Chance and natural law in Epicureanism [1]

A. A. LONG

When Epicurus discharged the gods from running the world he gave new fuel to a controversy which had been raging off and on for the past hundred years and which was to continue, at least as fiercely, into the Christian era. In preferring atoms and void to gods as ultimate causes of all natural phenomena, Epicurus knew perfectly well that he was entering an arena in which Plato and Aristotle had already done battle against the mechanistic explanations of earlier thinkers.[2] How could a purely mechanical combination of atoms moving in empty space account for the regular movements of the heavens and the orderly structure of living things? Plato and Aristotle had inferred divine causation and inherent purposiveness in the world or goal-directed processes from the evidence of such regularities, and within Epicurus' own lifetime the Stoics took up the same fundamental position as the Academy and the

[1] This is a slightly expanded version of a paper read to two meetings in 1974, the Scottish Classical Association and the Southern Association for Ancient Philosophy. I am grateful to members of the audience for their comments during discussion of the paper and also to the Fondation Hardt which offered me ideal conditions for writing the first draft. Full references to the books and articles I have cited or discussed are given in the bibliography at the end of the article.

[2] Some of the classic texts are Plato *Phd.* 98b (Socrates' disappointment with Anaxagoras), *Laws* x. 889 b-d (those who deny that νοῦς, θεός and τέχνη had any part in causing the world and living things), Aristot. *Phys.* ii. 198 b 14-199a 8 (attack on Empedocles and Anaxagoras for their neglect of the final cause). At *Phys.* 196 a 24-35 Aristotle challenges those who say that τὸ αὐτόματον was the cause of the heaven and all worlds, to reconcile this with their claim that animals and plants do not arise ἀπὸ τύχης 'but have nature or mind or another such thing as their cause' – οὐ γὰρ ὅτι ἔτυχεν ἐκ τοῦ σπέρματος ἑκάστου γίγνεται, ἀλλ' ἐκ μὲν τοῦ τοιουδὶ ἐλαία ἐκ δὲ τοῦ τοιουδὶ ἄνθρωπος. Modern scholars have generally followed Simplicius (*Phys.* 331, 16ff.) in identifying these as Atomists, cf. Bailey (1928) pp. 139-43, who takes the Greek text quoted above to give Democritus' own view. Epicurus modified Democritus by arguing that a world too can only arise out of σπέρματα ἐπιτήδεια, see p. 71. For Aristotle, an unpurposed result is ἀπὸ τύχης but this does not imply that it lacks a determinate cause, cf. Cherniss pp. 248-9. In discussing the Atomists, including Epicurus, it is essential to distinguish this sense of τύχη from mere contingency or sheer indeterminateness.

Lyceum.[3] By the time of Lucretius and Cicero it is possible to speak of a generalised deist standpoint which confronts and is confronted by Epicureanism. 'You Stoics', says Velleius in Cicero's *De natura deorum* (i.53 f.), 'do not see how nature's creative work can occur *sine aliqua mente*, and so you run to god like the tragic poets, needing a god to unravel the end of your plot'.

Epicurus believed he could undermine deist and teleological explanations of the world by explaining all phenomena in purely mechanistic terms. In 1951 Friedrich Solmsen wrote: 'Yet granted that Epicurus condemned the conclusions which men had drawn from the pattern of order in the firmament, could he deny or ignore the regularities? Why does the Sun rise every day *tempore certo* . . . On the basis of the atomist theory it was desperately difficult to cope with these problems and one can hardly maintain that Epicurus acquitted himself of his task in a manner likely to enhance his stature as a scientist' (p. 18). Solmsen 'is tempted to comment' that Epicureanism was unable 'to cope with the phenomena which the Academy ascribed to the operations of a divine Mind or Soul' (p. 19). Now this is a very serious charge, for it implies that Epicureanism failed to defend itself at the points where it issued its strongest challenge. In fact, Solmsen, somewhat hesitantly, qualifies his remarks by drawing attention to Lucretius' repeated emphasis on the fact that everything in the world arises out of something definite (i.174 ff. etc.).[4] In 1969 Phillip De Lacy shed further light on Epicurus' conception of order in the world in a valuable article, 'Limit and Variation in the Epicurean Philosophy'. De Lacy finds the notion of 'limit' a unifying theme throughout Epicurus' philosophy and he illustrates the way in which Epicurean writers set up limits to the variations which

[3] Cf. the texts cited in the previous note and also Plato *Laws* vii.821a ff., Aristotle *De gen. et corr.* ii.336 b 25-337 a1, and the useful remarks of D. J. Furley (1966) pp. 29-30. A clear statement of the Stoic view is to be found in Cic. *N.D.* ii.93 ff. which refers to the 'incredibility' of the Atomist position and also quotes against it a passage from Aristotle's lost *De philosophia*. Marcus Aurelius expresses the choice between divergent views as ἤτοι πρόνοια ἢ ἄτομοι (*Med.* iv.3, similarly ix.28 and x.6).

[4] As Solmsen rightly observes, Lucretius' proof of this point goes beyond the official thesis: *nihil e nihilo gigni*. In order to show that any new X arises out of some Y it is not necessary to show that it arises out of a definite (*certum*) Y. On Lucret. v.677-79, which Solmsen also cites for Epicurus' concept of order (p. 19), see below p. 84. Since I seek in this article to strengthen the Epicurean basis of natural laws, it would be disingenuous of me not to admit having previously expressed doubts about this very point, *Hellenistic Philosophy*, p. 41.

are possible within members of a given species. De Lacy recognizes that there are Epicurean equivalents to natural laws, but I believe Epicurus' restrictions on indeterminate occurrences were much tighter than De Lacy suggests. In particular, he seems to me to lay too much weight on the totally indeterminate and unpredictable 'swerve' of atoms, when he argues that this is responsible for variations within limits, such as the fact that a child sometimes resembles the mother, sometimes the father, sometimes even a grandparent (Lucret. iv.1209-1232).[5] The swerve of atoms, by definition, is the beginning of a new movement at no determinate time or place (Lucret. ii.218 ff., 251-60); it breaks or interrupts any antecedent set of causes. If Epicurus supposed that the manifold varieties within an animal species were due to the swerve of atoms, he permitted a measure of indeterminateness or purely spontaneous happenings in the world, which made his system appallingly vulnerable to attack by those who looked to the gods as guarantees of order in nature. The atomic swerve was much criticized by opponents of Epicureanism, but never on this obvious ground.[6] De Lacy, however, is not alone in assuming that Epicurus accepted into his explanation of natural phenomena an element of sheer contingency or indeterminateness. This

[5] P. 109. Lucretius is discussing in this context the sources of inherited characteristics. After observing that the manner of intercourse determines the genetic effects of the parents' seed, Lucretius makes his point about children sometimes resembling their grandparents or even remoter ancestors, for the following reason: *multa modis primordia multis | mixta suo celant in corpore saepe parentes, | quae patribus patres tradunt a stirpe profecta*, 1220-22. He then draws the conclusion that facial characteristics, voice and hair etc. are not created *semine certo*, and therefore *Venus varia producit sorte figuras*. There is clearly a contrast between *semen certum* and *varia sors*. But the latter expression does not imply spontaneous or strictly indeterminate happenings. Some inherited characteristics depend on the *primordia multa* in the bodies of the parents, and these in their turn have been transmitted genetically. All Lucretius is saying here is that a variety of atomic structures within the parents' bodies, rather than one determinate kind, can contribute to the features of offspring. This does not warrant any reference to the 'swerve' of atoms, which entails a 'new beginning' of motion that is contrary to the needs of Lucretius' discussion of *inherited* characteristics.

None of De Lacy's other examples of variation seems to me to introduce any idea of sheer contingency or interruptions of a causal sequence. Nor can I see that Plut. *Mor.* 1116 c (Usener 282) or Diogenes Oen. (fr. 16 Chilton) imply that 'the laws of physics determine the τοιόνδε, but not the τόδε τι' (p. 108). As Plutarch says, compound bodies are modified (ποικίλλεσθαι) by the coming and going of atoms, but this is a continuous process throughout nature, which is due to normal atomic motion and never attributed to the abnormal 'swerve'.

has become virtually an orthodox view.[7] Bailey stated that 'there can hardly be any doubt that Epicurus admitted the existence of a real contingency in nature, an element of 'chance', which at times worked in contravention of necessity' (1928, p. 326).

