
FRANCESCA GAMBETTI*

BEYOND DISCIPLINARY BOUNDARIES: ALCMAEON OF CROTON BETWEEN PHYSICS, MEDICINE AND PHILOSOPHY

Abstract

In recent decades, there has been a growing need to adopt a new approach to knowledge characterized by the broadest possible inter- and trans-disciplinary perspective, capable of responding to the rapid and complex changes in society, and the multidimensional nature of the problems and issues that run through it. Nevertheless transdisciplinarity is not really a product of the 20th century: this holistic approach that aims to hold all scientific knowledge together, that aspires to exist at once between, across and beyond different disciplines, has characterized our culture since antiquity. If we wished to search for the earliest example of transdisciplinary science, we should perhaps turn to the figure of Alcmaeon of Croton, an ‘experimental researcher’ who carried out his research across the fields of physics, medicine (neurophysiology), and philosophy (epistemology). For the concept of health as the isonomy of opposing forces, the study of the senses contained in the head, and encephalocentrism, he is regarded as fundamental to the development of Hippocratic medicine, an *ante litteram* neuroscientist, and a scientist truly across boundaries.

Keywords: Alcmaeon, Knowledge, Medicine, Nomadic Concepts, Transdisciplinarity

1. Introduction

In recent decades, there has been a growing need to adopt a new approach to knowledge characterized by the broadest possible inter- and trans-disciplinary perspective, capable of responding to the rapid and complex changes in society, and the multidimensional nature of the problems and issues that run through it. This approach has progressively come to influence scientific paradigms and the organization of research¹.

While modern science has indeed been characterized by specialized and well-defined disciplines, the rigid boundaries between disciplines are slowly breaking down, leading to greater fluidity and permeability. However, if modern science has achieved the considerable results it has achieved, this is due, among other things, precisely to its hyper-specialization, its precise division into disciplinary domains, the clear definition of research boundaries, the sharp delimitation of objects of inquiry, and the establishment of specific goals and objectives.

The fragmentation of scientific research has been determined not only by internal factors, but also by external ones – cultural, social, and economic factors – related to

* Consiglio Nazionale delle Ricerche, Istituto per il Lessico Intellettuale Europeo e la Storia delle Idee; francesca.gambetti@iliesi.cnr.it

1 E. Jantsch, *Vers l'interdisciplinarité et la transdisciplinarité dans l'enseignement et l'innovation*, in L. Apostel et alii (eds.), *L'interdisciplinarité – Problèmes d'enseignement et de recherche*, OECD, Paris 1972. B. Nicolescu, *Manifesto of Transdisciplinarity*, SUNY Press, New York 2002, translation from the French by Karen-Claire Voss.

its institutional organization: it is not by chance that the development and definition of research fields developed in parallel with the increasingly important role assumed by universities. Disciplinary boundaries have progressively become a socially constructed framework of assumptions, processes, and methodologies that belong or are embedded in a specific discipline, as they serve the purpose of giving internal cohesion to the discipline itself. This, in turn, has led to the establishment of a close-knit community of scholars with a specific professional identity.

The complexity of contemporary issues has made disciplinary boundaries less rigid and much more mobile. It has eroded disciplinary barriers by promoting forms of interdisciplinarity which, while always remaining within the framework of disciplinary research, have enabled the transfer of methods from one discipline to another. Above all, this complexity has increasingly pushed researchers towards a transdisciplinary, holistic perspective stressing the unity of knowledge. This is an approach that not only reshapes and transcends the boundaries between disciplines, but also involves linguistic forms of hybridization through the use of nomadic concepts and conceptual analogies, affecting the ways in which results achieved are communicated and disseminated, and involving not only the scientific community but also non-scientific stakeholder communities².

Transdisciplinarity is not really a product of the 20th century: this holistic approach that aims to hold all scientific knowledge together, that aspires to exist at once between, across and beyond different disciplines, has characterized our culture since antiquity. Indeed, if we wished to search for the earliest example of transdisciplinary science, we should perhaps turn to the figure of Alcmaeon of Croton, an ‘experimental researcher’ who lived at the turn of the 5th century BC and carried out his research across the fields of physics, medicine (neurophysiology), and philosophy (epistemology)³.

