

# **Vital Heat, Conception and Development**

**in**

**Aristotle**



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Thesis submitted for the degree of D.Phil  
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### Abbreviations used

I have generally followed the standard abbreviations of those of Aristotle's works which I have used:

<u>Categories</u>	(Cats)
<u>Posterior Analytics</u>	(Post An)
<u>Topics</u>	
<u>Physics</u>	(Phys)
<u>De Caelo</u>	
<u>On Generation and Corruption</u>	(GC)
<u>Meteorology</u>	(Meteor)
<u>De Anima</u>	(De An)
<u>Parva Naturalia:</u>	
<u>Sense and Sensibilia</u>	(De Sensu)
<u>On Memory</u>	(De Mem)
<u>On Sleep</u>	(De Somno)
<u>On Length and Shortness of Life</u>	(On Length)
<u>On Youth, Old Age, Life and Death and Respiration</u>	(On Youth)
<u>On Breath</u>	
<u>History of Animals</u>	(HA)
<u>Parts of Animals</u>	(PA)
<u>Generation of Animals</u>	(GA)
<u>De Motu Animalium</u>	(De Motu)
<u>On Plants</u>	
<u>Mechanics</u>	
<u>Problems</u>	
<u>Metaphysics</u>	(Meta)
<u>Nicomachean Ethics</u>	(NE)
<u>Eudemian Ethics</u>	(EE)
<u>Politics</u>	(Pol)
<u>Poetics</u>	

## Vital Heat, Conception and Development in Aristotle

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### Abstract

In this account of the part that heat plays in the conception and development of living substances according to Aristotle, I begin by examining the concept of heat. I discover that Aristotle uses a distinction between *to thermon* and *thermotes*: the former is, in living substances, material; the latter is never material, being the powerful aspect of heat. For example, an animal possesses heat (*to thermon*) which maintains it through its power (*thermotes*) to concoct.

I then turn to the biological works. Conception, it seems, does not fit the standard account of change, but is rather a concoction, performed by the heat of the semen. Nor is the usual account of conception ascribed to Aristotle adequate: I attempt to demonstrate that he held a more moderate account in which *pneuma*, the nature of which is *to thermon*, is transmitted to the embryo.

I then examine the development of the embryo, which is performed using *to thermon* as a tool. The transmission and development of the rational *psuche* in particular has often caused problems: I offer an account of the transmission of *psuche* from parent to embryo, and describe the part that *pneuma* plays in this transmission and in the development and operation of the various levels of *psuche*. Development extends from foetal development until adulthood, and this poses another problem for the standard account of change as it appears to be neither substantial nor accidental change, yet these are apparently exhaustive possibilities. I conclude that development, like conception, is a concoction performed by the vital heat.

Finally, I turn to the conception and development of spontaneously generated animals, and of abnormal animals such as monsters. I demonstrate the relationship between these generations and sexual generation, and the significance of heat and *pneuma*.

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## Introduction

The result of Aristotle's labours in the field of science is sometimes said to have been the stultification of science for the following two thousand years. While this is not entirely unfair, it ought to be pointed out that it was not his doing; indeed, such a result is contrary to the spirit of his science. However, as a result, Aristotle's biology has not received as great attention as some of his other works. Because, as Russell writes, 'ever since the beginning of the seventeenth century, almost every serious intellectual advance has had to begin with an attack on some Aristotelian doctrine'<sup>1</sup>, the renaissance of scientific endeavour has meant that most of Aristotle's work has been rejected - and, to be fair, superseded - by modern scientists. Modern scientists now rarely read Aristotle, and if they do, it is in the spirit of historical curiosity. The gradual increase in biological knowledge since Aristotle meant that full-scale attacks on his biology in order to advance were unnecessary, but even so, the rejection of Aristotle as an authority has been almost complete. This includes his biological works, despite the fact that here his claim to scientific relevance is perhaps greatest: some of his discoveries and observations have only recently been acknowledged.<sup>2</sup> And because of the growing divide between intellectual disciplines, philosophers have chosen to concentrate on the ethical, political and metaphysical aspects of his work. As a result of these factors, Aristotle's biology has been, to quite a large extent, ignored.

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<sup>1</sup> Russell (1961) p.173.

<sup>2</sup> See Peck (GA) p.viii-xi

Recently, however, there has been a change in this trend; his biological works are being reexamined and reexplored, not so much to learn about biology - for it is undoubtedly true that many (though by no means all) of his observations are wrong, or imperfect - but to learn about his metaphysics. A large part of the Aristotelian corpus is biological in orientation, and it seems a great omission that certain sections of the rest have been pondered over at great length, while the biology has been forgotten. This tendency, fortunately, is coming to an end; this thesis is part of the reexamination of Aristotle's biological works, on the assumption that the examination of the biological works can provide some insight into other aspects of his thought.

In this introduction, I shall briefly mention some of the problems that a too hasty attempt to join the more metaphysical works and the biological works can raise. Some of the solutions that I hope to offer to these problems will merely demonstrate that slightly different concepts must be used in biology and in metaphysics; in other cases, that study of the biology will reveal possible solutions to other problems; or that such study suggests that some of the basic assumptions made in solutions to the metaphysical problems must be revised.

### The standard account of change

Central to Aristotle's system is the distinction between substance and attribute: substances have ontological priority; the identification and reidentification of members of other categories (those of attributes) rests on the identification of primary substance. Now, there are two accounts of primary substance in Aristotle:

1/ the Categories view, in which examples of primary substance are Socrates, and that horse, and the distinctive mark of substance is that 'what is numerically

one and the same is able to receive contraries”<sup>3</sup>; that is, it is a reidentifiable subject of change.

2/ the more complex view of the Metaphysics, where that which is substance in the primary sense is form. Here we are told that the distinctive marks of substance are unity, 'thisness' - potential or actual - and separability; there seem to be several senses of 'substance'.<sup>4</sup>

On either account primary substance possesses a 'nature', i.e. an internal principle of change.<sup>5</sup> The use of the notions of change and persistence through change in characterising substance is very important, as is the dependence of nonsubstantial categories upon the category of substance, for in this we can see the basis of the standard account of change offered to us by Aristotle.

Change, he argues in Physics I 4-7, involves three elements: two contraries and a substratum. Change in both the substantial and the nonsubstantial categories can be accounted for in this way. Consider:

a lump of bronze comes to be a statue

a man comes to be pale.

In these examples, the bronze and the man act as substrata; they are the matter of the change in that they persist throughout the change; what changes is the form that applies to the matter. In the first example, which is of substantial change, the matter changes from being (relatively) formless to having the form of the statue. In the second example, nonsubstantial change, the man comes to possess an accidental

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<sup>3</sup> Cats 5 4b17-18

<sup>4</sup> Meta VII 3 1029a28, VIII 1 1042a25-33

<sup>5</sup> Phys II 1 192b12-20, b32-34. This is an important link between the Physics and the biological works.

form which he did not previously possess; from being not-pale he comes to be pale. Simplistically, in substantial change, matter persists while the substantial form changes, i.e. is replaced by another; in nonsubstantial change, the individual substance persists and an accidental form changes, i.e. is replaced by another.

Aristotle has distinguished between

- i/. X comes to be                      and
- ii/. X comes to be y.

Suppose X is Socrates: there clearly is a distinction to be drawn between the changes involved in Socrates coming into existence, and in Socrates turning pale, or getting fatter.

He further distinguishes between

- iii/. X comes to be from P            and
- iv/. X comes to be Y from (being) Q.

Strictly, only substances are said to come to be in the sense of (i) above; they come to be from matter (iii).<sup>6</sup> And substances can alter without ceasing to exist (ii/ above); in this case, for example, Socrates comes to be pale from being not-pale (iv).

Aristotle lists four types of cause involved in each substantial change: 1/ that out of which a thing comes to be and which persists, i.e. the material cause; 2/ the formal cause, that is, the form of the thing coming to be; 3/ the efficient cause, which is what we would ordinarily call the cause, e.g. the father is cause of the

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<sup>6</sup> Phys I 7 190a33

child; 4/ the final cause, which is that for the sake of which a thing comes to be.<sup>7</sup>

For example, consider again the case of bronze being made into a statue by a craftsman: the material cause is the bronze; the formal cause is the form of the statue, as thought by the craftsman; the efficient cause is the craftsman himself; and the final cause is that for which the statue is made. In the case of the generation of animals, the final cause is the new individual, and the formal cause is its form; hence these two causes are the same, in a sense. The form is of the same type as, if not actually identical to, the form of the parent, which is the efficient cause. The material cause is, of course, the matter of the new individual.

By insisting that every change involves some persisting thing, the material cause, Aristotle avoids contravening the rule 'nothing comes from nothing'. The material from which the statue, for example, comes to be, was present before the statue, persists throughout the generation and the existence of the statue, and will persist after its destruction. In this sense, the statue does not come to be from nothing. The statue potentially exists before the occurrence of the change which brings it into being, in that the matter has the statue-form potentially, although not yet actually. Indeed, Aristotle equates matter with potentiality, and form with actuality, and defines change as the actualisation, or bringing into being, of that which is only potential.<sup>8</sup>

Thus, from his distinction between substantial and nonsubstantial categories, Aristotle derives two corresponding types of change:

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<sup>7</sup> Phys II 3 194b23-195a3; Meta V 2 1013a24-b3. The last is an important aspect of causality in the biological works.

<sup>8</sup> Phys III 1 201a10

'the substratum is one thing and the affection whose nature is to be predicated of the substratum another, and either of them can change. So it is alteration when the substratum remains ... but change occurs in the affections which belong to it ... when, however the whole changes ... it is a case of generation'.<sup>9</sup>

In accidental change, the individual remains throughout the change but the form of white, say, is exchanged for that of black. The individual is the underlying matter of the change, the form of white is the privation, and the black is the form involved in the change. And in substantial change, for example, a bronze bowl being melted down and remoulded into a bronze statue, the bronze is the underlying matter, the bowl-form the privation, and the statue-form the form involved in the change.

### Change and the living organism

This account of change seems straightforward, and clearly substance and change are allied notions; yet when living things are considered, which are paradigm substances, it apparently fails. Growth, for example, in the sense of development of a living thing, not just increase in size, seems to be neither a substantial nor a nonsubstantial change. It involves the acquisition over time of various properties or capacities which might be thought to be essential properties in the sense that they are part of the essence of that species: for example, the ability to reproduce, generating an animal of the same species X; or, in the case of man, the development of the rational *psuche*. If the definition of man is 'rational animal', then these properties are part of his essence. Yet the change involved in the gain of

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<sup>9</sup> GC I 4 319b8-17

these properties is not obviously either substantial or accidental change: but Aristotle's metaphysics has set these up as exhaustive possibilities.

Intuitively, it would seem that in the development of an animal, the individual persists throughout the change; however, on the standard account of change just outlined, that means that the gain of a property such as rationality is an accidental change, and this is unsatisfactory, since if an individual comes to possess a property F, and by that change comes to possess all the properties essential to being an X, then the individual comes to be an X: a substantial change, surely. But substantial change is also unacceptable as an account of development, for in a substantial change the individual existing before the change is not identical with the individual existing after it, as the substantial form identifying the first individual no longer informs that matter; they are different substances. Yet we would agree that the boy and the man are the same substance, i.e. the same human being. We must suppose that the developing creature already has, in some sense, the substantial form identifying it as of type X, although it does not yet have all the properties essential to being X. In Physics II 1, Aristotle argues that the nature - in the sense of internal principle of change - that a living substance necessarily possesses throughout its existence is identical with the substantial form. If this is so, then growth cannot be easily classified as substantial or accidental change: this weakens the apparently axiomatic substance-accident distinction, if true.

