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Life and Lifeforms in Early Greek Atomism

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Abstract: What is Leucippus and Democritus' theory of the beginning of life? How, if at all, did Leucippus and Democritus distinguish different kinds of living things? These questions are challenging in part because these Atomists claim that all living beings – including plants – have a share of reason and understanding. We answer these questions by examining the extant evidence concerning their views on embryology, the soul and respiration, and sense perception, thereby giving an overview of life and lifeforms in early Greek atomism. We show, first, that the generation of all living beings happens through the combining of miniature copies of their parents' atomic structures. Second, we argue that the Atomists take respiration to mark the beginning of life. Yet they do not consider respiration nor being ensouled to distinguish humans, animals, and plants from each other. Finally, because Leucippus and Democritus make little distinction between sense perception and thought, these too cannot sharply distinguish between different kinds of living beings. We conclude that Leucippus and Democritus advocated a less anthropocentric and more holistic view of the cosmos.

Keywords: Democritus, ancient atomism, embryology, respiration, ancient biology

1 Introduction

Ancient Greek philosophers long before Aristotle dealt with the phenomenon of life and enquired into what makes us alive, when life begins and ends, and what the differences between various forms of living beings are. Leucippus and

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Democritus are no exception.[1] Although Aristotle writes that Democritus did not treat the study of animals in detail (*Resp*. I 22, 470b30; *GA* V 8, 788b10-15), substantial evidence of his observations of animals and plants has survived.[2] While Aristotle meticulously classifies various forms of life and constructs a hierarchy of them, Democritus tends to compare them and ascribes similar psychological and physical traits to all living things. This paper aims to unpack the Atomists' philosophy of life. It centres on two key questions: What is the Atomist theory of the beginning of life?[3] And how, if at all, did Leucippus and Democritus disambiguate between humans, animals, and plants? The plan is to analyse three aspects of Leucippus and Democritus' philosophy of life – embryology, the theory of the soul and respiration, and sense perception – with the purpose of giving an overall view of life and lifeforms in early Greek atomism. We start by looking at the first formation of the body and show that all living beings are the result of a process of combining copies of their parents' atomic structures. Next, we turn to the moment living beings take the first breath and come to life. We argue that, unlike some of his Presocratic predecessors, Democritus takes neither respiration nor soul to distinguish humans from animals and plants. Finally, we look at psychological faculties. As detailed below, Democritus makes little distinction between soul, sensation, and thought, and therefore does not differentiate sharply between forms of living, perceiving, and thinking beings. The conclusion is that the Atomists are more concerned with exploring the similarities among humans, animals, and plants, rather than their differences. This has broader relevance for our understanding of their view of the natural world and shows how Leucippus and Democritus advocate a less anthropocentric and more integrated and holistic view of the cosmos.[4]

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1 Most of our sources on early Greek atomism ascribe the biological theories to Democritus. However, in lack of a better criterion to separate Democritus from Leucippus, we shall not separate their contributions to ancient psychology and biology. Moreover, with all due caution, we follow Taylor's principle of interpretative charity and take the available testimonies as reliable representations of early Greek atomism: 'The critical stance (of our primary sources – i.e., Aristotle and Theophrastus) is not incompatible with the intention and the ability to represent accurately the views criticised' (1999, 159).

2 Our primary sources for this are the Peripatetic and doxographical traditions. See, for example, Aristotle on dentition (*GA* V 8, 788b9-14 = DK 68 A147 = LM 27 D185), Theophrastus on fishes (*Pisc*. 12 = DK A155b = LM D198), and Aelian on vision (*Nat. anim*. 5 39 = DK A156 = LM D188) and horns (12 18–20 = DK A154-6 = LM 190–2). For a discussion of the evidence, see Perilli 2007, 160–1.

3 The beginning of life can be understood in two senses: the ultimate origin of life (zoogony) and individual animal births (embryology). Since we have little evidence for atomist zoogony (Gregory 2005, 94), for the purpose of this article we focus on the latter.

4 For the claim that anthropocentrism is the dominant view in later Greek philosophy and before Democritus in Hesiod, see Renehan 1981.

2 Animals in the Ground

We begin with two interpretations atomist biology. In *Le Teorie della Percezione in Democrito*, Maria Michela Sassi argues that Democritus' elaborate theory of knowledge and perception suggests that he clearly discriminated between humans, animals, and plants (1978, 70–3). The available evidence, however, suggests the contrary:[5]

> **T1:** Democritus too … recognized that (non-human animals) have a share in reason.[6] (Porph. *Abst*. 3 6 7 = LM 27 D184)

> **T2:** The disciples of Plato, Anaxagoras, and Democritus think that plants are animals in the ground.[7] (Plut. *Quaest. nat*. 911d = DK 59 A116 (Diels and Kranz 1951) = LM 27 D199)

> **T3:** Anaxagoras, Democritus and Empedocles maintain that plants have reason and understanding.[8] (Ps.-Ar. *Plants* I 1, 815b17-18 = DK 31 A70 = LM 27 D200)

Democritus is said to maintain that all living beings, including plants, perform some form of reasoning. Plants, the Atomists contend, are animals living in the ground.[9] Knowing and understanding are not human prerogatives. Despite acknowledging this, Sassi writes that Democritus must have consciously distinguished human beings from the non-human. In what follows, we suggest that such distinction is neither sharp nor sought after.

By contrast, Claudia Zatta has recently argued that, unlike Plato and Aristotle, the Atomists and the other Presocratics did not have an anthropocentric view of the cosmos, but rather conceived of all living beings as akin and interrelated, and did not distinguish the human psychological makeup and living faculties from those of animals and plants (2017, 9–15). Once again, the surviving evidence is not conclusive. First, not every Presocratic philosopher considers humans to be the same as animals and plants. Alcmaeon, for example, distinguishes humans from animals, for animals only sense, whereas humans also think: 'Alcmaeon is the first to mark the difference in relation to animals, for he says that humans differ from other animals in that they alone understand, whereas the others perceive, but do not understand, because understanding is

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5 All translations are from Laks and Most 2016, unless otherwise stated.

6 Δημόκριτός τε καὶ … ἔγνωσαν τὸ μετέχον τοῦ λόγου.

7 Ζῷον γὰρ ἔγγαιον τὸ φυτὸν εἶναι οἱ περὶ Πλάτωνα καὶ Ἀναξαγόραν καὶ Δημόκριτον οἴονται.

8 Ὁ δὲ Ἀναξαγόρας καὶ ὁ Δημόκριτος καὶ ὁ Ἐμπεδοκλῆς καὶ νοῦν καὶ γνῶσιν εἶπον ἔχειν τὰ φυτά.

9 In *Timaeus* 90a, Plato reverses this definition by describing human beings as 'not earthly, but heavenly plants' (φυτὸν οὐκ ἔγγειον ἀλλὰ οὐράνιον). This shift in focus hints at a more anthropocentric take on nature. We thank our anonymous referee for the suggestion.

different from perceiving'[10] (Theophr. *Sens*. 25 = DK 24 A5 = LM 23 D11, modified). Similarly, Philolaus writes that, unlike humans, plants have no soul and animals have no intellect: 'The head (is the principle) of reason, the hearth of the soul and perception, the navel of rootedness and first growth … The brain has the principle of human beings, the heart of the animal, the navel of the plant'[11] (ps.-Iamb. *TA* 25, 17–26, 3 = DK 44 B13 = LM 12 D26, modified). Finally, Democritus himself at times appears to rank humans above other living beings.[12] This study builds on Zatta's findings about early Greek philosophy of life by highlighting the opposition of Democritus' theories, not just to Plato and Aristotle, but also his fellow Presocratics.

One note on the translation: in the available evidence, the Atomists appear to distinguish between βίος and ζωή (Peixoto 2017, 149 n. 23). The former indicates the human way of living,[13] whereas the latter is used for biological life in general. We tend to translate ζῷον as living being, rather than restricting it to animals, for two reasons: first, according to T2, Democritus considers plants to be ζῷα in the ground. Second, in T1-3 Democritus is said to ascribe reason to non-human things, including plants. The suggestion is either that plants are classified as ζῷα or that there is no significant difference between the two.[14]

3 Atomist Embryology

According to Zatta, one of our primary sources of evidence for the Presocratics' views of life and living beings are their theories of generation and embryology (2017, 50–6).

10 Ἀλκμαίων μὲν πρῶτον ἀφορίζει τὴν πρὸς τὰ ζῷα διαφοράν. ἄνθρωπον γάρ φησι τῶν ἄλλων διαφέρειν ὅτι μόνος ξυνίησι, τὰ δ' ἄλλα αἰσθάνεται μὲν οὐ ξυνίησι δέ, ὡς ἕτερον ὂν τὸ φρονεῖν καὶ αἰσθάνεσθαι.

