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Pythagoreans gave a correct explanation of an eclipse. There is no plausible
claimant before Anaxagoras. The apparent discrepancy in traditions of
derived light and the priority of Anaxagoras may be resolved by assuming
a distinction between reflection and kindling in theories of derived light.

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Anaxagore, suivi en cela par Empédocle, semble être le premier à
fournir une explication valable de l'éclipse. Contre cette hypothèse, on
invoque, d'une part, le témoignage de Thalès, Anaximène et certains
Pythagoriciens, et d'autre part, le fait que des prédécesseurs d'Anaxagore
ont saisi comment la lune empruntait sa lumière au soleil, cette dernière
théorie impliquant à leurs yeux une juste explication de l'éclipse.
Réponse à ces objections.



Derived Light and Eclipses in the Fifth Century

D. O'Brien

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DERIVED LIGHT AND ECLIPSES IN THE FIFTH CENTURY

I

IN a study earlier in this volume, 'The Relation of Anaxagoras and Empedocles', pp. 93-113, I listed the ancient evidence to the effect that Anaxagoras first gave the correct explanation of an eclipse, and that he was followed in this by Empedocles. A more extensive examination of the evidence raises certain difficulties. For what are, or might appear to be, Anaxagoras' theories are attributed elsewhere to earlier thinkers.

There are two principal elements in this contradiction, the one direct and the other indirect.

1. There is a direct contradiction when Thales, Anaximenes and some Pythagoreans are said to have given the correct explanation of an eclipse, at least if we suppose the Pythagoreans in question to have been earlier than Anaxagoras.

2. There has been thought to be an indirect contradiction when several thinkers before Anaxagoras are said to have derived the moon's light from the sun. For a theory of derived light for the moon has been thought, whether rightly or wrongly, to entail the correct explanation of an eclipse.

In what follows I shall attempt to solve these, and some other incidental difficulties.

II

1. *Thales*. The ways in which Thales is associated with an eclipse vary.

(i) Herodotus says that Thales forecast an eclipse of the sun.¹ According to Diogenes Laertius the prediction 'aroused the wonder' of Xenophanes, and was spoken of by Heraclitus and Democritus.²

(ii) One source for Eudemus repeats that Thales forecast an eclipse.³ Another source says that according to Eudemus Thales forecast eclipses, in the plural.⁴ A third source, Theo Smyrnaeus, says that according to Eudemus Thales *ἔδρε πρῶτος* an eclipse.⁵

(iii) According to Pliny Thales *investigavit primus omnium* an eclipse.⁶

(iv) Later this appears in the form that Thales understood eclipses, *κατελῆφεν*.⁷

(v) Finally, in Aetius and in a scholiast on Plato, Thales is said correctly to have explained the sun's eclipse.⁸

The possibility of Thales' having predicted an eclipse of the sun must rise or fall with the state of contemporary Assyrian evidence. But even if we allow that Thales may in some sense have predicted a solar eclipse, still it does not follow that he will have been able to give the true explanation, or any explanation, of the phenomenon, since in the Assyrian world, at least before 609 B.C., the observation of celestial phenomena does not

¹ i 74 (DK 11A5, these references are to Diels-Kranz, *Die Fragmente der Vorsokratiker*, 5th edn. onwards). There are frequent references in later writers, cf. n. 61 below.

² i 23 (DK 11A1), cf. Eudemus fr. 144 Wehrli.

³ Clem. *Strom.* i 65 (DK 11A5), fr. 143 Wehrli.

⁴ Diog. Laert. i 23 (DK 11A1), fr. 144 Wehrli.

⁵ Theo Smyrnaeus, quoting Dercyllides, *Expositio rerum mathematicarum ad legendum Platonem utilium*, 198.14-18 Hiller (DK 11A17), fr. 145 Wehrli.

⁶ *N.H.* ii 53 (DK 11A5).

⁷ Suda, s.v. *Θαλῆς* (DK 11A2): repeated in Cedrenus, *Historiarum compendium* i 275.15-16 Bekker.

⁸ Aet. ii 24.1 (DK 11A17a). In *Remp.* 600A (DK 11A3). In Aet. ii 29.6 (cf. DK 59A77), Thales is listed with those who gave the correct explanation of the moon's eclipse, an idea which is repeated in Simplicius, *Cat.* 191.5-7 and 194.12-13 (not in DK). This would have been a natural step, once it was thought that Thales had given the correct explanation of an eclipse of the sun.

seem to have been tied to attempts at explaining them. In the Greek world things were different: very possibly whoever first attributed the correct explanation of an eclipse to Thales supposed that the forecast of an eclipse, or still more of a number of eclipses, entailed an explanation, and since the forecast or forecasts, were, or were thought to be, successful, that the explanation must have been the correct one. It would not be difficult to imagine some such process of expansion underlying the passages cited above.

Kirk and Dicks allow that Eudemos may have been responsible for this expansion of ideas.⁹ Certainly Eudemos was capable of this kind of thing: elsewhere he argues that Thales 'must' have known a certain theorem, in order to calculate the distance of ships at sea.¹⁰ But in the present instance it seems fairly clear that Eudemos did not go beyond saying that Thales forecast an eclipse, for which Eudemos had the evidence of at least four fifth-century writers. The alternative version, in Theo Smyrnaeus, has fairly clearly arisen simply because a series of abbreviated extracts from Eudemos' *History of Astronomy* has been listed under the general rubric, εἶρε πρῶτος, which in the case of Thales leads to the fairly meaningless statement, εἶρε πρῶτος . . . Θαλῆς ἡλίου ἐκλείψιν.¹¹

At the same time, Theophrastus is probably not the immediate source of the report on Thales, (iv) and (v) above. For it is probable that Theophrastus is the source of the report in Hippolytus that Anaxagoras was the *first* to give the correct explanation of an eclipse.¹² Probably therefore the expansion of ideas, if such it was, comes from Aetius, or an intermediate source, working on material from Theophrastus or from Theophrastus and Eudemos.¹³

2. *Anaximenes*. The excerpts from Eudemos given by Theo Smyrnaeus also imply that the correct explanation of the moon's eclipse was known to Anaximenes, *Expositio* 198.14–199.2 Hiller (DK 13A16 = fr. 145 Wehrli): Εὐδημος ἱστορεῖ ἐν ταῖς Ἀστρολογίαις, ὅτι Οἰνοπίδης εἶρε πρῶτος . . . , Ἀναξιμένης δὲ ὅτι ἡ σελήνη ἐκ τοῦ ἡλίου ἔχει τὸ φῶς καὶ τίνα ἐκλείπει τρόπον.

I shall consider separately, in section III, the first part of this ascription, the question of the moon's derived light. The second part of the ascription would at first sight most naturally be taken to mean that Anaximenes was the first to discover in what way the moon is *in fact* eclipsed. But there are two reasons why this is unlikely to be true.

First, Anaximenes is also said to have had a fiery moon.¹⁴ A fiery moon would seem to be inconsistent with the correct explanation of the moon's eclipse. For a fiery moon would not be likely to be extinguished the moment it entered the shadow of the earth.¹⁵

⁹ Kirk, *The Presocratic Philosophers* 80. Dicks, 'Thales' in *CQ* n.s. ix (1959) 296. Both writers speak of Eudemos' error hypothetically. Guthrie is even more tentative, *A History of Greek Philosophy* i 49.

¹⁰ Fr. 134 Wehrli (DK 11A20). Cf. Dicks, 'Thales' 303.

¹¹ Boll rightly notes that the entry in Theo is simply an extension of the version recorded by Clement and Diogenes, but he does not make it clear that the genesis of the error lies in the formula εἶρε πρῶτος, and his simplified form of quotation, εἶρε πρῶτος ἡλίου ἐκλείψιν, helps to obscure the point, 'Finsternisse', Pauly-Wissowa *RE*, vol. vi 2 col. 2341.

¹² *Ref.* i 8.10 (DK 59A42). Cf. my earlier article, pp. 107 and 109.

