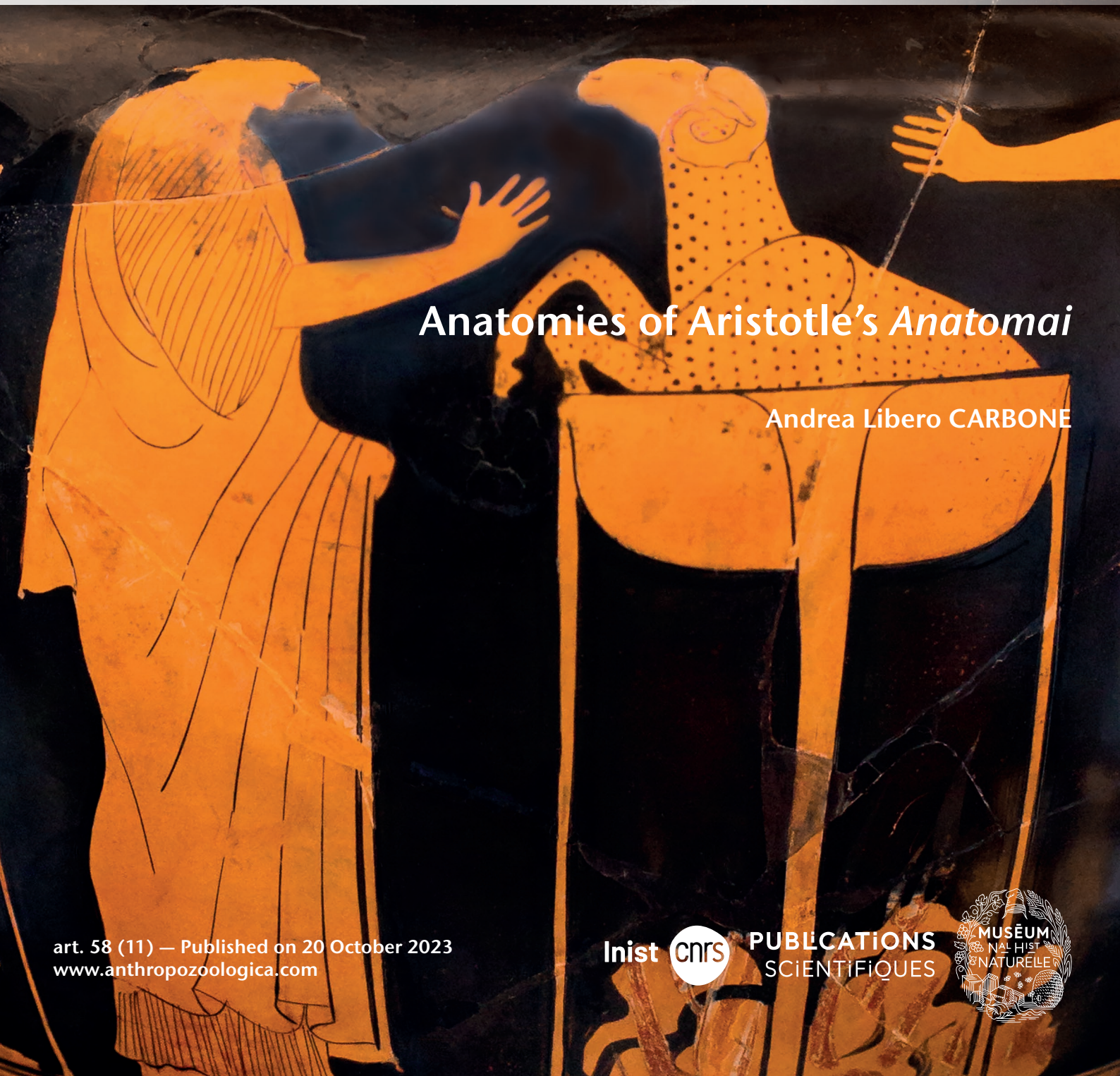
anthropozoologica

2023 • 58 • 11

OBSERVATION ZOOLOGIQUE, EXPÉRIENCE ET EXPÉRIMENTATION SUR L'ANIMAL. ANTIQUITÉ – MOYEN ÂGE

Édité par Anaelle BROSETA, Alessandra SCACCUTO & Arnaud ZUCKER



Anatomies of Aristotle's *Anatomai*

Andrea Libero CARBONE

art. 58 (11) — Published on 20 October 2023
www.anthropozoologica.com

Inist cnrs PUBLICATIONS SCIENTIFIQUES MUSÉUM NAT HIST NATURELLE

Couverture / *Cover*:
« Une magie cruelle. Médée fait la démonstration de son pouvoir magique sur un vieux bélier démembré qui sort intact et rajeuni de son chaudron. » Staatlichen Antikensammlungen, Munich (inv. 2408). Credits: ArchaiOptix (CC BY-SA-4.0) / *"Cruel magic. Medea demonstrates her magical power on a dismembered old ram, which emerges intact and rejuvenated from its cauldron." Red-figure pottery, Staatlichen Antikensammlungen, Munich (inv. 2408). Credits: ArchaiOptix (CC BY-SA-4.0).*

Anthropozoologica est indexé dans / Anthropozoologica *is indexed in:*

– Social Sciences Citation Index
– Arts & Humanities Citation Index
– Current Contents - Social & Behavioral Sciences
– Current Contents - Arts & Humanities
– Zoological Record
– BIOSIS Previews
– Initial list de l'European Science Foundation (ESF)
– Norwegian Social Science Data Services (NSD)
– Research Bible

Anthropozoologica est distribué en version électronique par / Anthropozoologica *is distributed electronically by:*

– BioOne® (https://www.bioone.org)

Anthropozoologica *est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris, avec le soutien du CNRS.*
Anthropozoologica *is a fast track journal published by the Museum Science Press, Paris, with the support of the CNRS.*
Les Publications scientifiques du Muséum publient aussi / *The Museum Science Press also publish:* ***Adansonia***, ***Zoosystema***, ***Geodiversitas***, ***European Journal of Taxonomy***, ***Naturae***, ***Cryptogamie*** **sous-sections** ***Algologie***, ***Bryologie***, ***Mycologie***, ***Comptes Rendus Palevol***.

Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél. : 33 (0)1 40 79 48 05 / Fax : 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / https://sciencepress.mnhn.fr

ISSN (imprimé / *print*) : 0761-3032 / ISSN (électronique / *electronic*) : 2107-0881

Anatomies of Aristotle's *Anatomai*

Andrea Libero CARBONE
Via Nunzio Morello 18, I-90144 Palermo (Italie)
andrealiberocarbone@gmail.com

Submitted on 25 May 2023 | Accepted on 4 August 2023 | Published on 20 October 2023

Carbone A. L. 2023. — Anatomies of Aristotle's *Anatomai*, *in* Broseta A., Scaccuto A. & Zucker A. (eds), Observation zoologique, expérience et expérimentation sur l'animal. Antiquité – Moyen Âge. *Anthropozoologica* 58 (11): 107-114. https://doi.org/10.5252/anthropozoologica2023v58a11. http://anthropozoologica.com/58/11

ABSTRACT
My aim here is to explore the critical and methodological issues involved in a potential reconstruction of the *Anatomai*, based on the underlying assumption that such a reconstruction should be based on an examination of the texts and contexts in which Aristotle refers to the *Anatomai* and the role he ascribes to them in the enquiry into differences and causes in biology. I critically discuss Aristotle's references to dissection experiments by comparing them with references to anatomical representations in an attempt to show that in Aristotle's eyes the scientific value of pictorial evidence is not inferior to the direct experience of dissection but may indeed have epistemological priority. Aristotle's reference to actual dissection experiments often refers to extremely simple procedures. This simplicity seems incompatible with the complexity of the anatomical techniques required to obtain the amount and accuracy of detail that Aristotle seems to gather from the anatomical drawings of the *Anatomai*. On the other hand, Aristotle tends to focus in his anatomical experiments on a few distinctive parts of animals. It thus seems unlikely that the *Anatomai* could have presented an encyclopaedic account of comparative anatomy. To account for this cleavage between anatomical experimentation and morphological representation, I attempt to describe Aristotle's approach by distinguishing between an anatomy of the "what" and an anatomy of the "why".

KEY WORDS
Aristotle's zoology,
history of comparative anatomy,
body plan,
dissection,
vivisection.

RÉSUMÉ
Anatomies des Anatomai *d'Aristote*.
Mon objectif est d'explorer les questions critiques et méthodologiques liées à la reconstruction éventuelle des *Anatomai*, en partant de l'hypothèse qu'une telle reconstruction devrait se fonder sur un examen des textes et des contextes dans lesquels Aristote fait référence aux *Anatomai* et au rôle qu'il leur attribue dans l'enquête sur les différences et les causes en biologie. Je discute de manière critique les références faites par Aristote aux expériences de dissection, en les comparant aux références qu'il fait aux représentations anatomiques dans le but de montrer qu'aux yeux d'Aristote la valeur scientifique des preuves imagées n'est pas inférieure à l'expérience directe de la dissection, et qu'elle peut même avoir une priorité épistémologique. Les allusions d'Aristote à des expériences de dissection proprement dites évoquent souvent des procédures extrêmement simples. Cette simplicité semble incompatible avec la complexité des techniques anatomiques requises pour obtenir la quantité et la précision de détails qu'Aristote semble tirer des dessins anatomiques des *Anatomai*. D'autre part, Aristote a tendance à se concentrer, dans ses expériences anatomiques, sur un petit nombre de parties distinctives des animaux. Il semble donc peu probable que les *Anatomai* aient pu présenter un compte rendu encyclopédique de l'anatomie comparée. Pour rendre compte de ce clivage entre l'expérimentation anatomique et la représentation morphologique, je tente de décrire l'approche d'Aristote en établissant une distinction entre une anatomie du « quoi » et une anatomie du « pourquoi ».

MOTS CLÉS
Biologie d'Aristote,
histoire de l'anatomie comparée,
plan du corps,
dissection,
vivisection.

INTRODUCTION

While mentioned in the main ancient lists of Aristotle's works, the *Anatomai* have not been preserved. Very few early authors seem to have had direct access to this work after Theophrastus: Aristophanes of Byzantium (*c.* 265-190 or 257-180 BCE), then Apuleius (124-170? CE) and Galen (129-*c.* 216 CE), and perhaps, about a thousand years later, Michael of Ephesus (early 12th century CE). The most important testimony we have, in fact, is that of Aristotle himself, so much so that the internal references to the *Anatomai* are among the most numerous in the entire Aristotelian corpus (for a review of ancient sources and critical literature see Hellmann 2004: 66-81).

Was it a stand-alone work or an appendix intended to accompany the school materials we know as the corpus of Aristotle's biological "treatises"? What were their sources? Did they refer to actual dissection experiences? Were they descriptive texts or figurative illustrations, diagrams or sketches? These are questions that remain largely unanswered to this day.

My aim here is to explore the critical and methodological issues involved in a potential reconstruction of the *Anatomai*, based on the underlying assumption that such a reconstruction should be based on an examination of the texts and contexts in which Aristotle refers to the *Anatomai* and the role he ascribes to them in the enquiry into differences and causes in biology.

PORTRAIT OF ARISTOTLE AS AN ANATOMIST

Let us start from a picture, a portrait by the Italian romantic painter Francesco Hayez, created in 1811 and displayed in the Galleria dell'Accademia in Venice (Fig. 1). This is one of the first results one gets when launching a Google image search on the iconography of Aristotle. The painting can be found on the Wikipedia page dedicated to our philosopher and has even been used on the cover of some books. It features a man holding a shell in one hand and an elongated object that looks like anything from a scalpel to a stylus in the other. One would be led to take it to be a scene from Aristotle's life while dissecting a testacean, probably near the shores of the bay of Pyrrha on the island of Lesbos. In reality, however, this painting does not depict Aristotle but rather Aristides – assonance may have played a role in this misunderstanding – an Athenian politician who lived between the 6th and 5th centuries B.C., depicted in the act of inscribing his name on a shell, rather than dissecting its inhabitant. This scene is actually an episode from the *Parallel Lives* (Plut., *Arist*. 7.5; Perrin 1914), where Plutarch tells how Aristides helped an illiterate citizen cast his vote of ostracism, even though the man wanted to vote to have Aristides himself banished from the city. Although this very well-known literary reference allows us to interpret the image unequivocally, we can see that the imagery of Aristotle the zoologist, and more precisely of Aristotle the anatomist, personally engaged in the practice of dissection, has found its way to be superimposed on this portrait.

