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ÍNDICE

	<i>Págs.</i>
Sumario	7-11

ARTÍCULOS

DE IUSTITIA

MARTÍNEZ CHICO, David, El bronce epigráfico de Monteagudo (Murcia), ¿el documento jurídico de una olvidada <i>civitas</i> ?	13-31
PEREA YÉBENES, Sabino, Breves apuntes jurídicos sobre el término <i>alumna</i> , a propósito del monumento funerario de <i>Lutatia Lupata</i> en <i>Augusta Emerita</i>	33-47

ARS MEDICA

ÁNGEL Y ESPINÓS, Jesús, <i>De Medicinae studio recte instituendo</i> d' Andrés Piquer : le regard d'un médecin des Lumières sur l'art médical.....	49-69
BELLINI, Elena, Herophilus on the (in)visibility of respiration	71-94

VARIA	Págs.
CRISTEA, George Bogdan, <i>Carmina non prius audita</i> : estructuras de argumentación y lenguaje poético en las odas de Horacio	95-121
FRATANTUONO, Lee, Lycia and the Lycians in the <i>Aeneid</i> : Virgil's Herodotus	123-143
FREÁN CAMPO, Aitor, La <i>strix</i> romana: análisis y caracterización.....	145-164
MANZANO-VENTURA, Victoria, La <i>Summa super Priscianum minorem</i> de Petrus Helias (ca. 1140): tradición e innovación	165-187
MARTÍN RUIZ, Juan Antonio & GARCÍA CARRETERO, Juan Ramón, Los matrimonios diplomáticos en las casas reales y la aristocracia fenicia y cartaginesa	189-208
RUIZ PÉREZ, Ángel, Caracterización genérica de <i>Pequeñeces</i> , de Luis Coloma, a través de las referencias clásicas.....	209-231
Reseñas	233-239

CONTENTS

	<i>Págs.</i>
Table of contents	7-11

ARTICLES

DE IUSTITIA

MARTÍNEZ CHICO, David, The epigraphic bronze from Monteagudo (Murcia), the juridical document of a forgotten <i>civitas</i> ?	13-31
PEREA YÉBENES, Sabino, Brief legal notes on the term <i>alumna</i> , regarding the funerary mo- nument of <i>Lutatia Lupata</i> in <i>Augusta Emerita</i>	33-47

ARS MEDICA

ÁNGEL Y ESPINÓS, Jesús, De <i>Medicinae studio recte instituendo</i> by Andrés Piquer: the view of an Enlightenment doctor on medical art.....	49-69
BELLINI, Elena, Herophilus on the (in)visibility of respiration	71-94

VARIA	<i>Págs.</i>
CRISTEA, George Bogdan, <i>Carmina non prius audita: Argumentation Structures and Poetic Language in Horace's Odes</i>	95-121
FRATANTUONO, Lee, Lycia and the Lycians in the <i>Aeneid</i> : Virgil's Herodotus	123-143
FREÁN CAMPO, Aitor, The Roman <i>strix</i> : analysis and characterisation	145-164
MANZANO-VENTURA, Victoria, The <i>Summa super Priscianum minorem</i> by Petrus Helias (ca. 1140): tradition and innovation	165-187
MARTÍN RUIZ, Juan Antonio & GARCÍA CARRETERO, Juan Ramón, Diplomatic marriages in the royal houses and Phoenician and Carthaginian aristocracy	189-208
RUIZ PÉREZ, Ángel, The Characterization of the Genre of <i>Pequeñeces</i> , by Luis Colo- ma, through Classical References	209-231
Book reviews	233-239

Herophilus on the (in)visibility of respiration*

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Abstract

Herophilus of Chalcedon's paramount advancements in the fields of anatomy and physiology are hailed as revolutionary not only in regard to their content, but also in regard to the methodology that made them possible. Concerning this latter point, later sources concur in attributing to Herophilus the use of human dissection (and possibly even of vivisection) for research purposes, an unprecedented practice that seems to have been abandoned and then systematically retrieved only in the sixteenth century by Leonardo da Vinci and Vesalius. Herophilus' audacity in the field of anatomical inquiry was nevertheless accompanied by a rather cautious approach to aetiology. "Let the appearances be described first, even though they are not primary" (*An. Lond.*, XXI., 22-3): the medical practitioner must rely on what is visible, even though what is visible is not necessarily sufficient to an exhaustive comprehension of physiological phenomena, nor is it always at one's disposal. Such a tension between the visible and the invisible, the perceptible and the imperceptible, lies at the very

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basis of Herophilus' inquiry of the human body, extraordinarily lucid in defining its own limits. Through this article I propose to focus on the particular case of respiration, subject of the chapter of the Aëtian *Placita* known under the title *Περὶ ἀναπνοῆς*, as an example of the Herophilean reflection about the theoretic observability of phenomena that, far from being marginal or occasional, deserves to be recognised as a fundamental part of his epistemology.

Keywords: Herophilus; Aëtius; respiration; Hellenistic medicine; epistemology.

Why do walls not breathe?
Because they are not animals.
(Aristotle, *An. Post.*, I.13, 78b)

I. Introduction

Herophilus of Chalcedon is usually regarded, together with his younger contemporary Erasistratus of Ceos, as a protagonist of Hellenistic, and in particular Alexandrian, medicine. His contributions to the field of anatomy, most groundbreakingly in regard of the nervous system, but encompassing an impressively large variety of bodily structures (such as the brain ventricles, the eye, the liver, the female and male reproductive systems, the vascular system, and more), significantly changed the way in which the human body was seen, understood, and spoken of¹. To such an expansion of what became observable and known corresponded, nevertheless, an equivalent expansion of the realm of what was yet to be seen and understood, and therefore needed to be imagined or inferred². If in the case of Erasistratus such a duality appears more blatantly at work (quintessentially represented by his conception of *τριπλοκία*), in Herophilus' it does not less so. In order to showcase Herophilus' possible involvement within the reflection over the visibility and invisibility of physiological phenomena, I propose to narrow the focus to one single process, namely respiration³. Since the only piece of textual evidence transmitting the Herophilean

1. Lloyd 1975: 143: «To turn from the vague and obscure descriptions of the eye, the brain or the heart in all earlier writers, Aristotle included, to the work of Herophilus and Erasistratus – difficult as this is to reconstruct – is to enter a new world». Vegetti 1997: 73: «Poche epoche della storia medicina – non solo di quella antica – hanno conosciuto un'accelerazione così brusca nello sviluppo, una trasformazione così profonda delle strutture, come quelle che si produssero nei primi cinquant'anni del III secolo a.C.».

2. As efficiently put by Kazantzidis, “what we witness is a slide from the visible back to the invisible” (Kazantzidis 2023: 237).

3. Lloyd 1964: 52: «experimentation is of varying usefulness and relevance in different fields of scientific investigation, or even on different problems within the same field: [...] we must try to assess

account of respiration turns out to be the doxographer Aëtius' chapter *On respiration*, this article follows the chapter's order: first Empedocles', then Asclepiades', and finally Herophilus' account of respiration will be analysed, to then be able to delineate some conclusions over the role played by the theoretical observability of phenomena within the Herophilean epistemological system.

II. Aëtius on respiration

Our only testimony of Herophilus' account of the respiratory process is to be found in one among the longest chapters of the Aëtian *Placita* known under the title Περὶ ἀναπνοῆς (*On respiration*). As one among the not very many ancient doxographical sources about respiration, this chapter fairly deserves our full attention (even regardless of Herophilus). The first of such sources, which is also the first treatise to be ever exclusively dedicated to respiration, should be considered Aristotle's *De respiratione*, the longest out of the nine treatises altogether known as *Parva Naturalia*. There Aristotle, after lamenting a certain lack of rigour of his predecessors' way of treating such a fundamental physiological process⁴, goes through a critical exposé of some *endoxa* in order to better illustrate, comparatively, his own explanation of the respiratory process⁵: he first takes into account Anaxagoras and Diogenes of Apollonia (*Resp.*, 470b28-471b29), offering then a more detailed and punctual critique in regard to Democritus, Plato, and Empedocles (*Resp.*, 471b30-474a24)⁶. It is Aristotle's report and interpretation of the Empedoclean verses about respiration that we will keep in mind to better frame Aëtius' own interpretation of it. A later equally precious doxographical source for ancient theories of respiration we will make use of in our analysis is the *Anonymus Londiniensis*, whose author, reasonably *grosso modo*

the Greek performance in each department of science, indeed on each problem, independently». Lloyd is here referring to early Greek natural philosophy and the so-called "Hippocratic" medicine, but there is no reason not to apply the same principle to Hellenistic medicine.

