie in einem mathematischen Lehrbuch aus Grundtatsachen (Prinzipien) deduziert werden"[8].

I agree, also, that there is no attempt to present biological explanation in syllogistic form, but I think that in *A Po* there isn't our distinction between philosophy of science and epistemolgy, nor between philosophy of science and methodology, that contemporary philosophy tend to treat separately[9]. First of all, we need to know what to look for. I don't think that if Aristotle would have pictured a science of zoology as an axiomatic system, he had based it on the syllogistic form. In a syllogistic argument the middle term must refer to the cause which explains the presence of some part in some

[8] Kullmann 1999, p. 108. See Aristotle, *A Pr* 46a17 ff.

group of animals. But in biological phaenomena there are a variety of kinds of cause. Syllogistic cannot reveal if the middle term is the matter, or the goal or the function. Only a non-syllogistic explanation makes the nature of cause in biological works clearer. On the other hand, I don't think that in *Posterior Analytics* Aristotle was attempting to do a "logical positivism".

A Po is an exploration of those themes central to the *Theaetetus*: what is scientific understanding, what sort of facts can we hope to have understanding of, what place do sense perception, causal explanation, definition and division have in our account of understanding. Briefly speaking, the *A Po* is the first attempt in the history of philosophy to provide a rigorous theory of explanatory proof. Its first six chapters characterize scientific understanding of facts in terms of deductive proof from premises which are true, unmediated, primary and causative of the fact stated in the conclusion[10], the first book being focused primarily, but not exclusively, on providing a theory of demonstrative proof. The second book presents a comprehensive view of Aristotle's theory of scientific inquiry, that is, inquiry aimed at producing demonstrative explanation. The book is a study of scientific inquiry and progress. The discussion is of science in progress, moving toward the principles, which will serve as explanatory strating point. The second book is important for our investigations, because it announces itself as an extended account of different sorts of inquiry and their interrelations[11]. I am interested in whether this broad picture of types of inquiry has any parallels in Aristotle's various works which record the results of his investigation of animals. Moving beyond the *Analytics,* this heterogeneity extends to discussion of "demonstration" in the *Rhetoric, Topics, Nichomachean Ethics* and *Parts of animals.*

[9] Cf. Burnyeat 1981, p. 97.
[10] Aristotle, *A Po* 71b19-23.
[11] Aristotle, *A Po* 89b23-35.

Jonathan Barnes has suggested that *A Po* was initially innocent of the syllogistic[12]; on the other hand, the function of the syllogistic was not primarily that of structuring explanation, but of testing the logical properties of explanations presented in a natural language[13]. It is possible that the *Analytics* demands only that a good scientific explanation be capable of syllogistic recasting, not that actually be written as a syllogism. One might attempt to characterise different sorts of accounts which approach, to different degrees, a scientific explanatory definition[14]. Even within the *A Po,* Aristotle often departs from the axiomatic ideal of science described in its five chapters. There are demonstrations that don't have causes as middle terms, demonstrations that don't have primary causes as middle terms, demonstrations in which the subject is a particular, demonstrations of predications that hold only for the most part, demonstrations that mix mathematical and natural premises.

In my opinion, the recent literature on the *A Po*[15] and the recent works on the zoological treatises[16] have altered the landscape. "Charakteristisch für Aristoteles' Methodik ist die Kombination von empirischer Beobachtung und theoretischer Überlegung. [...] Wir finden die apodeiktische Grundstruktur der *Analitika Posteriora* [...] aber Aristoteles ist immer zur Modifikation seiner theoretischen Annahme bereit, wenn die Erfahrung dies geraten erscheinen lässt"[17]. I think that the debate must be over the nature and the extent of the relationship, because principles enunciated in the *Prior* and *Posterior Analytics* regarding the form of a scientific proposition and about the nature of true, lie behind certain practices in the biological treatises: for example, the attention to find differences that are "commensurately universal", the practice of the method of division, the nature of the *megista genê* in biology, the structure and variety

[12] Barnes 1981.
[13] Lear 1980.
[14] Cf. Gotthelf 1987, pp. 194-6; Balme 1987, pp. 294-8.
[15] See Ferejohn 1990, p. 160; Kosman 1990, p. 359; Marcos 1996, pp. 59, 105, 270, 272; McKirahan 1992, p. 296.
[16] See Balme 1987, 1991, 1992; Bolton 1987; Charles 1990, 1997; Detel 1997; Gotthelf 1985, 1987, 1997; Kullmann

of biological explanation. Moreover a number of passages from the biology and the *Analytics* agree in detail that there is a distinction to be made between an investigation aimed at establishing *that p* is the case and one aimed at establishing *why p*.

I Specific Problem (SP)

Aristotle himself occasionally mentions the investigation of animals and plant[18], but it's difficult to understand the manner in which the study of animals is partitioned and the ways in which the different biological works are related to each other. The answers we have are in part influenced by recent developments in the biological sciences that have little to do with Aristotle[19].

I want to show that the distinction between the *Historia Animalium (HA)* and the *Parts of Animals (PA) - Generation of Animals (GA)* is in terms of the distinction between two stages of inquiry: 1) grasping that the predication is the case; 2) establishing the reason why. The reason for dividing up the investigation in this way is to be found in the *A Po.* In fact, *A Po* II opens by distinguishing two pairs of inquiry which issue in four kinds of knowledge: the fact, the reason why, whether something exists, what it is. Inquiries into whether some kind of thing exists lead to inquiries into that kind's nature; inquiries into questions regarding the truth of some fact lead to inquiries into why the fact is as it is[20].

HA stands apart from those treatises aimed at offering various explanations of animals, and much of the information it contains is duplicated in other treatises[21]. Attending to Aristotle's logical and epistemological vision perhaps can help us to understand this approach of *historia* to the study of living things. In fact, one passage in the *A Pr* insists that, just as demonstrations in astronomy were discovered only after the principles were

1974, 1990, 1997; Pellegrin 1982; Lennox 1984, 1987, 1990, 1992.
[17] Kullmann 1999, p. 117.
[18] Aristotle, *Mete.* 339a5-8, 390b19-22; *PA* I 4, 644b22-645a10.
[19] Cf. Balme 1987, pp. 9-11.
[20] Aristotle, *A Po* 89b24-35.

supplied by astronomical observation, any science has its principles supplied by experience[22]:

> So that if the predicates about each thing have been grasped, we will be well prepared to exhibit their demonstrations. For if none of the predicates which truly belong to the subjects have been left aside by our inquiry (*historia*), we will able, with respect to everything for which there is demonstration, to discover the demonstration and carry it out; but of that which in the nature of things has no demonstration, we will be able to make this apparent[23].

