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The Problem of Biological Terminology in Aristotle's *De generatione animalium* (*On Generation of Animals*)

Abstract: In his late work *De generatione animalium*, Aristotle develops a complex theory in order to explain all processes of generation and (anachronistically termed) inheritance as well as the development of the embryo of all kinds of animals, including humans. In his attempts to come up with one unified theory which is able to explain all phenomena, he uses his doctrine of four causes, his general understanding of processes of generation and corruption, and the role of movement. Biological research had already existed before Aristotle, but he was the first to systematize it and to integrate it into a complex theoretical approach. In doing so, he could not rely on preexisting technical terminology to express his research. Such lack created even more problems, because he faced the problem of having to explain very complicated processes. In order to cope with the variety of difficulties in explaining diverse phenomena, Aristotle forged different paths to meet this challenge: He uses theoretical terminology, which he has already introduced in other contexts such as *eidos*, which experiences shifts in meaning depending on the context. He uses terminology introduced by other authors. He explicitly coins new terminology by the addition “*legō*” and he implicitly coins new terminology by using common language in a specific way. He uses preexisting scientific metaphors and uses a concept of “*analogon*” in a certain sense. A very important feature of Aristotle’s technical terminology is the use of comparisons by way of analogy. Using these comparisons, he tries to express such complex processes as the development of the embryo, which according to his explanation is (in modern parlance) epigenetic, and processes of inheritance which modern biology explains by means of genetics.

Aristotle’s role as the founder of biology is undisputed¹ not only because he carried out large-scale individual zoological research, but legitimized biology theoretically as well. Thus, his interest was in the systematic-theoretical classification of facts.² His far-reaching influence is demonstrated not least in the fact that basic biological categories of systematization, such as ‘species’ and ‘genus’, can be traced back to him. Basic concepts that are still valid in modern biology, such as ‘nutrition’, ‘growth’, ‘reproduction’, ‘perception’, and ‘thinking’, likewise point back to Aristotle.

1 On the importance of Aristotelian research for modern biology see Kullmann 2003; Toepfer 2010, esp. 316. This does not mean that there was no biological research before him (cf. Harig & Kollesch 1998), but that he systematized it and gave it a methodological basis.

2 See Kullmann 2007, 130, on this.

In terms of theory, the *De generatione animalium* (GA), which belongs to Aristotle's later works (and is perhaps his final work),³ is particularly fascinating, not least because of its complex subject matter, for Aristotle offers in it explanations for the way in which male and female reproductive partners contribute to conception, how the embryo develops, and why the offspring becomes male or female and why it is similar to its parents and previous generations. In the course of this, Aristotle examines all kinds of animals, including humans.⁴ His goal was quite ambitious, because neither the function of the testicles nor the female egg were known at the time, and human dissections were not permitted. The speculative character of the writing is therefore not surprising, though one must nevertheless emphasize that Aristotle integrates numerous empirical observations. Indeed, his writing is based on the methodological principle that a theory must be able to explain the phenomena it examines – and indeed all phenomena. He sees the theoretical key to explaining the manifold phenomena of procreation and heredity in his doctrine of four causes, his general understanding of processes of generation and corruption, and the role of *kinēsis* (movement). Aristotle also draws on the opinions of his predecessors and contemporaries and takes a critical look at them – sometimes in a highly polemic manner. His main points of criticism are that they (a) have made too few empirical observations or have evaluated empirical observations prematurely or insufficiently, (b) that their respective theory cannot explain all phenomena, or (c) that they draw conclusions from incorrect assumptions. He himself sees – as he proudly notes – the advantage of his own approach in being able to explain everything with one unified theory.⁵ In doing so, his research objective also integrates reasoning as to why there even are two sexes in general. But his explanation becomes even more speculative – necessarily – when he explains why the embryo develops epigenetically, why the heart is the beginning of this development – that this was the case, he was able to empirically establish on the basis of his observations of chicken eggs – how the sexes come into being, why children resemble their parents and grandparents, and why there may be similarities between the daughter and her male ancestors and between the son and his female ancestors.

Aristotle entered highly complex terrain with these explanatory approaches, and we can note that GA itself is not always a didactically perfect implementation of problems that have previously been solved elsewhere, but sometimes it proceeds in a problem-solving manner so that the work combines the gaining of knowledge and its

³ The biological writings are subject to an overall concept, see Kullmann 2007, 141.

⁴ *De generatione animalium* offers in books I–IV explanations on the reproductive organs and the processes of reproduction, sex differentiation, and embryology as well as Aristotle's theories on inheritance. It is controversial whether Book V, on the body characteristics that develop after birth, originally belonged to it or was an independent work. See Liatsi 2000, 13–25, and Corcilius 2022.