This will be one recurrent theme: that the standard account of change is inappropriate for those changes occurring to living substance, such as conception and growth; the account that I shall argue for is one of concoction and perfection of potentialities.

Aristotle's general account of change is in terms of matter, form and privation; this is not, as we shall see, wholly satisfactory when applied to conception, which is the natural place to locate substantial change - conception is just too complex. If we consider mankind, which should be paradigm examples of living things, we see that man has three 'levels' of *psuche* or form to be imparted, and that two different principles are involved in generation, the semen and the catamenia. This is not so in the examples and analogies which Aristotle uses to explain change in general, and which are all of change involving these three principles. Although mankind is a peculiarly complex example, having the divine element of rationality, which may or may not be an independent substance, or tied to the body as the other capacities are, the difficulties are not restricted to mankind as examples of living things; other organisms come to be, develop and decay as well. More detailed examination of this account and of the four-cause analysis of the mechanism of change as applied to lifechanges is needed, but at first glance, it seems that this account may be over-simple, properly fitting accidental and substantial change with respect to artifacts only, which are not, strictly, substances at all, lacking as they do an internal principle of change.

I have mentioned two kinds of change: change by nature and change by art. Aristotle discusses another, change by chance, or spontaneity, which will have a bearing on my subject matter.<sup>10</sup>

'Of things that come to be some come to be by nature, some by art, some spontaneously'.<sup>11</sup>

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<sup>10</sup> Phys II 4 195b32-3; II 5, 6; Meta XI 8; VII 7 1032a13; XII 3 1070a5-9

<sup>11</sup> Meta VII 7 1032a11

While in some of these passages, Aristotle is thinking in terms of mutually exclusive possibilities, in the biological works it is clear that some of the natural things that come to be are spontaneously generated: flies coming into existence in cowpats, for instance, or lice in a wound. However, it also appears that these things are of a kind, that is, they are members of a species; the problem which arises here, of course, is how to explain how, if an individual has no parents, and no apparent formal cause, it can come to be at all, and how it can come to be of a similar kind to other individuals formed in the same way, when there is no relation between them.

### The pyramid of perfection

Aristotle's universe is an orderly one, and he often ranks various beings and attributes, in several different ways.<sup>12</sup> Everything has its place, and that of the Deity is at the top of the pyramid. In what follows, I will take mankind as my main example, both because man is the most complex animal in the Aristotelian world, and also because Aristotle sees men as the most perfect, and certainly as the most important animals. The reason for this is man's possession of rationality. Contemplation is the chief good, and the activity of the Deity<sup>13</sup>; hence, those beings which can reason are more perfect than those which cannot. The ability to reason is characteristic of man and is his peculiar defining function.

Man is described by Aristotle as the most perfect of the contingently existing things apparently because:

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<sup>12</sup> De An II 3 414a32-b20; HA VIII 1 588b4-12; GA I 23 731a30-b5; II 1 731b28-31, 732a4-10; Meta IX 9 1051a4-21, XII 7 1072a27; NE X 7 1177a20

<sup>13</sup> Meta XII 7 1072b23-5

'the nature of man is the most rounded off and complete, and consequently the qualities or capacities ... are found in their perfection'.<sup>14</sup>

There is very clearly an ascent towards the more complex forms of life. Even within the class of animals there are degrees of perfection; Aristotle points to the different types of reproduction as indications of these differing degrees:

'those animals are viviparous which are more perfect in their nature ... the more perfect animals are those which are by their nature hotter and more fluid and are not earthy'.<sup>15</sup>

Heat clearly is a mark of perfection. Certainly hot blood is better for intelligence, and the most perfect being is intellectual. Moreover, man is the hottest of the animals, and the heat within his heart is purest.<sup>16</sup>

Within mankind, too, there are degrees of perfection; male and female are distinct in the most perfect of the classes of animals.<sup>17</sup> This is because

'as the proximate motive cause, to which belong the definition and the form, is better and more divine in its nature than the matter, it is better also that the superior one should be separate from the inferior one. That is why wherever possible, and so far as possible, the male is separate from the female, since it is something better and more divine in that it is the principle of movement of generated things, while the female serves as their matter'.<sup>18</sup>

Why should Aristotle believe that the male is more perfect than the female?

The answer, I think, must lie in the primary assumptions that Aristotle makes.

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<sup>14</sup> GA II 4 737b16, b27; HA IX 1 608b6-8

<sup>15</sup> GA II 1 732b28-33

<sup>16</sup> GA II 6 744a29; PA II 2 648a9; presumably the Deity is of no temperature, being immaterial.

<sup>17</sup> GA IV 1 763b22

<sup>18</sup> GA II 1 732a3-10

These involve the belief that right is in some sense 'better' than left; up than down; male than female; front than back; hot than cold; form than matter.

This ranking within the species is also related to heat; Aristotle supposed women to have colder blood than men, and to this deficiency he attributes various differences between the sexes.<sup>19</sup> For example, because women are colder, they cannot concoct blood properly and hence fail to produce semen, producing only the catamenia. Presumably he holds that the semen is hotter than the catamenia; certainly he holds that it is the semen which imparts the (higher levels of) form. It is vital heat which makes semen productive, and the complexity of form that one can impart (to residues or to the embryo) is directly related to the degree of vital heat that one possesses.<sup>20</sup>

These beliefs, that heat is needed for reason, and that women are colder than men, could be used as justification of his belief that women are less able to reason than men. He does not himself explicitly use this, and perhaps for good reason: he holds that both male and female slaves are less rational than female freemen.

### Heat and *pneuma*

Heat is clearly important as a measure of rank in the Aristotelian hierarchy, and is closely linked with another element in the Aristotelian theory which must be briefly described in order that the connection and complexity of the issues may be grasped; this is the concept of the connate *pneuma*. This is material, though not, perhaps, of the common four elements (earth, air, fire and water), and serves in the explanations of movement, reproduction and sensation. My interest in it is due to

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<sup>19</sup> GA IV 6 775a7

<sup>20</sup> GA I 8 718a24; II 3 736b33-5

its importance in the explanation of conception, to its connection with *psuche* and its identification with vital heat.

Briefly, *pneuma* appears to be intimately connected with semen - indeed, to be the chief element in it - and involved in the transmission of *psuche*, and in particular it crops up in On the Generation of Animals (GA) II 3 as part of the solution to the problems involved in the explanation of the entry of reason into the embryo.

*Pneuma*, or the nature in it, is said to be analogous to the element of the stars, and is said to be more divine than the usual group of elements<sup>21</sup>; this may also be the only passage where Aristotle offers a material basis for reason. This may well illuminate the issue of the relationship between body and *psuche*; indeed, this whole passage in which *pneuma* is identified with vital heat is interesting, and will be further discussed. I shall argue that in conception the mother provides the nutritive, and the father the sensitive, *psuche*; the father also provides sufficient vital heat or *pneuma* for the realization of the rational *psuche*. This is an unorthodox interpretation; it is usually thought that the father was held to impart the whole of the form, while the mother provided matter alone.

However, before coming to discuss the role of heat and *pneuma* in biological change, I must attempt to clarify the nature of heat. This I shall do in the first chapter.

It is also necessary to be clear about *pneuma*, heat and the fifth element. Some authors, e.g. Peck (1945) and Solmsen (1957: 19), have assigned special powers to *pneuma*, which enable it to perform all the functions that Aristotle claims that it does. Balme objects to this interpretation. He writes:

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<sup>21</sup> GA II 3 736b30-737a1

'Nor does Aristotle credit *pneuma* with the special powers that his medical contemporaries postulated. He defines it simply as 'hot air' (GA II 736a1), and confines its role to actions that can be explained from the natural properties of heat and air.'<sup>22</sup>

While I do not want to claim that *pneuma* has all the special powers that have been assigned to it, I do want to point out that *pneuma* cannot be simply identical to air, not even to 'hot air'.

All water contains *pneuma*; this will be a significant part of the explanation of spontaneous generation. We should note that air is not present in, and cannot remain in, water:

'water contains no air (for whenever air is generated within water it rises to the surface)'.<sup>23</sup>

Therefore air and *pneuma* are not equivalent.

Indeed, they cannot be, for the powers that *pneuma* possesses, such as generation, are not possessed by air, nor by ordinary heat. These powers are due to the special nature of the heat possessed by connate *pneuma*.<sup>24</sup>

On the other hand, I do not want to identify vital heat and *pneuma*, as Solmsen does.<sup>25</sup> He identifies the two, saying that *pneuma* is hot air; and he holds that the semen contributes material, a *physis* analogous to the *aether*. Though I, too, will argue that the male makes a material contribution, I think that 736b36 is to be taken seriously: vital heat is the nature of the *pneuma*, not strictly identical to it.

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<sup>22</sup> Balme 'Teleology and Necessity' (1987) p.279

<sup>23</sup> De Sensu 5 443a5; On Youth 8 471a3-6. Note that this is *aer* not *pneuma*.

<sup>24</sup> On the heat in *pneuma*, see chapter I.

<sup>25</sup> Solmsen (1957)

'All have in their semen that which causes it to be productive; I mean what is called vital heat. This is not fire nor any such force, but it is the *pneuma* included in the semen and the foamlike, i.e. the natural principle in the *pneuma*, being analogous to the element of the stars.'<sup>26</sup>

*Pneuma* is hot air, of a rather special sort, and the heat is vital heat.

### A note on the texts used

As will become clear, I have relied chiefly on the biological works, and on the Meteorology; however, Meteor IV and parts of History of Animals have been considered spurious by most commentators.

It is commonly accepted that HA I-VI are mostly the work of Aristotle, while VII-X are controversial in varying degrees.<sup>27</sup> I have assumed that I-IX are satisfactory: however, I rarely refer to the later books, and put no weight on them. If we follow Huby, who suggests that the works of Theophrastus were used to compile VIII and IX, and that the biology of Theophrastus largely consisted of comment on that of Aristotle, then they are not in any case so very far from Aristotle.

HA X I I find very interesting, but have assumed that it is spurious. It has been referred to once or twice, but for its curiosity value, not as evidence for my thesis.

Balme's articles are very interesting on this subject, though regrettably I shall not have enough space to discuss them thoroughly.<sup>28</sup> In an unpublished article, he

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<sup>26</sup> GA II 3 736b34-737a1

<sup>27</sup> Aubert and Wimmer rejected VII and IX, followed by Dirlmeier, who claims that VIII 1 is from Theophrastus; D'Arcy W. Thompson says that VIII 21-26 are alien; Joachim holds that IX is not authentic. See Huby (1985).

<sup>28</sup> Balme (1985) and unpublished. See bibliography.

holds that what we call HA X does not belong to HA, but is not sure that it is unAristotelian.