2. Alcmaeon of Croton as a scientist across boundaries

Aristotle was the first to realize that Alcmaeon was an outstanding scholar who had made great scientific discoveries, so much so that – according to Diogenes Laërtius – he devoted an entire treatise (Πρὸς τὰ Ἀλκμαίωνος α΄) to discussing Alcmaeon’s teach-

2 The debate on interdisciplinary research is very broad and lively, involving issues that affect not only the disciplines themselves but also cultural, political, economic and gender issues. On the one hand, the integration of knowledge is promoted, and mutual engagement, exchange, intersections, and multidisciplinary approaches are pursued; on the other hand, the adoption of a truly interdisciplinary perspective is invariably met with resistance and difficulties, as it raises several problems – methodological (*how* interdisciplinary research should proceed), theoretical (*what* exactly counts as interdisciplinary), and organizational (*who* can evaluate interdisciplinary research and how). See. L.W.E. Tessaro, *Science and Interdisciplinarity: a Treatise on the Philosophy of Interdisciplinary Research*, in «Journal of Interdisciplinary Science», 6, 1, 2022, pp. 46-68.

3 For the fragments of Alcmaeon and reports about his teachings, I will follow the critical edition and translation by A. Laks and G.W. Most, *Early Greek Philosophy*, vol. V, part 2, Harvard University Press, Cambridge (MA)-London 2016, henceforth LM. In brackets will be given the references to the edition by H. Diels and W. Kranz, *Die Fragmente der Vorsokratiker*, Weidmann, Dublin-Zurich 1952⁶, henceforth DK.

ings⁴. However, the very fact that he was a thinker working across boundaries, at the intersection of multiple disciplines, has made it difficult for modern scholars to understanding his thought. Conflicting interpretations were put forward, because Alcmaeon could not perfectly be placed within the historiographical framework alongside the other so-called pre-Socratics⁵.

Although he lived in Croton, the city to which Pythagoras had fled from Samos, and was therefore necessarily immersed in the Pythagorean cultural milieu, Alcmaeon was not a Pythagorean⁶; although he conducted precise empirical observations on the sense organs contained in the head, he cannot be regarded as a physician⁷ (since medicine was only codified by Hippocrates at least one century later); finally, although he was involved in the investigation of *physis* – believing that most things come in pairs, that the planets move in the opposite direction from the fixed stars, from west to east, and that the sun is flat – he would appear to have sharply distanced himself from this field⁸.

Chalcidius⁹ account, which attributes the practice of anatomical dissection to Alcmaeon, has been significantly downplayed, especially by Mansfeld and Lloyd. Nonetheless, it represents significant evidence of just how pioneering and experimental Alcmaeon's