¹³ Wehrli suggests that Aetius ii 24, περὶ ἐκλείψεως ἡλίου, is taken from Eudemos and not Theophrastus, *Die Schule des Aristoteles, Eudemos von Rhodos* 120. If this were so, it would perhaps be significant that the entry on eclipses of the moon, which attributes the

correct explanation to Thales among others, ii 29.6 (DK 59A77), continues in Stobaeus' version with an additional half-entry, specifically referred to Theophrastus. Diels, *Doxographi Graeci* 217–18, supposes that both parts of this kind of double entry are taken, at different dates, from Theophrastus. On Wehrli's view it could perhaps be argued that they show a collation of material from Eudemos and from Theophrastus.

¹⁴ Aet. ii 25.2 (DK 13A16). A reconciliation of this report with the report from Eudemos that 'the moon has her light from the sun' is attempted in section III, see especially 123 below.

¹⁵ It was possible to hold such a theory in later antiquity, but only in virtue of a theory of light that was essentially Stoic and Aristotelean, see 123 below. Anaxagoras' moon was also described as διάπυρος and πεπυρωμένος: I shall try to show that in his case this was not incompatible with the moon's shining by reflection, 125–127 below.

Secondly, the correct explanation of an eclipse would also seem to be discordant with the notion of stars moving around, and not under, the earth, 'like a cap around our head'.¹⁶ The idea is presumably that the air on which the earth rests is too dense or buoyant for the stars to pass through it.¹⁷ The sun also moves around, and not under, the earth.¹⁸ It would seem likely that the moon is intended to follow suit. But if neither sun nor moon passes under the earth, it is difficult, although perhaps not impossible, to see how the earth could block the sun's light from the moon in an eclipse.

Tannery's suggestion seems very likely, that the γεώδεις φύσεις ἐν τῷ τόπῳ τῶν ἀστέρων συμπεριφερομένας ἐκείνοις, which Hippolytus and Aetius attribute to Anaximenes, were in fact the means which Anaximenes used to explain eclipses, whether of sun or moon.¹⁹ Tannery's suggestion was accepted by Burnet, Boll and Heath.²⁰ It has been rejected by Kirk, whose argument seems to have affected Guthrie.²¹ Kirk writes: 'It is usually assumed that Anaximenes postulated these invisible celestial bodies in order to explain eclipses; but according to Hippolytus I, 8, 6 (DK 59A42) Anaxagoras, too, believed in them. Yet Anaxagoras knew the true cause of eclipses, therefore he cannot have postulated the invisible bodies for this purpose'. Curiously, Kirk's argument is the reverse of the argument that was very properly adduced by Tannery in support of his thesis. For two sources affirm that Anaxagoras did in fact use these invisible heavenly bodies as an explanation of eclipses of the moon, in addition to the correct explanation. The one source is Hippolytus, who a few lines after the passage cited by Kirk, i 8.9, introduces what are evidently intended to be the same bodies, precisely as an explanation of lunar eclipses, alongside the correct explanation, the interposition of the earth. The same double explanation, interposition by the earth and interposition by other bodies, is attributed to Anaxagoras by Aetius, who specifically quotes Theophrastus.²² This combination of ideas is not in itself implausible, for it reappears in some Pythagorean accounts of lunar eclipses, which are considered in the section immediately following. The fact that Anaxagoras and some Pythagoreans used 'dark bodies' to explain the moon's eclipse supports Tannery's theory that similar bodies in Anaximenes were used for the same purpose.²³

A practical objection to Tannery's reconstruction might be that both sources which mention the 'earthy bodies' in Anaximenes place them in the same region as the stars, so that, if Tannery is right, the stars must be nearer the earth than the moon is (or nearer than the sun and moon, if the 'earthy bodies' are to explain solar eclipses as well). But this positioning of the stars is not impossible. Anaximander and others thought that the stars were nearer to the earth than the sun or moon, and Leucippus thought that they were

¹⁶ Hippol. *Ref.* i 7.6 (DK 13A7). Aet. ii 16.6 (DK 13A14).

¹⁷ Cf. Aet. ii 23.1 (DK 13A15). Anaximenes' earth 'rides' or floats on a cushion of air, Hippol. *Ref.* i 7.4 (DK 13A7); [Plut.] *Strom.* 3 (DK 13A6); Aet. iii 15.8 (DK 13A20); cf. Arist. *De caelo* 294b13 ff. (DK 13A20).

¹⁸ Hippol. *Ref.* i 7.6 (DK 13A7). Cf. Arist. *Meteor.* 354a27-32 (DK 13A14).

¹⁹ Hippol. *Ref.* i 7.5 (DK 13A7). A slightly different form of words in Aet. ii 13.10 (DK 13A14). Tannery, *Pour l'histoire de la science hellène* (2nd edn. by Diès), 157-8.

²⁰ Burnet, *Early Greek Philosophy*⁴ 78. Boll, 'Finsterlicheit', col. 2342. Heath, *Aristarchus of Samos* 44.

²¹ Kirk, *Pres. Phil.* 155-6. Guthrie, *History* i 135 n. 1.

²² Aet. ii 29.6-7 (DK 59A77).

²³ Kirk, *loc. cit.*, argues that Diogenes' ἀφανείς λήθαι, used to explain meteors (Aet. ii 13.9 = DK 64A12) have been read back into Anaximenes. With Tannery's suggestion there is no need to suppose that the evidence has been falsified.

Gershenson and Greenberg argue the other way round from Kirk, *Anaxagoras and the Birth of Physics* (New York, London, Toronto, 1964) 351 and 353. They assume that Anaximenes' γεώδεις φύσεις were used to explain eclipses, but suppose that the passage in Hippolytus has wrongly attributed this, as well as the correct explanation, to Anaxagoras. But they do not mention that the same double explanation is attributed to Anaxagoras by Aetius, specifically quoting Theophrastus, nor that the same duality recurs in accounts of Pythagoreans. Cf. 124 below.

below the sun but above the moon.²⁴ In the absence of evidence either way for Anaximenes, it is possible that he too thought that the stars were lower than the moon, or than the sun and moon.²⁵

Tannery's explanation of the moon's eclipse would be compatible with the idea of a fiery moon, and with the notion that the stars, sun and moon pass round, and not under, the earth. At the same time, *γεώδεις φύσεις* as an explanation of the moon's eclipse are perhaps sufficient to have given rise to the rather loose expression in Theo Smyrnaeus. As I have already noted, the items which Theo excerpts from Eudemus' *History of Astronomy* are made to depend on an initial *εἶρε πρώτος*. In the case of Thales this leads to the pretty meaningless statement, *εἶρε πρώτος . . . ἡλίου ἔκλειψιν*, where two other sources show fairly clearly that what Eudemus said was that Thales forecast an eclipse. Very possibly, in the case of Anaximenes, Eudemus said simply that Anaximenes gave an explanation of the moon's eclipse. Theo's formula turns this into *εἶρε πρώτος . . . ἡ σελήνη . . . τίνα ἐκλείπει τρόπον*, with the consequent (false) implication that Anaximenes gave the *correct* explanation of the moon's eclipse.²⁶

3. *Some Pythagoreans*. Two entries in Aetius attribute the correct explanation of the eclipse of sun and moon to some Pythagoreans. The entry which deals with the moon's eclipse adds the interposition of the antichthon as an explanation alongside the true explanation, the interposition of the earth.²⁷

Aristotle mentions an extension of this scheme, *De caelo* 293b21–25: *ἐνίοις δὲ δοκεῖ καὶ πλείω σώματα τοιαῦτα ἐνδέχεσθαι φέρεσθαι περὶ τὸ μέσον, ἡμῖν δὲ ἄδηλα διὰ τὴν ἐπιπρόσθησιν τῆς γῆς. διὸ καὶ τὰς τῆς σελήνης ἐκλείψεις πλείους ἢ τὰς τοῦ ἡλίου γίνεσθαι φασιν· τῶν γὰρ φερομένων ἕκαστον ἀντιφράττειν αὐτήν, ἀλλ' οὐ μόνον τὴν γῆν*. In the preceding lines Aristotle has considered a Pythagorean theory of an antichthon and a central fire. Fairly certainly the present scheme is also Pythagorean, for only on a Pythagorean scheme would there be bodies circulating around the centre and below the earth.²⁸

²⁴ The position of Anaximander's stars is determined by Hippol. *Ref.* i 6.5 (DK 12A11) and Aet. ii 15.6 (DK 12A18). Stobaeus' version of the entry in Aetius adds Metrodorus of Chios and Crates. For Leucippus, Diog. Laert. ix 33 (DK 67A1). Contrast the report on Democritus, Aet. ii 15.3 (DK 68A86). In a report on Parmenides, Aet. ii 15.4 (DK 28A40a), the stars are apparently put below the sun; but the difficulties in the arrangement of Parmenides' heavens are still unresolved, and it may be that this entry reflects misunderstanding of fr. 10–12, as Zeller argues, *Die Philosophie der Griechen*, Teil i Abteilung 1 (6th edn. by Nestle) 714 n. 2.