4. Such a lack of rigour is, according to Aristotle, twofold: on the one side, those who dealt with respiration before him failed in attributing the due importance to its final cause, namely the cooling (κατάψυξις) of the internal heat (*Resp.*, 478a28-30); on the other, they were not enough anatomically experienced and therefore failed in appropriately differentiating the process of respiration among living beings (*Resp.*, 470b9-10).

5. For the Aristotelian description of the method of *endoxa*, see *Top.*, I 10-13; for its usefulness, see *PA*, I.1.

6. Given the nuanced and complex articulation of the subject of the treatise, in which Aristotle makes use of his wide anatomical knowledge to better confute his predecessors, Repici finds the *De respiratione* the most technical as well as the most dialectical treatise of the *Parva* (Repici 2017: 9).

contemporary to our Aëtius (I century C.E.)⁷, shows a keen interest in the ways in which respiration and health are intertwined. Thanks to the Anonymus we know how Philolaos of Croton (*An. Lond.*, XVIII 19-28) and Philistion of Locri (*An. Lond.*, XX 43-50) conceived of respiration. Moreover, it is in the so-called “physiological section” of the treatise (chapters XXI – XXXIX) that the Anonymus engages in an animated (though unfortunately sometimes lacunose) discussion about digestion and the assimilation of food where Herophilus, Erasistratus (whose explanation of the respiratory process is illustrated at length at XXIII 8-25)⁸, and Asclepiades are his main interlocutors.

Since Herophilus is the third out of three authors mentioned by Aëtius, we shall take them into account one by one in order to better understand the context in which Herophilus is put as well as the general intent of the chapter as a whole.

A. Empedocles

[AËTIUS DOX., *Placita* IV.22,1 = Ps.-PLUT, *Placita* IV.22 = DK31 A74 = LM22 D170 b; D202] Ἐμπεδοκλῆς τὴν πρώτην ἀναπνοὴν τοῦ πρώτου ζῴου γενέσθαι τῆς (μὲν) ἐν τοῖς βρέφεσιν ὑγρασίας ἀποχώρησιν λαμβανούσης, πρὸς δὲ τὸ παρακενωθὲν ἐπεισόδου {τῆς ἔξωθεν} τοῦ ἐκτὸς ἀερώδους γινομένης εἰς τὰ παρανοιχθέντα τῶν ἀγγείων· τὸ δὲ μετὰ τοῦτο ἤδη τοῦ ἐμφύτου θερμοῦ τῆ πρὸς τὸ ἐκτὸς ὀρμῇ τὸ ἀερώδες ὑπαναθλίβοντος, τὴν ἐκπνοήν, τῆ δ' εἰς τὸ ἐντὸς ἀνθυποχωρήσει τῷ ἀερώδει τὴν ἀντεπίσοδον παρεχομένου, τὴν εἰσπνοήν. τὴν δὲ νῦν κατέχουσιν φερομένου τοῦ αἵματος ὡς πρὸς τὴν ἐπιφάνειαν καὶ τὸ ἀερώδες διὰ τῶν ῥινῶν ταῖς ἐαυτοῦ ἐπιρροίαις ἀναθλίβοντος κατὰ τὴν ἐκχώρησιν αὐτοῦ γίνεσθαι τὴν ἐκπνοήν, παλινδρομοῦντος δὲ καὶ τοῦ ἀέρος ἀντεπίσιόντος εἰς τὰ διὰ τοῦ αἵματος ἀραιώματα τὴν εἰσπνοήν. ὑπομιμνήσκει δ' αὐτὸ ἐπὶ τῆς κλειψύδρας.

Empedocles (says that) the first breath of the first living being took place as the moisture in newborns was excreted and in what had just been emptied an entrance of outside air was created towards the slightly opened vessels. After this, as soon as the innate heat pushed the air out by means of an impulse towards the outside, the exhalation (took place), whereas, when it provided a complementary entrance to the air because of a corresponding returning inside,

7. For the dating of the *Anonymus*, see Manetti in van der Eijk 1999: 97; Manetti 2019: 35. For Aëtius', see Mansfeld & Runia 1997: 320-323.

8. A significant *caveat* needs to be made here (Ricciardetto 2016: CVIII-CIX, n. 348): the extent up to which the respiratory process reported by the Anonymus at XXIII. 8-25 can be traced back to Erasistratus is rather uncertain. Unlike Diels (and then Furley & Wilkie 1984), Garofalo questioned its very compatibility with some general principles of the Erasistratean physiology (Garofalo 1988: 9).

the inhalation (took place). As for the current respiration, when the blood moves towards the surface and pushes the air up through the nostrils by its influxes, with the departure of the air the exhalation occurs, whereas, when (the blood) runs back and the air enters in turn into the crevices left by it, the inhalation (occurs). He makes mention of this in the passage about the clepsydra⁹.

The explanation of the respiratory mechanism that we find here corresponds, in its core, to that transmitted by our main source for the Empedoclean respiration, Aristotle's *De Respiratione* 473b9-474a6 (DK31 B100 = LM22 D201): two substances, blood and air, are involved, the former of which is the main respiratory agent whose movement determines the entrance and exit of the latter. When the blood moves towards the surface of the body, exhalation occurs; when the blood runs back towards the centre of the body, inhalation takes place¹⁰. The slightly open vessels (τὰ παρανοιχθέντα τῶν ἀγγείων) mentioned here can be seen as parallel to the channels of flesh lacking blood (λίφαιμοι σαρκῶν σύριγγες) at vv. 1-2, in so far as they are passages through which air freely enters and exits the body, whereas blood stays within. The entrance and exit of air seem to happen, in both passages, through the nostrils. Now, it is worth mentioning that while the διὰ τῶν ῥινῶν of the Aëtian passage has been peacefully taken to refer to the nostrils, from the plural genitive ῥινῶν at v. 5 reported by Aristotle stems a highly debated issue concerning Empedoclean respiration: is Empedocles describing nasal respiration (in which case ῥινῶν ἔσχατα τέρθρα would mean "the outer extremities of the nose", i.e. the nostrils), or is he actually presenting us with a model (perhaps the first) of skin-breathing (in which case ῥινῶν ἔσχατα τέρθρα would mean "the outer extremities of the skin", i.e. the skin-pores)? That is to say, going one step further: did Aristotle misunderstand Empedocles? For in his *De Respiratione*, Aristotle makes it clear that Empedocles was wrong in regarding respiration through the nostrils rather than that through the trachea (ἀρτερία) as the main (κύριος) kind of respiration (*Resp.* 473a). The scholarly debate on such an issue can hence be roughly divided into two macro-tendencies: those who took Aristotle's reading of Empedocles to be wrong, and those who thought he was right after all¹¹. Without going into much detail here, I

9. Unless differently stated, translations are mine.

10. Cf. DK31 B100, vv. 6-8 and 22-25.

11. In the former group we can find Diels 1903, Bignone 1916, Furley 1957, Gallavotti 1975, Wright 1981. Vegetti is clearly rounding numbers up when he writes, in note to his translation of the *De Respiratione*, that «Aristotele equivoca, come fanno rilevare tutti i commentatori, sul brano empedocleo» (Vegetti 1971: 1220, n. 25, my emphasis). In the latter group we can find Timpanaro-Cardini 1957, Booth 1960, Lloyd 1966, O'Brien 1970, Repici 2017.

would be inclined to think that retroactively projecting Plato's double (i.e. nasal and poral) respiration (*Tim.* 79a5-e9) onto the Empedoclean verses is not necessary nor particularly fair towards Aristotle's own reading and understanding of them¹². Rather, the Aëtian report could be taken as further evidence of the fact that Empedocles endorsed nasal respiration, since there is no mention of holes other than the nostrils. Be that as it may, the dispute nose/skin remaining scholarly relevant and somewhat exciting, it might not have been an Empedoclean problem *per se*: even regardless of the passages through which respiration occurs (the clepsydra analogy is far from determining in this respect), Empedocles might have rather intended to describe an