The function of *historia* is to enable one to "grasp" the predicates which hold of each item in the general subject being investigated. At the beginning of chapter 27, regarding the method to be used in selecting premises, Aristotle says that the method involves developing a list of everything that the predicate belongs to universally as well as a list of all the things that belong universally to the subject[24]. This description of *historia* as an inquiry establishing which predicates truly belong to which things is relevant to demonstration. This procedure provides a set of rules for identifying predications at the appropriate level of generality and specificity as well as distinguishing what is in the essence, what is predicated as a property and what is predicated as an accident[25]. The organisation of true propositions in this way is presented as facilitating the development of a demonstrative science, because it gives us a short list of candidates for demonstrative middles. The *HA* characterizes its task in terms very similar to those used in *A Pr* 46a22-27.

> These things have now been said thus in outline to give a taste of the number of things that one must study and how far - we will speak in detail later - so that first we may grasp the *differentiae* present and the attributes in every case. After this, we must attempt to discover the causes of these. For is natural that the study be carried out in this way, when there is an inquiry (*historia*) concerning each thing. For *about*

[21] See Le Blond 1945, p. 19, Balme 1987, pp. 13-17.
[22] Aristotle, *A Pr* 46a17-22.
[23] Aristotle, *A Pr* 46a22-27.
[24] Aristotle, *A Pr* I 27-29, esp. 43b39-43.
[25] Aristotle, *A Pr* 43b1-32.

which things and *from which* things the demonstration should be becomes apparent from these[26].

In this passage is clear the distinction between an investigation aimed at establishing the features of each kind of animal and an investigation aimed at establishing the causes. The first task is to grasp the differences and the incidental features that belong in 0each case. This alludes to an aspects of the methodology of *A Po* II 14, that is the division of a kind into its immediate sub-kinds and then the "grasping" of what belongs to each[27].

In *HA* as in the *A Pr* this investigation is called *historia*[28], and it is said naturally to precede the attempt to discover the causes. "The *historia* will make apparent the "about whiches" (the *explananda*) and the "from whiches" (the *explanans*) of our scientific explanation"[29]. Besides the reference to *apodeixis* , the description of the components of demonstration as that *about which* and that *from which* is reminiscent of the description of demonstrative understanding in *A Po* I 10, 76b12-23[30]. Thus, the *historia* is the first stage of a inquiry; the second stage is directed toward scientific demonstration. If one were looking *HA* for a systematic treatment of kinds of animals, kind by kind, organised by a uniform method of classification, one could be disappointed. *HA* isn't an encyclopedia of animals, and it has a non-taxonomic nature, as David Balme, Pierre Pellegrin and Wolfgang Kullmann have showed: "Aus dem gesagten folgt aber nicht, dass Aristoteles versuchen würde, eine taxonomische Ordnung des Tierreichs mit allen Arten, Gattungen und grössten Gattungen aufzustellen. Denn er hat festgestellt, dass sich viele Eigenschaften der Tierarten überlappen (*epallaxis*[31])"[32]. The focus remain on identifying the widest kind to which a predicate selected from division belongs

[26] Aristotle, *HA* I 6, 491a7-14.
[27] See also Aristotle *HA* 497b6-9: *"Some of the parts of the other [non-human] animls are common to all of them, just as was said before, while others are common to certain kinds"*.
[28] See Aristotle, *A Po* I46a24-8 esp.
[29] Lennox 1987, p. 45.
[30] See Aristotle, *A Po* 76b22-23 especially and 77a40-b3.
[31] Aristotle, *GA* II 1, 732b15.
[32] Kullmann 1999, p. 110.

universally. There is a persistent concern to distinguish these feature from those which are proper to the kind in question and to differentiate a list of other features peculiar to the sub-kind[33].

Consider *HA* IV:

> We have said previously, about the blooded animals, which parts they have in common and which are peculiar to each kind; and about the non-uniform and the uniform parts, which they have externally and which internally. Now we must discuss the bloodless animals[34].

This is a summary. The first part of the sentence reflects the feature of the earlier discussion: within an extensive kind, there is a tendency to move from the consideration of what this kind has in common with other kinds, to isolate the distinctive features of this extensive kind, and then to noting of what is distinctive to sub-kinds. The first six chapters of Book I introduce:

- the distinction between parts that are uniform (flesh, bone), simple and non-uniform (eye, finger), complex and non-uniform (head, limb);

- the distinction between sameness in form, sameness in kind, sameness by analogy;

- Aristotle says that animals are differentiated according to their lives, activities, dispositions and parts;

- finally Aristotle establishes a number of extensive kinds.

The second part of the sentence reflects the order of the composition of *HA* I.7-III, which within extensive kind surveys first the external non-uniform and internal non-uniform parts, then the external uniform and internal uniform parts. *HA* was offered by its author neither as a report of a systematic taxonomy of the animal kingdom[35], nor as a collection of simple natural history, but as a study of *differentiae*[36] for the purpose of causal demonstration. The apparent chaos in *HA* is dissipated when the aristotelian

[33] This organisation is akin to the ideas in *A Pr* I 27-30 and *A Po* II 14.
[34] Aristotle, *HA* IV 523a31-b2.
[35] Many attempts to construct a taxonomy out of its materials have failed. Cf. Meyer 1855; critiqued by Balme 1987, pp. 81-5.

science of nature is viewed within the context of the logic of division: the first task of *HA* is to grasp the differences and the incidental features that belong in each case. *A Po* II 14 suggests how to use "dissection and division":

> to select thus, positing the kind common to all; e.g., if the subjects of study are animals, [select] what follows all animals, and having grasped these, again what follows all the first remaining things, e.g. if this bird, what follows every bird, and thus always [ask what belongs] to nearest kind[37].

As *A Po* suggests, *HA* offers a study of differences. Even at the most abstract level, we begin with the assumption of four broad categories of *differentiae.* No kind of animal can be adequately characterised without a study of the life it leads in its environment and the activities it performs (locomotive, generative, perceptive, nutritive) (V - VIII), its dispositional differences (is it gregarious or a loner, timid or brazen, predator or prey?) (IX), and its parts (I 7 - IV 7). Further divisions are indicated under each category. Within the study of the parts, the investigation of the blooded animals (I 7 - III 22) is distinguished from that of bloodless animals (IV 1-7); and the investigation of the parts of the blooded animals is divided into an account of the external non-uniform parts (I 7 - II 14), the internal non-uniform parts (II 15 -17), the genitalia (III 1), and finally, the uniform parts (III 2- 22)[38]. Division are useful as a potentially exhaustive source of predicates from which to select appropriate predications[39]. *A Po* is critical of the use made of logical division by Plato, and yet give division an important place in the scientific interprise[40]. The second and third chapters of *PA* I develop a systematic reform of division[41]. Aristotle adopt both the criticism of platonic division[42] and *A Po* II 5 – 6, 13. The *Analytics* give guidance as to how a divisional method would work; *PA* I 2, 3 and *HA* provide the application. Aristotle's method is intended to identify the