It is significant that when Anaxagoras' 'invisible bodies' are first introduced by Hippolytus they are specifically said to be carried around with the sun and moon *below* the stars, *Ref.* i 8.6 (DK 59A42). In the account of eclipses they are said to be below the moon, *Ref.* i 8.9 (DK *ibid.*), Aet. ii 29.6–7 (DK 59A77).

²⁵ The fact that Anaximenes' stars *μὴ θερμαίνειν διὰ τὸ μῆκος τῆς ἀποστάσεως*, Hippol. *Ref.* i 7.6 (DK 13A7), need not show that they are further away from us than the sun, for their heat will presumably be proportionate to their size as well as to their distance. At Aet. ii 14.3 (DK 13A14), Anaximenes' stars are said to be fastened to the firmament; but mention of *τὸ κρυσταλλοειδές* shows that the first part of the entry in fact belongs to Empedocles.

²⁶ A more radical, and less likely, explanation

would be that Eudemus or Dercyllides thought that the correct explanation of the moon's eclipse followed from the fact of the moon's derived light.

²⁷ For the sun, ii 22.5 and ii 24.6 (not in DK), reconstituted from a single entry in Stobaeus by Diels, *Dox. Gr.* 352 and 354. For the moon, ii 29.4 (DK 58B36).

²⁸ This is Zeller's argument, Teil i Abteilung 1 532 n. 2. Simplicius writes, *De caelo* 515.25–26: *λέγει δὲ ὁ Ἀλέξανδρος, ὅτι δύναται τοῦτο καὶ ὡς Πυθαγορείων τινῶν ἐπὶ ταύτης γενομένων τῆς δόξης ἀκούεσθαι*. The dubitative note in *δύναται* seems to me to tell against Guthrie's suggestion, *History* i 283 n. 1, that Alexander is here drawing on Aristotle's lost work on the Pythagoreans. For Alexander would presumably have accepted Aristotle's authority on such a point as conclusive. On one occasion when Alexander disagrees with a point in Aristotle's history of the Pythagoreans he is at pains not to blame Aristotle, but to suppose that Aristotle's account *μεταγεγράφθαι μᾶλλον ὑπὸ τινος* *ap. Simpl. De caelo* 392.12–32.

Stocks' Oxford translation, taken over by Guthrie, in his Loeb edition of the *De caelo*, seems to me to misplace the *καί* in the first sentence quoted in the text above: 'Some of them *even* consider it possible . . .' (my italics). The force of the *καί* would seem to be intensitive, 'quite a number of such bodies', or additive, 'several such bodies as well (as the antichthon)'.

Both Pythagorean theories include the correct explanation of an eclipse. Will they antedate Anaxagoras? Burnet, Boll and Guthrie suppose that they do, or may do.²⁹ But, granted the unreliability of the attributions to Thales and Anaximenes, and in face of the evidence cited earlier for the priority of Anaxagoras, there will be no need to suppose that the Pythagoreans who included the correct explanation of an eclipse in their cosmology did so independently.³⁰

I conclude therefore that there is no plausible claimant, directly for the correct explanation of an eclipse, whether of sun or moon, before Anaxagoras.

III

There remains the second and indirect element in our contradiction, namely the apparent discrepancy that, although Anaxagoras is said to have been the first to explain eclipses correctly, there is nonetheless a variety of evidence that attributes derived light for the moon to a number of thinkers before Anaxagoras. Modern scholars have supposed (whether rightly or wrongly remains to be seen) that a theory of derived light for the moon would have entailed the correct explanation of an eclipse, and would have been an essential element in Anaxagoras' innovation. They have therefore either denied the reports of derived light before Anaxagoras, or denied Anaxagoras' priority.³¹

I have already listed the evidence for Anaxagoras' priority in my earlier article.³² The evidence for derived light before Anaxagoras is as follows:

1. Twice Plutarch says, or implies, that Parmenides made the moon derive her light from the sun. Each time he quotes a verse to illustrate the point:

fr. 14: νυκτιφαῆς περὶ γαῖαν ἀλώμενον ἀλλότριον φῶς.

fr. 15: αἰεὶ παπταίνουσα πρὸς αὐγὰς ἡελίου.

In particular, on one of these occasions, Plutarch refers to the theory that the moon derives her light from the sun as τὸ Ἀναξαγόρειον, when a moment before he has attributed what would appear (to us) to be the same theory to Parmenides.³³

2. Eudemos, in the passage quoted earlier from Theo Smyrnaeus, is said to have attributed derived light for the moon to Anaximenes.³⁴

3. Aetius attributes derived light for the moon to Thales, Pythagoras and Parmenides, as well as to Anaxagoras and Empedocles.³⁵

4. There is something of the same implication in Plato's remark in the *Cratylus*, that the

²⁹ Burnet, *EGP* 177 n. 1 and 272. Guthrie tentatively proposes this reconstruction in the second volume of his *History* 196–7, although in his first volume, 285–7, he supposes that the Pythagorean explanation of eclipses is later than Empedocles and Anaxagoras. Boll is inconsistent in another way. At one point he uses the evidence for Anaximenes to reject Anaxagoras' priority over the Pythagoreans, 'Finsterneisse', col. 2343: 'Die Annahme eines Einflusses des Anaxagoras auf diese Pythagoreer . . . ist angesichts des Anaximenes unnötig'. But in the preceding column he had rejected the evidence for Anaximenes: 'Denn eine Erklärung der Mond-Finsterneisse durch den Erdschatten ist bei des Anaximenes Vorstellung von der Erde als breiter Platte und von der nur seitlichen Bewegung der Gestirne kaum denkbar.'

³⁰ This is Zeller's view, *Teil I Abteilung I* 532 n. 2.

³¹ References 119 and 120–121 below.

³² Pp. 106–109 above.

³³ Fr. 14, *Adv. Col.* 1116A (partly quoted DK 28B14). Fr. 15, *De facie* 929A–B (partly quoted DK 28B15). In these two places the implication is quite clear that the moon depends for her light upon the sun. In another place, *Quaest. rom.* 282B (not in DK), fr. 15 is quoted with a slightly looser implication: ὥσπερ ἡ σελήνη προσέχειν ἐθέλει τῷ κρείττονι (i.e. τῷ ἡλίῳ) καὶ δευτερεύειν (fr. 15), κατὰ τὸν Παρμενίδην.

³⁴ Fr. 145 Wehrli = Theo Smyrnaeus, *Expositio*, 198.18–199.2 Hiller (DK 13A16). The report of derived light for Anaximander in Diog. Laert. ii 1 (DK 12A1) is clearly false, since it conflicts with the account of the moon as 'an opening in a wheel of fire', Aet. ii 25.1, ii 29.1 (DK 12A22), cf. Diels, *Dox. Gr.* 167, *Parmenides Lehrgedicht* (Berlin, 1897) 111.

³⁵ Jointly, ii 28.5. For Parmenides alone, ii 26.2 (DK 28A42); cf. ii 30.4 (DK 28B21).

idea which Anaxagoras put forward of the moon deriving her light from the sun was in fact an 'ancient' idea.³⁶

5. Plato's remark is enlarged upon by Cleomedes, *De motu circulari corporum caelestium*, 200.24–202.4 Ziegler: ἤδεσαν δὲ καὶ οἱ παλαιότατοι τῶν φυσικῶν τε καὶ ἀστρολόγων ὅτι ἀπὸ τοῦ ἡλίου ἢ σελήνῃ τὸ φῶς ἔχει· ὡς δηλὸν ἐστὶ πρῶτον μὲν ἐκ τῆς ἐτυμολογίας τοῦ ὀνόματος αὐτῆς, οὕτως ὀνομασμένης ἐκ τοῦ σέλας αὐτὴν αἰεὶ νέον ἔχειν (this is the explanation given by Plato in the *Cratylus*) καὶ ἐκ τοῦ ἐπιδίδοσθαι δαίδας τοῖς εἰς τὰ Ἀρτεμίσια εἰσιούσι· τοῦτο γὰρ σύμβολόν ἐστι τοῦ ἔξωθεν ἔχειν τὴν σελήνην τὸ φῶς.