11 Κεφαλὰ μὲν νόου, καρδία δὲ ψυχᾶς καὶ αἰσθήσιος, ὀμφαλὸς δὲ ῥιζώσιος καὶ ἀναφύσιος τοῦ πρώτου … ἐγκέφαλος δὲ ἔχει τὰν ἀνθρώπων ἀρχάν, καρδία δὲ τὰν ζώου, ὀμφαλὸς δὲ τὰν φυτοῦ.

12 On Democritus' anthropology, his account of the origin of language and the development of crafts and societies, which set humans apart from animals, see Diodorus Siculus (I 8, 1–9 = DK 68 B5 = LM 27 D202). Similarly, the substantial evidence of Democritean ethics suggests that he was especially interested in human behaviour: for example, Fr. 187 focuses on human perfection (Stob. 3 1 27 = LM 27 D236) and Fr. 285 on human sufferings (4 34 65 = LM D256).

13 See, for example, Stob. 3 1 47 (DK 68 B189 = LM 27 D227); 3 1 210 (DK B191 = LM D226); 3 10 65 (DK B223 = LM D234); 3 4 7 (DK B191 = LM D287); 3 4 78 (DK B204 = LM D299); 3 10 65 (DK B223 = LM D234); 3 37 25 (DK B61 = LM D304); 3 40 6 (DK B246 = LM D 254); 4 1 33 (DK B248 = LM D379); 4 52 40 (DK B297 = LM D189).

14 For testimonies that separate ζῷα, animals, and φυτά, plants, but nonetheless put them on the same level, see Ar. *GC* I 8, 324b–325b5 (DK 67 A7 = LM 27 D30); Plut. *Quaest. conv*. 735a-b (DK 68 A77 = LM 27 D152); Ps.-Hippol. *Ref*. 1 13 2–4 (DK 68 A40 = LM 27 D81).

We structure our examination of atomist embryology using four questions: (1) Do all male animals[15] emit seed? (2) Do all female animals emit seed? If not, then why? (3) Does the seed come from the whole body or only part(s) of the body? (4) And what does the seed contribute to generation?

Answering these questions will shed light on how animals are formed and whether there are any differences in their generative process. We show that the Atomists' embryology is ambospermatic and a version of complete preformatist pangenesis: both parents contribute seed drawn from the whole body, which contains fully formed body parts. Thus, once the offspring is assembled in the womb, it only undergoes enlargement.

It should be noted that these are Aristotle's questions, not the Atomists' (*GA* I 17, 721a32-721b6; I 18, 722a16-8).[16] Still, we use them to structure our examination of the Atomists' embryology for two reasons. First, Aristotle is a significant source of testimonies. Second, Aristotle presents Democritus as the fiercest rival of his theory of generation, which suggests that atomist embryology was as comprehensive and advanced and dealt with similar questions.

3.1 Male and Female Animals

The answer to (1) is: Yes, all male animals emit seed. Consider the following testimony.

> **T4:** Democritus of Abdera says that it is in the mother that the difference between female and male is produced, but that it is not because of heat or cold that the one becomes a female and the other male, but depending on whether the seed of the one or of the other dominates that comes from that part by which female and male are differentiated from one another (i.e., the reproductive organs).[17] (Ar. *GA* IV 1, 764a6-10 = DK 68 A143 = LM 27 D173)

The testimony describes the process that determines an offspring's biological sex, a topic that we return to later. For the moment, notice that whichever parent's seed – specifically, the seed that comes from the reproductive organs –

15 There is nothing in the extant testimonies concerning the reproduction of plants and suggesting we should differentiate this from the reproduction of animals. For an overview of Greek and Roman views of plant generation, see Totelin 2018.

16 Similarly, some of the language used throughout this section – homoeomerous, non-homoeomerous, monstrous births, and so on – is Aristotle's own, not that of the Atomists. It is unclear from the extant evidence what terminology the Atomists would use to classify various body parts or refer to malformed offspring.

17 Δημόκριτος δὲ ὁ Ἀβδηρίτης ἐν μὲν τῇ μητρὶ γίνεσθαί φησι τὴν διαφορὰν τοῦ θήλεος καὶ τοῦ ἄρρενος, οὐ μέντοι διὰ θερμότητά γε καὶ ψυχρότητα τὸ μὲν γίγνεσθαι θῆλυ τὸ δ' ἄρρεν, ἀλλ' ὁποτέρου ἂν κρατήσῃ τὸ σπέρμα τὸ ἀπὸ τοῦ μορίου ἐλθὸν ᾧ διαφέρουσιν ἀλλήλων τὸ θῆλυ καὶ τὸ ἄρρεν.

dominates during the offspring's generation determines the biological sex of the offspring.[18] The explanation for the presence of male animals, then, is that the male parent' seeds 'dominates' during generation. Hence, male animals emit seed. Yet T4 does not allow us to conclude that *all* male animals emit seed. Unfortunately, no extant fragments or testimonies can assist in securing this conclusion. We shall point out, however, that Aristotle does not mention anyone that denies that all male animals emit seed.[19] If someone did hold this position, we suggest that Aristotle would have mentioned it.

T4 also provides some evidence that female animals emit seed. Since whichever parent's seed dominates during the offspring's generation determines the biological sex of the offspring, there are female animals because their female parents' seeds dominated during generation. Hence, female animals emit seed. There is another testimony that supports this conclusion.

> **T5:** Democritus: the female too emits a seed, for she has the (spermatic) ducts inverted. And that is why she too has desire for sexual activities.[20] (Aet. 5 5 1 = DK 68 A142 = LM 27 D166)

We suggested above that all male animals emit seed. For female animals, however, there may be evidence to the contrary: female mules.

> **T6:** Democritus says that the passages in the wombs of mules have been destroyed because at the beginning they were not born from living beings of the same species.[21] (Ar. *GA* II 8, 747a29-31 = DK 68 A149 = LM 27 D178)

> **T7:** As for mules, he [Democritus] says that they do not give birth. For they do not have wombs similar to the other animals, but ones of a different form, not at all capable of

18 A testimony from Philoponus (*In GA* 167, 13–32 = Luria 530) provides an account of the process of domination.

19 Aristotle at *GA* I 17, 721b30-32 writes that, in his view, it is evident that all male, blooded animals emit seed. He expresses reservations, though, about insects and cephalopods – two kinds of bloodless animals – because it is not clear in which of the two ways they act. For cephalopods, he writes that the alternative to seed is either 'part or some sort of capability' (*GA* I 15, 720b30-1, trans. Balme). For insects, Aristotle reports that some are not produced from animals, but 'rotting liquids or in some cases solids, for example the fleas, flies, beetles' (*GA* I 16, 721a7-9). In addition, he notes that male insects are not seen with channels for seed and, generally speaking, the male does not penetrate the female, but the female penetrates the male (*GA* I 16, 721a12-4). While Democritus is said to distinguish blooded and bloodless animals (Ar. *PA* III 4, 665a28-33 = DK 68 A148 = LM 27 D187), no evidence survives that he also investigated the reproduction of the latter.

20 Δήμοκριτος καὶ τὸ θῆλυ προίεσθαι σπέρμα· ἔχει γὰρ παραστάτας ἀπεστραμμένους· διὰ τοῦτο καὶ ὄρεξιν ἔχει περὶ τὰς χρήσεις.

21 Δημόκριτος μὲν γάρ φησι διεφθάρθαι τοὺς πόρους τῶν ἡμιόνων ἐν ταῖς ὑστέραις διὰ τὸ μὴ ἐκ συγγενῶν γίνεσθαι τὴν ἀρχὴν τῶν ζώων.