- 4 See Diog. Laert. V, 25 = LM R1 (DKA3). Other references to Alcmaeon by Aristotle are to be found in: *Historia animalium* (1.11 492a14-15 = LM D14=DK24A7), concerning the refutation of the theory that goats breathe through their ears; in *De generatione animalium* (3.2 752b22-26 = LM 29=DK24A16), where Aristotle criticizes the belief that nourishment in birds' eggs is found in the albumen, arguing instead that it resides in the yolk; and, finally, in the *Historia animalium* (1.1 581a14-16 = LM D20=DK 24A15), where Aristotle takes up the alcmaeonian doctrine that establishes an analogy between the onset of the reproductive age of man and that of plants, both of which can be detected by precise anticipatory signs – the appearance of fluff in the former, flowering in the latter.
- 5 For a first and general overview of Alcmaeon see C.A. Huffman, 'Alcmaeon', *The Stanford Encyclopedia of Philosophy* (Summer 2021 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/sum2021/entries/alcmaeon/>.
- 6 The fact that Alcmaeon is said to have dedicated his writing to three Pythagoreans, Brontinus, Leo, and Batillus, as reported by Diogenes Laertius, must be interpreted more as a protreptic invitation or perhaps a polemical attack on three exponents of Pythagoreanism, rather than as any actual association with them. Moreover, the distinction Aristotle variously makes between Alcmaeon and the Pythagoreans is the strongest argument in favor of his not belonging to that movement. See Aristotle, *Metaph.* A5 986a27-b2 (LM D5 = DK24A3): «for he states that most of the things involving humans are two, speaking of contraries that are not, as theirs [scil. Pythagoreans] are, determinate, but instead are taken randomly, like white and black, sweet and bitter, good and evil, large and small. Regarding the others [scil. pairs of opposite], he spoke at random without determining them, while the Pythagoreans declared how many contraries there are and what they are».
- 7 Mansfeld and Lloyd do not consider Alcmaeon a physician and place him entirely within the philosophical tradition, crediting him as a pioneer in empiricist research, which in their view has nothing to do with precise and systematic medical practice. See J. Mansfeld, *Alcmaeon: "Physikos" or Physician? With some remarks on Calcidius' "On Vision" compared to Galen, Plac. Hipp. Plat. VII*, in J. Mansfeld and L.M. de Rijk, (eds.), *Kephalaion: Studies in Greek Philosophy and its continuation offered to Professor C.J. de Vogel*, Van Gorcum, Assen 1975, pp. 26-38; G.E.R. Lloyd, *Alcmaeon and the Early History of Dissection*, in «Sudhoff's Archiv», 59, 1975, pp. 113-47, reprinted in Id., *Methods and Problems in Greek Science*, Cambridge University Press, Cambridge 1991, pp. 164-193.
- 8 See M. Vegetti, *Ippocrate, Opere*, UTET, Torino 2000 (1965), p. 20.
- 9 Calcid., in *Timeus* 246 = LM R6 (DK 24A10): «[...] Alcmaeon of Croton, an expert on questions regarding nature, and the first person to dare to perform a dissection [...]».

research was considered to be, as well as of the fame he enjoyed in antiquity. His empirical observations on the structure of the sense organs and his hypotheses about the physiology of sensations led him to formulate important observations on the domain of knowledge and its foundations, paving the way for empirical enquiry.

In recent studies Alcmaeon is considered to be a «new type of thinker, a natural philosopher, [...] interested in questions about the nature of man, [...] about the functioning of the inner body and man's health [as] part of that important new idea of 'nature' which Greek intellectuals had quite recently postulated»¹⁰. However, much of the historical-philosophical literature of the first half of the 20th century regarded Alcmaeon as the father of medicine in general, and particularly of anatomy, physiology, embryology, and psychology¹¹. Even now in the medical literature Alcmaeon is mostly regarded as the father of neuroscience¹².

Whether Alcmaeon was a physician or not, in the sense in which this term would later be understood with Hippocrates, his research was certainly stimulated by the environment of the medical school based in Croton, founded long before the arrival of Pythagoras himself and the establishment of the school of Cos. It was at the Croton school that Democedes received his training, the best physician of the time, who even went to the court of Darius, whom he treated along with his wife Atossa¹³.

According to Mario Vegetti¹⁴, Alcmaeon played a key role in the development of medicine and was also essential for the development of the Hippocratic school, which owes to him some methodological indications on the centrality of observation and empirical investigation, the notion of a central nervous system governed by the brain and including the sense organs, and the pathophysiological theory of disease as the disruption of the balance between the different qualities or active principles that constitute the organism (disease resulting from the prevalence of only one of these elements)¹⁵.

Another crucial contribution to Hippocratic medicine was Alcmaeon's embryology (the study of the origin of the seed and the inheritance of traits). Here the Hippocratic tradition is said to depend entirely on Alcmaeon and to have added nothing new to his theories¹⁶. His embryology formed the basis for one of the most important achievements of Hippocratic medicine, namely the genetic etiology of certain diseases such as epilepsy (*morbum sacrum*), which presupposes precisely Alcmaeon's encephalocentrism¹⁷.