6. Diogenes quotes a tale similar to Plato's, ix 34 (DK 59A5): Φαβωρίνος δὲ φησιν ἐν Παντοδαπῇ ἱστορίᾳ λέγειν Δημόκριτον περὶ Ἀναξαγόρου, ὡς οὐκ εἴησαν αὐτοῦ αἱ δόξαι αἱ τε περὶ ἡλίου καὶ σελήνης, ἀλλὰ ἀρχαῖαι· τὸν δ' ὑφηγήσθαι.

The usual response of modern scholars has been to deny this evidence piecemeal, in order to safeguard the priority of Anaxagoras, or of Anaxagoras and Empedocles. Thus Tannery questioned the authenticity of one of the verses which Plutarch quotes as from Parmenides, and explained away the other as insufficient confirmation of Plutarch's statement.³⁷ Kirk assumes that Eudemus is speaking of reflected light, and says that this must be 'another backward projection, this time of a belief common to Xenophanes, Parmenides and Empedocles'.³⁸ (The inclusion of Xenophanes must be a mistake, since he is reported as having believed that the moon has her own light.)³⁹ Guthrie describes the reports in Eudemus and Aetius as 'isolated claims in late writers', and concludes, as does Heath, that there can have been no notion of derived light before Anaxagoras or Empedocles.⁴⁰

But the tradition of derived light before Anaxagoras cannot be so easily suppressed. Out of their context the verses quoted by Plutarch from Parmenides are not, it is true, conclusive evidence for the moon's derived light. But this is not unnatural. Plutarch's quotations are intended as a reminder, and as a literary adornment, not as a demonstration of something in a work that had become rare or unfamiliar, which is the purpose, for example, of Simplicius' quotations (*cf. Phys.* 39.20–21). As it is, even with the verses out of their context, an obvious reason why the moon's light is ἀλλότριον, and why she is always looking in the direction of the sun, would be because her light depends on the light of the sun.

There is no intrinsic reason to doubt Plutarch's evidence that this was in fact the intention of the verses. Parmenides' poem seems to have been available to Plutarch, for twice he includes Parmenides in a list of authors whose works, he seems to say, would have been familiar reading for an educated person of his day.⁴¹ There is no discernible reason

³⁶ 409A–B (DK 59A76). The passage has been quoted in my earlier article, 107 above.

³⁷ *Science hellène* 215–19. Boll, 'Finsterlicheit', col. 2342, remarks against Tannery that the evidence for derived light before Parmenides is 'absolut sicher'. Diels' attempted reconciliation of the evidence on Parmenides seems to me unsatisfactory, *Parmenides Lehrgedicht* 110–12. In effect Diels simply applies to Parmenides what we are told of Anaxagoras and Democritus by Aristotle and Olympiodorus (roughly the passages cited below 126–127).

³⁸ *The Pres. Phil.* 156 n. 2.

³⁹ Aet. ii 28.1 (DK 21A43).

⁴⁰ Guthrie, *History* i 286, *cf.* ii 66. Heath, *Aristarchus* 19 and 75–77. On the question of derived light, Guthrie speaks of 'the doubtful exception of their (i.e. Anaxagoras' and Empedocles') near-contemporary Parmenides'. But if the supposed

priority of Empedocles or Anaxagoras is to be breached by Parmenides, for whom there is good evidence of derived light, then there is no longer any reason, on grounds simply of priority, for refusing to allow the notion of derived light to other thinkers, as well as Parmenides, who are earlier than Empedocles and Anaxagoras.

⁴¹ At *De recta ratione audiendi* 45A–B (DK 28A16), Parmenides is listed with Archilochus, Phocylides (then still extant, see Pauly-Wissowa, vol. xx I col. 505), Euripides and Sophocles. At *Quomodo adolescens*, 16C (DK 28A15), he is listed with Empedocles (whom Plutarch knew well), Nicander and Theognis. In a quite different context, *De Pythiae oraculis* 402E (DK 11A1), designed to flatter Serapion by the antiquity of the tradition he follows of the poet philosopher, the list includes Orpheus and perhaps Thales.

why, if Plutarch knew Parmenides' poem, he should twice have falsified the context of his quotation.

Eudemos cannot properly be lumped with Aetius as a 'late writer'. Aetius quotes a sentence from, or based on, Anaximenes, which is presumably taken from Theophrastus:⁴² it is reasonable to suppose that Theophrastus' contemporary, Eudemos, whose researches were hardly less extensive, will likewise have had some independent knowledge of Anaximenes.

Aetius' inclusion of Thales is probably unreliable. In general, it is unlikely that much, or any, detailed knowledge of Thales' astronomical ideas, if he had any, was available to Theophrastus. In particular, Aetius' inclusion of Thales conflicts with the claim, quoted by Theo Smyrnaeus from Eudemos (115 above), that Anaximenes was the first to discover that the moon has her light from the sun. But Parmenides' work was clearly available to Theophrastus for the writing of the *De sensu*, 3-4: and Parmenides is not simply added to a list, as Thales is; in addition Aetius writes specifically, ii 26.2 (DK 28A42): *Παρμενίδης ἴσῃν τῶι ἡλίῳ* (sc. *τὴν σελήνην εἶναι φησιν*)· *καὶ γὰρ ἀπ' αὐτοῦ φωτίζεται*.⁴³

This whole complex of evidence therefore, two quotations from Parmenides, and three direct reports from Plutarch, Eudemos and Aetius, supported by the looser tradition from Plato and apparently Democritus, is unlikely to be simply wrong.⁴⁴

Boll takes the other choice. He denies the evidence on Anaxagoras' priority.⁴⁵ But this tradition is hardly less well authenticated than the other. Direct reports in Plutarch and in one of the sounder parts of Hippolytus are again supported by the looser evidence from Plato and Democritus.⁴⁶

⁴² i 3.4 (DK 13B2).

⁴³ *Γάρ* is in Stobaeus and Eusebius, xv 27.2; it is lacking in Pseudo-Plutarch and Galen, see *Dox. Gr.* 357a6, b10, 627.19. Diels, following Karsten (*Parmenidis Eleatae carminis reliquiae* [Amstelodami, 1835] 248 n. 80), dismisses the inclusion of *γάρ* as absurd, *Prol.* 62-63, and cites as 'omnino contraria', 62 n. 1, the Stoic idea that the sun is *μεῖζω δὲ τῆς γῆς τῶι πᾶσαν ὑπ' αὐτοῦ φωτίζεσθαι*, Diog. Laert. vii 144. But the connexion of thought implied in *γάρ* seems to me perfectly possible for the fifth century; and the argument of the Stoics, far from telling against it, seems to me to indicate a similar attitude of mind. (Cf. 'Anaximander's measurements', *CQ*, n.s. xvii [1967] 426. The point slightly affects the present argument, in that without *γάρ* the additional sentence is perhaps the more likely to be a simple repetition of the general attribution of derived light to Parmenides and others at ii 28.5.

⁴⁴ I have added these observations on the quality of the evidence, partly in order to off-set the generalisations recently put forward by Dicks in *CQ* n.s. ix (1959) 294-309, and to a lesser extent in *JHS* lxxxvi (1966) 26-40. Dicks writes, *CQ* 299, '... it can confidently be said that the chances that the original works of the earlier Pre-Socratics were still readily available to his (sc. Aristotle's) pupils, such as Theophrastus and Eudemos ... are extremely small'. Again, *CQ* 301, 'There is, therefore, no justification whatsoever for supposing that very late commentators, such as Proclus (5th century A.D.) and Simplicius (6th century A.D.), can possibly possess more authentic information about the Pre-Socratics than the earlier epitomators and excerptors ...'

But Simplicius in fact quotes what appears to be a large part of Parmenides' *Way of Truth*, and the

extent and style of his quotations from Empedocles show that he must have had access to a large part, if not the whole, of the physical poem: see *Empedocles' Cosmic Cycle* (Cambridge, 1968) 150-1.