Let us now explore how much truth there may be in this historical fake by asking ourselves about the very origin of this imagery of Aristotle the anatomist, and in particular about the anatomical illustrations that must have constituted his anatomical atlas, namely the *Anatomai*. The few scholars who have been interested in reconstructing this work have come to an almost unanimous agreement that Aristotle would have systematically practised dissection and, in some cases, vivisection (Lehoux 2017: 243-247). However, how and in what form the knowledge gathered through anatomical experience was presented in the *Anatomai*, and what role this work played in Aristotle's investigation of the living things, are questions that remain largely open to this day.

KNIVES OUT?

I have already argued elsewhere that to envision the *Anatomai* as a figurative repertoire of anatomical experiments would be extremely reductive (Carbone 2011: 53-87). This is only one of the functions that Aristotle attributes to this work. It is not the main one, and above all, this function makes no sense in Aristotelian terms if it is considered in isolation from the other aspects of the representation of the living body that contribute to making the *Anatomai* a key element of Aristotle's toolbox for his enquiry into living things. It is worth noting that in the vast majority of passages referring to the *Anatomai*, Aristotle focuses on the organisation of animals and on the relative positions of body parts along the axes of symmetry. Specifically, one-third of the occurrences of the term ἀνατομαί are found in contexts where the terminology of dimensionality is densely used, while one-quarter of the occurrences are related to the determination of the position of parts. Indeed, Aristotle expressly tells us, on several occasions, that the visual representation of the position of the parts is the main and distinctive subject of the *Anatomai vis-à-vis* the *History of Animals* (Balme & Gotthelf 2002).

Further, the *Anatomai* are not limited to the field of internal anatomy, accessible through dissection but also cover external anatomy.

> Τὰ μὲν οὖν μόρια τὰ πρὸς τὴν ἔξω ἐπιφάνειαν τοῦτον τέτακται τὸν τρόπον, καὶ καθάπερ ἐλέχθη, διωνόμασταί τε μάλιστα καὶ γνώριμα διὰ τὴν συνήθειάν ἐστιν· τὰ δ' ἐντὸς τοὐναντίον. Ἄγνωστα γάρ ἐστι μάλιστα τὰ τῶν ἀνθρώπων, ὥστε δεῖ πρὸς τὰ τῶν ἄλλων μόρια ζῴων ἀνάγοντας σκοπεῖν, οἷς ἔχει παραπλησίαν τὴν φύσιν (The externally visible parts are thus arranged in this way and, as we have said, are very well named and known, because of their familiarity. It is otherwise with respect to the internal parts, for those of men are for the most part unknown: it is therefore necessary to conduct the investigation starting from the parts of other animals which have a similar nature) (Arist., *Hist. an*. I 16, 494 b 19-24, translation mine).

Fig. 1. — *Aristides*, oil on canvas by Francesco Hayez, 1812. Venice, Accademia di Belle Arti.

In addition to a number of internal references in Aristotle, we find clear evidence of the actual extent of the content covered in the *Anatomai* in Theophrastus, who must have had first-hand knowledge of this work, and who at the very beginning of his *History of Plants* (Theophr., *Hist. pl.* I 1, 4, 11; Hort 1916a) tells us that the *Anatomai* covered both the organisation of the animal body considered in its entirety, and the detailed anatomy of the external and internal parts of living things. This means that the anatomy of the *Anatomai* did not only consist of accounts of practical dissection experiences, but were focused on the internal and external organisation of the living body as a whole. The most important information Aristotle seems to draw from these anatomical tables is not so much about anatomical detail but the form and position of the bodily parts and their orientation with respect to the axes of symmetry, i.e. the visual representation of where a given organ stands in the teleological hierarchy of the living body's activities.

Moreover, Aristotle makes it very clear that practical anatomy, while providing access to the otherwise inaccessible experience of the internal organisation of living things, is not in itself sufficient to provide scientifically reliable facts. This is clear from his criticism, in *De respiratione* 3, 471b 23-29 (Hett 1957), of those who do not acknowledge that all animals breathe:

> Αἴτιον δὲ μάλιστα τοῦ μὴ λέγεσθαι περὶ αὐτῶν καλῶς τό τε τῶν μορίων ἀπείρους εἶναι τῶν ἐντός, καὶ τὸ μὴ λαμβάνειν ἕνεκά τινος τὴν φύσιν πάντα ποιεῖν· ζητοῦντες γὰρ τίνος ἕνεκα ἡ ἀναπνοὴ τοῖς ζῴοις ὑπάρχει, καὶ ἐπὶ τῶν μορίων τοῦτ' ἐπισκοποῦντες, οἷον ἐπὶ βραγχίων καὶ πνεύμονος, εὗρον ἂν θᾶττον τὴν αἰτίαν. (But the chief reason why they do not speak correctly of these things is that they have no experience of the internal parts, and also that they do not posit that nature does everything for an end. For if they had looked for the purpose for which respiration belongs to animals, and had observed this in the parts concerned, namely the gills and the lung, they would have immediately found the cause.) (Arist., *Resp*. 3, 471b 23-29, translation mine)

It is the lack of appreciation of teleology that contributes, together with the lack of experience of the internal parts, to the scientific error. The one does not go without the other. What characterises the *Anatomai* seems to be precisely the interplay of these two angles, that of experience and that of teleology. But we should not overlook that for Aristotle epistemological primacy belongs to teleology. In other words, Aristotle's priority is to convey scientifical meaning to the anatomical experience by representing anatomical features in a scientifically meaningful way. Hence, the images of the *Anatomai* could not simply be figurative illustrations, however detailed, intended to record the experience of dissection in a descriptive way. The representation of the relative positions of body parts and the orientation of the body plan along the axes of symmetry certainly had to be conveyed through geometrical sketches and diagrams.