> receiving seed. For the mule is not a product of nature, but rather an artificial supplement and theft deriving from a human inspiration and audacity one might call adulterous. "It seems to me," he said, "that after an ass had violated a mare, she became pregnant by chance, and that humans learned from this violence and then progressed to the point of making their procreation a habit."[22] (Ael. *Nat. anim.* 12 16 = DK 68 A151 = LM 27 D179)

We learn from these testimonies that female mules are incapable of receiving seed – not just the seed of male mules but, presumably, any seed. The passages (πόροι) in the wombs of female mules were destroyed because of what Aelian describes as their unnatural origin: the union of a male mule with a mare. Worse still – at least, from Democritus' perspective – this continues because of the 'adulterous audacity' of human beings. This suggests that the origin of the mule violated what we call the 'like begets like' principle – that parents of the same species shall produce an offspring of the same species – seen in the following testimony.[23]

> **T8:** And for his part Democritus says that a human burst out of a human, and a dog out of a dog, and a bull out of a bull.[24] (Ps.-Gal. *An animal sit* 5 = DK 68 B32 = LM 27 D163c)

Should we infer from the female mule's inability to receive seed that female mules also cannot *emit* seed, and therefore that not all female animals emit seed? We maintain that the answer depends on where the seed comes from. For our purposes, there are two options: either the seed comes from one or more – but not all – of the body's parts or the seed comes from the whole body. If the seed comes from one (or more) of the body's parts *and* that part is the reproductive organs, then it is possible that damage to the passages in the wombs of female mules results in female mules being incapable of emitting seed, in addition to receiving seed. If the

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22 Ἡμιόνους δὲ λέγει μὴ τίκτειν· μὴ γὰρ ἔχειν ὁμοίας μήτρας τοῖς ἄλλοις ζῴοις, ἑτερομόρφους δε, ἥκιστα δυναμένας γονὴν δέξασθαι· μὴ γὰρ εἶναι φύσεως ποίημα τὴν ἡμίονον, ἀλλὰ ἐπινοίας ἀνθρωπίνης καὶ τόλμης ὡς ἄν εἴποις μοιχιδίου ἐπιτέχνημα τοῦτο καὶ κλέμμα. "δοκεῖ δε μοι," ἦ δ' ὅς, "ὄνου ἵππον βιασαμένου κατὰ τύχην κυῆσαι, μαθητὰς δὲ ἀνθρώπους τῆς βίας ταύτης γεγενημένους εἶτα μέντοι προελθεῖν ἐπὶ τὴν τῆς γονῆς αὐτων συνήθειαν."

23 See also Stob. 3 6 28; Clem. Alex. *Paed.* II 10, 94.3–4; Ps.-Hippol. *Ref.* 8 14 4 (DK 68 B32 = LM 27 D163a-b-d). What we call the 'like begets like' principle is different from the 'like to like' principle, central to the Atomists' cosmology. The latter in fact refers to the diverse set of ways in which 'like is moved to like' in a cosmos. For example, it is the vortex's whirl that moves like atoms to like atoms (D.L. IX 30–3 = DK 67 A1 = LM 27 80b). See Gregory 2013 for a presentation and defence of this interpretation of the 'like to like' principle, as well as criticisms of alternative interpretations.

24 Φησὶ δὲ καὶ Δημόκριτος ἄνθρωπον ἐξ ἀνθρώπου ἐξέσσυσθαι καὶ κύνα ἐκ κυνὸς καὶ βοῦν ἐκ βοός. This passage might have resonances with Empedocles who, by contrast, allows for the possibility of generating cattle-faced men and man-faced cattle (Ael. *Nat. anim.* 16 29 = DK 31 B61 = LM 22 D156). We thank the anonymous referee for this suggestion.

seed comes from the whole body, however, then damage to the passages in the wombs of female mules need not preclude female mules from emitting seed, even if they cannot receive seed. We must, then, answer (3) to complete our answer (2).

3.2 Part of the Body or the Whole Body?

According to the Atomists, the seed comes from the whole body.

> **T9**: Democritus: (The seed comes) from the whole of bodies and from their principal parts, like the bones, flesh, and muscles.[25] (Aet. 5 3 6 = DK 68 A141 = LM 27 D165)

> **T10**: Democritus … (says that the seed separates out) from the whole body; Democritus says, "One will be humans and a human will be all."[26] (Ps.-Gal. *Def. med.* 439 = DK 68 B124 = LM 27 D164)

The Atomists' embryology is a form of *pangenesis*, in that each part of the body emits seed. The question is what it means to say that the seed comes from 'the whole body'. Aristotle presents three possibilities (*GA* I 18, 722a16-b3): the seed contributes only homoeomerous, or like-parted, components to generation, such as bone, flesh, and muscles; the seed contributes only non-homoeomerous parts, such as face and hand; or the seed contributes both homoeomerous and non-homoeomerous parts to generation.[27] We can dismiss the possibility that the seed contributes only non-homoeomerous parts, as T9 confirms that the seed contributes at least homoeomerous parts. Specifically, the seed comes from bone, flesh, and muscles, which are described as 'principal parts'.[28] Therefore, the choice is between only homoeomerous parts or both homoeomerous and non-homoeomerous parts. We maintain that the καὶ in T9 is coordinative, not explicative.[29] If so, T9 is evidence in favour of the position that the seed contributes both homoeomerous parts, like bone and flesh, and the rest of the non-homoeomerous parts. This conclusion also provides part of an answer to (4).

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25 Δημόκριτος ἀφ' ὅλων τῶν σωμάτων καὶ τῶν κυριωτάτων μερῶν οἷον ὀστῶν σαρκῶν καὶ ἰνῶν.
26 Δημόκριτος … ἐξ ὅλου τοῦ σώματος, ὁ μὲν Δημόκριτος λέγων "ἄνθρωποι εἷς ἔσται καὶ ἄνθρωπος πάντες."
27 Once again, the language is Aristotelian, as Aristotle is our primary source for atomist pangenesis. There is no evidence that the Atomists draw sharp distinctions between homoeomerous and non-homoeomerous parts. Rather than separating them, they may have used the language of atoms and referred to all sorts of bodily parts as atomic compounds (de Ley 1980, 136). Yet this is not explicit in the sources.
28 The phrase 'principal parts' does not appear anywhere else in the available evidence for early atomism. Hence, this is unlikely to be Democritus' own definition.
29 Arguing for this is de Ley 1980, 134–6.

Moreover, T9 indicates that the Atomists' pangenesis is *preformationist*: the parts contained in the seed are, quite literally, already-formed miniature copies of the parents' parts. Consider the following testimony.

> **T11:** A human bursts out of a human, he says, and is torn away from him, being divided off by a kind of blow.[30] (Ps.-Hippol. *Ref.* 8 14 4 = DK 68 B32 = LM 27 D163d)

The result is that once the offspring is 'assembled' in the womb, it undergoes only enlargement.

These observations permit us to provide a tentative answer to (2). In the previous subsection, we asked whether damage to the passages in the wombs of female mules, which causes female mules to be incapable of receiving seed, might also prevent them from emitting seed. Since the Atomists' embryology is a form of pangenesis, however, even if damage to the passages in the womb prevents the emission of seed, it is prevented for *only* this part of the animal. That is, while the seed of female mules would not contain a miniature womb – for this part is not contributed to the offspring's generation – it would still contain miniature sinews, legs, arms, and so on, since the seed is drawn from the whole body. We tentatively conclude, then, that all female animals emit seed, just as all male animals emit seed. So far, there are no discernible differences in the generation of living beings.

This leads us to why the Atomists adopted a pangenesis embryology. Aristotle suggests that there could be four reasons. First, the intensity of the pleasure experienced through sexual intercourse: 'The same affection becomes pleasanter if there is more of it, and that which occurs in all the parts is more than that which occurs in one or a few' (*GA* I 17, 721b15-7, trans. (Balme 1992)).[31] Second, the fact that mutilated parents have mutilated offspring: 'Since the part is missing (in the parent) no seed comes from it, and that the part from which no seed comes is consequently not produced' (721b18-20).[32] Third, the resemblance between parents and offspring generally: 'Just as offspring resemble them in body as a whole, so they do part for part; therefore, if the reason for the whole's likeness is that the seed come from the whole, the reason for the parts' likeness must be that something came from each part' (721b21-2).[33] Four, the "whole/part" assumption: 'Just as there is some first thing in

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30 Ἄνθρωπος ἐξ ἀνθρώπου ἐξέσυται, φησίν, καὶ ἀποσπᾶται πληγῇ τινι μεριζόμενος. On conception as 'a kind of blow', see T12 below.

31 μᾶλλον γὰρ ἡδὺ πλέον ταὐτὸ γιγνόμενον πάθος, πλέον δὲ τὸ πᾶσι τοῖς μορίοις ἢ τὸ ἑνὶ ἢ ὀλίγοις συμβαῖνον αὐτων.

32 διὰ μὲν γὰρ τὸ τοῦ μορίου ἐνδεὲς εἶναι οὐ βαδίζειν σπέρμα ἐντεῦθέν φασιν, ὅθεν δ' ἂν μὴ ἔλθῃ τοῦτο συμβαίνειν μὴ γίγνεσθαι.