Up to the year 1879 it seems to have been generally assumed that human action is the only sphere of spontaneous or undetermined movement in the world of Epicurus.[8] This is the significant exception to the strictly mechanical causation or necessary chain of events which is otherwise evident in phenomena. Human freedom was accounted for by an exceptional form of motion, the 'swerve' of atoms, and this 'minimal' deviation was also invoked to explain the 'theoretical' first contact between atoms from which worlds arise. These, in fact, are the only functions of the swerve which are mentioned explicitly in Lucretius, and no word from Epicurus himself on the swerve has been discovered.[9] In the year I have just mentioned, M. Guyau published *La morale d'Épicure* in which he argued that Epicurus extended the function of the swerve to cover spontaneous happenings in the world now (pp. 72-102). At the time when he wrote, Guyau's attribution of spontaneity to nature was not accepted by most scholars.[10] But the effects of his work are still apparent. In 1972 J. M. Rist wrote: 'there is a random element, an element of chance in nature, and Guyau was probably right in holding that Epicurus attributed it to the swerve of atoms' (p. 52).[11]

But is there a 'random element, an element of chance in nature', as Epicurus conceives of the world?

In discussing this question it is most important to be clear about

[6] The standard criticism is that Epicurus introduced an inexplicable form of spontaneous movement in order to preserve human freedom, see the passages in Usener 281.

[7] Cf. Solmsen (1951) p. 19.

[8] See Guyau p. 86. For the same view in modern books, see De Witt p. 175 and Farrington p. 8.

[9] Brieger's view that the swerve was only introduced by later Epicureans was effectively criticized by Giussani (i pp. 129 ff.) and has not been accepted by later scholars.

[10] See the sound criticism by Zeller n. 5 pp. 421-2 and Hicks pp. 260 f.

[11] Bailey, who consistently attributed 'real contingency in nature' to Epicurus, was sceptical about Guyau's link between contingency and the swerve in 1928, p. 326. But in 1947 he found Guyau probably right (p. 840). Philod. *On signs* col. xxxvi.11 seems to have resolved his earlier doubts. This passage is discussed below, p. 86.

what we are asking. Random or chance in English, τύχη or μάτην in Greek, may mean that the event or thing which they qualify is aimless, not something purposed or determined by an end. This seems to have been Democritus' conception of the world, and he did not contradict himself if he also said that all things are the necessary outcome of antecedent conditions.[12] Random in the sense of aimless is quite compatible with necessary. Since Epicurus strenuously resisted the idea that the world is the outcome of any design or end to be attained, random or chance elements, in the sense I have just elucidated, are basic to his conception of things. But this cannot be the point which Rist and others have in mind when they attribute random and chance events to the swerve of the atoms. There is no need of any exceptional atomic movement to account for aimlessness and lack of purposiveness in Epicurus' view of nature. Paradoxically enough, the one phenomenon to which the swerve of atoms makes a certain contribution is the purposive movements of living things. Natural events in general are aimless and therefore require no special freedom from normal atomic movement in order to be explained.

But here I anticipate the later argument of this paper. To return to the meanings of random and chance – only if these words are used in a quite other sense, or series of senses, will there be point in attributing random or chance events to the swerve. The senses in question are contingency as distinct from necessity, indeterminateness as distinct from determinateness, and spontaneity as distinct from causation. Contingency, indeterminateness, and spontaneity, if Epicurus supposed them to have a part in natural events, might all, in theory, be attributed to the swerve of atoms, provided that they refer, like the swerve, to something which happens at no fixed time or place. Irregularity or disorderliness, on the other hand, are senses of random and chance which, like aimlessness, imply no contradiction of necessity. Irregular and disorderly happenings may be just as much the outcome of antecedent conditions as regular events describable by some 'law'.

The only senses of chance, therefore, which concern us in this paper are pure contingency, strict indeterminateness and spontaneity, since any other sense of chance is quite compatible with necessity. I shall

[12] This point has been well understood by modern scholars who have discussed Aristotle's interpretation of Democritus, cf. Cherniss pp. 248-9, Edmunds pp. 349-52. Unfortunately the same clarity is not always evident in modern discussions of chance in Epicureanism.

first consider the evidence for saying, with Bailey and others, that Epicurus admitted sheer contingency, pure indeterminateness, alongside necessity in his explanation of natural events. I shall then attempt to show how Epicurus and Lucretius dealt with the problem of accounting for the regularities of experience. The subject seems to me to be an important one, for if Bailey, De Lacy and Rist are right, Epicureanism was in the highly uncomfortable position of combining necessity and pure contingency, and this is paradoxical unless the limits of purely contingent happenings can be located. De Lacy concludes his paper by asserting that 'Epicurus [does not] tell us where the limits are' (1969 p. 113) and neither Bailey nor Rist raises the problem. A philosopher or scientist is entitled to admit exceptions to some natural law. But no-one will take him seriously, if he merely says: 'this is a law of nature but I can't say how far it extends'. If Epicurus held that continuity of causation or natural law is a feature of all observable happenings in our world except human (or other animal) behaviour, and that only in this exceptional case does the atomic swerve contribute to these events, at least he could not be criticized in this way. Was the orthodox view which Guyau combated correct after all?

Did Epicurus admit τύχη as a cause in nature?

The word τύχη occurs several times in the surviving work of Epicurus, but most of the contexts where it is found are ethical maxims which tell us nothing about any technical use which Epicurus might have had for such a concept in his natural philosophy.[13] There is, however, a passage at the end of the *Letter to Menoeceus* (133-5) which has been cited by Bailey and Rist as evidence for τύχη being a power in nature. The subject-matter of this letter is ethics, and in the context where τύχη occurs Epicurus is outlining the character of the truly wise man. Textual difficulties make many points of interpretation extremely difficult, but it is certain that Epicurus made the wise man hold the view that: 'it would be better to follow the myths about the gods than to be enslaved to the destiny of the natural philosophers; for the former suggest a hope of placating the gods by honouring them, whereas the latter involves implacable necessity' (κρεῖττον ἦν τῷ περὶ θεῶν μύθῳ κατακολουθεῖν ἢ τῇ τῶν φυσικῶν εἱμαρμένῃ δουλεύειν· ὁ μὲν γὰρ ἐλπίδα παραιτήσεως ὑπογράφει θεῶν διὰ τιμῆς, ἡ δὲ ἀπαραίτητον

[13] E.g. *Ep. Men.* 131, *Kuria Doxa* 16, *Gnom. Vat.* 17, Diog. Laert. 120. The purely ethical significance of these references is seen more clearly by Rist (p. 51) than by Bailey (pp. 325 f.).

ἔχει τὴν ἀνάγκην, 134). Following this rejection of destiny and implacable necessity – a most important statement to which I will return – Epicurus denied that the wise man regards τύχη as either a god or an 'unstable cause' (ἀβέβαιος αἰτία).[14] It is something which provides 'starting-points (ἀρχαί) of great good or bad things', but the wise man thinks it better 'to be unfortunate in company with sound reason than to fare well with folly'. This is the nearest we come to a definition of τύχη by Epicurus. If τύχη is not an 'unstable cause', it can hardly be a cause at all, for the converse of 'unstable' – βέβαιος – would be a nonsensical account of τύχη. In a defective sentence preceding the Greek passage printed above, Epicurus evidently referred to the wise man's attitude to three things – destiny or necessity, τύχη, and 'what is in our power' (τὸ παρ' ἡμᾶς). How the first of these was introduced is not quite clear, but immediately before the words, ἃ δὲ ἀπὸ τύχης, Epicurus said that the wise man 'does something with regard to her who is introduced by some as the mistress of all things'.[15] This 'mistress' might be τύχη as well as ἀνάγκη or εἱμαρμένη. The text is too defective for us to know how Epicurus went on. Following the lacuna he clearly gave reasons for rejecting the influence of destiny and τύχη on the wise man's life. Destiny, as we have seen, involves 'implacable necessity', and in this context τύχη is said to be ἄστατος, 'uncertain'. This does not contradict the later denial that τύχη is an ἀβέβαιος αἰτία, as Bailey thought.[16] Epicurus is describing the wise man's reasons for playing down the place of necessity and τύχη in human action. τύχη is uncertain, that is what the word naturally implies, but it is not an actual unstable force or cause.