⁵ See Föllinger & Busch 2022b.

presentation.⁶ This can be seen in the fact that Aristotle repeatedly works with ad hoc, non-valent, and dialectical premises. Sometimes, he suggests an argumentation that is not compelling, evidenced by the use of expressions of necessity or of stylistic devices that might provide coherence and persuasive power of argument. Also the fact that he uses analogies which, according to his own philosophy of science, actually provide no strict proofs is telling. The impression that one is watching a scientist break new ground arises from the observation that Aristotle often has no technical terminology to fall back on, such as the term 'epigenetic'. It is precisely these circumstances that make the reading a challenge because Aristotle likes to use well-known – though sometimes imprecise – general terms to describe what he means, or uses analogies that supplement or replace the general description. As such, he is not only faced with the problem of how knowledge can be conveyed didactically but also with how it can be expressed at all. This difficulty mainly concerns the explanation of the complex processes already mentioned, but it does not mean that Aristotle completely lacked technical terminology. On that note, I would like to show in what follows the different ways in which Aristotle uses technical terminology in *GA* or replaces it with something else, and in doing so I will specifically address examples of the complex cases mentioned. But the issue of Aristotelian nomenclatures of animal species will not play a role in my analysis; to them, a separate contribution by Marcel Humar is dedicated in this volume (183–204).

Roelcke's considerations are suitable as an initial heuristic approach to the question of how technical terms are actually created.⁷ He differentiates four groups within a technical vocabulary, for each of which he provides examples from biology:⁸ "the intra-disciplinary technical vocabulary, which consists of those technical terms that belong exclusively to the relevant technical language,"⁹ e.g., '*genom*' or '*zooplankton*' (A); the "interdisciplinary technical vocabulary" with "technical terms that appear both in the relevant and in other technical language systems,"¹⁰ e.g., '*structure*' or '*classification*' (B); the "extra-disciplinary technical vocabulary" with technical terms "that belong to other specialist language systems but are nevertheless expressed in specialist texts in the relevant subject,"¹¹ e.g., 'species protection' or 'global warming' (C); and the "non-disciplinary technical vocabulary," i.e., "general and technically not further developed words"¹² such as 'human' or 'goal' (D).

⁶ Cf. the two studies by Föllinger & Busch 2022a, 2022b.

⁷ Roelcke 2020.

⁸ The following quotations can be found in Roelcke 2020, 71, the examples from biology *ibid.*, 72.

⁹ "intrafachliche(n) Fachwortschatz, der aus denjenigen Fachsprachwörtern besteht, die ausschließlich der betreffenden Fachsprache angehören" (Roelcke 2020, 71).

¹⁰ "interfachliche(n) Fachsprachwortschatz" mit "Fachwörtern(n), die sowohl in dem betreffenden als auch in anderen fachsprachlichen Systemen erscheinen" (Roelcke 2020, 71).

¹¹ "extrafachlichen Fachsprachwortschatz" mit "Fachwörtern, die anderen fachsprachlichen Systemen angehören, dennoch in Fachtexten des betreffenden Faches geäußert werden" (Roelcke 2020, 71).

¹² "nichtfachlichen Fachsprachwortschatz," d. h. "allgemeinen und fachlich nicht weiter geprägten Wörtern" (Roelcke 2020, 71).

As a trial, I would like to apply this differentiation to *GA*, though an important difference must first be made aware of: unlike in modern times and ancient medicine and mathematics, there was no clearly defined disciplinary group of biologists who would have contributed to establishing terminology or who would have been the addressees for the establishment of certain specialist terms.¹³ Biology did not yet exist as a discipline; ‘biological research’ was part of the *philosophia phusikē*. Aristotle was the first to map it out as a separate area of investigation and legitimize it methodically; later in antiquity the scope of his research together with his abstract approach remained unrivalled.¹⁴ Biology, as an area of research, is, in his time, so to speak, only just being discovered. This may also be the reason why Aristotle likes to use his philosophical vocabulary and adjust it accordingly, especially since his general philosophemes form the basis for his theory.¹⁵ An example of this is the word *eidos*. To make matters worse, we know nothing about the audience for *GA*; to this end, we can only speculate. Wolfgang Kullmann suspected that the zoological writings were intended for an expert primary audience and simultaneously for an additional secondary audience.¹⁶ With regard to *GA*, this thesis seems plausible to me due to the heterogeneity of this writing: on the one hand it is full of implicit assumptions that actually would need further explanation; on the other hand, it offers up didactically styled passages.¹⁷ In addition, the areas distinguished by Roelcke (A)–(D) cannot be easily delimited from one another, precisely because we are living in a time when the single areas of science are emerging. Nevertheless, for heuristic reasons, a subdivision seems to be helpful: if one wishes to speak of an “intra-disciplinary” technical vocabulary (A), one can first refer to the naming of species.¹⁸ The “interdisciplinary” technical terms (B) make up a fairly large group. On the one hand, this includes the technical terminology with words such as *hulē*, *eidos*, *genos*, *kinēsis*, *telos*, and *psukhē*. However, sometimes only through context does it become clear what meaning they have. On the other hand, we also find medical terminology such as *kratein*.¹⁹ An “extra-disciplinary” tech-

13 On the importance of institutions in the development of technical terms in the modern age, see Felber & Budin 1989, 221–233; Roelcke 2020, 155–176.

14 See Lennox 1995.

15 For a discussion on the well-known problem that Aristotle even uses vocabulary in different contexts with different meanings, see the introduction by Markus Asper in this volume (1–9).

16 “Intended for an additional abstract audience and for posterity” (Kullmann 2007, 137). We are not well informed about the lessons in the Lyceum and the context of Aristotelian text production, cf. Van der Eijk 2017, 187 with reference to Lynch 1972 and further literature. The view, long held by researchers, that the Aristotelian *pragmateiai* are ‘lecture notes’ in a more or less revised state, has rightly been questioned or discussed and modified in recent years, see Föllinger 1993; van der Eijk 1997; Lenzen 2002; Föllinger 2012; and the volume by Wians & Polanski 2017.