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[36] Cf. Balme 1987, p. 89.
[37] Aristotle, *A Po* II 14, 98a1.
[38] This method can be seen clearly in the discussion of the lungs and the related organs: *HA* 505b32-506a12; see 507a11-12, a24-27, 508a17-21, 32-33, 508b30-509a16.
[39] Aristotle, *A Pr* 46a31-b19.
[40] Aristotle, *A Po* II 5, 13.

widest kind to which a predicate selected from a division belongs[43]. This does not mean that the universe of division is *differentiae,* however. It is often said explicitly that we are first to identify animals by a common feature and then to divide according to the way in which that common feature is differentiated. What we will want to know is the widest group to which a particular feature belongs, and how this feature differs or is differentiated in sub-kinds, and what the widest group is to which each of these differentiated features belongs.

A Po II 14 describes a procedure for using information imbedded in divisions to produce propositions of the sort required for a demonstrative science. This book provides us with the theoretical background for viewing *historia* as a pre-demonstrative preparation for causal explanation. *HA* aims to grasp the *differentiae* and the attributes which belong to all the animals (pre-demonstrative investigation) [44], since, after this is done, *PA* and *GA* can try to discover their causes (demonstration).

Aristotle's guiding question in his zoology seems to be "Why do all and only these animals have this feature?" His answer seems to require starting with the *differentiae*.

He seeks to identify groups relative to some difference and not to identify the difference relative to a pre-established group. This method succeeds in identifying animals with commensurately universal *differenciae,* the first step toward causal accounts in the explanatory model proposed in the *Posterior Analytics.*

II SP:

The first chapter of *PA* seems to integrate the account of natural substances with the demonstrative science. Does so in a way that specifies the *Analytics* ideal? The *A Po* adds that a demonstration involves knowing the causes of the fact to construct proofs in

[41] See Balme 1987, pp. 71-80.
[42] Aristotle, *A Pr* I 31.
[43] See Aristotle, *PA* I 4.
[44] Cf. Pellegrin 1982; 1987; Balme 1987.

which the cause is identified by the middle term of the proof[45], but only once does *Analytics* acknowledge that natural objects come to be both for the sake of something and from necessity[46], and it doesn't respond to the question: what would a demonstration look like in this case[47].

I want to examine whether *PA* was intentionally written to answer the question of how the *Analytics* model of science is to apply to Aristotle's biology.

The most important text for those of us who wish to see the demonstrative ideal at work in the biology is *De Partibus Animalium* I 1, which is sometimes referred to as "Aristotle's philosophy of zoology"[48]. The first book outlines a zoological research program. Aristotle needs a conceptual and methodological mechanism which, while consistent with the *A Po,* is specifically biological. It is in these passages that Aristotle insists on another "mode" of demonstration to accompany another "mode" of necessity, hypothetical necessity, operative in teleological contexts.

The first book of Aristotle's *De Partibus Animalium* is devoting to articulating "*...standards, by reference to which one will judge the manner of the demonstrations <of natural inquiry>, apart from the question of how the truth has it, whether thus or otherwise*"[49]. Books II-IV are the attempts to provide causal explanations for the facts regarding the parts that belong to the various kinds of animals, facts systematically organised in *HA*[50]. This means that Aristotle's *De Partibus Animalium* consists of a introductory book on the philosophy of biological science, where Aristotle explains what a theoretical science of natural objects should be. The first book begins by distinguishing two sorts of "proficiency" relevant to a given study: a first order proficiency in understanding the subject-matter, and a second order proficiency in

[45] Aristotle, *A Po* 89b24-31, 90a5-7.
[46] Aristotle, *A Po* 94b27-95a9.
[47] In *PA* I 1, 640a1-6 Aristotle faces this question directly.
[48] Balme 1972, p. 69; Le Blond 1945, pp. 51-72.
[49] Aristotle, *PA* I 1, 639a12-15.

judging whether the study is well presented. The rest of the book is organised around a series of questions bearing on the second type of proficiency:

- at what level of generality our investigation should be organised[51];

- should the biologist follow the lead of astronomy[52];

- since natural processes are subject to both motive causation and goal causation, which should take priority[53];

- there are two sorts of causation, teleological and necessitarian[54], and they are related to the concept of conditional necessity[55]. What is the nature of conditional necessity[56];

- biologists cannot study the animals in abstraction from matter[57]. Should we study only the material constituents of animal bodies, or the functional capacities specific to each of their parts[58] too?

The entire chapter want to integrate the account of natural substances and teleology and necessity with the demonstrative science laid out in the *A Po*. *PA* I begins by considering whether we should study the most common kinds first or the most specific. At first sight, it appears to be rather a trivial reason choosing the former strategy. But *A Po* is in the background[59].

> should one take each being singly and clarify its nature independently, making individual studies of, say, man or lion or ox and so on, or should one first posit the attributes common to all in respect of something common[60].

The question here is reminiscent *A Po* II 14-18, and it is difficult not to see its methodological suggestions in the background. The text of *A Po* recommends the latter

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[50] Aristotle, *PA* II 1, 646a8-12.
[51] Aristotle, *PA* I 1, 639a16-b5.
[52] Aristotle, *PA* I 1, 639b5-10.
[53] Aristotle, *PA* I 1, 639b10-21.
[54] *Posterior Analytics* II 11 discusses necessity and teleology and whether natural things can be demonstrated by reference to both.
[55] Aristotle, *PA* I 1, 642a1-24.
[56] Aristotle, *PA* I 1, 639b22-640a9.
[57] Aristotle, *PA* I 1, 641b10-642a1.
[58] Aristotle, *PA* I 1, 640a33-641a14.
[59] See Balme 1972, p. 72; 1987, p. 86.

approach. In fact, in *PA* Aristotle thinks it's better "studying which is common to the kind first, and then later the proper attributes"[61] on grounds that if one knew, for example, that lion and ox were each covered with body hair, but hadn't yet recognised that each of these had a common nature, both are viviparous quadrupeds, one would lack a true understanding of why these kind possess this feature. A researcher would describe in partial terms what belongs universally[62]. The same method is used in chapter 4[63].