It is crucial to see that the context of these references to τύχη is

[14] Bailey (1926 p. 90) adopted in his text the reading οὔτε ‹πάντων› ἀβέβαιον αἰτίαν. This is an entirely question-begging emendation, which has been rightly rejected by later editors, though it still appears in the critical apparatus of H. S. Long. Democritus described τύχη as μεγαλόδωρος ἀλλ' ἀβέβαιος, DK 68 B176. In his usage τύχη refers to undiscovered causes not indeterminateness, cf. Cherniss p. 248.

[15] Without emendation the text reads τὴν δὲ ὑπό τινων δεσπότιν εἰσαγομένην πάντων ἀγγέλλοντος (the reading of BFZf – as reported by von der Mühll; ἀγγέλωντος P before correction and ἀγγελῶντος P after correction) ἃ δὲ ἀπὸ τύχης, ἃ δὲ παρ' ἡμᾶς... Usener emended ἀγγέλλοντος etc. to διαγελῶντος and supplemented the text, exempli causa, ‹εἱμαρμένην καὶ μᾶλλον ἃ μὲν κατ' ἀνάγκην γίνεσθαι λέγοντος› which H. S. Long, the latest editor, prints. But it is impossible to ascertain the length of the lacuna.

[16] Hence his emendation referred to in n. 14.

entirely ethical. Epicurus is describing the wise man's attitude towards two things which some people regard as powerful determinants of human life. Necessity is rejected, because it undermines moral judgment. And τύχη is seen merely as something which offers starting-points for success or failure. The meaning of τύχη here is 'luck', and it has no more a technical sense in this context than in Aristotle's *Nicomachean Ethics*. Epicurus' word χορηγεῖσθαι in reference to τύχη reminds me of Aristotle who says that a man needs to be 'supplied' with external goods if he is to be happy.[17] Neither Aristotle nor Epicurus is implying a theory of sheer contingency or spontaneous happenings in the world by such references to τύχη. Epicurus' point is that 'luck' is relatively insignificant for human happiness, compared with φρόνησις (cf. *Kuria doxa* xvi). Rist says that 'Epicurus is concerned with the effect of the swerve in nature' (p. 52). But this passage does not support such a strong statement. Epicurus is talking about human nature not physics.[18]

The other principal piece of evidence from which Rist infers a 'random' element in nature and connects this with the swerve of atoms looks more promising at first glance. In his work *On the intelligence of animals* (964c = Usener p. 351, 11) Plutarch refers to opponents of Epicurus who do not allow him a minute swerve of a single atom ὅπως ἄστρα καὶ ζῷα καὶ τύχη παρεισέλθῃ καὶ τὸ ἐφ' ἡμῖν μὴ ἀπόληται, 'so that stars and animals and τύχη might be introduced and human autonomy not be destroyed'. This curious pairing of stars and animals is due, as Sandbach has pointed out, to the fact that Epicurus' deist opponents had no better arguments than celestial and

[17] Cf. *E.N.* i. 1099 a 30, φαίνεται δ' ὅμως καὶ τῶν ἐκτὸς ἀγαθῶν προσδεομένη (sc. ἡ εὐδαιμονία)... ἀδύνατον γὰρ ἢ οὐ ῥᾴδιον τὰ καλὰ πράττειν ἀχορήγητον ὄντα; 1100b8, οὐ γὰρ ἐν ταύταις (sc. ταῖς τύχαις) τὸ εὖ ἢ κακῶς, ἀλλὰ προσδεῖται τούτων ὁ ἀνθρώπινος βίος.

[18] When Epicurus is writing technically about the causes of human action he introduces distinctions between 'the cause in ourselves', the 'nature' we have inherited, and external necessity (34.27; 34.33 Arrighetti, cf. Lucret. ii. 284-292). If he drew the distinction suggested by Rist between necessity and random movements in nature no trace of this is found in the extensive fragments of the book *On Nature*, which discussed the causes of action (= 34 Arrighetti). There may be no 'formulable natural law' (Rist's phrase) for the countless external atoms which affect our sense organs, but Epicurus' description of this affect is not 'the swerve in nature' or τύχη but ἡ το[ῦ π]εριέχοντος καὶ ἐπεισίοντος κ[ατ]ὰ τὸ αὐτόμα[τον ἀ]ν[άγ]κ[η (34.27.7-9 Arrighetti).

biological phenomena for inferring the existence of gods.[19] The deist case is that such things cannot be explained adequately *as the effects of chance*, that is, purposeless combinations of atoms. But this is not what the received text says. It hypostatizes τύχη as a thing which Epicurus sought to bring into being. I have little doubt that Gassendi, Madvig and Sandbach were right to regard the words καὶ τύχη with suspicion.[20] The absence of the definite article is difficult, and τύχη makes a very odd partner for stars and animals. Sandbach has proposed τύχῃ or κατὰ τύχην as emendations (p. 114), and his second emendation has been accepted by Helmbold, the Loeb editor of this part of the *Moralia* (vol. xii, p. 350).

As emended the text ties in perfectly with Lucretius' comments on the atomic swerve where the existence of this atomic potentiality is inferred not from purely contingent events in our world but from the existence of *libera voluntas* in animals and the impossibility of introducing *genitalis motus*, from which a world can arise, if atoms always move in the same way without making contact with one another (ii. 216-93). Unlike the deists, Epicurus denied that stars and animals must be explained by final causes. Purposiveness is not a feature of the world, which came into being as a result of purposeless movements and combinations of atoms. κατὰ τύχην (τύχῃ) may imply a contrast with ἀνάγκη but its stronger contrast is with ἕνεκά του, 'for the sake of something'.

Bailey was cautious about inferring any connexion between chance in the world and the atomic swerve (see n. 11). But he found evidence in Epicurus and Lucretius for chance 'as an unaccountable force which to some extent thwarts natural law' (1928, p. 325). The passages he cited do not support this view on close scrutiny.

Only one passage from Epicurus himself was adduced by Bailey (p. 326). It is from the *Letter to Pythocles* (89) and concerns the conditions which must be fulfilled if a world is to come into being. 1, much void is needed (ἐν πολυκένῳ τόπῳ). 2, 'suitable seeds' (σπέρματα ἐπιτήδεια) are required 'which rush from a single world or interworld, or from

[19] Sandbach (p. 114) compares some anti-Epicurean remarks of Lactantius (*Inst. div.* iii.17.16 = Usener 370). *Si enim providentia nulla est, quomodo tam ordinate, tam disposite mundus effectus est? ... quomodo animalium corpora tam providenter ordinata sunt? ... non est, inquit, providentiae opus; sunt enim semina per inane volitantia, quibus inter se temere conglobatis universa gignuntur.*

[20] Gassendi proposed ὅπως εἰς τὴν ζωὴν ἡ τύχη, and Madvig ψυχή for τύχη. Cf. Sandbach loc. cit.

several, and gradually make additions and articulations and changes of position to another place, ἐὰν οὕτω τύχῃ, and cause irrigations from appropriate sources up to the stage of completion and stability, to the extent that the foundations which have been laid can admit them'.[21] Bailey takes the words, ἐὰν οὕτω τύχῃ, to support the view that Epicurus admitted the existence of an element of 'chance' which worked in contravention of necessity. But the phrase in question cannot, without further support, be supposed to make a point of such substance. It means no more than 'as it happens' and is a familiar Greek idiom.[22] If the phrase contributes anything material to Epicurus' account, which I venture to doubt, this is not a reference to absolute contingency but to the fact that world formation is contingent upon – or requires – appropriate atomic nuclei (σπέρματα) which behave in the way Epicurus enumerates.