17 See the studies by Föllinger & Busch 2022a, 2022b.

18 See Marcel Humar’s contribution in this volume (p. 91–93).

19 About this term, see below, p. 91–92.

nical vocabulary (C) could include more specific medical expressions such as *katamēnia* as well as mathematical expressions.

If one examines the use of ‘technical terminology’ in *GA* in more detail, the following paths that Aristotle takes can, in my opinion, be distinguished:

(1) Aristotle uses specialist terminology that he has already introduced and coined in theoretical contexts, such as *eidos*, *hulē*, *arkhē*, *kinēsis*, *poioun* vs. *paskhōn*, which, however, experiences shifts in meaning depending on the context. Such a shift in meaning occurs when he secretly turns the – singularly used – principle *kinēsis* into the plural *kinēseis* (767b35–a2) in Book IV, such that the movement, the origin of which is the male contribution to procreation, now becomes impulses, possessing the ‘hereditary information’.

An illustrative example for the narrowing of a semantically broad term is the use of *logos* in II 1. By using an analogy here to replace an explanation, Aristotle limits the meaning of this word and thus replaces a missing technical term.²⁰

(2) Aristotle uses terms introduced elsewhere. So it is probably a sign of missing specialist terminology that he occasionally makes to do with the term ‘participation’ (*methexis*), a Platonic expression that he otherwise actually rejects: In I 19. 719a5–8, he phrases it in such a way that the ovoviviparous animals “take part” in both genera (live-bearing as well as egg-layers) (719a6 f.: διὰ τὸ ἀμφοτέρων μετέχειν τῶν εἰδῶν). Obviously, there are no other terminological possibilities available to him to express that animals can combine characteristics of different genera. This is probably why the expression is so vague, and it is not for nothing that Aristotle exactly here refers to the need to obtain further knowledge from images of sections (*Anatomaî*) and the writing *Historia animalium* (719a8–10: δεῖ . . . θεωρηκέναι καὶ τῶν ἱστοριῶν).²¹

(3) With *kaloumena*, Aristotle signals that certain terms have already been introduced, but by whom they were introduced or which group accepts them as introduced remains unclear. The identification with *kaloumena* can then also serve as a starting point for a criticism of an introduced technical term. This is the case in *GA* I 23. 730b33–731a9. Here Aristotle speaks of the so-called “seeds” (*ta kaloumena spermata*) of the plants and, as the context makes clear, distances himself from this term because, in his opinion, the male and female principles are mixed in the plant, and plants can therefore ‘procreate from themselves’. He calls the product a *κύημα* (*kuēma*), using a term that describes the “embryo”²² in zoology. The traditional term *σπέρματα* – according to Aristotle – is not appropriate because the *σπέρματα* of plants

²⁰ See my comments below, p. 98.

²¹ For the references to *anatomaî*, see Lennox 2018.

²² Peck translates as “fetation” in contrast to the term γονή, which he translates as “semen.” Lefebvre 2014 translates κύημα as “embryon.”

are more than just σπέρματα, so to speak, insofar as they incorporate the functions of an egg.

(4) Aristotle explicitly coined new technical terminology by redefining a word with the phrase “I mean” (*legō*²³) in the form of a technical definition or by restricting its meaning.²⁴ And so with *legō* he introduces the word *perittōma* in a very specific meaning as ‘remnant of food’ (λέγω δὲ περίττωμα μὲν τὸ τῆς τροφῆς ὑπόλειμμα, GA I 18. 724b26f.) and defines *kuēma* as the “first mixture of female and male” (λέγω δὲ κύημα τὸ πρῶτον μίγμα ἐκ θήλεος καὶ ἄρρενος I 20. 728b34). In the modern age, definitions play an important role in the development or establishment of specialist terms.²⁵

The usage is somewhat different when Aristotle refers in the first person plural (*legomen*) to a terminology that he would like to identify as one that has already been introduced and is obviously already generally recognized within a certain group. In this way he speaks of *telos* (“goal”) as that “for whose sake other things happen” and uses the phrase *hou heneka* (οὗ ἕνεκα), which was coined and introduced for his philosophy (II 6. 742a28f.). The fact that he speaks in the first person plural could indicate that the target group he is addressing or, at least, the group of primary addressees is one of his fellow researchers and students who are familiar with this terminology. However, the emphasis on this terminology may also be an indication that he already has an additional group of addressees in mind that does not consist of experts and for whom he has to explain this expression.²⁶

(5) Aristotle implicitly coined a specialist terminology by using common language terms in a specific way. Two important technical terms are *existasthai* (ἐξίστασθαι) (“to step out”) for the formation of the sex and the similarity to the mother and father, and *luesthai* (λύεσθαι) (“to relapse”)²⁷ for the similarity with the ancestors (GA IV 3. 768a9–21).