33 γίγνονται γὰρ ἐοικότες ὥσπερ καὶ ὅλον τὸ σῶμα καὶ μόρια μορίοις. εἴπερ οὖν καὶ τῷ ὅλῳ αἴτον τῆς ὁμοιότητος τὸ ἀφ' ὅλου ἐλθεῖν τὸ σπέρμα, καὶ τοῖς μορίοις αἴτον ἂν εἴη τὸ ἀφ' ἑκάστου τι τῶν μορίων ἐλθεῖν.

the whole out of which the whole develops, so there is in each part; hence if the whole has a seed, each part must have a seed of its own' (721b22-4).[34]

The extant evidence suggests that the Atomists considered the third reason support for pangenesis. In addition, it indicates that this is the case for modified versions of the first and second reasons. There is no independent evidence, however, that the Atomists considered the fourth reason evidence for pangenesis. This explanation, then, is likely to be Aristotelian (de Ley 1980, 132–3).

The following testimony confirms that the Atomists considered sexual intercourse an intense experience.

> **T12:** The sophist of Abdera called sexual intercourse a small attack of epilepsy, considering it to be an incurable disease. For indeed is it not accompanied by feelings of faintness comparable to the magnitude of what is lost (i.e., the semen)? For a human is born out of a human and is torn away from him.[35] (Clem. Alex. *Paed.* II 10, 94 3–4 = DK 68 B32 = LM 27 D163b)

Yet the Atomists do not maintain that it is the intensity of the pleasure experienced that is evidence for pangenesis. Rather, it is the feeling of *faintness* experienced after sexual intercourse, a feeling that is proportionate to the magnitude of what is 'torn away' from the animal. That is, the more that is 'divided off by a kind of blow' from the animal's body, the greater the feeling of faintness.

Another reason for pangenesis is the case of mutilated offspring. Aristotle reports that Democritus explains 'monstrous births' or mutilated offspring in the following way.

> **T13:** Democritus said that monstrous births were caused by two seeds meeting, the one impelled first, the other later. This one too enters the womb after it is emitted, so that the parts grow together and become intermingled. And he says that in birds, since their copulation takes place rapidly, both the eggs and their colours are always intermingled.[36] (*GA* IV 4, 769b30-36 = DK 68 A146 = LM 27 D168)

We saw above that female mules are born with destroyed passages in their wombs because they are the product of a union that violates the like begets like principle. This is one cause of mutilation in an offspring. T13 introduces a different cause: the

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34 ἔτι δὲ καὶ εὔλογον ἄν εἶναι δόξειεν, ὥσπερ καὶ τοῦ ὅλου ἐστί τι ἐξ οὗ γίγνεται πρῶτον οὕτω καὶ τῶν μορίων ἑκάστου εἴη ἄν τι σπέρμα ἴδιον.

35 Μικρὰν ἐπιληψίαν τὴν συνουσίαν ὁ Ἀβδηρίτης ἔλεγεν σοφιστής, νόσον ἀνίατον ἡγούμενος. ἦ γὰρ οὐχὶ καὶ ἐκλύσεις παρέπονται τῷ μεγέθει τῆς ἀπουσίας ἀνατιθέμεναι; "ἄνθρωπος γὰρ ἐξ ἀνθρώπου ἐκφύεταί τε καὶ ἀποσπᾶται. Cf. Stob. 3 6 28 = DK 68 B32 = LM 27 D163a.

36 Δημόκριτος μὲν οὖν ἔφησε γίγνεσθαι τὰ τέρατα διὰ τὸ δύο γονὰς συμπίπτειν, τὴν μὲν πρότερον ὁρμήσασαν τὴν δ' ὕστερον, καὶ ταύτην ἐξελθοῦσαν ἐλθεῖν εἰς τὴν ὑστέραν ὥστε συμφύεσθαι καὶ ἐπαλλάττειν τὰ μόρια. ταῖς δ' ὄρνισιν ἐπεὶ συμβαίνει ταχεῖαν γίνεσθαι τὴν ὀχείαν, ἀεὶ τά τ' ᾠὰ καὶ τὴν χρόαν αὐτῶν ἐπαλλάττειν φησίν.

growing together and intermingling of two seeds in the womb, where one seed enters the womb before the other. The testimony's context indicates that the seeds in question are, and can only be, male seeds. It is not the case that the female's seed causes mutilation of an offspring (Ar. *GA* IV 4, 770a4-6). Still, there are questions. First, must the seed that enters the womb later be *another* male's seed?[37] Second, in what way do the parts that each seed contributes act jointly and similar, with the result that they grow together and intermingle? We address the latter in our discussion of resemblance between an offspring and its parents.

We are fortunate that Philoponus, in his commentary on Aristotle's *Generation of Animals*, expands on T13 (Philop. *In GA* 185, 33–186, 19 = (Luria 1970), 546). His discussion suggests that the second seed that enters the womb need not be another male's seed: the same male partner can cause an offspring to become malformed by discharging a second seed into the womb. For even though the female's partner is the same, each seed produced by the male is different in some way. For support, Philoponus consider the case of birds' eggs, which are both white and yellow, as opposed to being either white or yellow. He writes that since copulation between birds is rapid, the male bird shall discharge several seeds into the female bird. Perhaps the respect in which the male bird's several seeds are different is the colour they contain – either whiteness or yellowness. Whatever the difference, though, the result is a growing together and intermingling of the seeds, which produces a 'monstrous' egg. Yet this malformation of birds' eggs is not perceived as a malformation, because it always happens, whereas a human being with two heads and four feet is rare.

The example tells us something important. Even though we write of 'monstrous births' and 'malformed' or 'mutilated' offspring, this need not imply something extraordinary – a human being with two heads and four feet, once again – since even destroyed passages in the wombs of female mules and multicoloured birds' eggs are considered monstrous. The category of monstrous births, then, is quite inclusive. For the early Atomists, something is a monstrous birth just in case it is either the product of a union that violates the like begets like principle or the product of two male seeds that meet in the womb, grow together, and intermingle.

Overall, did the Atomists considered monstrous births to be evidence for pangenesis? T13 and Philoponus' commentary suggest that the explanation for multicoloured birds' eggs – or a human being having two heads and four feet – is an *overabundance* of parts in the womb. So, while Aristotle presents as evidence for pangenesis the case of an offspring's *missing* some body part, the Atomists would present as evidence for pangenesis the case of an offspring's having *too many* of some body part(s).

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37 Some ancient authors – e.g., Varro (first-century BCE) and Columella (first-century CE) – maintain that monstrous births are result of infidelity. We thank Sophia Connell for this point.

Finally, we turn to the question of heredity. The Atomists explain the resemblance between parents and their offspring in the following way.

> **T14:** Democritus: The parts common (to both sexes) come from either the one (parent) or the other, by chance. On the other hand, the parts that are peculiar to each are also due to the dominance (of one parent).[38] (Aet. 5 7 6 = DK 68 A143 = LM 27 D174)

> **T15:** Democritus reports that the nature of the parent whose principle was first to occupy the place is reproduced.[39] (Censor. *Die nat.* 6 5 = DK 68 A143 = LM 27 D177)

Each parent's seed contains two sorts of parts: common parts and peculiar parts. Some examples of common parts include face, hand, bone, and sinew, which both parents have. The peculiar parts, however, are those that distinguish male from female – namely, the reproductive organs. Both sorts of parts struggle for dominance of their places during the 'assembling' of the offspring. It is the 'victorious' parts that occupy the place, and these cause an offspring to resemble one of its parents and not the other in infancy by, say, having blue eyes, brown hair, or large ears, or in adolescence or adulthood by having a broad torso, long legs, or thick fingers. An offspring's biological sex is determined in the same way: whichever parent's 'principle' – that is, the miniature copy of its reproductive organs – is victorious in its struggle, occupies its place and determines whether the offspring is male or female.[40]

T14 tells us more: whether an offspring has, say, blue or brown eyes, a large or small nose, or is male or female – in short, whether a parent's particular common or peculiar part is dominant – is a matter of *chance*.[41] This helps explain why, say,

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38 Δημόκριτος τὰ μὲν κοινὰ μέρη ἐξ ὁποτέρου ἄν τῦχῃ, τὰ δ' ἰδιάζοντα καὶ κατ' ἐπικράτειαν.

39 Utrius vero parentis principium sedem prius occupaverit, eius redid naturam Democritus rettulit.

40 It is difficult to determine whether the Atomists had separate theories for sex differentiation and heredity. It would seem not, as it is the same process of struggle between the male's and female's parts, the dominance of one part and thereby victory that determines both biological sex and resemblance with respect to some common feature (for instance, eye colour). The only difference is the part in question – peculiar parts determine biological sex, while common parts determine resemblance with respect to some common feature. See the next note, however.

