

THE EFFECT OF A SIMILE: EMPEDOCLES' THEORIES OF SEEING AND BREATHING

I

A CURIOUS irony hangs over the two similes of the lantern and the clepsydra which Empedocles used to describe his theories of seeing and breathing (*fr.* 84 and 100). Similes were a feature of Empedocles' style, and it is clear that on these two in particular he has lavished considerable care. They have been preserved in their entirety, as almost the longest continuous quotations which Aristotle makes from any author. Despite such auspicious beginnings, these two similes have proved peculiarly resistant to modern attempts at interpretation. The reason for this, I shall try to show, is that certain features in the two similes took on a spurious significance as a result of Plato's remodelling of Empedocles' theories. Difficulties of interpretation have been caused by trying to read back these innovations of Platonic theory into details of the similes that in their original context were fortuitous and inessential.¹

II

In Plato vision occurs when fire leaves the eye and joins fire outside to form a single compacted body, along which movements from the visible object are communicated as sensations to the eye.²

According to Theophrastus, Empedocles explained vision as the result of effluences which are given off from objects and enter the appropriate pores of the eye. Dark effluences enter the watery pores of the eyes, and bright effluences enter the fiery pores of the eye. As I have tried to show in an earlier article, Empedocles distinguished good and bad vision, by day and by night, for eyes with a predominance of fire and for eyes with a predominance of water. Good vision results when the dark and light elements which enter the eye are equally balanced. Poor vision results either when there is too much fire in the eye, so that we are dazzled, or when there is too much water in the eye, so that our vision is dimmed. In the whole of his detailed and one would have thought exhaustive account, Theophrastus says nothing about fire leaving the eye as a factor in the act of vision.³

In the course of an argument in the *De sensu* Aristotle associates Empedocles with Plato. He says that, as well as explaining vision by effluences from the object seen, Empedocles also explained vision as Plato did, by the action of outward-flowing fire.⁴

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¹ Certain general features of Empedocles' style of simile relevant to *fr.* 84 and 100 are considered separately in note 1 pp. 154–7 below.

² *Timaeus* 45b–46c, cf. 31b and 67c–68d.

The originality of Plato's theory is considered separately in note 2 p. 157 below.

³ Theophrastus, *De sens.* 7–8 (DK 31A86; these references are to Diels-Kranz, *Die Fragmente der Vorsokratiker* 5th edn onwards). For the theory of

good and bad vision, see 'The relation of Anaxagoras and Empedocles', *JHS* lxxxviii (1968) 110–13. As an indication of the completeness of Theophrastus' account, note especially the concluding sentence of the report on vision, *καὶ περὶ μὲν ὄψεως σχεδὸν ταῦτα λέγει.*

Theophrastus' account does of course include mention of fire which leaves the eye (see p. 144 below), but Theophrastus does not give this as in any way the cause of vision. Beare distorts when he writes that in his account of Empedocles Theophrastus introduces us to 'vision by means of fire issuing forth', *Elementary cognition* 20.

⁴ Aristotle *De sensu* 437b10–438a5.

The usual response to Aristotle's remarks has been to attribute a synthesis of these two explanations to Empedocles, on the lines of Plato's theory in the *Timaeus*. But before we do this, the context and the form of Aristotle's remarks require careful consideration.⁵

Aristotle's own theory is that the eye is made of water, which manifests the character of transparency, τὸ διαφανές. Aristotle sees the opposition to this view as coming from two sides. There is first a direct contradiction by those who say that the eye is made of fire. There is secondly an apparent, but only an apparent, anticipation of Aristotle's theory by Democritus, who also said that the eye was made of water, but without any reference to transparency.⁶

Our concern is with the first half of this opposition. Aristotle's answer to those who say that the eye is made of fire falls into two parts.

1. First, Aristotle gives his own explanation of the bright spots that appear to flash from the eye when the eyeball is pressed or is moved quickly in the dark; for this, he asserts, was the phenomenon which had led 'everyone' to think that the eye was fiery.⁷

2. Secondly, Aristotle objects that if, as on Plato's theory, we see by fire leaving the eye, then we should be able to see at night-time, 437b10-14: ἐπεὶ εἴ γε πῦρ ἦν (sc. ὁ ὀφθαλμός), καθάπερ Ἐμπεδοκλῆς φησὶ καὶ ἐν τῷ Τιμαίῳ γέγραπται, καὶ συνέβαινε τὸ ὄραν ἐξιόντος ὡσπερ ἐκ λαμπτήρος τοῦ φωτός, διὰ τί οὐ καὶ ἐν τῷ σκοτεινῷ εἴρα ἂν ἦ ὄψις;

In each of these primary formulations there are two points which Aristotle attributes to his opponents: that the eye is made of fire, and that fire leaves the eye. The force of Aristotle's arguments is directed exclusively to the latter point. Aristotle is concerned to show, in the first case, that fire need not leave the eye, and in the second case that it cannot do so. On these grounds he supposes that his reader (or listener) will be persuaded that the eye need not be, and cannot be, made of fire.

The first formulation does not require the fire which leaves the eye to have any function beyond that of explaining the bright spots that appear when the eyeball is pressed or moved quickly in the dark. The answer to Plato requires that the fire which leaves the eye should be responsible for the act of vision. Verbally, the two parts of Aristotle's answer are run closely together. The statement of Plato's theory in the conditional clause εἴ γε is contained within and is dependent upon the clause ἐπεὶ, which is itself grammatically subordinate to the concluding sentence of Aristotle's own account of the phenomenon of pressing or moving one's eyes.

Mention of Empedocles is restricted to the conditional clause εἴ γε. Empedocles' influence does not properly extend even to the major subordinate clause, ἐπεὶ, for the continuation of Aristotle's argument is limited specifically to the version of the theory given in the *Timaeus*, 437b14 ff.: τὸ δ' ἀποσβέννυσθαι φάναι ἐν τῷ σκοτεινῷ ἐξιούσαν (sc. τὴν ὄψιν), ὡσπερ ὁ Τίμαιος λέγει, κενόν ἐστὶ παντελῶς· τίς γὰρ ἀπόσβεσις φωτός ἐστιν; κ.τ.λ.

Even within the minor subordinate clause, εἴ γε, Empedocles is strictly associated only with the first point, that the eye is made of fire. Empedocles' association with the second

⁵ A synopsis of earlier views is provided in note 3 pp. 157-9 below. References to works cited in note 3 are given elsewhere in an abbreviated form.

Bignone and Cherniss are exceptional in denying any part to outward-flowing fire in Empedocles' explanation of the act of vision, see p. 145 n. 28 below, and cf. note 3 p. 159 below.

Miss Millerd and Professor Guthrie are exceptional in allowing outward-flowing fire a place in Empedocles' explanation of vision, but in refusing to

synthesise this with an explanation in terms of effluences flowing from the object seen, see NOTE 3 pp. 157-9 below, and cf. p. 142 n. 9 below.

Doxographical evidence for Empedocles' theory of vision, other than that in Aristotle and Theophrastus, is considered separately in note 4 pp. 160-1 below.

⁶ *De sensu* 437a22-438b30.

⁷ *De sensu* 437a22-b10. The precise nature of the phenomenon to which Aristotle alludes in this passage is considered separately in note 5 pp. 161-2 below.

point, that the fire which leaves the eye is responsible for the act of vision, depends only on the passing reference to the image of the lantern.

When Aristotle has concluded his attack on Plato, he returns to Empedocles, 437b23–438a5: 'Εμπεδοκλήης δ' ἔοικε νομίζοντι ὅτε μὲν ἐξιόντος τοῦ φωτός, ὥσπερ εἴρηται πρότερον, βλέπειν· λέγει γοῦν οὕτως·

ὥς δ' ὅτε τις πρόοδον νοέων ὠπλίσατο λύχνον
 χειμερίην διὰ νύκτα, πυρὸς σέλας αἰθομένοιο,
 ἄψας παντοίων ἀνέμων λαμπτήρας ἀμοργούς,
 οἷ τ' ἀνέμων μὲν πνεῦμα διασκιδνάσιν ἀέντων,
 5 πῦρ δ' ἔξω διαθρῶσκον, ὅσον ταναώτερον ἦεν,
 λάμπεισκειν κατὰ βηλὸν ἀτειρέσει ἀκτίνεσσι·
 ὥς δὲ τότ' ἐν μήνιγξι ἐεργμένον ὠγύγιον πῦρ
 λεπτήσιν τ' ὀθόνησι λοχεύσατο κύκλοπα κούρη·
 <αἰ> χοάνησι δίαντα τετρήατο θεσπεσίησιν.
 10 αἰ δ' ὕδατος μὲν βένθος ἀπέστεγον ἀμφιναέντος,
 πῦρ δ' ἔξω δίεσκον, ὅσον ταναώτερον ἦεν.

ὅτε μὲν οὖν οὕτως ὀρᾶν φησίν, ὅτε δὲ ταῖς ἀπορροαῖς ταῖς ἀπὸ τῶν ὄρωμένων.⁸

There are three points to notice here.

1. First, Aristotle does not at all suggest that the two elements in Empedocles' theory are complementary parts in a single whole, which is what most modern commentators have tried to show.⁹ On the contrary, ὅτε μὲν . . . ὅτε δέ . . . is fairly clearly intended to suggest that outward-flowing fire and effluences are two independent, if not inconsistent, theories.¹⁰

2. Secondly, now that he is dealing with Empedocles on his own, Aristotle heavily qualifies his expression. Empedocles only ἔοικε νομίζοντι. Ross and Karsten are right to note the caution of this phrase.¹¹ For according to Bonitz's *Index* an equivalent expression occurs only twice elsewhere in Aristotle's writings; and on both occasions it introduces views that have been noticeably distorted by the context in which they appear in Aristotle.¹²

(i) In the *Metaphysics* Aristotle writes that Democritus ἔοικεν οἰομένῳ that there were only three differentiae of actualised sensible substance, namely shape, position and arrangement.¹³

⁸ I have done no more than transcribe the text of the fragment given by Ross in his edition of the *Parva naturalia* (except for one misprint), without intending to endorse the various interpretations of detail implied therein.

⁹ Miss Millerd and Professor Guthrie are exceptions, see note 3 p. 159 below.

¹⁰ Bignone exaggerates when he writes, 249 n. 2: 'Aristotele . . . dica che Empedocle . . . spiega la teoria della vista . . . per mezzo del fuoco che esce dall'occhio e si congiunge col fuoco esterno, come nella dottrina del *Timeo* di Platone' (my italics). Aristotle does not attribute to Empedocles the idea that outward-flowing fire mingles with fire outside the eye.

Likewise, there is no need to suppose that Aristotle's later criticism, 438a29 ff., τό τε γὰρ συμφύεσθαι τί ἐστι φωτὶ πρὸς φῶς; κ.τ.λ., is directed

specifically against Empedocles, as von Prantl supposes, *Aristoteles über die Farben* 45.

¹¹ Ross, in his edition of the *Parva nat.* 190. Karsten, 486.

¹² H. Bonitz, *Index Aristotelicus* 263b24–5. Other instances of the same construction, quoted immediately before and after this reference, have a clearly different sense.

There are of course a number of instances of ἔοικέναι with an infinitive, only some of which carry the connotation which is present when there is a dependent participle. A good example (not indexed by Bonitz) is *De caelo* 305a1–4, which concludes καθάπερ ἔοικεν Ἐμπεδοκλήης βούλεσθαι λέγειν. Comparison with *De gen. et corr.* 325b19–25 shows that Aristotle was not at all certain that the view in question could properly be attributed to Empedocles.

¹³ 1042b11–15.

Cherniss remarks, more or less rightly, that 'this disregards the distinction which the Atomists made between the differentiae of complexes and the limited set of differentiae of the atoms themselves'.¹⁴ Certainly it is true that complexes of atoms could properly have accounted for several of the differentiae in the list which Aristotle gives: a difference of position between threshold and lintel, a difference of time between supper and breakfast, a difference of place in the case of winds.¹⁵

(ii) In the *De generatione animalium* Aristotle writes that earlier thinkers *εἰκόασιν οἰομένοις* that semen is a colliquescence (*σύντηγμα*) and not, as Aristotle holds, a natural residue (*περίττωμα*). 'For to say that the semen is drawn from the whole body in virtue of the heat generated by movement is tantamount to saying that the semen is equivalent to a colliquescence.' *τὸ γὰρ ἀπὸ παντὸς ἀπιέναι φάναι (sc. τὸ σπέρμα) διὰ τὴν θερμότητα τὴν ἀπὸ τῆς κινήσεως συντήγματος ἔχει δύναμιν*.¹⁶

Precisely the view which Aristotle describes is found in the Hippocratic treatise *περὶ γονῆς*.¹⁷ Peck rightly remarks that 'Aristotle's equation of this view (*sc.* of the *περὶ γονῆς*) with the belief that semen is a *σύντηγμα* is hardly fair, in face of the context'.¹⁸ For in the *περὶ γονῆς* the semen is described as 'the strongest part' of the liquid in the body, and the proof of this, *ὅτι ἐπὶν λαγνεύσωμεν σμικρὸν οὕτω μεθέντες ἀσθενέες γινόμεθα*, is later repeated by Aristotle, precisely as a proof that the semen is a *περίττωμα*.¹⁹

There remains the distinction that for the Hippocratic writer the semen is, in Aristotle's phrase, *τὸ ἀπὸ παντὸς ἀπιόν*, whereas Aristotle prefers to say that it is *τὸ πρὸς ἅπαντ' ἰέναι πεφυκός*.²⁰ But clearly Aristotle's decision to class the semen of the Hippocratic writer, on these grounds, as a colliquescence and not as a natural residue is fairly arbitrary. The element of arbitrariness in Aristotle's decision would seem to find expression in the introductory phrase, *εἰκόασιν οἰομένοις*.

3. Thirdly, Aristotle's remarks here on Empedocles have nothing directly to do with his main argument. Aristotle makes no play with the theory of effluences. His remarks at this point are fairly clearly intended solely as a justification, or perhaps a correction, of his earlier association of Empedocles with Plato, in so far as this implied that for Empedocles as for Plato the fire which leaves the eye is responsible for vision. The fact that Aristotle should need to retrace his steps in this way is in itself significant. Still more significant is the manner in which Aristotle chooses to justify, or correct, himself. For the form of Aristotle's justification, or correction, makes it reasonably clear that the association of Empedocles with Plato depends solely on the image of the lantern.²¹

Does the image of the lantern in fact describe fire leaving the eye, and does it make this fire responsible for vision? The answer is yes to the first question, and no to the second. Fire leaves the eye in the way in which fire or light (Empedocles apparently does not distinguish the two) leaves the lantern. But the lines which Aristotle quotes do not say that this fire was responsible for vision. Whether it was so or not must depend on the context and the purpose of the fragment.

Now by a happy chance the context of the fragment is not altogether unknown to us.

¹⁴ *ACP* 97 n. 409.

¹⁵ 1042b15-1043a28.

¹⁶ 724b34-725a1.

¹⁷ Chapter 1 = vii 470 Littré.

¹⁸ Loeb edition of the *De gen. anim.* 78.

¹⁹ 725b4-8.

²⁰ 725a21-4.

²¹ There has inevitably been a tendency to suppose that the two factors in the act of vision were harmonised in some part of the poem now lost to us,

e.g. by Beare, *Elementary cognition* 19 n. 3, and Lackenbacher, *WS* xxxv (1913) 42-3. But Aristotle gives a fairly clear impression, it seems to me, that the simile of the lantern was his only evidence for the notion of fire leaving the eye. Alexander makes it fairly clear that he too has taken Aristotle's words in this way, *De sensu* 23.8-10, *cf.* 24.2-3. The lack of other evidence is also indicated by the implied completeness of Theophrastus' account, *cf.* n. 3 above.

The first chapter of Theophrastus' account of Empedocles' theory of sensation falls into three parts.²²

1. First, Theophrastus outlines Empedocles' general theory of perception by means of different sizes of pores and effluences (*Doxographi* 500.19–23).

2. Secondly, he describes the composition and the structure of the eye, *Dox.* 500.23–5: *πειρᾶται δέ (sc. Empedocles) καὶ τὴν ὄψιν λέγειν, ποία τίς ἐστὶ καὶ φησι τὸ μὲν ἐντὸς αὐτῆς εἶναι πῦρ, τὸ δὲ περὶ αὐτὸ γῆν καὶ ἀέρα, δι' ὧν διέειναι λεπτὸν ὄν καθάπερ τὸ ἐν τοῖς λαμπτήρσι φῶς.*²³

3. Finally, Theophrastus describes the act of vision in terms of pores and of effluences from the object seen, *Dox.* 500.25–9: *τοὺς δὲ πόρους ἐναλλάξ κείσθαι τοῦ τε πυρὸς καὶ τοῦ ὕδατος, ὧν τοῖς μὲν τοῦ πυρὸς τὰ λευκά, τοῖς δὲ τοῦ ὕδατος τὰ μέλανα γνωρίζειν· ἐναρμόττειν γὰρ ἑκατέροις ἑκάτερα. φέρεσθαι δὲ τὰ χρώματα πρὸς τὴν ὄψιν διὰ τὴν ἀπορροήν.*²⁴

The point to notice is that in Theophrastus' summary the image of the lantern is introduced *antecedently* to the account of vision, as part of a description of the composition and the structure of the eye.

This placing of the simile reveals Theophrastus' understanding of the purpose of the fragment. In Theophrastus' account there are two kinds of passages or pores: there must be passages through the earth and air surrounding fire, and there are pores of fire and water. The pores of fire and water are alone said to act as channels of perception. In the simile only one kind of pore or passage is mentioned: the 'wonderful funnels' in line 9 of the fragment. These pierce the delicate membranes which protect the fire in the eye from the water which surrounds it. Now these membranes are evidently the same as the 'earth and air' which Theophrastus tells us surrounded fire, in the *second* part of his summary (*Dox.* 500.23–5). The funnels which pierce the membranes are not the same therefore as the pores of fire and water by which we see white and black, or light and dark things, as described in the *third* part of Theophrastus' summary (*Dox.* 500.25–9). The 'wonderful funnels' do not therefore, according to Theophrastus, act as channels of perception.²⁵

Thus on Theophrastus' interpretation it appears that outward-flowing fire and effluences from the object seen were described at two distinct stages in the account of vision. Outward-flowing fire was mentioned first, in the simile of the lantern, as part of a description of the composition and the structure of the eye. Effluences from the object seen came next, as part of an explanation of the act of vision.

If this was so, then there may well have been no need for Empedocles to explain what fire did when it left the eye. For even apart from the experience described by Aristotle in the *De sensu*, it was common belief that fire or light shone from the eye. In Aeschylus, Prometheus says of Typhon,

ἐξ ὀμμάτων δ' ἤστραπτε γοργωπὸν σέλας.²⁶

²² *De sens.* 7 (DK i 301.26–35 = *Doxographi* 500.19–29).

²³ On the text of this passage see note 6 p. 163 below.

²⁴ In Plato's account of Empedocles' theory of vision in the *Meno* 76c–d (DK 31A92) there is a twofold division. Plato first outlines the general theory of pores and effluences, 76c7–d2. He then applies this theory to the process of vision, 76d2–5. But Plato so abbreviates the application of the theory to vision that he gives no more specific account of the structure of the eye than that it is 'symmetrical' to effluences from the object seen.

²⁵ I have avoided calling these funnels 'pores'. This is probably an unnecessary scrupulosity: for the function of these 'funnels', to keep back water and let through fire, is directly analogous to the function of the 'furrows' (*ἀλοξίω fr.* 100.3) which in the process of breathing keep back blood and let through air; in his paraphrase of *fr.* 100 Aristotle speaks of the furrows as 'pores', *De resp.* 473b1–5.

The composition and function of the funnels and membranes is considered further in note 6 pp. 163–6 below, where I conclude that in fact fire and water are the only percipient elements in the eye.

²⁶ Aesch. *Prom.* 356.

Theocritus says of the snakes that advance upon the infant Heracles,

ἀπ' ὀφθαλμῶν δὲ κακὸν πῦρ
ἐρχομένοις λάμπεισκε.²⁷

Empedocles and his audience could well have taken it for granted that fire did in fact leave the eye, even if they did not think that its leaving the eye had any particular part to play in the act of vision.²⁸

If we do suppose that Empedocles' intention in composing the simile was to give an account of the structure and composition of the eye, and not to explain the purpose or function of fire leaving the eye, then it seems to me that we can explain Aristotle's behaviour, without supposing that Theophrastus' account of Empedocles is seriously, and surprisingly, deficient, and yet without on the other hand needing to suppose that Aristotle has distorted or suppressed the evidence to an implausible degree.

For when we turn to Aristotle it is at once obvious that there has been a crucial alteration in the placing of the simile.