(6) A special case is the use of metaphors: In *Rhetoric* (III 10–11), Aristotle explains that the metaphor is not just an ornament, but has a learning effect, i.e., a didactic function. This learning effect is generated by the pleasure that the recipient feels when deciphering the metaphor:²⁸ for the recipient has to partake in translations of a sort, and pleasure is associated with this cognitive process. For the field of science, however, according to Aristotle, somewhat different conditions apply, because in sci-

23 On this use of λέγω see Asper 2007, 132 with note 270 and Brink 1933, 56f.

24 According to Roelcke 2020, 72–83, the definition is the most important way of creating new specialist terms. He distinguishes between the “explicative definition” (77) and the “exemplary definition” (78) from the classic definition of Aristotelian provenance.

25 See Roelcke 2020, 72–83.

26 On the possible addressees of GA see above, p. 88.

27 This is the translation by Peck.

28 See Rapp 1992, 542.

ence there exist demands for clarity and explicitness. This is why clarifications of terms and definitions are necessary. The charm of metaphors and comparisons, on the other hand, lies precisely in the fact that they are not explicit, but that one has to make inferences. Therefore metaphors, even if they have a certain didactic value, are not suitable for science.²⁹ In the natural sciences, Aristotle himself repeatedly criticizes the pre-Socratic philosopher Empedocles for the metaphors he used in his poem *Peri phuseōs* (*Meteorologica*. II 3. 357a24–28).

In *GA*, Aristotle likes to quote Empedocles verbatim because, given the nature of his criticism, he can express the inadequacy of the language of poets for scientific contexts. In his criticism of Empedocles' view that milk is a product of putrefaction, he clearly states that a poetic expression can have an obscuring effect. Here he uses the word-for-word quote (*GA* IV 8. 777a7–12):³⁰

τὸ γὰρ γάλα πεπεμμένον αἷμά ἐστιν ἀλλ' οὐ διεφθαρμένον. Ἐμπεδοκλῆς δ' ἡ οὐκ ὀρθῶς ὑπελάμβανεν ἢ οὐκ εὖ μετήνεγκε ποιήσας ὥς τὸ γάλα “μηνὸς ἐν ὀγδοάτῳ δεκάτῃ πύον ἐπλετο λευκόν”. σαπρότης γὰρ καὶ πέψις ἐναντίον, τὸ δὲ πύον σαπρότης τίς ἐστιν, τὸ δὲ γάλα τῶν πεπεμμένων.

since milk is *concocted*, not *decomposed*, blood. As for Empedocles, either he was mistaken, or else his metaphor was a bad one, when he wrote how the milk is formed “on the eighth moon's tenth day, a whitish pus.” No; putrefaction and concoction are opposites, and pus is a putrefaction, whereas milk is to be classed as something concocted.

The criticism does not only apply to the content (milk is a putrefactive product), but Aristotle criticizes the metaphorical expression in general.³¹ So it is not suitable for the scientific field.

Yet, Aristotle himself makes use of metaphors in the scientific realm. For example, in *GA* he uses the verb *kratein* (= to win, get the upper hand) to denote that when a child is conceived, a child looks more like its father than its mother, if the paternal part has become stronger.³² He obviously takes this expression from the Hippocratic writings,³³ where it is likewise used in the area of procreation doctrines; it is therefore an established term that describes a process for which no word is yet available. The verb *kratein* comes from the military-political field and denotes physical strength. But in Aristotelian reproductive biology, it describes the dominance of the paternal or maternal ‘inheritance’. The Hippocratic writings, from which Aristotle accesses this metaphor, actually represent a ‘symmetrical’ doctrine of procreation, according to which male and female seeds fight for dominance. Aristotle, on the other hand, uses the

²⁹ See Rapp 2013.

³⁰ This and the following translations of *GA* are from Peck 1942.

³¹ For this, as for the criticism of Empedocles in *GA* in general, see Föllinger 2022b.

³² Modern biology uses similar metaphors.

³³ See Föllinger 1996, 170–179.

word in the context of his ‘asymmetrical’ doctrine of procreation to explain the emergence of individual properties in ontogenesis: if the male contribution to procreation is ‘stronger’, i.e., prevails, certain individual properties are based on the father; if not, then on the mother.

Insofar as Aristotle reflects on the use of the metaphor to name things that have not yet been named³⁴ in *Rhetoric* (III 2. 1405a34–1406b6) and in *Poetics* (21.1457b25–30), one can say that he himself here provides clues for how one can arrive at a ‘technical terminology’. However, these metaphors, which name something that has not yet been given a name³⁵ must not be too far-fetched – in contrast to metaphors used by rhetors and poets – but rather they have to be taken from the field of the same *genus* and of the same type (*ek tōn suggenōn kai tōn homoeidōn*, *Rhetoric* III 2. 1405a34–35). In so far as “strength” is the type of metaphor for *kratein* and the power struggle between male semen and female menstrual blood is one about a balance of power, one can say that the metaphor is not too far-fetched. For, modern biology also speaks of ‘dominance’ when it comes to inheritance. Another metaphor is that of cooking (*pepsis*) for physiological processes (which we also know: we ‘burn’ calories).