The objections that are made to its acceptance as Aristotelian are that it argues that the female contributes sperm in generation; that it uses *pneuma* in a way thought to be unAristotelian; and that its vocabulary and style are unAristotelian. I am not equipped to comment on the last of these, but, following Balme, shall point out, contra the other objections, that the use of *pneuma* is not unlike Aristotle's use. Balme does not specify the similarity, but the only use made of *pneuma* in HA X is that it draws in the semen; this is very similar to the use made of it in De Motu 10 where it explains the tensing and relaxing of sinews and muscles.

With respect to the objection that HA X holds that the female contributes sperm, Balme argues that the book is a demonstration that the female contributes to generation. Whether this was so or not was an ancient debate: the flowerpot or furrowed field theory - that woman is but a vessel, earth for the seed provided by the male to grow in - was common, so before Aristotle can argue for his account of generation, he needs to establish that there is a female contribution to generation. GA hardly touches on this point, concentrating on different debates (e.g. pangenesis and the preformation against epigenesis argument). So Balme concludes that something like HA X is a necessary preliminary to GA; that it was written before GA, and possibly belongs as part of the Problems.

Interestingly, in another article<sup>29</sup>, Balme writes that wherever a generation theory is indicated in Meta or Phys<sup>30</sup> it differs from that in GA, being more like the

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<sup>29</sup> Balme (1962)

<sup>30</sup> Phys I 7 190b4; II 4 196a31; II 8 199b7; Meta IX 7 1049a1; XI 9 1058b23; XIV 5 1092a32, GA sometimes uses similar phrases, but they are later corrected: e.g. IV 1 765b10-15.

flowerpot theory. Clearly the view expressed in Meta was Aristotle's view before he went into the matter thoroughly.

As for Meteor IV, I have followed Düring and Furley in holding that there is no reason to suppose that it is not genuine. Düring, for instance, believes it to be genuine but misplaced: it does not belong to the meteorologic course but is a separate lecture, closely related to GC; Furley holds that it is a prolegomenon to the biological writings.<sup>31</sup>

The chief objection to acceptance of Meteor IV is that it is inconsistent with other passages in GC and Phys which reject the theory of pores held by Empedocles and Alcmaeon. Gottschalk, who holds that this book is not Aristotelian, maintains that pores are used to account for three kinds of phenomena: chemical change proper, such as hardening and softening, and concoction<sup>32</sup>; compression<sup>33</sup>; and various qualities of some substances, such as breakability.

Furley, in response, argues that as long as it is accepted that the Meteor IV pore theory does not include the existence of a void, there is no inconsistency with Phys IV on compression. And the qualities explained by the pore-theory are similar to the account of compression: there is an unexplained assumption of the mutual force of repulsion between hot and cold, and a slight conceptual confusion in Aristotle as to whether the hot and the cold are concrete substances or stuffs. In the next chapter, I shall discuss this question; here it is sufficient to note that since these are

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<sup>31</sup> Düring (Aristotle's Chemical Treatise 1980); Furley (1983)

<sup>32</sup> Gottschalk (1961); Meteor IV 3 381b1; IV 8 385a29; IV 9 385b19, b24, 387a19; cf. IV 7 384b10

<sup>33</sup> Meteor IV 9 386b2

in several cases bodies, not qualities, pores are necessary, and clearly not empty in any strict sense.

Does the Meteor IV pore theory involve the existence of a void? There is no reason to suppose so; as Furley points out, even Gottschalk is prepared to accept a weak sense of 'empty' with respect to empty pores. Thus the pores may be empty qua pores, but actually filled with matter in the real world: a soaked sponge has full pores by comparison with a dry one, which has empty pores.

Düring also says that there is no mention of the Empedoclean theory of pores in Meteor IV. If we examine the passages in Meteor IV where Aristotle speaks of pores, we find that they are channels in porous substances through which a substance consisting of small particles could trickle, e.g. pottery<sup>34</sup>; or cavities filled with air, e.g. sponge<sup>35</sup>; or they explain the crystalline or fibrous condition of certain substances.<sup>36</sup> These are the pores under discussion in Meteor IV. (Elsewhere, *poroi* is used of natural ducts.<sup>37</sup>)

In the following pages, then, I shall accept Meteor IV as genuine; indeed, I shall regard it as an important and interesting text, which is closely related to the biological works.

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<sup>34</sup> Meteor IV 8 385a29; cf. HA VIII 2 590a24; Meteor II 3 358b35; GA II 6 743a8

<sup>35</sup> Meteor IV 9 386b2-7

<sup>36</sup> Meteor IV 9 386a15, 387a2, a19

<sup>37</sup> HA III 11 518a2; GA II 7 747a11; IV 4 773a14; V 3 782b2

## Heat

What is heat, according to Aristotle? It is now thought to be a form of energy arising from the random motion of molecules, which can be transmitted by conduction, convection or radiation; it has been thought to be an elastic material fluid.<sup>1</sup> Did Aristotle believe heat was in some sense substantial or material, that it was a force, or that it was some other thing - perhaps qualitative? One way of establishing this, since he nowhere tells us very clearly about its nature or essence, is to examine the way in which it operates, and to compare it with its contrary, cold.

Perhaps the first question to arise is whether heat is substantial or not. From GC we know that the hot is one of the four principles that between them bring about the four elements, which in turn compose the material bodies of the sublunary world.<sup>2</sup> We also know that primary substances are individual material objects (men, trees ...)<sup>3</sup>; it is clear that the hot is not one of these. Rather, it underlies them in the sense that it is an agent in the production of - or perhaps a component of - their matter. So is it a stuff, like bone, or blood? Or is it rather a quality possessed accidentally by other stuffs, which may be replaced by its contrary, cold, in certain circumstances?

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<sup>1</sup> e.g. by Black, Lavoisier and Laplace in the eighteenth century. This view was held until the middle of the nineteenth century, concurrently with the mechanical interpretation of Rumford and Davy.

<sup>2</sup> GC II; see also On Length 5 466a21; PA II 1 646a17; II 2 648b10

<sup>3</sup> Cats 5 2a12-15

A distinction between *thermon* and *thermotes*

I suspect that there may be a difference in the way that Aristotle uses *to thermon* and *thermotes*, his most common words for heat, and that this difference may be important in understanding Aristotle's theory of heat. (It is true that he uses another word (*alea*) for heat, but in fact this reduces to very few problem passages. Mostly, it describes the effect of the warm weather<sup>4</sup>, and once or twice something desired by man or animals<sup>5</sup>; the odd passages are in PA, where it is produced in the bone marrow, and in the head.<sup>6</sup> None of these is very important.)

On examination of the occurrences of these words, I believe that *to thermon* is, in some passages (though not all, and Aristotle does not draw an explicit distinction), to be understood as 'the hot stuff', and *thermotes* as the power possessed by that stuff. Indeed, a further distinction can be made: *to thermon* appears sometimes to be a peculiar stuff, i.e. the hot stuff, of which there is but one kind, and such that a hot individual has some of this stuff, and at other times it appears that *to thermon* is merely the hot stuff under discussion, that is, the stuff (water, say, or blood) which happens to be hot at the time of discussion. I suspect that whenever *to thermon* is of the first kind, Aristotle is referring to the hot stuff in the heart, that is, the vital heat of animals, which is responsible for their proper functioning (including reproduction), and which is analogous to the stuff of the stars;

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<sup>4</sup> Meteor I 3 341a20; I 10 347a20; I 12 348b4; IV 1 379a27; On Youth 10 472a31; HA IV 6 531b16; V 8 542a25; VI 16 570a23; VIII 13 598a1; PA IV 5 680a30; GA III 2 753a23; [Prob] I 9 860a14; I 20 861b24; II 28 869a14; II 30 869a32; II 33 869b38; V 40 885a19; XXIII 9 932b19; XXVI 16 939b9; Meta VI 2 1026b34

<sup>5</sup> NE VII 4 1148a8; EE III 1 1229b5; GA III 11 761b8; HA V 16 548b26

<sup>6</sup> PA II 6 652a8; IV 10 686a12. See below, fn.48.

if so, where *to thermon* is of the second kind, it should be inanimate heat which is being discussed.

By examining the occurrences of *to thermon* and *thermotes* we can see that it is usually *to thermon* (or *thermon*, without the article) that is responsible for hardening, drying, melting, and solidification, and hence the production of bodies.<sup>7</sup> Only thrice is *thermotes* used for such an action: once in Meteor IV 3, where he is discussing the species of concoction and inconcoction (ripening, rawness, boiling and scalding, roasting and its opposite)<sup>8</sup>; again in Meteor IV 12, where he is discussing the production of homoeomerous parts of the body<sup>9</sup>; and in GA IV 4 772a29.

In these passages in Meteor, the action has failed because of a lack of *thermotes*. For example, scalding is due to a lack of *thermotes* in the surrounding liquid<sup>10</sup>, and failure to roast is due to a deficiency of *thermotes* in the external fire (since roasting is due to the *thermotes* of fire rather than that of liquid).<sup>11</sup> An example of a different type: rawness is due to a lack of natural *thermon* - in milk, for example - relative to the amount of the wet present. So, due to this lack of natural *thermon* the milk remains unaffected by *thermotes* even though it would usually be

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<sup>7</sup> Meteor IV 2 380a5; III 1 380b18; IV 6 383a1-4, 383a9, a16, a29, 383b10, b15; IV 7 383b17, 384b4, b11-15; IV 8 384b24, 385a25, a31; IV 9 387a27, b15; IV 10 388a24, a33, 388b12, 389a9; IV 11 389a28; IV 12 390b4; GA II 1 735a1; V 3 783a33, b1

<sup>8</sup> Meteor IV 3 380b7, b10

<sup>9</sup> Meteor IV 12 390b2-13; GA II 6 743a5

<sup>10</sup> Meteor IV 3 381a15-19

<sup>11</sup> Meteor IV 3 381a24, a28, 381b17

affected by it<sup>12</sup>; the *thermotes* is unable to master the matter (milk). Elsewhere in the corpus, similarly, deficiency in *thermotes* causes failure in concoction.<sup>13</sup>

These passages evidently refer to a lack of power in the agent, due to a deficiency of *to thermon*. In the first case, the lack is in an outside agent; in the second, the lack is in the object itself, since it is self-concoction (bringing to maturity) that is being discussed.

This would help to explain how it is that fire, which is an excess of *thermon*, and a sort of boiling<sup>14</sup>, can fail to heat something adequately; it may not be powerful enough. It might be objected that fire is an excess of *thermotes* and hence that *thermotes* is substantial, not a power, but in this passage he goes on to explain that the sort of boiling that fire is, is a boiling of *thermon*, and that boiling itself is an excess of *thermotes*.<sup>15</sup> *to thermon* is the essential property of fire.<sup>16</sup> So the stuff that boils (*to thermon*) is substantial and boils because it has too much *thermotes*; instead of merely radiating heat, or containing it within its own bounds, it is caused to seethe. When it has insufficient *thermon*, it has insufficient *thermotes*, and so does not transmit enough to concoct adequately some other object.