12. I will attempt to summarise the debate revolving around such a delicate issue, without aspiring to cover it in its entirety. Two main reasons are brought about to justify the presence of skin-pore respiration in the Empedoclean fragment: first, the possibility of applying the theory of πόροι and ἀπορροιαί to the respiratory process; second, the retroactive superimposition of the Platonic ἀντιπερίστασις. Concerning the former point, many scholars did not hesitate to recognise in the fragment the description of a mechanism akin to perception: as the porosity of the sense-organs allows them to receive the corresponding effluences, the porosity of the surface of the skin would allow the body as a whole to breathe. Nevertheless, while in terms of interaction between πόροι and ἀπορροιαί are explained perception and cognition (Thphr. *De sensu*, VII-XII), such a principle does not seem to regulate other physiological processes as clearly. For instance, in no extant fragments does Empedocles use the term πόρος to describe the passages or channels in the body (Wright 1981: 230). Concerning the latter point, a strong continuity has been remarked between the Empedoclean respiration and the Platonic respiration as described in the *Timaeus*, with the suggested mediation, between the two, of Philistion of Locri. According to Plato, we recall, each inhalation through the nostrils corresponds to an exhalation through the pores of the skin and vice versa, and there is no doubt about the fact that «there are two outlets, the one out by way of the body, the other by way of the mouth and nose» (*Tim.* 79d-e, transl. Lamb 1925). The same can be stated for what we know about Philistion of Locri's explanation of respiration, according to which «non seulement la respiration se fait par la bouche et par le narines, mais aussi par le corps tout entier» (*An. Lond.*, XX.45-7, transl. Ricciardetto 2016). There is no trace of such a bilateral process in Empedocles, meaning that if one had to see him endorsing cutaneous respiration, that would make of cutaneous respiration the main (or better to say, the only) kind of respiration (see Booth 1960: 14; Lloyd 1966: 332). Empedocles was well aware, though, of the connection between respiration and the sense of smell, that happened through the nose (DK31 B101-2 = LM22 D132-2; and for establishing a causal relation between respiration and sense of smell he is harshly criticised by Theophrastus in *De sensu* XXI-II). Without questioning the Empedoclean roots of certain aspects of Plato's physiology, in the specific regard of respiration it has been hence suggested that a familiarity between Plato and Philistion does not require the antecedent of Empedocles (Timpanaro-Cardini 1957: 263-264). I would like to conclude this criminally long note with Longrigg's cautious statement: «For his theory of respiration Plato has adopted from Philistion this belief in transpiration through pores in the skin. As was seen above [...], there has been considerable controversy as to whether Empedocles himself subscribed to such a belief in cutaneous respiration over the whole body. Unfortunately, our source, *Anonymus Londinensis* XX, 25, says only that this was the belief of Philistion. It is therefore impossible to say how fully developed this theory was prior to its adoption by Plato». (Longrigg 1993: 137-140).

alternating movement in which blood could be regarded as the centre and main agent of yet another vital activity, namely respiration¹³.

The additional piece of information given in the *Placita*, absent from the *De Respiratione*, is the respiration of the first living being: the passage is in fact articulated into two parts, the former dealing with what could be called “primordial” respiration, the latter (starting at τὴν δὲ νῦν) dealing with present, hence adult, respiration¹⁴. The “primordial” respiration is also reported, almost *verbatim*, in the physiological book of the *Placita*, the fifth, within the chapter about the living status of the embryo (*Placita* V.15, Εἰ τὸ ἔμβρυον ζῶον)¹⁵. There, given the theme of the chapter, the respiration passage is preceded by Empedocles’ position on the matter: the embryo is *not* a living being until it comes to light and its moisture (ὕγρασιος) is excreted, after which it can breathe for the first time through the vessels that have been emptied¹⁶. For the continuation of the process, we have to go back to IV.22,1: after the first inhalation (that brought the embryo to the state of ζῶον), the innate heat (ἐμφύτου θερμοῦ) of the newborn, pushing such just-inspired air back outside,

13. Within the emocentric Empedoclean system, blood is in fact responsible for activities such as perception, cognition, respiration, and sleep, in so far as it «può rispondere a tutte le domande inerenti all’origine delle funzioni della vita e del pensiero» (Manuli & Vegetti 1977: 62).

14. This bipartition between infancy and adulthood of humanity is mirrored by the opposition γενέσθαι/γίνεσθαι. Cf. *Placita*, V.15,3 where, since there is no such opposition needed, we have γίνεσθαι instead of γενέσθαι in an otherwise almost identical phrasing.

15. The collocation of these two chapters in two different books (one psychological, *On respiration*, the other physiological, *Whether the embryo is a living being*) despite the strong intersection of their themes may attract some attention. Not only do we have an almost identical Empedoclean testimony about the first breath of the first living being, but also Herophilus and Diocles in V.15 somewhat deal with respiration (that of the new-born). Concerning V.15, a parallel passage within the *Medical Definitions* (Ps.-Gal., *Def. Med.*, 498 Kollesch = 445 K.), whose scheme and content are analogous to that of the Aëtian chapter, could be derived from the proximate doxographical tradition (Mansfeld & Runia 2020: 1886). It is therefore possible that the Stoic background suggested by the presence of the term ὁρμή in both texts, and of προαίρεσις in the *Definitions* (Mansfeld & Runia 2020: 1891), is extendible to IV.22: there we have both ὁρμή and προαίρεσις, but most of all we have the presence of Asclepiades, the only explicitly mentioned author in *Def. Med.* 498, nevertheless absent from V.15. Whatever the relation among these three texts may be, they certainly have in common the physiological interest of their authors.

16. Cf. Wright 1981: 246: «The account in Aetius IV.22.1 and V.15.3 seems to mean that at birth the mucus in the body is ejected through the nose and mouth – the process is hastened by holding the baby up by its feet – as a preliminary to cutaneous and nasal inhalation of air». The texts do not seem to show, though, any signal of such a change between early and adult respiration. The only difference is that the very first breath needs the humidity to leave the body in order to be performed by the newborn. If one takes the humidity to be expelled through nose and mouth, the same should stand for outer air, since no other pores are mentioned with exception of the nostrils.

causes the first expiration. Then, presumably, a further inspiration would follow, and so on. As for the present, respiration in adult human beings consists of an oscillatory movement in which blood, moving towards the surface of the body and retiring back, makes air respectively exit and enter the body through the nostrils. The analogy built by Empedocles to illustrate the (invisible) alternating motion of blood and air within the body through the (visible) alternating motion of air and water in the clepsydra is here reduced to a brief mention, without any further detail¹⁷.

It is worth remarking the mention of the crevices: the idea that air flows into the crevices (*ἀραιώματα*) left empty by the blood may tell us something of the lenses through which Aëtius is reading Empedocles. The term *ἀραιώμα*, pretty much absent from the medical discourse up until Hellenistic times¹⁸, acquires then a certain relevance within corpuscular theories, not only within the medical context (for instance, the term is used several times by the *Anonymus Londinensis*' author in relation to the Asclepiadean as well as to his own conception of the body)¹⁹, but also within the development of other *technai*, such as mechanics (a good example is Heron's *Pneumatica*, where the term is used within the theory of interstitial void)²⁰. Aëtius, describing the interaction between blood and air not as a simple alternance,

17. It is useful to remind that the clepsydra Empedocles is referring to in DK31 B100 is not a time-measuring device, but an instrument designed for the transport of liquids from one vessel to another: its main body is a perforate sieve, the handle of which is a perforated tube (Last 1924). The analogy involves a girl playing with a clepsydra: the air contained inside the sieve whose opening is obstructed prevents the water from entering, and it is only when the girl lets the air out that the clepsydra is filled with water; at this point, it is the outside air that prevents the water from exiting, and only when the girl releases the opening at the top of the handle can the water freely flow (vv. 4-21). Since, in the Empedoclean verses, blood and air in the clepsydra are subjects of absolute genitives, while air in the body and water are subjects of principals, it is reasonable to infer that blood is to air in the body as air in the clepsydra is to water (Booth 1960: 12-13). Those who have not agreed with such an interpretation have mostly done so on the basis of finding counterintuitive not to divide liquids (blood and water) from air (for instance Furley 1957: 32: «it seems extraordinarily unlikely, in the first place, that Empedocles would choose to make air play opposite parts in the two halves of the simile; to do this simply *asks* for misunderstanding»).