(7) Another, somewhat more specific way of dealing with specialist terminology or the lack of specialist terminology is to use the term *analogon*. In *GA*, Aristotle uses *analogon* with regard to parts of the body such as the heart, brain, and lungs.³⁶ He often speaks of an analogue of menstrual blood in female animals of other genera and species, without it being clear which substance this is supposed to be. For Fiedler,³⁷ the reason is that Aristotle could dispose of the problem of having to create a new *terminus technicus*. This could very well be a reason. But then the question arises of why he wanted to avoid this act of creation. Would it have been too ambitious an undertaking, or would the new creation no longer have been understandable for a wider audience? In any case, one has to go beyond the reason assumed by Fiedler as to why Aristotle avoids a specific naming of terms. Aristotle’s aim in *GA* is to offer a *unified* theory for all generation and inheritance phenomena throughout the entire animal kingdom. Due to this, he needs a single explanatory approach. He sees this single explanatory attempt in his hylemorphic approach. Accordingly, he must assume that

³⁴ This use was later called catachresis. Cf. Rapp 2002, second half volume, 843, on *Rhetoric* 1405a35–1405b6.

³⁵ See also *Poetics* 21. 1457b25–30.

³⁶ See the passages cited in Fiedler 1978, 27 note 3.

³⁷ Aristotle offers no systematic reflections on analogies, though they play an important part in his practice. Fiedler has systematically examined Aristotle’s “occasional theoretical utterances in the various writings, (. . .) commentary remarks on individual comparisons by analogies and . . . his practical approach” (Fiedler 1978, 21: “gelegentliche(n) theoretische(n) Äußerungen in den verschiedenen Schriften, (. . .) kommentierende Bemerkungen zu einzelnen Analogievergleichen und (. . .) sein praktisches Vorgehen”) in order to explain Aristotle’s conception of analogy. On Aristotle’s use of analogy, see also Sier 2022.

there is something in every female sexual partner in the entire animal kingdom that is 'analogous' to menstrual blood in that it offers the matter. By simply speaking of the fact that there is an analogy to menstrual blood and/or by taking its existence for granted, he can give his theory the general character that he would like to give it without actually having to empirically prove the existence of a corresponding body part or component.

(8) Comparisons that use analogies can serve to replace missing technical terms. I would now like to turn to this particular procedure in more detail:

In *GA*, Aristotle offers a surprising number of comparisons. At first glance, this is astonishing, for the comparison is, according to the explanations of Aristotle's *Rhetoric*, a metaphor that is made more precise by inserting a comparative word. But metaphors are actually not suitable for the field of science because metaphors are ambiguous,³⁸ and in the field of science, a claim to clarity and explicitness has been made. But the fact that, nevertheless, Aristotle often uses comparisons in *GA* can be justified by the fact that these comparisons work with analogies.³⁹ Aristotle himself defines analogies in *Poetics* (21. 1457b16–33) as a relation of 'units' in which the second is related to the first as the fourth is to the third. With such comparisons based on analogies, Aristotle can now illustrate in *GA* complex scientific connections that are on the theoretical level difficult and not immediately understandable; as such, they can be a didactic tool. But Aristotle uses such comparisons to serve also heuristic purposes because they can serve to clarify difficult facts in the cognitive process – also for the scientist/author himself – by functioning as models. Indeed, Aristotle partially substitutes them for explanations so that they have an evidentiary function.⁴⁰ When reading *GA*, one even gets the impression that analogies provide a means for the scientist himself in order to understand coherences and to gain knowledge, with which he then simultaneously allows the reader to participate in his own knowledge process. This corresponds to the character of the entire writing.⁴¹

Now I would like to address comparisons that Aristotle, by analogizing abstract processes with concrete phenomena taken from everyday life, uses as heuristic aid for explanation, comparisons which at the same time help to 'find words' for that which he desires to express. This applies in particular to his theory that the male's contribution is immaterial in nature, consisting rather in initiating the procreation process by way of movement. From this movement, a process is set in motion whereby the 'dispositions'

38 Christof Rapp has shown this on the basis of Aristotle's explanations in *Topics and Metaphysics*. According to the *Topics*, a metaphor is not suitable for a definition because it is not explicit (*asaphēs*) (Rapp 2013).

39 That the analogy is a subgroup of the metaphor becomes clear from the *Poetics* passage mentioned. Aristotle deals extensively with metaphor and comparison as its sub-form in *Rhetoric* III.

40 A separate study is being prepared to categorize different types of comparisons.

41 See my remarks on the character of writing, above, p. 86–87.

of the offspring are successively transformed through the ‘transmission of information’ such that the formation of body parts and certain physical characteristics can be realized. With the terms ‘dispositions’ and ‘transmission of information’ I use modern terminology and ideas.⁴² Aristotle, on the other hand, expresses himself generally through circumscriptions – such as (general) relative clauses – and general philosophical vocabulary such as *dunamis* (potentiality), *energeia* (actuality/realization), *eidos* (form), *kinēsis* (movement), and *logos*.