The same background in the *Analytics* explains the parallel between this strategic recommendation in *PA*[64] and the ideas discussed in *A Po* I 2 and I 5 about unqualified understanding[65]. The evidence for this will consist of the theoretical and practical concern with the way in which lack of an appropriate zoological nomenclature can hamper the achievement of understanding. Aristotle often considers the importance of naming animals[66] so that one refers to their nature at the correct level of generality. According to *A Po* I 5 one source of a failure to achieve anything more than incidental understanding is the lack of the name which characterises a subject at the appropriate level of generality[67]. In *A Po* 74a8-9 and 74a17-25, while the same feature is predicated distinctly of a variety of different sort of entity, and that feature actually belongs to each of them in virtue of their being of same wider kind, this fact about them goes

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[60] Aristotle, *PA* I 1, 639a16-19, tr. Balme.
[61] Aristotle, *PA* I 1, 639b5.
[62] Aristotle, *PA* I 1, 639a23.
[63] Aristotle, *PA* I 4, 644b1-7; 645b1-12.
[64] Gotthelf 1985 has focuses attention on the passage in *PA* III 6 which indicates the complexity of the issues which the lack of common names can raise.
[65] The distinction between incidental and unqualified understanding appears in the preliminary account of understanding (*episteme*) which opens *A Po* I 2. The discussion is clarified in *A Po* I 5, which is primarily devoted to indicating circumstances under which we will fail to demonstrate "universally and primitively" that a predicate holds of some subject. There are three sources of such failures discussed and exemplified at 74a6-32, and the chapter closes with a brief methodological suggestion for determining "when you know without qualification". Cf. Barnes 1975, p. 122; Ross 1949, p. 324. The importance of the disctinction between incidental and unqualified *episteme* to the argument of the *Analytics* is brought out forcefully by Miles Burnyeat 1981. See also Kosman 1973, p. 374.

[66] *HA* raises the issue of whethet a variety of kinds ought to have a common name at 490a13-14; 505b30; 531b20-25; 623a3.
[67] Aristotle, *A Po* 74a17-23.

unrecognised, owing to the more general kind lacking name. The lack of a general term may be the source of a failure to grasp the wider kind. This will have methodological ramifications, which again are the concern of *A Po* II 14[68].

Then, having distinguished between the actual practitioner of a science and the person with a methodological concern with the principles "to which one will refer in appraising the method of demonstration"[69], Aristotle goes on:

> Should the natural philosopher, like the mathematicians when they demonstrate astronomy, first survey the appearances in regard to the animals and their parts in each case, and only then go on to state the bacause-of-what (i.e. the causes), or should he proceed in some other way?[70]

The question here is methodological: whether the investigation should first establish the "appearance" before the causal explanation. It is answered in the affirmative at 640a14-15:

> [natural philosopher] are first to take the appearances (*phainomena*) in respect of each kind, and only then go on to speak of their causes[71].

Aristotle introduces the distinction from the domain of astronomy and claims mathematical astronomy as his model for this methodology[72]. In fact, *A Po* I 13 records that astronomy is a science which has mathematical and physical aspects, and the latter are called the phenomena[73]. To establish the facts is to attend to the appearances, whereas to consider the mathematical principles is to attend to the reason why the facts are as they are[74]. This difference is an instance of the more general distinction between the two sorts of inquiry given in *A Po*, the fact, the reason why[75]. The two pairs of inquiry that structure the argument of *A Po* II structure both the overall zoological

[68] Aristotle, *A Po* 98a13-19.
[69] Aristotle, *PA* I 1, 639a13.
[70] Aristotle, *PA* I 1, 639b7-10.
[71] See Aristotle, *HA* I 6, 491a7-14; *PA* II 1, 646a8-12; *IA* I, 704b6-11.
[72] In the *Prior Analytics* 46a20-24 we find a detailed articulation of this position.
[73] Aristotle, *A Po* 78b39.
[74] Aristotle, *A Po* 79a2-6.
[75] Aristotle, *A Po* 89b24-35

program[76] and the details of each discussion. *PA* II 1 opens by noting that *HA* made clear from which parts each of the animals is constituted, while the present work will investigate the causes of the fact through which each of the animals is so constituted[77].

Many of Aristotle's accounts of biological parts close with this summary: "That P is present in all the Ss was shown in *HA*; here we have said what P is, and why it is present in all Ss"[78]. Elsewhere, in the *Prior Analytics*[79] we find a detailed articulation of this particular view of how factual and explanatory claims are related to one another. The *Posterior Analytics* adds that a demonstration involves knowing the causes , and using that knowledge to construct proofs in which the cause is identified by the middle term[80].

It is clear that there are a number of important methodological questions in *PA*, most obviously, in book I. That it is related to *A Po* seems plain: there appear to be references to *Analytics* at 639a12-15, 639b8-11, 640a1-9, 642a5-6. Moreover David Balme thinks that the discussion in *PA* I 2-3 is a development of the discussion of the same topic in *A Po* II.

III SP

Is *A Po* behind the organisation of *GA*?

The *Generatione Animalium* opens with a discussion which leads up to the identification of the chief factors in animal reproduction: the female, the male, and sperma. Aristotle argues that of these the female and the male are the most basic[81], but a dominant aim of the whole of the work is to discover the nature and definition of each of these factors in a way that brings to light the role of each in animal reproduction. The

[76] See SP I.
[77] Aristotle, *PA* II 1, 646a8-12.
[78] See Aristotle, *PA* 650b8-12; 651b18-19; 652b20-23; 667b12-14; 673a32-b4; *IA* 1, 704b7-10; *Somn.* 3, 458a26-32.
[79] Aristotle, *A Pr* 46a17-27.
[80] Aristotle, *A Po* 89b24-31; 90a5-7.
[81] Aristotle, *GA* I 17, 716a4.

discussion of sperma, to which Aristotle assigns a special importance[82], is the most compact and clearly organised. Aristotle's main investigation of sperma begins at I 17, 721a30 and runs through I 23 to the end of the book. It resumes at important points in II 1-5. The discussion opens in the following way:

I) Some types of animals obviously emit sperma […]

II) therefore, we must investigate this: whatever all males emit sperma, or not all; and if not all, what sort of cause is it by virtue of which some do and others not; and whether females contribute a kind of sperma; and if not sperma, whether they contribute nothing else at all or something but not sperma.

III) Then we must also ask, further, what those who emit sperma contribute through their sperma to generation and, generally, what the nature of sperma is (and also of the so-called menses in those animals which emit this fluid).

This paragraph is carefully organised. It falls into three parts. First there is the claim that a certain fact obviously obtains. Second, there is the claim that the obviousness of this fact impels us to investigate a certain group of related questions. Third, there is the claim that we must find the answer to another pair of questions of which the second is in some way the more general. What is the reason for this particular organisation?