18. It appears only once in the “Hippocratic” *Corpus*, at *Morb.*, IV.7, 570.

19. Manetti underlies how both the Anonymus and Asclepiades share the assumption according to which the body is porous and matter flows through its *araiomata*, as well as the belief that continuous *apophorai* emanate from the body (Manetti 2003: 340; 346). Cf. *infra*, n. 27.

20. The dialogue between medicine and technology in Hellenistic times, and particularly in Alexandria, goes well beyond the usage of a single term, but has rather to do with shared epistemologies, methodological commitments, and the design and employment of new instruments. For the specific case of Heron's knowledge of medical practises and development of medical devices based on his pneumatic principles, see von Staden 1996: 94-95. On the interactive environment between medicine and mechanics in the Hellenistic period, with a focus on Erasistratus, see Kazantzidis 2023.

but rather in terms of a flow of one towards the ἀραιώματα left empty by the other (the same stands for the relation between air and moisture when the first breath takes place), gives an interpretation of Empedocles that could be defined, to some extent, “Asclepiadean”²¹. There is no better occasion to pass on to the next author.

B. Asclepiades

[AËTIUS DOX., *Placita* IV.22,2 = PS.-PLUT., *Placita* IV.22 = VALLANCE, ANRW 2.37.1, p. 724] Ἀσκληπιάδης τὸν μὲν πνεύμονα χώνης δίκην συνίστησιν, αἰτίαν δὲ τῆς ἀναπνοῆς τὴν ἐν τῷ θώρακι λεπτομέρειαν ὑποτίθεται, πρὸς ἣν τὸν ἕξωθεν ἀέρα ρεῖν τε καὶ καθαίρεσθαι παχυμερῆ ὄντα, πάλιν δ’ ἀπωθεῖσθαι μηκέτι τοῦ θώρακος οἴου τ’ ὄντος μήτ’ ἐπεισδέχεσθαι μήθ’ ὑποστέγειν· ὑπολειπομένου δὲ τινος ἐν τῷ θώρακι λεπτομεροῦς ἀεὶ βραχέος (οὐ γὰρ ἅπαν ἐκκρίνεται), πρὸς τοῦτο πάλιν τὸ εἶσω ὑπομένον (τὴν) βαρύτητα τοῦ ἐκτὸς ἀντεπιεσφέρεσθαι. ταῦτα δὴ ταῖς σικταῖς παρεικάζει· τὴν δὲ κατὰ προαίρεσιν ἀναπνοὴν γίνεσθαι φησι συναγομένων τῶν ἐν τῷ πνεύμονι λεπτοτάτων πόρων καὶ τῶν βραγχιῶν στενουμένων· τῇ γὰρ ἡμετέρα ταῦθ’ ὑπακούει προαιρέσει.

Asclepiades constructs the lung in the manner of a funnel and supposes that the cause of respiration is the fine particles within the thorax, in which the outside air flows and it is reduced since it (the outside air) is thick. Then it is pushed back again as the thorax is not anymore able to receive it further or contain it. Since a small amount of fine particles always remains in the thorax (for it is not all expelled), it is towards that which remains within that the weight from outside comes in turn. He compares this process to cupping-glasses. Then he says that voluntary respiration occurs when the finest pores in the lung contract and the bronchial passages narrow. For this complies with our will.

Differently from Empedocles, Asclepiades is only mentioned in six occasions within the *Placita*, and he is also the most recent author to be found there from a chronological point of view²². Aëtius is the main source transmitting his explanation

21. Neither should this come as a surprise, given the possible derivation of the Aëtian *doxai* from Alexander Philaletes (50 BC – 25 CE), disciple of Asclepiades, with whom Alexander shared some doctrinal points (macroscopically, the corpuscular and porous nature of the body). He then became a member of the Herophilean school (as shown, for instance, by his particular interest in sphygmology and gynaecology), becoming the only Herophilean (except for Herophilus himself) to be trained by an “outsider” (von Staden 1989: 532-539; Ricciardetto 2016: CV-CVI; Casadei 1997: 80, n. 17). The chapter on respiration we are taking into account, gathering Empedocles, Asclepiades, and Herophilus, might possibly reflect, under this respect, Alexander’s formation as a medical practitioner and his interpretation of the tradition.

22. Asclepiades’ life and activity can be dated back around the late second – early first century BC (Vallance 1990: 2; Leith 2020: 138). In the composition of this chapter, chronology was clearly not the guiding principle of the doxographer.

of respiration, which is nevertheless quite a rich one²³: it starts off with a metaphor according to which the lung is compared to a funnel, suggesting that it functions as a passage through which something flows²⁴. Then the cause of respiration is made explicit and identified with the λεπτομέρεια contained within the thorax²⁵. Since said λεπτομέρεια, as suggested by its own name, is made of fine-light-subtle-rare parts, whereas the outside air is παχυμερής, namely made of thick-heavy-big-dense parts, the latter flows within the thorax²⁶. The movement of the παχυμέρεια towards the λεπτομέρεια lies at the very basis of the Asclepiadean theory of movement, whose premise is a corpuscular conception of matter: according to him, as anticipated, the human body is made of intelligible corpuscles, called ὄγκοι, that move through intelligible channels, called πόροι²⁷. The masses of ὄγκοι move because of their difference

23. Galen simply glosses over it in his *De Usu Respirationis*: «As for the things said by the school of Asclepiades, I think them better pass over in silence, being clearly foolish, and having received the appropriate refutation from Athenaeus» (*De Usu Resp.* 475 K., transl. Furley & Wilkie 1984).

24. Such a metaphor has an interesting parallel in Herophilus, who seems to have called either πύελος or χώνη the cavity receiving the nerve passages in correspondence of the suture of the skull. He and his followers called this structure «tub (πύελος) on the basis of its shape, but funnel (χώνη) on the basis of its function; for it is pierced downward by a perceptible passage, and consequently represents a funnel» (fr. 76 vS, transl. von Staden 1989).

25. The term is not easily translatable: Mansfeld and Runia choose “filter” in this particular case, but “fineness” elsewhere (Mansfeld & Runia 2020: 2135); Vallance opts for “fineness” (Vallance 1990, 1993); Leith uses the periphrasis “fine-structured stuff” (Leith 2020: 140); Debru opts for a transliteration (Debru 1997). I chose “fine particles” to preserve both parts of the compound word, but I am aware of its perfectibility.

26. Analogously, Asclepiades describes the pulse as the movement of dilation and contraction of the arteries filled by the pneuma that flows in them towards the fine particles (Gal. *Diff. Puls.* IV.2, 714 K.). Both respiration and pulsation hinge upon the movement of pneumatic particles towards areas of rarefaction. As remarked by Leith, «it is striking that [...] there is no reference to blood in the surviving testimonia on pulsation» (Leith 2020: 144), which could suggest possible common ground among Asclepiades, Erasistratus, and Praxagoras in regard of what Harris defined «one of the tragical mistakes in the history of Greek medicine» (Harris 1973: 109), namely the solely pneumatic content of the arteries.