In order to explain his rather abstract view that the male’s actual contribution to the process of procreation does not consist of anything material, Aristotle uses a comparison that analogizes the procreation process with everyday handiwork activity. He starts from his basic philosophical view⁴³ that between that which is acted upon (*pa-thetikon*) and that which acts (*poioun*) there is no unity in which that acts would be a component. He transfers the distinction between that which acts and that which is acted upon to the two sexes, where what is being acted upon is the female partner. Aristotle does not justify this statement nor does he explain the process of acting upon on a theoretical level, but instead illustrates with two comparisons what, according to his theory, happens. One comparison cites as an analogy the bed as a ‘product’ made by carpenter and wood, whereby the analogy does not illustrate but actually replaces an explanation (I 22. 730b5–23):

καὶ γὰρ πρὸς τῷ ξύλῳ ὁ τέκτων καὶ πρὸς τῷ πηλῷ ὁ κεραμεύς, καὶ ὅλως πᾶσα ἡ ἐργασία καὶ ἡ κίνησις ἡ ἐσχάτη πρὸς τῇ ὕλῃ οἷον ἡ οἰκοδόμησις ἐν τοῖς οἰκοδομουμένοις. λάβοι δ’ ἂν τις ἐκ τούτων καὶ τὸ ἄρρεν πῶς συμβάλλεται πρὸς τὴν γένεσιν· οὐδὲ γὰρ τὸ ἄρρεν ἅπαν προίεται σπέρμα, ὅσα τε προίεται τῶν ἀρρένων, οὐθὲν μόνιον τοῦτ’ ἔστι τοῦ γιγνομένου κυήματος, ὥσπερ οὐδ’ ἀπὸ τοῦ τέκτονος πρὸς τὴν τῶν ξύλων ὕλην οὐτ’ ἀπέρχεται οὐθέν, οὔτε μόνιον οὐθέν ἐστίν ἐν τῷ γιγνομένῳ τῆς τεκτονικῆς, ἀλλ’ ἡ μορφή καὶ τὸ εἶδος ἀπ’ ἐκείνου ἐγγίγνεται διὰ τῆς κινήσεως ἐν τῇ ὕλῃ, καὶ ἡ μὲν ψυχὴ ἐν ἧ τὸ εἶδος καὶ ἡ ἐπιστήμη κινουσί τὰς χεῖρας (. . .) ποιάν τινα κίνησιν (. . .) αἱ δὲ χεῖρες τὰ ὄργανα, τὰ δ’ ὄργανα τὴν ὕλην. ὁμοίως δὲ καὶ ἡ φύσις ἡ ἐν τῷ ἄρρενι τῶν σπέρμα προεμένων χρῆται τῷ σπέρματι ὡς ὄργάνῳ καὶ ἔχοντι κίνησιν ἐνεργείᾳ, ὥσπερ ἐν τοῖς κατὰ τέχνην γιγνομένοις τὰ ὄργανα κινεῖται· ἐν ἐκείνοις γὰρ πῶς ἡ κίνησις τῆς τέχνης.

After all, the carpenter is close by his timber, and the potter close by his clay; and to put it in general terms, the working or treatment of any material, and the ultimate movement which acts upon it, is in all cases close by the material, *e.g.*, the location of the activity of house-building is in the houses which are being built. These instances may help us to understand how the male makes its contribution to generation; for not every male emits semen, and in the case of those which do, this semen is not a part of the fetation as it develops. In the same way, nothing passes from the carpenter into the pieces of timber, which are *his* material, and there is no part of the art of carpentry present in the object which is being fashioned: it is the shape and the form which pass from the carpenter, and they come into being by means of the movement in the material. It is his soul, wherein is the “form”, and his knowledge, which cause his hands (. . .) to move

42 For a comparison of Aristotelian considerations with modern views, see Kullmann 1979; Föllinger 1996, 162f. and 168f.

43 See, *e.g.*, *Physics* III 1–3.

in a particular way (. . .) his hands move his tools and his tools move the material. In a similar way to this, nature⁴⁴ acting in the male of semen-emitting animals uses the semen as a tool, as something that has movement in actuality; just as when objects are being produced by any art the tools are in movement, because the movement which belongs to the art is, in a way, situated in them.

The analogy consists in the fact that the 'forming' of the wood is brought about by the movement but without that moving part actually providing anything material. It is the 'form' that brings about the shape of the bed, the originator of which is the carpenter or his idea of the product. His hands are the tools that use movement to impart the shape to the wood. Correspondingly, according to Aristotle, the seed itself is not part of the resulting embryo, but rather imparts form to the matter – the menstrual blood – through its movement. So, one can make out the following equivalents:

Hands – seeds = tools

Wood – catamenial material = matter

Movement – movement = movement

Carpenter – nature = 'mover'

Even if this comparison is problematic in that the carpenter is an external agent who is not quite equivalent to 'nature',⁴⁵ it can clarify what is important in Aristotle's explanation: the essential thing is not the physical nature of the seed, but the transferrence of the 'form', a process that we would in modern times call 'information' – which itself is also a metaphor.

So, this comparison – as a substitute for theoretical explanation – conveys a theory by contrasting the general philosophical vocabulary on the theoretical level with the concrete equivalents on the level of metaphor. But it also serves as a substitute for specialist terminology. This means: the general philosophical terminology + the analogization with concrete things and known processes from the everyday world replace the technical terminology.

Another theoretical and speculative element of Aristotelian theory puts forth the idea that the development of the embryo takes place successively or, as one would put it in modern terms, proceeds 'epigenetically'. For this demanding thesis – whose empirical starting point was obviously the observation made through experiments with chicken eggs that the heart develops first – Aristotle uses a comparison with 'automatic puppets' (*automata*) (II 1. 734b4–19).⁴⁶ In order to better understand the way in which the comparison based on analogy replaces a (as yet) non-existent technical terminology, this text should also be cited in full (II 1. 734b9–19):

⁴⁴ Peck: "Nature."