41 It may be the case that an offspring's biological sex can be determined by manipulation. A testimony from Columella's *On Agriculture* (Col. 6 28 = Luria 531a) reports that 'Democritus asserts that in breeding horses it is up to us whether a male or female is conceived. He advises that when we want a male to be conceived, we should tie up the left testicle of the stallion with a linen string or something similar, and if a female, the right, and he says that we should do the same in the case of virtually all animals' (trans. Taylor 1999). Zatta observes that the significance of the left and right sides of the male parent's body is found in other early Greek theories of sexual reproduction, specifically Parmenides and Anaxagoras. See DK 28 A53 and DK 59 A107, respectively. She extends this to the Atomists and suggests that 'the left is associated to a weaker sperm, bent toward female

some parents' first offspring is male and the second female; why all of some parents' three offspring are female; or why two of some parents' three offspring are male and the third is female; and so forth. That is, it is a matter of chance which of the parents' peculiar parts shall dominate during the offspring's generation, thereby determining its biological sex. The same holds for the variation (or lack thereof) in eye colour, hair colour, skin tone, and so forth.

This analysis of resemblance between the offspring and its parents, whatever questions remain concerning it, agrees with Aristotle's third reason for pangenesis (*GA* I 17, 721b21-2). The offspring resembles one of its parents 'in body as a whole' by being either male or female, where this is determined by whichever parents' principle first occupies its place. In addition, the other bodily parts of the offspring resemble the corresponding parts of each parent because the seeds of each parent also contain common parts. These too struggle for dominance during the assembling of the offspring, and those that are victorious cause the offspring to resemble its parents in particular ways. Thus, the Atomists considered the third reason support for pangenesis and, arguably, this applies to all living beings.

3.3 Complete or Incomplete Preformatist Pangenesis?

Thus far, we showed that the Atomists maintain that the seed, which comes from the whole body, contains both homoeomerous and non-homoeomerous parts, where the latter may be divided into common parts and peculiar parts. This constitutes a nearly complete answer to (4). There remains only to determine whether the seed contains *all* or only *some* of the parent's homoeomerous and non-homoeomerous parts.

We begin with the following passage from Book I of Aristotle's *Generation of Animals*.

> **T16:** Further, if it comes equally from all of both parents, two living beings are produced; for they will have every part of each parent. Therefore, if this is the right way to speak, Empedocles' account seems most consistent with it … for he says that the male and the female contain as it were a tally, and that neither produces a whole, "but sundered in limbs' nature, part in man's (seed)…" Otherwise, why do not the females generate from themselves, if in fact the seed comes from all the body and they have a receptacle? But, as it seems, either it does

reproduction, while the right is associated to a stronger sperm, conducive to male dominance. The occlusion of the left testicle would confer more impetus to the emission of semen from the other testicle and a higher capability to fight the mother's seed thereby controlling the result of the process of reproduction' (2017, 53 n. 46).

> not come from all the body, or comes in the way that Empedocles says, not the same things from each parent, and this is why they need intercourse.[42] (*GA* I 18, 722b6-17, trans. Balme)

In T16, Aristotle reports that Empedocles held what we call a version of *incomplete* preformatist pangenesis: while the seed comes from the whole body, it contains only *some* of the parent's homoeomerous and non-homoeomerous parts. The alternative is *complete* preformatist pangenesis, where the seed contains *all* of the parent's homoeomerous and non-homoeomerous parts. And it is the latter that Aristotle questions in T16. If the seed comes from the whole body in this way, why are two offspring not produced? After all, a complete set of parts from each parent is present in the womb. In addition, if the seed comes from the whole body in this way, why do females not generate offspring all by themselves? Aristotle regards these as serious problems for complete preformatist pangenesis.[43]

The proponent(s) of complete preformatist pangenesis is not named in the first book of the *Generation of Animals*. When we read Book IV, however, where the discussion of pangenesis continues (764b10*ff.*), Democritus is explicitly mentioned and frequently set against Empedocles. We conclude, then, that the Atomists were proponents of complete preformatist pangenesis.[44]

Overall, the Atomists' embryology is ambospermatic and a version of complete preformatist pangenesis: both parents contribute seed, drawn from the whole body, which includes all bodily parts. Despite its complexities, the Atomists' embryology appears quite straightforward: 'torn away' or 'divided off by a kind of blow' from each parent's body are miniature copies of their parts. These parts struggle against each other for dominance of their place during the assembling of the offspring's body and, when the war has ended, the offspring, now fully assembled, undergoes only enlargement. We suggest that the Atomists conceive of generation as a process of copying and combining the parents' atomic structures, producing an atomic

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42 Ἔτι εἰ ἀπ' ἀμφοτὲρων ὁμοίως ἀπό πάντων ἀπέρχεται, δύο γίγνεται ζῷα· ἑκατέρου γὰρ ἅπαντα ἕξει. διὸ καὶ Ἐμεδοκλῆς ἔοικεν, εἴπερ οὕτω λεκτέον, μάλιστα λέγειν ὁμολογούμενα τούτῳ τῷ λόγῳ … φησί γὰρ ἐν τῷ ἄρρενι καὶ τῷ θήλει οἷον σύμβολον ἐνεῖναι, ὅλον δ' ἀπ' οὐδετέρου ἀπιέναι, ἀλλὰ διέσπασται μελέων φύσις, ἡ μὲν ἐν ἀνδρός … διὰ τί γὰρ τὰ θήλεα οὐ γεννᾷ ἐξ αὐτῶν εἴπερ ἀπὸ παντός τε ἀπέρχεται καὶ ἔχει ὑποδοχήν; ἀλλ' ὡς ἔοικεν ἢ ἀπέρχεται ἀπὸ παντὸς ἢ οὕτως ὥσπερ ἐκεῖνος λέγει, οὐ ταὐτὰ ἀφ' ἑκατέρου, διὰ καὶ δέονται τῆς ἀλλήλων συνουσίας. Cf. Empedocles DK 31 B63 = LM 22 D164, D171.

43 We add to Aristotle's questions the following: if the male's seed and the female's seed contain all of the male parent's and the female parent's homoeomerous and non-homoeomerous parts, then why it is the case that only two male seeds that meet, intermingle, and grow together in the womb can produce a monstrous birth? Put differently, why it is the case that a single male seed and a single female seed cannot by themselves produce a malformed offspring?

44 For a discussion of the influence of the early Atomists on later atomism and mechanical philosophy, with reference to preformatist pangenesis, see Horne 1963.

aggregate (the offspring) that shares some structural similarities with two other atomic aggregates (the parents). This process of copying and combining yields the possibility that all lifeforms can have similar traits.

Perhaps the way to distinguish different lifeforms is found further up, in the Atomist theory of the beginning of life, soul, and respiration. For the Atomists describe the seed as a fragment of the soul.

> **T17:** [1] Leucippus …: (the seed is) a body, for it is a fragment of the soul. [3] … Democritus: the power (of the seed and not only its matter) is also a body, for it is of the nature of breath.[45] (Aet. 5 4 1–3 = DK 67 A35, 68 A140 = LM 27 D162)

We shall see that the soul sets living beings in motion, specifically the respiratory organs that enable them to breathe. The soul, the respiratory organs, and air all contribute to something's being a living thing. The seed's being 'a fragment of the soul' and 'of the nature of breath', then, links embryology and the first formation of the body to the psychology and the beginning of life.

4 Soul, Breath, and the Limit of Life

Once formed, humans, animals, and plants come to life. Concerning the atomist theory of the beginning of life, Aristotle writes the following:

> **T18:** On this supposition (i.e., that soul produces movement), Democritus argues that it is some kind of fire and heat. For since forms and atoms are countless, he says that the spherical ones are fire and soul, such as the so-called motes in the air, which appear in the sunbeams passing through our windows, and the atomic aggregates are the elements of all nature. And so argues Leucippus. They think that the soul is made of spherical atoms because (i) such shapes can most readily pass through anything and (ii) move the rest with their own motion, for according to them the soul is that which produces movement in living things. On this account, they also think that respiration is the limit of life. For since the surrounding atmosphere exerts pressure upon bodies and expels those atoms which impart motion to living things, for they themselves are never at rest, there is help from the outside, when other atoms of this kind enter during respiration; for they prevent the atoms which are in the living body from escaping by counteracting the compression and solidification; and there is life as long as living beings are able to do this.[46] (Ar. *DA* I 2, 404a1-16, trans. LM modified, numbers added)

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45 [1] Λεύκιππος … σῶμα· ψυχῆς γὰρ εἶναι ἀπόσπασμα. [3] … Δημόκριτος καὶ τὴν δύναμιν σῶμα· πνευματικὴ γάρ.