I would not claim to distinguish between 'available' and 'readily available' in the case of Theophrastus and Eudemos. Apollodorus found Anaximander's work, Diog. Laert. ii 2 (DK 12A1); and Simplicius records a direct quotation from it, which is taken presumably from Theophrastus, *Phys.* 24.18-21 (DK 12A9 = Theophr. fr. 2, *Dox. Gr.* 476).

In this instance Dicks' judgment has perhaps been coloured by his belief that of the series of three pairs of figures offered by Tannery in his reconstruction of Anaximander's system, 'only 27 in the series has any textual authority', *JHS* 36. This is a thoughtless simplification of Kahn, *Anaximander and the Origins of Greek Cosmology* 88 n. 2, cf. 68. In fact 27, 28 and 19 are recorded in the doxographical tradition, if Diels' text is to be trusted, *Dox. Gr.* 348a3-4, b2-3, 351a8, 355a18-19, b16-17. These figures, and the report that 'the sun is equal to the earth', Aet. ii 21.1 (DK 12A21), cf. Diog. Laert. ii 1 (DK 12A1), very possibly explain Eudemos' claim that Anaximander was concerned *περί μεγεθῶν καὶ ἀποστημάτων*, if we suppose that in Simplicius' rather ragged context, *De caelo* 471.2-11 (DK 12A19), this has become attached to planets instead of to sun, moon and stars. By insisting on the formal connexion with planets, Dicks finds the report from Eudemos 'nonsensical', *JHS* 30. For Tannery's reconstruction of Anaximander, see 'Anaximander's Measurements', *CQ* n.s. xvii (1967) 424-7.

⁴⁵ 'Finsterliche', col. 2343.

⁴⁶ Cf. 106-107 above.

Boll's choice carries another disadvantage. Boll accepts the reports of derived light for philosophers before Anaxagoras, including Anaximenes and Parmenides, and he supposes that derived light means reflected light. But successive entries in Aetius say that Anaximenes' and Parmenides' moon was fiery, *πύρινος*.⁴⁷ A longer entry says that Parmenides' sun is an expiration of fire, while the moon is a mixture of fire and air.⁴⁸ A fiery moon, even a partially fiery one, would seem to be inconsistent with the moon's deriving her light from the sun, if derived light means reflected light.⁴⁹

The whole difficulty is therefore as follows.

1. Anaxagoras is the first person who is reliably reported as having given the correct explanation of an eclipse, and he is said to have been the first to do so.

2. But there is a wide complex of evidence to the effect that thinkers before Anaxagoras held a theory of derived light for the moon: derived light has been thought, whether rightly or wrongly, to entail the correct explanation of an eclipse.

3. Two thinkers before Anaxagoras who are said to have held a theory of derived light for the moon are also said to have had a fiery moon: a fiery moon would seem inconsistent with the moon's deriving her light from the sun, if derivation means reflection.

A partial solution would be to break the assumption that reflected light would have entailed the correct explanation of an eclipse. Anaximenes and Parmenides, it could then be argued, thought that the moon's light was reflected from the sun; while Anaxagoras first used the idea to explain eclipses.

But this solution does not fully explain the evidence.

1. It does not give Parmenides and Anaximenes a fiery moon.

2. It does not fully account for the form of words in Plutarch and Hippolytus, quoted above, 106–107 that Anaxagoras was the first to give a clear account specifically of the *lighting* of the moon:

Plutarch, *Nic.* 23 (DK 59A18) : *περὶ σελήνης καταυγασμῶν καὶ σκιάς.*

Hippolytus, *Ref.* i 8.10 (DK 59A42) : *οὗτος ἀφώρισε πρῶτος τὰ περὶ τὰς ἐκλείψεις καὶ φωτισμούς.*

Cf. Plato *Crat.* 409A–B (DK 59A76) : *ὁ ἐκείνος νεωστὶ ἔλεγεν, ὅτι ἡ σελήνη ἀπὸ τοῦ ἡλίου ἔχει τὸ φῶς.*

3. And so clear-cut a distinction between Anaxagoras and his predecessors does not altogether explain the controversial note in Democritus and Plato, as cited above 118–119.⁵⁰

⁴⁷ ii 25.2 (DK 13A16); ii 25.3 (DK 28A42). Theodoretus makes a composite entry, and writes, more emphatically . . . *ἐκ μόνου συνεστάναι πυρός, Graecarum affectionum curatio* iv 23 (*Dox.* 356).

⁴⁸ ii 7.1 (DK 28A37). A later and shorter entry, ii 20.8a (DK 28A43), says that the sun comes from the rarer and hotter part of the Milky Way, while the moon comes from the denser and colder part. Zeller, *Teil i Abteilung* 1 715 n. 1, and Guthrie, *History* ii 66, more or less despair over the discrepancies in these two reports and in those cited in the preceding footnote. They can best be reconciled if Theodoretus is taken as a rewriting of the (original of the) more specific entries in Stobaeus (the only representative here of Aetius), ii 25.2 and 3, and if these and the report at ii 20.8a are taken as equally one-sided versions of the exceptionally full statement at ii 7.1, where the moon is a mixture of fire and a colder element. It is not unnatural for the moon to be colder than the sun, if her light is derived light: *cf.* n. 54 below.

⁴⁹ Anaxagoras' moon is also described as *διάπυρος* and *πεπυρωμένος*. I shall try to show that in his case this was compatible with a theory of reflection, 125–127.

Empedocles' moon is made of air solidified by the action of fire: Plut. *De facie* 922C (DK 31A60); Aet. ii 25.15 (DK *ibid.*); [Plut.] *Strom.* 10 (DK 31A30); *cf.* the account of the formation of the firmament, Aet. ii 11.2 (DK 31A51). There is no need to accept the inference of Aetius that it is composed of fire: that it is an inference is shown by *ὥστε*.

⁵⁰ The position outlined in the last paragraph but one is more or less that taken by Tarán, *Parmenides, a text with translation, commentary, and critical essays* (Princeton University Press, 1965) 245 nn. 39 and 40. But to achieve this position Tarán has to deny the reports of a fiery moon for Parmenides (in fact he offers the hesitant formula, that the moon is 'most probably composed entirely or predominantly of air (Night)', 244–5, my italics); to

The proper solution, I suggest, lies in breaking the other assumption: that derived light means reflected light. This is in fact a modern assumption, which was not shared in later antiquity. For a theory that the moon derives her light from the sun, not by reflection, but by a mixing and joint kindling of the moon's own light with light from the sun, is given at some length by Plutarch's Lucius in the *De facie* and by Cleomedes.⁵¹

1. Lucius introduces kindling and absorption as together a pair of alternatives to the theory that the moon shines by reflection, 929B–C: φωτίζεσθαι τοίνυν τὴν σελήνην (i) οὐκ ὥς ὕalon ἢ κρύσταλλον ἐλλάμψει καὶ διαφάσει τοῦ ἡλίου πιθανόν ἐστιν (ii) οὐδ' αὖ κατὰ σύλλαμψίν τινα καὶ συνανασμον ὥσπερ αἱ δαῖδες αὐξομένον τοῦ φωτός. οὕτως γὰρ οὐδὲν ἦττον ἐν νομηνίαις ἢ διχομηνίαις ἔσται πανσέληνος ἡμῖν, εἰ μὴ στέγει μηδ' ἀντιφράττει τὸν ἥλιον ἀλλὰ (ia) διήσιν ὑπὸ μανότητος (iia) ἢ κατὰ σύγκρασιν ἐκλάμπει καὶ συνεχέσπει περὶ αὐτὴν τὸ φῶς.⁵² The same idea is mentioned again briefly towards the end of Lucius' speech where he concludes, in favour of the theory of reflection, that the behaviour of the moon παντὸς μᾶλλον ἐπιδείκνυσιν οὐ σύγκρασιν ἀλλ' ἐπαφήν οὐδὲ σύλλαμψιν ἀλλὰ περιλάμψιν αὐτῆς ὄντα τὸν φωτισμόν, 931A–B. The context immediately preceding shows that the σύγκρασις and σύλλαμψις would be a conjunction of the light of sun and moon.