As Bailey and others have noticed, Epicurus proceeds in his next remarks to reject the earlier atomist explanation of world formation. 'For it is not merely necessary that a gathering together (ἀθροισμός) should occur, or a vortex (δῖνος) in the empty space where a world can arise by necessity (ἐξ ἀνάγκης), as some suppose, and grow until it comes into collision with another world, as one of the so-called natural philosophers says. For this is contrary to appearances'.

What was Epicurus' objection to the earlier atomist explanation? Not, or not simply, its reference to necessity, but the claim that an atomic aggregate or vortex of atoms was sufficient by itself, without further conditions being satisfied, to account for the origin of a world.[23] The point which Epicurus stresses more than once in the *Letter to Pythocles* is the need for 'suitable seeds'. Insufficient attention has been given to the word, ἐπιτήδειος. It should not be regarded as an incautious lapse into teleological language but a fundamental concept which helps Epicurus to outline a doctrine analogous to Aristotle's 'hypothetical necessity'. 'If there is to be a wall', argued Aristotle, 'materials of a

[21] Cf. in general Lucret. ii. 1105-1119 (discussed below, p. 81) and v. 432-94. 'Irrigations' (ἐπαρδεύσεις) is a remarkable term to find in Epicurus' description, but it accords with the 'biological' language with which he expresses world formation. See in general Solmsen (1953) who discusses similar motifs in earlier cosmology, but does not mention this passage.

[22] Cf. Plato *Crat.* 430 e, Aristot. *Cat.* 8 b 12.

[23] This criticism of earlier atomist cosmology may be more than a little tendentious on Epicurus' part, but the exact views of Democritus and Leucippus do not affect the argument of this paper.

certain kind with a certain location are necessary' (*Phys.* ii.199 b 34-200 a 15). The necessity is not ἁπλῶς, that a wall must exist, but ἐξ ὑποθέσεως, what is required if there is to be a wall. Similarly, Epicurus is asserting against Democritus the conditional necessity of suitable atomic nuclei which behave in certain specific ways (joining together (προσθέσεις), structural organisation (διαρθρώσεις), change of location (μεταστάσεις ἐπ' ἄλλον τόπον), supply of suitable materials (ἐπαρδεύσεις ἐκ τῶν ἐχόντων ἐπιτηδείως). Democritus perhaps supposed that the formation of every world was a necessary event in a strict causal sense. If so, Epicurus rejected his view. But this is not the point he is making in our passage.

We need not linger long over the three passages from Lucretius which Bailey cites as evidence for contingency coupled with necessity in Epicurus' conception of nature (1928, p. 326). First, Lucretius (ii.1059-62) speaks of the *magnarum rerum exordia* (Epicurus' ['suitable] seeds') being formed as the sources of worlds by atoms uniting together after they have jostled one another *sponte sua, forte, temere, incassum, frustraque.* The impressive group of adverbs expresses most plainly the aimless, unplanned preliminaries of world formation, and we may say that they emphasize its 'chance' occurrence. But we must be more careful than Bailey in analyzing the meaning of 'chance'. The stress is not on uncaused movements of atoms, but on their lack of purposive movement. It may be that some of the atoms which help to form the nuclei of worlds came together by 'swerves' or wholly spontaneous movements. But even if Lucretius is referring to spontaneous as well as purposeless atomic movements here, it does not follow that in the world as experienced by us, the world as formed, spontaneous or wholly indeterminate natural events take place. Lucretius' subject here is the origin of a world, and we have seen the importance Epicurus attached to the necessity of 'suitable materials'. This Lucretian text is quite neutral with respect to the problem of contingency in the world *now.*

Secondly, the words *'fortuna gubernans'*, which Lucretius uses in an invocation where he seeks to ward off the inevitable end of the world (v.107), have no more technical significance than Venus of whom Lucretius writes: *rerum naturam sola gubernas* (i.21). We must allow Lucretius some poetic licence in his use of traditional language. Bailey's third passage also comes from a context where Lucretius is writing without technical exactitude, the prooemium of book vi: there we find the expression *naturali ... seu casu seu vi* (30-31), but its reference is not to two opposed aspects of nature in any general sense. Lucretius is

speaking of Epicurus' benefits to man in pointing out both foreseeable troubles, such as death or old age (*naturalis vis*), and those which do not happen with inevitable regularity. Such a use of *casus* does not imply that some of the troubles which afflict man are spontaneous or purely contingent natural happenings.[24]

The main evidence from which scholars have concluded that Epicurus admitted chance as a force at work in the world has now been discussed.[25] Some may find it more compelling than I do, but whatever one's assessment, it must be weighed against the massive stress on *foedera naturae, ordo certus, fines* and *leges* in Lucretius. But of course it would be quite wrong to deny that Epicurus adopted, in some respects at least, a non-determinist standpoint. Before considering the basis of the *foedera naturae* we should return to Epicurus' strong rejection of the 'destiny of the natural philosophers', which he stated in his account of the wise man's disposition.

Who were these natural philosophers? The standard modern answer has been (Leucippus and) Democritus, and this is very likely right.[26]

[24] Sallmann, who finds no evidence that τύχη is a constituent of nature in Lucretius (p. 50), effectively dismisses the supposition that this passage contrasts causality with something else, or that it has anything to do with the swerve (p. 79). His study of *natura* in Lucretius deserves more attention than it has received.

[25] Rist (p. 52 n. 4) refers to a new fragment of Diogenes of Oenoanda (published by Smith pp. 367-70) for 'chance in Epicurean physics'. The last complete words of this fragment are εἶτα γὰρ τύχην, and Mr Smith, in his first publication of the text, supposed that the subject-matter of the whole fragment was cosmological. In developing this interpretation he commented: 'new fr. 7 is in fact the only extant Epicurean passage in which τύχη is mentioned as a physical cause' (p. 367). Further study of this fragment by Diskin Clay, in association with Mr Smith, has shown that even here τύχη has nothing to do with cosmology (Clay, 1973b). The subject-matter of the fragment appears to be a shipwreck experienced by Epicurus on a voyage to Lampsacus. In Smith's new fr. 8 (pp. 370f.) τύχη is discussed in an ethical sense, and this must also be its function in the defective sentence which concludes new fr. 7.

[26] Furley (1967, pp. 174-5) is 'not quite convinced' that Epicurus criticized Democritus at *Ep. Men.* 134. He doubts whether Democritus was really a 'fatalist' in any recognizable sense, but recognizes that Epicurus 'may have thought that fatalism followed from Democritus' physical theories'. Furley suggests that Epicurus may have had Nausiphanes in mind. Cicero (*De Fato* 10, 23; *N.D.* i.69) and Diogenes of Oenoanda (fr. 32 cols. ii and iii Chilton) associate the swerve of atoms with Epicurus' resistance to Democritean ἀνάγκη. Chronology does not rule out Zeno of Citium as a determinist who may have strongly influenced Epicurus' defence of human freedom, see A. A. Long p. 61.

There are good reasons for thinking that Epicurus found in his atomic predecessors a concept of necessity which seemed to him to undermine human freedom and the basis of moral judgment. It is improbable, in my opinion, that Democritus anticipated the Stoics in working out the idea of a fixed sequence of causes in any formal sense. But he may have supposed that everything which happens in the world now, including human thoughts and actions, follows inevitably from previous movements of atoms.

In order to combat a strictly determinist theory of atomic motion Epicurus introduced the potentiality of an atom to deviate from its *natural* downward movement. For on this thesis he was able to base his claim that the actions of living things are not wholly necessitated by a sequence of causes which stretches back to infinity (Lucret. ii.251-60). But the atomic swerve is an exception to normal atomic motion, and it seems certain that Epicurus also differed from Democritus in specifying a natural movement of atoms from which deviations exceptionally occur.

Aristotle had complained that the early atomists failed to specify the natural movement of atoms, and Epicurus was probably influenced by Aristotle in attributing downward movement due to weight to his atoms.[27] Since, as Lucretius tells us, atoms which always moved in this way would never make contact with one another and thus create a world, Epicurus asserted that 'at undetermined times' and 'at undetermined places' they deviate from the line of their previous movement by a distance *nec plus quam minimum* (ii.244). The absolutely minimal deviation which an atom may make is clearly emphatic.

