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Greek Philosophy and the Discovery of the Nerves

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Introduction

In a study primarily concerned with the text and the composition of Hippocrates' *De morbo sacro* Wilamowitz at one point digresses from his analysis to wax enthusiastic about the significance of the ideas contained in chs. 14–17: «Das ist eine ... Lehre von hoher Bedeutung; liegt doch in ihr eine Ahnung des Nervensystems, und die Postulierung eines einheitlichen Zentrums aller menschlichen Tätigkeit ... hat auch philosophisches Interesse¹.» *Mutatis mutandis* Wilamowitz's comments could be transferred to some other texts of the fifth and fourth centuries². For long before the Alexandrian physicians Herophilus and Erasistratus actually discovered the nerves the questions had been raised and discussed to which this discovery was to be the "final" and correct answer. Not only physicists and physicians but philosophers too had wondered how and where the sense organs deliver their message and how the movements of the body are controlled by a central organ. And it is hardly necessary to add that the nature and identity of the controlling or coordinating organ had also been a subject of philosophical thought.

As for the answers, the difference between those advanced in the fifth and fourth centuries and the final solution is of course that the former were essentially speculative whereas the latter was empirical. Herophilus' and Erasistratus' great discoveries rightly figure among the triumphs of Hellenistic research and empiricism³. These men were "anatomists"; they dissected the body and one, if not both, of them opened the brain. Yet when we look more closely at their doctrines we soon realize that they had not emancipated themselves completely from the "speculative" legacy. To anticipate but one point, both thought of the nerves as carrying *pneuma*—the soul *pneuma* which had for some time been regarded as the agent of messages between soul and senses or soul and limbs. There was continuity between the speculative solutions and the work of the Alexandrian empiricists. To put the matter in simple terms, Plato's and Aristotle's doctrines about the relation between soul and senses (or soul and body) provided a new impulse and set a new task for medical research.

¹ Berl. Sitzb. 1901, 14.

² See e.g. F. M. Cornford, *Plato's Cosmology* (London 1937) 269: "Knowing nothing about the nerves, Plato ..." (credits other organs with the functions in question; see below pp. 163 ff.); J. I. Beare, *Greek Theories of Elementary Cognition* (Oxford 1906) 271 n. 1 makes a similar observation. It may also be mentioned that Galen throughout the *De plac. Hipp. et Plat.* takes it for granted that the discovery and theory of the nerves bear on the same problems which the philosophers discuss when dealing with *ψυχή*, *ἡγεμονικόν* etc.

³ See e.g. W. H. S. Jones, *CAH* VII 285f.

This paper attempts to trace the continuity. From the end of the fifth century a coherent story can be told—in the relatively few instances in which the material does not allow to draw firm lines of development I shall not press too hard for definite results but rather put the alternative possibilities before the reader.

I. Presocratic and Related Doctrines

Chronology ought to be our guide but unfortunately for the first thinker here to be considered it provides no guidance and leaves us struggling in quicksand. If we could be sure that Alcmaeon was active “during Pythagoras’ old age” the problem would be settled. Yet this statement in the text of Aristotle’s *Metaphysics* is open to serious doubt¹—regarding its authenticity as well as its validity—and the intrinsic evidence for his place in the history of Greek thought is no more conclusive than the extrinsic. The biological subjects on which his opinions are recorded point to the middle or later half of the fifth century when other thinkers dealt with the same questions², yet arguments derived from such observations are of limited value; they may work in the case of others but not in that of a pioneer. When everything is taken into consideration it seems best to begin our study with a brief account of his doctrines, treating them not as the ἀρχή of all later efforts³ but as one theory among several that competed with one another in the minds of subsequent thinkers.

Alcmaeon brought the sense functions, with the exception of touch, together in one class, using perhaps the word αἰσθάνεσθαι as the generic term for them, and set over against them a mental function which he called ξυνιέναι⁴. This function has a synthetic character. Theophrastus was not well advised when he identified it with φροεῖν⁵ nor should we translate the word by “thinking”. In the act of ξυνιέναι we bring together or correlate the sense impressions. This coordination is performed by the brain and Alcmaeon must have emphasized that all sense functions and sense impressions converge to this central organ⁶. What the individual sense

¹ See the treatment of this passage (*Metaph.* A 5. 986 a 29f.) in the editions of Jaeger (Oxford 1957; note also p. X) and Ross (Oxford 1924).

² See e.g. W. A. Heidel, *AJPh* 61 (1940) 3ff.; *Hippocratic Medicine* (New York 1941) 42ff., and for a convenient survey of the conflicting opinions L. Edelstein, *AJPh* 63 (1942) 371.

³ It is very difficult to form an opinion about his possible influence on thinkers of the fifth century. There may be some kind of relation between Diogenes’ conception of ξυνιέναι (Vorsokr. 64 A 19. 44f.; see also “Hipp.” *De morbo sacro*, below p. 155) and Alcmaeon’s emphasis of this mental function as being man’s distinctive characteristic. One may form the impression that Diogenes—and the Hippocratic—having introduced another mental function (φροεῖν, νοεῖν ?) as the cardinal one—“reinterpreted” ξυνιέναι, giving it a different place in the physiological pattern. To be sure, it is possible to understand their opinions also without reference to a hypothetical antecedent but if it is borne in mind that Diogenes looked for “channels” between sense organs and brain and that Alcmaeon did—or had done—the same, the possibility of discerning Alcmaeon’s influence in Diogenes becomes somewhat less chimerical.

⁴ Vorsokr. 24 A 5, 25 = B 1 a (Theophrastus’ paraphrase φροεῖν suggests that ξυνιέναι is Alcmaeon’s word). Cf. J. I. Beare, *Greek Theories of Elementary Cognition* (Oxford 1906) 251f.

⁵ Ibid. (A 5, 25).

⁶ Ibid. A 5, 26.

organs do is—not necessarily in his own words but in words somehow reflecting his conceptions—a δέχεσθαι and διαδιδόναι⁷. The latter word in particular is important; we shall meet it again and again in our inquiry and shall appreciate it as symbol of the continuity which we are engaged in tracing, even though it does not always denote the communication between a particular organ of sense and the brain. Regarding the manner of this communication, Alcmaeon was remarkably concrete and specific. It takes place by means of “passages” (πόροι). He postulated such passages to the brain for eyes, ears, nostrils, and probably also for the tongue⁸. If the passages are blocked the result is a serious functional disturbance. The normal functioning of the mechanism clearly depends on the unimpeded cooperation of the senses and the brain. It is very doubtful whether Alcmaeon ascribed to the brain any activity independent of the senses and other than the correlation of their reports.