The variability in the interpretations of Alcmaeon and the difficulty of assigning canonical scientific labels to his work are not due not so much to the impossibility of ap-

10 R. Lane Fox, *The Invention of Medicine. From Homer to Hippocrates*, Penguin, Dublin 2022, p. 58.

11 L. Perilli, *Alcmeone di Crotone tra filosofia e scienza. Per una nuova edizione delle fonti*, in «Quaderni Urbinati di Cultura Classica», n.s. 69, 3, 2001, pp. 55-79.

12 A.M. Zemelka, *Alcmaeon of Croton – Father of Neuroscience? Brain, Mind and Senses in the Alcmaeon's Study*, in «Journal of Neurology and Neuroscience», 8, 3, 2017, pp. 1-5.

13 Herodot. 3, 125 ff. See L. Perilli, *Alcmeone di Crotone tra filosofia e scienza. Per una nuova edizione delle fonti*, cit.

14 M. Vegetti, *Ippocrate, Opere*, cit., p. 30.

15 *Ibidem*.

16 *Ivi*, p. 45.

17 *Ibidem*.

plying to him descriptive categories that were only clearly established much later, or to the limited information about him and his writings, but rather to his transdisciplinarity: his being a scientist who straddled, crossed and transcended the boundaries between different disciplines, namely medicine, physics and epistemology.

3. 'Isonomia' and 'monarchia' as nomadic concepts

Applying contemporary categories to the past can often be very risky: there is the risk of interpreting it anachronistically and distorting its objective reconstruction. It may seem bold to describe Alcmaeon using the category of 'nomadic concepts'¹⁸ – also known as traveling concepts – which are among the latest heuristic tools in contemporary scientific debate, created to share the understanding of concepts across disciplinary, professional and cultural boundaries, in such a way as to foster communication even outside restricted communities of insiders¹⁹. Nevertheless, when Alcmaeon creates the concept of health as *isonomy*, that is «the proportionate mixture of the qualities», a dynamic balance of opposing forces (τὴν σύμμετρον τῶν ποιῶν κρᾶσιν)²⁰, he gives us a perfect example of how science has progressed from the very beginning, building its theories through analogies, metaphors, linguistic borrowings, and nomadic concepts.

The concept of isonomy is precisely an emblematic case of how concepts having no fixed basis, but spanning various different areas, connect different contents and empirical problems, (co)creating new concepts²¹. Alcmaeon has no definition of health that he can draw upon; in the Homeric poems as well as in tragic plays, illness is usually a misfortune that happens suddenly, whose real cause is not understood, and it is interpreted as divine punishment or plague. A positive definition of bodily health is missing; the state of health is conceived as well-being in the absence of illness, and even healing is conceived as the result of a deity's intervention.

Alcmaeon introduces an important theoretical shift by providing a positive definition of health, establishing an analogy between the structure of nature and the constitu-

18 See I. Stengers (ed.), *D'une science à l'autre. Des concepts nomades*, Seuil, Paris 1988; G. Deleuze, F. Guattari, *Qu'est-ce que la philosophie?*, Minuit, Paris 1991; F. Darbellay, *The Circulation of Knowledge as an Interdisciplinary Process: Travelling Concepts, Analogies and Metaphors*, in «Issues In Integrative Studies», 30, 2012, pp. 1-18.

19 M. Rossini, *Nomadic Concepts. Td-Net Toolbox Profile* in «Swiss Academies of Arts and Sciences: Td-Net Toolbox for Co-Producing Knowledge», 13, 2020, www.transdisciplinarity.ch/toolbox. doi.org/10.5281/zenodo.3717144. About the use of analogy in the ancient science see G.E.R. Lloyd, *Polarity and Analogy: Two Types of Argumentation in Early Greek Thought*, Cambridge University Press, Cambridge 1966.

20 Aet. 5, 30, 1 = LM D30 (DK 24 B5). For a sharp analysis of political metaphors in medicine and philosophy, see G. Cambiano, *Patologia e metafora politica. Alcmeone, Platone, 'Corpus Hippocraticum'*, in «Elenchos», 3, 2, 1982, pp. 219-236. See also S. Kouloumentas, *The Body and the Polis: Alcmaeon on Health and Disease*, in «British Journal for the History of Philosophy», 22, 5, 2014, pp. 867-887.