Critics of Epicurus in antiquity ridiculed this *res commenticia* (Cic. *Fin.* i. 19) and we may agree that it is nothing more than an arbitrary expedient. But that will not help us to understand the function which Epicurus attributed to the minimal swerve of atoms. Since he does not tell us, explicitly at least, we naturally turn to Lucretius and there we find the existence of this atomic potentiality inferred not from unexpected or 'chance' happenings in the world but from a theoretical point – the need to bring atoms into contact – and the existence of *libera voluntas* (ii.216-293). There are no other phenomena which we can

[27] Aristotle *De caelo* 275 b 29, 300 b 11. Cf. Guthrie pp. 400-404. For Epicurus see A. A. Long p. 36.

say were explained wholly or partially by reference to the swerve.[28] It would no doubt be wrong to rule out the possibility of atoms swerving in things other than the soul of living creatures. But Epicurus could maintain, with some plausibility, that since the soul, as he understands it, is composed of the finest and most mobile of all atomic structures, it is only in this case that the minimal swerve of an atom breaks through the *fati foedera* and makes possible an observable event – animal action – which is not wholly determined by conditions already present in the world.[29] We must realize that Epicurus, in his account of phenomena, is concerned not so much with the behaviour of individual atoms as with the behaviour of atoms in groups, compounds of atoms and void. He may have supposed that the swerve of an atom in a compound of denser structure than the soul has too little power to modify the general conditions imposed by the shape, weight and determinate movements of its fellow atoms. Having accepted atomism as the best way of countering deist and teleological explanations of the world, Epicurus was faced with the problem of reducing human behaviour to a necessary consequence of atomic movements. He countered this objection by introducing the potentiality of an individual atom to initiate a new beginning of movement; and in order to explain the orderly events on which the Platonists and Aristotelians rested their case for inherent purposiveness in the world, he made the swerve absolutely minimal and therefore not something which made him vulnerable to the charge of explaining regular phenomena by irregular causes. Perhaps he made freedom of action the sole observable exception to strict causality in a world otherwise determined by natural laws throughout its lifespan. Is there enough evidence to suggest that this was Epicurus' procedure?

How did Epicurus account for observable regularities in the world?

[28] The exceptional nature of the swerve is underlined by the fact that Lucretius introduces his discussion of atomic motion by referring to only *two* kinds of movement – that caused by weight and movement resulting from collisions (ii.83-85). This point and the indeterminateness of the swerve speak strongly against Bignone's attempt to link the swerve with the movement of Aristotle's fifth element and the world soul of Plato *Laws* X (pp. 166-8).

[29] Epicurus *Ep. Hdt.* 63 (σῶμα λεπτομερές), Lucret. iii.179-80 (*persubtilem atque minutis perquam corporibus factum*), 204 (*mobilis egregie*), 209 (*quam tenui constet textura*). The 'nameless' element of the soul, which above all gives soul its specific character (cf. Kerferd pp. 83-5), is described by Lucret.: *qua neque mobilius quicquam neque tenuius exstat, | nec magis e parvis et levibus ex elementis* (iii.243-4). For two recent discussions of the manner in which the swerve saves freedom of action, see Furley (1967, Second Study) and A. A. Long pp. 56-61.

As Diskin Clay has recently shown (1973a), Epicurus found it a useful educational device to reduce his philosophy to a number of elementary propositions or axioms (στοιχειώσεις). A scholium to chapter 44 of the *Letter to Herodotus*, which summarises the basis of Epicurean physics, refers to Epicurus' twelve στοιχειώσεις, and Clay has identified these with ten propositions from the *Letter* (38.8-44.1, 54.3-6), which also recur in Lucretius, and the first two *Kuriai Doxai*.[30] Clay's list includes a set of what we may call natural laws or necessary truths, conspicuous among which are the first: 'nothing comes into being out of nothing' and the second: 'nothing is reduced to nothing'. Two fundamental concepts which are stated or implied in this list are 'limit' and 'unlimited'. The universe is unlimited, for it contains an infinite number of bodies (atoms) and infinite void. There is an infinite number of atoms with similar shapes, but the variety of atomic shapes is not infinite, though too large to be conceived of (ἀπερίληπτα).

The validity of these general statements is established largely by reference to phenomena, and their purpose is to provide the foundations for a strictly mechanistic explanation of the world. By postulating an infinite number of atoms with enormously varied shapes, Epicurus was influenced by the need to account for the variety of things we experience (*Ep. Hdt.* 42). The limit on the number of atomic shapes was also justified, as Lucretius shows, on empirical grounds: our sense experience is not constantly subject to new colours, smells and so forth (ii.478-521). Moreover, the number of atoms which constitutes our world at any moment is also limited. A limited world derived from and stocked by an unlimited supply of atoms provided Epicurus with a method of explaining the regular change and constant movement of phenomena.

In the *Letter to Pythocles* (88) Epicurus describes a world as an enclosure of the heavens (περιοχή τις οὐράνου) . . . which is cut off from the infinite and terminates in a boundary (ἀποτομὴν ἔχουσα ἀπὸ τοῦ ἀπείρου καὶ καταλήγουσα ἐν πέρατι). This emphatic reference to the limited nature and boundary of a world gives some conceptual and linguistic support to Lucretius' *foedera naturae* and *fines*. Not only is a world limited in time and space and the number of its atomic constituents. It is also, as we have seen, limited by the conditions which govern its

[30] An earlier, less careful attempt to identify the στοιχειώσεις was made by De Witt (pp. 156 f.). Clay (p. 271) finds it 'odd' that there is no mention among these of the 'swerve' of atoms.

initial formation. A world arises not from any aggregation of atoms but from 'suitable seeds', and these presuppose appropriate combinations of atoms with specific shapes. There is good evidence to show that the basic materials from which the world 'grows' (the biological metaphor is a notable feature of Epicurus' and Lucretius' cosmological descriptions) are not, save in the last analysis, individual atoms but atomic nuclei, or what another philosopher might have called elements.[31] Epicurus rejected the theory of four elements, but he did not entirely abandon the concept of an element. In a fragment of the 14th book of περὶ φύσεως he opposed to the Platonic doctrine of four elements the preferable idea of those who 'do not define a specific form of fire or earth or water or air, but admit, whether freely or not, that there arise in (mechanical) mixtures certain specific kinds of forms corresponding to each so-called essential aggregate (σύγκρισις)'.[32] The term σύγκρισις has a technical usage in Epicurus' own work to denote 'atomic compound', and here he is referring to a restricted class of compounds, which we may call elemental. I believe they are approximately, if not entirely, identical to the cosmic 'seeds' of which I have already spoken, or what are called συστροφαί in a brief reference to world formation in the *Letter to Herodotus* (73).[33]

We have here the notion of an atomic aggregate which can serve as the seed or progenitor of a world. This idea helps Epicurus to reject deist accounts of the heavenly bodies. In place of direction by divine souls or gods, the heavenly bodies behave as they do because of their

[31] See Bailey (1928) pp. 343-4. Attempts to find specific technical terms for this concept are criticized by Kerferd p. 89, who argues, however, that Epicurus must have had a *doctrine* of molecules. It is clear from Lucret. v.429-31 that the *magnarum rerum exordia* are not individual atoms but aggregates (cf. *conveniant, convecta*).

[32] Arrighetti 29.22, ὁρίζοντας σχῆμα π[υρ]ὸς ἴδιον ἢ γῆς ἢ ὕδατος ἢ [ἀέ]ρος, ὅτι γελοιότεροί εἰσὶ τῶν οὐχ ὁριζόντων μέν, κατὰ δὲ τὰς παραθέσεις ὁμολογησάν[τ]ων ἂν ἢ ἑκουσίως ἢ ἀκου[σ]ίως γίνεσθαί τινα σχημά[τ]ων ἴδια εἴδη καθ' ἑκάστην [οὐ]σιώδη ῥηθεῖσαν ἂν σύγ[κρ]ισιν.