According to one account, Alcmaeon did more than merely postulate the existence of such passages. He verified his theories by means of anatomical investigations and actually discovered two “ducts” from the eyes to the brain. This at any rate is what Chalcidius leads us to understand⁹, and if his account were completely reliable, we should have to regard Alcmaeon as the discoverer of the optic nerves (for the ducts or πόροι can hardly be anything else). Actually Chalcidius does not deserve unqualified confidence; he makes no attempt to distinguish between the achievements of Alcmaeon and those of Herophilus, and most of the items specified in his account, like the four tunics of the eye and the *pneuma* which is conveyed to it¹⁰, definitely reflect the latter’s findings and even his interpretation of his findings. This state of facts lends a certain support to the opinion of an ophthalmologist who denies Alcmaeon any actual empirical knowledge of these nerves, leaving him only the “postulate” of physiological connections between eye and brain¹¹. On this view, Alcmaeon would have to be credited with an intuition far ahead not only of its verification but even of any possibility of such verification. As we have seen, this extreme view has some arguments to support it, but it may nevertheless be erroneous. For since Aristotle definitely knew these “passages”¹² (although he did not know that they are nerves) we cannot rule out the possibility that they had been found already by a physiologist of an earlier generation. To credit Alcmaeon with empirical knowledge of these passages would still not be the same as to make him the discoverer of “the nerves”—μία χελιδὼν ἔαρ οὐ ποιεῖ—but it would imply that the tradition, again unfortunately represented by Chal-

⁷ A 5, 25; <δια>διδόναι is J. G. Schneider’s convincing correction.

⁸ 25f.

⁹ In *Tim.* p. 279 Wrobel (= A 10).

¹⁰ Ibid. (II 215, 25 D.-K.).

¹¹ Hugo Magnus, *Die Augenheilkunde der Alten* (Breslau 1901) 57f. 79f. I gather that another ophthalmologist, Julius Hirschberg (*Archiv f. Ophthalmol.* 105 [1921] 129ff.; not available to me) takes a less radical view.

¹² See below in III passim.

cidius, is correct in making him the first Greek known to have tried his hands at anatomy¹³.

Diogenes of Apollonia too gave particular attention to communication and the channels connecting the brain with sense organs like the ears and nostrils. Superficially there is agreement between him and Alcmaeon even in the role which both assign to the air in the functions of hearing and smelling¹⁴, yet in Diogenes' explanations the air must have had quite a different significance. For him the air is the agent of life, sense perception, thought, and movement; by having his share of the air man participates in the divine principle¹⁵. It is not entirely clear how definite a distinction Diogenes made between the nature of sensation and that of thought but there are indications that the difference was for him one of degree rather than one of essence¹⁶. The air enables us to perceive as well as to think but to make us think, and especially think well, the air must be pure and dry.

By and large Diogenes' teachings about the sense organs and their communication with other parts of the body organs reflect the interests of a physiologist, not to say of a physician; such gain as there may be for epistemology materializes incidentally. Words like *ἡδονή*, *λύπη* and even *θράσος* (if this is what he himself used) have medical connotations and refer to the condition of the body¹⁷. Theophrastus in the summary of his views once speaks of a *διαδιδόναι* from ear to brain¹⁸; the word, whether or not it reflects Diogenes' usage, certainly reflects his interest in the normal and effective transmission of sense impressions. He conceived of this process as a "mixing"¹⁹. The air arriving (say, in the ear) from outside must mix with that in the brain and if both of them are in the right condition the best results in the way of normal apperception may be expected.

The references to the brain²⁰ leave no doubt about its important place in Diogenes' physiology but it would be rash to conclude that it actually was for him something in the nature of a central organ. The statements that might lead us to take this view are counterbalanced by other and even more explicit, if not necessarily better, testimonies suggesting such a role rather for the heart²¹. It seems impossible to rule out either organ completely. While ears and nostrils are connected, and communicate, with the brain, the tongue seems to pass on its impressions in a different direction—although it is not easy to say where they are meant

¹³ Loc. cit. (212.23).

¹⁴ Vorsokr. 64 A 19, 39ff.

¹⁵ See esp. *ibid.* B 4. 5; cf. A 19, 42 (II 56, 3 D.-K.).

¹⁶ See A 19.44. According to Theophrastus *φρονεῖν* as well as *αἰσθάνεσθαι* is an activity of the air in our body (see esp. A 19, 42 ex.).

¹⁷ A 19, 43.

¹⁸ A 19, 40.

¹⁹ Esp. 39 and 42 (the word *σύμμετρος* should however be discounted as being a part of Theophrastus' own terminology).

²⁰ See 39–41.

²¹ A 20 (Aet. IV 5, 7. where the terminology is however apt to arouse suspicion).

to arrive²². For vision too we must leave a blank; yet the explanations reported of *μνήμη* and *λήθη* point to the heart as the organ involved in these conditions²³. Burnet's conclusion: "No special seat, such as the heart or the brain, was assigned to the soul"²⁴ is brief, cautious, and correct, although to speak of "soul" is to beg a question. The organ of thought and the organ of life need not have been identical. Diogenes may have been judicious in assigning different responsibilities to brain and heart; he was under no obligation of answering the doxographic question: "where is the hegemonikon to be found?"

From what has been said it is obvious that Diogenes needed passages connecting the sense organs with brain, heart and the rest of the body and also that these passages must receive the air and allow it to move. His description of the blood vessel system (preserved in Aristotle's *Historia animalium*)²⁵ says nothing about the physiological function of these vessels but from other testimonies it becomes certain that the air moves through them²⁶. Even the transmission of perception from the nostrils and the ears to the brain materializes by way of the veins, and there is room for the impression that veins in the eye had a similar function²⁷. Clearly, then, the blood vessels contain air as well as blood but the blood itself—which is of such crucial importance in Empedocles—seems in Diogenes' system to have been limited to minor or subsidiary functions²⁸. It is to the air that man owes respiration and life, sense perception, thought, and according to a passage in Aristotle's *De anima*²⁹, also movement. Evidently the air makes limbs and organs active, keeps up vital processes, and renders the limbs moveable. They act and move under the direction of *νοῦς*. Diogenes may, like the author of the book *On the Sacred Disease*³⁰, have spoken of "messages" from the brain; for since the ears pass on their perceptions to the brain it is likely to have functioned as a kind of relaying station. However no such thought is attested; rather what Theophrastus, our chief authority, emphasizes is the need for a smooth and unhampered passage of the air through the blood vessels and through the entire body³¹. This establishes communication and coordination, and such mutual

²² See for the tongue esp. A 22 (cf. A 19, 43). Since blood vessels are indicated as the channels transmitting perceptions of taste we may note that in Diogenes' blood vessel system two large veins are described as reaching the heart (B 6 [63, 8]). Even so, the reference to the *ἡγεμονικόν* in A 22 looks suspiciously like a gratuitous addition of the doxographers. For Diogenes it may have sufficed that the tastes reached the blood vessels in which air was present to "perceive" them.