2. Cleomedes describes the view that the moon shines by mixing her own light with that of the sun immediately after the view that the moon shines by reflection, *De motu*, 182.20–184.3 Ziegler: τρίτη ἐστὶν αἴρεσις ἢ λέγουσα κινᾶσθαι αὐτῆς (sc. τῆς σελήνης) τὸ φῶς ἔκ τε τοῦ οἰκείου καὶ τοῦ ἡλιακοῦ φωτός καὶ τοιοῦτον γίνεσθαι οὐκ ἀπαθοῦς μενούσης αὐτῆς οὐδέ . . . [by reflection] . . . ἀλλ' ἀλλοιουμένης ὑπὸ τοῦ ἡλιακοῦ φωτός καὶ κατὰ τοιαύτην τὴν κρᾶσιν ἴδιον ἰσχύουσης τὸ φῶς, οὐ πρώτως, ἀλλὰ κατὰ μετοχήν, ὥς διάπυρος σίδηρος κατὰ μετοχήν ἴσχει τὸ φῶς οὐκ ἀπαθῆς ὢν, ἀλλὰ τετραμμένος ὑπ' αὐτοῦ. This is the view which Cleomedes himself adopts, 188.4–7 Ziegler: εὐδηλον ὡς οὐ κατὰ ἀνάκλασιν ἐκπέμπει (sc. ἡ σελήνη) τὸ φῶς, ἀλλὰ δι' ὅλης ἀπὸ τῶν ἡλιακῶν ἀκτίνων λαμπρυνομένη καὶ κεκραμένον ἔχουσα τὸ φῶς οὕτω λαμπρύνει τὸν αἶρα.

Cleomedes' later discussion, 190.1–16, makes it reasonably clear that this was in fact the theory of Posidonius, for Posidonius is credited with a defence of the objection that a moon which shines by kindling could not block the light of the sun in an eclipse. Posidonius' reply is that the airy nature of the moon has sufficient βάθος to prevent the rays of the sun passing right through the moon, so as to be visible to us. Plutarch attributes the same defence to Posidonius, 929D, although from Plutarch's account alone it would not be clear whether the theory that Posidonius defends is one of kindling or absorption.

Cleomedes raises the equivalent objection, 188.8–28: if the moon has a light of her own, mixed with or kindled from that of the sun, how can she be darkened instantaneously

ignore the report of a fiery moon for Anaximenes; to relate Plato's remark in the *Cratylus* exclusively to the explanation of eclipses; and to ignore, or overlook, the specific mention of lighting in Plutarch and Hippolytus.

⁵¹ Ferguson suggests that derived light in Pseudo-Plutarch's report on Empedocles, *Stromateis* 10 (DK 31A30), could mean kindled light and not reflected light, 'Two notes on the Preplatonic' in *Phronesis* ix (1964) 99. But he rightly rejects this idea, without considering whether the distinction would explain the evidence for thinkers other than Empedocles.

⁵² The views are marked (i) and (ia), (ii) and (iia), to make it clear that there are two, and only two, principal theories, each of which is once repeated. Cherniss, in the Loeb edition of the *De facie*, gives separate attributions for glass and ice in

(i), for (ii), and for (iia), thus suggesting that there are three (or four) different theories involved, and so confusing the structure of the piece.

Two of Cherniss' attributions are questionable. View (i) cannot be taken simply as Empedocles' view, for it is the theory that light shines *through* the moon, whereas Empedocles is introduced a moment later, 929E, to illustrate what is clearly intended to be a different view, that light is reflected *from* the moon. View (ii) is not adequately paralleled by the Pythagoreans mentioned in Aetius ii 29.4 (DK 58B36), for there the moon which is kindled and extinguished is not said to be kindled *from the sun*, which is an essential element in the theory which Plutarch speaks of.

The use of torches to describe kindling is interesting. Cleomedes, quoted 119 above, uses the same image to describe the 'ancient' theory of the moon's light.

by the shadow of the earth in her own eclipse? Cleomedes' answer is the Aristotelean and Stoic theory that lightness and darkness are instantaneous affections of air and other rare bodies.⁵³

Now if we strip off these two more or less sophisticated accretions offered by Posidonius and Cleomedes, then the simple theory of a moon whose light is kindled from the sun will at once resolve the difficulties in the evidence for the fifth century. For derivation by kindling, as distinct from reflection, is not inconsistent with, in fact it demands, a fiery moon. Equally, derivation by kindling, in a simple sense, does not entail, in fact it excludes, the correct explanation of an eclipse. For derivation by kindling, except on a specifically Aristotelean theory of light, makes it unlikely that the moon would lose her light the moment she entered the shadow of the earth; and similarly one would not expect a moon which shone by kindling to be able to conceal the light of the sun, except at the expense of revealing her own.

Hence I suggest that two pairs of ideas should be distinguished, in order to resolve the apparently discrepant traditions on the question of derived light and the priority of Anaxagoras.

1. Empedocles and Anaxagoras derive the moon's light from the sun by *reflection*. In accordance with this, they both give the correct explanation of eclipses.

2. Anaximenes and Parmenides are said to have derived the moon's light from the sun: they are also said to have had a fiery moon; and they are not (reliably) reported to have given the correct explanation of eclipses. This, I suggest, is because their moon derives its light from the sun not by reflection but by *kindling*.⁵⁴

These two pairs of ideas are sufficiently similar, in that they both derive the moon's light from the sun, for it to be possible to allege, as did Plato and apparently Democritus, that Anaxagoras was revamping an ancient idea, and for Plutarch to write, in the *Life of Nicias* 23 (DK 59A18): ὁ γὰρ πρῶτος σαφέστατόν τε πάντων καὶ θαρραλεώτατον περὶ σελήνης κατανασμάων καὶ σκιᾶς λόγον εἰς γραφήν καταθέμενος Ἀναξαγόρας . . . A theory of the moon's being lit from the sun by kindling, and not by reflection, with 'invisible earthy bodies' or some other means to explain eclipses, would fit nicely the notion of something less 'clear' and less 'bold' than the correct explanation.

However, I must at once admit that there is no direct evidence for the fifth century of a moon whose light is kindled from the sun. What was familiar in the fifth century was the idea that heavenly bodies were kindled and extinguished, either in eclipses or by their rising and setting. Xenophanes and Metrodorus of Chios thought that the stars and sun respectively were kindled and extinguished.⁵⁵ Diogenes thought that the sun was extinguished.⁵⁶ Some Pythagoreans thought that the moon was kindled and extinguished.⁵⁷ Later the idea was taken up in the Epicurean school;⁵⁸ and Dercyllides, in the fourth century, mentions as a false, but apparently common, assumption that the 'divine', i.e. the heavenly, bodies rose and set because they were kindled and extinguished.⁵⁹ It would

⁵³ Apart from the passages in Plutarch and Cleomedes, the idea of kindling seems to make a fleeting appearance in Martianus Capella, *De nuptiis Philologiae et Mercurii* ii 118, 'quis Lunam flammam vel minuat radius', if *flammare* has a literal sense, and possibly in Philo, *De prov.* ii 95 Aucher, 'iubar Lunae . . . secundum perceptionem et redintegrationem lucis solaris', although on p. 92 the idea is of reflection. Reflection seems to be the usual view, although the phrasing is not always explicit: Geminus, *Elementa astronomiae*, chapters 9–11; Macrobius, *In somn. Scip.*, i 15.10–12, cf. i 19.8–14; Pliny, *NH* ii 8.11; Basil, *Hexaemeron* 189A. Possibly *incensa*

and *accensa* should be taken literally in Cicero's brief descriptions of the moon at *De nat. deor.* i 8.7 and *De Rep.* vi 17.

⁵⁴ This would explain why, although Parmenides' moon is fiery, it is apparently not as fiery as the sun, cf. n. 48 above.

⁵⁵ Xenophanes: *Act.* ii 13.14 (DK 21A38). Metrodorus: [Plut.] *Strom.* 11 (DK 70A4).

⁵⁶ *Act.* ii 23.4 (DK 64A13).

⁵⁷ *Act.* ii 29.4 (DK 58B36).

⁵⁸ *Diog. Laert.* ix 92.

⁵⁹ *Ap. Theo Smyrnaeus, Expositio* 199.21–200.2 Hiller.

have been a simple step from this to the idea that the moon's light was kindled *from the sun*, which is essentially Cleomedes' view and the view which appears in Plutarch. But this extension is not directly attested for the fifth century, and the reconstruction I have offered must therefore remain a speculative one.

IV

To simplify the exposition of the foregoing argument, I have delayed consideration of some incidental difficulties, real and imaginary, in the evidence on Anaxagoras' moon.