21 See G. Deleuze, F. Guattari, *Qu'est-ce que la philosophie?*, cit.

tion of the body: as in nature, «most of the things involving humans are two, [...] like white and black, sweet and bitter, good and evil, large and small»²²; and concerning human health he states:

[...] what maintains health is the equality of the powers (ἰσονομίαν τῶν δυνάμεων), of the moist and dry, cold and hot, bitter and sweet, and the other ones [scil. opposites], while the monarchy of only one among them causes sickness, for the monarchy of one of the two is destructive for the other.²³

The remaining passage reported by Aetius, which lists some possible causes of disease, does not really seem to come from Alcmaeon, because the terminology used «is clearly anachronistic». However, precisely because they do not occur elsewhere in ancient medical literature, the terms isonomy and monarchy used to define health and disease are believed to have been coined by Alcmaeon, borrowing political terminology that he evidently believed to be clearer and more comprehensible than biological jargon²⁴.

Health is «the proportionate mixture of the qualities», meaning that it is produced by the symmetrical relationship between different pairs of opposing powers (δυνάμεις), all of which have equal dignity and importance. In the human body, as in the body politic, well-being is the result of opposing powers not giving rise to destructive conflict but integrating one another, in such a way as to generate a kind of solidarity between the various functions. Just as in the polis it is important to have a balance between all segments of society, even in the antagonism between them, in the healthy body the equality of opposites maintains a dynamic opposition. On the contrary, in both the body and the polis disease is the product of μοναρχία, that is, the prevailing of one function over its opposite; disease is the disruption of the healthy balance within a pair of opposites (and not more generally between all δυνάμεις) – a disruption probably caused by «climatic or dietary changes»²⁵.

The balanced dialectic of opposites is therefore not something that should be eliminated, but on the contrary something healthy that should be maintained and preserved.

Of course, one could also try to extrapolate Alcmaeon's political views from his analogy between the human body and the body politic, but this is of secondary importance compared to the crossing of boundaries that he created between the fields of medicine and politics, and compared to the concept of health he developed, which – as a nomadic concept – would later return from medicine to politics (with Plato for example), once theoretical perspectives and priorities had changed.

22 Aristot., *Metaph.* A5 986 a27 ff = LM D5 (DK A3).

23 LM D30 (DK 24B4).

24 See LM, n. 1 to D30; see also G. Cambiano, *Patologia e metafora politica. Alcmeone, Platone, 'Corpus Hippocraticum'*, cit., pp. 219 and 221.

25 Ivi, p. 222.

4. The physiology of perception and knowledge

Whether they were the result of precise dissections of the cranial box²⁶, or the outcome of accurate extemporaneous observations (skull fractures or autopsies on cadavers in which the eyeballs were removed), the most important discoveries made by Alcmaeon concern encephalocentrism. The mechanisms of perception of the sense organs contained in the head – hearing, smell, taste, and sight – are all traced back to the brain, with a consequent distinction between αἰσθάνεσθαι/sensing and ξυνίηναι/understanding, which in Alcmaeon's view distinguishes humans from all other animals.

Censorinus states that Alcmaeon did not know which part was formed first in the embryo²⁷, while according to Aetius he believed that the first part to be formed in the womb was the head, where the ἡγεμονικόν or guiding principle was located²⁸. Whether it was the first part formed in the fetus or not, the head was seen to contain the most important sense organs, which Alcmaeon, according to Theophrastus, studied and described with precision and accuracy. He stated that:

hearing occurs by the ears, since there is void in them; for this resounds (and a sound is produced by what is hollow), and air makes an echo in response²⁹; we hear by means of the void inside the ear. For this is what resounds when breath strikes it. For all empty things resound³⁰;