46 Ὅθεν Δημόκριτος μὲν πῦρ τι καὶ θερμόν φησιν αὐτὴν εἶναι· ἀπείρων γὰρ ὄντων σχημάτων καὶ ἀτόμων τὰ σφαιροειδῆ πῦρ καὶ ψυχὴν λέγει, οἷον ἐν τῷ ἀέρι τὰ καλούμενα ξύσματα, ἃ φαίνεται ἐν ταῖς διὰ τῶν θυρίδων ἀκτῖσιν, ὧν τὴν πανσπερμίαν στοιχεῖα λέγει τῆς ὅλης φύσεως. Ὁμοίως δὲ καὶ Λεύκιππος. Τούτων δὲ τὰ σφαιροειδῆ ψυχήν, διὰ τὸ μάλιστα διὰ παντὸς δύνασθαι διαδύνειν τοὺς

On Aristotle's account in the first book of the *De Anima*, the Presocratics attributed two distinctive traits to the soul: movement and perception (I 2, 403b25-26). The Atomists are among those thinkers according to whom the soul moves and initiates movement. According to Leucippus and Democritus, Aristotle argues, the soul is made of round, swift, and fiery atoms (*DA* I 2, 404a1-5 = DK 67 A28 = LM 27 D132 – cf. Ar. *DA* I 2, 405a8-13 = DK 68 A101; Aet. 4 3 5 = DK 68 A102). The implication is twofold: (i) soul atoms can pass through all kinds of things (404a6-7)[47] and (ii) they cause other things to move (404a8). Because of (i), soul atoms flow out of the body they animate. However, thanks to (ii), and specifically the respiratory movement, bodies breathe in new soul atoms, thus balancing the loss of fiery particles with a similar intake and keeping the body alive (404a10-15 = DK 67 A28 = LM 27 D136).[48] As a result, respiration marks the limit of life (τοῦ ζῆν ὅρος, 404a10), and the birth and passing away of a living being. Things are alive as long as they are able to breathe and inhale soul atoms (404a16). Aristotle gives a similar account of Democritus' theory of the origin of life in *On Respiration* (I 2, 471b30-472a17 = DK 68 A106 = LM 27 R29a-b), where life and death are again said to 'depend on inhaling and exhaling' (*Resp*. I 2, 472a11-2).

From Aristotle's account of the atomist theory of the soul, we can draw the following conclusions. First, life begins when we start breathing and ends when we breathe our last. Second, since the process of inhaling and exhaling soul atoms is central to *all* forms of life, respiration and soul cannot be used as criteria for distinguishing forms of life.

While Aristotle describes the soul as the life-bringing principle (*DA* I 1, 402a6-7; II 4, 415b9-10), the distinctive feature of soul atoms is being especially mobile. The life-bringing process begins with respiration: when alive, humans, animals, and plants breathe.[49] In *On Respiration*, Aristotle writes the following:

τοιούτους ῥυσμούς, καὶ κινεῖν τὰ λοιπὰ κινούμενα καὶ αὐτά, ὑπολαμβάνοντες τὴν ψυχὴν εἶναι τὸ παρέχον τοῖς ζῴοις τὴν κίνησιν. Διὸ καὶ τοῦ ζῆν ὅρον εἶναι τὴν ἀναπνοήν. Συνάγοντος γὰρ τοῦ περιέχοντος τὰ σώματα, καὶ ἐκθλίβοντος τῶν σχημάτων τὰ παρέχοντα τοῖς ζῴοις τὴν κίνησιν διὰ τὸ μηδ' αὐτὰ ἠρεμεῖν μηδέποτε, βοήθειαν γίγνεσθαι θύραθεν ἐπεισιόντων ἄλλων τοιούτων ἐν τῷ ἀναπνεῖν· κωλύειν γὰρ αὐτὰ καὶ τὰ ἐνυπάρχοντα ἐν τοῖς ζῴοις ἐκκρίνεσθαι, συνανείργοντα τὸ συνάγον καὶ πηγνύον· καὶ ζῆν δὲ ἕως ἂν δύνωνται τοῦτο ποιεῖν.

47 Aristotle raises a similar objection against the Pythagorean theory of the soul and, specifically, reincarnation (*DA* I 3, 407b20-24).

48 It should be noticed that in the available evidence for atomists psychology the soul is not explicitly said to be responsible for respiration (*Resp*. I 4, 472a21-22). However, respiration is a movement (Ar. *DA* III 9, 432b11-12) and for the Atomists the soul causes movement (I 2, 403b29), which suggests that these two features are connected.

49 According to Aetius (5 15 3 = DK 31 A74 = LM 22 D170) and the Anonymous of London (18, 20–9 = DK 44 A27 = LM 12 D25), Empedocles and Philolaus also link the beginning of life to the

T19: Then, Democritus of Abdera and others of those who have spoken about respiration did not draw lines between other living things but appear to speak as if they all breathed.[50] (Ar. *Resp*. I 2, 470b29-31)

After noting that the Atomists ascribe breathing to all living things, Aristotle adds that they do not draw any specific lines (διωρίκασι) among them. While respiration marks the beginning of life and thus distinguishes living beings from the non-living, it does not differentiate among forms of life. Yet respiration in turn entails having soul atoms flowing in and out of the body. Since humans, animals, and plants breathe, they *all* inhale and exhale soul atoms. Thus, not only do all living beings share the ability to breathe, but they are also all ensouled. Both respiration and soul prevent us from drawing any specific lines among living beings.

4.1 Sleeping and Dying

We can take this one step further: soul atoms also prevent us from distinguishing living beings from the non-living. Since the fast-moving spherical particles constituting the soul can pass through all sorts of atomic compounds, they can also enter non-living things.

T20: Democritus says that all things have a share in some kind of soul, even corpses, for they always manifestly partake in some kind of heat and sensation, even if the majority has been breathed out.[51] (Aet. 4 4 7 = DK 68 A117 = LM 27 D140 modified)

T21: On this point, Democritus also notes that the nails and hair of buried bodies grow for some time.[52] (Tert. *An*. 51 = DK 68 A160 = LM 27 D142 modified)

Democritus believes that corpses can take in soul atoms, but not many. The evidence for this is threefold: first, corpses contain heat. According to Aristotle's testimony in T18, fire and soul are composed of the same kind of spherical atoms. Therefore, since corpses 'partake in some kind of heat', they too may contain soul atoms. Second, corpses are said to have some sensations, which, as we shall see below, is also the result of swiftly moving atoms colliding with the sense organs.

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animal's first breath. Aristotle, by contrast, criticizes this theory arguing that not all beings have lungs and thus can breathe (*Resp*. I 2, 470b25-30).

50 Δημόκριτος μὲν οὖν ὁ Ἀβδηρίτης καί τινες ἄλλοι τῶν περὶ ἀναπνοῆς εἰρηκότων οὐδὲν περὶ τῶν ἄλλων διωρίκασι ζῴων, ἐοίκασι μέντοι λέγειν ὡς πάντων ἀναπνεόντων.

51 Ὁ δὲ Δημόκριτος πάντα μετέχειν φησὶ ψυχῆς ποιᾶς, καὶ τὰ νεκρὰ τῶν σωμάτων, διότι ἀεὶ διαφανῶς τινος θερμοῦ καὶ αἰσθητικοῦ μετέχει τοῦ πλείονος διαπνεομένου.

52 Ad hoc et Democritus crementa unguium et comarum in sepulturis aliquanti temporis denotat.

Third, in T21 corpses are said to perform some movements, such as growing nails and hair. Since soul atoms impart motion to things, the limited movement in dead bodies suggests that they are ensouled to a limited extent. The small number of soul atoms, however, is not sufficient for respiration. Therefore, corpses do not breathe and are not alive.[53]

These texts suggest that to come to life the body does not simply need soul, but rather an *adequate* number of soul atoms that initiate the respiratory movement. On the other hand, death does not occur when *all* soul atoms leave the body, but when *most* particles have been breathed out and thus the body does not have enough soul atoms to produce further respiratory movement. The difference between life and death does not seem to be a difference of process, for soul atoms pass through both living things and corpses. Rather, it is a difference of number, for bodies need to breathe enough soul atoms to compensate for those that have flowed out.

Further support for this comes from the Atomists' account of sleeping and dying. According to Leucippus and Democritus, there are neither predictable signs of future death nor clear signs that life has ended (Cels. *Medic.* II 6 = DK 68 A160 = LM 27 D141). What makes death difficult to detect is that there are two kinds of interruptions of the respiratory movement: a temporary and milder lack of breath, which only looks like death, and a severe and permanent one.

> **T22:** On the question of whether sleep and death belong to the soul or the body, Leucippus says that it does not only belong to the body but occurs because of an outflow of the fine part that is greater than the inflow of the heat of the soul; an excess causes death.[54] (Aet. 5 25 3 = DK 67 A34 = LM 27 D138 modified)

The first kind of suspension is a state of sleep, which Democritus describes as 'a lack of breathing' (Tert. *An.* 43 = DK 68 A136 = LM 27 D137). Sleep occurs when the soul atoms (that is, 'the fine part')[55] the body expels is greater than the particles it breathes in.