²³ A 19.45.

²⁴ *Early Greek Philos.* (4th ed., London 1948) 358. J. I. Beare, *Greek Theories of Elementary Cognition* (Oxford 1906) 105 does not carry resignation quite so far.

²⁵ III 2, 511 b 30ff. (= B 6).

²⁶ A 19 pass., esp. 43. 29.

²⁷ A 39–41 (the details do not emerge as clearly as one would wish in Theophrastus' account but the repeated references to the *φλέβες* must be significant).

²⁸ A 19.43; the blood must not block the passage of the air.

²⁹ See A 20.

³⁰ See below.

³¹ 43–45; see also A 29.

cooperation and mutual response seem to have been Diogenes' definition of *συν-ιέναι*³².

The "Hippocratic" treatise *On the Sacred Disease* embodies very similar ideas regarding the normal and abnormal (or diseased) condition of man. The author has evidently accepted some of Diogenes' main tenets³³, and it is an inestimable advantage for us to find them here set forth in the language of the fifth century instead of having to depend on the idiom of second hand reports. Like Diogenes, the author regards the normal functioning of limbs and organs as due to the unimpeded movement of the air in them and through them; an organ through which the air does not pass loses its mobility and becomes numb³⁴. As chapter 16 sets forth, the air enters the body through the process of respiration and having entered first reaches the brain, where it leaves its best (*ἀκμή*) and with this the *φρόνιμον* and *γνώμην* ἔχον³⁵.

Chapter 14 includes a list of the activities and sensations that originate in the brain. No attempt is made to differentiate between functions which later thinkers would distribute between mind, soul, and senses. *εὐφροσύνη, γέλωτες, παιδιαί, λῦπαι, ἀνία...*, *φρονεῖν*—perhaps also *νοεῖν*—*βλέπειν*, and *διαγιγνώσκειν*³⁶ are all lumped together, and this variegated assortment is followed by references to abnormal conditions (*μαίνεσθαι, παραφρονεῖν*) for which the brain is likewise responsible. The latter are due to an excess of the hot or the cold, the dry or the moist in the brain.

The other organs—sense organs as well as hands and feet—receive their orders from the brain³⁷. As far as we can make out from a sentence whose text is unfortunately not above doubt, these organs have *φρόνησις* according to the degree in which they participate in the air, yet they also have *σύνεσις* owing to their direct communication with the brain and to the orders or messages sent by it³⁸. *φρόνησις* must imply more than what later authors, like Plato, have in mind when they refer to these parts of the body as "sentient" (*αἰσθητικά*); as long as *φρονεῖν* and *αἰσθάνεσθαι* are not strictly set apart from one another, a part of the body said to have *φρόνησις* is thereby endowed with some degree of intelligence. Still

³² See esp. A 19, 44 (56, 21; not quite clear); 45 (56, 27).

³³ This indebtedness has often been noted (see Diels on Vorsokr. 64 C 3a; Wellmann, Arch. Gesch. Med. 22 [1929] 290ff.; Pohlenz, *Hippokrates* [Berlin 1938] 39ff.).

³⁴ See esp. ch. 4 (Littre; W. H. S. Jones in his edition, Loeb Library, has different chapter divisions). The explanation of epilepsy—the author's main subject but not ours—follows the same line: the normal passage of the air is disturbed or interrupted.

³⁵ See also ch. s 4 and 7.

³⁶ Wilamowitz, Berl. Sitzb. 1901, 11f. and Regenbogen, *Symbola Hippocratea* (Diss. Berlin 1914) 31ff. refuse to believe that chs. 14–17 were originally a part of our treatise; however Wilamowitz admits identity of authorship. This identity is further supported and I should say, made practically certain by the arguments of Wellmann, Arch. Gesch. Med. 22 (1929) 308; 17 (394, 6) refers back to 3 (366, 5). See further O. Temkin, Bulletin Inst. Hist. Med. 1 (1933) 297ff.

³⁷ Ch. 16: *οἷα ἂν ὁ ἐγκέφαλος γινώσκη ταῦτα πρῆσσουνσι*. See also ch. 7.

³⁸ Ibid. See Jones' note on the text; in spite of his qualms I should accept the text of θ.

without *σύνεσις* and the messages coming from the brain these parts would obviously not know how to act³⁹.

Our next question is how the messages reach the various organs. The author's views may be confidently inferred from doctrines set forth in other chapters. Messages must be communicated through the channels by which the air penetrates to every part of the body⁴⁰. For him, as for Diogenes, these channels are the blood vessels. The account of the blood vessel system in chapter 3 is briefer than Diogenes'. Both agree in essential points, yet there is in our author a remarkable additional observation. "Veins lead up (to the brain) from the entire body, many of which are thin, while two are stout." In a slightly later sentence where the course of the splenitis is traced we learn that "its thickest, largest, and most capacious part ends in the brain"⁴¹. Diogenes' account of the blood vessels (as quoted by Aristotle) includes no veins that reach the brain. However his characteristic doctrines concerning the connection of ears, nostrils, and eyes(?) with the brain are not to be found in that account either. He must have dealt with these subjects in another section of his treatise where he may well have been quite specific about the passages or channels from some sense organs to the brain. The Hippocratic author on his part is from the beginning anxious to secure a pivotal position for the brain. It has been suggested that he derived this fundamental doctrine from Alcmaeon⁴². Unsettled as the chronology of Alcmaeon is, a writer of the late fifth century may easily have fallen under his influence. Startling ideas of the kind once put forward were not likely to be forgotten. But let us beware of underrating our author's originality. The discoveries—or, if it must be, rediscoveries—are in a large measure his own. For Diogenes both of his major veins (the hepatitis and the splenitis), "come to an end right at the ear"⁴³. Compare with this what our author knows about the splenitis: "Right by the ear it hides itself (*κρύπτεται*) and here it splits, the thickest, largest, and most capacious part ending in the brain ..." If it "hides itself" it had evidently remained hidden from Diogenes. Decidedly, the author of our treatise bases his assertions regarding the controlling place of the brain on observations that presuppose Diogenes' account of the blood vessels but were not yet known to Diogenes. That he also refers to

³⁹ See again ch. 16 and for *ξύνεσις* also the first sentence of 17 (strangely misunderstood by Pohlenz, op. cit. 32). Wilamowitz loc. cit. 7 translates *φρόνησις* well by "Empfindungsvermögen". See also ch. 17 for *αἰσθάνεσθαι* as said of the heart. Ch. 16: *ἐς τὴν σύνεσιν ὁ ἐγκέφαλος ἐστὶν ὁ διαγγέλλων* does not mean what Jones finds in it but rather: it is the brain which sends messages for the 'understanding' (scil. of the other organs); i.e. messages to be understood by the other organs which act on them.