26 Scholars in favor of attributing the practice of anatomical dissection to Alcmaeon include: W.A. Heidel, *Hippocratic Medicine*, New York 1941, and J. Schumaker, *Antike Medizin*, Berlin 1940, who speaks of animal dissections; H. Erhard, *Alkmaion der erste Experimentalbiologe*, in «Sudhoffs Archiv für die Geschichte der Medizin und der Naturwissenschaft», 24, 1941, pp. 77-89, who is even inclined to speak of vivisection, as is M. Wellmann, *Alkmaion von Kroton*, in «Archeion», 11, 1929, pp. 156-69. Alcmaeon is regarded as a natural philosopher rather than a physician by F. Kudlien, *Der Beginn des medizinischen Denkens bei den Griechen*, Zürich-Stuttgart 1967; J. Mansfeld, *Alcmaeon: 'Physikos' or Physician? With Some Remarks on Calcidius' "On Vision" Compared to Galen, Plac. Hipp. Plat. VII*, cit., pp. 26-38; and G.E.R. Lloyd, *Alcmaeon and the Early History of Dissection*, cit. Other scholars instead believe that Alcmaeon conducted a number of anatomical observations on cadavers, limited to the eyeball, albeit on the basis of general philosophical rather than purely medical interests: see E. Zeller, *Die Philosophie der Griechen in ihrer geschichtlichen Entwicklung*, Leipzig 1892, It. transl. by R. Mondolfo, *La filosofia dei Greci nel suo sviluppo storico*. Parte I volume ii, Ionia e Pitagorici, La Nuova Italia, Firenze 1967., p. 614; W.K.C. Guthrie, *A History of Greek Philosophy*, vol. 1 *The Early Presocratics and the Pythagoreans*, CUP, Cambridge 1962, pp. 341-59. In support of the idea of Alcmaeon's use of anatomical dissection for epistemological rather than purely medical purposes, see also P. Manuli, in P. Manuli, M. Vegetti, *Cuore, sangue e cervello. Biologia e antropologia nel pensiero antico*, Milano 1971, Pistoia 2009², p. 42. Finally, Perilli also believes that Alcmaeon practiced dissection: see L. Perilli, *Alcmeone di Crotone tra filosofia e scienza. Per una nuova edizione delle fonti*, cit., p. 65-66.

27 See Censorinus, *de die nat.* 5, 4 = LM D26 (24A13): «Alcmaeon confessus est, ratus neminem posse perspicere quid primum in infante formetur».

28 Aetius, V, 17, 3 = LMD27 (24A13): τὴν κεφαλὴν, ἐν ᾗ ἔστι τὸ ἡγεμονικόν (sc. πρῶτον τελεσιουργεῖσθαι ἐν τῇ γαστρὶ). Despite the use of Stoic lexicon, it is possible to attribute encephalocentrism to Alcmaeon with sufficient certainty.

29 See Theophrastus, *De sens.* 25 = LM D12a (DK 24A5): ἀκούειν μὲν οὖν φησι τοῖς ὤσιν, διότι κενὸν ἐν αὐτοῖς ἐνυπάρχει· τοῦτο γὰρ ἡγεῖν (φθέγγεσθαι δὲ τῷ κοίλῳ), τὸν ἀέρα δ' ἀντιχεῖν.

30 Aet. 4, 16, 2 = LM D12b (DK 24A6): ἀκούειν ἡμᾶς τῷ κενῷ τῷ ἐντὸς τοῦ ὠτός· τοῦτο γὰρ εἶναι τὸ διεχούον κατὰ τὴν τοῦ πνεύματος εἰσβολήν· πάντα γὰρ τὰ κοῖλα ἡχεῖ.

smelling occurs by the nostrils, at the same time as breathing occurs, by making the breath rise up to the brain³¹; it is thus by this [*scil.* the brain], which attracts odors by means of acts of breathing, that odors are perceived³²;

it is by means of the tongue that flavors are distinguished; for being tepid and soft, it melts because of heat, and it receives and transmits because of its porosity and softness³³;

the eyes see thanks to the peripheral water. But it is clear that it [*scil.* the eye] contains fire, for when it is struck it flashes. But it sees by means of what is brilliant and is transparent when it reflects, and does so all the more the purer it is.³⁴

Regarding touch he seemed to have said nothing³⁵, while according to Chalcidius, in his commentary on Plato's *Timaeus*, his description of the structure of the eye, sight, and optic nerves was very accurate³⁶.