⁴⁵ Elsewhere, even Aristotle himself points out this problem.

⁴⁶ See below, p. 97.

ἐνδέχεται δὲ τότε μὲν τότε κινῆσαι, τότε δὲ τότε, καὶ εἶναι οἷον τὰ αὐτόματα τῶν θαυμάτων. ἔχοντα γὰρ πως ὑπάρχει δύναμιν τὰ μόρια ἡρεμοῦντα· ὦν τὸ πρῶτον ὅταν τι κίνησι τῶν ἐξωθεν εὐθὺς τὸ ἐχόμενον γίγνεται ἐνεργεία. ὥσπερ οὖν ἐν τοῖς αὐτομάτοις τρόπον μὲν τινα ἐκεῖνο κινεῖ οὐχ ἀπτόμενον νῦν οὐθενός, ἀψάμενον μέντοι· ὁμοίως δὲ καὶ ἀφ' οὗ τὸ σπέρμα ἢ τὸ ποιῆσαν τὸ σπέρμα, ἀψάμενον μὲν τινος, οὐχ ἀπτόμενον δ' ἔτι· τρόπον δὲ τινα ἢ ἐνοῦσα κίνησις ὥσπερ ἢ οἰκοδόμησις τὴν οἰκίαν. Ὅτι μὲν οὖν ἔστι τι ὃ ποιεῖ, οὐχ οὕτως δὲ ὡς τότε τι οὐδ' ἐνυπάρχον ὡς τετελεσμένον τὸ πρῶτον, δῆλον.

And it is possible that A should move B, and B move C,⁴⁷ and that the process should be like that of the “miraculous” automatic puppets: the parts of these automatons, even while at rest, have in them somehow or other a *potentiality*, and when some external agency sets the first part in movement, then immediately the adjacent part comes to be *in actuality*. The cases then are parallel: just as with the automaton (1) in one way it is the external agency which is causing the thing's movement – viz., not by being in contact with it anywhere now, but by having at one time been in contact with it, so too that from which the semen originally came, or that which fashioned the semen, <causes the embryo's movement⁴⁸> – viz., not by being in contact with it still, but by having once been in contact with it at some point; (2) in another way, it is the movement resident within <which causes it to move⁴⁹>, just as the activity of building causes the house to get built. It is clear by now that there is something which fashions the parts of the embryo, but that this agent is not by way of being a definite individual thing, nor is it present in the semen as something already perfected to begin with.

Here, Aristotle's comparison, which works with an analogy, clearly serves as a model by means of which Aristotle can make it possible to explain how the effect of the seed is to be imagined.⁵⁰ The comparison is intended to make it clear that the successive development of the offspring from the seed is based on an initial impulse that develops gradually. It is important for Aristotle to explain how it can be that the parts of the newly emerging living being developed successively from the seed without having to make the (absurd) claim that one part of the body is always potentially contained in the previous one. Rather, his explanation points to the fact that a process is set in motion during procreation, in which the body parts gradually arise, starting from the initial impulse.⁵¹ Aristotle could not yet find any technical terminology for that, and his philosophical terminology, which forms the framework for the theoretical explanation (*energeia*, *dunamis*, *tode ti*), is too unspecific, as is particularly clear in the following:

47 Here, the Greek text actually has: “this moves this, and this moves this . . .”

48 “Causes the embryo's movement” is an addition by Peck.

49 “Which causes it to move” is an addition by Peck.

50 The analogization of the blood vessels with a system of irrigation channels in *De partibus animalium* (PA) IV 10. 688a11ff and 24ff has a comparable heuristic function. This analogy, according to Fiedler, is no conclusive proof, but it also illustrates not only because Aristotle could not observe the processes concerning the blood vessels: “The irrigation system offers a model from which Aristotle can understand, i.e. justify, all the manifestations that can be determined in connection” (Fiedler 1978, 32).

51 Quarantotto 2022 seeks an explanation.

It is clear by now that there is something which fashions the parts of the embryo, but that this agent is not by way of being a definite individual thing, nor is it present in the semen as something already perfected to begin with. (*end of passage quoted above*).

The lack of precision in the existing terminology is probably the reason why Aristotle's explanation is initially set on a very theoretical level that is too general to really express what happens, in order to then replace the missing technical terminology by comparing it with the specific 'automatic puppets' that the recipients were familiar with. In these 'automatic puppets' an impulse that was not visible from the outside, viz., from the viewer's perspective, triggered a process that we would call a 'chain reaction'.⁵² This analogy, which likewise creates a mental image of the *automata* in the recipient, makes it clearer how one should imagine the process. Here also a movement starts from the first element, the seed, which in turn sets something else in motion so that the movement reaches all subsequent parts, even if they are not in direct contact with the original mover. Another comparison with building a house, already introduced above, serves to illustrate that the movement emanating from the seed is nothing external. The formulation chosen by Aristotle "because the movement (. . .) is, in a way, situated in them" makes it clear that he can only express what he means very vaguely. The comparison with the building of a house even replaces a scientific argument or a proof, and Aristotle concludes with the aforementioned reference to the obviousness of the fact (734b17–19) that what triggers the movement is neither individual nor anything like a finished product present in the seed.