⁴⁰ Chs. 3f.

⁴¹ Ch. 3 (366,11 and 20 L.). Wellmann's assertion (loc. cit. 290. 293) that the author knows the nerves has no basis in the text. All vessels or channels mentioned in the treatise carry blood. Equally baseless are Wellmann's contentions that the author distinguishes veins and arteries (296), that Alcmaeon presented a system of the blood vessels, and that in Diogenes "der Kopf (Gehirn)" (sic) was the "Sammelplatz aller Adern". Cf. Temkin, loc. cit. 286 n. 37; 299 n. 78.

⁴² See esp. Pohlenz, op. cit. 37ff.

⁴³ B 6 (64, 13f.).

⁴⁴ 3 (366.20f. L.).

small veins branching out from the splenitis to the right ear, eye, and nostril⁴⁵ is another matter; we need not speculate whether these veins may be identical with the passages from these organs to the brain which Diogenes specified. For our author these veins are of minor interest since his concern is entirely with messages from the brain but not at all with reports to the brain. Before we leave him, let us still note that the brain is for him simply a part or an organ of the body. Thinking, sensitivity, and movement are in the last analysis responses to a vivifying influence coming from outside and all of them are actions performed by the body. There is no concept of soul.

The fragmentary material of the fifth century does not yield much additional evidence for our subject⁴⁶. In the case of Empedocles our information, while copious in regard to the sense organs and sense functions as such, gives no clue for their connection with the "center". If we wonder how Theophrastus could omit this subject from his otherwise remarkably full account⁴⁷, it gradually dawns on us that our question is somehow not germane to Empedocles' frame of thought. Is his system each of the four elements has consciousness and *νόημα*⁴⁸ but it is in the heart—or, more precisely, in the blood in and around the heart—that the elements attain their perfect mixture⁴⁹ and thought its highest degree. *τῷ αἵματι μάλιστα φρονεῖν* says Theophrastus, keeping in this instance close to Empedocles' own statement⁵⁰. From this point of view, the apprehension of one element by a sense organ would be a "thought" of a lower order—which comes to the same as Aristotle's and Theophrastus' correct observation that Empedocles did not recognize an essential difference between *φρονεῖν* and *αἰσθάνεσθαι*⁵¹. Thus Empedocles might contrast perfect thought as it materializes in the blood with less perfect thought, but would he also trace the way of perception from say, the eye to the blood and the heart? We have no evidence that he did or that he visualized such a way at all⁵². One might ask whether the blood vessels would not present themselves

⁴⁵ Ch. 3 (366, 21f. L.).

⁴⁶ Heraclitus' spider simile (22 B 67a) is important as illustrating the instantaneous presence of soul (*ψυχή*? vitality? consciousness?) in whatever part of the body has been hurt (or otherwise affected?); however the very derivative account on which we have to rely includes no reference to physiological channels, mechanisms, or processes and one may doubt whether such subjects were of interest to Heraclitus.—For Anaxagoras the evidence is tantalizingly inadequate (see Beare, op. cit. 256ff.).

⁴⁷ Vorsokr. 31 B 86.

⁴⁸ See esp. B 110, 10; however the divine quality of each element should also suffice to establish this point.

⁴⁹ B 98, 105. The flesh, though an equally perfect mixture, is not thought of as endowed with "intellectual" capacities.

⁵⁰ A 86, 10; cf. B 105, 2. *μάλιστα* may be compared with what the Hippocratic calls *ἀκμή* (ch. 16 where he sets forth that the brain has *ἀήρ* pure and unmixed whereas other parts of the body have a share or degree of it).

⁵¹ A 86, 10.23; B 106.

⁵² The doctrine of the pores may here seem to be relevant but as far as I can see it relates entirely to the arrival of the "effluences" in the eyes and other sense organs, not at all to a "passing on" of the perceptions after they have taken effect. This is not the place for a closer scrutiny of the tradition regarding this doctrine; all I can do is to record my conclusion that Theophrastus' account is vitiated by misunderstandings comparable in type,

to him as the obvious paths—or indeed whether they would not recommend themselves to him even more strongly than to the thinkers just discussed who had not nearly so high an opinion of the blood and its mysterious powers. Actually a theory that perceptions travel in the blood to the heart did develop on the basis of Empedocles' system and those who developed it were probably his disciples or at any rate thinkers committed to the essential ideas of his physics and physiology⁵³. But we have no right to argue back from the pupils to the master and must postpone consideration of these doctrines to a later part of this study.

The only other Presocratic to whom we must give attention is Democritus. Theophrastus' summary of his views leaves no doubt that besides dealing with the events in the sense organs he also explained how perceptions are "passed on". Theophrastus speaks of a *παραδιδόναι τῷ ἄλλῳ σώματι*, a *σκιδνασθαι* of the entering atoms, a *διαχεῖσθαι κατὰ πᾶν* (τὸ σῶμα)⁵⁴. There being empty interstices everywhere, the atoms which cause the perceptions find it easy to enter and move far into the body⁵⁵. As a result they touch not only the atoms composing our sense organs but also deeper layers of atoms in the interior of the body; and it must be by such "touching" (*ἄφῃ*)⁵⁶ that impressions are made and the body is affected. Theophrastus has nothing to say about contact with the soul but in view of Democritus' peculiar doctrine that soul atoms alternate with those of the body⁵⁷ it is difficult to refrain from the inference that the soul too must be "touched" by incoming atoms. Doxographic reports which refer to the *hegemonikon* as being in the brain or the rational part as being in the thorax⁵⁸ need not be rejected as entirely baseless; by Democritus' time brain and chest had definite claims for consideration that could not easily be ignored. How and how far he took account of these claims are more difficult questions, yet whatever answer we may wish to give, it will not do to restrict the soul too much to particular organs or places. Another moot point is the function of the blood vessels in conveying perceptions (i.e. atoms causing perceptions). Theophrastus mentions these vessels especially as receiving visual and acoustic impressions; in connection with the latter he brings out the correlation between effective hearing and empty spaces in the

gravity, and genesis to those which J. B. McDiarmid has so often traced in his historical statements.

⁵³ See below pp. 164f. and III (beginning).

⁵⁴ Vorsokr. 68 A 135, 54–57 (esp. 2, 116; 2, 13. 20. 22f.). *σκιδνασθαι* may well, as the editors suggest, be Democritus' own word.

⁵⁵ See esp. Theophrastus' remarks (ibid. 54) about *κενότης* in the eyes.

⁵⁶ Cf. again Theophrastus ibid. 55 (166, 14f.).