1. In a recent study of Anaxagoras, two American writers, Gershenson and Greenberg, deny that Anaxagoras gave the correct explanation of an eclipse. They write that Anaxagoras 'held that it (*sc.* the moon) does not give off its own light but shines instead by the reflected light of the sun. On the basis of this view he (Anaxagoras) would have been able to give a fairly complete explanation for the phases and eclipses of the moon provided he assumed also that the moon was nearer the earth than the sun. Unfortunately we do not know if he made this assumption nor have we any reliable reports from which we could conclude that he constructed a theory of lunar phases or eclipses', *Anaxagoras and the Birth of Physics* (New York, London, Toronto, 1964) 41.

The idea that the moon is 'lower' than the sun, and so nearer the earth, is in fact explicitly attributed to Anaxagoras by Hippolytus, i 8.7 (DK 59A42): *εἶναι δὲ τὴν σελήνην κατωτέρω τοῦ ἡλίου πλησιώτερον ἡμῶν*. Anaximander and Empedocles thought the same. There is, I think, no indication that anyone in the fifth century thought otherwise.⁶⁰

The denial that there are any 'reliable' reports that Anaxagoras gave the correct explanation of an eclipse of the moon in effect dismisses the evidence already noted from Plutarch, Hippolytus and Aetius. Gershenson and Greenberg offer no specific arguments against the reliability of Hippolytus and Aetius, and they do not even mention Plutarch.⁶¹

2. The size of Anaxagoras' sun, larger, or many times larger, than the Peloponnese, could be an obstacle to the correct explanation of an eclipse. For if the sun is smaller than the earth, then the shadow cast by the earth should extend outwards in an ever increasing cone, and the moon would be eclipsed night after night.⁶²

But even if Anaxagoras did intend the sun to be smaller than the earth (and this need not have been his intention), it is clear that he did not draw the conclusion that the earth's

⁶⁰ Anaximander: Aet. ii 20.1, ii 21.1, ii 25.1 (DK 12A21 and 22); Hippol. *Ref.* i 6.5 (DK 12A11). Empedocles: Aet. ii 31.1 (DK 31A61). Cf. 'Anaximander's Measurements', *CQ* n.s. xvii (1967) 423-9. There was of course in the fifth century a difference of opinion over the position of the stars, see 116-117.

⁶¹ They do of course include the passage from Plutarch in their translation of the testimonia, 128, but Plutarch is not mentioned in the note to the passage quoted above, 474, nor in the brief discussion of the point later in the work, 351 and 353.

Plutarch and Hippolytus are cited above, in the discussion of Anaxagoras' priority, 106-107. For the passage from Aetius, ii 29.6-7 (DK 59A77), cf. 116 n. 22 above. In the second half of this entry the *καί* in 'Αναξαγόρας, ὥς φησι Θεόφραστος, καὶ τῶν ὑποκάτω τῆς σελήνης ἐσθ' ὅτε σωμάτων ἐπιπροσθούτων may imply that the correct explanation as well as the additional bodies were attributed to Anaxagoras by Theophrastus. On the nature of this double entry cf. n. 13 above.

There are of course less 'reliable' reports in later writers, who associate Anaxagoras with the forecast or the explanation of an eclipse, e.g. Valerius Maximus, *Facta et dicta memorabilia* viii 11, ext. 2 (not in DK), Philostratus, *Vita Apollonii* i 2 (DK 59A6).

⁶² 'Larger': Hippol. *Ref.* i 8.8 (DK 59A42); Diog. Laert. ii 8 (DK 59A1); Theodoret. *Graec. aff. cur.* iv 22 (*Dox. Gr.* 351). 'Many times larger': Aet. ii 21.3 (DK 59A72); Eus. *Praep. Evang.* xv 24.2 (cf. *Dox. Gr.* 351). Galen's statement, that the sun is larger than the earth, *Hist. philos.* 63 (*Dox. Gr.* 626), although it may be true in substance, is probably in Galen simply a random error, arising from the fact that the preceding sentence, on Anaximander, twice makes a comparison of sun and earth. (The corresponding statement, that the moon is the same size as the Peloponnese, quoted by Plutarch, *De facie* 932B, is missing from Diels-Kranz.)

shadow covers a large part of the heavens. For, according to Aristotle, Anaxagoras explained the Milky Way as the light of stars screened from the rays of the sun by the shadow of the earth.⁶³ The shadow of the earth must therefore be a fairly narrow band, which would only occasionally obscure the light of the moon.

3. Burnet allows that Anaxagoras gave the correct explanation of an eclipse, but he gives a particular twist to the question whether he was the first to do so. He writes, *EGP* 272: 'As to the moon's light and the cause of eclipses, it was natural that Anaxagoras should be credited at Athens with these discoveries'. Burnet's explanation is an expansion of a remark by Zeller, to the effect that Anaxagoras was 'one of the first' to bring the idea of reflected light for the moon to mainland Greece.⁶⁴

Burnet's idea might possibly account for Plato's remark in the *Cratylus*, if it stood in isolation. But it is difficult to see why a local Athenian tradition should determine both Plutarch's testimony and Aristotle's, if we suppose Hippolytus' testimony to derive ultimately from Aristotle's school. It is fairly evident that Burnet and Zeller write as they do simply by way of providing covert defence for their own (false) belief that Empedocles wrote before Anaxagoras.⁶⁵

4. I turn to a more serious point. It is not explicitly stated that Anaxagoras' moon shines by reflection. Plutarch's words, accounted a verbatim quotation (fr. 18) by Diels, are not in themselves decisive, *De facie* 929B: ἥλιος ἐντίθησι τῇ σελήνῃ τὸ λαμπρόν. This sentence shows that the moon's light is derived light, but not whether it is derived by kindling or by reflection. (The adjective λαμπρός might perhaps suggest reflection, but it is hardly conclusive evidence.)

Moreover, Anaxagoras' moon is described in the doxographical tradition as γῆν πεπυρωμένην στερέμνιον ἔχουσιν πῦρ, or as στερέωμα διάπυρον, and the unevenness of the moon's appearance is said to be the result of a mixture of τὸ πυροειδές and τὸ ζοφώδες.⁶⁶ If the body that 'reflects' light itself becomes hot or fiery, this would seem to be a process of mixing and kindling, and not of reflection.

These difficulties, although serious, are not, I think, insurmountable. In the first place, it is reasonably clear from the context of Plutarch's discussion in the *De facie* that the words quoted, or summarised, by Plutarch were intended to describe a theory of reflected light. For Lucius remarks, 929B: ὁ μὲν οὖν ἑταῖρος ἐν τῇ διατριβῇ τοῦτο δὴ τὸ 'Αναξαγόρειον ἀποδεικνύς ὡς 'ἥλιος ἐντίθησι τῇ σελήνῃ τὸ λαμπρόν' ἡὐδοκίμησεν. There is a slight break in the dramatic sequence of the dialogue at this point, but the most natural implication of Lucius' remark would be that 'our comrade' won the applause of the company by his exposition and defence of Anaxagoras' thesis. Now throughout the dialogue the trio composed of 'our comrade', Lucius and Lamprias is evidently intended to present a common front, by way of providing the scientific foundation for Sulla's myth. The thesis which Lucius, their spokesman on this point, himself approves is that the moon shines by reflection (and so has an earthy rather than a fiery nature) as opposed *inter alia* to the view that she shines by mixture and kindling. Probably therefore the theory which 'our comrade' defended was likewise a theory of reflection.

It is no inconsistency that after referring to τὸ 'Αναξαγόρειον, Lucius puts forward the theory of reflection as τὸ τοῦ Ἐμπεδοκλέους. In the rich display of erudition which Plutarch likes his characters to offer it is entirely natural that the two theories should be, at least in essentials, the same. The ideological structure of this part of Lucius' speech will then be as follows:

⁶³ *Meteor.* 345a25-31 (DK 59A80), discussed more fully below, 126.

⁶⁴ Teil i Abteilung 2, 1241-2. Zeller notes without comment, 1241 n. 3, the evidence for the priority of Anaxagoras' explanation of an eclipse.

⁶⁵ See 93 n. 3 and 94-96 above.