The other passage mentioned above is Meteor IV 12 390b2-13, where we are told that *thermotes*, *psuchrotēs* and the motions set up by these are sufficient to form flesh and bone, since solidification is due to *to thermon* and *to psuchron*, and

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<sup>12</sup> Meteor IV 3 380b10

<sup>13</sup> PA III 5 668b12; GA IV 1 766a20; IV 7 776a3; V 4 784a33; V 5 785a18

<sup>14</sup> Meteor I 3 340b24

<sup>15</sup> GC II 3 330b26

<sup>16</sup> De Sensu 4 441b12

these parts are distinguished by differentia produced by *thermon* and *psuchron* and the combination of their motions.

On a superficial reading, this passage might be thought to say that it is *thermotes* and *psuchrotes* that perform these actions. However, we should note that these are produced by *thermon*, *psuchron*, and the combination of their motions. Far from being counterevidence, this passage provides us with a clue to the relationship between the two.

Meteor IV 1 378b15, the other passage where *thermotes* is spoken of as producing these differentia, is similar. We are told that there are four causal factors (the active ones, i.e. the hot and the cold, and the passive, i.e. the moist and the dry) yielding four elements. The confirmation of this, says Aristotle, is that it is always *thermotes* and *psuchrotes* which change things; clearly these are the powerful aspects of the hot and the cold.

These passages do not, I suggest, disprove the claim that it is *to thermon* and not *thermotes* which is responsible for hardening, drying, melting and solidification, and hence for the production of bodies, and are not, therefore, evidence against the suggestion of a distinction between *to thermon* and *thermotes*. Clearly, *thermon* and *psuchron* interact in some way to produce some agent, which I believe to be *thermotes/psuchrotes*. This, though, requires further argument.

Only *to thermon* is ever used to describe the elemental quality of the Hot<sup>17</sup>; it is *to thermon* which rises<sup>18</sup>, being a constituent of fire and air<sup>19</sup>, and usually *to thermon* which causes things to rise<sup>20</sup>, although in some cases it is *thermotes*.<sup>21</sup>

The first of these exceptions refers to the *thermotes* in the exhalation leaving it, being dispersed or quenched by rising to a great height, and causing the exhalation to cool as a result of the loss of *to thermon*. Now, I cannot see why *to thermon* should be extinguished by approaching its natural place; it would be far better understood by supposing that it is the power of *to thermon*, *thermotes*, which is 'used up' by causing the exhalation to rise so high.

The second passage is also talking about vapour rising due to *thermotes*, and here we learn that the vapour is like a burden too heavy for the *thermotes*, and hence it falls again. This too is best read as discussing the power of *thermotes*. Further confirmation of this view is lent by passages which show that while it is *thermon* that is a constituent of fire, it is *thermotes* that is produced by fire in an object.<sup>22</sup>

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<sup>17</sup> GC II 2 329b24, 330a26-29; Meteor I 3 340b16; III 6 378b12; IV 1 378b22, 379a1; IV 8 385b3; IV 10 388a24; On Length 5 466a22

<sup>18</sup> Meteor I 3 341a8; I 4 342a15; II 4 360b34; II 9 369a22; On Sleep 3 456b22, 457b16, b21, b25, 458a2

<sup>19</sup> GC II 3 330b2; II 4 331a6-b32; Meteor I 3 340b25, b28; I 4 341b12, b15; I 7 344a11; III 3 372b30; IV 1 379a30; De Sensu 4 441b12; GA II 2 735b30

<sup>20</sup> Meteor I 4 341b12; I 9 347a8; I 12 348a20; On Youth 13 474a14; PA II 7 653a6

<sup>21</sup> Meteor I 9 346b26; I 10 347a33

<sup>22</sup> Meteor II 3 358b8; IV 11 389b4; PA III 9 672a5

Of the other heats in Aristotle's cosmos, *thermotes* is used of sunheat (far more commonly than *alea*, and once in conjunction with it<sup>23</sup>) and environmental heat<sup>24</sup>, including that of the earth<sup>25</sup>, that from fire<sup>26</sup>, and that transmitted from above.<sup>27</sup> But again, *thermon* is occasionally used of external heat.<sup>28</sup> However, this use never describes environmental heats: once it is of the hot in fire, causing roasting, and in the other case, he gives an example of boiling causing drying and contrasts this with internal *thermotes* doing the same. It is clear that in these two cases he is referring to heat imposed from outside as part of a skill.

Once or twice he says that the stars are hot and radiate *thermotes* (though he does seem a little undecided<sup>29</sup>). But it is indubitably *thermotes* that is produced by movement<sup>30</sup>; of the heavenly bodies and of more lowly bodies.

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<sup>23</sup> Meteor I 3 341a12, a20, a24, a30; I 14 351a31; II 4 359b33; II 5 362a6; II 8 367b22; II 9 369b25; On Sleep 3 457b31; GA II 3 737a4 (Meteor II 8 367b28 the heat - *to thermon* - of the moon)

<sup>24</sup> Meteor I 9 346b26-8; I 10 347b4; IV 1 379a17-18, a22, a32, a35; IV 3 381a23; IV 11 389a26, b6-7; GA II 6 743a35; III 11 762b14; V 3 782b29; V 4 784b7; V 6 786a12; V 7 788a17

<sup>25</sup> Meteor I 14 351a31; II 4 360a17; II 5 362a5; II 9 369a25; GA III 2 752b33, 753a20; but cf. II 4 360b32 (*thermon*)

<sup>26</sup> Meteor IV 3 380b24; IV 11 389a26, b3, b20

<sup>27</sup> Meteor I 3 340a21, 341a24, a30; I 9 346b26

<sup>28</sup> Meteor IV 3 380b18; IV 5 382b24

<sup>29</sup> Meteor I 3 340a28; cf. I 3 341a33

<sup>30</sup> Meteor I 3 340b14, 341a13, a20-1; GA I 18 724b36

natural heat, *thermon* and *thermotes*

Natural heat is referred to in Meteor both as *thermon*<sup>31</sup>, and as *thermotes*.<sup>32</sup> On looking at these passages, we can see that the three places where he refers to natural heat as *to thermon* are by way of definition: maturity is produced by *to thermon* (and immaturity by its failure). Those passages where heat is *thermotes* speak of *thermotes* as mastering the matter, determining the concoction and initiating the process of maturation. The one passage that doesn't, says that the failure to reach maturity is due to a deficiency in *thermotes*, and this can quite easily be read as saying that there was insufficient power to master the matter present. So I claim that there is a difference in the usage of these words: *to thermon* is possessed by the animal, and *thermotes* is produced by this, and is (directly) responsible for the living processes that go on in the animal (or plant, of course). *to thermon* is of course also responsible, but is further back in the causal chain.

Elsewhere in the Aristotelian corpus, *thermotes* is the word used most often to discuss the natural heat of the animal<sup>33</sup>, though it is the inner *thermon* that must be preserved.<sup>34</sup> Moreover, sometimes Aristotle refers to inner *thermon* or the *thermon*

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<sup>31</sup> Meteor IV 1 379a24; IV 2 379b19; IV 3 380a23, a31, 382b20

<sup>32</sup> Meteor II 2 355b10; IV 1 379b8; IV 2 379b22, b25, b33, 380a2, a8; IV 3 380a20; IV 3 381b8; IV 5 382b18, b20, b25

<sup>33</sup> For example: Meteor II 2 355b10; IV 1 379b7; IV 2 379b22, 380a4; IV 3 381b8; De An II 4 416b30; On Youth 4 469b8, b12, b15; 5 470a20, 12 473a9; 13 474a25; PA II 2 649a1; II 3 650a15; II 7 652b27; III 7 670a24; IV 5 681a8; GA II 1 732a19, b32; II 2 735b34; II 3 737a4, a7; II 4 739a11, b23; II 6 743a20, a27-30, b27-30, 744a29; II 7 747a19; III 1 750a10, 752a2; III 11 762a20, b7, b13, b15, 766a35; IV 2 766b34; IV 4 772a24; IV 6 775a7; IV 7 776a3; V 3 783b30; V 4 784a35, b5, b8, b26; V 5 785a35; V 6 786a11, a20

<sup>34</sup> On Youth 4 469b20; 5 470a6-8; 10 472b3; 15 475b5; 23 478b32, 479a8; 24 479a32

of the animal<sup>35</sup>, elsewhere to that of other substances<sup>36</sup>; in the first set of passages Aristotle is certainly referring to some substance which is centred in the heart and maintains the life of an animal. So what is meant by the natural *thermotes* of an animal? And what by *thermon* of other substances? I shall return to the second question, so should first ask whether there is any distinct use of *thermotes* here, perhaps in some causal sense, or whether this too refers to some substance, located in the heart.

On examination, it can be seen that most of these passages speak of *thermotes* as an agent of generation and development, and as an agent in digestion; here its causal nature is clear. The *psuche* uses *thermotes* as an instrument (740b32) to perform many necessary functions<sup>37</sup>, including formation of the uniform parts<sup>38</sup>, conception<sup>39</sup>, movement<sup>40</sup> and perception.<sup>41</sup> *thermotes* is generated by nourishment<sup>42</sup>, i.e. by concoction<sup>43</sup>; its cause is in the heart.<sup>44</sup> The heart contains *thermotes* and

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<sup>35</sup> De An II 4 416b29; De Sensu 3 442a5; On Sleep 2 456a10; 3 456b22, b28, 457b2, 458a27; On Dreams 3 461a6; On Length 5 466a18, b32; On Youth 4 469b12, b18; 5 470a7, a22; On Youth 10 472b2; 11 472b14, b16, 472b30, b34; 12 473a14; 14 474b29; 15 475a4, 475b5, b9; 26 479b20, b24; 27 480b5; PA II 4 651a11; II 7 653b6; II 8 654a5-7; III 4 666b6, 667a18, a27, 667b26; III 6 669a37; III 9 672a16; IV 5 681a4; GA II 1 732a21; II 1 733a8; II 2 735b34; 3 736b35; III 1 751b7; III 4 755a20

<sup>36</sup> Meteor IV 1 379a24; IV 2 379b19; IV 3 380a22, a33, b2; IV 5 382b22, b24

<sup>37</sup> De An II 4 416b30; GA II 4 740b30

<sup>38</sup> GA I 8 718b19; II 6 743a5, a20

<sup>39</sup> GA I 21 729b27; IV 4 772b4; IV 10 777b29

<sup>40</sup> PA IV 5 681a6; IV 13 697a27

<sup>41</sup> De An III 1 425a7

<sup>42</sup> On Dreams 3 461a14; On Youth 26 480a4; PA III 10 672b19, b27

<sup>43</sup> Meteor IV 11 389b7-8; PA III 9 672a8

passes it through the body<sup>45</sup>, and the more *thermotes* an animal possesses, the stronger and more perfect it is.<sup>46</sup>

Other passages tell us that all animals possess *thermotes*; if all animals possess *to thermon*, and this produces *thermotes*, then this use is obvious. The remaining passages are rather more specific: there is *thermotes* in the heart, where it is purest, and it is cooled by the brain; it is not fire; nutriment produces it. That *thermotes* is not fire is not a problem; we know that fire is an excess of *to thermon* and a boiling of *thermotes*. That it is produced by the nutriment is also not a difficulty; nutriment permits the animal to stay alive and perform its various functions. That there is *thermotes* in the heart is not surprising, since *to thermon* is also to be found in the heart; but that *thermotes* is purest in the heart and tempered by the coolness of the brain may need some explanation. An excess of *thermotes* can kill a living organism; consider fevers. Since the heart is the hottest part of the body, and is the store of *to thermon*, it is liable to overheat, producing too much *thermotes*, and so causing the systems of the body to overload. An excess of *thermotes* can cause death if the surrounding *thermon* is excessive<sup>47</sup>, so it must be counteracted by a cold

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<sup>44</sup> On Youth 4 469b10; PA III 7 670a24

<sup>45</sup> PA II 7 652b21, b27; II 9 654b10; II 10 656b5; III 4 667a3; GA II 6 743b27, 744a29

<sup>46</sup> On Youth 14 474a26; 19 477a17; PA IV 10 686b29; GA ! 19 726b34; II 1 732b33; IV 6 775a7

<sup>47</sup> On Youth 5 469b28; 14 474b20. On fevers: On Dreams 2 460b10-11; 3 461a21-3; On Youth 23 479a25

organ, which happens to be the brain.<sup>48</sup> The mechanism of this cooling, how the *thermotes* can be cooled without extinguishing *to thermon*, I intend to discuss later.