⁵⁷ 68 A 108 (Lucr. 3, 370ff.); cf. 104a. From B 125 we learn that the *φροῖν* receives its *πίστις* from the senses. Does this epistemological relationship between senses and *φροῖν* require a physiological relationship between senses and soul as basis or parallel? Not being as sure as C. Bailey (*The Greek Atomists and Epicurus* [Oxford 1928] 160ff.) is of the identity of soul and mind in Democritus' system, I prefer to leave this question open. Bailey seems to me to place too much trust in the statements of Aristotle and the doxographers and also to argue too readily from Epicurus to Democritus. Since 1928 we have learned (especially from Cherniss) to take a more critical view of Aristotle's doxographic statements.

⁵⁸ See 68 A 105.

small veins⁵⁹. Again it seems best neither to rule out the blood vessels nor yet to allow them a monopoly. The presence of empty spaces was not restricted to them and wherever the incoming atoms found the way free they could move ahead and communicate the perceptions of which they were the bearers.

Democritus' conception of soul atoms also enabled him to account for the causation of bodily movement, the other major function whose varying explanations we are tracing. Soul atoms are the smallest and thanks to their spherical shape also the most mobile of all. They easily set themselves in motion and having begun to move pass on motion to the atoms of the body between which they find themselves embedded⁶⁰. Here we should like to know what—if any—specific psychic activities prompted the soul atoms to move and also how many bodily actions are brought about by the contagious motion of the soul atoms. Yet our sources offer nothing further⁶¹. In the case of Democritus, as in that of Empedocles, we know some of the relevant theories better and more fully in the form which they took when restated and remolded by later thinkers⁶². Even Plato's "mechanism of transmission" has similarities with what we know—or may reconstruct—of Democritus' corresponding scheme. Imperfectly as we know Democritus' doctrines, we must reckon with the possibility that they accounted for the arrival of sense impressions at the "soul", thereby making a noticeable advance over those of all earlier thinkers.

II. Plato

As we pass on from the earlier thinkers to Plato, we are prepared to find our subjects acquire a new philosophic significance. Where earlier physiologi had acknowledged a difference of degree—some part of the body having more *phronesis* than others—Plato establishes an emphatic and uncompromising dualism, separating the sense functions from the operations of soul or mind and treating the two as entirely heterogeneous and heteronomous. Moreover, Plato's ethics, his epistemology, his doctrine of soul had developed and consolidated themselves in a context of problems which suggested no, or very little, consideration of physiology. Plato himself was neither a physician nor a physiologist and when in one of his last dialogues, the *Timaeus*, he invaded the domain of the physiologists he brought to his venture firm convictions that he had formed while dealing with altogether different subjects. A Platonic physiology had to respect the dualism of body and soul, mind and senses; yet it had also (in the words of the *Theaetetus*) to provide for a *σύναψις αἰσθησεως πρὸς διάνοιαν*¹. It had to conform to the epistemological tenet that sense perceptions "reach" the soul and "report" to the soul, submitting

⁵⁹ 68 A 135, 50 (115, 1); 56 (116, 16).

⁶⁰ A 101. 104. 104a.

⁶¹ In fact, if Aristotle in A 104 (*De an.* I 3, 405 b 16ff.) conveys the right impression, we should not even ask what psychic action causes soul atoms to move; according to this passage movement is natural to them, their spherical shape making rest impossible.

⁶² See below IV (Epicurus).

¹ *Theaet.* 195e.

their findings to its arbitration². To be sure, Plato's soul is invisible and non-material. It would be too much to expect that the physiology of his time—or of any time—should be able to bridge the gulf between the material and the non-material; nor, as far as I can see, was this Plato's main concern or principal problem³.

In the *Timaeus* Plato saw fit to assign his non-material soul and its parts to specific places in the body⁴. The rational part is "housed" in the head and there are definite indications that Plato thinks of it as being concentrated in the brain⁵—a noteworthy point of agreement with Alcmaeon and the Hippocratic author. The spirited impulse (*θυμός*) receives its place in the chest or, more generally, in the region between neck and midriff, and the habitation of the desires is "between the midriff and the boundary towards the navel"⁶. The same section which acquaints us with this distribution of the soul parts gives us also Plato's new version of our Hippocratic's idea that: "eyes, ears, tongue, hands and feet carry out whatever the brain decides"⁷. But there is a difference; for Plato this kind of relationship obtains not so much between organs of the body as between parts of the soul. The *θυμός* too must be kept under control. If the *θυμός* is aroused and inclined to go its own way, there is a "boiling" in the region of the heart. However, Plato knows the heart to be "the knot (*ἄμμο*) of the veins and the fountain (*πηγή*) of the blood which moves impetuously through all the members"⁸; availing himself of this physiological fact he goes on to explain how the control of the rational soul part is reestablished. "Through every narrow channel" (*στενωπά*) all sentient parts of the body become aware of the commands and threats and are thus caused to obey the best and ruling part"⁹.

² See e.g. *Rep.* 7, 523a f. 524a f.; *Theaet.* 184d. 186c (here the grammatical object of *αἰσθάνεσθαι* is *ὅσα διὰ τοῦ σώματος παθήματα ἐπὶ τὴν ψυχὴν τρέπει*; note that *τείνειν* and *ἀγγέλλειν*, the latter of which is found at *Rep.* 524a, recur in the *Timaeus*). *Phileb.* 33d–34b embodies thoughts remarkably similar to what we shall find in the *Timaeus*. More passages could be cited and more could be said about the epistemological presuppositions of Plato's physiology but for the very well known subjects indicated in the text, a few references should suffice. Passages like *Phaedo* 79c and *Phaedr.* 249b suggest additional aspect of the relationship between the *αἰσθήσεις* and soul. On *Rep.* 5, 462c 10ff. see below n. 25.

³ The difficulties involved in any kind of doctrine trying to establish connections between physical and psychic processes are very well brought out by Paul Siwek in his book *La psychophysique humaine d'après Aristote* (Paris 1930) where Plato's (pp. 46ff.) as well as Aristotle's theories are treated from this point of view.

⁴ *Tim.* 69c–71a.

⁵ *Ibid.* 69d f.; cf. 73c.

⁶ 69e f. 70d f.

⁷ See above p. 156 and n. 37.

⁸ 70a f. However the description of the two principal blood vessels in 77c–e is not easy to square with the statements of this passage; cf. F. M. Cornford, *Plato's Cosmology* (London 1937, reprint 1957) 305f.

⁹ 70b; cf. Cornford, op. cit. 283. I differ from Cornford, however, in that I distinguish two phases in the process described. First the *θυμός* boils because it has learned of some injustice; next the *λόγος* establishes its control by way of commands and threats. When this happens the blood too is cooled; at least I find it difficult to suppose that the boiling blood should carry, or carry out, the commands of reason. The *ὅτε* clause (b 3–5) describes the condition to be remedied. I do not know whether Plato deliberately transferred Empedocles' *στενωπά* (31 B 2, 1) to other organs of communication.