Aristotle's second set of criticisms contains three points: that the eye is made of fire, that fire leaves the eye, and that the fire which leaves the eye is responsible for vision. Aristotle isolates the first point from the other two, 437b10 ff.: ἐπεὶ εἴ γε πῦρ ἦν (*sc. ὁ ὀφθαλμός*), καθάπερ Ἐμπεδοκλῆς φησὶ καὶ ἐν τῷ Τιμαίῳ γέγραπται. . . . But he does not separate the second point from the third, 437b12 ff.: καὶ συνέβαινε τὸ ὁρᾶν ἐξιόντος ὥσπερ ἐκ λαμπτήρος τοῦ φωτός. . . . This grouping of ideas alters radically the purpose of the simile. The outward-flowing fire of the lantern is no longer attached to the composition and the structure of the eye, as it is in Theophrastus' account of Empedocles. It is associated with the act of vision, as it would be in Plato.

How do we explain this discrepancy?

As I have noted, Aristotle's interest is centred on the idea of fire which leaves the eye. Aristotle never pauses to consider the composition of the eye, except in terms of the fire which is thought to leave the eye; and he never pauses to criticise the idea of outward-flowing fire, except in terms of its purpose or function.²⁹

Aristotle's concentration of interest is reflected in his style. As I have noted, Aristotle passes quickly, and in a rather intricately woven series of clauses, from the notion of fire leaving the eye, when the eyeball is pressed or moved quickly in the dark, to the idea that the fire which leaves the eye is responsible for vision. This second idea is clearly dominated by Plato.

²⁷ Theocr. *Id.* xxiv 18–19. These and other examples, from human and non-human eyes, are quoted (in the course of a different argument) by Verdenius, *Studia Vollgraff* 161–2.

²⁸ Bignone, 249 n. 2 and 381 n. 1, and Cherniss, *ACP* 317 n. 106, both take the simile to explain some kind of flashing from the eye, whether as an account of the structure of the eye (Cherniss), or as an indication that the eye was made of fire (Bignone). Verdenius, *Studia Vollgraff* 156 n. 5 and 159, objected that this rendered the description of φῶς ἐξω διαθρῶσκον otiose. Since Cherniss, versions of the theory that we see by outward-flowing fire have been repeated by Verdenius, Guthrie and several other scholars, as cited in note 3 pp. 157–9 below.

Two loose suppositions could have served to attach the notion of outward-flowing fire to the act of vision. First, the fact that there are pores of the right size for

fire to *leave* the eye through naturally implies that there are pores of the right size for fiery effluences to *enter* the eye through. Secondly, Empedocles may conceivably have thought that fire must leave the eye in order to make room for fiery effluences from the object seen.

In neither case would the fire which leaves the eye have acted as an organ of vision, so that both suppositions would be compatible with Theophrastus' silence and with the explanation that I offer of Aristotle's implied charge of inconsistency.

²⁹ It would be wrong to set limits to Aristotle's ingenuity, but it would perhaps be difficult to see what other grounds of argument he could have employed without resorting to dissection, which in this context would have been untypical of Aristotle's method. As it is, Aristotle does once cite an instance from the battlefield, 438b11–16.

Thus the style and purpose of Aristotle's criticism serves to give the fire which leaves the eye in Empedocles' simile dominant importance. The association with Plato, I would suggest, has served to misplace the image of the lantern, in such a way as to suggest that the fire which leaves the eye is responsible for vision.

When Aristotle turns to justify, or to correct, himself, he does not need wholly to repudiate the association of Empedocles with Plato which he had implied earlier.

What Aristotle does in effect repudiate is the notion that for Empedocles, as for Plato, the fire leaving the eye and the effluences from visible objects were complementary parts of a single theory. Indeed by writing *ὅτ' ἐ μὲν . . . , ὅτ' ἐ δέ . . .*, Aristotle acknowledges in effect that outward-flowing fire and effluences from the object seen were described at two distinct stages in the poem, as they are in Theophrastus' summary.

But if, as I have suggested, Empedocles had not in fact been concerned to specify the purpose of fire leaving the eye, it would still be open for Aristotle to make a loose and qualified defence of his earlier implication, by continuing to suggest that this fire did have, or should have had, something to do with the act of vision. Such a loose and qualified form of defence is I think all that need be implied by the expression: *ἔοικεν νομιζόντι*.

My conclusion therefore is that Aristotle's ascription to Empedocles of vision by fire flowing from the eye is explicable as the product of a chance conjunction of circumstances: first, Aristotle's polemical absorption with the notion of fire leaving the eye; secondly, a highly elaborated simile in Empedocles, describing *inter alia* outward-flowing fire, and, from Aristotle's point of view, somewhat loosely applied to its purpose; and finally, Plato's extension of Empedocles' theory, precisely to include outward-flowing fire as an integral factor in the act of vision.

The true purpose of Empedocles' image, I suggest, is simply to describe the composition and structure of the eye, with 'funnels' that are large enough for fire and too small for water.

III

In his account of breathing in the *Timaeus*, Plato describes a theory whereby, in order to avoid a vacuum, and in order to account for the blood's irrigation and cooling of the body, air breathed *in* through the nostrils displaces air from the lungs *out* through the skin; while air breathed *out* through the nostrils displaces air from outside the chest *into* the lungs through the skin.³⁰

According to Aristotle in the *De respiratione*, Empedocles' theory of breathing is the more normal theory that we breathe in and out through the mouth or nostrils only. The complication, from the modern point of view, is that Empedocles supposes that when the inside of the body, presumably the lungs or the chest, is emptied of air it is filled with blood.³¹ Quite possibly Empedocles' purpose, like Plato's, is to avoid a vacuum and perhaps to account for a cooling of our inner heat.³² The theory is illustrated by the simile of the clepsydra, which Aristotle quotes in full.

However, it has commonly been thought that the simile of the clepsydra in fact describes breathing through the skin, *ῥινῶν*, as well as through the mouth or nostrils, and that Aristotle's understanding of *ῥινῶν* as 'nostrils' is mistaken. Here again it seems to me that

³⁰ *Tim.* 77c–79e. On the element of purpose in Plato's account *cf.* note 7 pp. 166–9 below.

³¹ *De resp.* 473a15–474a24. Throughout this essay I have used the convenient periphrasis of 'lungs and chest', taken from the *Timaeus* 79c2, simply in order to avoid attributing any too detailed anatomical knowledge to Empedocles.

³² Both these suggestions on the purpose served by Empedocles' theory of breathing are intended to be speculative. They are considered further in note 7 pp. 166–9 below.

the interpretation of Empedocles' simile has suffered as a result of the elaboration of Empedocles' theories by Plato.³³

The simile of the clepsydra is as follows:

ὄδε δ' ἀναπνεῖ πάντα καὶ ἐκπνεῖ· πᾶσι λίφαιμοι
 σαρκῶν σύριγγες πύματον κατὰ σῶμα τέτανται,
 καὶ σφιν ἐπὶ στομίοις πυκιναῖς τέτρηται ἄλοξιν
 ῥινῶν ἔσχατα τέρθρα διαμπερές, ὥστε φόνον μὲν
 5 κεύθειν, αἰθέρι δ' εὐπορίην διόδοισι τετμηῆσθαι.
 ἔθθεν ἔπειθ' ὀπόταν μὲν ἀπαῖξῃ τέρεν αἷμα,
 αἰθῆρ παφλάζων καταΐσσεται οἴδματι μάργω,
 εἶτε δ' ἀναθρώσκη, πάλιν ἐκπνέει, ὥσπερ ὅταν παῖς
 κλεψύδρῃ παίζῃσι διειπετέος χαλκοῖο—
 10 εἶτε μὲν αὐλοῦ πορθμὸν ἐπ' εὐειδεῖ χερὶ θεῖσα
 εἰς ὕδατος βάπτῃσι τέρεν δέμας ἀργυφέοιο,
 οὐδεὶς ἄγγοσδ' ὄμβρος ἐσέρχεται, ἀλλά μιν εὔργει
 ἀέρος ὄγκος ἔσωθε πεσῶν ἐπὶ τρήματα πυκνά,
 εἰσόκ' ἀποστεγάσῃ πυκινὸν ῥόον· αὐτὰρ ἔπειτα
 15 πνεύματος ἑλλείποντος ἐσέρχεται αἴσιμον ὕδωρ.
 ὡς δ' αὐτως, ὅθ' ὕδωρ μὲν ἔχῃ κατὰ βένθεα χαλκοῦ
 πορθμοῦ χωσθέντος βροτέω χροῖ ἡδὲ πόροιο,
 αἰθῆρ δ' ἐκτὸς ἔσω λελιγμένος ὄμβρον ἐρύκῃ
 ἀμφὶ πύλας ἡθμοῖο δυσηχέος ἄκρα κρατύνων,
 20 εἰσόκε χερὶ μεθῆ, τότε δ' αὖ πάλιν, ἔμπαλιν ἢ πρὶν,
 πνεύματος ἐμπύπτοντος ὑπεκθέει αἴσιμον ὕδωρ.
 ὡς δ' αὐτως τέρεν αἷμα κλαδασσόμενον διὰ γυίων
 ὀππότε μὲν παλίνορσον ἀπαῖξιε μυχόνδε,
 αἰθέρος εὐθὺς ῥεῦμα κατέρχεται οἴδματι θῦον,
 25 εἶτε δ' ἀναθρώσκη, πάλιν ἐκπνέει ἴσον ὀπίσσω.³⁴

The rivalry between the Aristotelian and what I may call the Platonising interpretation of the simile stems in the first place from an ambiguity in two expressions in the opening lines of the fragment: *πύματον κατὰ σῶμα* in line 2, and *ῥινῶν ἔσχατα τέρθρα διαμπερές* in line 4. *Πύματος* and *ἔσχατος* may mean innermost or outermost. *Ῥινῶν* may mean skin or nostrils.

1. On the Platonising interpretation, the opening lines will mean that tubes, partly filled with blood, are stretched across the *outside* of the body, and that their mouths are pierced with numerous little openings right through the *outermost* surface of the *skin*.

2. On the Aristotelian interpretation, the opening lines will mean that tubes, partly filled with blood, are stretched across the *inside* of the body, and that their mouths are pierced with numerous little openings right through the *inside* base or root of the *nostrils*.³⁵

³³ References to modern interpretations of Empedocles' theory of breathing are given separately in note 8 pp. 169–71 below.

If we abandon the theory of cutaneous respiration for Empedocles, the question arises: how original is Plato's theory of respiration? This question is considered separately in note 9 pp. 171–3 below.

³⁴ As with the lantern I print the text from Ross, without intending to commit myself to the details of interpretation implied therein.

³⁵ The element of ambiguity in *πύματος*, *ἔσχατος*, *ῥίς* and *ῥινός* is considered further in note 10 pp. 173–6 below.

'Partly filled with blood' paraphrases *λίφαιμοι* (line 1). Aristotle writes, 473b2–3: *φλέβας . . . ἐν αἷς ἔνεστι μὲν αἷμα, οὐ μέντοι πλήρεις εἰσὶν αἵματος*. Aristotle's qualification may be based on no more than the lines before us: the veins are not full of blood because blood moves up and down in them, periodically leaving room for the entry of air.

In the second place the choice between the two interpretations turns on the detailed application of the simile.³⁶

(i)

According to the Platonising interpretation, the air which beats on the perforations of the clepsydra, when the clepsydra is full of water, is parallel to the air which in Plato's theory is waiting, as it were, to enter the body through pores in the skin of the chest, but which is held back, so to speak, by the blood which has advanced to the outermost surface of the skin.

Unfortunately the parallelism stops there. For Plato's air *does* enter through pores in the chest, while air *does not* enter through perforations in the clepsydra. On the contrary, water pours out through the perforations in the clepsydra. This, if we tried to correlate Plato's theory exactly, should mean that blood oozed out through pores in the chest.

This is not the only difficulty which results from a Platonising interpretation of the simile. An extreme form of Platonising interpretation was recently put forward in this Journal by Professor Furley. Furley's pursuance of his thesis creates an impossible tangle of absurdities.³⁷

1. In the fragment, Empedocles describes essentially a single stream of breath, in and out.³⁸ To provide for the second stream of breath which is required by the Platonising interpretation, Furley seeks to reconstruct the concluding lines of the fragment.³⁹ At the end of the fragment, Empedocles says that when blood rushes *μυχόνδε*, a stream of aether at once pours into the body (lines 23-4). Furley seeks to interpret *μυχόνδε* as meaning not 'to the *inside* of the body', which is what one would expect, but 'towards the pores of the skin', and so as meaning in effect to the *outside* of the body. In the following line, he proposes to change the usual reading, *αἰθέρος*, which exactly matches *αἰθήρη* in the first description of breathing in line 7, to *τοῦτ'ερον* (from *ἕτερον* in some manuscripts), so as to mean 'the other' stream of air to that which passes through the pores. But it is much more natural to suppose that the two descriptions of breathing, before and after the account of the clepsydra, will match, as Furley half admits.⁴⁰

2. Furley himself seems aware of the weakness of this reconstruction of the concluding lines of the fragment. He writes that he would not wish to 'insist' on it.⁴¹ But he admits that in that case his analysis leaves him 'faced with the objection that Empedocles *said* nothing about breathing through the nose and mouth. I can only

³⁶ The nature and workings of Empedocles' clepsydra are excellently described by H. Last, 'Empedokles and his klepsydra again', *CQ* xviii (1924) 169-73. The clepsydra in question is a vessel with perforations at the bottom and a vent at the top. By blocking and unblocking the vent at the top, liquids can conveniently be transferred from one container to another.

Various misunderstandings connected with the workings of the clepsydra are considered separately in note 11 pp. 176-9 below.

³⁷ D. J. Furley, 'Empedocles and the clepsydra', *JHS* lxxvii (1957) 31-4. Furley is more thoroughgoing than most other writers in his pursuance of a Platonising interpretation for the simile. But his primary suggestion, 32, that the upper vent of the clepsydra corresponds to the nose or mouth, while the perforations correspond to pores, is not original,

as both Furley himself, 31-2, and Lloyd, *Polarity and analogy* 329-30, seem to suppose. Precisely this correlation was put forward by Winnefeld, *Philosophie des Empedokles* 38. Before that, the same correlation had been put forward, and rejected for its deficiencies, by Lommatzsch, *Die Weisheit des Empedokles* 223-4.

³⁸ The air which presses on the perforations from below, but which does not enter the clepsydra, is taken into account below, pp. 153-4, see also note 11 pp. 176-9 below.

³⁹ Furley, 33.

⁴⁰ The half admission is in the footnote, 33 n. 5. Such repetition is of course a regular feature of Homeric simile, cf. Hermann Fränkel, *Die homerischen Gleichnisse* (Göttingen, 1921) 4-5.

⁴¹ Furley, 33.

answer that he must have known about it . . . and we are forced to guess what he meant.⁴² But for the simile not to describe the most obvious fact of breathing, breathing through the nose or mouth, would seem to be in itself a *reductio ad absurdum* of Furley's thesis.

3. Not only, on Furley's analysis, does Empedocles say nothing about breathing through the nose or mouth. The clepsydra does not function properly as a description of breathing through pores in the chest. For air, on Furley's interpretation, enters through pores in the chest. But air does not enter through the perforations at the base of the clepsydra; it enters through the mouth of the clepsydra, when water pours out through the perforations. Furley has to write that Empedocles 'could not find a model in which air followed the liquid inside; but he *could* show that there is air pressure on the surface so that the air *would* follow if it could.'⁴³

4. Not only does the clepsydra not explain what it should explain. It seems to explain something else. On Plato's theory there is a kind of continuous process: breathing in through the nose is accompanied by breathing out through the chest, and *vice versa*. But the clepsydra describes a stage where the vessel is full of air and water cannot enter. Furley has to find something for this to represent. He concludes that the fact that water cannot enter the clepsydra when the neck is blocked 'seems to explain why you cannot breathe with your nose and mouth gagged'.⁴⁴ But it would seem nonsensical to make Empedocles' simile describe this fairly unusual phenomenon, when at the same time it has failed, on Furley's interpretation, to describe the primary fact of breathing through the mouth or nostrils.

5. Finally, Furley has to suppose, as others have done, that Aristotle has misunderstood *ῥινῶν* to mean 'nostrils' and not 'skin', and that Aristotle's 'mistaken idea that Empedocles was talking about nostrils instead of pores prevented him from understanding the passage'.⁴⁵

But Aristotle's behaviour in the *De respiratione* is entirely different from his behaviour when he talks of the lantern in the *De sensu*. In the *De sensu* Empedocles is introduced into a preordained and rather intricately formulated scheme. This leads, I have suggested, to an association with Plato, with implications which are false, but which in the context of Aristotle's argument are fairly easily understandable. In the *De respiratione* Empedocles' theory is presented free from entanglement with other thinkers. Aristotle criticises Empedocles, it is true, but on comparatively simple grounds, primarily that Empedocles has failed to distinguish breathing through the nostrils from breathing through the *ἀπρηρία* or windpipe. There is no obvious reason why this simple criticism should have perverted Aristotle's whole understanding of Empedocles' theory and made him blind to an essential

⁴² Furley, 33. The observation is taken from Taylor, *Timaeus* 560: 'unfortunately nothing has been left to show how Empedocles worked the mouth and nostrils into his account'.

⁴³ Furley, 33.

⁴⁴ Furley, 33. The same idea occurs in Lommatzsch, *Die Weisheit des Empedocles* 224: 'denn so wie, wenn die Hauptmündung geschlossen ist, der jedesmalige Zustand der Wasserglocke unverändert bleibt, so würde dann auch dasselbige in Beziehung auf den Athmungsprozess wohl als empedocleisch gelten, nämlich bei geschlossener Nase und Mund der Athmungsprozess gleichfalls still stehen'.

We might expect Furley to argue that being gagged was explained by the clepsydra's being full of water, not full of air. But the picture he has in mind

is that 'blood cannot leave the surface of the body to make room for air, because the air cannot escape through the nose and mouth' (p. 33). In other words, Furley supposes that the clepsydra's being full of water is equivalent to there being both blood and air in the body. It is true that the writer of the *Problemata* 915a4-24 (in part DK 59A69) explains the retention of water in the clepsydra by the presence of air wedged in the neck of the clepsydra. This explanation has been applied to Empedocles' clepsydra by Diels, and recently by Wilkens, see note 11 p. 176f. below. But this is not the explanation of the clepsydra's behaviour which Furley has adopted on the preceding page of his article.

⁴⁵ Furley, 34.

identity of Empedocles' theory and Plato's, especially since Plato's theory has been described in detail in the chapters immediately preceding.

(ii)

How successfully then will Aristotle's interpretation explain the application of the workings of the clepsydra to the process of breathing?

An Aristotelian version of the simile was put forward recently in this Journal by Mr Booth.⁴⁶ Virtually the same interpretation was put forward simultaneously by Signora Timpanaro Cardini.⁴⁷ Booth's reconstruction has been adopted tentatively by Professor Guthrie, and it is followed in essentials by Dr Lloyd.⁴⁸

Booth's interpretation clears away the absurdities in Furley's account. But it leaves us faced with a new and strange anomaly. The opening lines of the fragment tell us that there are pores large enough for air to pass through them, but too small for blood. But in the clepsydra, water, not air, passes through the perforations. Booth therefore supposes that water in the clepsydra represents air in breathing and that air in the clepsydra represents blood.⁴⁹

But the comparison of blood with air and not with water is highly implausible. It seems to me equally implausible that air in the body should not be represented by air in the clepsydra.

This primary implausibility is not, I think, sufficiently mitigated by Booth's subsidiary argument, that blood in the body is presented in subordinate clauses (lines 6-8 and 22-5) and that air in the clepsydra is likewise presented in subordinate clauses (lines 15 and 21).⁵⁰

This argument is materially correct, but it seems to me to have little force. For the correspondence of clauses is not in fact strongly marked between the description of air, πνεύματος ἐλλείποντος (line 15) or πνεύματος ἐμπίπτοντος (line 21), and the description of blood, ὅπταν μὲν ἀπαίξῃ . . . , εὔτε δ' ἀναθρώσκη . . . (lines 6-8) or ὅπποτε μὲν . . . ἀπαίξειε . . . , εὔτε δ' ἀναθρώσκη . . . (lines 22-5).⁵¹

Signora Timpanaro Cardini and Dr Lloyd seek to argue that blood and air are parallel

⁴⁶ N. B. Booth, 'Empedocles' account of breathing', *JHS* lxxx (1960) 10-15.

⁴⁷ M. Timpanaro Cardini, 'Respirazione e clessidra (Empedocle fr. 100)', *La parola del passato* xii (1957) 250-70.

⁴⁸ Guthrie, *History* ii 220-6. Lloyd, *Polarity and analogy* 328-33. For Verdenius, and for Seeck's recent article, see note 8 pp. 169-71 below.