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53 The claim that in corpses 'the majority (of atoms) has been breathed out' suggests that those inside a corpse are soul particles that have not left the body yet, rather than particles that entered after death. Yet the claim that 'all things' have some kind of soul suggests that atoms can also enter compounds that were never ensouled, such as stones.

54 Ὁποτέρου ἐστὶν ὕπνος καὶ θάνατος, ψυχῆς ἢ σώματος, Λεύκιππος οὐ μόνον σώματος γίνεσθαι, ἀλλὰ ἐκκρίσει τοῦ λεπτομεροῦς πλείονι τῆς εἰσκρίσεως τοῦ ψυχικοῦ θερμοῦ, τὸν δὲ πλεονασμὸν αἴτιον θανάτου.

55 We read λεπτομερής (fine part) as indicating soul atoms both because Leucippus contrasts this with the body and because atoms are described as λεπτόν, fine, elsewhere (e.g., Theophr. *Sens.* 82 = DK 68 A135 = LM 27 D67). Moreover, we read ἔκκρισις (excretion) and εἴσκρισις (intake), instead of following Laks and Most, according to whom sleep occurs when 'the mixture (κράσις) of fine atoms surpasses the outflow (ἔκκρισις) of the soul.' The reason for this is that, according to the process of respiration described above, the exhalation of soul atoms should be counteracted by

Hence, when asleep, bodies have fewer soul atoms within themselves. Yet the number is sufficient to reprise the respiratory movement, increase the amount of soul atoms in the body, restore the counteraction of intake and outflow, and thus awake the animal. The second kind of lack of breath occurs when the number of atoms flowing out is *much* greater than those flowing in and eventually leads to death.[56] Therefore, sleep is seen as some kind of *ante-mortem* event: it resembles the loss of soul atoms that leads to death, but it is not as extreme and irreversible.[57] This, again, suggests that the presence of soul atoms alone does not enable us to determine if beings are alive or dead, asleep or awake, as well as what kind of animal they are. The difference between living things is not a difference in kind, but degree: it depends on the amount and ratio of soul atoms flowing in and out.[58]

So, when does life begin according to Leucippus and Democritus? The answer is that what separates living from non-living things is their ability to breathe, rather than simply having a soul. Respiration, not soul, marks the limit of life. And what distinguishes different forms of life? Thus far, we have taken both breathing and soul out of the equation. The ability to breathe is shared by all living beings and thus does not separate humans from animals and animals from plants. Soul, in turn, does not even separate the living from corpses. We shall now examine whether specific psychological faculties may be used as a criterion to differentiate forms of life.

5 Thinking and Perceiving

Taylor argues that among the few things we can state with a fair amount of certainty about Leucippus and Democritus' views concerning the soul are, first, that it

inhalation of similar particles. If so, the shortness of breath, either temporary or permanent, occurs in cases of excessive outflow (cf. Taylor 1999, 127).

56 Aristotle criticizes Democritus for failing to explain what causes a complete, as opposed to partial, loss of soul atoms and simply making the general claim that this happens naturally in old age or unnaturally with violence (*Resp*. I 2, 472a16-26 = DK 68 A106 = LM 27 R29a-b). On Democritus' views on death and dying, see Warren 2002a, and Taylor 2008.

57 Democritus was known for believing that the dead might come back to life (Procl. *In Rep*. II 113, 6–9 = DK 68 B1 = LM 27 143). More likely, this means that one could mistake those bodies that are asleep – namely, beings that have expelled part of their soul atoms and have temporarily decreased respiration but nonetheless have enough soul atoms to reincrease the breathing rhythm – for those bodies whose number of soul atoms falls below the limit for respiration and thus life.

58 The very fact that all atoms are constantly moving (e.g., Aet. 1 12 6, 1 23 3 = DK 68 A47 = LM 27 52–3), but soul atoms are exceptionally fast owing to their shape and size confirms that atomic compounds are only different in degree. We thank our anonymous referee for this point.

distinguishes living things from the non-living and, second, that it is somehow connected with sensation and thought (1999, 200). In the previous section, we challenged the first claim. We shall now focus on the relation among being ensouled, thinking and perceiving, and the extent to which sensation, mind, and more generally psychological activity might help us distinguish between animate and inanimate, on the one hand, and different kinds of animate beings, on the other hand.

Democritus was reputed to liken soul, mind, and sensation.[59]

> **T23:** For soul and mind are the same thing. This (the mind) is made of the first and indivisible bodies and it is mobile because of their smallness and shape. And Democritus says that among the shapes that which moves more easily is the spherical one, and mind and fire are of this kind.[60] (*DA* I 2, 404a27-29 = DK 68 A101 = LM 27 D130, modified)

Mind and soul are the same in that they are both made of spherical, swiftly moving atoms (cf. *Resp*. I 4, 472a7-8 = DK 68 A106). In his commentary to the *De Anima*, Philoponus writes that soul and mind are in turn similar to the senses (Phil. *DA* 35 12 14 = DK 68 A105). Thus, the link between soul, sensation, and mind is firstly material – that is, they are all constituted by the same stuffs.

Between mind and senses, there is also an identity of process. The atomist theory of perception is most thoroughly discussed by Theophrastus (*Sens*. 49–83 = DK 68 A135).[61] Sense-perception occurs when atoms are released from the surfaces of sense-objects in the form of εἴδωλα, atomic films,[62] and are carried through air and affect the atomic structure of our sense-organs.[63] All perceptual states are therefore grounded in the contact between the atoms emitted by the perceived object and the atoms of the perceiver.[64] Thought

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59 For an alternative account, according to which the objects of sense-perception are separate from the objects of thought, see Plu. *Adv. Col*. I 110e; S.E. *Adv. Math*. VII 135–139 (DK 68 B9-11 = LM 27 D14); D.L. IX 72 (DK B117 = LM D24). According to Galen, mind relies on and yet battles with the senses (Gal. *Exper. Med*. 15 7 5 = DK B125 = LM D23a).

60 Ψυχὴν μὲν γὰρ εἶναι ταὐτὸ καὶ νοῦν, τοῦτο δ' εἶναι τῶν πρώτων καὶ ἀδιαιρέτων σωμάτων, κινητικὸν δὲ διὰ μικρομέρειαν καὶ τὸ σχῆμα· τῶν δὲ σχημάτων εὐκινητότατον τὸ σφαιροειδὲς λέγει· τοιοῦτον δ' εἶναι τόν τε νοῦν καὶ τὸ πῦρ. Cf. *DA* I 2, 405a8-13 = DK 68 A101 = LM 27 D133; Aet. 4 5 12.

61 See LM 27 D22, D64-67, D69, D134, D147, D157–159, R21, R25, R46, R55–57, R59–60, R62.

62 On εἴδωλα in the specific case of vision, see D.L. IX 44 (DK 68 A1 = LM 27 D13); Aet. 4 13 1 (DK 67 A29 = LM 27 D145). Theophrastus also uses the term ἀπορροή, stream, both for sight (*Sens*. 80–1) and smell (82).

63 A thorough discussion of the atomist theory of perception is beyond the scope of this paper. The most detailed analysis is Sassi 1978. On sight, see Rudolph 2011. That the same process applies to all senses is suggested by Aetius (4 8 5–10 = DK 67 A30), according to whom no psychological activity happens without the impact of εἴδωλα (Sassi 1978, 51).

64 Aristotle takes this to imply that touch is primary, and the other senses are somehow connected to this (*Sens*. IV, 442a29-b3 = DK 68 A119 = LM 27 R54 – cf. Theophr. *Sens*. 55 = DK A135 = LM D157).

appears to function in a similar way, with atomic streams impacting on mind atoms (Cic. *Ad Fam.* 15 16 1).[65]

Whether and how thought can be differentiated from perception is debated. Similarly, how the Atomists explained why some perceivers are able to think, whereas others merely sense, is unclear. Perception depends on two factors: the perceiver and the atoms penetrating the body. If so, the first difference between sensation and thought may lie in the body of the perceiver. The perceiver should have the relevant sense organs: for example, the eyes for sight. The organ of thought, however, is difficult to identify. There is limited evidence suggesting that, according to early Greek atomism, thought takes place in the head or the chest (Aet. 4 4 6, 4 5 1 = DK 68 A105 = LM 27 D135). Yet most of our sources, including Lucretius, attests that the finer atoms constituting mind and soul are in fact scattered throughout the whole body (*DRN* III 370–374 = DK 68 A108 – cf. S.E. *Adv. Math.* VII 349 = DK 68 A107). This would then suggest that the ability to think cannot depend on a specific organ in the body of the perceiver.[66]

The second way to separate thought from senses is by looking at the kind of atomic film impacting on the body. Lucretius, for example, distinguishes different kinds of εἴδωλα, finer ones reaching the mind and coarser streams stimulating the senses (*DRN* IV 728–731). According to this interpretation, however, there is not much the perceiver can do to be able to think, rather than simply sense.