In at least one passage it is the flow of *to thermon* which, being reversed in sleep, is responsible for the loss of perception, while others tell us that *thermotes* is necessary for perception.<sup>49</sup> Again, in the biological works at least, it is *to thermon* in the heart which is essential for life, and which must be preserved, and the *thermotes* which is produced by it which is responsible for many of the powers of the *psuche*. The more heat, the more powerful the *psuche*: animals with lower capabilities have little of *to thermon*.<sup>50</sup>

There are passages where it is *to thermon* which is responsible for growth<sup>51</sup>, and others where it is *thermotes*.<sup>52</sup> More specifically, and importantly, both are used of concoction.<sup>53</sup> In the passages on growth it is noticeable that those where *thermon* is mentioned are all general statements, along the lines of '*to thermon* promotes growth'. In the other passages, the statements are far more particular: '*thermotes* is

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<sup>48</sup> *alea* is used of bodily heat in two passages: PA II 6 652a8; IV 10 686a12. In the first of these cases it results in concoction of the blood. The second is surprising: we learn that the blood of the head is suitable for producing warmth for the brain as well as quiet and accuracy for the senses. It is surprising because the brain is a cold counterpoise to the heat of the heart; perhaps the point is that despite this, it must have some warmth in order to operate.

<sup>49</sup> On Dreams 3 461a6; De An III 1 425a7

<sup>50</sup> On Youth 15 474b28, 475b9

<sup>51</sup> De An II 4 416b29; De Sensu 4 441b29, 442a5; PA II 7 653a31 III 6 669b3; GA V 8 789a7

<sup>52</sup> GA I 8 718b19; II 4 740b33; V 8 789a5-9

<sup>53</sup> *thermotes*: Meteor IV 3 380b8, 381a16; IV 11 389b8; PA III 5 668b12; III 9 672a22; GA III 2 753a19; IV 1 766a19; IV 6 775a18; V 4 784a34, b26  
*to thermon*: Meteor IV 2 379b12; PA III 7 670a21; IV 3 677b32; IV 5 682a24; GA V 6 786a17

the cause of the nature of skin and hair' or 'it forms the shell'.<sup>54</sup> So I do not see these passages as problematic for my suggestion that there are two uses of these words. As for the passages about concoction, it is interesting to note that the words accompanying *thermotes* are much more direct: 'is effected by' 'is formed by' 'acts on' and so on, while those accompanying *thermon* are 'aids' 'the effect of is' 'works by means of' and so on.

Those passages where both are used throw strong light on the relationship. For example, digestion is due to *thermotes* in environs which are *thermon*<sup>55</sup>, and:

'what produces digestion is *to thermon*; that is why everything that has *psuche* in it possesses *thermotes*'.<sup>56</sup>

This adds weight to the claim that *thermotes* is the powerful aspect of heat, as does PA III 9 672a22, which says that the kidneys can concoct better if they are fat, because fat is *thermon* and *thermotes* causes concoction.

The higher creatures have more *thermotes* and lungs with more *thermon*; lungs with little blood have little *thermotes*<sup>57</sup> - since blood and *to thermon* are closely allied, this is not surprising. And, as I said above, the animals with less of *to thermon* have fewer capacities of *psuche*. The fact that we can have excess *thermotes* due to fevers needs some explanation,<sup>58</sup> though it may be no more than extra powers of heat in that one feels hotter to the touch than usual, sweats more,

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<sup>54</sup> GA I 8 718b19; V 6 786a19-20

<sup>55</sup> Meteor IV 3 381b8

<sup>56</sup> De An II 4 419b29-30

<sup>57</sup> On Youth 7 470b20, b24-6; 19 477a17-20; PA IV 13 697a28

<sup>58</sup> On Youth 23 479a24

suffers from delirium due to the excessive action of the perceptive faculties, and so on.

As for those passages which speak of *to thermon* of substances that are not animals, I do not believe that they provide counterexamples to this distinction either. They discuss drying (as an object's own heat leaves, its own moisture evaporates), and concoction, produced by an object's own heat.

We are told that bodies are *thermon* because manufactured by *thermon*, but bodies contain *thermotes* because they have been concocted.<sup>59</sup> And clouds contain *thermotes* because of *to thermon*.<sup>60</sup> But then, bodies formed by *thermon* contain *thermotes*<sup>61</sup>; there is no conflict here.

Things are dried by their internal *thermon*, which evaporates the moisture (if there isn't too much of it), the *thermotes* being driven out by the surrounding cold.<sup>62</sup> Non-recognition of the difference in usage of these two words obscures an important detail: neither the Lee translation nor the Webster see that though the drying is done by the inner *thermon*, it is the *thermotes* which is lost, and this is an important part of the explanation of cooling.

Cooling, we are told, is deprivation of *thermotes*.<sup>63</sup> From certain passages, it seems quite clear that *to thermon* and *to psuchron* can be cooled and heated: for example, GC I 6 322b15 says that *to thermon* gets cool and then warm again (not

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<sup>59</sup> Meteor IV 11 389a28, b8

<sup>60</sup> Meteor I 11 347b25-28; III 1 371a2

<sup>61</sup> Meteor IV 8 384b24-28

<sup>62</sup> Meteor IV 5 382b22

<sup>63</sup> GA II 6 743a36

that these two change into one another<sup>64</sup>). So, how does it work? I suggest that though the quasi-substantial nature of *to thermon* remains unchanged, that is, it does not reduce in quantity, the power of its *thermotes* is diminished by the presence of the cold; and the power of the cold is similarly and simultaneously diminished by the presence and the powers of the hot. I have suggested that the capacity of *thermotes* can be 'used up'; here I suggest that this can happen in trying to master the opposing quality, the *psuchrotes*. If it fails, then the hot loses all or most of its power and may be, quite literally, ousted. (This is what appears to happen in the Meteor passages. See below, fns. 77-82). A fire can resist extinction due to the supply of *thermotes* which it possesses.<sup>65</sup> The earthy stuff in the nourishment contains little *thermotes*, and so becomes cooled while the moist evaporates with *to thermon*.<sup>66</sup> The cold is concentrated by the surrounding *thermotes*.<sup>67</sup> And Meteor IV 8 384b28 tells us that some bodies contain *psuchrotes* in so far as they lack *thermotes*. If these are understood simply as being the powers or capacities possessed due to the possession of a substance, which itself is not transferred, then there is no problem of transference of some 'caloric fluid'. When the powers are mastered, then the substance has become of another kind: not because its matter has changed, but because its essential, formal quality has altered. The relationship between this quality, the substance, and the powers it possesses is of a rather peculiar nature, and I shall return to this later.

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<sup>64</sup> GC II 1 329a32. Nor, I should point out, do *thermotes* and *psuchrotes* (GC I 6 322b16).

<sup>65</sup> On Youth 5 470a14

<sup>66</sup> GA II 6 743a14

<sup>67</sup> Meteor I 12 348b7, b15; II 4 361a1

Senses of *to thermon*

'Hot [*thermon*] is that which associates things of the same kind ... while cold is that which brings together, i.e. associates homogeneous and heterogeneous things alike'.<sup>68</sup>

Things are called hotter in several ways ... Is then the term hot used in one way or in many? To answer this we must ascertain what special effect is attributed to a hotter substance, and if there be several such, how many these may be. A body then is in one sense said to be hotter than another, if it imparts a greater amount of heat to an object in contact with it. In a second sense, that is said to be hotter which causes the keener sensation when touched, and especially if the sensation be attended with pain ... Again, of two bodies, that is the hotter which the more readily melts a fusible substance, or sets on fire an inflammable one. Again, of two masses of one and the same substance, the larger is said to have more heat than the smaller. Again, of two bodies, that is said to be the hotter which takes the longer time in cooling, as also we call that which is rapidly heated hotter in its nature than that which is long about it - as we call something contrary if it is at a distance, similar if it is nearby ... In some of the bodies which are called hot the heat is derived from without, while in others it belongs to the bodies themselves ... it is plain that cold is not a mere privation but a fact of nature.'<sup>69</sup>

Before turning to examine these ways in which 'hot' is used, I should point out that Aristotle is looking at effects attributed to hot substances: a hotter substance interacts in a different way with other substances, suggesting that the important capacity of *to thermon* is a power, a potential for action.

Aristotle here distinguishes five ways in which *to thermon* is used. The first two concern interaction between bodies that are hot, and the rest concern properties of one hot body alone. We learn that *to thermon* is that which heats, whether perceived or not, and that it is that which causes certain reactions in other substances. We are also told that it is possessed in virtue of size, and that bodies

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<sup>68</sup> GC II 2 329b26-30

<sup>69</sup> PA II 2 648a36-649a20

are called hot if their retention or absorption of heat are good. Some of these are clearly 'derived from without', such as the absorption of heat, while others depend on the possession of natural *thermotes* (and here that heat is possessed in virtue of size is the chief example). I shall discuss the relation between internal and external heat later, but shall first look at the more important of these senses of hot.

### I: temperature; the nature of the hot and the cold; privation

First, then, the idea that the hot is that which causes certain reactions in other substances (and here it is *to thermon* that is under discussion). The hot is one of the four basic principles, and reacts primarily with the cold, its contrary, and secondarily with the other principles, which are passive in comparison with the hot.<sup>70</sup> So if its main reagent is the cold, what is the relation between hot and cold? Such sentences as 'lack of heat implies ... the presence of cold'<sup>71</sup> tell us only that they are contraries. What we want to know is whether they are contrary qualities, contrary powers or contrary 'substances', and whether Aristotle recognised them as degrees of one underlying thing, temperature.

Do we have any evidence for the idea that he recognised hot and cold as degrees of the same thing? There are some passages that might be offered as such, but they are far from conclusive. For example:

'All this makes it clear that bodies are formed by heat and cold and that these agents operate by thickening and solidifying. It is because these qualities fashion bodies that we find heat in all of them, and in some cold in so far as heat is absent'.<sup>72</sup>

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<sup>70</sup> GC II 2 329b24-26; see Joachim (1903-4).

<sup>71</sup> Meteor IV 3 381a15; IV 1 379a19; IV 8 384b29

<sup>72</sup> Meteor IV 8 384b24-29

This passage may suggest that the fact that cold and heat are related as degrees of some one thing has been recognised. However, it might also be read as saying that the absence of heat leaves 'room' which is necessarily filled by the contrary stuff, cold: both, after all, are called agents, suggesting that they are different.