⁴⁹ Booth, 13. The equation of blood with air first appears in a very confused form in Freeman, *Pre-Socratic philosophers* 195. Within the space of a few sentences Miss Freeman first implies the equation of blood with air, and then implies the opposite equation, of blood with water and of air with air.

The explicit equation of blood with air and of air with water is also made in the course of some very brief remarks by T. B. L. Webster, 'From primitive to modern thought in ancient Greece', *Acta congressus Madvigiani = Proceedings of the second international congress of classical studies* ii (Copenhagen, 1958) 35.

Bollack equates both air in the clepsydra and water with air in breathing, while blood, he thinks, is represented by the girl's hand, *Empédocle* i 244, see further note 11 pp. 176-9 below.

The equation of blood and air is already beginning to breed its own mythology. In *Studi Torricelliani* 155-6 Timpanaro Cardini writes that the equation shows 'come Empedocle avesse osservato il funzionamento della clessidra senza un' interpretazione preconcepita'.

⁵⁰ Booth, 12-13.

⁵¹ It is in favour of Booth's interpretation (although he does not take up the point) that the two descriptions of aether παφλάζων . . . οἰδαμι μάργω (line 7) and βεῦμα . . . οἰδαμι θῶν (line 24), contain words commonly used of a liquid, see LSJ s.vv.

On the other hand, τέρεν is used three times, twice of blood (lines 6 and 22) and once of water (line 11). This tells, if only very slightly, in favour of the other correlation, of water with blood.

In fact I should be loth to lean at all heavily on these slight similarities of language. For example, eyes are ἀτειρέα in fr. 86. Fire or light flows from the lantern ἀτειρέσων ἀκτινεσσων fr. 84.6. But I do not take the repetition of the adjective as an indication that we see by fire flowing from the eye.

because blood controls the entry and departure of air in the body, while air in the clepsydra controls the entry and departure of water.⁵²

In its simplest form, this argument seems to me to do no more than repeat, from a different point of view, Booth's argument that the movement of blood and of air in the clepsydra is presented in subordinate clauses, while the entry or departure of air in breathing and of water is presented as a main clause.

In a more complex form, this argument is tied to the notion that the *tertium comparationis* in the simile lies in 'variations of pressure' through a perforated strainer. I have tried to show separately that this notion rests on a fundamental misunderstanding of the nature of pores and perforations.⁵³

(iii)

The solution I propose for the simile is that we retain the Aristotelian interpretation, of breathing through the nostrils and not through the skin, but that we abandon the comparison of pores and perforations.

At first blush, this may seem as bitter a pill to swallow as that air and water should not be equal respectively to air and to blood. But on acquaintance the solution that I propose proves, I think, more palatable than Mr Booth's alternative.

It is true that there is an initial similarity of language between pores and perforations. The 'bloodless' tubes in the body *πυκναῖς τέτρηνται ἄλοξιν* (line 3). Ten lines later, the perforations in the clepsydra are called *τρήματα πυκνά* (line 13).⁵⁴

But the repetition of adjective and the repetition in noun and verb is outweighed, I suggest, by the fact that pores behave quite differently from perforations in the clepsydra.

In breathing, Empedocles applies his usual rule, the rule that we have seen illustrated in the simile of the lantern, to the effect that there are pores or 'funnels' of the right size for one element, but too small for another. In this case the pores somewhere at the base of the nostrils are the right size for air to pass through, but too small for blood.

In the working of the clepsydra, a quite different situation obtains. Both the elements which are active in the working of the clepsydra could pass through the perforations. Air could pass through the perforations of the clepsydra, although in the filling and emptying of the clepsydra it does not in fact do so, but enters only through the neck at the top of the clepsydra. Water can, and periodically does, pass through the perforations. When it does not do so, it is not because the perforations are too small for it, but because air either beats back the water from within, or presses against the perforations from without.⁵⁵

Not only are the workings of pores and of perforations entirely different. On the Aristotelian version of Empedocles' theory of breathing, their relative positions are not at all comparable. The position of perforations at the base of the clepsydra could plausibly be taken (on the Platonising interpretation of the simile) to represent the position of pores in the skin of the body. But the position of perforations at the base of the clepsydra cannot plausibly represent the position of pores at the base of the nostrils. For when air enters the nose or mouth, it *passes through* the pores somewhere at the base of the nostrils, and presumably comes to rest *below* the pores, somewhere inside the lungs or chest. When air enters the clepsydra, it *stops short* of the perforations at the base of the clepsydra, and comes to rest inside the clepsydra *above* the perforations. To compare the perforations at the *base*

⁵² Timpanaro Cardini, 257 and 269-70, see also *Studi Torricelliani* 155-6. Lloyd, *Polarity and analogy* 330-1.

⁵³ Note 11 pp. 176-9 below.

⁵⁴ The same verb, *τετρήατο* (a virtually certain emendation), is used for the 'wonderful funnels' in the eye, *fr.* 84.9.

It should be noted that *πυκ(ι)νός*, the adjective applied to pores and perforations in *fr.* 100, is also once used of air (line 14). This diminishes perhaps, if only very slightly, the idea that the word is intended to indicate a parallelism of pores and perforations.

⁵⁵ This point, which is obscured in Lloyd's account, is considered further in note 11 pp. 176-9 below.

of the clepsydra with pores at the root of the nostrils, i.e. presumably somewhere at the *top* of the lungs or chest, is, literally, to stand the simile on its head.

The anomaly is not removed by equating air in the clepsydra with blood and water in the clepsydra with air in breathing, as Booth has done. For in the clepsydra water enters and departs through the strainer at the bottom of the clepsydra, while air comes in and goes out through the opening at the top of the clepsydra. If water represents air, then air in breathing should move in and out *below* the blood. In fact of course, on Empedocles' theory, it does just the opposite. Somehow Booth's interpretation of the simile is still upside down.

It is only if pores and perforations are no longer equated that the relation of air and water in the clepsydra at once matches exactly the relation of air and blood in breathing. The clepsydra is filled alternately with air and with water, in the same way that the lungs or chest are filled alternately with air and with blood. Air passes up and down through the neck of the clepsydra, in the same way that air is breathed in and out through the mouth or nostrils. Water passes in and out through the base of the clepsydra, in the same way that blood wells up and then drops back through veins in the lungs or chest.

On this interpretation, the detailed application of the working of the simile to the process of breathing is as follows. The simile contains four parts, corresponding to four stages in the act of breathing: 1 holding one's breath in, 2 breathing out, 3 holding one's breath out, as it were, and 4 breathing in.

1. Lines 8–13. Water cannot enter the clepsydra when it is full of air and the top of the clepsydra is closed. In the same way, blood cannot enter the lungs when they are full of air.

2. Lines 14–15. When the girl's hand is taken from the top of the clepsydra, water enters. In the same way, blood enters the lungs when we breathe out.

3. Lines 16–19. When water fills the clepsydra and the top of the clepsydra is closed, air cannot enter. In the same way, air cannot enter the lungs when they are full of blood.

4. Lines 20–1. When the girl's hand is taken from the top of the clepsydra, air enters the clepsydra and water rushes out. In the same way, blood rushes out of the lungs when we breathe in air.

This interpretation, it seems to me, at once restores the simplicity which must be a criterion of a successful resolution of the simile. No one, I suggest, on a first, or a second hearing, could possibly have appreciated that the simile did not describe breathing through the nose or mouth, but explained 'why you cannot breathe with your nose and mouth gagged'. It seems to me almost equally difficult to read the simile, keeping in mind the idea that perforations at the base of the clepsydra represent pores at the top of the lungs or chest, and that water in the clepsydra represents air in breathing, while air in the clepsydra represents blood. But once we do not anticipate the description of perforations in the clepsydra, and once we do not set out with the assumption that pores in breathing must be represented by perforations in the clepsydra, then the simile, it seems to me, becomes at once entirely simple and uncomplicated.

It has been said that 'no explanation ought to be accepted unless it can show why Empedocles chose the *clepsydra* as his illustrative model, and why having chosen it he stressed particularly its odd behaviour when the top vent is plugged'.⁵⁶ The answers to these two questions should now be apparent. First, the clepsydra offers an example, I think perhaps a unique example, of a vessel which is filled alternately with air and with water, which enter and leave, the air through the top of the vessel, and the water through its base. In

⁵⁶ Furley, *JHS* lxxvii (1957) 32.

the same way, the lungs or chest are filled alternately with air and blood, which enter and leave, the air through the mouth and nostrils, the blood from somewhere inside the body. Secondly, the two moments when we have breathed in, and the lungs are full of air, and when we have breathed out, and the lungs are filled with blood, correspond nicely to the two stages when the clepsydra is filled respectively with air and with water.

This interpretation gives point to the fact that the little girl is *playing* with the clepsydra (line 9). The little girl holds the clepsydra full of air, under water, with the upper vent blocked (lines 10–13). There would be no need to do this, if one were simply transferring liquids from one container to another. As it is, playing with the clepsydra happily provides a stage when the clepsydra is full of air and water cannot enter. This exactly matches the time when the clepsydra is full of water and air cannot enter (lines 16–19). This *pair* of stages provides a neat parallel for the two moments when we have breathed in, and the lungs or chest are full of air, and when we have breathed out, and the lungs or chest, on Empedocles' theory, are full of blood.

Other interpretations fail to provide a complete correlation between the working of the clepsydra and the act of breathing because they fail at this point to take into account the two terminal moments in breathing: the one when we have breathed in, and the lungs are full of air, and the other when we have breathed out, and the lungs or chest, according to Empedocles, are filled with blood. Thus Lloyd finds the behaviour of the clepsydra 'more complex' than the act of breathing, because he considers the process only of inhalation and exhalation, not the term of either process.⁵⁷ Similarly, two recent authors write: 'The point of comparison between the breathing body and the *clepsydra* is the movement of liquid (blood or water) and air in and out or up and down through the "strainer" of the skin or the vessel. This means that only that part of the *clepsydra's* action which follows the finger being lifted off the top-hole is relevant to the comparison.'⁵⁸

It is true of course that Empedocles describes the process only of breathing, i.e. the movement of air in and out, and leaves the term of either process to be inferred, while in his account of the clepsydra he describes both the process, the movement of air and water in and out, and the term of either process.

However it seems to me at once inevitable and reasonably obvious that in a complete act of breathing there are two terminal moments, a moment when the lungs or chest are full of blood, and a moment when the lungs or chest are full of air. It also seems to me entirely natural that as a writer in the Homeric tradition Empedocles should spend longer on, and therefore describe in more detail, the illustration and not the thing it illustrates. Thus Empedocles spends thirteen verses (lines 9–21) on the clepsydra, and only three or four verses on each account of breathing, before and after the description of the clepsydra (lines 6–8 and 22–5).

In general, the point to appreciate, I suggest, is that the simile of the clepsydra, unlike the simile of the lantern, has been designed as a description of *what* happens, not as an explanation of *how* it happens. The clepsydra is filled alternately with air and with water, in the same way that the lungs or chest are filled alternately with air and with blood. *How* the air and water move to and fro is irrelevant to the purpose of the simile.

This distinction in the purpose of the simile will explain the two different movements of air in the clepsydra, a feature of the simile which has troubled one or two recent scholars. In the first half of the description of the clepsydra (lines 8–15), air beats *down* on the perforations from within the clepsydra, and then moves *up* through the top of the clepsydra. In the second half of the description (lines 16–21), air beats on the perforations of the clepsydra *from below*, and then enters the clepsydra through the neck *from above*. But on the Aristotelian version of Empedocles' theory of breathing, air never finds itself below the

⁵⁷ *Polarity and analogy* 330–1.

⁵⁸ Harry and Agathe Thornton, *Time and style, a psycho-linguistic essay in classical literature* (London, Methuen, 1962) 23.

blood, which on Aristotle's interpretation would place it somewhere in the entrails of the body. Air simply passes in and out through the nostrils, as the blood wells up and then drops back.⁵⁹

This discrepancy between the movements of air in the clepsydra and the movement of air in breathing can be explained on the principle I have suggested: the difference between what happens in the clepsydra, and how it happens. The air which passes in and out through the neck of the clepsydra represents the air we breathe in and out through the mouth or nostrils. But the air which controls the behaviour of water by beating on the perforations from below is not intended to be an active element in the application of the simile.⁶⁰

It is really only the comparison with Plato which has given the air beating on the perforations of the clepsydra a spurious significance, as a parallel to the air which in the *Timaeus* enters the lungs or chest through pores in the surface of the skin. In the same way, the fire which leaves the eye in Plato, and forms a single body with effluences from the object seen, has given a spurious significance to the fire which leaves the eye in the simile of the lantern. In both cases, Empedocles' beautiful elaboration of *simile* has been turned into an elaboration of *theory*, which is not his but Plato's.

NOTE 1.—*Empedocles' style of simile*

Kranz, in an article in *Hermes*, offers a study of fourteen similes in Empedocles.⁶¹ Snell, in *Die Entdeckung des Geistes*, compares Empedocles' similes with Homer's.⁶² Neither study is wholly successful.⁶³ I consider here two points which are relevant to this essay.

(i)

Snell fails fully to note the way in which Empedocles follows Homer in his pursuance of the details of a simile for their own sake, at the cost of distancing himself from what is strictly the *tertium comparationis*.⁶⁴

An appreciation of this technique is essential for the interpretation which I have offered of the two similes. In *fr.* 84 the *tertium comparationis*, I have argued, lies in the nature of 'funnels', large enough for fire, too small for wind or water. The description in line 6 of the fire which leaves the lantern,

λάμπροσκεν κατὰ βῆλὸν ἀτειρέσιν ἀκτίνεσσιν,

⁵⁹ The different directions in which air moves in the clepsydra seem to puzzle Otto Regenbogen, 'Der Klepsydravergleich des Empedokles', Beilage iv of 'Eine Forschungsmethode antiker Naturwissenschaft', first published in *Quellen und Studien zur Geschichte der Mathematik Astronomie und Physik*, Abteilung B Studien, Band i (Berlin, 1931) 181, reprinted in *Kleine Schriften* (München, 1961) 193.

Timpanaro Cardini runs two points together, *La parola del passato* xii (1957) 257 *sub finem*. First, air moves in opposite directions. Secondly, it is the same air which keeps water out of the clepsydra and which then leaves the clepsydra; while the air which keeps water inside the clepsydra is different from the air which then enters through the neck of the clepsydra.

It would of course be possible to remove this second anomaly by attributing to Empedocles a theory of ἀντιπερίστασις, whereby the air which

pressed on the perforations from below moved around and entered the clepsydra from above.

⁶⁰ These two movements of air, and the whole difference between pores in the body and perforations in the clepsydra, are considered further in note 11 pp. 176–9 below.

⁶¹ W. Kranz, 'Gleichnis und Vergleich in der frühgriechischen Philosophie', *Hermes* lxxiii (1938) 100–9.

⁶² Bruno Snell, *Die Entdeckung des Geistes, Studien zur Entstehung des europäischen Denkens bei den Griechen*, 3rd edn (Hamburg, 1955) 284–98.

⁶³ References to other studies may be found in *Bibliographie zur antiken Bildersprache* unter Leitung von Viktor Pöschl, bearbeitet von Helga Gärtner und Waltraut Heyke (Heidelberg, 1964) 150–2.

⁶⁴ Snell does have some remarks pointing in this direction, 286–7, but his purpose is to contrast Empedocles and Homer.

is part of the elaboration of the simile. Equally, in *fr.* 100, the *tertium comparationis*, I have argued, lies in the filling of the clepsydra and the lungs alternately with air and with water or blood. The description in line 13 of the air which presses on the perforations of the clepsydra,

ἀέρος ὄγκος ἔσωθε πεσῶν ἐπὶ τρήματα πυκνά,

is part of the elaboration of the simile. This elaboration of detail inessential to the *tertium comparationis* is entirely natural for a writer in the Homeric tradition.

At the same time it is of course inevitable that in the kind of similes Empedocles has chosen there should be features peculiar to one half only of the comparison. The image of the *κύαθοι* is a warning. Aristotle writes, *De caelo* 295a16–21 (DK 31A67): οἱ δ' ὥσπερ Ἐμπεδοκλῆς, τὴν τοῦ οὐρανοῦ φορὰν κύκλῳ περιθέουσιν καὶ θάπτον φερομένην τὴν τῆς γῆς φορὰν κωλύειν, καθάπερ τὸ ἐν τοῖς κύαθοις ὕδωρ· καὶ γὰρ τοῦτο κύκλῳ τοῦ κύαθου φερομένου πολλάκις κάτω τοῦ χαλκοῦ γινόμενον ὅμως οὐ φέρεται κάτω, πεφυκὸς φέρεσθαι, διὰ τὴν αὐτὴν αἰτίαν.

Here the *tertium comparationis* lies in the presence of a heavier element, water or earth, above a lighter element, air, because of the force of rotation. The *κύαθοι* themselves are not an active element in the simile, in the sense that the earth is not carried round 'in' anything. The fact that the water in the *κύαθοι* is carried round in a circle, while the earth is immobile, is equally incidental to the primary purpose of the simile.⁶⁵

The image of the *κύαθοι* has another lesson to teach us. I have argued that it is implausible to compare air with water and blood with air in the simile of the clepsydra.⁶⁶ But it is evidently not implausible to compare *water* in the *κύαθοι* with *earth*. The reason for this, it seems to me, is largely that the other element, air, is identical in the two halves of the comparison. Equally, it is not implausible to compare the *winds* outside the lantern with the *water* in the eye. For here again the other element, fire, is identical in the two halves of the comparison.

The reason why the image of the *κύαθοι* has not caused modern commentators as much confusion as the lantern and the clepsydra is that in this case we are shielded from Empedocles' own elaboration of the simile, and that we also have a reasonably clear idea of the fact to be explained, namely the immobility of the earth. In the other two cases the nature of the theory to be explained is itself less obvious. This and Empedocles' stylistic elaboration have conspired to give certain features in the similes a quite undue significance.

(ii)

A particular feature of Empedocles' art not noted by Kranz is the way in which a fresh metaphorical stratum is introduced within an already established simile.

1. Thus *fr.* 33 describes the action of fig-juice on milk:

ὡς δ' ὄτ' ὀπὸς γάλα λευκὸν ἐγόμεφωσεν καὶ ἔδησε . . .

The comparison is with Love's binding force, perhaps her formation of tears from blood, or perhaps more probably the coagulation of an embryo from the mixing of male and female seminal fluid.⁶⁷ The point to note is that the fig-juice 'rivets and binds' milk.

⁶⁵ I think it is improbable that Empedocles' earth rotates, cf. *ECC* 52 n. 3. Even if it does, it will not be the same as the water in the *κύαθοι*, for except on a Pythagorean system the earth would rotate in the same place, while water in the *κύαθοι* is carried round in a circle.

⁶⁶ Pp. 150–1 above

⁶⁷ Plutarch speaks explicitly of Empedocles' having connected curdling with tears, *Quaest. nat.* 917a (DK 31A78). But tears do not match happily the emphasis on hardening in *ἐγόμεφωσεν καὶ ἔδησε*.

Hardening could be accounted for in Empedocles' embryology, for Aristotle says that Empedocles explained the sterility of mules by the mixture of

In this way, a metaphor from the working of metal describes the action of fig-juice, which itself then provides the analogue or paradigm for Love's activity.⁶⁸

In this case the complexity was no doubt facilitated, and perhaps necessitated, by the fact that the simple simile of milk and fig-juice was already familiar to Empedocles' listeners from Homer. Paeon stops the flow of blood from Ares' wound, *Il.* v 902–3:

ὡς δ' ὅτ' ὀπὸς γάλα λευκὸν ἐπειγόμενος συνέπηξεν
ὑγρὸν ἔόν . . .

2. The same doubling of ideas occurs in a simile of which two parts are probably preserved in *fr.* 34 and 73:

ἄλφιτον ὕδατι κολλήσας . . .
ὡς δὲ τότε χθόνα Κύπρις, ἐπεὶ τ' ἐδίηεν ἐν ὄμβρῳ,
εἶδα ποιπνύουσα θοῶ πυρὶ δῶκε κρατῦναι.

If these two fragments are parts of a single simile, then Love's action, probably in producing animal parts at the beginning of her zoogony, is compared to a baker making a paste of barley-meal and water.⁶⁹ In the second part of the simile, *θοῶ πυρὶ δῶκε κρατῦναι* means literally that Love 'gave it to leaping fire to harden'. The phrase probably also has the connotation that Love 'allowed fierce fire to conquer'—*κρατύνειν* can have both meanings, and *θοός* is frequently used in a military context by Homer.

3. Within the simile of the lantern, Empedocles again doubles his imagery, by presenting the formation of the pupil either as an ambush, *λοχάζετο*, or more probably as a giving-birth, *λοχεύσατο*.⁷⁰ Either expression exploits the ambiguity of *κύκλοπα κούρην*, literally 'the round-eyed pupil', metaphorically 'a round-eyed baby girl'.