The recent revival of interest in the *Anatomai*, which revolves around Aristotle's empirical approach and his practice of dissection, would appear to have completely disregarded this focus on diagrammatic representation centred on the teleological explication of organised bodily shapes. Scholarly consideration of Aristotle's dissections as a source of his biological knowledge has been most notably revived by the British biologist Armand Leroi, who explored Aristotle's biology in a short documentary series for the BBC and in a book (Leroi 2014). To be fair, Leroi takes up and refines the views of Geoffrey Lloyd, who, as is well known, was the first to focus on the systematic nature of Aristotle's dissection practice (Lloyd 1975). According to Leroi's calculations, Aristotle refers to the internal anatomy of about 110 different animal species. "For about thirty-five of them", he claims, "his information is so extensive or accurate that he must have dissected them himself". However, as he adds shortly thereafter, "Dissection is hard. Open a corpse and you do not see organs neatly arrayed, logically connected and conveniently labelled in contrasting colours, but a morass of dimly discernible tubes and sacs and membranes swimming in pools of bodily fluids. What you see in that morass is deeply influenced by what you expect to see, for in dissection, as in all investigations, expectation and practical difficulties conspire to hide the truth." In fact, Leroi points out that "As any anatomist knows, you don't really *see* until you *draw*." (Leroi 2014: 59, 60).

This is precisely the function that the *Anatomai* seem to play for Aristotle. The experience of practical dissection is not sufficient in itself to acquire a scientific knowledge of the internal anatomy of living beings. The construction of meaning through graphic representation is an indispensable step in this process.

RE-ENACTING ARISTOTLE'S DISSECTIONS, REDRAWING ARISTOTLE'S DIAGRAMS

Armand Leroi is also one of those researchers who have attempted to reproduce Aristotle's dissections experimentally, as did Christopher Cosans, who also tried to do so in the late Nineties (Cosans 1998) – although he performed his experiences on previously prepared anatomical parts in the laboratory, under conditions that were therefore considerably different from those encountered by Aristotle – or Alexander Fürst von Lieven, Marcel Humar and Gerhard Scholtz in Berlin, who attempted to reconstruct the *Anatomai* by using an interdisciplinary collaborative approach (Fürst von Lieven *et al.* 2021).

Before going further on the question of the empirical dimension of the *Anatomai*, I would like to mention some methodological caveats. It must be borne in mind, I believe, that any problematisation of the empirical and experiential dimension of Aristotle's investigation that would result in an attempt to reconstruct the anatomical drawings or, *a fortiori*, in an attempt to repeat his dissections in order to revisit what Aristotle may have had in front of his eyes at different stages of his research, inevitably entails the risk of anachronistically projecting the modern criterion of repeatability onto Aristotle's scientific experience. In this sense, it would be misleading to interpret the *Anatomai* as an *ekphrasis* of what dissection reveals, or as a repertoire of guiding images that would allow one to repeat the actual experience of dissection and thus come back to "reading" the inside of the living body with a scientifically trained eye. Nothing in the texts seems to point in this direction. Rather, Aristotle's use of images seems mostly related to finding valid evidence to support his arguments in the framework of scientific proof-building. To his eyes, the value of such pictorial evidence is no less than the direct experience of dissection. But in fact, we find in Aristotle a clear awareness of the possibility of observational error, which always concerns the experience of direct observation and never pictorial representation. Aristotle points out, for example, that when dissected, the heart is dislodged from its natural location so that its forward orientation is no longer discernible (Arist., *Hist. an*. I 17, 496a 11), or that the lung, if observed in isolation, as a part extracted from dissected animals, appears to be completely exsanguinated (Arist., *Hist. an*. I 17, 496b 4-6), whereas if it is observed in vivisection, it appears so interwoven with veins that it seems full of blood (Arist., *Hist. an*. III 3, 513b 22-23), or again, more extensively, he emphasises the difficulty of observing the path of the veins, which, in dissected corpses, immediately collapse (Arist., *Hist. an*. III 2, 511b 14-19).

Thus, it can be argued that, since direct observation takes place under conditions that can lead to alteration of the object of observation and there are strong risks of variability and error, it is rather the anatomical picture, once refined by a combination of observation and reference to relevant scientific principles, that carries the crucial informational content for the distinction of differences and the determination of causes, and this indeed confers on it an even higher epistemological status than direct experience.

EVIDENCES OF ARISTOTLE'S METHOD OF DISSECTION

This awareness of high error risk associated with the practice of dissection is a key aspect in the more unique than rare hints offered by Aristotle in *Historia animalium* III 3 regarding the method he favoured for practical anatomy:

> Τὰ μὲν οὖν ὑπὸ τῶν ἄλλων εἰρημένα σχεδὸν ταῦτ' ἐστίν· εἰσὶ δὲ καὶ τῶν περὶ φύσιν οἳ τοιαύτην μὲν οὐκ ἐπραγματεύθησαν ἀκριβολογίαν περὶ τὰς φλέβας, πάντες δ' ὁμοίως τὴν ἀρχὴν αὐτῶν ἐκ τῆς κεφαλῆς καὶ τοῦ ἐγκεφάλου ποιοῦσι, λέγοντες οὐ καλῶς. Χαλεπῆς δ' οὔσης, ὥσπερ εἴρηται πρότερον, τῆς θεωρίας ἐν μόνοις τοῖς ἀποπεπνιγμένοις τῶν ζῴων προλεπτυνθεῖσιν ἔστιν ἱκανῶς καταμαθεῖν, εἴ τινι περὶ τῶν τοιούτων ἐπιμελές.
> (This, then, is roughly what others have said about veins. Among naturalists, there are some who have not treated this subject with such rigour; nevertheless, they all assume the head and encephalon as the principle, which is not correct. Since observation is difficult, as has already been said, it is only in animals that have undergone great emaciation and have been killed by preventing them from breathing that it is possible to carry out a correct observation, when dealing with such matters.) (Arist., *Hist. an*. III 3, 513a 8-15, translation mine)

As Christopher Cosans has pointed out (Cosans 1998: 321), Aristotle is clearly referring here to animals that have been purposely prepared for dissection, by subjecting them to weight loss so that the veins are more visible, and then killing them by a specific breath-deprivation operation, also designed to preserve the visibility of the veins. In the modern forensic literature (Dix & Calaluce 1998: 79, 80; McEwen & Gerdin 2016: 1052, 1053), there are indeed references to the large amount of blood in the vessels near the heart in subjects who died of suffocation. Aristotle's aim was precisely to provide experimental proof that the heart is the principle of the veins. It would also seem that in animals that die of drowning in fresh water, a hypotonic environment, inhaled water can be pumped by the heart into the blood vessels due to the lower osmotic concentration of water.