Then again, the idea that contraries refuse to be coupled 'for it is impossible for the same thing to be hot and cold'<sup>73</sup> might suggest that Aristotle sees them as black/white, with no shades of grey, in which case we could conclude that he had no concept of a single scale of temperature. But all that is meant here is that something cannot possess both the contraries; there is no reason to suppose that an intermediate is impossible. In fact Aristotle later discusses intermediacy:

'Now since there are differences of degree in hot and cold, then although when either is actual without qualification, the other will exist potentially; yet, when neither exists in the full completeness of its being, but both by combining destroy one another's excesses so that there exist instead a hot which (for a hot) is cold and a cold which (for a cold) is hot; then there will exist neither their matter, nor either of the contraries in actuality without qualification, but rather an intermediate'.<sup>74</sup>

However, this passage may have to be read as saying that the intermediates are a mixture of two distinct things, one of which is cooler and one of which is hotter than the absolutes, since they have affected each other, but still two: 'there exist a hot which is cold and a cold which is hot'. Can we say that these are in fact one?

Later in the same section we are told again that each contrary is potentially the other:

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<sup>73</sup> GC II 3 330a31

<sup>74</sup> GC II 7 334b8-13

'the actually hot is potentially cold and the actually cold potentially hot; so that hot and cold, unless they are equally balanced, are transformed into one another ... the hot becoming cold and the cold becoming hot when they have been brought to the mean. For at the mean is neither hot nor cold. The mean, however, is of considerable extent and not indivisible'.<sup>75</sup>

This certainly suggests that there is a process by which one becomes the other, with no moment at which one can say now there is hot and one moment later there is cold.<sup>76</sup> The mean is the range of intermediate temperatures, which are, strictly speaking, neither hot nor cold.

In descriptions of the reactions between the hot and the cold, we are told that the hot is expelled by cold<sup>77</sup>, compressed by cold<sup>78</sup> and extinguished by cold<sup>79</sup>; it can be counteracted by cold<sup>80</sup>, lost by evaporation<sup>81</sup>, and, generally speaking, it can leave and return.<sup>82</sup> This does not sound very much as if Aristotle has a concept of the hot and the cold as two aspects of the same thing, temperature.

Yet there are other passages which suggest that perhaps he is working towards such a concept. One such is the discussion of the heart cavities.<sup>83</sup> The heart has,

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<sup>75</sup> GC II 7 334b22-28

<sup>76</sup> On it being a process, see GC I 7 324a12.

<sup>77</sup> Meteor I 4 342a1, a21; IV 6 383a19; IV 8 385a25; IV 10 388b22, b28; PA II 4 651a8-11; GA V 3 783a16

<sup>78</sup> Meteor I 10 347b7; IV 5 382b10; On Youth 26 479b20-25. Similarly, the cold can be concentrated or compressed by the hot: Meteor I 12 348b7, b15; II 4 361a1

<sup>79</sup> De Sensu 2 437b17

<sup>80</sup> De Sensu 5 443b16; On Sleep 3 457b16

<sup>81</sup> Meteor II 3 359a32; IV 6 383a30; GA II 2 735b35

<sup>82</sup> Meteor III 1 371a2; IV 1 379a24; IV 6 383a28; IV 7 383b31, 384b9; IV 10 389a24

<sup>83</sup> PA III 4 667a1-6

according to Aristotle, three cavities, of which the right hand one has the hottest blood, and the left hand one the coldest. The central cavity is intermediate in heat. However, none of the cavities are actually cold, and the heart is the hottest of the organs.<sup>84</sup>

Another passage is one of the discussions of eggs: birds produce an external hard egg, because they are hot, and selachia produce an internal soft egg, because they have less heat. That is, they produce an egg because they are cold, and it is internal because they are moist. Moreover, there are animals which are colder still.<sup>85</sup>

Again, Aristotle often tells us that the male is hotter than the female; he also says that the female is colder.<sup>86</sup>

In all these passages, his language might suggest that he recognises degrees of heat, and that whatever is less hot is colder; hence that if everything were ranked according to degree of hot and cold, they could be ranked on one scale, according to temperature.

And, perhaps most importantly, he speaks in GC II 6-7 of the measurement of amounts of hot and cold: at 333a25, of relative cooling effects, at 333a34 of heating effects; and at 334b10-14 of an intermediate being proportionately twice as hot in potentiality as cold. While he does not see how measurement of temperature is possible according to a quantitative standard, these passages do perhaps indicate that the notion of a single scale of measurement was emerging.

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<sup>84</sup> De Sensu 2 439a2

<sup>85</sup> GA I 10; I 11 718b37; II 1 733a7, b1-11; III 1 751a25-752a9; III 3 754a33

<sup>86</sup> On Length 5 466b17; GA IV 1 765b16; IV 6 775a7

So there are indubitably degrees of hot and degrees of cold<sup>87</sup>; are these degrees of the same thing? I think not, for there is at least one passage which suggests that the cold must have a nature of its own<sup>88</sup>, and this is confirmed by the argument in GC for four principles rather than two. If hot and cold (or wet and dry) were perceived by Aristotle as poles of a single scale, then his four principles would reduce to two. However, that Aristotle does not recognise hot and cold as degrees of a single thing, temperature, does not mean that they are two distinct material substances.<sup>89</sup> So, the next question to be discussed is the nature of the hot and the cold.

Aristotle's vocabulary certainly seems to suggest that heat and cold are material in some way: he talks about heat departing, being driven out, being expelled and entering. Now, it seems clear that the hot, and even heat, cannot exist without matter. But the relation between *to thermon* and *thermotes* is not identity, and so although I have assumed that there is some matter peculiar to *to thermon*, that does not mean that *thermotes* has some matter peculiar to it; there is no reason why it might not be some potency or quality transferred from matter to matter in some way. This will, I hope, become clear.

Is there any analogy between the relations of hot and cold, and of wet and dry? We are told that the relation between the wet and the dry is like that of a dish and its condiments, because the wet is easily determined and the dry determined with

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<sup>87</sup> See also Cats 8 10b26-28; Phys V 2 226b3-4

<sup>88</sup> De Caelo II 3 286a24; see also PA II 2 649a20

<sup>89</sup> I am in disagreement with Düring (Aristotle's Chemical Treatise e.g. p.60; he points to Meteor IV 1 379a22; GA II 6 743a36): while I agree that Aristotle recognises that heat and cold are relative qualities, it doesn't follow that he has a general idea of temperature.

difficulty. The wet is what makes the dry determinable, and each serves as a sort of glue to the other.<sup>90</sup> What is the meaning of 'determinable' here? The use of the condiment analogy suggests that varying amounts of wet (condiment) added to the dry (dish) make the results vary (taste different). This in turn suggests that the moist and dry are related as two distinct entities, but need not suggest that they are two different substances. After all, varying amounts of white added to black produce varying results.

It might be objected that these two (wet/dry) form the matter of all bodies<sup>91</sup>, so it would be impossible to draw a comparison between this and the hot/cold relation, as might be useful here. I don't think that it is impossible, because although there is a difference in potency between the four principles, due to their differing in form, the parallels between the various contrary relations are the same. Moreover cold is in some sense the matter of all bodies.<sup>92</sup> So what can we say about the hot and the cold? Other than that varying amounts of one added to the other give differing results, we can say very little. This is because we do not know which of the two Aristotle regards as the more determinable. The dry is more difficult to determine because it holds its own shape well, but this does not help with the hot/cold relation, and nor do the parallel definitions for hot and cold, which state that the hot associates things of the same kind, and the cold brings things together regardless of their kind.<sup>93</sup> All we can say is that hot is more active than cold, which, I suppose, may mean that it is less easily determined, being more potent (that is, being

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<sup>90</sup> Meteor IV 4 381b29-31

<sup>91</sup> On Youth 20 477b24

<sup>92</sup> Meteor IV 11 389a29 (*psuchrotes*)

<sup>93</sup> GC II 2 329b26-30

stronger, rather than having more possibilities). Are these mere assumptions, or is there something more behind this part of the theory - and if there is more, what does it mean?

Lloyd says that hot is clearly the positive term, cold the privation.<sup>94</sup> This he finds surprising, given that Aristotle does not define the hot and the cold in such terms, points out the ambiguities in use of 'hot' and of 'cold', and describes the arguments between previous thinkers as to which things are hot and cold. I am not so sure that the passages Lloyd indicates suggest that cold is merely a privation so clearly. Though it is true that heat is more active than cold is, both are active qualities. Immediately before one passage (286a25), for instance, where Aristotle does indeed say that 'the positive is prior to its privation (warm, for instance, to cold)', he said:

'if one of a pair of contraries naturally exists, the other, if it is really contrary, exists also naturally, and has a nature of its own (for the matter of contraries is the same)'.<sup>95</sup>

So cold, at least, is more than merely the privation of heat; it 'has a nature of its own'. Moreover, as was said above, if cold is merely a privation of heat, Aristotle's four principles would reduce to two.

But this needs closer examination, for there is something interesting here. In the early books at least, Aristotle seems prepared to recognise only one type of privation: that in which a substance lacks some property which it should have by nature. In Cats 10, he says that things are opposed in one of four ways: as

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<sup>94</sup> Lloyd (1966) p.61; De Caelo II 3 286a25; GC I 3 318b16-18; Meta XII 4 1070b11; cf PA II 2 649a20

<sup>95</sup> De Caelo II 3 286a22-25

relatives, as contraries, as privation and possession, or as affirmation and negation; hot and cold are contraries.<sup>96</sup> He writes:

'We say that anything capable of receiving a possession is deprived of it when it is entirely absent from that which naturally has it, at the time when it is natural for it to have it';

'all privation is a privation of some natural attribute'.<sup>97</sup>

From this point of view he has to conclude that

'change occurs from possession to privation but from privation to possession it is impossible; one who has gone blind does not recover sight nor does a bald man regain his hair'.<sup>98</sup>

This recognises privation only as of something that has been lost, not of something that has not yet been gained - which is not what his original statement seemed to imply. This seems a very unnatural Aristotelian position; he later sees that this must be extended, and, in so doing, relaxes the distinction between the four oppositions mentioned above:

'one of every two contrary qualities is a privation'.<sup>99</sup>

This introduces another type of privation, to be met explicitly in only a few of the other books, although there remain relics of it: here,

'a material whose constitutive differences signify more a "this somewhat" is itself more a substance, while a material whose constitutive differences signify privation, is more not-being. (Suppose, for example, that the hot is a

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<sup>96</sup> GC II 1 329a34; II 2 329b19

<sup>97</sup> Cats 10 12a28-30; Topics VI 3 141a10

<sup>98</sup> Cats 10 13a33-35

<sup>99</sup> GC II 5 332a24

positive predication, i.e. a form, whereas cold is a privation, and that earth and fire differ from one another by these constitutive differences)'.<sup>100</sup>

Again, 'the positive is prior to its privation (warm for instance to cold)', and, as examples of this type of privation: 'rest being privation of motion'; 'sleep is evidently a privation of waking'.<sup>101</sup> Movement from the negative to the positive is a directional (though sometimes reversible) process, like moving from sleep to waking, or from childhood to adulthood. It is a movement towards perfection.