27. According to Sextus Empiricus, Asclepiades assumed three hypotheses: the existence, in our bodies, of intelligible passages (νοητοί πόροι) different in size; the existence of corpuscles that are observable through reason (ἐκ λόγῳ θεωρητῶν ὄγκων) and are in constant movement; the occurrence of continuous emanations (ἀποφοραί), bigger or smaller according to the circumstances (S. E., *Adv. Math.*, III.4-5). Caelius Aurelianus (*Cel. Pass.*, I.14, 105-6) defines the Asclepiadean corpuscles as *corpuscula intellectu sensa* and reports their capability of being infinitely divisibility into smaller pieces (*in infinita partium fragmenta solvantur*), possibly tracing a paramount difference between Asclepiadean ὄγκοι and Epicurean atoms, in-divisible by definition. Caelius’ testimony is nevertheless not that straightforward and has been used either to stress such an incompatibility (Vallance 1990, 1993), or to prove a certain continuity between Epicurus and Asclepiades (Casadei 1997, Leith 2012). This issue, strongly entangled with a larger one concerning the possible role of void within the Asclepiadean physics, is far too big to be detangled here. As of now, I will just remind that Galen has to be given a non-insignificant

in density, the denser masses drifting towards the less dense masses, according to a principle that Galen calls πρὸς τὸ λεπτομερὲς φορὰ («movement towards what is finely particulated»)²⁸. The ὄγκοι, even though deprived, *per se*, of any tangible quality (as paradigmatically stated in the case of digestion)²⁹, can nevertheless form aggregates that differ in terms of size, number, shape, and order³⁰. The respiratory process offers a perfect occasion to see such principles in action within the body: the particles of outside air flow into the thorax, for it contains finer particles (this phase

responsibility for the reception of Asclepiades as an atomist, mostly in an Epicurean sense, in the context of his criticism of anti-teleological physiologies (but Galen was not alone: an explicit conflation of Asclepiades, Democritus, and Epicurus is spelled out, for instance, in the pseudo-Galenic treatise *De Theriaca ad Pisonem*, XI.1). That being said, the presence and elaboration of Epicurean elements in the Asclepiadean physics cannot be reduced to a by-product of Galen's activity *qua* historian of medicine. Rather, it is possible to recognise in Asclepiades «la presenza di motivi propri dell'atomismo e della fisica eraclidea che ripensati originalmente, ed in costante confronto con i risultati della ricerca erasistratea, avevano probabilmente costituito gli strumenti teorici di quel radicale rinnovamento della *medendi ratio*, del fondamento dogmatico della pratica medica che rende Asclepiade una figura originale e di primissimo piano nella storia della medicina antica» (Casadei 1997: 81-82).

28. Gal. *In Hippocr. Epid. lib. III Comment.*, 17A 506 K. Attraction is not involved in the Asclepiadean theory of movement: rather, the movement of the masses entirely relies on their relative difference in density (Cael. Aur. *Cel. Pass.*, I.XIV, 115: *neque naturam aliud esse quam corpus vel eius motum. deinde, inquit, non solum prodest sed etiam nocet*). Such a system, where matter is equated to its own movement, not encompassing any role whatsoever for natural faculties nor for nature's providentialism, is firmly dismayed by Galen.

29. Cael. Aur. *Cel. Pass.*, I.14, 113: *et neque ullam digestionem in nobis esse, sed solutionem ciborum in ventre fieri crudam et per singulas particulas corporis ire, ut per omnes tenuis vias penetrare videatur, quod appellavit leptomeris, sed nos intelligimus spiritum. Et neque inquit ferventis qualitatis neque frigidae esse, nimiae suae tenuitatis causa, neque alium quemlibet sensum tactus habere, sed per vias receptaculorum nutrimenti nunc arteriam nunc nervum vel venam vel carnem fieri*. The Asclepiadean account of digestion, refusing the Aristotelian process of concoction of food (πέψις) in favour of the *cruda solutio* of the particles, is incompatible with the qualitative change (ἀλλοίωσις) which assimilation hinges upon. The extremely fine particles are in fact so thin that they are deprived of tangible qualities, such as cold or heat: they become (*fieri*) the part that need to be nourished passing through the channels of the body. The Asclepiadean theory of digestion is severely frowned upon by Galen, whose own explanation of it is fundamentally Aristotelian. Galen writes: «È immediatamente chiaro che la nutrizione deve essere una forma di assimilazione di ciò che nutre a ciò che viene nutrito. Tuttavia alcuni affermano che questa assimilazione non avviene realmente ma è solo apparente. Costoro sono quelli che pensano che la natura non possenga arte e non provveda all'animale e non abbia affatto nessuna sua propria facoltà con la quale essa altera alcune sostanze, altre ne attira o ne secerne» (*De Nat. Fac.*, I.12, 26 K., transl. Vegetti 1971). See Casadei 1997: 82-86. *Cf. supra*, n. 27.

30. Cael. Aur. *Cel. Pass.*, I.14, 106: *quae rursum eundo sibi adiecta vel coniuncta omnia faciunt sensibilia, vim in semet mutationis habentia, aut per multitudinem sui, aut per multitudinem, aut per schema, aut per ordinem. Cf. the Aristotelian criticism of the theory of change (generation and corruption) held by the Atomists (Democritus and Leucippus) in *De gen. et corr.*, I.314.*

would correspond to an inhalation); in the thorax, the *παχυμέρεια* is somehow “reduced” (*καθαίρεσθαι*). Once the thorax has reached its full capacity, it expels some of the particles back outside (this phase would correspond to an exhalation). Since some fine particles always remain within the thorax, masses of outside air always flow in and out, assuring a continuous succession of respiratory movements. This process is compared to the functioning of cupping glasses, suction tools almost every medical practitioner was familiar with, and oftentimes used to provide an illustration of theories of attraction (in this case, an illustration of the Asclepiadean principle of *πρὸς τὸ λεπτομερῆς φερά*)³¹.

The alleged “reduction” taking place in the thorax needs now to be addressed: Mansfeld and Runia opt for a rather unorthodox translation of *λεπτομέρεια* as “filter”, in order to better convey the cleansing activity indicated by the verb *καθαίρεσθαι*³²; despite their admirable effort to synthetically express a process of filtering of some sort within the thorax, *λεπτομέρεια* is too much of a key-term to be overshadowed by a second instrumental analogy (the first one being the funnel-like lung) which is, as a matter of fact, absent from the text³³. Whether or not a “filter in the chest” is there to be cleaned, it is however unlikely that it corresponds to the *λεπτομέρεια* itself. Another line of interpretation reflects a different tradition that reads *φέρεσθαι*³⁴ instead of *καθαίρεσθαι*: Vallance, adhering to such tradition, does not translate it, perhaps taking *ρεῖν τε καὶ φέρεσθαι* as a hendiadys, and therefore renders the whole expression with “flows”³⁵. Quite interesting is the case of Leith who, despite accepting the *lectio facilior* and translating *ρεῖν τε καὶ φέρεσθαι* as “flows and moves”³⁶, later specifies, in his comment to the passage, that Asclepiadean respiration might have involved a process of «rarefaction that transforms the coarse outside air into the *pneuma* which is physiologically active within the human body»³⁷. He even presents a quite significant parallel in which Calcidius discredits the Atomists for not assigning a defined place to the ruling part of the soul, in so far as they thought that «*pneuma* (*spiritus*) travels through the mouth to the lungs, and having been rarefied (*attenuatus*) in respiration makes its way to the location of the heart, then through the arteries which extend to the heart, and arrives to the carotid

31. See Vallance 1990: 58-59.

32. According to Ps.-Galen. See Mansfeld & Runia 2020: 1721.

33. Furthermore, had the author wanted to make use of the filter metaphor, he would have had many Greek words for as many filtering devices at his disposal in order to do so.

34. According to Ps.-Plutarch. See Mansfeld & Runia 2020: 1721.

35. Vallance 1990: 83.

36. Leith 2020: 140.

37. Leith 2020: 142.

vessels»; through them «the same pneuma is brought to the head through the fine and narrow passages of the nerves (*per tenues nervorum et angustos meatus*), and they say that there the origin of sensation is first generated and spreads throughout the rest of the body»³⁸. If Asclepiades were Calcidius' polemical target, then the latter's report would help us shedding some light on the καθαίρεσθαι in question: once inhaled, the thick outer air passes through the funnel-like lungs and fills up the thorax, undergoing a process of rarefaction that lessens its thickness. From there, it flows into the heart and into the carotid vessels, and then, through the narrow passages of the nerves, it reaches the head (at this point, possibly even rarer) where perception comes to be and can spread throughout the body. It is now time for us to recall the Galenic assumption according to which Asclepiades thought that respiration was the source of the soul itself (τῆς ψυχῆς αὐτῆς γένεσις)³⁹. Furthermore, we know from another chapter within the *Placita* that Asclepiades equated the soul with the common exercise of the senses (συγγυμνασίαν τῶν αἰσθήσεων)⁴⁰. Therefore the soul, a pneumatic substance composed of masses that are smooth, round, and fine⁴¹, appears to be the result of the process of rarefaction that takes place in the thorax and that makes this refined λεπτομέρεια, in constant motion through the whole body, the means of sensible perception. Whether such a process happens through friction,