The point of this passage is clearly to contrast mechanical mixtures (παραθέσεις) as a way of accounting for 'essential' aggregates with an a priori notion of (Platonic) forms or elements. The words ἑκουσίως ἢ ἀκουσίως lead me to think that Epicurus is saying: 'Some earlier thinkers, whether intentionally or not, have seized on the correct explanations of so-called essential substances.'

[33] Here 'worlds', and 'every limited compound which regularly has the same form as things that we see', are said to be separated ἐκ συστροφῶν ἰδίων. Bailey's interpretation, 'vague masses of matter' (1926 p. 245), hardly renders the force of ἰδίων. With συστροφαί cf. *conque globata* of heat molecules, Lucret. ii. 154.

material structure. But Epicurus does not deny the regularity of their movements. 'This necessary regularity of movement must be ascribed to the inclusion of these aggregates (συστροφαί) in the cosmos at its beginning' (ὅθεν δὴ κατὰ τὰς ἐξ ἀρχῆς ἐναπολήψεις τῶν συστροφῶν τούτων ἐν τῇ τοῦ κόσμου γενέσει δεῖ δοξάζειν καὶ τὴν ἀνάγκην ταύτην καὶ περίοδον συντελεῖσθαι *Ep. Hdt.* 77). A star (πῦρ ἅμα ὄντα συνεστραμμένον) is a result of those atomic aggregates which joined together at the formation of the world.

Epicurus seems to be saying that a regular event now – the movements of the heavenly bodies – is to be traced back to the original structure of matter in the world. In the *Letter to Pythocles* (90) this point is confirmed and amplified: the heavenly bodies did not enter the world from outside; they have developed from within, 'thanks to additions and whirlings of certain substances with fine parts, which are either like breath or fire, or both'. Here further limits on the structure of the heavenly bodies are imposed: only atoms already compounded to form breath, fire or both can constitute the stars.

So far as the structure of the heavenly bodies is concerned, Epicurus seems to have claimed that the material conditions which obtain at their formation will continue to be valid throughout the history of the world. In this domain at least he left no room for uncertainty. Particular celestial phenomena – eclipses, thunder, shooting stars – may be due to one of several different causes, but Epicurus explicitly denied that more than one cause can account for the nature of the heavenly bodies (*Ep. Hdt.* 78).[34] The history of the world is analogous to a living thing's life cycle. During its earliest stages the world grows by absorbing more matter than it loses; then a period of stability is reached (διαμονή) during which the absorption of new matter balances the loss of atoms previously contained; finally, the forces of destruction prevail over those of conservation.[35] A static world is quite foreign to Epicurus'

[34] Epicurus' notion of multiple causes (πλεοναχὸς τρόπος), which informs his discussion of celestial phenomena throughout the *Letter to Pythocles*, does not constitute any denial of causal continuity. In our world one set of causes in fact will be responsible for thunder, shooting stars, etc., but the conditions of perception prevent us from deciding between a series of explanations, any one of which will account for the phenomenon equally well. Cf. Rist p. 40, and the passages he cites in his n. 2. In other worlds the same phenomenon may in fact be due to a different cause from that which is operative here. But in *Ep. Hdt.* 78 Epicurus is claiming that his account of the heavenly bodies is valid for all possible worlds.

[35] *Ep. Pyth.* 89-90, Lucret. ii.1105-1149. See in general Solmsen (1953).

cosmology and he recognized that living things which were not suitably adapted to their environment perished during the early history of the world (Lucret. v.837-77).[36] But I believe he also supposed that the initial structure of matter in the world is sufficiently stable to establish a series of persistently operative causes or natural laws, and that these could withstand fundamental modification by the gain and loss of individual atoms up to the time when the growing loss of atoms from the world begins to disrupt its internal coherence.

If the surviving words of Epicurus do not allow us to establish this conclusion as absolutely certain, Lucretius can be called upon to give confirmation. I take first a short passage from Book ii, 294-307. Here Lucretius is arguing that the proportion of matter to void in the universe has never changed and he infers from this that atomic motion is invariant. The conjunction of changeless matter and changeless motion sanctions the conclusion that 'such things as have been wont to come into being will continue to do so', *eadem condicione, . . . quantum cuique datum est per foedera naturai.*

This proof of the invariant state of the universe is an amplification of Epicurus' own words, and its interesting addition to these is the mention of constancy of genesis within the universe.[37] Lucretius is not referring to genesis within a single world, the subject I have just been considering. But his very forceful denial of irregular change is particularly striking in its context. The topic with which he has just dealt is the atomic swerve, and Gerhard Müller makes the excellent observation that the 'tearing of free will from the *fati foedera*' (cf. *rumpat* and *avulsa*, ii.254, 257) is now followed most appropriately with an emphasis on the (otherwise) constant nature of motion and the *foedera naturae* (p. 31). It can be no accident that Lucretius stresses *motus idem* immediately following his account of free will and the swerve on which it depends. *Motus idem* and the reassertion of the *foedera naturae* advise us to expect nothing analogous to free will in the universe at large.

[36] This principle of the 'survival of the fittest' provides Epicurus with a means of explaining animal life without reference to final causes. The point is fundamental to any comprehensive study of Epicurean responses to teleological or deist views of the world, but the details fall outside the scope of this paper.

[37] Cf. i.584-98, where Lucret. infers the unchangeability of atoms from the unchangeability of animal species; ii.700-19, where limits on atomic combinations are inferred from the same evidence. Is there any reason to agree with Bailey (1947, p. 699) that 'Lucretius is not thinking of an observed uniformity in nature'?

What are the *foedera naturae*? I cannot discuss this question at length, but I should like to mention the interesting suggestion of Klaus Reich.[38] He proposed to identify the *foedera naturae* with the συγκρίσεις or basic compounds. Accordingly he offered the translation 'Bündnis' (bond) rather than 'Gesetz' (law). As a complete explanation this is too simple, in my opinion. The *foedera naturae* cannot be identified with just one physical constituent of the Epicurean universe. But it is notable that Lucretius uses the expression in contexts where he is discussing the regularity of species and the limits of change within the world (i.586; ii.302; v.57). In particular, he rejects the belief that there could ever have been Centaurs or Scyllas by an appeal to these *foedera*. Although the earth contained many seeds at the time when living things first developed, hybrids are evidently impossible:

sed res quaeque suo ritu procedit et omnes
foedere naturae certo discrimina servant. v.923-4

It could be that Lucretius is playing on the meaning of *foedus* as both something concrete – a bond or union of atoms with congruent shapes – and the more abstract notion of law. Lucretius indeed gives us more evidence on the importance of the primary compounds in determining orderly change and development.

The significance of the world's first structure in determining its subsequent development is seen very clearly in a later passage from book ii, 1105-1117. Lucretius is discussing the world's behaviour, from its origin to its eventual destruction, but only the stage from birth to maturity concerns us here. Since the birth of the world and the beginning of sea, earth and sun, Lucretius writes, 'many bodies have been added from outside and seeds (i.e. atomic nuclei) have been added all round, which the great universe brought together by hurling them about'. This process has enabled sea, earth, sky and air to grow. 'For from all regions all bodies are dispersed by impact each to their own place, and travel back to their own kinds, water to water etc.' The growth of like by like is a very old idea, and Lucretius' formulation of the principle is an undoubted imitation of Empedocles. His predecessor in didactic poetry regarded the attraction of like to like as an expression of cosmic Love, but Lucretius would have found nothing analogous to this in his Epicurean sources. It was a feature of early atomism that bodies of symmetrical shape unite together by the motion of the cosmic

[38] P. 125. See also Boyancé pp. 86 ff.

vortex.[39] Epicurus modified Democritus' cosmology by interpolating the need for 'suitable atomic seeds', but these too must be formed from atoms of congruent shapes. So, in the world once formed, the behaviour of new atoms is limited and governed by the basic structures to which they are assimilated. Stability and order arise not from the intervention of mind but as the necessary consequence of matter in motion. The indestructibility, size, shape, and motion of individual atoms limit the combinations which they can form, and thus in the world as we experience it definite kinds of things are evident.