In any case, it should be emphasised that we are not dealing with dissections conducted in the context of ritual sacrifice. Both suffocation and drowning are beyond the scope of sacrificial practices. This is a subject widely studied by Nicole Loraux (1990: 126-139), who stresses that sacrifice by suffocation is an exclusively barbarian custom, documented for example by Herodotus among the Scythians. In other words, critical remarks such as the one on the lung extracted from dissected animals, or *a fortiori* on the inefficiency of dissection for the observation of blood vessels, and methodological orientations such as the one just mentioned, show that from Aristotle's point of view, the ritual of sacrifice is by no means a privileged source of anatomical information, but fairly an occasion for observational errors from a scientific angle. We are thus confronted with a strong claim to the autonomy and specificity of anatomy, both in terms of dissection practices and in relation to the representation of the living body that constitutes the theoretical framework of Aristotle's anatomy.

What, then, is the anatomical method of Aristotle's *Anatomai* and what role and importance does he attribute to experience? First of all, it should be made clear that the appeal to the body plan and axes of symmetry means that the *Anatomai* encompass what, in the modern evolution of biology, are two distinct fields, namely anatomy proper and morphology. Therefore I prefer to speak of the anatomies (in the plural) of the *Anatomai*. Thus, not all of Aristotle's anatomy-morphology is experimental, since, as I have already pointed out, the visual aspects of his approach are of equal importance, as they reflect the scientific principles relevant to the teleological explication of the living body's organisation. Moreover, not all aspects of experimental anatomy in Aristotle are related to dissection or vivisection, as we find several references to experiments that do not require the use of these practices.

I then propose to distinguish in Aristotle's experimental approach to anatomy-morphology four different branches:
– dissection;
– vivisection;
– practical experiments without dissection;
– thought experiments.

It is beyond the scope of this discussion to examine in detail the passages that fall into all of these categories, and in particular to discuss those experiments that do not require dissection, such as the experiments on drowning aquatic and terrestrial turtles and frogs (Arist., *Resp*. 1, 470b 22-23) or the suffocation of turtles, frogs, fishes (Arist., *Resp*. 3, 471b 2-4), *malakostraka* and molluscs (Arist., *Resp*. 9, 475b 6-9) mentioned several times in the *De respiratione*, as well as the thought experiments that consist, for example, in visualising the beaks of birds as the fusion and topological deformation of human teeth and lips (Arist., *Part. an.* II 16, 659b 23-26), or to visualise snakes as elongated lizards without feet (Arist., *Hist. an*. II 17, 508a 9-11), or to imagine the consequences of alternative organisations, for example by picturing horns positioned elsewhere than on the head (Arist., *Part. an.* III 2, 663a 34-b 20) or by constructing a combinatorial of parts that also incorporates combinations unknown in nature, for example in the examination of joints (Arist., *IA* 13, 712 a 1-22). I will therefore limit myself to pointing out that these are all further aspects of Aristotle's experimental approach which, in his method, are comparable in all respects to that of dissection, but which do not, or do not always, have an immediate connection with the *Anatomai*.

DISSECTION AND VIVISECTION

Let us turn then to dissection and vivisection. As such, the question of whether, whenever Aristotle quotes the *Anatomai*, he is referring to an actual dissection experiment carried out by him or his collaborators remains undecidable for lack of sufficient data and evidence. Nor does it seem relevant to distinguish between the use of the noun *ἀνατομαί* and the periphrases using the verb *ἀνατέμνω*, which might be thought to imply a direct reference to the practice of dissection, since in *Resp*. 16, 478a 27 and 478 1 the two variants appear only a few lines apart in the same passage and are undoubtedly synonymous in a context lacking explicit references to direct experience. Moreover, in *De generatione animalium* IV 1, 764a 33-36, Aristotle seems to tell us that he personally practised dissection on all viviparous animals (Lehoux 2017: 244), at least according to what Daryn Lehoux understands from the grammar of the passage, where the verb τεθεωρήκαμεν ("we have observed") is conjugated in the first person plural. Here again, however, on closer scrutiny, it turns out to be impossible to ascertain whether this is a reference to an actual experience of dissection or to the consultation of anatomical plates.

We are therefore compelled to stick to an educated guess, which leads us to believe that Aristotle and his collaborators conducted dissection experiments regarding all the animals whose anatomy is accounted for in the biological corpus, or were at least aware of experiments that they considered reliable. However, it is probably an exaggeration to think that this thoroughness was the result of a systematic and exhaustive practice. Such an approach does not match with Aristotle's method in zoology, which consists in proceeding by kinds, similarities, and analogies. Indeed, this is what Aristotle expressly tells us about his approach: knowledge of the internal parts of humans, unknown from lack of experience, can be obtained by exploring the internal parts of similar animals. Thus, many anatomical observations clearly derived from dissection experiments refer generically to the body part in question (the heart, the lung) without specifying which animal is being observed. Conversely, when experiments are conducted on specifically identified animals, for example the chameleon or the turtle, Aristotle focuses on the parts that specifically characterise them or that show significant differences or anomalies from the reference kind.