In this case the metaphorical stratum appears in the second half of the simile, as in *fr.* 73 above. The lantern provides an analogue or paradigm for the eye, whose formation is then described metaphorically as a giving-birth.

4. There is probably the same doubling of ideas when Empedocles writes *πορθμοῦ χωσθέντος* and *ἀμφὶ πύλας . . . ἄκρα κρατύνων* in his description of the workings of the clepsydra, *fr.* 100.17 and 19. On the immediate level, these expressions mean that the

male and female semen being too hard, 'like copper mixed with tin', *De gen. anim.* 747a34–b10 (in part DK 31B92). Now Aristotle several times himself compares the action of fig-juice or rennet on milk with the effect of male sperm on matter provided by the female, *De gen. anim.* 729a9–14, 737a12–16, 739b20–6, 771b18–27, 772a22–5. This analogy therefore, although it is not attributed to Empedocles by name, may perhaps provide a better context for *fr.* 33.

Both applications of the simile are mentioned (with less evidence) by Zeller, *ZN* 991 n. 2.

⁶⁸ For *ἔδησε* the manuscripts also have *ἔπηξε*, *Plut. De amic. mult.* 95a.

With *ἐρόμφωσεν* cf. *γόμφοις* *fr.* 87. Other metallurgical images are:

(i) copper and tin in *fr.* 92, mentioned in the preceding footnote.

(ii) *χόαναι* 'hollows for melting metal' in *fr.* 96.1, cf. *χόαναι* *fr.* 84.9.

(iii) the mixing of four elements compared to the mixing of four metals, Galen, *Hippocratis de natura hominis* i 2 = xv 32 Kühn (DK 31A34).

(iv) the comparison of stars with nails in Aetius

ii 14.3 (DK 13A14). (For the attribution to Empedocles, see *JHS* lxxxviii [1968] 117 n. 25: the mention of nails indicates that *πέταλα* in the next entry may be metal plates, and not, as is usually assumed, leaves.)

(v) perhaps the comparison of hot rivers or springs with some kind of underground heating system, Seneca, *Quaest. nat.* iii 24.1–2 (DK 31A68). (Only perhaps—for it is possible to read the passage as though the comparison were Seneca's own.)

There may conceivably be a secondary metallurgical connotation in *κολλήσας* 'welding' in *fr.* 34 (cf. *κόλλησιν* *fr.* 96.4) and in *παρ' ἐλήλαται* 'hammered' or 'beaten out' in *fr.* 30.3.

⁶⁹ Arguments for taking these two fragments together are listed by Bignone, 427–8. Love's formation of animal parts at the beginning of her zoogony (for which see *ECC* 200–3) provides the simplest context for the fragment.

⁷⁰ The manuscripts have *λοχάζετο* and *ἐχεύσατο*, *Arist. De sensu* 438a1. *Λοχεύσατο* is A. Förster's emendation, 'Empedocleum', *Hermes* lxxiv (1939) 102–4.

neck of the clepsydra is blocked, and that air presses against the surfaces of the strainer. But the expressions can also mean that 'the straits are blocked' and that air 'commands the heights'.

Some copyists have tried to extend the military metaphor, and for ἀμφὶ πύλας ἠθμοῖο δυσηχέος (line 19) 'around the openings of the gurgling strainer', they have written ἰσθμοῖο 'above the pass of the isthmus of ill-repute'. The adjective δυσηχής, when applied to the workings of the clepsydra, shows that this cannot be the true reading.⁷¹

NOTE 2.—*Was Plato's theory of vision original?*

In a recent article Dr Long writes: 'There is no particular evidence for thinking Plato's theory (*sc.* of vision) to be original.'⁷²

To my mind Theophrastus fairly clearly implies that Plato was original in joining the two theories of vision by fire flowing outwards from the eye and vision by effluences from the object seen. Theophrastus writes, *De sens.* 5 (*Doxographi* 500.12–13): . . . ὡςπερ ἂν εἰς τὸ μέσον τιθεῖς (*sc.* Plato) τὴν ἑαυτοῦ δόξαν τῶν τε φασκόντων προσπίπτειν τὴν ὄψιν (i.e. the visual ray) καὶ τῶν φέρεσθαι πρὸς αὐτὴν ἀπὸ τῶν ὄρατῶν.

In the later doxographical tradition, Archytas is specifically distinguished from Plato as having held a theory of vision by outward-flowing fire alone.⁷³ Empedocles, in the following chapters of Theophrastus, is credited with a theory of vision by effluences. If, as I have argued, Empedocles did not combine this with a theory of vision by outward-flowing fire, then there is no evidence for a conflation of the two theories by anyone before Plato.

I suggest therefore that the simplest historical explanation of the passage in Theophrastus is that Plato was original in combining the theory of vision by outward-flowing fire, as held by Archytas and perhaps others, and the theory of vision by effluences from the object seen, as held by Empedocles.⁷⁴

NOTE 3.—*Bibliography of earlier interpretations of Empedocles' theory of vision*

There are of course many differences of detail, but I list here the principal and the most recent writers who in one way or another have given outward-flowing fire an active part to play in Empedocles' explanation of vision.

Friedrich W. Sturz, *Empedocles Agrigentinus de vita et philosophia eius exposuit* . . . (Lipsiae, 1805) 416.

Justus F. K. Hecker, *Geschichte der Heilkunde* i (Berlin, 1822) 85.

Ludwig Philippson, Ὑλη ἀνθρωπίνη, pars ii *Philosophorum veterum usque ad Theophrastum doctrina de sensu* (Berolini, 1831) 178–9.

Simon Karsten, *Empedoclis Agrigentini carminum reliquiae* . . . (Amstelodami, 1838) 254 and 485–6.

Carl von Prantl, *Aristoteles über die Farben, erläutert durch eine Übersicht der Farbenlehre der Alten* (München, 1849) 44–6.

E. Zeller, *Die Philosophie der Griechen in ihrer geschichtlichen Entwicklung*, Teil i Abteilung 2, 6th edn by W. Nestle (henceforward ZN) 994.

Friedrich W. A. Mullach, *Fragmenta philosophorum graecorum* i (Parisii, Didot, 1860) 49.

Hermann Winnefeld, *Die Philosophie des Empedokles, ein Versuch*, in *Beilage zum Programm des Grossherzoglichen Gymnasiums in Donaueschingen vom Schuljahr 1861/1862* (Rastatt, 1862) 41–2.

F. Überweg, *Grundriss der Geschichte der Philosophie von Thales bis auf die Gegenwart* i *Die Philosophie des Altertums* 12th edn by K. Praechter (Berlin, 1926) 95.

⁷¹ See note 11 pp. 176–9 below.

⁷² *CQ* n.s. xvi (1966) 263.

⁷³ Apuleius, *Apologia* 15 (DK 47A25).

⁷⁴ Cherniss, *ACP* 317 n. 106, infers Plato's origi-

nality solely from the reference to Archytas. But there is little need for Apuleius' report to carry this implication, unless it is taken in conjunction with the passage from Theophrastus.

- Hermann Siebeck, *Geschichte der Psychologie* Theil i Abtheilung 1 (Gotha, 1880) 270-1.
- H. Diels, 'Gorgias und Empedokles', *SBB* (1884) 353-6, cf. 345-6.
- J. Burnet, *Early Greek philosophy* 4th edn (henceforward *EGP*) 248-9.
- T. Gomperz, *Griechische Denker* i 189-90.
- Hugo Magnus, *Die Augenheilkunde der Alten* (Breslau, 1901) 96-8.
- William A. Hammond, *Aristotle's psychology, a treatise on the principle of life, De anima and Parva naturalia, translated with introduction and notes* (London and New York, 1902) 152 n. 5.
- John I. Beare, *Greek theories of elementary cognition from Alcmaeon to Aristotle* 14-23, cf. 38 and 97.
- A. E. Haas, 'Antike Lichttheorien', *AGPh* xx n. F. xiii (1907) 354-5, 362, 372-3.
- Walther Kranz, 'Empedokles und die Atomistik', *Hermes* xlvii (1912) 41-2, and *Empedokles, antike Gestalt und romantische Neuschöpfung* (Zürich, 1949) 61.
- H. Lackenbacher, 'Beiträge zur antiken Optik', *Wiener Studien* xxxv (1913) 39-45.
- J. Hirschberg, 'Die Seh-Theorien der griechischen Philosophen in ihren Beziehungen zur Augenheilkunde', *Zeitschrift für Augenheilkunde* xliii (1920) = *Festschrift für Hermann Kuhnt* 7-12.
- W. Jablonski, 'Die Theorie des Sehens im griechischen Altertume bis auf Aristoteles', *Sudhoffs Archiv für Geschichte der Medizin* xxiii (1930) 309-13.
- Wilhelm Capelle, *Die Vorsokratiker, die Fragmente und Quellenberichte übersetzt und eingeleitet* (Leipzig, 1935) 231 n. 1 (the pagination is unchanged in later issues of this work, Berlin 1958 and Stuttgart 1963).
- Aram M. Frenkian, *Études de philosophie présocratique ii La philosophie comparée, Empédocle d'Agrigente, Parménide d'Élée* (Paris, 1937) 58-9.
- Joseph Schumacher, *Antike Medizin, die naturphilosophischen Grundlagen der Medizin in der griechischen Antike* 2nd edn (Berlin, 1963) 118-19.
- Solomon Y. Lur'e, *Essays in the history of ancient science* (Moscow and Leningrad, 1947) 76 (in Russian): the relevant part is translated as Salomo Luria, *Anfänge griechischen Denkens aus dem Russischen übertragen von Peter Helms*, in the series *Lebendiges Altertum* Band 14 (Berlin, 1963) 85.
- Jean Zafropulo, *Empédocle d'Agrigente* (Paris, 1953) 170-2.
- W. D. Ross, with some hesitation, in his edition of the *Parva naturalia* 189-90.
- Gilles Nélot, *Empédocle d'Agrigente* (Bruxelles, 1959) 96-7.
- R. E. Siegel, 'Theories of vision and color perception of Empedocles and Democritus; some similarities to the modern approach', *Bulletin of the history of medicine* xxxiii (1959) 145-59, especially 146-9.
- Felix M. Cleve, *The giants of pre-Sophistic Greek philosophy, an attempt to reconstruct their thoughts* ii (The Hague, 1965) 372-7.
- Jean Brun, *Empédocle, ou le philosophe de l'Amour et de la Haine* (Paris, 1966) 97-100.
- A few variations on this essentially Platonising interpretation deserve brief mention.
- W. J. Verdenius explains effluences and the visual ray as accounting respectively for the passive and the active connotations of vision, something like the difference between 'seeing' and 'looking', in 'Empedocles' doctrine of sight', *Studia varia Carolo Guilielmo Vollgraff a discipulis oblata* (Amsterdam, 1948) 155-64. There is essentially the same idea in the earlier editions of Burnet, *EGP* 1st edn (1892) 267-8, abbreviated in the 2nd edn (1908) 287-8, omitted in the third and fourth editions.
- A. E. Taylor supposes that effluences and pores were used to explain the perception of colours, while the visual ray issuing from the eye was used to explain vision more generally, in his commentary on the *Timaeus* (Oxford, 1928) 278-82.
- Kathleen Freeman, following a hint in Zeller, *ZN* 994 n. 4, apparently supposes that the theory of outward-flowing fire was meant to explain vision at a distance, *The pre-Socratic*

philosophers, a companion to Diels, *Fragmente der Vorsokratiker* (Oxford, Blackwell, 1946) 197–8 (there is the same pagination in the 'second edition' 1949).

Charles Mugler believes that vision by effluences from the object seen belongs to the world of increasing Love, while vision by fire issuing from the eye belongs to the world of increasing Strife, 'Sur quelques fragments d'Empédocle', *Revue de Philologie* 3ème série xxv (1951) 33–65, partly repeated in 'Deux thèmes de la cosmologie grecque: devenir cyclique et pluralité des mondes', *Études et commentaires* xvii (1953) 52–7. This kind of reconstruction seems to me very implausible, cf. *Empedocles' cosmic cycle* (Cambridge, 1969) (henceforward *ECC*) 264–5.

H. H. Joachim asserts both elements in the theory, but does not endorse any specific reconciliation, in his edition of the *De generatione et corruptione* 157–8.

Clara E. Millerd, *On the interpretation of Empedocles* (printed dissertation, Chicago, 1908) 84–5, and Professor W. K. C. Guthrie, *A history of Greek philosophy* ii 237, both suppose that the fire which leaves the eye is an essential part of the act of vision, but both explicitly refuse to synthesise this with explanation in terms of effluences. This is also more or less the position taken by George R. T. Ross, in his edition of the *De sensu* and *De memoria* (Cambridge, 1906) 137–8.

A. A. Long first explains, as Siebeck, Beare and Kranz had done, that outward-moving fire need not pass beyond the surface of the eye: 'ἐξω need not mean right outside the eye, but beyond the other elements which are contained in the eye', 'Thinking and sense-perception in Empedocles: mysticism or materialism?' *CQ* n.s. xvi (1966) 263. He then explains the presence of fire in the eye on the principle that by like we see like, and concludes, 264: 'It is unnecessary to ask whether these two sources of light actually meet, and if so where.' There is however no explicit rejection of Aristotle's testimony, and I am not clear whether or not Long finally intends fire's moving outward to the surface of the eye to be a necessary part of the act of vision.

Long's suggestion that perception of like by like need not entail the contact of perceived and percipient seems to me very dubious. Aristotle says that Democritus and οἱ πλείστοι τῶν φυσιολόγων explained all sensible perception in terms of contact, *De sensu* 442a29–b3.

Geoffrey E. R. Lloyd, in an analysis of *fr.* 84, speaks of fire leaving the eye as 'the "visual ray" itself', but makes no mention of vision by effluences, *Polarity and analogy, two types of argumentation in early Greek thought* (Cambridge, 1966) 326.

Ettore Bignone, *Empedocle, studio critico* (Torino, 1916) 249 n. 2 and 381 n. 1, and H. F. Cherniss, *Aristotle's criticism of Presocratic philosophy* (henceforward *ACP*) 317 n. 106, both suppose that the simile is concerned simply with the phenomenon of flashing eyes and its consequences.⁷⁵

It is an indication of the insecurity of the usual interpretation that there have been strange discrepancies on precisely where outside the eye the visual ray is joined to effluences from the object seen: whether in between the eye and the object seen (Winnefeld and Cleve), or just outside the eye (Gomperz), or on the surface (Siebeck, Beare, with qualifications, 15 and 18, cf. 16 n. 1 and 20, and Kranz), or by an oscillating movement (Lackenbacher). (These variations have mostly arisen by attempting to apply to Empedocles the concluding portion of Aristotle's account of earlier theories of vision, 438a25–b2.) The explanation given by Karsten, Mullach and Hammond is different still, founded on the supposed purpose of the simile of the lantern, to the effect that fire leaving the eye illumines the object we see.

If we were to synthesise the two explanations, then it seems to me that the simplest method would be to suppose that fire leaves the eye in order to make room for equivalent effluences which enter the eye from outside.⁷⁶

⁷⁵ Cf. p. 145 n. 28 above.

⁷⁶ Cf. p. 145 n. 28 above.

NOTE 4.—*Doxographical evidence for Empedocles' theory of vision, apart from Theophrastus and Aristotle*

I have rested my reconstruction of Empedocles' theory of vision on an attempted reconciliation of the evidence in Aristotle and Theophrastus.

(i)

The entry in Aetius' chapter *περὶ ὀράσεως* is as follows, iv 13.4 (DK 31A90): 'Ἐμπεδοκλῆς καὶ πρὸς τὸ διὰ τῶν ἀκτίνων καὶ πρὸς τὸ διὰ τῶν εἰδώλων ἐκδοχὰς παρέχεται. πλείους δὲ πρὸς <τὸ add. Diels> δεύτερον. τὰς γὰρ ἀπορροίας ἀποδέχεται.

This entry is usually taken as a simple repetition of the passage from Aristotle's *De sensu*.⁷⁷ There are however two discrepancies.

1. First, where Aristotle uses the word *ἀπορροιαί*, Aetius speaks of both *ἀπορροιαί* and *εἴδωλα*. The latter expression is usually confined to the Atomists' theory.⁷⁸ The inclusion of *εἴδωλα* in Aetius' account of Empedocles is probably a simple doxographical error.⁷⁹

2. Secondly and more significantly, Aetius adds the note that Empedocles gave more weight to the 'reception of images' than to perception by means of the visual ray. Similarly, Alexander elaborates the notion of vision by effluences from the object seen, but does no more than repeat what Aristotle says on the question of vision by fire leaving the eye.⁸⁰ This emphasis on effluences by both Aetius and Alexander gives some slight support to the interpretation I have offered, that outward-flowing fire was not in fact an active element in Empedocles' explanation of vision.

(ii)

Two other doxographical entries, in pseudo-Plutarch's version of Aetius and in pseudo-Galen's *Historia philosopha*, attribute to Empedocles the idea that we see by means of a visual ray which leaves the eye.⁸¹ Verdenius seems to accept the entry in pseudo-Plutarch as a genuine representation of Aetius.⁸² But in Stobaeus' version of Aetius the entry from pseudo-Plutarch is attributed to Hestiaeus. It seems preferable to accept this attribution, for Stobaeus gives by far the fuller version of this chapter of the *Placita*. In both Stobaeus and in pseudo-Plutarch the entry in Galen is attributed to Hipparchus.⁸³

(iii)

In elaborating Aristotle's account of Empedocles' theory of transparency in the *De generatione et corruptione*, Philoponus speaks of the visual rays making contact with the things seen, 153.27 (not in DK): *τὰς ὀψεις . . . προσβάλλειν τοῖς ὀρατοῖς*.⁸⁴ In Aristotle's account there is no mention of outward-flowing fire.⁸⁵ But Philoponus is quite capable of mis-

⁷⁷ Aristotle, *De sensu* 437b10–438a5. This attitude is exemplified by Siebeck, *Geschichte der Psychologie* i 1 p. 270, and by Beare, *Elementary cognition* 17 n. 4.

⁷⁸ See for example Arist. *De sensu* 438a12 (DK 68A121), Alexander, *De sensu* 24.19 and 22, 56.12 (in part DK 67A29), and Aet. iv 13.1 (DK *ibid.*).

⁷⁹ Lur'e supposes that Empedocles here anticipates the Atomists, *Essays in the history of ancient science* 76 = Luria, *Anfänge griechischen Denkens* 85.

⁸⁰ *De sensu* 23.5–24.9, especially 23.8–10 and 24.2–9.

⁸¹ Aet. iv 13.5 (not in DK). [Galen] *Historia philosopha* 94 (not in DK = *Doxographi* 636).

⁸² *Studia Vollgraff* 156.

⁸³ Aet. iv 13.9 (*cf.* DK 28A48).

⁸⁴ The whole passage runs from *De gen. et corr.* 153.22–154.2. For the technical use of the verb *προσβάλλειν* see Charles Mugler, *Dictionnaire historique de la terminologie optique des grecs*, in *Études et commentaires* liii (1964) s.v.

⁸⁵ *De gen. et corr.* 324b26–35 (DK 31A87). Joachim, in his edition of the *De gen. et corr.* 157–8,

interpreting what Aristotle says about Empedocles.⁸⁶ In this case he has either himself simply added the notion of outward-flowing fire, or drawn on what he remembers from the *De sensu*.

Michael Ephesius perhaps introduces the notion of outward-flowing fire in the *De generatione animalium*, in his commentary on Aristotle's account of Empedocles' theory of different kinds of vision by day and by night.⁸⁷ His mode of expression is not wholly explicit. But the idea, if it does appear, is fairly clearly no more than a repetition of Aristotle's account in the *De sensu*, which is specifically acknowledged at the beginning of the passage.

NOTE 5.—*The precise nature of the phenomena which led to the belief that eyes were made of fire*

Aristotle elaborates as follows the phenomenon which he asserts led everyone to believe that the eye was made of fire, *De sens.* 437a22–6: ποιῶσι δὲ πάντες τὴν ὄψιν πυρὸς διὰ τὸ πάθους τινὸς ἀγνοεῖν τὴν αἰτίαν· θλιβομένου γὰρ καὶ κινουμένου τοῦ ὀφθαλμοῦ φαίνεται πῦρ ἐκλάμπειν· τοῦτο δ' ἐν τῷ σκότει πέφυκε συμβαίνειν, ἢ τῶν βλεφάρων ἐπικεκαλυμμένων· γίγνεται γὰρ καὶ τότε σκότος.⁸⁸

Theophrastus writes of Alcmaeon, *De sens.* 26 (DK 24A5): ὅτι δ' ἔχει πῦρ (*sc.* ὁ ὀφθαλμός) δῆλον εἶναι· πληγέντος γὰρ ἐκλάμπειν.

There are strange discrepancies in modern interpretations of these two passages.