According to Alcmaeon, therefore, all sensations, in some way (πῶς) reach the brain through channels called *poroi* (πόροι): when the latter undergoes some alteration or change place, sensations are distorted, because the conduits through which they pass are obstructed³⁷.

The adverb πῶς should not suggest obscurity or uncertainty on Alcmaeon's part, but rather a clear distinction of the different ways in which sensations are conveyed to the brain, which is the unifying principle of all human cognitive possibilities³⁸.

On the basis of his careful observations and anatomical descriptions, Alcmaeon established what we now refer to as the field of neuroscience. He conducted research ranging from physiology to epistemology, in an effort to explain what knowledge is³⁹.

The unifying action of the brain first led him to distinguish man from all other animals: «the human being differs from the others [*scil.* animals] because he is the only one that understands, while the others perceive but do not understand». Significantly, the

31 Teophrastus, *De sens.* 25 = LM D13 (DK 24A5): ὁσφραίνεσθαι δὲ ῥισὶν ἅμα τῷ ἀναπνεῖν ἀνάγοντα τὸ πνεῦμα πρὸς τὸν ἐγκέφαλον.

32 Aet. 4, 17, 1 = LM D13b (DK 24A8): τούτῳ οὖν ὁσφραίνεσθαι ἔλκοντι διὰ τῶν ἀναπνοῶν τὰς ὁσμάς.

33 Teophrastus, *De sens.* 25 = LM D15a (DK 24A5): γλώττῃ δὲ τοὺς χυμοὺς κρίνειν· χλιαρὰν γὰρ οὖσαν καὶ μαλακὴν τήκειν τῇ θερμότητι· δέχεσθαι δὲ καὶ διαδιδόναι διὰ τὴν μανότητα καὶ ἀπαλότητα.

34 *Ibidem* = LM D16 (DK 24A5): ὀφθαλμοὺς δὲ ὄραν διὰ τοῦ πέριξ ὕδατος. ὅτι δ' ἔχει πῦρ, δῆλον εἶναι· πληγέντος γὰρ ἐκλάμπειν. ὄραν δὲ τῷ στίλβοντι καὶ τῷ διαφανεῖ, ὅταν ἀντιφαίνει, καὶ ὅσον ἂν καθαρώτερον ἢ μᾶλλον.

35 Teophrastus, *De sens.* 26 = LM D19a (DK 24A5): περὶ δὲ ἀφῆς οὐκ εἵρηκεν οὔτε πῶς οὔτε τίτιν γίνεται.

36 Calcidius, in *Timaeus* 246 = LM R6 (DK 24A10) associates Alcmaeon with Callisthenes and Herophilus, crediting them with a precise description of the sense of sight. In the collection edited by Laks and Most, this description is not given because it is considered to date back to the Hellenistic medical writer Herophilus of Alexandria.

37 Teophrastus, *De sens.* 26 = LM D19a (DK 24A5): ἀπάσας δὲ τὰς αἰσθήσεις συνηρητῆσθαι πῶς πρὸς τὸν ἐγκέφαλον· διὸ καὶ πηροῦσθαι κινουμένου καὶ μεταλλάττοντος τὴν χώραν· ἐπιλαμβάνειν γὰρ τοὺς πόρους, δι' ὧν αἱ αἰσθήσεις.

38 See L. Perilli, *Alcmeone di Croton tra filosofia e scienza. Per una nuova edizione delle fonti*, cit., p. 66.

39 See G.G. Celesia, *Alcmaeon of Croton's Observations on Health, Brain, Mind, and Soul*, in «Journal of the History of the Neurosciences», 21, 4, 2012, pp. 409-426. E. Crivellato, D. Ribatti, *Soul, mind, brain: Greek philosophy and the birth of neurosciences*, in «Brain Research Bulletin», 71, 4, 2007, pp. 327-336.

verb used here for knowing is ξυνίημι, which describes precisely the reduction to one of what instead has a multiple and composite origin.