Recognition of another type of privation would help to explain passages where he talks of the hot as a form in comparison to the other elemental qualities. The elements composed of these four principles vary in approximation to form, or perfection, but this seems to depend on location rather than composition:

'For fire alone - or more than all the rest - is akin to the form because it tends by nature to be borne towards the limit. Now each of them naturally tends to be borne towards its own place; but the figure - i.e. the form - of them all is at the limits';

'For wind and air are in truth more a "this somewhat" or a "form" than earth';

'in all changing things alike, we speak of coming to be when the thing comes to be something in one of the two columns e.g. in substance, if it comes to be fire but not if it comes to be earth'.<sup>102</sup>

One might object that hot is active rather than passive, and hence more formal than material, and claim that since fire and heat are closely related, the formal nature of fire depends on its composition. However, the cold too is active, but it is 'in a sense the matter of bodies', and the elements composed of it are located far away

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<sup>100</sup> GC I 3 318b14-18

<sup>101</sup> De Caelo II 3 286a26; Phys VIII 8 264a27; On Sleep 1 453b26

<sup>102</sup> GC II 8 335a18-21; I 3 318b27-30, 319a13-15

from the heavens.<sup>103</sup> So the formal perfection of the elements depends on their proper location.

This kind of privation is unlike the others in that it is not a privation of something that the substance might possess in virtue of what it is, but is privation in some more absolute sense, of perfection. Just as living beings can be ranked in order of perfection, so can other forms. It could also be seen in terms of priority: as one of the passages quoted above said, the positive term of a pair of contraries is prior to its privation. The sense of prior here is unusual, being none of those described in Meta V 18, but having the meaning of 'closer to perfection'.

This has been lost by the time we read the (middle books, at least) of Meta:

'We speak of privation (1) if something has not one of the attributes which a thing might naturally have, even if this thing itself would not naturally have it, e.g. a plant is said to be deprived of eyes; (2) If, though either the thing itself or its genus would naturally have an attribute, it has it not, e.g. a blind man and a mole are in different senses deprived of sight; the latter in contrast with its genus, the former in contrast with his own normal nature; (3) If, though it would naturally have the attribute and when it would naturally have it it has it not; for blindness is a privation, but one is not blind at any and every age, but only if one has not sight at the age at which one would naturally have it. Similarly a thing suffers privation when it has not an attribute in those circumstances, or in that respect and in that relation and in that sense in which it would naturally have it; and (4) the violent taking away of anything is called privation.'<sup>104</sup>

There is no mention here of this 'perfection' privation unless under (1), though this has no explicit implication of a perfection relation. What would guarantee that this was the type of privation noted above, would be a refusal by Aristotle to say that a man is deprived of leaves; this might be found in the more biological books, where the parts of living things are seen as analogous, though I don't know of any

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<sup>103</sup> Meteor IV 11 389a29

<sup>104</sup> Meta V 22 1022b22-32; IX 1 1046a32-35; X 4 1055b3-5

parallel in the Meta. However, there remains the unargued assertion that certain pairs of contraries are related as good/bad: hot/cold, male/female, right/left, motion/rest and so on. For example:

'perhaps the elements of perceptible bodies are, as form, the hot, and in another sense the cold, which is the privation; and as matter, that which directly and of itself is potentially these';

'There is difficulty in the question how the matter of each thing is related to its contrary states ... it is the matter of one in virtue of its positive state and its form, and of the other in virtue of the privation of its positive state and the corruption of it contrary to its nature'.<sup>105</sup>

So does all this suggest that heat and cold are two substances? Or can we say that since the matter of contraries is the same, the hot and the cold are qualities? I suspect that because hot and cold are such basic principles, the question of whether they are substances or qualities loses its point. The nature of the cold is not substantial, but qualitative; however, this quality is not a quality of any substance (other than, perhaps, prime matter), being prior to all others. Further, being a principle, it exists alone in some sense, while all true qualities are dependent on the existence of some substance.

Let me look at just one of the passages discussed by Lloyd in a little more detail here:

'perhaps the elements of perceptible bodies are, as form, the hot, and in another sense, the cold, which is the privation, and as matter, that which directly and of itself is potentially these'.<sup>106</sup>

Why could it not be that if the change were occurring in the other direction, then the form is the cold, and the privation the hot? Presumably because, in this

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<sup>105</sup> Meta XII 4 1070b10-12; VIII 5 1044b29-34

<sup>106</sup> Meta XII 4 1070b10-12

case, there is something essential about the possession of these qualities. It makes sense to say that health is the ideal, and ill-health the opposite, defining one in terms of the other; this is because the ideal is included in the form. It makes less sense to say of the black/white pair that one is the ideal and the other an imperfection, because these are truly accidental qualities; the specific colour of something is not included in its form. Now, of the two examples, the first is nearer the case of hot/cold as described by Aristotle. This seems a little odd, but is explained by the fact that the hot/cold pair are really rather special in that the matter underlying them is entirely determined by the possession of these qualities. But even so, there is still no reason given for the hot to be more perfect than the cold other than common assumption - for there seems little more to Aristotle's idea of perfection in the ranking of forms than this.

## II: Agency; cosmology and separation

The second of the senses of hot that Aristotle distinguished was that something was hot if it could make other things hot, whether the other things were animate or not.

'When the sun warms the earth the exhalation which takes place is necessarily of two kinds, not of one only as some think. One kind is rather of the nature of vapour, the other of the nature of a windy exhalation. That which rises from the moisture contained in the earth and on its surface is vapour, while that rising from the earth itself, which is dry, is like smoke. Of these the windy exhalation, being warm, rises above the moister vapour, which is heavy and sinks below the other. Hence the world surrounding the earth is ordered as follows. First below the circular motion comes the warm and dry element, which we call fire, for there is no word fully adequate to every state of the smoky evaporation but we must use this terminology since this element is the most inflammable of all bodies. Below this comes air. We must think of what we just called fire as being spread round the terrestrial sphere on the outside like a kind of fuel, so that a little motion often makes it burst into flame just as smoke does; for flame is the ebullition of a dry exhalation. So whenever the circular motion stirs this stuff up in

any way, it catches fire at the point at which it is most inflammable.'<sup>107</sup>

This, together with the explanation of rainfall, explains how the world comes to be structured as it is, and, in particular, explains such phenomena as lightning, comets, and shooting stars. But there is something odd about this:

'We have already laid down that the outermost part of what is called the air has the powers of fire and that therefore when the air is dissolved by motion, there is separated off a kind of matter - and of this matter we assert that comets consist.'<sup>108</sup>

And the movement of the sun and stars 'does not only cause *to thermon* to be secreted but also dissolves it when it is gathering.'<sup>109</sup>

Is it the 'fire', *to thermon* or 'a kind of matter' that is ignited?

The outermost part of the 'atmosphere' is dissolved by motion of the spheres, and is dissolved into its elemental parts; and a kind of matter is separated off. The 'atmosphere' at this level is called air by most people; Aristotle has called it fire, but points out that it is not fire as we know it, but has the properties of fire. The matter is that which composes comets; what is this 'kind of matter'? We should note that *to thermon* is constantly being separated off<sup>110</sup>, and that a certain kind of matter also follows the sun.<sup>111</sup> What can this matter be? Surely not prime matter:

<sup>107</sup> Meteor I 4 341b6-24

<sup>108</sup> Meteor I 8 345b31-35; see I 3 340b4-32; Thorp (1982) points out that there is a problem here: the outer layer of the sublunary world is fire, not air; how is it, then, that air is ignited? The solution, of course, is that 'fire' is used improperly here: Aristotle says that the outer layer is not fire in the same sense as a bonfire is fire, but is, rather, 'fiery' (Meteor I 3 340b22; I 4 341b15; I 8 345b32).

<sup>109</sup> Meteor I 7 345a7-9

<sup>110</sup> Meteor II 4 360b34

<sup>111</sup> Thorp raises two further questions here: i/. why the ignition is greatest where the heavenly bodies are located; ii/. how the furthest distant heavenly bodies can cause ignition. He suggests that De Caelo II 7 289a27 should be understood as 'the air,

although I agreed to assume that there was such a thing underlying the principles, it is very clear that it could not exist unqualified by one of them.

Examination of the passages where the relevant words (*apokrinein* and *diakrinein*) occur reveals that there are at least two senses of separation being used (though not explicitly). One sense is that of simple physical division, for example, waters separating.<sup>112</sup> In the well-known jar in the sea experiment, the earthy substance is separated off as though by a filter.<sup>113</sup> The filter analogy surely means no more than a separation in place; the saltiness of the sea is due to a mixture.<sup>114</sup>

Since there are two ways in which elements might be combined<sup>115</sup>, composition and chemical combination, this is not surprising: the filter analogy applies to the separation of elements combined by simple juxtaposition.

A second sense of separation is that used in the biological works of the production of the useful (and not so useful) residues or secretions of the body

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as a result of the blow is fired by means of motion': the idea of friction is a modern import. The motion is the immediate cause of its heat. The air is buffeted by the fifth element and made to move from its normal radial motion to a circular one which causes it to ignite, producing heat and light.

<sup>112</sup> Meteor I 13 349b29

<sup>113</sup> Meteor II 3 359a4; HA VIII 2 590a24-7. A sealed pot is lowered into the sea; some time later fresh water is found inside it, the seal remaining unbroken. Düring (ACT) p.76 suggests that this wax vessel should rather be thought of as a pottery vessel: not *kerinon* but *kerameon*. A wax one, he says, is almost inconceivable, and wax is not permeable. And Aristotle has observed that water trickles through pottery, especially if it has not been fired: GA II 6 743a8. He also speaks of pottery as porous at Meteor IV 8 385a29, though there says that the pores too small for the water to enter. Perhaps in this latter case, the pottery has been glazed?

<sup>114</sup> Meteor II 3 358b34

<sup>115</sup> Topics IV 2 122b26-31; GC I 10; De Sensu 3 440b1-13

(semen, menstrual blood, milk, digestive juices etc).<sup>116</sup> The account given of the digestive system, though scattered and unclear, is not one of simple filtering of the nutriment. The nutriment is concocted in the body to form blood and the residues, and this involves a change in nature, not merely a breakdown and filtering. Then there are passages which speak of the differentiation of the foetus, saying, for example, that the heart is first separated off in actuality.<sup>117</sup> But what exactly this form of separation is, and whether it is the same as that used in the Meteor has yet to be established.