1. Beare thinks that in Aristotle's passage there are two actions: movement with pressure or movement without pressure.⁸⁹
2. Ross denies this: he supposes that there is pressure and then movement.⁹⁰
3. Cherniss fairly clearly thinks of a single action: movement and pressure together.⁹¹
4. Others run together the action of pressing the eye, as described by Aristotle, and striking the eye, as described by Theophrastus.⁹²
5. Finally, Lloyd confuses more than one issue when he says that Aristotle speaks of 'rubbing' the eyes, and when he supposes that this is the same as what we call 'seeing stars'.⁹³

Phenomena of the kind alluded to by Aristotle and Theophrastus are described in some detail by a number of modern writers on optics, including Sir Isaac Newton.⁹⁴ From these it is clear that three distinct actions are possible:

takes the passage in the way that Philoponus has done. But there is no ground for this interpretation in Aristotle's text.

⁸⁶ Examples are given, *ECC* 203, 207–9, 212–13.

⁸⁷ [Philoponus] *De gen. anim.* 217.13–25 (not in DK). Cf. Arist. *De gen. anim.* 779b15–20 (DK 31A91).

⁸⁸ For the context of this passage see p. 140 above.

⁸⁹ J. I. Beare, Oxford translation of the *Parva nat.* ad loc.

⁹⁰ W. D. Ross, edition of the *Parva nat.* 188.

⁹¹ *ACP* 316.

⁹² Magnus, *Augenheilkunde der Alten* 97. G. R. T. Ross, edition of the *De sensu* and *De memoria* 134. Taylor, *Timaeus* 279. Siegel, *Bulletin of the history of medicine* xxxiii (1959) 147.

⁹³ *Polarity and analogy* 326 n. 1.

⁹⁴ Sir Isaac Newton, *Opticks: or, a treatise of the reflections, refractions, inflections and colours of light* 4th edn (London, 1730) 321–2 (=Book iii Query 16).

Johannes Müller, *Handbuch der Physiologie des Menschen*: of the fourth and latest edition I have been able to obtain only the French translation by A. J. L. Jourdan, *Manuel de physiologie* ii (Paris, 1845) 253–9.

Hermann L. F. Helmholtz, *Handbuch der physiologischen Optik* 3rd edn ii (Hamburg und Leipzig, 1911) 6–11, cf. 19: translated as *Helmholtz's treatise on physiological optics* ii (Menasha, Wisconsin, 1924) 5–11, cf. 20.

Thomas Young, 'Observations on vision', *Philosophical transactions of the Royal Society of London* 1793 ii 178–80.

Johann Purkinje, *Beobachtungen und Versuche zur Physiologie der Sinne* Bändchen i *Beiträge zur Kenntniss des Sehens in subjektiver Hinsicht* (Prag, 1819: 'zweite unveränderte Auflage' Prag, 1823) 176 pages: conveniently available in Jan E. Purkyně, *Sebrané spisy = Opera omnia* i (V Praze, 1918) 1–56.

Further references to literature on the subject may be found in these works.

1. Striking the eye.
2. Pressing the eye, for example with a finger nail or with the head of a pin (the eye is tougher than you might think).
3. Moving the eye quickly, without pressing it.

The first action leads to a momentary flash of light in the eye. The second and third actions produce the appearance of various bright spots and lines in the eye, which may last for some while, and which are described at length in the works I have cited. The explanation now adopted for both effects, the momentary flash and the prolonged spots, is that any stimulation of the optic nerve produces the effect of light.

Pressing the eye produces the required effect either when the eye is closed or when the eye is open in the dark. This explains Aristotle's qualification, that what happens must take place 'in the dark or with the eyes closed'. The conjunction 'or' implies that Aristotle envisages the possibility of the eye being open in the dark. Moving the eye, on the other hand, produces the required effect only when the eyes are closed, perhaps because then the friction of the inner surface of the eyelid on the eyeball takes the place of pressure.⁹⁵

Theophrastus clearly refers to striking the eye, the first of the actions listed above. Aristotle, on the other hand, clearly refers to pressing the eye, the second action listed above. Does Aristotle's account also include moving the eye without pressing it, the third action listed above?

Certainly Aristotle does not exclude movement. He asks why, if the eye is made of fire, it does not see itself even when the eye is still, 437a29: *διὰ τί οὐκ ἡρεμοῦντι τοῦτ' (sc. αὐτὸν ἑαυτὸν ὄραν τὸν ὀφθαλμόν) οὐ συμβαίνει;* But the movement which Aristotle thinks of here could be movement which accompanies pressure, as in Newton's account of pressing the eye: 'If the Eye and the Finger remain quiet these Colours vanish in a second Minute of Time, but if the Finger be moved with a quavering Motion they appear again.' However I am inclined to think that Aristotle's movement is more than this. The emphasis on speed of movement in Aristotle's own explanation of the phenomenon in question makes it seem very likely that he also has in mind moving the eye quickly without pressing it, the third action listed above.⁹⁶

Whether this is so or not, it is clear, I think, that Aristotle does not refer to 'rubbing one's eyes', if by that is meant the kind of thing that one often does with one's knuckles or with the palm of one's hand. As I have noted, Aristotle envisages the possibility of the eye being open in the dark. Moving the eye quickly produces the required effect only if the eyes are closed. Therefore the eye being open must refer to the action described as *θλιβομένον*. But it would be impossible, I think, to rub one's eyes, in the conventional sense, if the eyes were open.⁹⁷

'Seeing stars', the other phenomenon attributed to Aristotle by Lloyd, is, I am pretty sure, something different both from 'rubbing one's eyes' and from any of the three actions listed earlier. 'Seeing stars' is something I have experienced myself: a short-lived effect of bright points of light like stars, which comes from being struck a blow not on the eye itself but on the head.

⁹⁵ This is a rather less common experience than the other two, and the point about the eyes being closed is not stated quite as explicitly as I would have wished in the works I have quoted; but Professor Sir Vincent Wigglesworth informs me that in his own experience the point is as I have stated it.

⁹⁶ 437a29-b9.

⁹⁷ Young, 178 (cited above n. 94), speaks of the eye being 'rubbed or compressed'. But I think it is

clear that this means more or less the same as Newton's reference, quoted in the preceding paragraph, to moving one's finger 'with a quavering Motion'.

It should also be noted that 'rubbing the eyes', in the conventional sense, usually at least produces no more than faint blobs of light, which are much less vivid than the effect described as the result of pressing the eye.

NOTE 6.—*The composition and function of membranes in the eye*

(i)

On p. 144 above I transcribed the central portion of Theophrastus' *De sensu*, chapter 7, virtually as it appears in the two manuscripts: *πειράται δὲ (sc. Empedocles) καὶ τὴν ὄψιν λέγειν, ποία τίς ἐστὶ καὶ φησὶ τὸ μὲν ἐντὸς αὐτῆς εἶναι πῦρ, τὸ δὲ περὶ αὐτὸ γῆν καὶ ἀέρα, δι' ὧν διέειναι (Wimmer, δῦὸν PF) λεπτὸν ὃν καθάπερ τὸ ἐν τοῖς λαμπτήρησι φῶς.*

Theophrastus' words are clearly based, in part, on *fr.* 84. *Τὸ μὲν ἐντὸς αὐτῆς εἶναι πῦρ* clearly represents the fire implanted in the pupil of the eye in lines 7–8. The earth and air through which the fire passes are fairly clearly intended to be the membranes which surround the fire in lines 8–11.

However, at this stage Theophrastus makes no mention of the *ὑδατος βένθος ἀμφιναέντος* in line 10. Diels therefore sought to emend the passage by adding water to fire: *τὸ μὲν ἐντὸς αὐτῆς εἶναι πῦρ <καὶ ὑδωρ>*.⁹⁸ But it is impossible to read the passage with this supplement, for two reasons at least. First, *περὶ αὐτό* in the same line must have a singular reference, and this is most naturally taken to be *πῦρ* in the preceding clause. Secondly, the expression in the next line, *διέειναι λεπτὸν ὃν καθάπερ τὸ ἐν τοῖς λαμπτήρησι φῶς*, must refer exclusively to fire, which it cannot do if the subject of the preceding infinitive has been specified as both fire and water.

Diels early abandoned this emendation.⁹⁹ But he then sought to add water, not to the fire, but to the earth and air: *τὸ δὲ περὶ αὐτὸ <ὑδωρ καὶ> γῆν καὶ ἀέρα*.¹⁰⁰ Karsten and Panzerbieter had done the same some fifty years earlier.¹⁰¹ Burnet hopes to achieve the same result by paraphrasing *ἀέρα* as 'watery vapour, not the elemental air or *αἰθήρ*'.¹⁰²

Long adopts the later of Diels' two emendations, only to entangle himself thereby in the consideration that if the membranes in the eye are made of water, then water corresponds *both* to the sides of the lantern *and* to the winds which blow against the sides of the lantern.¹⁰³

The difficulty is imaginary. The passage in Theophrastus needs neither paraphrase nor emendation. Water in the eye is taken account of in Theophrastus' very next sentence: *τοῦς δὲ πόρους ἐναλλάξ κείσθαι τοῦ τε πυρὸς καὶ τοῦ ὑδατος*. But water is not required in the composition of the membranes. For the membranes which surround the fire in the eye must be made of earth and air only, and not of water, if their purpose is precisely to *prevent* water from passing through them.

Theophrastus has quite simply abbreviated Empedocles' account of the membranes. He has told us that they let fire through. He has not told us that they prevent water from passing through them. This omission cannot be, and need not be, repaired either by making water as well as fire occupy the centre of the eye, for this makes nonsense of Theophrastus' Greek, or by making water a constituent of the membranes which surround the fire, for this makes nonsense of the theory.

(ii)

Long is also concerned to account for the presence in the eye of pores by which we see earth and air, in addition to the pores of fire and water mentioned by Theophrastus.¹⁰⁴ In this he follows Verdenius.¹⁰⁵ Both argue from *fr.* 109, *γαίη μὲν γὰρ γαίαν ὀπώπαμεν, κ.τ.λ.*

⁹⁸ *Doxographi* 500.24.

⁹⁹ *SBB* (1884) 354 n. 2.

¹⁰⁰ *Poetarum philosophorum fragmenta* 99.32 (repeated in Diels-Kranz i 301.31).

¹⁰¹ Karsten, 484, has *γῆν καὶ ἀέρα <καὶ ὑδωρ>*. Panzerbieter has precisely the same text as Diels, 'Zu

Empedokles', *Zeitschrift für die Alterthumswissenschaft* iii (1845) no. 111 col. 883.

¹⁰² *EGP* 246 n. 2.

¹⁰³ *CQ* n.s. xvi (1966) 262 n. 2 and 263 n. 2.

¹⁰⁴ *CQ* n.s. xvi (1966) 261 and 264, cf. 263 n. 5.

¹⁰⁵ *Studia Vollgraff* 155, cf. 163.

But *fr.* 109 need not, and probably does not, refer exclusively to vision. The verb *ὄραν*, including forms from the root *ὄπ-*, can be used of perception or recognition more generally.¹⁰⁶ That *ὀπώπαμεν* is so used in *fr.* 109 is shown by line 3: *στοργῆν δὲ στοργῆ (sc. ὀπώπαμεν)*. For of Love Empedocles tells us, *fr.* 17.21,

τῆν σὺ νόῳ δέρκευ, μηδ' ὄμμασιν ἦσο τεθηπῶς.

Both Aristotle and Theophrastus have taken *fr.* 109 as a description of perception generally, for they paraphrase *ὀπώπαμεν* as *γινώσκειν*, *γνώσις*, *γνωρίζει*, *γνωρίζομεν*, *αἰσθάνεσθαι*.¹⁰⁷ Indeed it seems very likely, from this same passage of Theophrastus, that *fr.* 109 was followed immediately by *fr.* 107,¹⁰⁸ and in that case *ὀπώπαμεν* is picked up by *φρονέουσι fr.* 107.2. Therefore the translation of *fr.* 109 should be: 'by earth we recognise earth', etc.

Long in part has been misled by his apparent acceptance of Aetius' account of four primary colours in Empedocles corresponding to the four elements.¹⁰⁹ The same mistake is made by several other writers.¹¹⁰

Aetius' attribution of four primary colours to Empedocles had already aroused the suspicion of Diels.¹¹¹ It is shown to be false by the clear implication in Theophrastus that the theory of four primary colours was introduced by Democritus, and that Empedocles did not, and could not, give a detailed explanation of specific colours other than black and white.¹¹² The confusion with Democritus has very likely been encouraged by the association of colours and elements in *fr.* 23 and 71.¹¹³

According to Theophrastus, we perceive black things by the watery pores in the eye, and white things by the fiery pores.¹¹⁴ The fact that, according to Theophrastus, Empedocles accounted for the perception of black and white alone probably means that fire and water were the only percipient elements in the eye. Earth and air will have been introduced solely as constituents of the membranes.¹¹⁵

(iii)

What precisely was the function of the membranes? The application of the verb *ἀποστέγγειν* is ambiguous. It is not immediately clear whether in *fr.* 84.10 the membranes surrounding the fire are intended:

1. To keep water outside the eye.
2. Or to keep water inside the eye.
3. Or to separate the water in the eye from the fire in the eye.

1. Alexander fairly clearly gives a version of the first view. He writes, *De sensu* 23.16-17:

¹⁰⁶ See LSJ s.v. *ὄραω* and Stephanus s.v. *ὄπτω*.

¹⁰⁷ Aristotle: *De anima* 404b8-15, *Met.* 1000b3-9. Theophrastus: *De sens.* 10 (DK i 302.21-2 = *Doxographi* 502.9-10).

¹⁰⁸ This point is made by Bignone, 372 n. 1, 476.

¹⁰⁹ Aet. i 15.3 (DK 31A92). Long, *CQ* n.s. xvi (1966) 264 n. 1.

¹¹⁰ Winnefeld, *Philosophie des Empedokles* 42-3. Von Prantl, *Aristoteles über die Farben* 41-2. W. Kranz, 'Die ältesten Farbenlehren der Griechen', *Hermes* xlvii (1912) 126-8, cf. *Hermes* xlvii (1912) 41-2 and *Empedokles* 61. Siegel, *Bulletin of the history of medicine* xxxiii (1959) 152-3 (where 152 n. 31 is misplaced, and 31B32 should read 31B23).

¹¹¹ *Doxographi* 222.

¹¹² *De sens.* 17, 59, 73, 76, 79 (DK 31A86, 68A135).

¹¹³ This confusion can be seen at work in all the writers cited above in n. 110. Kranz starts off by accepting Theophrastus' testimony, but he abandons it in effect in the course of his exegesis.

¹¹⁴ *De sens.* 7 (DK 31A86), quoted above p. 144.

¹¹⁵ Michael Ephesius remarks in passing that the organ of vision for Empedocles is made of the four elements [Philoponus], *De gen. anim.* 217.13-14 and 17. But he seems to think that fire alone is the active element in vision, 217.14-16.

οἱ (sc. ὑμένες) τὰ μὲν ἕξωθεν προσπίπτοντα λυμαντικά τοῦ πυρὸς ἀπείργουσι καὶ οὐκ ἔωσιν ἐνοχλεῖν τῇ κόρῃ, τὸ δὲ λεπτότατον τοῦ πυρὸς εἰς τὸ ἕξω διαῖσιν.¹¹⁶

2. Magnus, Taylor and Lloyd take the second view.¹¹⁷ Something like this view is found also in Plato's *Timaeus*. The gods fashioned fire in the centre of the eye in such a way, 45C1–2: ὥστε τὸ μὲν ἄλλο ὅσον παχύτερον στέγειν πᾶν, τὸ τοιοῦτον δὲ (sc. πῦρ) μόνον αὐτὸ καθαρόν διηθεῖν.¹¹⁸

3. The third view is taken by Panzerbieter, Diels, Burnet and Lackenbacher.¹¹⁹

The third view is most likely the right one.

First, Theophrastus tells us that there are pores of water in the eye which allow the entry of effluences from dark objects and which alternate with pores of fire.¹²⁰ It is impossible therefore to suppose that the surface of the eye is covered with membranes which permit the entry of fire but exclude the entry of water. Alexander must therefore be mistaken.

But equally, if there are pores spread across the surface of the eye which allow the entry of water, then these same pores cannot be covered with a membrane which would prevent the departure of water. This excludes the interpretation of Lloyd and Taylor.

The membranes therefore, it seems to me, must be designed not to keep water out of the eye, nor to hold water within the eye, but to protect the fire in the eye from the water in the eye.

Possibly there remains an element of truth in Alexander's account. For conceivably the membranes are somehow so arranged that they cover not the whole surface of the eye or the pupil, but only the pores of fire, so that they still allow dark effluences to enter the pores of water in the eye. Possibly therefore we should conclude that the function of the membranes is to protect the fire in the eye both from the water which surrounds it in the eye and from the effluences of water which especially at night-time block the fiery pores of the eye.

I am reluctant however to add this complication to the theory. For first, Theophrastus gives the impression that the light and dark effluences fall directly onto the pores of fire and water in the eye. He writes, *De sens.* 8 (DK 31A86): ἀμβλωπεῖν μὲν γὰρ καὶ οἷς ὑπερέχει τὸ πῦρ, ἐπεὶ ἀξήθηεν ἔτι μεθ' ἡμέραν (sc. τὸ πῦρ) ἐπιπλάττει καὶ καταλαμβάνει τοὺς τοῦ ὕδατος πόρους· οἷς δὲ τὸ ὕδωρ (sc. ὑπερέχει) ταῦτὸ τοῦτο (sc. ἀμβλωπεῖν) γίνεσθαι νύκτωρ· καταλαμβάνεσθαι γὰρ τὸ (sc. ἐντός) πῦρ ὑπὸ τοῦ (sc. ἕξωθεν) ὕδατος. Secondly, it is fairly clear from Theophrastus' account that fire can neither enter the eye nor escape from the eye when the pores of fire in the eye are blocked by water from outside. Therefore the description in

¹¹⁶ The description of air outside the eye as ὕδατος βένθος ἀμφωαέντος may seem impossibly exaggerated. But Theophrastus, in his account of Empedocles, does once use ὕδατος for the dark air of night-time, *De sens.* 8 (DK i 302.6 = *Doxographi* 501.8).

Alexander is evidently led to his interpretation by taking the lantern to equal the whole of the eye, so that whatever is outside the lantern must represent whatever lies outside the eye: contrast the interpretation which I offer below.

Verdenius, *Studia Vollgraff* 159–60, rightly compares Empedocles' ὕδατος βένθος ἀμφωαέντος with the report on Alcmaion in Theophrastus, *De sens.* 26 (DK 24A5): ὀφθαλμοὺς δὲ ὄραν διὰ τοῦ περίξ ὕδατος. If, as seems most likely, Alcmaion's water is inside the eye, then this is a powerful argument against Alexander's view. Unfortunately, it is possible to take Alcmaion's water as being outside the eye: this is the view of Taylor, *apud* George M. Stratton, *Theo-*

phrastus and the Greek physiological psychology before Aristotle (London and New York, 1917) 176, expressed more cautiously, *Timaeus* 282. Since disagreement is possible, I have thought it best not to use Alcmaion's theory as evidence here for Empedocles.

¹¹⁷ Magnus, *Augenheilkunde der Alten* 97. Taylor, *Timaeus* 280 n. 1, cf. 277 and 282. Lloyd, *Polarity and analogy* 326. Also Frenkian, *Études* ii 59.

¹¹⁸ Cf. 78A2–6.

¹¹⁹ Panzerbieter, *ZAW* iii (1845) no. 111 coll. 883–4. Diels, *SBB* (1884) 354. Burnet, *EGP* 248. Lackenbacher, *WS* xxxv (1913) 39–40. This also seems to be the interpretation of Winnefeld, *Philosophie des Empedokles* 41–2.

It is not possible to determine with certainty the view of those who simply translate 'keep out', e.g. Millerd, 83, Ross, *Parva nat.* 190, Guthrie, *History* ii 235.

¹²⁰ *De sens.* 7 (DK 31A86): quoted above 144.

the fragment of the fire which gets out while the water cannot get in, seems to me to apply most naturally to the water *inside* the eye.

Empedocles' problem, it seems to me, has been to protect the fire in the eye from the water in the eye, and at the same time to allow fire to pass in and out of the eye. The answer to the problem is provided by the theory of various sizes of pores and effluences. The fire in the eye is enclosed in membranes of earth and air, which 'keep off' water in the eye from the fire in the eye, without hampering the movement of fire in and out of the eye.

I conclude that fire and water are the only percipient elements in the eye. Earth and air are present in the eye solely as constituents of the membranes, whose function it is to protect the fire in the eye from the water which surrounds it.

(iv)

By supposing that the membranes serve to keep water within the eye, Lloyd entangles himself in the difficulty that 'while the panes in the lantern *protect* the fire inside from the wind that is outside, the membranes in the eye do not *separate* the fire from the water, but enclose both of them, allowing the one, but not the other, to pass through'.¹²¹

The interpretation which I have adopted releases us from this difficulty.