38. Chal., *In Plat. Tim. Comment.*, 214 (transl. Leith 2020). Even though Calcidius does not explicitly attribute such a process to Asclepiades, it is significant that Asclepiades' denial of the existence of a ruling part of the soul and of its localization in any specific part of the body is confirmed by other sources, such as Tertullianus in *De Anima* XV.2: «Un certo Dicearco di Messene, e tra i medici Andrea e Asclepiade, hanno fatto a meno dell'ἡγεμονικόν, poiché vogliono che nell'intelletto stesso vi siano i sensi, ai quali è attribuito l'ἡγεμονικόν. Asclepiade si rifà anche a quel famoso ragionamento, e cioè che moltissimi animali, quantunque privati di quelle parti del corpo in cui per lo più si ritiene che abbia sede l'ἡγεμονικόν, non solo vivono ancora un po', ma hanno anche reazioni; questo, ad esempio, è il caso delle mosche, delle vespe e delle cavallette quando sia tolta loro la testa, o delle capre, delle tartarughe, delle anguille, quando sia tolto loro il cuore. Per questo conclude che non vi è l'ἡγεμονικόν, poiché se ci fosse stato, una volta andato perso con le sue rispettive sedi, la forza dell'anima non continuerebbe a esserci» (transl. Vegetti 2021). Calcidius' testimony is also included in the list of Asclepiadean *loci* compiled by Vallance (Vallance 1993: 714).

39. *De Usu Resp.*, 471 K. According to Galen, this view was common to Erasistratus, Praxagoras, and Philotimus (*De Usu Resp.*, 483 K.). Galen finds it particularly outrageous the fact that Asclepiades thought the substance of the soul to be continually generated (*De Usu Resp.*, 484 K.).

40. *Placita*, IV.2.8. Cf. Ps.-Gal. *Def. Med.*, 112 Kollersch = 116 K and Tert., *De Anima*, XV (cf. *supra*, n. 38).

41. Chal., *In Plat. Tim. Comment.*, 215.

heat⁴², or through the passage itself of the particles into finer and finer pores is hard to be determined. On the basis of the Aëtian chapter, as well as of Calcidius' testimony, one could only lean for the last option, and precisely in this sense have the texts been interpreted by Leith, who locates a first "sorting process" in the lungs, and a second one in the nerves through which the particles reach the brain⁴³.

As for the last lines of the passage, they briefly give account of what Asclepiades classifies as voluntary respiration (*κατὰ προαίρεσιν ἀναπνοήν*), implying a differentiation between two respiratory phases: the first one, involuntary, regulated by the principle of *πρὸς τὸ λεπτομερὲς φορά*, and the second one, voluntary, coinciding with the contraction of the finest pores in the lungs as well as with the narrowing of the bronchial tubes. The two phases were probably not to be intended diachronically, but rather synchronically, the voluntary one coinciding with exhalation. Despite the absence of details, the presence itself of such a distinction appears relevant to remark the Asclepiadean involvement within the Hellenistic debate revolving around the voluntariness (and involuntariness) of movement⁴⁴. Once again, no better transition could be offered to pass to Herophilus.

C. Herophilus

[AËTIUS DOX., *Placita* IV.22,3 = Ps.-PLUT., *Placita* IV.22 = vS 143a-b] Ἡρόφιλος δυνάμεις ἀπολείπει περὶ τὰ σώματα τὰς κινητικὰς ἐν νεύροις ἐν ἀρτηρίαις ἐν μυσί· τὸν οὖν πνεύμονα νομίζει πρῶτον ὀρέγεσθαι διαστολῆς τε καὶ συστολῆς φυσικῶς· εἶτα δὲ καὶ τᾶλλα. ἐνέργειαν μὲν οὖν εἶναι τοῦ πνεύμονος τὴν ἐξῶθεν τοῦ πνεύματος ὀλκήν· ὑπὸ δὲ τῆς πληρώσεως τῆς θύραθεν γινομένης

42. As in Cael. Aur. *Cel. Pas.*, II.40, 233. With regard to heat in particular, a traditionally paramount component of ancient respiration theories (Empedocles' being just one among the many), it is absent from that of Asclepiades. It seems instead to be considered a cause of rarefaction mainly in pathological cases, such as that of phrenitis (Gal. *De Experientia Medica*, 28.3; Cael. Aur. *Cel. Pas.*, *Preaf.*, 6). Caelius' joint mention of *pneuma* and heat (*spiritum et fervorem*) to be composed of small corpuscles (*Cel. Pas.*, I.15, 124) is not sufficient to establish a precise correlation between *λεπτομέρεια* and heat. The same difficulty concerns Galen's own use of the concept of *λεπτομέρεια*, in his case not part and parcel of a corpuscular theory of matter, but rather of his pharmacological system: «Ce n'est pas que substance leptomère et chaleur soient indissociablement liées. Mais l'affinité du leptomère et du chaud est grande, que le chaud soit considéré comme la cause de l'affinement de la matière, on son résultat» (Debru 1997: 88).

43. Leith 2020: 142; 147. A parallel case of sorting can be that performed by the bladder, compared by Asclepiades to a sponge (*De Nat. Fac.*, I.13, 31-2 K.).

44. The problem of the voluntariness of movement, at least as old as the Aristotelian *De motu animalium*, was brought to further levels of complexity by the Herophilean discovery and differentiation of the nerves (see Solmsen 1961: 180).

ἐφέλκεται· παρακειμένως δὲ διὰ τὴν δευτέραν ὄρεξιν ἐφ' αὐτὸν ὁ θώραξ τὸ πνεῦμα μετοχετεύει, πληρωθεὶς δὲ καὶ μηκέτι ἐφέλκεσθαι δυνάμενος πάλιν εἰς τὸν πνεύμονα τὸ περιττὸν ἀντιμεταρρεῖ, δι' οὗ πρὸς τὰ ἐκτὸς τὰ τῆς ἀποκρίσεως γίνεται, τῶν σωματικῶν μερῶν ἀντιπασχόντων ἀλλήλοις. ὅτε μὲν γὰρ διαστολὴ (ὅτε δὲ συστολὴ) γίνεται πνεύμονος, ταῖς ἀλλήλων ἀντιμεταλήψεσι πληρώσεώς τε καὶ κενώσεως γινομένης, ὡς τέσσαρας μὲν γίνεσθαι κινήσεις περὶ τὸν πνεύμονα, τὴν μὲν πρώτην καθ' ἣν ἔξωθεν ἀέρα δέχεται, τὴν δὲ δευτέραν καθ' ἣν τοῦθ' ὅπερ ἐδέξατο θύραθεν ἐντὸς αὐτοῦ πρὸς τὸν θώρακα μεταρρεῖ, τὴν δὲ τρίτην καθ' ἣν τὸ ἀπὸ τοῦ θώρακος συστελλόμενον αὐθις εἰς αὐτὸν ἐκδέχεται, τὴν δὲ τετάρτην καθ' ἣν τὸ ἐξ ὑποστροφῆς ἐν αὐτῷ γινόμενον θύραζε ἐξερᾷ. τούτων δὲ τῶν κινήσεων δύο μὲν εἶναι διαστολάς, τὴν τ' ἔξωθεν τὴν τ' ἀπὸ τοῦ θώρακος· δύο δὲ συστολάς, τὴν μὲν ὅταν ὁ θώραξ ἐφ' αὐτὸν τὸ πνευματικὸν ἐλκύσῃ, τὴν δ' ὅταν αὐτὸς εἰς τὸν ἐκτὸς ἀέρα ἀποκρίνη· δύο γὰρ μόναι γίνονται περὶ τὸν θώρακα, διαστολὴ μὲν ὅταν ἀπὸ τοῦ πνεύμονος ἐφέλκεται, συστολὴ δ' ὅταν τούτῳ πάλιν ἀνταποδιδῶ.