The situation is similar with the comparison which Aristotle uses after the comparison with the *automata*. In order to explain how the individual parts of the body are formed during embryonic development, he starts from his theoretical premise that what initializes the development of the embryonic parts is neither a specific individual entity nor some completed product in the semen.⁵³ His own approach consists in explaining that there is potentially something in the male semen that is the cause for the individual body parts to develop, i.e., becoming actual, in the course of embryonic genesis. Again one notices clearly how Aristotle can use his philosophical terminology (potentiality: *dunamis* – actuality: *energeia*), but he lacks a more specific form of expression, i.e., technical terminology. So he takes the opportunity to explain what he meant by using a comparison. He analogizes the development of body parts with a process of artificial production (GA II 1. 734b28–735a4):

καὶ ὥσπερ οὐδ' ἂν πέλεκυν οὐδ' ἄλλο ὄργανον φήσαιμεν ἂν ποιῆσαι τὸ πῦρ μόνον οὕτως οὐδὲ πόδα οὐδὲ χεῖρα. τὸν αὐτὸν δὲ τρόπον οὐδὲ σάρκα· καὶ γὰρ ταύτης ἔργον τί ἐστίν. σκληρὰ μὲν οὖν καὶ μαλακὰ καὶ γλίσχρα καὶ κραῦρα καὶ ὅσα ἄλλα τοιαῦτα πάθη ὑπάρχει τοῖς ἐμψύχοις μορίοις θερμότης καὶ ψυχρότης ποιήσειεν ἂν, τὸν δὲ λόγον ὃ ἤδη τὸ μὲν σὰρξ τὸ δ' ὅστων οὐκέτι,

⁵² Primavesi 2018, CX–CXXVI, explains how the *automata* functioned.

⁵³ This is probably an allusion to theoretical approaches that attempted to explain the development of an embryo with a kind of preformation theory.

ἀλλ' ἡ κίνησις ἡ ἀπὸ τοῦ γεννήσαντος τοῦ ἐντελεχείᾳ ὄντος ὃ ἐστὶ δυνάμει ἐξ οὗ γίγνεται, ὥσπερ καὶ ἐπὶ τῶν γιγνομένων κατὰ τέχνην· σκληρόν μὲν γὰρ καὶ μαλακὸν τὸν σίδηρον ποιεῖ τὸ θερμὸν καὶ τὸ ψυχρόν, ἀλλὰ ξίφος ἡ κίνησις ἡ τῶν ὀργάνων ἔχουσα λόγον τὸν τῆς τέχνης. ἡ γὰρ τέχνη ἀρχὴ καὶ εἶδος τοῦ γιγνομένου, ἀλλ' ἐν ἐτέρῳ· ἡ δὲ τῆς φύσεως κίνησις ἐν αὐτῷ ἀφ' ἐτέρας οὐσα φύσεως τῆς ἐχούσης τὸ εἶδος ἐνεργεία.

And as in speaking of an axe or any other instrument, we should not say that it was made solely by fire, so we should not say this about a foot or a hand <in the embryo>, nor similarly of flesh either, because this too is an instrument with a function to perform. As for hardness, softness, toughness, brittleness and the rest of such qualities which belong to the parts that have soul⁵⁴ in them – heat and cold may very well produce these, but they certainly do not produce the *logos* in direct consequence of which one thing is flesh and another bone; this is done by the movement which derives from the generating parent, who is in *actuality* what the material out of which the offspring is formed is *potentially*. Exactly the same happens with things formed by the processes of the arts. Heat and cold soften and harden the iron, but they do not produce the sword; this is done by the movement of the instruments employed, which contains the *logos* of the art; since the art⁵⁵ is both the principle and form⁵⁶ of the thing which is produced; but it is located elsewhere than in that thing, whereas nature's⁵⁷ movement is located in the thing itself which is produced, and it is derived from another natural organism which possesses the form⁵⁸ in *actuality*.

The key point is that it is not the material influences that make a becoming thing what it is. Rather, it is what Aristotle calls here both with regard to the artificial production and with regard to the natural process *logos* (λόγος). This *logos* is transmitted through the movement of the tool in the artificial process and through the movement of the male parent in the natural process and conveys the 'form', i.e., that which is the essence of the respective product. It is difficult to translate the term *logos*, which occurs twice in this passage (734b33 and 735a2), even if it is factually clear what it means in each case. So, Peck leaves it untranslated in both places; Balme translates as "definition" in both places, Lefebvre translates it as "raison." If one wanted to use a more specific vocabulary, one could translate it in the first passage (734b33) using a modern concept like 'information', while the second passage (735a2) deals with the 'designation' of a tool. At this point it becomes very clear how Aristotle uses, in a particular context, comparison via analogy to give a semantically diverse term, for which he himself has no word, a certain meaning.

The variety of paths that Aristotle takes to find suitable terms, and also the way in which he uses comparisons working with analogies didactically, heuristically, and additionally as a substitute for missing technical terminology, demonstrate well the status of biology in the fourth century and the creative achievement that is due to Aristotle.

⁵⁴ Peck: "Soul."

⁵⁵ Peck: "Art."

⁵⁶ Peck: "Form."

⁵⁷ Peck: "Nature's."

⁵⁸ Peck: "Form."

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