The "narrow channels" must be the blood vessels whose physiological connection with the heart Plato specifies in the same sentence. They are once more the channels of communication. The heart however has advanced to a new function, for whose knowledge Plato is obviously indebted to Empedocles and his followers¹⁰. Empedoclean and Hippocratic traditions have become fused in this account. As there is not mention of the air, this part of the Hippocratic legacy has evidently been dropped and the role once played by the air has been taken over by the blood. However, Plato does not tell us here how the limbs or other parts of the body are moved; he probably regarded this as a purely physiological question not requiring closer consideration¹¹. What interests him is the control of every sentient part, i.e. of every part capable of responding to, and receiving directions from, the rational soul. We must understand that the heart, when left to itself, may begin to "boil", and that the heart and the *θυμός* in it are brought under control¹². According to a physiological doctrine, the brain, being colder than the region of the heart, is in a position to quiet the latter by sending down currents of cooling matter¹³. In a later section we read of blood vessels closely connecting the trunk of the body with the head¹⁴. Thus it should not be difficult to imagine the brain as being via the blood vessels in communication with the heart.

We may wonder whether in processes of the opposite direction—not from the rational soul part but toward it—the blood vessels fulfil a similar function but it is better to postpone this question and first to examine a section where Plato explains in more general terms how sense impressions are reported. To understand his explanation, we should bear in mind that all four elements have gone into the making of our body¹⁵. In his mathematical derivation of the elements, Plato has seen to it that the units of fire (being pyramids) have the greatest mobility and that those of earth (being cubes) have least; of the two other elements, air is in point of mobility closer to fire, water to earth¹⁶. To these differences Plato now comes back¹⁷.

Plato's main points may be summarized as follows: When particles possessing a higher degree of mobility are affected, say by the sensation of hot or cold, they pass on this affection to other particles next to them, and this process continues, particles communicating their experiences to other particles "until they reach

¹⁰ Vorsokr. 31 B 105 (A 84). Cf. Wellmann, *Fragm. d. sikel. Ärzte* 15f.; Jaeger, *Diokles v. Karystos* (Berlin 1938) 214. See also the account of the blood vessel system with the heart as *ἀρχή* in Arist. *Hist. an.* III 3, 513 a 8ff.; esp. 21ff. Note Aristotle's repudiation of those who believe that the blood vessels start in the head *ibid.* 9ff.

¹¹ Cf. the purely physiological account of the sinews (74 b. d).

¹² For the *θυμός* as helper of the rational part cf. *Rep.* 4, 440a ff.

¹³ See Arist. *De somno* 3, 457 b 29–485 b 10; *De part. an.* II 7, 652 b 16–653 a 10; cf. also *De an.* I 1, 403 a 16–b 2.

¹⁴ *Tim.* 77d f.

¹⁵ This is first stated in 42e f. and remains the fundamental assumption throughout the physiological sections.

¹⁶ See 55 d 8ff.; 56 a 2ff.

¹⁷ See for what follows 64 a 2–65 b 3; cf. Siwek, *op. cit.* 43ff.

the intelligence (*τὸ φρόνιμον*) and report the power of the agent"¹⁸; thus the central organ learns that something hot, sweet, or hard has touched a part of the body's surface. Experiences of the eyes are also conveyed in this fashion because in Plato's scheme these organs too are touched by incoming particles producing the impressions of colors¹⁹. The verbs "pass on" (*διαδιδόναι*) and "report" (*ἐξαγγέλλειν*) sound a familiar note; we have encountered them several times in the context of comparable doctrines and need not doubt that Plato here consciously makes contact with earlier theories bearing on the same subject.

Plato next states that particles of a less mobile nature do not pass on their sensation to their neighbors; thus the "experience" (*πάθος*) remains confined or, as we might say, localized and the living being as a whole is "insensitive" (*ἀν-αἰσθητον*) with regard to it. The particles in question are units of earth, and since they dominate in the composition of bone and hair, Plato has here accounted for the insensitiveness of these tissues²⁰. Conversely, particles of fire and air being copiously present in the sense organs, such as eyes and ears, we understand that these organs have a high degree of sensitivity²¹.

We are most eager to learn what the mobile particles report and where they deliver their message. In the sections preceding ours, we read of sense-perceived experiences like hot and cold, hard and soft, and in the immediately following sections we are given an account of the individual sense organs and of the perceptions peculiar to each of them²². Evidently all such perceptions are relayed by the mobile particles but what interests Plato here particularly are the sensations of pleasure and pain²³. They are *αἰσθήσεις* in a special sense and *par excellence*; for they are "felt". What we see, hear, smell and taste may give us pleasure or pain but it need not do so; in the latter case, the experiences passed on from the sense organs by way of the particles produce *μέγιστα αἰσθήσεις*, but these are, nevertheless, as Plato puts it, with deliberate paradox, an *ἀναἰσθητον*²⁴. To distinguish these two forms of "sensation" was necessary in the interest of clear and correct thinking: yet as far as the mechanism of the particles is concerned the difference lies in the degree of the dislocation and the violence (or lack of it) of the movements²⁵. Even the "cuttings" and "burnings" which the eye under-

¹⁸ 64 b 3-6.

¹⁹ 67 c 4ff.

²⁰ 64 b 6ff. c 4. Does Plato (b 7) say that the immobile particle "merely" suffers or that it "alone" suffers. Both interpretations of *μόνον* would be defensible. c 3 raises another problem; Plato may mean to say that even that (scil. particle) which has suffered is *ἀναἰσθητον* because *αἰσθήσεις* comes about only if the soul is reached by the affection. Yet the parallel in the *Philebus* (43 b 2) suggests that *τὸ παθόν* is the entire being. Cf. also *Phil.* 33d.

²¹ Cf. in this connection also *Phileb.* 33d. For the "insensitiveness" of tissues consisting of earth cf. Arist. *De an.* I 5, 410 a 30f.; III 13, 435 a 24f.

²² 61c-63e; 65b-68d.

²³ See 64 a 2ff.; c 7ff.

²⁴ See esp. 64 c 7-d 5; but also what follows, d 5-65 b 3.

²⁵ C 8-d 7; e 3-65 b 2. The Greek words which bring out the difference are *βία* and *βίαιον* on the one side and *ἡρέμα* or *μετ' εὐπειρίας* on the other. See also *Phil.* 43b f. For the *συναλγεῖν* of the entire organism (body and soul) with a hurt part of it cf. *Rep.* 5, 462

goes in many acts of vision need not cause pleasure or pain²⁶ if the particles affected are small or not numerous, if they yield readily, and if there is no "violence". We need not follow Plato here into the details of his disquisition and differentiation; for while his distinctions are important—not least for the subsequent history of Greek philosophy²⁷—what matters for us is the basic pattern of his explanation, and this remains the same throughout the section.