⁶⁶ The three statements come respectively from Achilles, *Isag.* 21 p. 49.4-7 Muller (DK 59A77); Aet. ii 25.9 (DK *ibid.*); and Aet. ii 30.2 (DK *ibid.*).

- (i) Reflection is introduced, as τὸ Ἀναξαγόρειον, 929B.
- (ii) Two alternative theories, kindling and absorption, are then disposed of, in part with the help of illustrations from Empedocles, 929B–D.
- (iii) Lucius concludes by endorsing reflection, ἀπολείπεται τοίνυν τὸ τοῦ Ἐμπεδοκλέους, 929E.

But if Anaxagoras' moon shines by reflection, how can it be πεπυρωμένος and διάπυρος? The answer, I suggest, is to be seen in terms of a comparison with Anaxagoras' stars. In the *Meteorologica* Aristotle says that Anaxagoras' stars have a light of their own, but that this is 'prevented' or 'held back', κωλύεσθαι, by the light of the sun, except for the stars of the Milky Way, whose own light is visible, because it is screened from the sun's rays by the shadow of the earth.⁶⁷ Olympiodorus makes explicit the parallel with the moon: the moon has a light of her own which is visible as a 'smouldering' light in eclipses; at other times we see the sun's light reflected from the moon, 67.32–68.2 Stüve: τρίτη δόξα Ἀναξαγόρου καὶ Δημοκρίτου. οὗτοί φασι τὸν γαλαξίαν εἶναι τὸ ἴδιον φῶς τῶν ἀστέρων τῶν μὴ φωτιζομένων ὑπὸ τοῦ ἡλίου. ἔχουσι γάρ, φασι (Stüve, φησι codd.), τὰ ἄστρα τὸ ἴδιον φῶς καὶ ἐπικτήτον τὸ ἀπὸ τοῦ ἡλίου. καὶ δηλοῖ ἡ σελήνη. ταύτης γὰρ ἕτερον μὲν τὸ ἴδιον φῶς, ἕτερον δὲ τὸ ἀπὸ ἡλίου. τὸ γὰρ ἴδιον αὐτῆς φῶς ἀνθρακῶδες ἐστίν, ὡς δηλοῖ ἡμῖν ἡ ἔλλειψις αὐτῆς. ἀλλ' οὐ πάντα, φασι (Stüve, φησι codd.), τὸ ἐπικτήτον δέχονται. τὰ οὖν μὴ δεχόμενα ἐκεῖνα τὸν κύκλον τοῦ γαλαξίου ἀπεργάζονται.⁶⁸

Olympiodorus, it is true, does not usually show any knowledge of the Presocratics which he could not have obtained from Aristotle, or earlier commentators, or from the commonplaces of doxographical tradition. In any case, the parallel with the moon seems to be offered as Olympiodorus' own illustration, as distinct from the views said to be held by Democritus and Anaxagoras, which are marked by φασί. It would be wrong therefore to take Olympiodorus' words as positive evidence for Anaxagoras. Nonetheless in this instance Olympiodorus' idea seems to have a good chance of representing Anaxagoras' view. For sun, moon and stars, according to Anaxagoras, have the same origin: they are stones, or earth, caught up into the sky and heated by the force of rotation.⁶⁹ But the stars and the moon are colder than the sun: the stars because they move in a colder part of the sky; and the moon because of coldness in her composition.⁷⁰ It would seem reasonable to expect that the same kind of origin for stars and moon will mean the same kind of light for both. When a similar theory of 'natural' light which is overwhelmed by the light of the sun is credited to Antiphon, it is specifically applied to the moon as well as to the stars.⁷¹ The same theory for Anaxagoras would explain both Plutarch's evidence,

⁶⁷ *Meteor.* 345a25–31 (DK 59A80). Repeated in Aet. iii 1.5 (DK 59A80); Diog. Laert. ii 9 (DK 59A1); Hippol. *Ref.* i 8.10 (DK 59A42). The idea that the light of the moon, or of the stars of the Milky Way, shines out brightly in the darkness, but is, or would be, overwhelmed by the light of the sun became fairly common. In one form or another it is attributed to Democritus, Arist. *Meteor.* 345a25–31 (DK 68A91); and to Antiphon, Aet. ii 28.4 (DK 87B27); and it reappears in Plutarch's *De facie* 933C–E; in Cleomedes, *De motu* 180.2–13 and 216.28–218.6 Ziegler. For the general theory of weak and strong lights, Arist. *De caelo* 305a9–13.

⁶⁸ The smouldering light of the moon when she eclipses the sun is described in *Larousse Encyclopedia of Astronomy* (revd. edn. 1966) 159–60, with a colour photograph, facing p. 166.

⁶⁹ Hippol. *Ref.* i 8.6 (DK 59A42). Aet. ii 13.3 (DK 59A71): I take τῇ δὲ εὐτονίᾳ τῆς περιδινήσεως to explain καταφλέξαντα as well as ἀναρπάζαντα. Diog. Laert. ii 12 (DK 59A1). For the motion of the moon as earth, see Plato, *Apol.* 26D (DK 59A35), and Achilles, *Isag.* 21 p. 49.4–7 Muller (DK 59A77).

⁷⁰ For the stars: Hippol. *Ref.* i 8.7 (DK 59A42). For the moon: Aet. ii 30.2 (DK 59A77), cf. Hippol. *Ref.* i 8.9 (DK 59A42).

⁷¹ Aet. ii 28.4 (DK 87B27). There is a somewhat similar theory of natural and derived light for the moon in Gregory of Nyssa, *Hexaem.* 117 B–C. But here the moon's own light is suppressed not by the stronger light of the sun, but by the density of the moon's own nature: τὴν μὲν γὰρ οἰκοθεν λαμπηδόνα ἢ τῆς οὐσίας παχύτης ἀπήμβλυνε.

that the moon shines by reflected light, and the doxographical tradition, that she is πεπυρωμένος and διάπυρος.⁷²

This theory would help to explain, and I think derives some confirmation from, the continuation of Plato's account of Anaxagoras' moon in the *Cratylus* 409B (the earlier part of Plato's account is quoted 107 above):

Hermogenes: πῶς δῆ;

Socrates: τὸ μὲν που 'σέλας' καὶ τὸ 'φῶς' ταῦτόν.

Hermogenes: ναί.

Socrates: νέον δέ που καὶ ἔον αἰεὶ ἐστι περὶ τὴν σελήνην τοῦτο τὸ φῶς, εἴπερ ἀληθῆ οἱ Ἀναξαγόρειοι λέγουσιν· κύκλῳ γάρ που αἰεὶ αὐτὴν περιῶν (sc. ὁ ἥλιος) νέον αἰεὶ ἐπιβάλλει, ἔον δὲ ὑπάρχει τὸ τοῦ προτέρου μηνός.

Hermogenes: πάνυ γε.

Plato's words apparently mean that according to Anaxagoras, or his disciples, a new moon retains some light from the previous month. This idea, that the moon stores or absorbs light, fits well with the idea that Anaxagoras' moon does not simply reflect light, but is herself, at least to some extent, a fiery body, as the doxographical tradition claims.⁷³

Such a theory, of residual natural light for the moon, would be a plausible step from what I have suggested was the 'ancient' theory of mixing and kindling to the pure theory of reflection in Empedocles.

D. O'BRIEN.

Gonville and Caius College, Cambridge.

⁷² The bodies 'below the moon' (cf. 116 above) may have been retained (from Anaximenes) to explain eclipses when the occulting body did not show any light of its own, or to explain the greater frequency of lunar over solar eclipses.

Gershenson and Greenberg, *Anaxagoras* 338–40, argue that the tradition of a fiery moon is wholly false, and arose 'by generalizing from the sun to all the heavenly bodies'. The trouble with this argument is that it makes the process of generalisation go back at least to Aristotle, since Aristotle says that the stars of the Milky Way had a residual light of their own: but a generalising tradition of this kind would

more naturally have arisen in a doxographical compilation, where the original work was no longer known, and where there would be pressure to make Anaxagoras' views conform to other accounts of a fiery moon.

⁷³ Ferguson, *Phronesis* ix (1964) 100, notes the 'very strange picture' which Plato gives of the Anaxagoreans; but he appears to think that Plato's account is incompatible with a theory of reflection.

It is interesting that the moon is in fact now thought to have some light of her own, see the report in *The Times*, 20 Nov. 1967, p. 6.