According to *Posterior Analytics* inquiry into some subject begins with a grasp of *the fact* the thing exists, based on what is apparent to perception. This provokes a search for an understanding of *why* the thing so understood exists, which is the same as a search for *what* it is[83]. In *A Po* II 8, 93a15 ff. Aristotle affirms that we need to know *that* something exists in order to search for and come to know *what* it is. He clearly supposes that the search for the knowledge of *what* something is, which is identified with the knowledge of *why* it is[84], begins from an awareness *that* the thing exists. When we are aware that something is so we search for why it is; but it is not possible to know why a

[82] Aristotle, *GA* I 7, 716a7-13.
[83] It is useful to see also *A Po* I 13 when Aristotle distinguishes *demonstration that* and *demonstration why*. Aristotle discusses this problem in detail in *A Po* 98a35-b24.

thing is so before knowing that it is. Similarly, it is clear that it is not possible to know what it is to be something without knowing that it exists[85]. This doctrine exercises a heavy influence on Aristotle's pattern of thought here. Certain animals emit sperma, so we are aware *that* the sperma exists. The other questions are: *why* the sperma exists, that is what does it contribute to generation; and *what* is sperma, which is, according with *Analytics*, a general way of putting the question we are asking when we ask *why* sperma exists.

It is clear that there is a relation between Aristotle's official account in the *A Po* of the nature of scientific knowledge and of the means by which it is reached and his practice in arriving at the results presented in *GA.* To facilitate and make clearer this consideration it is worth studying the relation between the place given in the *Analytics* and in certain passages in biological works to the vehicle of scientific knowledge: definition. In fact, to know *why*, that is an account of *what* a thing is, is just the standard description of the definition[86]. The comparison of the role assigned to definition in the *Analytics* and in the biological treatises will show the influence of *Analytics* on *Generatione Animalium.*

I close my research program with a rhetorical question: it is plausible that a philosopher as systematic as Aristotle could formulate the first rigorous theory of scientific inquiry and demonstration, pepper the treatise in which he does so with biological examples, and not aim to structure his science of animals in accordance with that theory?

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[84] Aristotle, *A Po* 90a14-15, 93a4.
[85] See the exemple of the definition of thunder in *A Po* 93b7-14. In *A Po* II 16-17 the same process is alluded to by Aristotle in a similar language. The example we have to explain is the fact the certain plants shed their leaves (98a36-99a27).
[86] Aristotle, *A Po* 93b29.

Forma de análise dos resultados

I make use of four "criteria" to test the results of the research program:

1) Was a relatively self-contained domain of research identified?

Parts of Animals, Historia Animalium, Generatione Animalium and *De Anima* clearly demarcate ensouled substances as a distinct set of objects with organs and tissues defined by, and existing for the sake of realizing, their instrumental capacities[87]. This is my domain of research.

2) Does that investigation aim at theoretical knowledge of this domain?

HA, PA I and *GA* are philosophical introduction and execution of the science of living nature like the prescriptions for theoretical science in *Analytics*. They make regular reference to the aim of such a science and explicitly defend the view that this aim includes establishing definitions, discovering causes and providing causal demonstrations of those non-primary predications that hold of necessity[88].

3) Are basic principles for that investigation explicitly identified?

PA I 1 and *Physica* II 8-9 refine both the concept of final causality and of necessity, intimately related explanatory tools for organic investigation[89]. The discussion of necessity and teleology in *A Po* II 11, 94b26-95a9 and the study of the relationship between these concepts and the conditional necessity in zoological works give us the basic principle of our investigation.

4) Is a set of concepts and methods defined for answering questions within the domain?

These domain-specific principles imply certain methodological practices. The second book of *A Po* announces itself as an extended account of different sort of inquiry and

[87] Aristotle, *PA* I 1, 641a6-29; 5, 645b15-20; see II 1, 647a22-24.
[88] Aristotle, *PA* I 1, 639a15; 639b8-9; 640a1-2; 644b32-645a15.
[89] Aristotle, *PA* I 1, 639b12-640a9; 642a2-14; *Physica* II 9-200a7-15.

their interrelations[90]. It's useful to integrate the different account of natural substances in zoological works with the model of science found in the first book of *A Po* and the different sort of inquiry found in the second book of the same treatise.

Cronograma e execuçâo

- The model of science in *Analytics:* 60 days
- Correspondences between the picture of science in *Analytics* and in zoological works; and distinction that are absent from the *Analytics:* 30 days
- Demonstration and explanation in *Analytics* and in biological works: 40 days
- Role of syllogistic in *Analytics:* 20 days
- Different sort of account in the second book of *Posterior Analytics* and correspondence with the account in zoological works: 40 days
- Relationship between *HA* and *PA-GA.* Correspondence with the stages of inquiry in *A Po:* 30 days
- *"Historia"* in *Analytics* and in *HA:* 20 days
- The "Logic of division" in *A Po* and *HA:* 40 days
    - the critic of the use made of logical division by Plato;
    - the development of a systematic reform of division;
    - the procedure for using information imbedded in division.
- Study of *PA* I as integration of account of natural substances and teleology and necessity with the demonstrative science laid out in *A Po:* 30 days
- The methodological questions in *PA:* 15 days
- Study of the role assigned to definition in the *Analytics* and in biological treatises: 30 days

[90] Aristotle, *PA* I 1, 639b11-21; 642b5-643b8; 643b9-26; 644a6-11; 640a33-b4; 642a31-b4; 639a15-b3; 644a12-b15; 644b1-15; 645a36-645b28; *A Po* 89b23-35.

Resumo (max 20 linhos)

Aristotle was the first Greek thinker to articulate a taxonomy of scientific pursuits. He distinguishes theoretical, practical, productive areas of knowledge and a rigorous theory of explanatory proof. He characterises the scientific understanding of facts and different sorts of inquiry in order to count as a theoretical science. A number of questions arise when we turn to the treatises of biology and zoology, because it's difficult to understand if there is a conflict between the account of scientific explanation in the *Posterior Analytics* and the investigations reported in treatises such as the *Historia Animalium, Parts of Animals, Generation of Animals.* In my research program I want to show that there are affinities between the theory of explanation in the *A Po* and the zoological treatises and I want to study the nature and the extent of this relationship. I think that the apparent chaos in *HA* is dissipated when the aristotelian science of nature is viewed within the logic of division found in *Analytics;* I think that *PA* was intentionally written to answer the question of how the *Analytics* model of science is to apply to Aristotle's biology; and the comparison of the role assigned to definition in the *Analytics* and in the biological works will show the influence of *Analytics* on *GA.* In my opinion it is implausible that a philosopher as systematic as Aristotle could formulate the first theory of scientific demonstration, pepper the *Organon* with biological examples, and not aim to structure his science of animals in accordance with that theory.