The account includes two indications regarding the terminus of the relaying process. In a sentence already quoted the recipient of the messages is called τὸ φρόνιμον. Another passage informs us that the movements of pleasure and pain are "passed on into the whole" (scil. of the body) and that these sensations finally materialize for the "mortal part of soul"²⁸. We know where the two subdivisions of this part are localized. Since the φρόνιμον is probably to be identified with the divine soul part²⁹, it follows that both the mortal and the immortal soul part are terminal points of the διαδιδόναι. That the sense impressions set up "movements" and that these movements are carried through the body to the soul Plato also states in an earlier part of the *Timaeus*. There, setting forth the experiences of the souls at the time of their first incorporation, he describes the movements arriving from the sense impressions as a disturbance of soul's own motions and "revolutions"³⁰ ("revolutions" are a characteristic of the divine part). Some passages of the *Timaeus* make sensation (αἴσθησις) as such an experience or even ingredient of the mortal soul³¹. Still, when everything is taken into account, there can be no doubt that the sense impressions must penetrate to the immortal part in the head as well as to the mortal parts in the trunk. Reason must after all know what the senses experience; on epistemological grounds it would be unsatisfactory if only the spirited impulse or the desires were to receive this information³².

So far we have not found any specific paths for the messages and on the whole it is probably correct to assume that sensations are reported wherever there are particles of the necessary mobility. The sections devoted to the individual sense

c 10ff.; note however that not only the wording but the idea of this passage differs from the view presented in the *Timaeus*. With the passage of the *Republic* Littré compared Hipp. *De loc. in hom.* 1 (VI 278, 3–13, ad loc.), aptly except for the fact that soul is absent in the Hippocratic.

²⁶ 64 d 5–e 4.

²⁷ I hope to show this in another study (to be published soon).

²⁸ The two passages are 64 b 5 and 65 a 5.

²⁹ Still Cornford had good reasons for rendering the word by "consciousness" (center of "consciousness" Beare, op. cit. 211). Yet even in the Hippocratic author this meaning would hardly be adequate (see above p. 155f.). And is it not reasonable to suppose that the word as here used by Plato combines with its traditional connotations new and Platonic ones?

³⁰ See 43 b 5–e 4, esp. c 4–7. For the "revolutions" see 43 a 4–6. Cf. also 37 a 2–c 5 (revolutions of the world soul), a section which shows that the divine soul takes cognizance of αἰσθητά (b 6) and also that Plato assumes a διαγγέλλειν and διαδιδόναι within the soul itself (a 6; b 7f.).

³¹ 42 a 5; 69 b 4.

³² In the *Timaeus* itself a passage like 70 b 3–5 would suggest this ("the rational part as the headquarters of sense perception", Cornford ad loc.), if we do not wish to use the evidence of other dialogues (*Phaedr.* 249 b et al.). Note also *Tim.* 47 b–d.

functions³³ are primarily concerned with the perceptions as such, i.e. with impressions made in the sense organs themselves; the transmitting of such perceptions is here of secondary importance. Instead of paraphrasing these chapters we may content ourselves with extracting the statements relevant to our topic. Sound is defined as a stroke which, being produced by the air, is "through ears, brain, and blood passed on (*διαδίδασθαι*) to the soul"³⁴ (this is the only reference to the brain in these sections). While dealing with the sense of taste, Plato has much to say about the small blood vessels of the tongue; he calls them the "testing instruments" of this organ and describes them as "extending (*τεταμένα*) to the heart". There is a graphic account of how the blood vessels and "the particles present in them" are affected by the entering units of food³⁵; some of these units create a considerable commotion and disturbance. Blood vessels serve also as carriers of smell³⁶. On the other hand it may not be accidental that the section treating of vision never refers to blood vessels³⁷. Even so we are left with the impression that the blood vessels and the blood in them are the main vehicles of communication with the soul. This impression receives support from a passage in a physiological chapter where it is said that the two principal blood vessels which connect head and trunk have been implanted in the body "in order that the effect of sense perceptions may become known throughout the entire body"³⁸.

Recalling the description of the heart as "knot of the veins" we may readily surmise that experiences (*πάθη*) affecting the veins—or the blood in them—are passed on to the heart³⁹. Thus channels of one and the same kind would convey the commands of reason from the head to the rest of the body and carry sensations or sense impressions to the heart. Since the blood has its share of mobile air and fire units⁴⁰ the scheme which emerges would be physiologically as well as psycho-

³³ 65 b 4–68 d 7. "Touch" is not among the sense functions here analyzed by Plato. Cf. for its peculiar position in Plato's scheme AJPh 76 (1955) 159f. or *Aristotle's System of the Physical World* (Ithaca, N.Y., 1960) 349.

³⁴ 67 b 2ff.

³⁵ 65 c 7ff.; 66 a 2ff. Cf. Cornford, op. cit. 269f. Note that 65 e 7 the *αἰσθήσεις τῆς κεφαλῆς* (the sensitive parts of the head) are said to be affected.

³⁶ 66 d 4.

³⁷ The *διέξοδοι* 67 e 8 are probably pores. For the *διαδιδόναι* from the organ of vision to the soul see 45 d 1ff. For the blood vessels in Diogenes' physiology of vision see above p. 164.

³⁸ 77 e 5. For passages like this (and also in a good number of other instances) it is however well to bear in mind the distinction between two meanings of *αἴσθησις* made by Plato himself in the section (analyzed above p. 161ff.) 64 a 2–65 b 3. It is not always easy to decide which meaning applies.

³⁹ See again 70 b. Needless to say, the circulation of the blood was not known. In fact the blood is assumed to flow only in the direction from the heart to the tissues and limbs; see 80d ff. I do not think that this would necessarily exclude "sensory" movements—from particle to particle—in the opposite direction. Still, our arguments must be admitted to be "speculative" and we shall in due course make the necessary qualifications.

⁴⁰ The blood is replenished by the food (mainly vegetable, 77a ff.), 80d ff., which must contain all four elements; its own function is to provide fresh material for the tissues; see *ibid.* Obviously Plato agrees with Empedocles' view (B 98) that the blood is mixed of the four elements. For the presence of fire in particular see 80 e 1ff. I have studied these doctrines more closely in *Philos. Rev.* 59 (1950) 452ff.

logically satisfactory, although we are still left to wonder whether the sense perceptions should not reach the brain rather than the heart. Nor should we forget that the scheme involves a certain amount of speculative "reconstruction", a filling in of things which Plato does not actually say.