But a most important class of 'definite things' in the world, and the one from which Aristotle's defence of teleological explanation drew its strongest support, is animal species. The modern critic may be willing to acknowledge that Epicurus has a coherent, if simple, explanation of celestial movements and other regular natural phenomena – the primary structures of matter in the world and an infinite number of atoms with shapes appropriate to these structures. But does this, or any other explanation Epicurus can offer, provide an answer to Aristotle's question, 'why does man beget man'?

The essence of reproduction is that species breed true, and there is no doubt that Lucretius at least held as fixed a view of species as Aristotle.[40] We have no surviving evidence from Epicurus himself on zoology, and any inferences about his views must be drawn from Lucretius. The zoological passages in his poem deserve more detailed study than I can attempt to give here, but it does not need extensive argument to show that he would answer Aristotle's question along the following lines.

Living things without exception are seen to originate from definite seeds (*seminibus certis*) such that their growth is invariably true to type. The phenomenon of reproduction is one of Lucretius' strongest arguments for the existence of atoms: there must be changeless and indestructible bodies in order that the regularity of species may be maintained.[41] The changelessness and indestructibility of atoms, along with the fact that the universe contains an infinite number of atoms of every shape which it is possible for atoms to have (Lucret. ii.526-7), satisfy one necessary condition of regular species – the availability of suitable materials.

[39] Cf. C. W. Müller p. 74.

[40] Cf. i.584-98, v.923-4. Reich (p. 124) argues that Epicurus took over this doctrine from Aristotle while abandoning the latter's belief in the eternity of the world.

[41] Lucretius i.159-214, ii.584-98.

But the availability of suitable materials is not a sufficient condition for the regularity of species. Lucretius seems to recognize this when he asserts that there is a *certa ratio* which determines the *certa semina* of things, their *certa genetrix* and the fact that they grow (*crescentia*) true to type (ii.707 ff.). He is drawing attention to the limitations on possible atomic compounds – we do not see hybrids, half man and half beast, part animal and part plant. The reason for this is not only the *certa semina* of each species, but also the fact that in nutrition only those *corpora* are assimilated which can be joined to the structure of the creature's body and move in harmony with this.[42] We may infer that the parents' atomic structure is such that any seed they produce can only assimilate those atoms, by interaction with the environment, which fit the form predetermined by the parents. It is a rudimentary theory of genetics.[43]

This theory of genetic development seems to be entirely consistent with the explanation of regular natural phenomena I have already discussed. It is also probable that Epicurus regarded the regularity of species as a second example of the manner in which the world's primary structure has determined its subsequent history. In his account of the origins of life Lucretius insists that the earth is the mother not only of all vegetation but also of man and other animals (v.783-836). With the passage of time the earth has ceased to bring forth animals, and its function as mother of these has been taken over by union between the sexes of each species. But there is no suggestion that the offspring resulting from intercourse differ in form from those produced by the earth itself. Some species have failed to survive, but those which persist today have not 'evolved'. Epicureanism does not anticipate Darwinian natural selection. We may conjecture with Giussani that the fixity of species is to be traced back to the atomic structures which the earth contained during its time of fertility.[44]

One passage from Lucretius is quite explicit in relating the *certus ordo* manifest in the world now to the causes which were operative

[42] 711-716, *nam sua cuique cibis ex omnibus intus in artus | corpora discedunt conexaque convenientis | efficiunt motus* ... those atoms are not assimilated, *quae neque conecti quoquam potuere neque intus | vitalis motus consentire atque imitari*. For the latter phenomenon on a cosmic scale cf. ii.109-11.

[43] Note that Lucretius explains the behavioural characteristics of each species by the *certa vis animi* determined by its own *semen* and *seminium*, iii.746-7: that is, they are transmitted genetically.

[44] Vol. iv p. 172.

during its earliest days (v.677-79). Lucretius is in the middle of his explanation of astronomical phenomena, and he offers two reasons for the *certum tempus* at which dawn appears each day. The details of his explanations do not concern us here, but his emphasis on 'fixed time'. Within twenty-four lines there are six instances of *tempore certo*, and the phenomenon of dawn is related to other phenomena from biology and meteorology which also occur at a fixed time. Therefore, Lucretius concludes, there is nothing *mirabile* in the regularity of dawn, and he rounds off his argument:

> *namque ubi sic fuerunt causarum exordia prima*
> *atque ita res mundi cecidere ab origine prima,*
> *conseque quoque iam redeunt ex ordine certo.*[45]

This statement was rightly interpreted by Giussani for what it is – an expression of strict causality. Events recur in a regular sequence following the *causarum exordia prima* which operated at the world's beginning. As he put it, 'cosi si spiegano e si conciliano la cecità meccaniche e l'assoluto impero della legge nel sistema atomico epicureo' (iv p. 172). It is instructive, if somewhat depressing, to see how later commentators have evaded the plain meaning of Lucretius' text. Robin lays stress on the word *cecidere*: 'c'est une idée essentielle à l'Épicurisme que la répétition régulière des phénomènes et leurs lois sont la conséquence d'une organisation spontanée du hasard' (ad loc.). Certainly the Epicureans wished to avoid any suggestion of purposiveness in their explanations of order in the world. But the emphasis of our text is not on the world's unplanned origin and organisation but on the *certus ordo* which follows from its primary structure. Bailey declines to take a clear stand (1947 vol. iii pp. 1427-8). He approves Giussani's insight into the 'scientific' significance of Lucretius' text, but thinks he may be reading too much into the lines. This charge applies more appropriately to Bailey, who reads too much into Lucretius' very occasional references to *casus* and thereby finds the poet 'speaking as though either chance or necessity were the ultimate cause of phenomena in the world'. Bailey does scant justice to Lucretius when he says: 'If, as is probable, this (i.e. Giussani's interpretation) is the strict Epicurean doctrine, it must be admitted that Lucretius is elsewhere forgetful or not fully conscious

[45] *Conseque* is Lachmann's emendation of *consequiae* read by O and Q. His suggestion has been adopted by most modern editors and even if he is wrong, there can be little doubt concerning the sense of the line.

of it'.[46] Solmsen finds our passage 'the best in the way of theory that Epicurus could offer to explain cosmic regularities' (1951, p. 19) but he goes on to describe it as a 'somewhat oracular statement which seems to credit the atoms ... with a mysterious power to effect what the philosopher cannot explain'. But there is nothing oracular or mysterious about Lucretius' words unless one approaches them from the position of a Platonist, an Aristotelian or a Stoic. Lucretius is offering us a clear mechanistic account of causation.

But what Lucretius says here is nothing more than a gloss on Epicurus' own explanation of regular phenomena by reference to the initial state of things (*Ep. Hdt.* 77). Lucretius' *causarum exordia prima* correspond to Epicurus' αἱ ἐξ ἀρχῆς ἐναπολήψεις τῶν συστροφῶν τούτων (see p. 79). Where Epicurus explains in terms of matter, Lucretius speaks of causes, and these of course are identical. My earlier suggestion about Epicurus' explanation of regular phenomena seems now to have been confirmed. He did refer these to the material conditions which obtained at the formation of the world.

A number of conclusions may now be stated. First, the consistency between Epicurus and Lucretius is too great to support the suggestion, which has been made in the past, that the poet's emphasis on *foedera naturae* is a later development in Epicureanism.[47] Secondly, references to chance in Epicurus and Lucretius do not imply, as many modern scholars say, that sheer contingency or spontaneous events play a part in nature along with necessity. The world arises as a result of purposeless atomic movements, and Epicurus gave at least one spontaneous atomic movement or swerve a function in explaining the origin of worlds. But within our world, as we know it, law-like regularities hold good and will continue to do so as long as the basic structure of the world remains intact. A causal sequence, which can be traced back to the formation of the world, determines natural events. Thirdly, human (and perhaps other animal) behaviour is not entirely dependent on this causal sequence. The structure of the mind is such that swerving atoms among its constituents free behaviour from being wholly determined by

[46] Boyancé's criticism of Giussani (p. 233) gives no argument against his interpretation.