A third, and more promising, account comes from Theophrastus.

> **T24:** Concerning thinking, Democritus said this much: it happens when the soul is in equilibrium after movement, but whenever someone becomes hot or cold all round it changes. Thus, the ancients spoke well when they said that this is "to have thoughts that are other". So that he clearly makes thought a result of the mixture of the body, which is surely consistent with his theory, for he makes the soul a body.[67] (Theophr. *Sens.* 58 = DK 68 A135 = LM 27 D134 modified)

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65 According to Taylor, sense-perception is connected to thought because it provides the data for the mind to explain (1999, 221). On senses as the starting point of knowledge, see also Sassi 1978, 213. According to Sassi, Democritus distinguishes levels of reality, but instead of separating the sensible from the intelligible, he separates subjective appearances from objective atomic reality (1978, 223).

66 On the location of thought in the brain, see English 1915, 223. Arguing for thought atoms in the whole body is Bicknell 1968. According to Bicknell, the identification of thought with a restricted part of the body is a feature of Epicurean atomism. This makes Lucretius' account especially valuable and reliable, as he was evidently aware of the difference between fifth-century Atomists and the Epicureans, who located fine thought atoms in the brain (*DRN* IV 722–748).

67 Περὶ δὲ τοῦ φρονεῖν ἐπὶ τοσοῦτον εἴρηκεν, ὅτι γίνεται συμμέτρως ἐχούσης τῆς ψυχῆς μετὰ τὴν κίνησιν· ἐὰν δὲ περίθερμός τις ἢ περίψυχρος γένηται, μεταλλάττειν φησί. Διὸ καὶ τοὺς παλαιοὺς καλῶς τοῦθ' ὑπολαβεῖν, ὅτι ἐστὶν 'ἀλλοφρονεῖν'. Ὥστε φανερόν, ὅτι τῇ κράσει τοῦ σώματος ποιεῖ τὸ φρονεῖν, ὅπερ ἴσως αὐτῷ καὶ κατὰ λόγον ἐστὶ σῶμα ποιοῦντι τὴν ψυχήν.

Theophrastus explains that thinking occurs when the soul is balanced and the body is neither too cold nor too hot.[68] According to Aristotle in T18 and T23, the same swift spherical atoms forming the soul also constitute fire and produce heat. Life is said to depend on such atoms flowing in and out of the body, and Theophrastus' account suggests that thinking happens when soul atoms are in equilibrium (συμμέτρως). By contrast, a loss of equilibrium coincides with some kind of madness.[69] The claim that thinking is a matter of *balance* offers further support to the suggestion that between living beings and living faculties there are no differences in kind, but only in degree. This reading is in line with the claim that perception partly depends on the perceiver – that is, on the atomic balance of their soul. Moreover, it leaves open the possibility that the internal soul atoms ratio might be modified and improved through education, and perhaps regimen and diet.[70]

From Theophrastus' account of the Atomist theory of thought, we can draw two conclusions. First, in order to be able to think, living beings must develop the right soul ratio. Not only, therefore, does the number of soul atoms determine whether an animal is awake and alive, rather than asleep or dead, but it also affects its psychological activity. Second, the difference between those beings that think and those that are solely able to perceive does not coincide with the differences among humans, animals, and plants. Rather, it depends on the number and ratio of soul atoms. If these two conclusions are correct, the soul atoms in some plants may be so balanced as to enable them to think. For this reason, Democritus is included in the list of philosophers who allow for the possibility of finding traces of understanding and reason in non-human life (T1-3). All living beings (ζῷα) may have a share of mind atoms in their bodies, including those animals that find themselves 'in the ground' – plants.

This leads us back to the case of sleeping and dying. Sense-perception also fails to separate living beings from the non-living. For example, sensory activity occurs at night, with εἴδωλα penetrating bodies and prompting them to dream (Ar. *Div. Somn.* 464a5-17; Aet. 5 2 1 = DK 68 A136 = LM 27 D151; Plu. *Quaest. Conv.* 734f-375c,

68 The connection between heat, soul and thus all living beings shows that the Atomists did not link heat with male and female with coldness (cf. Ar. *GA* I 18,723a24-26 = DK 31 B65 = LM 22 D172). Philolaus, too, describes both male and female life as a balance of hot and cold (Anon. Lond. 18, 20–29 = DK 44 A27 = LM 12 D25). On the Presocratic theories of sex differentiation, including Democritus', see Ar. *GA* IV 1, 763b20-765b6.

69 On deranged thinking, see also Ar. *DA* I 2, 404a27-30 (DK 68 A101 = LM 27 D133). On συμμετρία of atoms in the soul producing cheerfulness (εὐθυμία), see Stob 3 1 210 (DK 68 B191 = LM D226).

70 In Stob. 2 31 65 (LM 27 D403), Democritus argues that education modifies the configuration (μεταρυσμόω) of a human being – which seems to refer to the configuration of atomic particles (ῥυσμός, Ar. *Met.* I 4, 985b4-20 = DK 67 A6 = LM 27 D31; Simpl. *In Phys.* 28, 4–27 = DK 67 A8, 68 A38 = LM 27 D32). See also Vlastos 1946, 54–5; Warren 2002b, 71–2 n. 126; Johnson 2014. We could wonder whether Democritus would have considered the possibility of educating animals, as Pythagoras was believed to do (Porph. *VP* 23–24, Iamb. *VP* 60–61).

682f-683b = DK 68 A77 = LM 27 D152-153). As mentioned above, the Atomists conceive of sleep as a temporary and partial deprivation of soul atoms, which nevertheless does not prevent animals from sensing. An even greater loss of soul atoms causes death. Yet corpses, too, have a minimal share in sense-perception (T21).[71] Overall, not only is the general state of being ensouled unable to distinguish between different lifeforms, but the specific psychological makeup and the specific psychological faculties also appear to be the same, at least to a certain extent, for plants, animals, and human beings.

6 Conclusion

We set out to answer two questions: What is the Atomists' theory of the beginning of life? And how did the Atomists disambiguate the forms of human, animal, and plant life?

With respect to the first question, we found that beings come to life after the body is formed, when they start breathing. Respiration marks the beginning of life. The second question was motivated by several perplexing reports about the Atomists' views on various lifeforms, notably the report that all living beings – including plants – possess reason and understanding. We sought to understand what reasons, if any, the Atomists might have had for not drawing sharp distinctions among various forms of life, especially since other philosophers in the fifth-century BCE were willing to do so. We found the following: the difference between living and dead, sleeping and awake, humans, animals, and plants, as well as thinking and perceiving is neither a difference of process nor of kind, but one of number and degree. Soul atoms flow in and out of all kinds of things. Hence, non-living things, too, can have a minimal share in soul. A greater number of soul atoms is found in bodies that are simply asleep, and an even greater number enables bodies to breathe, wake up, and come to life. When the inflow and outflow of soul atoms is in equilibrium, living beings can think, rather than simply sense. The Atomists do not draw lines between different kinds of lifeforms from each other. Rather, they view the natural world and living beings as akin and interrelated.

Two final remarks are in order. First, although between thought and perception there is substantial overlapping, these two faculties are not identical. Thinking and perceiving depend on various factors: the right balance of soul atoms, the right organs, and perhaps even education. This may well imply some kind of distinction, and arguably even hierarchy, between those beings that

71 Soul atoms may also be found in stones (Albertus Magnus, *On Stones* 1 1 4).

think and gain genuine knowledge, and those that are merely able to perceive via the senses. Yet the hierarchy is not one of lifeforms. For example, plants too may have the same atomic ingredients for thought (T1-3). Second, the body still has an impact on what we can do: for example, to breathe one needs lungs. Thus, while we might find soul atoms in tables, tables will never breathe and come to life, regardless of the amount and balance of soul atoms within them. This leads us to back to embryology. Although there are no fixed criteria separating different forms of life, the body is a direct copy of the parents. This explains why the generative process does not keep producing new and different species with different psychological faculties. Overall, we do not argue that in early Greek atomism there were no distinctions whatsoever among various forms of life. We argue, rather, that the Atomists were more interested in the commonalities among various forms of life.

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