The point to appreciate, I suggest, is that the lantern itself does not represent the whole of the eye, but only the fire in the pupil and the membranes. The fire in the lantern and the winds outside the lantern together represent the fire and the water in the eye.¹²²

Once this step is taken, then the membranes and the sides of the lantern are seen to work in exactly the same way. They separate the fire from the wind or the water, and they do it in such a way that fire can get out but the wind or the water cannot get in. Thus the sides of the lantern protect the fire *inside* the lantern by separating the fire from the winds that blow *outside*. In the same way the membranes protect the fire *inside* the membranes by separating it from the water *outside* the membranes.

There remains a dissimilarity between the eye and the lantern, in that fire or light leaves the lantern but does not enter it, whereas fire both leaves the eye and enters it, in the form of effluences from the object seen. But this discrepancy is irrelevant if, as I have suggested, the purpose of Empedocles' simile was to describe not the process of vision, but the structure and composition of the eye.

NOTE 7.—*The purpose of breathing*

I have suggested above that for Empedocles, as for Plato, breathing may have served to avoid a vacuum and perhaps to account for a cooling of our inner heat.¹²³

(i)

It might be thought that Empedocles could not have made the purpose of breathing wholly explicit, for Aristotle begins his account, *De sensu* 473a15–16: λέγει δὲ περὶ ἀναπνοῆς καὶ Ἐμπεδοκλῆς, οὐ μέντοι τίνος γ' ἔνεκα. Taylor uses these words to deny that Plato can have been influenced by Empedocles in using breathing as a means of controlling the temperature of the body.¹²⁴

But Aristotle's words do not prove that no purpose, other than an explanation of the obvious fact of breathing, was worked into Empedocles' poem. For Aristotle has decided that in general, 470b7–9: τίνος μέντοι χάριν ὑπάρχει (sc. ἀναπνοῆ) τοῖς ζώοις, οἱ μὲν οὐδὲν

¹²¹ *Polarity and analogy* 326.

¹²³ P. 146 above.

¹²² For this correlation of two different elements, wind and water, see p. 155 above.

¹²⁴ *Timaeus* 569.

ἀπεφάναντο, οἱ δὲ εἰρήκασιν μὲν, οὐ καλῶς δ' εἰρήκασιν ἀλλ' ἀπειροτέρως τῶν συμβαινόντων. In particular, he writes of Plato, 472b24–6: ἔτι δὲ τὸ τίνος ἔνεκα ταῦθ' ὑπάρχει τοῖς ζώοις (λέγω δὲ τὸ ἀναπνεῖν καὶ τὸ ἐκπνεῖν) οὐθὲν εἰρήκασιν οἱ τοῦτον τὸν τρόπον (i.e. as in the *Timaeus*) λέγοντες. Ross endorses this: 'Plato in fact says nothing about the purpose of respiration.'¹²⁵ But Plato really makes it quite explicit that breathing has a purpose: it is designed for the irrigation and cooling of the body.¹²⁶ The question of void is touched on more lightly.¹²⁷

(ii)

The suggestion that Empedocles' account of breathing, like Plato's, was designed to provide for a cooling of the body, or perhaps in Empedocles' case more specifically of the blood, was advanced by Gilbert.¹²⁸ The idea has been taken up by Longrigg.¹²⁹

The association of breathing and cooling is attributed to several of Empedocles' contemporaries or close successors: Philistion, Philolaus, Hippon, Diogenes of Apollonia.¹³⁰ The prevalence of the idea makes it very possible that Empedocles too used breathing as a means of cooling our inner heat. But this can be no more than a conjecture.¹³¹

¹²⁵ *Parva nat.* 312.

¹²⁶ *Tim.* 77c8–9, 78e3–5, cf. 70c–d and 80d.

¹²⁷ *Tim.* 79b1, c1, cf. 80c3.

Aristotle mentions Plato's avoidance of a vacuum, 472b16; but he does not of course count this as a final cause.

He also considers, and rejects, Plato's theory that breathing is τροφής χάρις, 473a3–14.

It is true that in Plato's account of breathing the element of purpose is not given nearly as much prominence as it is in Aristotle. This, and the inadequacy of Plato's account in Aristotle's eyes, lead to the exaggeration that on the question of the final cause in breathing Plato and his followers οὐθὲν εἰρήκασιν.

Aristotle also complains of the lack of a final cause at the conclusion of his criticisms of Anaxagoras and Diogenes, 471b23–9, and at the beginning of his account of Democritus, 472a1–3.

¹²⁸ Otto Gilbert, *Die meteorologischen Theorien des griechischen Altertums* (Leipzig, 1907) 343–4, cf. 339 and 380–3.

¹²⁹ J. Longrigg, 'Empedocles's fiery fish', *Journal of the Warburg and Courtauld Institutes* xxviii (1965) 314–15.

¹³⁰ Philistion: Galen, *De usu respirationis* I = iv 471 Kühn = Wellmann, *Sikelischen Ärzte* 112 (where the word ἀνάπνευξις is missing).

Philolaus: Anonymus Londinensis xviii 8–29 (DK 44A27).

Hippon: Arist. *De anima* 405b24–9 (DK 38A10). The attribution is from Philoponus, *De anima* 92.2–11 (DK *ibid.*). The etymology which Aristotle alludes to is made explicit (ψυχῆ—ἀναψύχων), without attribution, in the *Cratylus* 399d–e (not in DK).

Diogenes of Apollonia: Aet. v 15.4 (DK 64A28).

The same association of breathing and cooling occurs in two Hippocratic treatises: *περὶ ἱερῆς νόσου* 4 = vi 368 Littré, and *περὶ καρδίας* 5 = ix 84 Littré.

In the *περὶ σαρκῶν* 5–6 = viii 590–4 Littré, πνεῦμα

feeds the heart. This implies cooling, since the author remarks both that the heart is θερμὴ . . . μάλιστα τῶν ἐν τῷ ἀνθρώπῳ and that τροφή ἐστι τῷ θερμῷ τὸ ψυχρόν.

In the *περὶ φνσῶν* 7–8 = vi 98–104 Littré, an excessive amount of breath taken into the body with food and drink cools the blood and causes shivering and fevers.

Galen attributes the association of breathing and cooling jointly to Plato and to 'Hippocrates', *De Hippocratis et Platonis placitis* viii 9 = v 713 Kühn.

¹³¹ Longrigg is wrong to add as evidence for the association of breathing and cooling the passage from Theophrastus, *Hist. plant.* v 9.6 (DK 32A3): πυρεῖα δὲ γίνεταί μὲν ἐκ πολλῶν, ἄριστα δέ, ὡς φησι Μενέστωρ, ἐκ κητοῦ· τάχιστα γὰρ καὶ πλείστον ἀναπνεῖ.

Longrigg, 315, interprets this as meaning that 'ivy is fiery and . . . has the fastest and most copious rate of respiration'. But it is at once evident from the context (not supplied by Diels-Kranz) that πυρεῖα here is 'kindling', and that the verb ἀναπνεῖ has the sense of burning, or as we might say of 'drawing up' (see LSJ s.v.).

From the fact that it makes good kindling it does of course follow for Menestor that ivy is fiery, *De caus. plant.* i 21.5–7 (in part DK 32A5), cf. i 22.5 (not in DK) and *Hist. plant.* v 3.4 (DK 32A3a). But there is no mention of breathing: at *De caus. plant.* i 21.7 τάχιστα . . . ἀναπνεῖ is represented as τάχιστα ἐκπροσόμενα.

Longrigg's primary reason for attributing the idea of breathing and cooling to Empedocles is the report that Empedocles spoke of fish moving to a cool element in order to counteract an excess of internal heat. This and the contrary notion, that birds have a lot of fire and move upwards through the attraction of like for like, seem to me to be best explained as part of two zoogonies in the cosmic cycle, see *ECC* 189–95.

If Empedocles did associate breathing and cooling, then it may be that he also shared Plato's theory that heat in the blood is drawn to fire outside the body by the attraction of like for like. This is the reason for the movement of blood in one of Aetius' accounts of Empedocles' act of breathing, iv 22.1 (DK 31A74): τοῦ ἐμφύτου θερμοῦ τῆ πρὸς τὸ ἐκτὸς ὀρμῆ τὸ ἀερῶδες ὑπαναθλίβοντος. It might be argued that this is simply a reflection of Plato's theory, for Empedocles thinks that blood is an equal, or nearly equal, mixture of all four elements (*fr.* 98), and there might seem to be no immediate reason therefore why its movement should be determined by the action of a single element. But it may be that it is the cooling effect of breath which keeps the component elements in equilibrium.¹³²

(iii)

My suggestion that Empedocles' purpose, again like Plato's, may have been to avoid a vacuum, is also intended to be speculative, although it may derive some slight colour from the description of air moving πρὸς . . . τὸ παρακενωθέν in the two accounts of breathing attributed to Empedocles by Aetius.¹³³

Anaxagoras seems to have tied his account of breathing in fishes to a denial of void. Aristotle writes, *De resp.* 470b30–471a2 (DK 59A115): Ἀναξαγόρας δὲ καὶ Διογένης, πάντα φάσκοντες ἀναπνεῖν, περὶ τῶν ἰχθύων καὶ τῶν ὀστρέων λέγουσι τίνα τρόπον ἀναπνεύουσιν, καὶ φησιν Ἀναξαγόρας μὲν, ὅταν ἀφῶσι τὸ ὕδωρ διὰ τῶν βραγχίων, τὸν ἐν τῷ στόματι γινόμενον ἀέρα ἔλκοντας ἀναπνεῖν τοὺς ἰχθύς· οὐ γὰρ εἶναι κενὸν οὐδέν.

In suggesting that Empedocles may have done something similar, I have not meant to endorse the claim, very frequently made, that in this fragment, or elsewhere, Empedocles observed, or even experimented with, a clepsydra in order to prove the corporeality of air or to disprove the existence of void.

Versions of this claim have been put forward most forcefully by Burnet and by Farrington, and most recently by Lloyd.¹³⁴

The claim seems to rest on two passages.

1. In the *De caelo* Aristotle speaks of Anaxagoras and Empedocles together as having denied the existence of void.¹³⁵

2. In the *Physics* he speaks of Anaxagoras and others who seek to disprove the existence of void by showing that what is apparently empty is in fact full of air, and who think to achieve this latter aim by squeezing wine skins and shutting up air in clepsydras.¹³⁶

These two passages, taken together, might conceivably mean that Empedocles used a clepsydra to try to disprove the existence of void. But that is by no means a necessary or even a probable conclusion.

It is significant that clepsydras appear again in an earlier passage of the *De caelo*. Aristotle refers to the theory held by Anaximenes, Anaxagoras and Democritus, that the

¹³² Empedocles did allow for changes of temperature in the blood, for sleep is the result of a partial cooling of the blood, Aet. v 24.2 (DK 31A85), *cf.* v 25.4 (DK *ibid.*). Theophrastus' two kinds of unintelligence, *De sens.* 11 (DK 31A86), are also to be explained, I think, in terms of a difference of temperature, as well as of texture, in the blood. (I intend to develop this point in a future article.)

¹³³ iv 22.1 (DK 31A74). v 15.3 (not in DK).

¹³⁴ Burnet, 'L'expérimentation et l'observation dans la science grecque', *Scientia* (= *Rivista di scienza* = *Rivista internazionale di sintesi scientifica*) vol. xxxiii

anno 17 (1923) 94–5, *cf.* *EGP* 27, 228–9, 266–7. Benjamin Farrington, *Science in antiquity*, in the Home University Library series (London, 1936) 76–8, and *Greek science, its meaning for us (Thales to Aristotle)* in the Pelican series (Harmondsworth, Middlesex, 1944) 51–3. Lloyd, *Polarity and analogy* 331–2.

¹³⁵ 309a19–21 (DK 59A68), *cf.* 305b16–18 (DK 68A46a).

¹³⁶ 213a22–b2 (in part DK 39A68). *Cf.* [Arist.] *Probl.* 914b9–915a24 (in part DK 59A69), where again Anaxagoras' name alone is mentioned.

earth is prevented from falling by its width and by the air trapped beneath it.¹³⁷ He adds, 294b19–23: ταὐτὸ δὴ τοῦτο ποιεῖν τῷ πλάτει τὴν γῆν πρὸς τὸν ὑποκείμενον ἀέρα (τὸν δ' οὐκ ἔχοντα μεταστῆναι τόπον ἰκανὸν ἀθρόω τῷ κάτωθεν ἡρεμεῖν), ὥσπερ τὸ ἐν ταῖς κλεψύδραις ὕδωρ. ὅτι δὲ δύναται πολὺ βᾶρος φέρειν ἀπολαμβάνόμενος καὶ μένων ὁ ἀήρ, τεκμήρια πολλὰ λέγουσιν.¹³⁸

Now it is true that neither Anaximenes nor Democritus is a suitable candidate for Aristotle's description in the *Physics*. Democritus did not deny the existence of void. Anaximenes was probably not concerned with the question. But the mention of clepsydras in this earlier passage of the *De caelo* shows that Anaxagoras and Empedocles were not alone in their use of this instrument, and serves as a warning therefore that Empedocles is not necessarily in Aristotle's mind when in the *Physics* he claims to speak of Anaxagoras and others who used clepsydras to disprove the existence of void.

It is interesting to notice that clepsydras appear in yet one more simile. Theophrastus remarks that holding one's breath prevents sweat leaving the body in the same way that air prevents water leaving a clepsydra.¹³⁹ Forster refers the observation to Empedocles, on the strength of *fr.* 100.¹⁴⁰ This is essentially the same as the error about void. Theophrastus may conceivably have copied Empedocles. But there is no need at all to suppose that he must have done.

It should be noted also that even if we were to introduce Empedocles into Aristotle's analysis in the *Physics* it would not follow that Empedocles was concerned, in Lloyd's phrase, 'to prove the corporeality of air'.¹⁴¹ Anaxagoras was concerned to disprove the existence of void. Aristotle does not say that he intended to prove the corporeality of air. But this raises wider issues, on the association of air and the void, which are incidental to my present thesis, and which I shall hope to pursue in a future article.

NOTE 8.—*Bibliography of modern interpretations of Empedocles' theory of vision*

Bernhard H. C. Lommatzsch first ascribed to Empedocles a theory of breathing through the skin, *Die Weisheit des Empedokles* . . . (Berlin, 1830) 217–24, 293. Aristotle's misunderstanding of ῥινῶν was here left implicit. This side of Lommatzsch's interpretation was elaborated by Karsten, 244–8 and 477–80.¹⁴²

Karsten's view was rejected by Panzerbieter, 'Zu Empedokles', *Zeitschrift für die Alterthumswissenschaft* iii (1845) no. 111 col. 886. It was also rejected by William Ogle, for the simple but quite sensible reason that παφλάζων . . . οἴδματι μάργω (line 7), while exaggerated as a description of breathing through the nostrils, was altogether impossible as a description of breathing through pores in the skin, *Aristotle on youth and old age, life and death and respiration, translated, with introduction and notes* (London . . . , 1897) 119, *cf.* 20–1.

Mullach, i 68–9, retained the sense of nostrils for ῥινῶν, but claimed that Empedocles meant to speak of breathing through the skin as well. A more extreme version of this idea was put forward by Antonio Traglia, who offers an impossible translation of Aristotle's Greek to show that ῥινῶν was taken by him to mean both nostrils and skin, *Studi sulla lingua di Empedocle* (Bari, 1952) 25 n. 43. Traglia seems in fact to have been misled by a reference in Diels–Kranz, i 347.6, and not to have consulted Aristotle's actual text at all.

Apart from these few expressions of dissent, or partial dissent, Karsten's interpretation

¹³⁷ 294b13–30 (in part DK 13A20).

¹³⁸ This is of course not quite the same as the observation described in the later passage of the *De caelo*, for there it is air trapped *inside* the clepsydra which is relevant, while here the idea appears to be that the air *outside* the clepsydra prevents the heavier element, water, from falling through the perforations, in the same way that air, allegedly, prevents the earth from falling.

¹³⁹ *De sudore* 25–6, repeated in an abbreviated

form and without Theophrastus' name in [Arist.] *Probl.* 866b9–14. There is the opposite theory in the *περὶ διαίτης* ii 64 = vi 580 Littré.

¹⁴⁰ E. S. Forster, Oxford translation of the *Problemata ad loc.*

¹⁴¹ *Polarity and analogy* 331–2.

¹⁴² References to works that have already been cited in note 3 pp. 157–9 above are given here in an abbreviated form.

had until recently been accepted unanimously. Usually there is an explicit reference to Aristotle's 'mistake'. Sometimes there is simply the assumption that Empedocles spoke of breathing through the skin.

Zeller, ZN 993. Winnefeld, *Die Philosophie des Empedokles* 37–8. Paul Tannery, *Pour l'histoire de la science hellène* 2nd edn by A. Diès (Paris, 1930) 345. Burnet, *EGP* 219 n. 2, 245. Gomperz, i 191–2. Diels, *Poetarum philosophorum fragmenta*, on fr. 100.4, repeated in the apparatus of Diels–Kranz. Max Wellmann, *Die Fragmente der sikelischen Ärzte Akron, Philistion und des Diokles von Karystos* (Berlin, 1901) 70–1, 82–4. Beare, *Elementary cognition* 133. Gilbert, *Meteorologischen Theorien* 343–4. Millerd, 72. Schmidt, *Kulturhistorische Beiträge* ii 86. Bignone, 359 n. 3, 471–2, 621–2, cf. 581–2. Powell, *CQ* xvii (1923) 173. Taylor, *Timaeus* 544 ff., especially 554–5 and 567–9. Cherniss, *ACP* 263. Cornford, *Plato's cosmology* 306–7, cf. 319 n. 1 and see pp. 174–5 below. Capelle, *Die Vorsokratiker* 226 n. 2. Frenkian, *Études* ii 57–8. Schumacher, *Antike Medizin* 115–17. Freeman, *Pre-Socratic philosophers* 195. Zafiropulo, who shows some initial hesitation, *Empédocle* 141–2, 158, 278–9. Ross, who stifles his misgivings, *Parva nat.* 314–15. John E. Raven, *The Pre-socratic philosophers, a critical history with a selection of texts* (Cambridge, 1957) 341–2. D. J. Furley, 'Empedocles and the clepsydra', *JHS* lxxvii (1957) 31–4. Kranz, *Empedokles* 58–9 71, 151–2. Charles H. Kahn, *Anaximander and the origins of Greek cosmology* (New York, 1960) 23. Bollack, *Empédocle i introduction à l'ancienne physique* (Paris, 1965) 240–5. Brun, *Empédocle* 88–90.

The view that the fragment describes breathing through the nostrils alone was then put forward independently by M. Timpanaro Cardini, 'Respirazione e clessidra (Empedocle fr. 100)', *La parola del passato* xii (1957) 250–70, and by N. B. Booth, 'Empedocles' account of breathing', *JHS* lxxx (1960) 10–15. Booth's interpretation has been accepted by Guthrie, *History* ii 220–6, and in essentials by Lloyd, *Polarity and analogy* 328–33, but not by Verdenius, *ap.* Guthrie, *History* ii 220 n. 3.

Timpanaro Cardini's other paper, 'La clessidra di Empedocle e l'esperienza di Torricelli', in *Convegno di studi Torricelliani in occasione del 350° anniversario della nascita di evangelista Torricelli 1958* (Faenza, 1959) 151–6, deals more with the supposed theoretical implications of fr. 100.¹⁴³

More recently, Booth's interpretation has also been taken up by G. A. Seeck, 'Empedokles B 17, 9–13 (=26, 8–12), B8, B100 bei Aristoteles', *Hermes* xcv (1967) 28–53 (pp. 41–53 deal with breathing). But Seeck does not deal in any detail with the interpretation of the simile.

I should add that while Seeck seems to me right to abandon the Platonising interpretation, the primary argument by which he seeks to refute this interpretation, 42 ff., seems to me fallacious.

Seeck's general argument appears to be an unacknowledged restatement of Karsten's position, 246: 'Quonam sensu Aristoteles voc[em] $\rho\acute{\iota}\nu\omega\acute{\nu}$ acceperit, non plane liquet: nam etsi Empedoclis dicta ad narium praesertim respirationem refert, id tamen e sententia potius quam ex ipso hoc vocabulo effecisse videtur'. The particular proof which Seeck offers of this is that at *De resp.* 474a9–10 Aristotle allows the possibility of $\rho\acute{\iota}\nu\omega\acute{\nu}$ meaning windpipe and not nostrils.