This is the case in relation to the mole dissection experiment:

> Τοῦτον δὲ τρόπον μέν τιν' ἔχειν ἂν θείη τις, ὅλως δ' οὐκ ἔχειν. Ὅλως μὲν γὰρ οὔθ' ὁρᾷ οὔτ' ἔχει εἰς τὸ φανερὸν δήλους ὀφθαλμούς· ἀφαιρεθέντος δὲ τοῦ δέρματος ἔχει τήν τε χώραν τῶν ὀμμάτων καὶ τῶν ὀφθαλμῶν τὰ μέλανα κατὰ τὸν τόπον καὶ τὴν χώραν τὴν φύσει τοῖς ὀφθαλμοῖς ὑπάρχουσαν ἐν τῷ ἐκτός, ὡς ἐν τῇ γενέσει πηρουμένων καὶ ἐπιφυομένου τοῦ δέρματος. (In fact, one might assume that on the one hand it has eyes, but on the other hand it has none at all: for it cannot see at all and has no clearly recognisable eyes. If we remove the skin, however, we find that it has the lodging of eyes, and that the black part and the part surrounding the eyes are in their natural place, as if the eyes had been damaged in the course of development and the skin had grown over them.) (Arist., *Hist. an*. I 9, 491b 28-34, translation mine)

However, it is only after stating that all animal kinds, apart from ostracoderms and some other incomplete animals, have eyes, and that in this respect the mole in particular is an exception to the other viviparous animals, that Aristotle refers to a dissection of this animal, referring exclusively to the part that constitutes the anomaly.

The same can be said of certain vivisection experiments performed on the chameleon or the turtle:

> Διὸ καὶ τῶν ἐντόμων ἔνια διαιρούμενα ζῶσι, καὶ τῶν ἐναίμων ὅσα μὴ ζωτικὰ λίαν εἰσὶ πολὺν χρόνον ζῶσιν ἐξῃρημένης τῆς καρδίας, οἷον αἱ χελῶναι, καὶ κινοῦνται τοῖς ποσίν, ἐπόντων τῶν χελωνίων, διὰ τὸ μὴ συγκεῖσθαι τὴν φύσιν αὐτῶν εὖ, παραπλησίως δὲ τοῖς ἐντόμοις. (This is why some insects live when divided, and why some animals among the blooded which are not very active, live long after the heart has been excised, e.g. turtles move even with their feet if the shell is left on, because their nature is not organised in a complex way, as is also the case among insects.) (Arist., *Resp*. 17, 479a 3-7, translation mine)

As we can see, nothing is said about the details of the anatomy of these animals, and the experience of removing the heart, a part which is itself described neither in its conformation nor in its position, is only intended to support the general claim that in animals that are not very active (a category of which turtles are a proverbial example) a certain tendency to movement is preserved, as if by a delaying effect, even after the heart (which, according to Aristotelian physiology, is the principle of movement) has been removed. Thus, vivisection focuses on this functional aspect, and on the other characteristic part of the turtle, namely the shell, to the exclusion of any reference to other parts of the animal that are not relevant to the phenomenon in question.

One might think that the vivisection and dissection of the chameleon contravenes this approach, since it is one of the few cases where Aristotle dwells on several details of the anatomy of a single animal:

> Στρέφει δὲ τὸν ὀφθαλμὸν κύκλῳ τὴν ὄψιν ἐπὶ πάντας τοὺς τόπους μεταβάλλει, καὶ οὕτως ὁρᾷ ὃ βούλεται. Τῆς δὲ χροιᾶς ἡ μεταβολὴ ἐμφυσωμένῳ αὐτῷ γίνεται· ἔχει δὲ καὶ μέλαιναν ταύτην, οὐ πόρρω τῆς τῶν κροκοδείλων, καὶ ὠχρὰν καθάπερ οἱ σαῦροι, μέλανι ὥσπερ τὰ παρδάλια διαπεποικιλμένην. Γίνεται δὲ καθ> ἅπαν τὸ σῶμα αὐτοῦ ἡ τοιαύτη μεταβολή· καὶ γὰρ οἱ ὀφθαλμοὶ συμμεταβάλλουσιν ὁμοίως τῷ λοιπῷ σώματι καὶ ἡ κέρκος. Ἡ δὲ κίνησις αὐτοῦ νωθὴς ἰσχυρῶς ἐστι, καθάπερ ἡ τῶν χελωνῶν. Καὶ ἀποθνήσκων τε ὠχρὸς γίνεται, καὶ τελευτήσαντος αὐτοῦ ἡ χροιὰ τοιαύτη ἐστίν. Τὰ δὲ περὶ τὸν στόμαχον καὶ τὴν ἀρτηρίαν ὁμοίως ἔχει τοῖς σαύροις κείμενα. Σάρκα δ> οὐδαμοῦ ἔχει πλὴν πρὸς τῇ κεφαλῇ καὶ ταῖς σιαγόσιν ὀλίγα σαρκία, καὶ περὶ ἄκραν τὴν τῆς κέρκου πρόσφυσιν. Καὶ αἷμα δ> ἔχει περί τε τὴν καρδίαν μόνον καὶ τὰ ὄμματα καὶ τὸν ἄνω τῆς καρδίας

τόπον, καὶ ὅσα ἀπὸ τούτων φλέβια ἀποτείνει· ἔστι δὲ καὶ ἐν τούτοις βραχὺ παντελῶς. Κεῖται δὲ καὶ ὁ ἐγκέφαλος ἀνώτερον μὲν ὀλίγῳ τῶν ὀφθαλμῶν, συνεχὴς δὲ τούτοις. Περιαιρεθέντος δὲ τοῦ ἔξωθεν δέρματος τῶν ὀφθαλμῶν περιέχει τι διαλάμπον διὰ τούτων, οἷον κρίκος χαλκοῦς λεπτός. Καθ> ἅπαν δ' αὐτοῦ τὸ σῶμα σχεδὸν διατείνουσιν ὑμένες πολλοὶ καὶ ἰσχυροὶ καὶ πολὺ ὑπερβάλλοντες τῶν περὶ τὰ λοιπὰ ὑπαρχόντων. Ἐνεργεῖ δὲ καὶ τῷ πνεύματι ἀνατετμημένος ὅλος ἐπὶ πολὺν χρόνον, βραχείας ἰσχυρῶς ἔτι κινήσεως ἐν αὐτῷ περὶ τὴν καρδίαν οὔσης, καὶ συνάγει διαφερόντως μὲν τὰ περὶ τὰ πλευρά, οὐ μὴν ἀλλὰ καὶ τὰ λοιπὰ μέρη τοῦ σώματος. Σπλῆνα δ> οὐδαμοῦ ἔχει φανερόν. Φωλεύει δὲ καθάπερ οἱ σαῦροι. (The chameleon turns its eye in a circle, revolving its sight everywhere, and is thus able to see what it wants. The change of colour occurs when it inflates: it is black like the crocodile, yellow like the lizards, but spotted with black like the leopards. This change occurs throughout the body, the eyes themselves changing in accordance with the rest, and the tail too. Its movements are very slow, like those of turtles. When it dies, however, it turns yellow, and ultimately this is its colour. The oesophagus and trachea region is similar to that of lizards. It has no flesh except in the head and the jaws are somewhat fleshy, as is also the top of the tail at the junction. It has blood only in the heart, in the eyes, in the region above the heart and in the small veins branching off from it, where very little is found. The brain is just above the eyes, in continuity with them. If you remove the skin around the eyes on the outside, something shines through, like a thin copper ring. All along the body are membranes, numerous and hard to a far greater extent than those of other animals. Even if the animal is dissected in its entirety, the activity of respiration continues for a long time, and in addition there is a very short movement around the heart, and there is a contraction especially in the hips, but also in other parts of the body. It has no visible spleen anywhere. It hibernates like the lizards.) (Arist., *Hist. an*. II 11, 503a 35-b 28, translation mine)