[47] This is argued by Reich. He attempts to trace the origin of the modern Naturgesetz to Lucretius and to detect a Peripatetic influence on Lucretius – Critolaus – through a comparison of Philo *De aet. mundi* 55-69, which reports Critolaus' views, and Lucret. v.878-924. His hypothesis seems to me unnecessarily complicated. More generally cf. De Lacy (1948).

antecedent causes. But no word from Epicurus or Lucretius connects chance events in the world with the atomic swerve.

Against all this it must be said that there is a passage from Philodemus *On signs* (col. xxxvi. 11-17) which speaks of chance and free will as insufficient by themselves to establish the swerve: there is a need, in addition, to show that the swerve does not conflict with any empirical evidence.[48] This passage clearly implies that in Philodemus' view, chance may be cited, in addition to free will, as evidence of the swerve although neither of these is sufficient to prove its existence. The first thing I would say about this passage is that it goes beyond Lucretius who does regard free will as a sufficient proof of the swerve. Secondly, Philodemus is not purporting to indicate the scope of chance. It would be rash to infer that he gave it the status of a power now at work in nature merely on the evidence of this text. He might have nothing more in mind than Lucretius, who makes the deviation of atoms from their downward movement a spontaneous factor in those initial atomic encounters from which worlds arise. Thirdly, even if Philodemus had a more positive view of chance than this, we would not be justified in attributing his view to Epicurus and Lucretius, on the evidence I have discussed. The assumption that later Epicureans never deviated from the master's views is highly improbable, and I would hesitate to attribute all of Philodemus' crude theologizing to Epicurus himself.

If the general line of argument in this paper is sound, Epicurus confined the verifiable evidence of the swerve in nature to 'free' animal behaviour. It is worth noting that his denial of necessity to propositions of the form 'Either Hermarchus will be alive tomorrow or he will not' is illustrated by an example referring to man.[49] Epicurus was most anxious to free human actions from necessity. But in other respects he developed the model of a world which conforms to natural law. The *foedera naturae* are probably identical to the *foedera fati* except in the case of *libera voluntas*.[50] If Epicurus was to let nature explain all phe-

[48] οὐ γὰρ ἱκανὸν εἰς τὸ προσδέξασθαι τὰς ἐπ' ἐλάχιστον παρεγκλίσεις τῶν ἀτόμων διὰ τὸ τυχηρὸν καὶ τὸ παρ' ἡμᾶς, ἀλλὰ δε[ῖ] προσεπιδεῖξα[ι κ]αὶ τ[ὸ] μηδαμ[ῶ]ς [ἐτέρ]ῳ μάχεσθ[αι] τῶν ἐνα[ργῶν. The text is that of De Lacy (1941).

[49] Cic. *Acad. Pri.* 97, cf. *N.D.* i 70 and *Fat.* 10, 21 (all passages cited by Usener as testimonium 376).

[50] Cf. Lucret. v.309-310 where the poet denies that the *sanctum numen* can *fati protollere finis* or *adversus naturae foedera niti*. Bailey (1947 ad loc.) seems to have no warrant for saying 'there is probably a contrast between *fati* and *foedera*, the former representing the element of chance'.

nomena and thus discharge gods and final causes from any place in the world, he could make only the most minimal concession to spontaneous or purely contingent events. The atomic swerve is *nec plus quam minimum*, and I conjecture that the scope of its operation in the world is equally minimal. At least it does not have power to counter the *validae aevi leges* and undermine the powers of nature, which are offered in place of the dominion of gods to those ignari *quid queat esse,*

quid nequeat, finita potestas denique cuique
quanam sit ratione atque alte terminus haerens.

(Lucret. v. 88-90)

University of Liverpool

BIBLIOGRAPHY

Arrighetti, G. (1973), *Epicuro Opere*, nuova edizione, Turin

Bailey, C. (1926), *Epicurus. The extant Remains*, Oxford, Clarendon Press

— (1928), *The Greek Atomists and Epicurus*, Oxford, Clarendon Press

— (1947), *Titi Lucreti Cari. De rerum natura*, 3 vols., Oxford, Clarendon Press

Bignone, E. (1940), 'La dottrina epicurea del "clinamen"', *Atene e Roma* s. iii. viii, 159-98

Boyancé, P. (1963), *Lucrèce et l'Épicurisme*, Paris

Bréhier, E. (1948), *Histoire de la philosophie*, vol. 2, Paris

Brieger, A. (1884), *Die Urbewegung der Atome und die Weltentstehung bei Leukipp und Demokrit*, Halle

Cherniss, H. (1935), *Aristotle's Criticism of Presocratic Philosophy*, Baltimore

Chilton, C. W. (1967), *Diogenes of Oenoanda*, Leipzig, Teubner

Clay, D. (1973a), 'Epicurus' Last Will and Testament', *Archiv für Geschichte der Philosophie* 55, 252-80

— (1973b), 'Sailing to Lampsacus: Diogenes of Oenoanda, New Fragment 7', *Greek Roman and Byzantine Studies* 14.1, 49-59

De Lacy, P. and E. A., (1941) *Philodemus: On Methods of Inference*, Philological Monograph X of the American Philological Association, Philadelphia

De Lacy, P. (1948), 'Lucretius and the History of Epicureanism', *Transactions of the American Philological Association*, 79, 12-23

— (1969), 'Limit and Variation in the Epicurean Philosophy', *Phoenix* 23, 104-113

De Witt, N. W. (1954), *Epicurus and his Philosophy*, Minneapolis

Edmunds, L. (1972), 'Necessity, Chance and Freedom in the Early Atomists', *Phoenix* 26, 342-57

Ernout, A. and Robin, L. (1925), *Lucrétius: Commentaire Exégetique*, Paris

Farrington, B. (1967), *The Faith of Epicurus*, London

Furley, D. J. (1966), 'Lucretius and the Stoics', *Bulletin of the University of London Institute of Classical Studies* 13, 13–33

— (1967), *Two Studies in the Greek Atomists*, Princeton University Press

Giussani, C. (1898), *Lucreti De Rerum Natura*, 4 vols., Turin
Guthrie, W. K. C. (1967), *A History of Greek Philosophy*, vol. 2, Cambridge University Press
Guyau, M. (1910), *La Morale d'Épicure*, 5th ed., Paris
Hicks, R. D. (1910), *Stoic and Epicurean*, London
Kerferd, G. B. (1971), 'Epicurus' Doctrine of the Soul', *Phronesis* 16, 80-96
Long, A. A. (1974), *Hellenistic Philosophy*, London
Long, H. S. (1964), *Diogenis Laertii Vitae Philosophorum*, vol. 2, Oxford, Clarendon Press
Muehll, P. von der (1923), *Epicurus, Epistulae Tres et Ratae Sententiae*, Leipzig, Teubner
Müller, C. W. (1965), *Gleiches zu Gleichem*, Wiesbaden
Müller, G. (1959), *Die Darstellung der Kinetik bei Lukrez*, Berlin
Reich, K. (1958), *Der historische Ursprung des Naturgesetztbegriffs*, Festschrift Ernst Kapp, Hamburg
Rist, J. M. (1972), *Epicurus. An Introduction*, Cambridge University Press
Sallmann, K. G. (1961), *Die Natur bei Lukrez* (= *Archiv für Begriffsgeschichte* 7, 1962), Bonn
Sandbach, F. H. (1941), 'Some Textual Notes on Plutarch's *Moralia*', *Classical Quarterly* 35, 110-118
Smith, M. F. (1971), 'New Fragments of Diogenes of Oenoanda', *American Journal of Archaeology* 75, 357-89
Solmsen, F. (1951), 'Epicurus and Cosmological Heresies', *American Journal of Philology* 72, 1-23
Solmsen, F. (1953), 'Epicurus on the Growth and Decline of the Cosmos', *American Journal of Philology*, 74, 34-51
Usener, H. (1887), *Epicurea*, Leipzig, Teubner
Zeller, E. (1909), *Die Philosophie der Griechen*, vol. III.i, 4th ed., Leipzig