But the phrase in question, $\epsilon\acute{\iota}\ \mu\acute{\epsilon}\nu\ \pi\epsilon\acute{\rho}\iota\ \tau\alpha\acute{\upsilon}\tau\eta\varsigma\ \lambda\acute{\epsilon}\gamma\epsilon\iota\ \tau\eta\varsigma\ \acute{\alpha}\nu\alpha\pi\pi\omicron\eta\varsigma$, does not exclude breathing through the nostrils, as Seeck seems to suppose. This is clear from Aristotle's statement, before his quotation of the fragment, 473a17–19: $\kappa\alpha\acute{\iota}\ \pi\epsilon\acute{\rho}\iota\ \tau\eta\varsigma\ \delta\iota\acute{\alpha}\ \tau\omega\acute{\nu}\ \mu\upsilon\kappa\kappa\tau\eta\acute{\rho}\omega\acute{\nu}\ \acute{\alpha}\nu\alpha\pi\pi\omicron\eta\varsigma\ \lambda\acute{\epsilon}\gamma\omega\acute{\nu}\ \omicron\upsilon\tau\epsilon\alpha\iota\ \kappa\alpha\acute{\iota}\ \pi\epsilon\acute{\rho}\iota\ \tau\eta\varsigma\ \kappa\upsilon\acute{\rho}\iota\alpha\varsigma\ \lambda\acute{\epsilon}\gamma\epsilon\iota\upsilon\ \acute{\alpha}\nu\alpha\pi\pi\omicron\eta\varsigma$. 'In speaking of breathing through the nostrils, Empedocles thinks that he is also speaking of primary respiration' (i.e. breathing through the windpipe). $\tau\alpha\acute{\upsilon}\tau\eta\varsigma$ therefore at 474a10 refers to breathing through the nostrils and the mouth, and so breathing through the windpipe, as opposed to

¹⁴³ Cf. p. 150 n. 49 above.

breathing *only* through the nostrils, 474a17-18: εἰ δὲ περὶ τῆς κατὰ τοὺς μυκτῆρας λέγει μόνως, κ.τ.λ.

Aristotle's point is that Empedocles *either* includes breathing through the windpipe in his theory (in which case his account of the mechanism of respiration is deficient), *or* supposes that we breathe exclusively through the nostrils (which can be disproved by the fact that if you block your nostrils you can continue to breathe). Nowhere does Aristotle suppose that Empedocles has excluded breathing through the nostrils.

NOTE 9.—*Was Plato's theory of respiration original?*

(i)

If we abandon the theory of cutaneous respiration for Empedocles, the question arises: how original is Plato's theory of respiration in the *Timaeus*?

Seeck contends that the idea of cutaneous respiration, if it does not appear in Empedocles, is first known to us in Plato.¹⁴⁴

Seeck is perhaps right to reject as evidence for cutaneous respiration a passage in the Anonymus Londinensis, which compares man to some kind of water plant, vi 18-29: δίκην τε ἐπέχειν ἡμᾶς φυτῶν· ὡς γὰρ ἐκεῖνα προσερρίζωται τῇ γῆ, οὕτως καὶ αὐτοὶ προσερρίζωμεθα πρὸς τὸν ἀέρα κατὰ τε τὰς ῥίνας καὶ κατὰ τὰ ὅλα σώματα. εὐοικένας μὲν γε φυτοῖς ἐκείνοις, οἱ στρατιῶται καλοῦνται. ὥσπερ γὰρ ἐκεῖνοι προσερρίζωμένοι τῷ ὑγρῷ μεταφέρονται νῦν μὲν ἐπὶ τοῦτο τὸ ὑγρὸν, νῦν δὲ ἐπὶ τοῦτο, οὕτως καὶ αὐτοὶ οἰονεῖ φυτὰ ὄντες προσερρίζωμεθα πρὸς τὸν ἀέρα καὶ ἐν κεινήσει ἐσμέν μεταχωροῦντες νῦν μὲν ἐπὶ τάδε, αὐθις δὲ ἐπ' ἄλλην.¹⁴⁵ The ex-

¹⁴⁴ *Hermes* xciv (1967) 50-2.

¹⁴⁵ In quoting from this work I have transcribed the text from Diels, *Supplementum Aristotelicum* iii (Berolini, 1893), without distinguishing the additions made by Diels to the original text of the papyrus.

The *στρατιώτης* is spoken of also in Pliny, *Nat. hist.* xxiv 18.105 § 169, in Dioscorides, *De materia medica* iv 101 = ii 256.5-257.5 Wellmann, and in Galen, *De simplicium medicamentorum temperamentis ac facultatibus* viii 40 = xii 131 Kühn.

Two alternative identifications are offered by Lewis and Short, s.v. 'stratiotes': the *stratiotes aloides*, water aloe or water soldier, and the *lemna polyrrhiza*, or greater duckweed (which they appear to confuse with the *pistia stratiotes*, mentioned below). A comparison with duckweed is offered also by W. H. S. Jones, to illustrate the passage from the Anonymus Londinensis, *The medical writings of Anonymus Londinensis* (Cambridge, 1947) 39. The identification with the water soldier is offered by several other writers, in particular Max Pohlenz, who concludes that the fact that the leaves of the water soldier 'liegen nicht flach auf, sondern sind steil emporgerichtet und recken sich jedenfalls zur Blütezeit in die Luft empor' is intended as an indication that 'der Mensch seinen Geist erst dann voll entfaltet, wenn er sich über die feuchten Regionen des Bodens in die reine Luft erhebt', *Hippokrates und die Begründung der wissenschaftlichen Medizin* (Berlin, 1938) 73.

Neither identification is likely to be correct.

(i) *The water soldier*. This is described as having leaves with 'teeth and points very sharp', in James Sowerby, *English botany* vi (London, 1797) tab. 379.

The leaves would hardly have been suitable therefore as a cold compress, the use prescribed by Pliny, Dioscorides and Galen. It is a further disadvantage that in Europe the water soldier is rare in the southern part of the continent.

(ii) *The greater duckweed*. According to Pliny and Dioscorides, the *stratiotes* has leaves like the *sempervivum*, but larger. The comparison is probably with the *sempervivum tectorum*, or common houseleek, for according to the commentary in Sowerby this too was used for cold compresses, xix tab. 1320: 'The bruised leaves are by rustic surgeons used as a cooling external application, but their virtues are inconsiderable'. Other haemostatic and curative properties attributed to the common houseleek in John T. Boswell Syme, *English botany* 3rd edn iv (London, 1865) 61, are similar to those claimed for the *stratiotes* by Pliny, Dioscorides and Galen. The leaves of the greater duckweed are from $\frac{1}{4}$ to $\frac{3}{8}$ inch across, according to Syme, ix 24. The leaves of the common houseleek are more than twice as large as this, Syme iv 61.

The *stratiotes* is identified with the *pistia stratiotes* or water lettuce by Kurt Sprengel, *Geschichte der Botanik 'neu bearbeitet'* i (Altenburg und Leipzig, 1818) 155, by LSJ s.v., and by Humphrey Gilbert-Carter, *Glossary of the British flora* 3rd edn (Cambridge, 1964) 79. (I owe this last reference to the kindness of Dr S. M. Walters of the Cambridge Botany School.)

This identification may well be right. The water lettuce floats on the water and has leaves larger than the common houseleek. It also approximates to Pliny's condition, 'in Aegypto tantum et inundatione

pression κατὰ τὰ ὅλα σώματα is taken to indicate cutaneous respiration by Deichgräber and Pohlenz.¹⁴⁶ But it is certainly possible to read that expression as applying simply to man's habitat.

However, Seeck is fairly certainly wrong, it seems to me, to deny the theory of cutaneous respiration attributed to Philistion later in the same document, Anon. Lond. xx 43-9: ὅταν γὰρ, φησίν (sc. Philistion), εὐπνοῇ ὅλον τὸ σῶμα καὶ διεξίη ἀκωλύτως τὸ πνεῦμα, ὑγίεια γίνεται· οὐ γὰρ μόνον κατὰ τὸ στόμα καὶ τοὺς μυκτῆρας ἢ ἀναπνοῇ γίνεται, ἀλλὰ καὶ καθ' ὅλον τὸ σῶμα. ὅταν δὲ μὴ εὐπνοῇ τὸ σῶμα, νόσοι γίνονται, καὶ διαφόρως.

Seeck claims that this means no more than the idea contained in a passage of the *περὶ ἱερῆς νόσου* 16 = vi 390 Littré: ὁκόταν γὰρ σπάση τὸ πνεῦμα ὠνθρωπος ἐς ἑωυτόν, ἐς τὸν ἐγκέφαλον πρῶτον ἀφικνέεται, καὶ οὕτως ἐς τὸ λοιπὸν σῶμα σκίδνεται ὁ ἀήρ.

In the Hippocratic treatise, the preceding chapters make it clear that once air has been drawn in through the mouth and nostrils, it is then dispersed throughout the body by a system of internal veins.¹⁴⁷ In the passage of the Anonymus Londinensis, it would perhaps be possible to take εὐπνοῇ in this sense, as meaning that the body is 'well ventilated' internally; but in the middle sentence of the three I have quoted the emphasis in ἀλλὰ καί fairly obviously means that breathing takes place through the mouth, the nostrils and καθ' ὅλον τὸ σῶμα.¹⁴⁸

Some kind of cutaneous respiration seems also to be intended by the author of the *Ἐπιδημιῶν* vi 6.1 = v 322 Littré: δῆλον ἢ αἰσθησις, ὡς ἔκπνοον καὶ εἴσπνοον ὅλον τὸ σῶμα. This treatise is dated to shortly after 399 by Deichgräber.¹⁴⁹

I conclude that Plato is indebted to Philistion and perhaps others for the idea of breathing through the skin.

(ii)

There remain at least two features of Plato's theory which are, I think, arguably Empedoclean.

1. The principle that fire and air pass through earth and water, but not *vice versa*, which god employs in fashioning the *κύρτος*, 78a ff., looks to me very like an application of Empedocles' theory of different sizes of pores and effluences.
2. The connection of breathing with the movement of the blood, or at least of τὰ τῆς τροφῆς νάματα, 80d, could also, I think, have been suggested by Empedocles' theory.

On the strength of these two features in Plato's account I have ventured to speak of 'the elaboration of Empedocles' theories by Plato', in the case of respiration as in the case of

Nili nascitur', for its presence in the Upper Nile at least is noted by C. W. Hope, 'The "Sadd" of the Upper Nile: its botany compared with that of similar obstructions in Bengal and American waters', *Annals of botany* xvi (1902) 495-516, especially 506. Pliny's *inundatione* may indeed reflect the flooding caused by accumulation of vegetation called the 'sudd' or 'sadd'.

The water lettuce is described and illustrated in (Curtis's) *Botanical magazine* lxxvii, series 3 vii (1851) tab. 4564. There are a couple of fine specimens in the Cambridge botanical gardens.

¹⁴⁶ K. Deichgräber, 'Die Epidemien und das Corpus Hippocraticum, Voruntersuchungen zu einer Geschichte der Koischen Ärzteschule', *Abhandlungen der Preussischen Akademie der Wissenschaften, philologisch-historische Klasse* (Berlin, 1933) no. iii 154-5. Pohlenz, *Hippokrates* 71-4.

¹⁴⁷ Especially chapters 3-4 and 7 = vi 366-8 and 372-4 Littré.

Pohlenz comes close to attributing cutaneous respiration to the *περὶ ἱερῆς νόσου*. He writes, *Hippokrates* 71-2: 'Bei der Atmung spricht die Schrift über die Heilige Krankheit (Kap. 7) freilich nur vom Mund und Nase als den Hauptwegen; aber das geschieht im beiläufiger Erwähnung und schliesst die Hautatmung "durch den ganzen Leib" . . . keineswegs aus.'

¹⁴⁸ This is also the view of Guthrie, *History* ii 223. It was of course also Wellmann's view, but joined in his thesis to a theory of cutaneous respiration for Empedocles, *Sikelischen Ärzte* 70-1.

¹⁴⁹ *Die Epidemien und das Corpus Hippocraticum* 74-5.

vision, although the connection between Empedocles and Plato is of course much lessened, once we abandon a theory of cutaneous respiration for Empedocles, as I think we should.¹⁵⁰

NOTE 10.—*The ambiguities of πύματος, ἔσχατος, ῥίς and ῥινός*

(i)

In my earlier discussion, I made a simple division of the ambiguity in πύματος and ἔσχατος, *fr.* 100.2 and 4. Either both words refer to the *outside* of the body, if ῥινῶν means *skin*, or both refer to somewhere *inside* the body, if ῥινῶν means *nostrils*.¹⁵¹

Dr Lloyd proposes a different alignment. Lloyd takes ῥινῶν to mean nostrils, and πύματος in line 2 to mean *innermost*, but he seems to suggest that ἔσχατος in line 4 may still mean *outermost*.¹⁵²

This seems to me an unnecessary and indeed an impossible complication. For it is reasonably clear that on the Aristotelian interpretation (where ῥινῶν means *nostrils* and πύματος means *innermost*) the pores which are driven ῥινῶν ἔσχατα τέρθρα διαμπερές divide our nostrils from some area within the body, the lungs or chest, which is filled alternately with air and with blood. This division between the nostrils and the lungs or chest can be expressed, it seems to me, only as the *innermost* ends of the nostrils, as distinct from the outermost ends, which is where our nostrils join the outer air.

Michael of Ephesus, in the late eleventh or early twelfth century, proposes in effect the opposite alignment to that in Dr Lloyd. Michael evidently takes ῥινῶν ἔσχατα τέρθρα to be the *innermost* ends of the nostrils, but he takes πύματος κατὰ σῶμα to refer to the *surface* of the body, τὴν ἐπιφάνειαν τῆς σαρκός.¹⁵³

Michael seems to achieve this curious combination of ideas in two ways. First, he explicitly says that only some of the veins are joined to the nostrils.¹⁵⁴ Secondly, he appears to take the 'surface' of the skin, ἡ ἐπιφάνεια τῆς σαρκός, to include as it were an internal surface.¹⁵⁵ In this way those of the veins which have their 'little mouths' attached to the root of the nostrils find themselves in effect inside the body.

(ii)

In my main discussion I also allowed that ῥινῶν was simply ambiguous between 'skin' and 'nostrils'.¹⁵⁶ On closer inspection, the ambiguity, at a simply verbal level, diminishes perhaps. But it does not altogether disappear.

1. 'Ῥίς, 'nose' or 'nostrils', is used frequently by Homer in both the singular¹⁵⁷ and the plural.¹⁵⁸

2. 'Ῥινός, 'skin', is used in the singular both for human skins¹⁵⁹ and for the skins or hides of beasts.¹⁶⁰ In the plural however it is usually used only for the skins or hides of beasts.¹⁶¹

¹⁵⁰ The sentiment in question is expressed on pp. 140 and 146–7 above.

I prefer not to rely on Professor Guthrie's suggestion, that Plato is following Empedocles in his avoidance of void, *History* ii 223–4, for the addition of this feature to Empedocles' theory can be only speculative, see pp. 166–9 above.

¹⁵¹ Pp. 146–7 above.

¹⁵² *Polarity and analogy* 328–30, especially 329 n. 2.

¹⁵³ *Parva nat.* 124.14–127.8.

¹⁵⁴ *Parva nat.* 125.19–22, *cf.* 4–9.

¹⁵⁵ *Parva nat.* 124.18, 125.4–5 and 19.

¹⁵⁶ Pp. 146–7 above.

¹⁵⁷ *Il.* v 291, xiii 616. *Od.* iv 445, xviii 86.

¹⁵⁸ *Il.* xiv 467, xvi 349, 503, xix 39, xxiii 395, 777. *Od.* v 456, xxi 301, xxii 18, 475, xxiv 318.

¹⁵⁹ *Il.* v 308. *Od.* xiv 134, xxii 278.

¹⁶⁰ *Il.* vii 248, x 155, 262, 334, xvi 636, xx 276. *Od.* v 281, xii 423.

¹⁶¹ *Il.* iv 447, vii 474, viii 61, xii 263, xiii 406, 804. *Od.* i 108, xii 395.

From this it has been thought to follow that *ῥινῶν* in *fr.* 100 cannot mean 'skin'.¹⁶² But this is not necessarily so.

1. There are three exceptions, all in the *Odyssey*, to the rule that *ῥινῶν* in the plural is used only for the skins of beasts.¹⁶³

(i) The skin, or skin and flesh (*ῥινοί*), shrivels on the bones of dead men ensnared by the song of the Sirens, xii 46.

(ii) Odysseus is caught on jagged rocks in a rough sea: his skin, or again his skin and flesh (*ῥινός*, the manuscripts also have *ῥινός*), would have been torn from him and his bones broken, if Athena had not come to his rescue, v 426-7.

(iii) In the same passage, the skin (*ῥινοί*) is in fact torn from Odysseus' hands as he clings to the rocks, v 432-5.

In the first two cases, *ῥινοί* is distinguished from bones, and so seems to be used for skin and flesh. This would not fit happily with *ἔσχατα τέρθρα*, as meaning the outermost part (only) of the skin. In the last instance however the plural is used for skin that is torn to shreds. It seems to me conceivable, but unlikely, that Empedocles should have used *ῥινῶν* in this same sense for skin that is pierced *πυκιναιῖς . . . ἄλοξιν* (line 3).

2. If we discount this possibility, it is still true that *fr.* 100 begins as a description of all breathing animals, not only man: *ὦδε δ' ἀναπνέει πάντα . . . πᾶσι λίφαιμοι . . .* Admittedly, in the next line the expression *πύματον κατὰ σῶμα* is singular in its reference. But the singular connotation may be outweighed by the introductory *πᾶσι*. If the fragment describes a plurality of animals, including man, then the meaning of 'skin' for *ῥινῶν* cannot, on grounds simply of Homeric usage, be discounted.

I have therefore sought to resolve the ambiguity, not in terms of the meaning of *ῥινῶν* taken in isolation, but in the light of Aristotle's evidence and the sense of the fragment as a whole.¹⁶⁴

(iii)

The ambiguity of *ῥινῶν* has spread into the interpretation of the doxographical evidence.

Aetius gives an account of Empedocles' act of breathing in the chapter *περὶ ἀναπνοῆς*.¹⁶⁵ This is partly repeated in the chapter *εἰ τὸ ἔμβρυον ζῶον*.¹⁶⁶

Wellmann takes the second entry to describe breathing through pores in the skin.¹⁶⁷ But the account, in both entries, of air entering *εἰς τὰ παρανοιχθέντα τῶν ἀγγείων* could refer equally to breath that has come through the skin or to breath that has come through the mouth or nostrils only.

Cornford refers to the first entry as containing 'an account of respiration similar to Plato's'.¹⁶⁸ In fact the central part of the first entry runs: *τὴν δὲ νῦν κατέχουσιν (sc. ἀναπνοὴν γίνεσθαι) φερομένου τοῦ αἵματος ὡς πρὸς τὴν ἐπιφάνειαν καὶ τὸ ἀερώδες διὰ τῶν ῥινῶν ταῖς ἑαυτοῦ ἐπιρροίας ἀναθλίβοντος*. Bollack translates *διὰ τῶν ῥινῶν* here as 'à travers la peau'.¹⁶⁹ Millerd, Bignone and Booth understand the expression to mean 'through the nostrils'.¹⁷⁰ This is the sense we should expect in a prose author.¹⁷¹ Conceivably Aetius

¹⁶² Seeck, *Hermes* xcv (1967) 49. Cf. Timpanaro Cardini, *La parola del passato* xii (1957) 259 n. 2.

¹⁶³ Karsten, 248, quoted in support of *ῥινῶν* meaning skin *Il.* xix 39, where, to preserve Patroclus' corpse, Thetis pours ambrose and nectar *κατὰ ῥινῶν*. But the meaning here is nostrils, cf. Herodotus ii 86.

¹⁶⁴ It is interesting to note that some confusion between skin and nose seems to have arisen in ancient times. In a gloss on *Il.* xiii 616, *ῥινός ὑπὲρ πυμάτης*, which clearly means 'above the bridge of the nose', Apollónius Sophistes wrote *ἐπὶ μὲν τοῦ δέρματος*

τοῦ μυκτῆρος Lexicon graecum Iliadis et Odysseae s.v. ῥινός.

¹⁶⁵ iv 22.1 (DK 31A74).

¹⁶⁶ v 15.3 (not in DK).

¹⁶⁷ *Sikelischen Ärzte* 72.

¹⁶⁸ *Plato's cosmology* 319 n. 1, cf. 306-7.

¹⁶⁹ *Empédocle* i 242.

¹⁷⁰ Millerd, 72. Bignone, 359 n. 3. Booth, *JHS* lxxx (1960) 14.

¹⁷¹ Apart from the Homeric passages cited above, *ῥινός* is moderately common, as both singular and

could have repeated a poetic use of the word by Empedocles to mean 'skin'. But the passage in Aetius certainly affords no independent evidence for a theory of transpiration.