Bibliografia Fundamental:

Works of Aristotle

BARNES J., *The Complete Works of Aristotle. The revised Oxford translation*, vol. I.II (Bollingen Series LXXXI 2), Princeton (1984) 1985.

ANALYTICA PRIORA ET POSTERIORA

BARNES J., *Aristotle, Posterior Analytics.* Translated with commentary, Oxford (1975) 1993.
DETEL W., *Aristoteles. Analytica posteriora. Übersetzt und erlautert* (Aristoteles Werke in Deutscher Uberstzung, hrsg. v. H. Flashar, Band 3, Teil II 1.2), Berlin 1993.
ROSS W. D., *Aristotle's Prior and Poterior Analytics.* A revised text with intr. and comm., Oxford (1949) 1957.

DE PARTIBUS ANIMALIUM (PA)

BALME D. M., (1992), *De Partibus Animalium I and De Generatione Animalium I (with passages from II 1.3)*, Oxford.
LE BLOND J.M., (1945), *Aristote, Philosophe de la vie, Le livre premier du traité sur les Parties des animaux*, Paris (Aubier).
LENNOX J. G., (2001), *Aristotle: On the Parts of Animals I-IV*, translated with an Introduction and Commentary, Oxford.
LOUIS P., (1957), *Aristote: Les parties des Animaux*, text établit et traduit, Paris (Collection Budé).
BODSON L., (1990), *Aristote, De partibus Animalium, Index Verborum, Listes de frequence*, Liège.
FRANTZIUS A. von, *Aristoteles' Vier Bücher Über die Teile der Tiere. Griechisch und deutsch und mitsacherklärenden Anmerkungen (Aristoteles Werke, Bd. 5), Leipzig 1853 (Neudruck Aalen 1978).*
LANGKAVEL B., *Aristoteles, De Partibus Animalium*, ed. Leipzig (Bibliotheca Teubneriana) 1868.
OGLE W., *The works of Aristotle transl.*, vol. V *De Partibus Animalium*, Oxford (1912) 1958.
PECK A. L., *Aristotle. Parts of Animals*, with translation, Cambridge/Mass. (1937) 1968.

DE GENERATIONE ANIMALIUM (GA)

BALME D. M., (1992), *De Partibus Animalium I and De Generatione Animalium I (with passages from II. 1-3)*, Oxford.
LOUIS P., (1961) *Aristote, De la generation des animaux*, Paris.
AUBERT h. UND WIMMER F., *Aristoteles' Funf Bücher von der Zeugung und Entwicklung der Tiere, übers u. Erl.* (Aristoteles Werke. Griechisch und Deutsch und mit sacherklärenden Anmerkungen, Bd.3) Leipzig 1860 (Neudruck Aalen 1978)
PECK A., *Aristotle. Generation of Animals* (The Loeb Classical Library)

London/Cambridge/ Mass. (1942) 1979.
PLATT A., *The works of Aristotle, transl.,* vol. V *De Generatione Animalium*, Oxford 1912.

DE MOTU ANIMALIUM (MA)

NUSSBAUM M., (1978), *Aristotle: De Motu Animalium*, Princeton.

HISTORIA ANIMALIUM (HA)

BALME D. M., (2002), *Aristotle: Historia Animalium, Books I-X,* prepared for publication by Allan Gotthelf, Cambridge.
AUBERT H. UND WIMMER F., *Aristoteles' Thierkunde,* Bd. I.II 1868.
BALME D. M., *Aristotle. History of Animals VII-X,* ed. by D.M.B. prepared for publication by A. Gotthelf (The Loeb Classical Library), Cambridge/ Mass.- London 1991.
DITTMEYER L., *Aristotelis De Animalibus Historia,* Leipzig (Bibliotheca Teubneruana) 1907.
KARSCH A., *Aristoteles' Naturgeschichte der Tiere.* Zehn Bücher. Deutsch, Stuttgart 1866.
LOUIS P., *Aristote, Histoire des Animaux,* t. I-III (Collection Budé) Paris 1964, 1968, 1969.
PECK A.L., *Aristotle. Historia Animalium* I-II, London - Cambridge/Mass (The Loeb Classical Library) 1965, 1970.
THOMPSON, D'ARCY W., *Historia Animalium,* in: *The works of Aristotle,* Translated into english, vol. IV, Oxford 1910.

DE ANIMA

ROSS W. D., *Aristotle. De Anima*, ed. with Introduction and Commentary, Oxford 1961.
THEILER W., *Aristoteles. Über die Seele (=* Aristoteles Werke in deutscher Übersetzung hrsg. v. E. Grumach, Bd. 13) Berlin-Dämstadt 1959.

METAPHYSIK

FREDE M. UND PATZIG H., *Aristoteles, Metaphysik Z.* Text, Übersetzung und Kommentar, I.II, München 1988.
JAEGER W., *Aristotelis metaphysica (OCT),* Oxford 1957, repr. 1985.
ROSS W. D., *Aristotle's Metaphysics*. A revised text with introd. and comm., I.II Oxford (1924) 1958.

List of recents works

ACKRILL J. L., *Aristotle's theory of definition: some questions on Posterior Analytics II 8-10,* in Berti 1981, pp. 359-84.
AYALA F., *The autonomy of biology as a natural science,* in A. D. Breck and W. Yourgrau, eds., *Biology, History and Natural Philosophy,* New York 1974, pp. 1-16.
BALME D. M., *Aristotle's Uses of the Teleological Explanation. Inaugural*