Herophilus admits motor capacities for bodies in the nerves, arteries, and muscles. He thus believes that the lung is the first that naturally tends to dilate and contract, and then the others. He hence thinks that the activity of the lung is the attraction of the air from outside, i.e. the air is drawn in by the repletion occurring from outside. Soon after, because of a second (natural) tendency, the thorax diverts the pneuma to itself, and when it is full and can no longer draw it in, it lets the excess flow back again into the lung, through which what is excreted passes outwards. Since the parts of the body inversely affect each other, now a dilation, then a contraction of the lung occurs. Since repletion and emptying occur through reciprocal exchange, four movements occur in the lung: the first is that through which the lung accepts air from outside, the second is that through which it diverts towards the thorax the air that it had accepted within itself from outside, the third is that through which it receives again into itself the air contracted by the thorax, the fourth is that through which it evacuates to the outside the air just turned back in it. Of these movements, two are dilations – the one from outside and the one from the thorax – whereas two are contractions, one when the thorax draws the pneumatic substance to itself, the other when this (the lung) excretes air outwards. For only two movements occur in the thorax, dilation when it draws air from the lung, contraction when it sends it back again to the lung.

The passage is quite dense and deserves to be properly analysed. Aëtius starts with a rather general remark according to which not better specified κινήτικὰς δυνάμεις are attributed by Herophilus to nerves, arteries, and muscles. This introductory sentence seems to overlook a fundamental distinction proper to Herophilean physiology, namely the one between voluntary and involuntary movement. The three body parts mentioned, in fact, do not share the same motor capacities: while nerves

and muscles move out of voluntary motion, arteries' movement is involuntary⁴⁵. Given the order in which the parts are disposed, distinguishing them according to the type of movement they perform does not seem to be the author's main worry. Strictly speaking, moreover, nerves, muscles, and arteries are neither explicitly involved within the respiratory process, nor are they mentioned any further. His intention might rather be that of recalling Herophilus' strong interest towards the mobility of body parts, meanwhile introducing the reader to the fact that the process about to be described, respiration, is connected to the motor capacities of the body.

The protagonist and main agent of the Herophilean respiratory process turns out to be the lung, whose peculiarity consists in naturally tending to dilate and contract. The other parts (i. e. the thorax) move afterwards, διὰ τὴν δευτέραν ὄρεξιν. Whether the lung is the only organ in possession of such a yearning, or it is that which has such a yearning in the first place (compared to the thorax), depends on whether one reads μόνον or πρῶτον ὀρέγεσθαι⁴⁶. Von Staden adopts the first possibility, therefore translating "the lung alone has a natural tendency of dilate and contract"⁴⁷; Mansfeld and Runia opt instead for the acceptance of Diels' correction of πρῶτον inspired by the compositum προορέγεσθαι, that we also find in a parallel passage in the pseudo-Galenic *De Historia Philosophia*⁴⁸. In the case of πρῶτον, well correlated with the later δευτέραν, the author would be conveying the sequence in which lung and thorax possess the capacity of dilating and contracting, the lung having it first and foremost, the thorax only secondarily and consequently (παρακειμένως), in so far as it follows and replicates the lung's own movement⁴⁹. In the case of μόνον, one should not take Herophilus to be saying that the lung is the only one, among the bodily organs, possessing such a capacity. Herophilus recognises the presence of a number of capacities aimed at regulating bodily activities⁵⁰: some of them, specific

45. Galen endorses Herophilus's attribution of voluntary movement to the "nerve-like class" of body parts (fr 141 vS). He also endorses, *contra* Praxagoras, Herophilus' association of nerves and muscles with voluntary movements such as palpitation, spasm, and tremor, as well as his attribution to arteries and heart of the involuntary movement of pulsation (fr. 149 vS).

46. See Mansfeld & Runia 2020: 1721, apparatus, line 25.

47. Von Staden 1989: 321. Despite accepting Diels' correction, though, they do not appport any modification to von Staden's translation.

48. Fr. 143c vS. Content-wise, this testimony adds nothing to the Aëtian chapter.

49. Debru offers a rather cautious interpretation according to which the lung's movement «laissait inexplicé le contrôle du mouvement thoracique, à moins qu'Hérophile ait conçu sa double respiration pulmonaire et thoracique selon deux principes différents, ce qui n'apparaît pas clairement d'après les témoignages» (Debru 1996: 89).

50. Such a faculty-based explanation of the physiological phenomena, particularly appreciated by Galen, has nevertheless a significant difference with Galen's own application of it: as well put by von

to the soul, are associated with nerves and responsible for perception and voluntary motion; others, specific to nature, are independent from the nerves and responsible for involuntary motion⁵¹. The lung, possessing a faculty of the latter kind, is hence not an isolated case: a parallel process in which the natural faculty of (involuntarily) dilating and contracting is transmitted from a part of the body to another is that of the arterial pulse. Galen reports that the heart, according to Herophilus, is «a source of the faculty which dilates the arteries»⁵². More specifically, such faculty «flows to them through their coats» (διὰ τῶν χιτῶνων ἐπιρρέουσιν ἔχειν τὴν παρ' αὐτοῖς δύναμιν) so that «they dilate in a manner similar to the heart itself» (ἢ χρώμεναι παραπλησίως αὐτῇ τῇ καρδίᾳ διαστελλόμεναι)⁵³. Without going into much detail for now, it is sufficient to notice that in the case of arterial pulse the transmission of movement between heart and arteries is made explicit: the arteries do not have themselves the δύναμις of dilating and contracting, but they receive it from the heart through the arterial coats⁵⁴. By contrast, the means through which such a faculty passes from the lung to the thorax is not stated in the Aëtian text. Another important aspect differentiating vascular motion and respiration deserves to be mentioned: while arteries and heart are told to dilate and contract at the same time with respect to one another⁵⁵, lung and thorax dilate and contract inversely to one another, and

Staden, Herophilean faculties are «thoroughly secularized; no claim of divine designer or divine force is made for them» (von Staden 1996: 87).

51. For the former kind, see fr. 141, 143c, 81 vS; for the latter, see fr. 141, 143-5 vS. Herophilus' distinction between natural-involuntary and psychic-voluntary movement probably stems from his anatomical discoveries concerning the nervous system, and in particular from his individuation and distinction of sensory and motor nerves, the latter in charge of voluntary movement. The fact that the soul, through the nerves, attends bodily movements, does not allow the conclusion that all bodily movements are mediated by the soul: in this sense, Herophilus' exploration of involuntary movement shows his commitment to the principle according to which «for nature's activity, the soul is not responsible» (von Staden 2000: 90).

52. Fr. 145a vS, transl. Furley & Wilkie 1984.

53. Fr. 144 vS, transl. Furley & Wilkie 1984.

54. Concerning this particular issue, Galen agrees with Herophilus *contra* Praxagoras and Philotimus, who attributed the arteries an innate ability to pulsate (*De puls. diff.*, 4.2, 701-3 K. = fr. 9 Lewis; *PHP*, 560-2 K. = fr. 10 Lewis). Erasistratus was only in partial agreement with Herophilus, for he also put the arteries' movement in dependence of the heart, but the flowing of pneuma from the heart, rather than a δύναμις, makes the arteries pulsate (fr.110 Garofalo). Harris 1973: 182: «Herophilus did not accept this [Praxagoras'] theory of independent pulsation of arteries, but maintained, as Galen did after him, that they received the power of pulsation from the heart, though he did not interpret this transmission of power, like Erasistratus, in mechanical terms». Erasistratus' position was in fact not dissimilar to that of Asclepiades, who believed pulsation to be the result of the flowing of pneuma toward the fine particles present in the arteries (*De puls. diff.*, 4.2, 714 K.).

55. Fr. 144 vS.

not at all times⁵⁶. Even though both based on involuntary movement, therefore, the two mechanisms do not perfectly overlap and should be compared with due caution. That being said, von Staden's adoption of *μόνον* seems motivated by his own interpretation of the Herophilean respiration. He writes: «Herophilus ascribed to the lungs themselves and to the thorax a natural tendency to dilate and contract. “The drawing in of pneuma from outside accordingly is the activity of the lung alone”, he said, not of the heart»⁵⁷. The opposition between lung and heart is nevertheless absent from the text, the purpose of which does not seem that of trying to highlight the marginality of the heart in the Herophilean explanation of respiration, but rather that of clarifying the primacy of the lung, possessor of a natural capacity of dilating and contracting, *qua* initiator of the process.