Aetius' first entry begins with the words τὴν πρώτην ἀναπνοὴν τοῦ πρώτου ζώου. *Prima facie* this sets the report in a zoogonical context. This has been thought to be at variance with Aetius' placing his second account of breathing in a section dealing with embryology, and the zoogonical context of the first entry has therefore been denied, initially by Karsten and Panzerbieter, and most recently by Reiche.¹⁷²

In pursuance of this line of thought, Karsten and Panzerbieter suppress πρώτου, and refer the 'first breath' to the first breath of any new-born animal. This must also have been the intention of the scholiast recorded in Diels' apparatus who wrote ἀρτιγενοῦς as an explanation of πρώτου.

In fact, it seems to me very probable that respiration and embryology should have been treated together in a zoogonical context, either as part of the formation of animal parts in Love's zoogony, or more probably as part of the account of sex and reproduction which probably fell in Strife's zoogony, after, or rather as part of, the separation of the whole-natured creatures.¹⁷³

If we do place Aetius' entry in a zoogonical context, then a passage in Aristotle's *De partibus animalium* may offer a very brief account of the same event.¹⁷⁴ Aristotle writes of the ἀρχαῖοι καὶ πρῶτοι φιλοσοφῆσαντες περὶ φύσεως specifically including Empedocles, 640b11–15: ὁμοίως δὲ καὶ περὶ τῆντ ὧν ζώων καὶ τῶν φυτῶν γένεσιν λέγουσιν, οἶον ὅτι ἐν τῷ σώματι ρέοντος μὲν τοῦ ὕδατος κοιλίαν γενέσθαι καὶ πᾶσαν ὑποδοχὴν τῆς τε τροφῆς καὶ τοῦ περιπτώματος, τοῦ δὲ πνεύματος διαπορευθέντος τοὺς μυκτῆρας ἀναρραγῆναι.¹⁷⁵

The successive movements of water and air in Aristotle's account match fairly closely the successive movements of water and air in the two doxographical accounts of Empedocles' 'first breath': τῆς μὲν ἐν τοῖς βρέφειν ὑγρασίας ἀποχώρησιν λαμβανούσης, πρὸς δὲ τὸ παρακενωθὲν ἐπεισόδου τοῦ ἐκτὸς ἀερώδους γινομένης εἰς τὰ παρανοιχθέντα τῶν ἀγγείων.¹⁷⁶

plural, in poetry. It does not seem to occur at all in prose.

The meaning of 'skin' or 'skins' for ῥῖνες is not merely unfamiliar, as Professor Guthrie observes in his note on this passage from Aetius, *History* ii 223 n.3. It is unknown.

¹⁷² Karsten, 479 n. 275. Panzerbieter, *ZAW* iii (1845) no. 111 col. 886. Harald A. T. Reiche, *Empedocles' mixture, Eudoxan astronomy and Aristotle's connate pneuma* (Amsterdam, 1960) 67–9.

Diels started off by agreeing with Karsten, *Doxographi* 411. But he later thought better of it, *Poet. phil. fragm.* 96.20, repeated in DK i 298.9.

¹⁷³ For these two features of Empedocles' zoogonical theory, cf. *ECC* 200–3 and 50, 209–10.

Diels, *Poet. phil. fragm.* 96.21, repeated in DK i 298.10, rightly notes that τοῦς . . . πρώτους ἄρρενας is used by Aetius in a zoogonical context in v 7.1 (DK 31A81).

Reiche, *Empedocles' mixture* 67–9, argues that Empedocles cannot have spoken of 'the first breath of the first animal', apparently on the ground that the whole-natured creatures were the first animals, and these, Reiche supposes, had no air in their composition.

In fact there seems to me no good reason for supposing that air was missing from the composition of the οὐλοσυνῆ, see *ECC* 203–4 and 206.

It is true that whole-natured creatures had no voice (*fr.* 62.8), and it may be that they did not breathe. If so, then 'the first breath of the first animal' would simply be intended to refer to the first *breathing* animal, i.e. to the first animal of the kind that we know now. An abbreviation of this kind would be entirely natural in a doxographical compilation.

¹⁷⁴ 640b4–15.

¹⁷⁵ On this passage cf. *ECC* 213, and for the verses forged to match this context, *ECC* 346.

¹⁷⁶ A somewhat similar process for the formation of 'channels of air' may be found described in the *περὶ διαίτης* i 9 = vi 484 Littré.

It is unfortunately not wholly clear whether in Aetius the liquid which withdraws is (i) the amniotic fluid, which on birth fills the mouth and nostrils, and most of which leaves the body as soon as pulmonary respiration begins, or (ii) mucenum, which at birth fills the lower part of the ileum and the whole of the great intestine, and which is passed out of the body during the first three or four days after birth, which is also about the time that the lungs take to become fully distended. If only the former, which admittedly seems more probable, then the parallel with the passage in Aristotle is less exact, for in Aristotle the fluid must presumably pass down through the body in order to fashion the belly.

If we do interpret Aetius' first entry in the light of this passage in Aristotle, then Aristotle's *μυκτῆρας* is a good indication that *ρίνω* in Aetius means nostrils.

NOTE 11.—*The workings of Empedocles' clepsydra*

(i)

Throughout my analysis I have taken for granted Last's account of the workings of Empedocles' clepsydra.¹⁷⁷

Last's article has usually been given formal acknowledgment, although its conclusions have not always been accurately reproduced. Thus Professor Guthrie, although referring to Last, still in effect confuses Empedocles' clepsydra with a water-clock, for he writes of both of them together that 'when the thumb was removed, the water *dripped* out' (my italics).¹⁷⁸ This verb, which is also used by Taylor, is appropriate only to a water-clock.¹⁷⁹ A contrivance which could release its liquid content only in drips would not be, in Heron's phrase, *πρὸς τὸ οἶνοχοεῖν χρήσιμον*.¹⁸⁰

Other anomalies abound. In *fr.* 100.19 the manuscripts have *ἡθμοῖο* (MSS. PSXZ) and *ἰσθμοῖο* (MSS. LM). *Ἡθμός* means a strainer, and applied to a clepsydra would therefore most naturally refer to the perforations at the *bottom* of the vessel. *Ἰσθμός* would most naturally apply to the neck or vent at the *top* of the clepsydra. The reading may be in doubt. The meaning of the two words is not. Nonetheless Raven contrives to print *ἡθμοῖο* and translate 'neck', a term which he realises applies to the narrow opening at the top of the clepsydra.¹⁸¹

(ii)

The function of the strainer seems to be misunderstood by Lloyd. He writes: 'It is clear that the strainer of the clepsydra . . . allows both air and water to enter and escape'.¹⁸² This is inaccurate. Air *could* pass through the perforations of the clepsydra, but in the emptying and filling of the clepsydra it does not *in fact* do so.¹⁸³

¹⁷⁷ Cf. p. 148, n. 36 above.

The difficulties inherent in the earlier confusion of Empedocles' clepsydra with a water-clock are well exemplified by Taylor, *Timaeus* 554–5, and by J. U. Powell, 'The simile of the clepsydra in Empedocles', *CQ* xvii (1923) 172–4. The confusion goes back at least as far as Dionysius Petavius, whose attempt to distinguish Empedocles' clepsydra from a water-clock is only partially successful, in his edition of Synesius (Lutetiae, 1612) *Notae* 21–2.

A useful collection of texts on both kinds of clepsydra, with many illustrations, is provided by Max C. P. Schmidt, *Kulturhistorische Beiträge zur Kenntnis des griechischen und römischen Altertums* Heft ii *Die Entstehung der antiken Wasseruhr* (Leipzig, 1912) 84–113. Unfortunately Schmidt's own comments, 24–30, on *fr.* 100 consist of a lengthy and really rather ridiculous attempt to show that Empedocles' clepsydra was used as an egg-timer.

The chief texts which describe a clepsydra of the kind in use in *fr.* 100 are as follows:

[Arist.] *Probl.* 914b9–915a24 (in part DK 59A69).

Hero, *Opera i Pneumatica et automata* i 7 = 56.12–60.3 Schmidt.

Philo Byzantinus, *De ingenis spiritualibus* 11 = 480.21–482.15 Schmidt.

Alexander Aphrodisiensis, *Probl. phys.* i 95 = i 33.6–15 Ideler.

Simplicius, *De caelo* 524.17–525.4, *Phys.* 647.26–30.

Two scholia on Aristotle's *De caelo*, printed in *Aristotelis opera* ed. Academia regia Borussica iv (Berolini, 1836) 506b17–22 and 23–43.

There is also a competent short account of Empedocles' clepsydra by Michael Ephesius *Parva nat.* 123.24–124.11 (reading *κενοῦ γὰρ μὴ ὄντος* at 124.2), cf. 125.25–126.14.

In the twelfth century a similar device was used for washing one's hands under. It is described by Adelard of Bath, *Quaest. nat.* 58.

¹⁷⁸ Loeb edition of the *De caelo* 226–9.

¹⁷⁹ Taylor, *Timaeus* 554.

¹⁸⁰ *Opera i Pneumatica et automata* i 7 = 56.15–16 Schmidt.

¹⁸¹ *Presocratic philosophers* 341, 342 n. 1.

¹⁸² *Polarity and analogy* 331.

¹⁸³ To suppose, as does Guthrie, *History* ii 222, that a certain amount of air follows the water through the strainer, when the clepsydra is being emptied, would be possible perhaps, but fanciful.

Recognition of this distinction would have helped Lloyd's thesis, in so far as it assists the equation of pores and perforations. For only one element, air, *can* pass through the pores, in the same way that only one element, water, *does in fact* pass through the perforations.

As it is, Lloyd's carelessness over the working of the clepsydra is coupled with a more serious error, the supposition that the *tertium comparationis* of the analogy lies in the effect of pressure through a perforated strainer. Lloyd writes: 'The main point which is illustrated by the comparison seems to be that the entry and departure of one substance through a perforated strainer may depend on the variations of pressure exerted on it by another substance.'¹⁸⁴ There is a similar idea in Timpanaro Cardini: 'L'ufficio che egli (*sc.* Empedocles) fa compiere al sangue rispetto all'aria nel meccanismo respiratorio, *cioè quello di pressione e di spinta*, nel paragone della clessidra è affidato all'aria rispetto all'acqua' (my italics).¹⁸⁵

In fact, from the point of view of pressure, the working of the clepsydra and the process of breathing are not at all comparable.

The clepsydra

Pressure of air is responsible for preventing water from entering the clepsydra: *εἴργει . . . ἔσωθε πεσών* (lines 12–13). It is also responsible for holding water within the clepsydra: *ἐκτὸς ἔσω λελημένος . . . ἐρύκη* (line 18).

But it is not clear that the entry and departure of water is effected by pressure:

πνεύματος ἐλλείποντος ἐσέρχεται αἴσιμον ὕδωρ (line 15)

πνεύματος ἐμπίπτοντος ὑπεκθέει αἴσιμον ὕδωρ (line 21).

'*Ἐμπίπτει* perhaps denotes pressure. '*Ἐλλείπει* does not. The idea that water is forced to enter and leave the clepsydra by the pressure of air (or *vice versa*) in effect takes its colour from the pressure exerted by air during the two preceding periods, the retention of air and water in the clepsydra.

Breathing

When we turn to breathing, there is no obvious mention of pressure. Blood 'darts away' (*ἀπαίξῃ* and *ἀπαίξειε* lines 6 and 23), or 'darts up' (*ἀναθρόσκη* lines 8 and 25). Air 'darts back' (*καταίσσειται* line 7) or simply 'comes back' (*κατέρχεται* line 24).¹⁸⁶

There is here no obvious mention of pressure. And there need be no silent implication of it. For in the account of breathing there is no description of the two terminal states that would add to the simple movement of air and blood any notion of pressure. Moreover, if we introduce these two terminal states, it is reasonably clear that the pressure exerted by air on water in the clepsydra does not correspond to any pressure of air on blood or of blood on air in the process of breathing.

1. If we take the correlation of air with air and of water with blood, then it would perhaps be possible to envisage air held in the lungs or chest because *ἔσωθε πεσών* it beats back blood. But it is quite out of place to imagine blood held in the lungs or chest because air beats upon it from outside or from below, *ἐκτὸς ἔσω λελημένος*.

2. We fare no better if we take the opposite alignment, of air with blood and of

¹⁸⁴ *Polarity and analogy* 331.

¹⁸⁵ *Studi Torricelliani* 156, cf. *La parola del passato* xii (1957) 257 and 269–70.

¹⁸⁶ It is true that Aetius uses verbs which denote pressure in his account of Empedocles' theory of breathing: *ὑπαναθλιβοντος* and *ἀναθλιβοντος*, iv 22.1 (DK 31A74). This has perhaps helped to mislead Lloyd.

In Aristotle's account, *De resp.* 473b1–8, the verbs are again (as in Empedocles) simply verbs of movement: *κινεῖσθαι*, *φερομένον* and *ίόντος* of blood, *εἰσρεῖν* and *ἐκπίπτειν* of air. Only *ἐκπίπτειν* (as *ἐμπίπτοντος* in Empedocles) might perhaps denote pressure.

water with air. We might perhaps imagine that blood is able to occupy the lungs or chest because *ἔσωθε πρὸς αὐτὸν* it beats back air. But it is quite impossible to imagine breath prevented from leaving the lungs or chest because blood beats upon it from outside or from below, *ἐκτὸς ἔσω λελημένος*.

The fact is that Lloyd's extension of the notion of pressure to cover both the process of breathing and the working of the clepsydra obscures a fundamental distinction between the nature of pores and the nature of perforations. Pores keep back blood and allow air to pass through them because they are smaller than blood and larger than air. Perforations by themselves are incapable of preventing either element from passing through them. When water is in fact prevented from passing through the perforations, it is not because of the size of the perforations, but because of the pressure of air from within or from outside.

Thus pressure is essential for the workings of perforations. It is not needed for the functioning of pores.¹⁸⁷ It follows that in his talk of pressure Lloyd has in effect singled out as the *tertium comparationis* in the simile a factor which is peculiar to one half only of the comparison.¹⁸⁸

Bollack's interpretation is akin to Lloyd's, in that Bollack too sees the cause of movement as constituting the *tertium comparationis* in the simile. He writes: 'La violence faite à la nature, à la loi physique du lieu naturel, contient la clef de l'analogie.' This orientation leads Bollack to identify blood, as cause of movement in the body, with the girl's hand, as ultimately the controlling factor in the working of the clepsydra.¹⁸⁹

There is a certain logic in this process of thought. For the movement of blood, in Aristotle's phrase *πεφυκός κινεῖσθαι ἄνω καὶ κάτω*, provides what we might call the motive force in the process of breathing.¹⁹⁰ In the same way, the girl's hand, as she dips the clepsydra in and out of the water, provides the motive force for the behaviour of water and air in the clepsydra. But while the comparison is true enough, it seems to me totally inadequate as an expression of the *tertium comparationis*. The movement of blood, even if it is caused by the desire of fire in the blood to reach its like, is something internal to the body.¹⁹¹ The girl's hand is external to the clepsydra.

Since Bollack compares blood in the body with the girl's hand, he is led on to say that air in breathing is represented by both air and water in the clepsydra.¹⁹² The unlikelihood of this further conclusion serves only to reveal the fundamental defectiveness of the premiss, namely Bollack's supposition, essentially identical with Lloyd's, that the *tertium comparationis* lies in the explanation of movement.

(iii)

Shadows of another kind have been cast by a recent article by Wilkens.¹⁹³

Following Last, I have taken the meaning of lines 18–19 to be that aether keeps the

¹⁸⁷ For this reason Aristotle isolates only two factors as required for Empedocles' account of the process of breathing: the movement of blood, and the presence of pores, *De resp.* 473b1–8. There is no mention of pressure, because pressure is required solely for the workings of the clepsydra.

¹⁸⁸ In criticising Lloyd in this way I am conscious that I may be attributing to him too careful and deliberate a distinction between pressure and movement. But if we consider the two halves of the simile simply in terms of movement, then the alleged comparability of air with blood and of water with air seems to me not at all clearly marked, certainly not sufficiently well marked to be able to oust the obvious comparison of air with air and of blood with water, *cf.* pp. 150–1 above.

¹⁸⁹ *Empédocle* i 244. There is essentially the same idea in Lommatzsch, *Die Weisheit des Empedokles* 223: 'Bei der empedocleischen Vergleichung selbst nun entspricht . . . das Spiel des Mägdleins, welche die Wasserglocke einsenkt und wieder hervorhebt, der ein und ausstrebenden Kraft des Blutes selbst'.

¹⁹⁰ *De resp.* 473b5–6.

¹⁹¹ The question of movement caused by fire in the blood has already been considered in note 7, pp. 166–8 above.

¹⁹² *Empédocle* i 244.

¹⁹³ K. Wilkens, 'Wie hat Empedokles die Vorgänge in der Klepsydra erklärt? Bemerkungen zur Fragment B 100', *Hermes* xcv (1967) 129–40.

water in the clepsydra by 'straining inwards from outside', and by 'having control of the surface of the water around the gates of the gurgling strainer' (*ἡθμοῖο*).

Wilkens argues that the aether which keeps the water within the clepsydra is air wedged inside the top of the upper vent of the clepsydra. This air is 'inside straining outwards', and it 'controls the heights around the gates of the ill-sounding upper vent' (*ισθμοῖο*).

This is in effect the explanation of the clepsydra's behaviour given in the *Problemata*.¹⁹⁴ It is essentially the same as the interpretation advanced in a brief note by Diels.¹⁹⁵

It is in Wilkens' favour that *ἄκρα* (line 19) is repeated in the *Problemata* precisely for the surface at the top of the clepsydra (*τῶν δὲ ἄκρων τοῦ αὐλοῦ*, 914b34), and that the expression is in itself perhaps more suitable for the surface at the top and not at the bottom of the clepsydra.¹⁹⁶

If Wilkens' interpretation were adopted, the essential point of the concluding paragraphs of my essay would still remain, although the expression would have to be changed.¹⁹⁷ For it would still be true that the air which keeps water in the clepsydra (whether by beating on the perforations from below, or by being jammed within the neck of the clepsydra) has no parallel in the account of breathing.

In fact however there are two grave disadvantages to Wilkens' reconstruction.

1. The air which prevents water entering the clepsydra is clearly inside the strainer, pushing out, *ἔσωθε πεσῶν ἐπὶ τρήματα πυκνά* (line 13). This makes it most natural for air which prevents water leaving the clepsydra to be outside the strainer, pressing in, *ἐκτὸς ἔσω λεληγμένος . . . ἀμφὶ πύλας ἡθμοῖο* (lines 18–19). It would be odd if the two expressions, *ἔσωθε* and *ἐκτὸς ἔσω*, meant the same, 'from inside outwards', as in effect they do on Wilkens' interpretation.

2. Wilkens is content to repeat the old argument, that *δυσσηχῆς* properly applies to the upper vent of the clepsydra, and not to the perforations, because of the sound made when a carafe of water is emptied.¹⁹⁸

This argument was effectively refuted by Last.¹⁹⁹ A clepsydra was not emptied through the upper neck; and if a clepsydra is in fact so emptied, the process is soundless. Last writes: 'As a matter of fact, when a klepsydra is submerged and the upper vent is opened two noises are heard. The first seems to be made by the convergence of several streams of water as they flow through the perforations and meet inside. The second . . . is a gulping sound made by the water as it rises irregularly inside and forces the air out in a series of spasms. Neither of these noises has its origin in or near the *αὐλός*. Both occur low down in the vessel, and either of them alone, as well as both together, will explain the application by Empedokles of this epithet *δυσσηχῆς* to the *ἡθμός*.'

Wilkens seems to be unaware of Last's article, and, as it stands, I find Last's account convincing. I have therefore retained Last's explanation of lines 18–19 with the reading *ἡθμοῖο*.

I have already suggested that the reading *ισθμοῖο* may have arisen through an attempt to extend the military metaphor in *πορθμοῦ χωσθέντος* and *ἀμφὶ πύλας . . . ἄκρα κρατύνων*.²⁰⁰

D. O'BRIEN

Gonville and Caius College, Cambridge.

¹⁹⁴ 915a4–24 (in part DK 59A69).

¹⁹⁵ *Poet. phil. fragm.* addenda 270. Wilkens finds Diels' note on *fr.* 100 'ganz unverständlich' 133 n. 2. He has evidently not consulted the addenda.

¹⁹⁶ Wilkens makes this second point, 133, but he does not note in this connexion the stronger point, the usage in the *Problemata*.

¹⁹⁷ Pp. 153–4 above.

¹⁹⁸ Wilkens, 133. This argument comes initially from Karsten, 252. It was repeated by Powell, *CQ* xvii (1923) 174. It seems to be echoed in Regenbogen, *Quellen und Studien* i 182 = *Kleine Schriften* 194, from whom Wilkens has taken it.

¹⁹⁹ *CQ* xviii (1924) 173.

²⁰⁰ See note 1, p. 157 above.