Lecture, University of London, 1965.
BALME D.M., *Greek Science and Mechanism I. Aristotle on Nature and Chance*, <Classical Quarterly > 33 1939, pp. 129-138.
BALME D.M., *Aristotle's De Partibus Animalium I and De Generatione Animalium I (with passages from III 1-3) with a report on recent work and an additional bibliography by Allan Gotthelf*, Oxford 1992.
BALME D.M., *Aristotle's Biology was not essentialist*, <Archiv für Geschichte der Philosophie> vol. 62 1980, pp. 1-12.
BALME D. M., *The place of biology in Aristotle's philosophy*, in Gotthelf and Lennox 1987, pp. 9-20.
BALME D. M., *Aristotle's Historia Animalium: date and authorship*, in *Aristotle: History of Animals VII-IX*, Cambridge, MA and London, 1991 pp. 1-13.
BARNES J., *Aristotle's Posterior Analytics*, Oxford 1975.
BARNES J., *Aristotle's theory of demonstration*, in Barnes, Schofield and Sorabji 1975, pp. 65-87.
BARNES J., *Proof and the syllogism*, in Berti 1981, pp. 17-59.
BARNES J., *Aristotle*, Oxford 1982.
BARNES J., SCHOFIELD M., AND SORABJI R., *Articles on Aristotle I: Science*. London 1975.
BERTI E. (eds.), *Aristotle on science: the Posterior Analytics*, Proceedings of the 8th Symposium Aristotelicum, Padova 1981.
BOLTON R., *Essentialism and semantic theory in Aristotle: Posterior Analytics II 7-10*, in "Philosophical Review" LXXXV, 1976 pp. 514-44.
BOLTON R., *Definition and scientific method in Aristotle's Posterior Analytics and Generation of animals*, in Gotthelf and Lennox 1987, pp. 120-66.
BOLTON R., *Division, définition et essence dans la science aristotelicienne*, in "Revue Philosophique" II 1993, pp. 197-222.
BOURGEY L., *Observation et expérience chez Aristote*, Paris 1955.
BUNGE M., *Causality. The place of the causal principle in modern science*, Cambridge 1959, trad. ital. Torino 1970.
BURNYEAT M. F., *Aristotle on understanding knowledge*, in Berti 1981, pp. 97-139.
BYL S., *Recherches sur les grands traités biologiques d'Aristote: sources écrites et prejugés.* Académie Royale de Belgique, Mémoires de la Classe des Lettres, 2nd. ser. 64, 3, Bruxelles.
CHARLES D., *Meaning, natural kinds and natural history*, in Devereux and Pellegrin 1990, pp. 145-67.
CHARLES D., *Teleological causation in the Physics*, in L. JUDSON (ed.), *Aristotle's Physics:* a collection of essays, Oxford 1991, pp. 101-128.
CHARLES D., *Aristotle and the unity and essence of biological kinds*, in Kullmann and Föllinger 1997, pp. 27-42.
COOPER J., *Aristotle on Natural Teleology*, in M.C. NUSSBAUM AND M. SCHOFIELD (eds.), *Logos and Language. Studies in Ancient Greek Philosophy presented to G. E. L. Owen*, Cambridge 1982.
COOPER J.M., *Hypothetical Necessity*, in *Aristotle on Nature and Living Things. Philosophical and Historical Studies (presented to D.M. Balme)*, ed. By A Gotthelf, Pittsburgh-Bristol 1985, pp. 151-167.
CRUBELLIER M. ET PELLEGRIN P., *Aristote, le philosophe et le savoir*, Paris 2002.
DETEL W., *Why all animals have a stomach. Demonstration and axiomatization in Aristotle's Parts of animals*, in Kullmann and Föllinger 1997, pp. 63-84.

DEVEREUX D. AND PELLEGRIN P. eds., *Biologie, logique et métaphysique chez Aristote,* Paris 1990.
DÜRING I, *Aristotle's De Partibus Animalium: Critical and Literary Commentaries,* Göteborg 1943.
FEREJOHN M., *Aristotle on necessary truth and logical priority,* "American Philosophical Quarterly" XVIII, 1981 pp. 285-93.
FEREJOHN M., *Definition and the two stages of Aristotelian demonstration,* "Review of Metaphysics" XXXVI 1982/3, pp. 375-95.
FEREJOHN M., *The Origins of Aristotelian Science,* New Haven 1990.
FINE G., *Forms as causes: Plato and Aristotle,* in A. GRAESER (hrsg.), *Mathematics and Metaphysics in Aristotle,* Bern 1987, pp. 69-112.
FREDE D., *Aristotle on accidental causes in Metaphysics E 3,* in A. GOTTHELF (ed.), *Aristotle on Nature and Living Things ...,* 1985 pp. 200-244.
FREDE M., *The original notion of cause,* in M Schofield, M Burnyeat e J. Barnes, *Doubt and Dogmatism in Hellenistic Epistemology,* Oxford 1980, pp. 217-249; ora in *Essays in ancient philosophy,* Oxford 1987, pp. 125-150.
FREELAND C., *Accidental Causes and Real Explanation,* in L. JUDSON (dir.), *Aristotle's Physics. A Collection of Essays,* Oxford 1991.
FREELAND C.A., *Aristotle on bodies, matter and potentiality,* in Gotthelf and Lennox 1987, pp. 392-407.
FREELAND C. A., *Scientific explanation and empirical data in Aristotle's Meteorology,* in Devereux and Pellegrin 1990, pp. 287-320.
GOTTHELF A., *Aristotle's conception of Final Causality,* <The Review of Metaphysics>, vol 30 1976, pp. 226-54.
GOTTHELF A., *First principles in Aristotle's Parts of Animals,* in Gotthelf and Lennox 1987, pp. 167-98.
GOTTHELF A., *The elephant's nose: further reflections on the axiomatic structure of biological explanation in Aristotle,* in Kullmann and Föllinger 1997, pp. 85-96.
GOTTHELF A., *review of M. Nussbaum (1978), Aristotle's De Motu Animalium* (Princeton 1978), <The Journal of Philosophy>, vol. 77 1980, pp. 365-78.
GOTTHELF A & LENNOX J.G., *Philosophical Issues in Aristotle's Biology,* Cambridge 1987.
GOTTHELF A. (ed.), *Aristotle on Nature and Living Things: philosophical and historical studies presented to David Balme on his seventieth birthday,* Pittsburgh and Bristol 1985.
GOTTHELF A., *Notes towards a study of substance and essence in Aristotle's Parts of Animals II-IV,* in Gotthelf 1985, pp. 27-54.
GRENE M., *About the Division of the Sciences,* in *Aristotle on Nature and the Livings Things ... "*, 1985 pp. 9-13.
HINTIKKA J., *Time and Necessity, Studies in Aristotle's Theory of Modality,* Oxford 1973.
HULL D., *Philosophy and biology,* in G. Floistad ed., *Contemporary philosophy: a new Survey,* vol. II (The Hague) 1981, pp. 281-316.
JAEGER W., *Aristotle: Fundamentals of the History of his Development,* Oxford 1948.
JUDSON L., *Aristotle's Physic: A collection of Essays,* Oxford 1991.
JUDSON L., *Chance and always or for the most part in Aristotle,* in Judson 1991, pp. 73-100.
KOSMAN L. A., *Aristotle's definition of motion,* in "Phronesis" XIV 1969, pp. 40-62.