For Alcmeon, then, feeling and thinking are not the same thing – as Parmenides held, for example⁴⁰ – but two distinct activities. They represent two equally fundamental steps in the process of the acquisition of knowledge, which takes the form of the specifically human activity of making inferences or judgments about evidence coming from various senses⁴¹.

Although Alcmaeon is not mentioned by name, Plato is clearly referring to his theory of knowledge in the famous *Phaedo* passage in which Socrates describes his early infatuation with natural science and questions such as whether we think through our blood, or air, or fire, or the brain⁴².

Socrates explains that the brain furnishes the sensations of hearing, seeing, and smelling from which memory and opinion are generated, and that knowledge (ἐπιστήμη) is produced when opinion takes a stable form through memory. This theory can be regarded as an original insight of Alcmaeon's, who limited the possibilities of human knowledge to the field of things we can experience. He stated that only the gods have a clear knowledge of everything, including both human things and things that are not manifest; more precisely, the gods also know those things whose causes and inner workings are not visible, whereas humans do not have access to this kind of knowledge and can at best proceed by means of evidence and proofs⁴³.

This quotation from Diogenes Laertius, however, should not be taken to attest to the widespread endemic scepticism typical of that time, as clearly expressed, for instance, by Xenophanes⁴⁴. On the contrary, by separating human knowledge from divine knowledge, and by rejecting all knowledge based on divine revelation, Alcmaeon assigned a central role to experience, overcoming the dichotomy between sensible experience and rational knowledge (which Eleatism continued to uphold) and paving the way for man to safely explore the world.

40 See Theophrastus, *de sensu*, 1 ff. = LM D52 (DK 28 A46).

41 See C.A. Huffman, 'Alcmaeon', cit.

42 Among those scholars who dispute the claim that the *Phaedo* passage contains a reference to Alcmaeon we find Laks and Most, who do not include the passage in the collection they have edit. The passage in question is instead present in the edition by Diels and Kranz (24 A11). In favour of referring the Platonic page to Alcmaeon are Huffman, 'Alcmaeon', cit. and Perilli, *Alcmeone di Crotone tra filosofia e scienza. Per una nuova edizione delle fonti*, cit., p. 71, who even considers it possible to establish a close connection between Alcmaeon and Aristotle, who considered sensitive perception to lie at the origin of all knowledge.

43 See Diogenes Laertius VIII, 83 = LM D4 (DK 24 B1): περὶ τῶν ἀφανέων, περὶ τῶν θνητῶν σαφήνειαν μὲν θεοὶ ἔχοντι, ὥς δὲ ἀνθρώποις τεκμαίρεσθαι καὶ τὰ ἐξῆς. The interpretation of the quotation by Diogenes Laertius is disputed and the text has been variously amended. The problem concerns the interpretation of τῶν ἀφανέων and τῶν θνητῶν, which some scholars understand in a sapiential sense as 'human destiny'; it seems preferable to interpret the text as referring to the medical practice of tracing the hidden causes of diseases from manifest signs. See E. Dettori, *Alcmae. fr.1 D.-K.*, in «Museum Criticum», 25-28, 1990-1993, pp. 45-57.

44 See Hippol., *Ref. I*, 14 (DK 21 A33); Stobaeus, *Ecl. I* 8, 2 (DK 21 B18); Sext., *adv. math.* VI, 49 (DK B34).

***II** tema di B@bel*

Alcmaeon developed his new epistemology through the generalization of medical practice (which sought to identify the etiology of illnesses through their symptoms). This shows that he was a researcher who cut across boundaries, someone capable of bringing together disciplines as diverse as physics, medicine, and philosophy. It also proves that transdisciplinarity is not really a product of the 20th century, but that holistic approaches, the comparison and integration of different disciplinary fields, the exchange of concepts and methodologies, and the multidimensional approach to problems have characterized human knowledge and shaped its continuous progress since ancient times.