Here again though, on closer reading, the dissecting experience seems to focus on the eyes, whose peculiarity is noted, and which are therefore the subject of a specific investigation, and on other features that seem remarkable to Aristotle, especially in relation to the lizard kind. Furthermore, the vivisection experiment and the remarks about the heartbeat and the fact that, once the skin has been removed, movement is more observable in other regions of the body than in the region of the heart itself, in turn, are to be seen in relation to the observation that the chameleon's entire body has more hard and numerous membranes than those observed in other animals.

In short, just as Aristotle, when examining differences, focuses only on the characteristic features of a certain group of animals in relation to the larger whole of which that group is a part, or on specific anomalies, so, when it comes to dissection or vivisection, he tends to concentrate on these same distinctive parts. Scholars who have addressed Aristotle's practice of dissection, from Lloyd onwards, have not emphasised this essential aspect.

CONCLUSION

Given these major methodological reasons, it seems unlikely to me that the *Anatomai* could have presented an encyclopaedic account of the anatomy of individual animals, considered one by one in detail in their conformation as established by systematic dissection work, as in a modern atlas of zoology and comparative anatomy. To quote Aristotle himself from his methodological framework in *De partibus animalium* I, 1, if this were the case, there would be much repetition, in this case not of terms but of experiences and pictures. Again, one should be careful not to attribute to Aristotle modern ideas such as the encyclopaedism of natural history and the belief in the necessity of repeating experience for confirmation, which do not fit into his understanding of science.

It should also be noted that such references to direct observational experience by dissection or vivisection to clarify a phenomenon or correct an error in explanation are relatively rare in Aristotle, and in any case no more frequent than critical remarks on methodologically erroneous or misleading observational experiments.

Here again, Aristotle's call for actual dissection experiments typically points to an extremely simple gesture compared to the actual procedure required to obtain the amount and accuracy of detail that we are said one was able to derive from the anatomical drawings of the *Anatomai*. What is usually required is quite simply to carve the outer envelope of the body to ascertain the mere presence or absence of some feature.

In fact, I believe that from this point of view, it is useful to distinguish in Aristotle's approach two different views of dissection as a source of anatomical data, which in fact relate to two different conceptions of anatomy, or rather to the two aspects of Aristotelian anatomy that we have highlighted, one linked to anatomy proper, the other to morphology. One approach is purely empirical, preliminary or dialectical in character, and simpler, while the other is "theory-laden", in the sense that it is imbued with a distinct teleological understanding of the living being, as well as with a representation of the spatial layout of the body as functionally oriented along the axes of symmetry (Carbone 2011: 89-104; 2016). In other words, I believe we can argue that in Aristotle's approach to anatomy, a distinction can be made between an anatomy of the *hoti* (of the "that") and an anatomy of the *dioti* (of the "why").

We can find a good example of the anatomy of the *hoti* in a criticism addressed to some followers of Anaxagoras in *De partibus animalium* IV 2:

> Οὐκ ὀρθῶς δ' ἐοίκασιν οἱ περὶ Ἀναξαγόραν ὑπολαμβάνειν ὡς αἰτίαν οὖσαν τῶν ὀξέων νοσημάτων· ὑπερβάλλουσαν γὰρ ἀπορραίνειν πρός τε τὸν πλεύμονα καὶ τὰς φλέβας καὶ τὰ πλευρά. Σχεδὸν γὰρ οἷς ταῦτα συμβαίνει τὰ πάθη τῶν νόσων, οὐκ ἔχουσι χολήν, ἔν τε ταῖς ἀνατομαῖς ἂν ἐγίνετο τοῦτο φανερόν. (The followers of Anaxagoras do not seem to be right when they argue that bile is the cause of acute diseases because when it is too abundant it would spill over the lung, vessels and flanks. Almost all the animals that suffer from these diseases have no bile, which is clearly seen in dissections" (Arist., *Part. an.* IV 2, 677a 4-9, translation mine).

In his now classic study of experience in Aristotelian zoology, G. E. R. Lloyd regards this mention of dissection as not related to an actual dissection experiment (Lloyd 1987: 59 n. 47). Nevertheless, Aristotle's argument clearly adheres here to the simple factual level of the *hoti* (of the "that"). A bodily part (or fluid) is pointed out as the cause of a pathology. It is enough to "cut open" the animal's body – whether physically with a knife or metaphorically by consulting some anatomical plates – to "look in there" and find that this item is absent, and that therefore the cause is incorrectly identified. If the anecdote about Anaxagoras' recourse to dissection reported by Plutarch in the *Life of Pericles* (Plut., *Per*. 6.2; Perrin 1916) is to be believed, Aristotle is here resorting to the same weapon against these disciples of Anaxagoras that their master is said to have taken to refute the divination of a fortune teller, who interpreted the birth of a one-horned goat as a sign that Pericles' party would prevail over Thucydides'. Anaxagoras' approach at that time was exactly the same as that advocated here by Aristotle: he cut the goat's skull in two and showed that this condition had a rational cause, namely the uneven development of the brain. However, for Aristotle, this straightforward anatomy of the *hoti* is nothing more than a premise for the other anatomy, that of the dioti (of the "why"). Indeed, it is the latter that constitutes the main focus of the *Anatomai*, which are above all the tool of an anatomy/morphology aimed at revealing the teleological logic of the living body, based on the axes of symmetry.