KOSMAN L. A., *Understanding, explanation and insight in the Posterior Analytics,* in Lee, Mourelatos and Rorty, 1973 pp. 374-92.
KOSMAN L. A., *Necessity and explanation in Aristotle's Analytics,* in Devereux and Pellegrin 1990, pp. 349-64.
KULLMANN W., *Wissenschaft und Methode. Interpretationen zur aristotelische Theorie der Naturwissenschaft,* Berlin-New York 1974.
KULLMANN W., AND REICHEL M. (eds.), *Der Übergang von der Mündlichkeit zur Literatur bei den Griechen,* Tübingen 1990.
KULLMANN W. AND FÖLLINGER S. (eds.), *Aristotelische Biologie. Intentionen, Methoden, Ergebnisse,* Stuttgart 1997.
KULLMANN W., *Hintergründe und Motive der platonischen Schriftkritik,* in Kullmann and Reichel (eds.) 1990, pp. 317-34.
KULLMANN W., *Notwendig in der Natur* in *Aristoteles Werk und Wirkung. Paul Moraux gewidmet,* hrsg. v. J. Wiesner, Bd. I, Berlin- New York 1985, pp. 207-238.
KULLMANN W., *Der wissenschaftliche Charakter der Biologie des Aristotle. Eine Überprüfung,* in *Festschrift für Klaus Oehler zum 60. Geburtstag,* hrsg. v. R. Claussen und R. Daube-Schackat, Stauffenburg Verlag, 1985.
KULLMANN W., *Different Concepts of the final Cause,* in *Aristotle on Nature and Living Things ... ,* 1985 pp. 169-175.
KULLMANN W., *Aristotle's wissenschaftliche Methode in seinen zoologischen Schriften,* in *Biologie,* Georg Wörle hg., Stuttgart 1999, pp. 103-123.
LANDOR B., *Definitions and Hypotheses in Posterior Analytics 72a19-25 and 76b35-77a4,* in "Phronesis" XXVI, 1981 pp. 308-18.
LE BLOND J.-M., *Logique et methode chez Aristote,* Paris 1939.
LEAR J., *Aristotle and Logical Theory,* Cambridge 1980.
LEE E. N., MOURELATOS A. D. P., RORTY R. M., *Exegesis and Argument: studies presented to Gregory Vlastos. Phronesis* suppl. Vol. I Assen 1973.
LEE H. D. P., *Place-names and date of Aristotle's biological works,* in "Classical Quarterly" XLII 1948, pp. 61-7.
LEFEBVRE R., *La theorie aristotélicienne de la génération des animaux: un certain desordre etiologique,* <Elenchos> 14, 1993, pp. 257-276.
LENNOX J. G., *Between data and demonstration: the Anal. and the HA,* in A. C. Bowen ed., *Science and Philosophy in Classical Greece,* Oxford 1987, pp. 39-71.
LENNOX J. G., *Recent Studies in Aristotle's Biology,* in *Ancient Philosophy* IV, 1984 pp. 73-82.
LENNOX J. G., *Notes on David Charles on HA,* in Devereux and Pellegrin 1990, pp. 169-183.
LENNOX J. G., *Teleology.* In Evelyn Fox Keller and Elisabeth A. Lloyd, eds., *Keywords in Evolutionary Biology,* Cambridge, Mass., 1992 pp. 324-333.
LLOYD G. E. R., *Aristotle: the Growth and structure of his Thought,* Cambridge 1968.
LLOYD G. E. R., *Aristotle's zoology and his metaphysics: the status quaestionis,* in Devereux and Pellegrin 1990.
LLOYD G. E. R., *Methods and Problems in Greek Science,* Cambridge 1991.
LLOYD G. E. R., *Aristotelian Explorations,* Cambridge 1996.
MARCOS A., *Aristóteles y otros animales. Una lectura filosófica de la Biologia aristotélica,* Barcelona 1996.
MAYR E., *The Growth of Biological Thought,* Cambridge 1982.
McKIRAHAN R. D. Jr., *Principles and Proofs: Aristotle's Theory of Demonstrative Science,* Princeton 1992.

MORAVCSIK J., *Aristotle on adequate explanation,* <Synthèse> 28, 1974 pp. 3-17.
MORAVCSIK J., *What makes reality intelligible? Reflections on Aristotle's theory of aitia,* in L. JUDSON (ed.), *Aristotle's Physics, a collection of Essays,* Oxford 1991, pp. 31-47.
NAGEL E., *The structure of Science,* New York 1961.
NATALI C., *Aitia in Aristotele. Causa o spiegazione?,* in *Beiträge zur Antiken Philosophie,* hrsg. v. H. C. GÜNTER und A. RENGAKOS, Stuttgart 1997, pp. 113-124.
NUSSBAUM M. C., R*eview of Edwin Hartmann, Substance, Body and Soul: Aristotelian Investigation* (1977), in <The Journal of Philosophy>, vol. 77, 1980, pp. 355-65.
NUSSBAUM M. C., *Aristotle's De Motu Animalium,* Princeton 1978.
NUSSBAUM M. C. AND SCHOFIELD M. (eds.), *Language and Logos,* Ithaca 1982.
OGLE W., *Aristotle: De Partibus Animalium. The works of Aristotle transl. in to English,* vol. V, Oxford 1912, 1958.
PELLEGRIN P., *La classification des animaux chez Aristote: statut de la biologie et unité de l'aristotlelisme,* Paris 1982.
PELLEGRIN P., *Logical and biological difference: the unity of Aristotle's though,* in Gotthelf and Lennox 1987, pp. 313-38.
PEKS, A. L., *Aristotle. Parts of Animalis,* with transl., Cambridge 1937, 1968.
PECK A. L., *Arisrotle Generation of Animals,* Cambridge 1963.
PREUS A., *Science and Philosophy,* in *Aristotle's Biological Works,* Hildesheim-New York 1975.
RAPP CH., *Aristoteles zur Einführung,* Hamburg 2001.
SCHOFIELD M., *Explanation projects in Physics 2.3 and 7,* in "Oxford Studies in Ancient Philosophy", suppl. vol. 1991, pp. 29-49.
SCHOFIELD M. AND NUSSBAUM M. C. (eds.), *Language and Logos: studies in ancient Greek philosophy presented to G.E.L. Owen,* Cambridge 1982.
SORABJI R., *Necessity, Cause and Blame. Perspectives on Aristotle's Theory,* London 1980.
SORABJI R., *Causation, Laws and Necessity,* in M. SCHOFIELD ed altri (eds.), *Doubt and dogmatism. Studies in hellenistic epistemology,* Oxford 1980, pp. 250-282.
WATERLOW P., *Nature, Change and agency,* in *Aristotle's Physics. A philosophical Study,* Oxford 1982.
WIELAND W., *The Problem of Teleology,* in J. BARNES et al., *Articles on Aristotle,* vol. I Science, London 1977.

There were some important **Conferences** about these subjects:

- Conference on Aristotle's Biology held by Cambridge and Trenton State Universities (July 1985).

- APA Pacific Division's Symposium, Classification and Explanation in Aristotle's Biology (March 1986).

- Conference, The Interaction of Science and Philosophy in Fifth and Fourth Century Greece, held by the Institute for Research in Classical Philosophy and Science (May 30-June 1, 1986).