The reconstruction, if correct, implies that when the air in the blood vessels was no longer considered the best messenger, the blood as such took over its role. Now it is well known how much in the physiology of the *Timaeus* (beginning with the basic theory of the four elements) goes back to Empedocles and there are good reasons for thinking that Plato kept in close contact with physicians of Sicily or Southern Italy who carried on the tradition of Empedocles⁴¹. For Empedocles blood was the organ of thought (*νόημα*) and as he did not make a sharp distinction between thought and sense perception⁴², there was no reason why his followers should not regard the blood also as the instrument of sensory activity. Theories like those advanced by Diogenes and the Hippocratic author were a challenge for the other schools: to meet the challenge they would, naturally enough, come forward with alternative explanations more in line with their own cardinal doctrines. We shall presently see that Aristotle (who, like Plato, owes a large debt to the Empedocleans) knows the blood as vehicle of perceptions⁴³.

But when all this has been said it is only fair to emphasize Plato's reserve in this matter, especially as this reserve contrasts so strongly with his readiness to advance very specific theories about the processes materializing in the sense organs as such. We must face the fact that Plato only once—in the account of hearing—specifically mentions the blood as carrier⁴⁴. As a rule his references are simply to the blood vessels. These vessels too have probably the right kind of particles in their composition⁴⁵. So has the flesh, and we should not fail to note what Plato says about it, even if his statements increase rather than dispel our uncertainties. He asserts that a solid mass or large layer of flesh is detrimental to sensitivity but while working up to this point makes an exception which might easily be developed into the contrary thesis; for he says, with special reference to the tongue, that our creators sometimes "formed a mass of flesh to be itself an organ of sensation"⁴⁶.

We conclude that Plato himself is not entirely certain of his ground—at least as soon as he goes beyond his basic point that it is particles of a "mobile" nature

⁴¹ Cf. C. Friedrich, *Hippokrat. Untersuchgg.* (Philolog. Untersuchgg. 15, Berlin 1899) 47; Wellmann, op. cit. 15, 73ff. (whose conclusions are however in need of revision); Jaeger, *Diokles von Karystos* (Berlin 1938) 211ff. See also the point made in the preceding note and e.g. Cornford's comments on 45 b and on 81 e ff. (pp. 333f.). With Empedocles (B 84) Plato shares the theory of respiration through the pores, and even items of Empedocles' comparative anatomy have been incorporated in the *Timaeus* (Emp. B 82; *Tim.* 91 d 7).

⁴² See above p. 157.

⁴³ And even as the physical substratum of *διάνοια*; see below III (beginning).

⁴⁴ 67 b 3.

⁴⁵ 65 d 2; 66 d 4 is puzzling: particles coming from outside are either too small or too large for the *φλέβες* in the nostrils. One wonders why if they are too small they do not enter and affect the blood units. They may however pass without touching the walls of the blood vessels.

⁴⁶ 74 e ff. (esp. 74 3 7–10; 75 a 5f.).

which transmit the perceptions. This was after all the essential explanation of the process: as for more specific questions—including the important one how the messages reach the brain—the state of physiological knowledge at the time probably made it difficult to answer them and we should recognize that Plato does not press on to conclusions that would be at variance with the results of scientific research. While knowing what powers Empedocles and his followers assigned to the blood⁴⁷ he himself probably had some hesitations about crediting the blood with so delicate and responsible a function. When we come to deal with Aristotle, we shall find him equally or even more reluctant but in his case it will be easier to discover the reason for this attitude. Shall we speculate about the possibility that Plato was influenced by the same reason? There is more to be gained by recording two recent developments in Greek physiology both of which are likely to have had some bearing on his decision—or, rather, indecision. The best and newest theory concerning the system of the blood vessels made the heart the center of this system. Plato accepts this view⁴⁸ but insists, nevertheless—for reasons of a philosophic and aprioristic character—on placing the organ of rational control in the head⁴⁹. This conviction was bound to land him in difficulties; we have seen that he cannot explain how perceptions arrive at the brain. As for the blood itself, physiological research credited it with a function not necessarily incompatible with the other which has here been discussed but in any case lowlier and perhaps in Plato's opinion more germane to the nature of the blood. Being constantly replenished by the food which is "cut up" in the belly, the blood carries nourishment to every part of the body and thus replaces the material taken from our tissues through the incessant attacks of "outside" forces⁵⁰. This doctrine too was based on recent discoveries, and this too Plato accepts and incorporates in the *Timaeus*. Did this role of the blood interfere with the other and more ambitious one which it had taken on in the mechanism of our sense functions? Whatever specific considerations may have influenced Plato, he clearly had very good reasons for not being dogmatic. Let us respect his caution. The story which we are tracing is not a sequence of full-fledged theories, each of them firmly held and presented as something definite or definitive. Rather it is a record of tentative approaches, of trials and errors. If the proponents of the theories had been less circumspect, the "errors" would probably have persisted longer.

The over-all impression is that Plato has imposed his own psychological scheme of the soul parts upon the physiological theories of earlier thinkers. In dealing with these theories he is selective as well as synthetic. It is in the synthesis that new conclusions emerge. The passing on of sense impressions from particle to particle

⁴⁷ See above p. 165 (and p. 157).

⁴⁸ 70 a 7ff.; cf. above p. 160.

⁴⁹ 69 c-e; cf. 75 a-c; 85 a 5-b 2. Cf. on the whole (for the two *ἀρχαί* in Plato's scheme) Beare, *op. cit.* 274 whose observations largely coincide with mine.

⁵⁰ 80 d-81 b; for details and antecedents of this theory see *Philos. Rev.* 59 (1950) 452ff.

had probably been described by Democritus⁵¹, the important role of the blood vessel system had been established by Diogenes and others, and the blood itself had been chosen as carrier by the "Sicilian" school. Plato, having committed himself to Empedocles' four elements and given their units geometrically defined shapes, is in a position to select two elements whose units qualify them as mobile and sensitive. About the travelling of the sound from ear to brain Diogenes knew as much or more than what we read in the *Timaeus* (what Plato adds is that at the end of this process the soul is reached)⁵², and that blood vessels stretch from the tongue to the heart may have been a relatively novel doctrine but is not likely to be Plato's own discovery. Such progress as he makes is due to his more precise views regarding the parts of the soul and the functions that are centralized in brain and heart. The conception of a tripartite soul was essential to his ethics, and although this ethics does not need a physiological basis the ethicist will nevertheless be glad to know what kind of basis there may be.

Mitteilungen

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⁵¹ There is however a difference inasmuch as Plato—at least in principle—rejects the idea of empty interstices (passages like 58 b 2ff., 81a ff., and esp. 65a f. show that he is not entirely consistent). It is better here not to reopen the question whether or not Plato knew and used Democritus' system. Similarities may be noticed, and have been noticed, in many phases of their accounts; yet our observations hardly suffice for far-reaching conclusions.

⁵² 67 b 7. In dealing with the process of hearing Plato evidently found it difficult to reformulate earlier theories in terms of his particles or units.