From this point of view, I can only agree with Arnaud Zucker's remark (Zucker 1994: 34) concerning Aristotle's view of the legendary anatomy of the hyena's sex, when he suggests that multiple "degrees of conformity" of the discourse to reality exists, and perhaps also, we may add, multiple "modes of conformity". As such, the anatomy of the *hoti* and that of the *dioti* represent two distinct modes of conformity of discourse to reality: of these two, the *dioti*'s, which is reflected in the visual representation of the organisation of the living body, is given gnoseological priority.

Acknowledgements

My heartfelt thanks to the anonymous reviewers of this journal for their insightful comments and to the editorial team for their thorough revision. I would especially like to thank Arnaud Zucker, Anaelle Broseta and Alessandra Scaccuto for their invitation and for the many insights they provided into an early version of this paper, as well as Stavros Lazaris and the whole Zoomathia group, and Marco Vespa and Oliver Hellmann for the passionate exchanges we had in Nice.

REFERENCES

ARISTOTLE, *Parts of Animals. Movement of Animals. Progression of Animals*: see PECK & FOSTER 1937; *Generation of Animals*: see PECK 1942; *On the Soul. Parva Naturalia. On Breath*: see HETT 1957; *Historia Animalium*: see BALME & GOTTHELF 2002.

BALME D. M. & GOTTHELF A. (eds) 2002.— *Aristotle. Historia Animalium*. Vol. I, Books I-X: *Text*. Cambridge University Press, Cambridge, 628 p.

CARBONE A. L. 2011. — *Aristote illustré. Représentations du corps et schématisation dans la biologie aristotélicienne*. Classiques Garnier, Paris, 236 p.

CARBONE A. L. 2016. — The axes of symmetry. Morphology in Aristotle's biology. *Apeiron* 49 (1): 1-31. https://doi.org/10.1515/apeiron-2014-0019

COSANS C. E. 1998. — Aristotle's anatomical philosophy of nature. *Biology and Philosophy* 13: 311-339. https://doi.org/10.1023/A:1006515414945

DIX J. & CALALUCE R. 1998. — *Guide to Forensic Pathology*. Columbia University Printing Service, Columbia, 272 p.

FÜRST VON LIEVEN A., HUMAR M. & SCHOLTZ G. 2021 — Aristotle's lobster: the image in the text. *Theory in Biosciences* 140: 1-15. https://doi.org/10.1007/s12064-020-00322-6

HELLMANN O. 2004. — "Multimedia" im Lykeion? Zu Funktionen der *Anatomai* in der aristotelischen Biologie. *Antike Naturwissenschaft und ihre Rezeption* 14: 65-86.

HETT W. S. (transl.) 1957. — *Aristotle. On the Soul. Parva Naturalia. On Breath*. Harvard University Press (Loeb Classical Library; 288), Cambridge, MA, 544 p.

HORT A. F. 1916a. — *Theophrastus. Enquiry into Plants*. Vol. I: *Books 1-5*. Harvard University Press (Loeb Classical Library; 70), Cambridge, MA, 512 p.

HORT A. F. 1916b. — *Theophrastus. Enquiry into Plants*. Vol. II: *Books 6-9. On Odours. Weather Signs*. Harvard University Press (Loeb Classical Library; 79), Cambridge, MA, 512 p.

LEHOUX D. 2017. — Observation claims and epistemic confidence in Aristotle's biology. *Isis* 108 (2): 241-258. https://doi.org/10.1086/692679

LEROI A. M. 2014. — *The Lagoon: How Aristotle Invented Science*. Bloomsbury, London, 502 p.

LLOYD G. E. R. 1975. — Alcmaeon and the early history of dissection. *Sudhoffs Archiv* 59 (2): 113-147.

LLOYD G. E. R. 1987. — Empirical research in Aristotle's biology, *in* GOTTHELF A. & LENNOX J. G. (eds.), *Philosophical Issues in Aristotle's Biology*. Cambridge University Press, Cambridge: 53-63. https://doi.org/10.1017/CBO9780511552564.006

LORAUX N. 1990. — *Les expériences de Tirésias: le féminin et l'homme grec*. Gallimard, Paris, 397 p.

MCEWEN B. J. & GERDIN J. 2016. — Veterinary forensic pathology: drowning and bodies recovered from water. *Veterinary Pathology* 53 (5): 1049-1056. https://doi.org/10.1177/0300985815625757

PECK A. L. & FORSTER E. S. (transl.) 1937. — *Aristotle*. Vol. XII, *Parts of Animals. Movement of Animals. Progression of Animals*. Harvard University Press (Loeb Classical Library; 323), Cambridge, MA, 560 p.

PECK A. L. (transl.) 1942. — *Aristotle. Generation of Animals*. Harvard University Press (Loeb Classical Library; 366), Cambridge, MA, 688 p.

PERRIN B. (transl.) 1914. — *Plutarch. Lives*. Vol. II: *Themistocles and Camillus. Aristides and Cato Major. Cimon and Lucullus*. Harvard University Press (Loeb Classical Library; 47), Cambridge, MA, 640 p.

PERRIN B. (transl.) 1916. — *Plutarch. Lives*. Vol. III: *Pericles and Fabius Maximus. Nicias and Crassus*. Harvard University Press (Loeb Classical Library; 65), Cambridge, MA, 464 p.

PLUTARCH, *Lives*: see PERRIN 1914, 1916.

THEOPHRASTUS, *Enquiry into Plants*: see HORT 1916a, b.

ZUCKER A. 1994. — Raison fausse et fable vraie: sur le sexe ambigu de la hyène. *Pallas* 41: 27-40.

Submitted on 25 May 2023;
accepted on 4 August 2023;
published on 20 October 2023.