1. The respiratory movements

The lung's *ἐνέργεια*, the author says, consists in its attraction of external pneuma. Then the thorax dilates, too, following the lung's dilation, and draws in pneuma from the lung until its own replenishment. Once full, it sends the surplus pneuma back to the lung, from where it gets expelled outwards. The pneumatic surplus (*τὸ περιττόν*) mentioned here could be interpreted, as pointed out by von Staden, either as the pneuma exceeding the thorax's maximal capacity or as the pneumatic substance remained undistributed or unneeded⁵⁸. He opts for the latter alternative, but both options remain plausible. Lung and thorax, the doxographer underlines, during their exchange of pneuma, simultaneously perform opposite activities: while the lung expels pneuma, the thorax receives it; vice versa, while the thorax expels pneuma, the lung receives it. The reader is then provided with a more detailed explanation of the sequence of the lung's movements, which goes as follows:

- (i) the lung firstly dilates and lets the outer pneuma in (diastole). The thorax does not partake in this phase.
- (ii) The lung contracts (systole) and emits the pneuma that is in turn drawn in by the dilating thorax (diastole).

56. See discussion *infra*.

57. Von Staden 1989: 261.

58. Von Staden 1989: 261. There is a gap concerning the way in which pneuma gets distributed throughout the heart and arteries (and possibly nerves) in the extant Herophilean testimonies.

- (iii) The lung dilates again (diastole), receiving pneuma back from the thorax. Pneuma is here referred to as συστελλόμενον (“contracted”, “reduced”), in so far it has just undergone a thoracic systole.
- (iv) The lung eventually contracts once again (systole) and expels the just received pneuma to the outside. During this last phase the thorax does not move. Then the cycle starts again.

It is made clear that, whereas the thorax has only one source for pneuma (the lung), the lung has two, namely the external atmosphere and the thorax itself. Hence the four lung’s movements, two diastolic and two systolic, have only two movements of the thorax as their counterpart: the thorax’s diastole, when it receives pneuma from the lung, corresponds to the lung’s first systole (ii); its systole, during which it emits pneuma back to the lung, corresponds to the lung’s second diastole (iii). The thorax partakes neither in the first lung’s diastole nor in its second systole. The itinerary followed by the pneumatic substance within the body is unambiguously described by the verbs μεταρρέω and ἀντιμεταρρέω: the former («flow differently», «change from one side to the other») describes the movement of pneuma changing its flow internally *from* the lung *to* the thorax, while the latter (“flow back”) indicates the movement of pneuma flowing *back* from the thorax to the lung. Pneuma follows a very specific, linear direction, namely from the outer atmosphere into the lung, then into the thorax, back to the lung again, and finally back outwards.

A question may rise from the difference in number between the movements of the lung (four) and those of the thorax (two): if it is true that lung and thorax are affected inversely to one another (τῶν σωματικῶν μερῶν ἀντιπασχόντων ἀλλήλοις), why then does the thorax not partake in all four pulmonary movements? Had it not been an important detail, hardly would have the author underlined, in the very last sentence of the passage, that the thorax performs only two (δύο μόναι) movements. I would propose to inscribe such a detailed description of the sequence of respiratory movements within the discourse of perceptibility of movement. Indeed, we know from Galen that Herophilus engaged with the problem of the perceptibility of systole and diastole in the context of arterial motion, speaking of the systole «as though it is perceptible»⁵⁹. Neither should such a worry appear out of place, given the advancements Herophilus made in the diagnostic of the pulse, where touch was the means through which the pulse itself was perceived, measured, and used to determine the patient’s state of health⁶⁰. There is no reason, then, to infer that the Herophilean

59. Fr. 160 vS.

60. «Upon entering to visit a patient, he [Herophilus] would set up his water-clock and feel the pulse of the person suffering from a fever. By as much as the movements of the pulse exceeded the number

reflection upon the perceptibility of contraction and expansion of body parts should have been limited to the pulse-lore: rather, I believe that the distinction between pulmonary and thoracic movements might underlie a similar reflection. Herophilus, we know from another chapter of the *Placita*, distinguished between motion that is observable by reason and sense-perceptible motion (κινήσεως τὴν μὲν λόγῳ θεωρητὴν, τὴν δ' αἰσθητὴν)⁶¹. The insistence on the difference between the four pulmonary movement and the two thoracic ones could be interpreted, then, as a sort of *caveat*: despite the perceptibility of only two thoracic movements, there is more happening underneath, that is to say, the lung contracts and expands twice as much as the thorax.

III. Final thoughts

If we do not concentrate on what it lacks, the Aëtian report of the Herophilic explanation of respiration presents us with some interesting inputs: first and foremost, like Empedocles' and Asclepiades', it concerns movement. The purpose of respiration is, as a matter of fact, not included in any of these reports, being they rather aimed at the clarification of the physico-mechanical functioning of the respiratory process in terms of the movement of the bodily parts and fluids involved. The agent of respiration is made explicit in all cases: blood to Empedocles, the fine particles within the thorax to Asclepiades, the lung's natural capacity of contracting and dilating to Herophilus. The only thermo-related reference concerns Empedocles, who is also the only author admitting the presence, within the body, of innate heat. Asclepiades stands out in so far as he is the only one explicitly regarding respiration as a "mixed" physiological process, namely both voluntary and involuntary, probably implying the involvement of the soul therein⁶². Herophilus, on the other hand,

that is natural for filling up the water-clock, by that much he declared the [patient's] pulse too frequent – that is, that [the patient] had either more or less of a fever» (Fr. 182 vS, transl. von Staden 1989). Such a practice reflects his overall «aspiration to deal with all bodily phenomena, large and small, normal and abnormal, with as much precision as possible, and to achieve such precision by mathematical or other quantitative means whenever possible» (von Staden 1996: 90).

61. *Placita*, I.23, 9. In the same chapter Asclepiades is attributed the view that all movements, on the contrary, are sense-perceptible.

62. Galen, too, gives an account of respiration as a "mixed" movement, for the muscles' movement is, according to him, psychic and voluntary: «il movimento della respirazione [...] è azione del diaframma e dei muscoli del torace, come è dimostrato nei libri *Sulla cause della respirazione*; è dunque opera dell'anima, e non della natura, se è vero che muovere i muscoli è opera sua». (*De Motu Musc.*, II. 442-3 K., transl. Rosa 2009).

presents us with a detailed account of respiration as an involuntary (hence non-psychic) movement hinged upon the natural capacity of the lung to dilate and contract. In this respect, his explanation fits within the “dynamic” model he adopted in order to give reason of bodily functions. His audacity in the field of anatomical inquiry was in fact accompanied by a rather cautious (Galen would have said “shy”)⁶³ approach to aetiology. «Let the appearances be described first, even though they are not primary»⁶⁴: the medical practitioner must rely on what is visible, even though what is visible is not necessarily sufficient to an exhaustive comprehension of physiological phenomena, nor is it always at one’s disposal. Such a tension between the visible and the invisible, the perceptible and the imperceptible, lies at the very basis of Herophilus’ inquiry of the human body, extraordinarily lucid in defining its own limits: he was indeed aware, Galen reports, of the fact that «the faculties that control us are discovered on the basis of other things that become apparent, not simply on the basis of the act of looking at the parts»⁶⁵. Respiration should be inscribed, then, precisely within such a frame: a fundamental involuntary process (together with digestion and pulsation) showcasing one among the many natural faculties at work, consisting of four pulmonary movements and two thoracic ones, probably not all equally perceptible. For these reasons I find Grimaudo’s statement, according to which «in Erofilo il nesso λόγῳ θεωρητὸν risulta attestato in via del tutto episodica»⁶⁶, a little ungenerous. On the contrary, I believe that Herophilus’ contribution to the discourse revolving around the theoretic observability of phenomena, far from being marginal or occasional, deserves to be equally analysed and recognised as his paramount contribution to the field of anatomy, constituting a fundamental part of his epistemology.

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63. *Summe enim timidi est dimittendo rationem, ut hominibus videtur, sic existimare* (fr. 59 vS).

64. *An. Lond.*, XXI., 22-3: λεγέσθω δὲ τὰ φαινόμενα πρῶτα, καὶ εἰ μὴ (ἔστιν) πρῶτα.

65. Fr. 57 vS, transl. von Staden. According to Vegetti, this would be the only case in which Herophilus “si sia spinto oltre i limiti dell’osservazione anatomica” (Vegetti 2019: 267).

66. Grimaudo 2018: 176.

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