In other passages Aristotle talks of the separation of heat itself. After rain the earth gives off exhalations which are the substance of wind. When this separation is in process winds prevail; when they drop, because *to thermon* is always being separated out and rising, the vapourous exhalation is cooled and condenses to form rain. If the air is not yet in a state to overcome the heat contained in it and to develop into a watery condensation, it is clear that the vapour is not yet separated from the hot dry exhalation.<sup>118</sup>

This is one of the puzzling uses of separation. First there is the separation of exhalations from the earth, which occurs periodically, and then there is the separation of *to thermon* from the air, as a standing condition, and the separation of the hot dry exhalation from the vapour. While none of these is separation in the

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<sup>116</sup> On Dreams 3 461a25; HA III 20 521b19; VII 1 582a5; PA III 2 664a9; III 4 665b25; III 7 670a22; III 9 671b25, 672a21; IV 5 679a20, 681b35; IV 10 690a9; GA I 2 716a11; I 18 723b12, 724a12, b27, 726a19; I 19 726a33, b8, 727a1, a6, a28, b5; I 20 727b36, 728a9, a15, 729a7; II 4 737b27, 738a5, a14, a27, b4, 739a5, a15, b20; II 6 744a9; II 7 747a12; II 8 748b2, b15, b20; III 1 749b5, 750b6, b12, 751a1, a4, a33; III 7 757b7; IV 1 765a1, b29; IV 5 773b33; IV 8 776a27, b29, 777a4, a17; V 3 783b30

<sup>117</sup> HA VI 3 561a10-17; GA II 4 740a4, a17, a36, b2, b13; IV 6 775a12, a17

<sup>118</sup> Meteor I 4 341b15; II 4 360b33; II 5 361b17; III 3 372b30-35

sense of differentiation, it is not yet clear whether they are separation in place or separation in some third sense. The separation of exhalations from the earth seems to be like evaporation, being greater when the sun is near (Aristotle speaks of the cycle of rain, that is, the water rising due to heat and falling due to cold, in Meteor I 9). This is not merely a separation of place, since the water evaporated has changed state; simple filtering does not change the nature of the elements, merely their concentration and location. So it would seem that there must be a third kind of separation, that due to change of state.

The separation of the hot dry exhalation from the vapour, is presumably due to the natural tendency of the elemental forces (hot tends to rise, cold to fall), and is again concerned with place, which may make it a physical separation, not a chemical one.<sup>119</sup> This is not generation of one element from another, but is more of a natural filtering, though it is not due to the external application of heat, but to the elements themselves, and only indirectly involves a change of state. However, *diakrinein* does seem to be used of generation of one element from another: air comes to be by separation from water, fire from air.<sup>120</sup>

The third is the separation of *to thermon* from the air; is this the same as the separation of the exhalations? I suspect that it is not always, though it is here: in some cases of this separation, fiery phenomena result (comets and the like). This can happen due to pressure or to the movement of the sun and stars.<sup>121</sup>

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<sup>119</sup> Meteor I 3 340b20; I 4 341b12

<sup>120</sup> Meteor I 3 340a10

<sup>121</sup> Meteor I 4 342a1; I 7 344a35, 345a5-7

Sometimes it is not *to thermon* but a mixture that is separated from the air: when the air is disintegrated by motion a kind of mixture is separated off.<sup>122</sup> What is this disintegration? Is it physical or chemical? Is it the same as the separation of *to thermon* due to pressure or friction? *diakrinein* is the word used here, and this is most often used of dissolution into elements, often as a result of motion, which suggests that in these passages the separation involved is not that of filtering or of differentiation, but of another kind, chemical breakdown.<sup>123</sup> However, it does seem to be the same as that of *to thermon*; both result from motion, and Aristotle did not distinguish very clearly between the material and *to thermon* separated off in this way.

Earlier we learnt that when air is contracted by cold *to thermon* is separated off; however, that is not the case here, for that occurs at a lower level. There are two causes of fiery phenomena in the sky, depending on the place it occurs: in the upper levels it is due to the separating off of some substance, and at lower levels to the separating off of *to thermon*.<sup>124</sup> Since this does not exist alone except in the upper levels<sup>125</sup>, this either ignites, causing fiery phenomena, or rises: the separation of *to thermon* is a natural, inevitable and common part of the cycle of rainfall.<sup>126</sup> Which of these occurs presumably depends on its concentration, and on the surrounding conditions.

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<sup>122</sup> Meteor I 8 345b34, 346b8

<sup>123</sup> Meteor I 3 340a30, b11, 341a19, a28; I 7 344b23, 345a8; I 8 345b34; I 8 346a15; [Prob] XXVI 33 944a21; Meta XII 10 1075a23

<sup>124</sup> Meteor I 4 342a1; I 7 345a7-9; I 8 345b33-346a10, 346b7; II 4 360b34

<sup>125</sup> GC I 7 324b17; On Length 3 465b3, b12

<sup>126</sup> Meteor II 4 360b30-34

What is the substance separated off at the upper levels? The motion of the stars not only separates off *to thermon* but 'dissolves into its elemental parts the thing being formed'. And if there is plenty of hot secretion, the air is dry and the moist evaporation is dissolved and dissipated by the the hot exhalation, so that it doesn't readily condense into water.<sup>127</sup> Dissipation is clear, but dissolution? If these were not the principles, I would suppose that Aristotle means the breaking down of compounds into their elements. This would pass if it were air under discussion: the air could be broken down into its component principles of the hot and the wet. Similarly, the moist exhalation could be broken down into air and water and the hot. But the hot? What is the motion separating *to thermon* from?

It seems clear that the hot cannot exist without matter, but it is not clear that the hot can exist with prime matter alone; at a sublunary level it needs to be embodied in higher level matter - combined with the dry, for example, to create what we call fire. But perhaps at the outer level of the earth, the hot principle can exist alone. This should not, I suppose, be so surprising, since this is its proper location, and, once there, it is incorruptible.<sup>128</sup> While the exact process Aristotle has in mind here is not clear, it is clear that if the hot principle is of the right consistency, then the motion of the heavens causes it to ignite.

There is great variation in the relative amounts of these two exhalations which causes different weathers: what causes these different amounts? Is it the maturation of the different parts of the earth:

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<sup>127</sup> Meteor I 7 344b23, 345a7-9

<sup>128</sup> On Length 3 465b1-7

'the interior of the earth has its periods of maturity like the bodies of plants and animals ... [and] the causes are cold and heat, which increase and diminish on account of the sun and its course'?<sup>129</sup>

And how is the earth warm? For it is clearly warm independently of the sun:

'there is a great quantity of fire and heat in the earth'.<sup>130</sup>

We learn from the section on volcanoes that the cause of the fire that is generated in the earth is that the air is broken up into small bits and then the wind is beaten about and catches fire.<sup>131</sup> This is a very similar account to that given to explain comets and similar phenomena: the motion of the air creates heat, and if this is excessive, and the space around is filled with a suitable fuel, the fuel will ignite. But unless there is some account of continual motion of air within the earth, this will not give us any explanation of the natural heat of the earth. Of course, all bodies possess heat in that they were created from the hot and the cold, but I cannot believe that Aristotle had this in mind for the earth: after all, there was no original creation of it. But we learn that:

'excessive rain causes more of the exhalation to form in the earth. Then this secretion is shut up in a narrow compass and forced into a smaller space by the water that fills the cavities.'<sup>132</sup>

All we need assume is that the air thus trapped in the earth is in motion; we know that compressed hot has a certain power.

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<sup>129</sup> Meteor I 14 351a27-32

<sup>130</sup> Meteor II 4 360a5-16 (*thermotes*), b31 (*thermon*), II 5 362a6 (*thermotes*), II 8 365b25 (*pyre*)

<sup>131</sup> Meteor II 8 367a9-11

<sup>132</sup> Meteor II 8 366b9-11

What is the relationship between heat and fire? Hot is the essential property of fire, and fire is productive of heat.<sup>133</sup> We should note, for clarity, that the element we commonly call fire is not really fire, for fire is an excess of heat and a sort of ebullition of *thermotes*.<sup>134</sup> That is, the fourth element is not flame-like, for bonfires and such are areas of excessive heat, and are 'boilings' of the hot and the dry. Rather, the fourth element, of which heat is the essential property, and which it produces, is something with the potential to boil over in this way, but itself is fuel-like, being a mixture of the hot and the dry. How it produces the heat I shall come to in a moment; first I want to mention one aspect of the relationship between heat as an essential property of, and as a product of, fire.

Unless we recognise a difference between *to thermon* and *thermotes* it will seem rather strange that something should give off its essential property and yet remain the same. But there is nothing puzzling in the idea that it should possess one and radiate the other in virtue of this possession. However, there is one oddity: we are told that both heat and fire (alone of all the elements) require sustenance or else perish.<sup>135</sup> Since there is, I suspect, a corresponding difference in the uses of *psuchron* and *psuchrotes*, at least, there should be a corresponding need for sustenance. The answer may be that the hot makes hot by radiating, and the cold cools by absorbing. However that may be, I shall now turn to the transmission of heat.

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<sup>133</sup> De Caelo III 8 306b32; De Sensu 4 441b11

<sup>134</sup> GC II 3 330b28; Meteor I 3 340b24

<sup>135</sup> PA IV 5 682a24; [Prob] III 26 875a4-9

### The transmission of heat

As for the heat derived from the sun, Aristotle says the right place to discuss it is in the treatise about perception, since 'heat [*to thermon*] is an affection of perception'<sup>136</sup>, but we can explain how it can be produced by the heavenly bodies which are not themselves naturally hot. The sun heats up the air surrounding it in the following way:

'the circular motion of the first element and of the bodies it contains dissolves, and inflames by its motion, whatever part of the lower world is nearest to it, and so generates heat'.<sup>137</sup>

Surely this is against one of his chief principles, that something that is actually X is required for the production of another X? Indeed, he says that it is a body that is *thermon* that can cause change in one that is potentially *thermon*,<sup>138</sup> and, moreover, that the stars are hot. And we said that in one sense the hot is that which causes certain reactions in other substances, and the examples given include melting and dissolving, which is just what we are told the sun does to the outer layer of the earth. So in what sense are the heavenly bodies not themselves hot? The heavenly bodies neither are composed of the four sublunary elements, nor are alive in any sense that requires vital heat. So they are not hot in themselves; they are not naturally hot. However, they are hot in that they produce heat in other bodies.

Light is actualization of the transparent - how does heat work? How is heat transmitted? The sun heats up the air surrounding it in the following way: the circular motion of the first element and of the bodies it contains dissolves and

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<sup>136</sup> Meteor I 3 341a15

<sup>137</sup> Meteor I 3 340b10-12, 341a19-28

<sup>138</sup> Phys VIII 4 255a23

inflames by its motion whatever part of the lower world is nearest to it, and so generates heat. Presumably this is so on the lower levels too; 'it is the air that is nearest to a thing in rapid motion which is heated most'.<sup>139</sup>

So, heat is generated by the sun's motion. This is one reason why heat reaches our world. 'Another is that the fire surrounding the air is often scattered by the motion of the heavens and driven downwards in spite of itself'.<sup>140</sup> We know that this is not strictly fire as we would call it, but has fire-like properties, notably the potential for producing heat. (Note, incidentally, that Meteor I 9 346b25 speaks of two kinds of heat from above, the sun's rays and a more generalised background heat from that layer. This could be either the fire-element that is forced down, or heat from the heavenly bodies.) So the heat source sets up movement in the medium.

How does the heat reach us? This, I suppose, occurs in the same way as one substance heats another, and for a clue to this process:

'fire heats not only when in contact, but also from a distance. For the fire heats the air, and the air - being by nature such as both to act and suffer action - heats the body.'<sup>141</sup>

'What happens in these cases may be compared with what happens in the case of projectiles moving in space. For in the case of these the movement continues even when that which set up the movement is no longer in contact. For that which set them in motion moved a certain portion of air, and this in turn being moved excites motion in another portion ... This we must likewise assume to happen in the case of qualitative change; for that part which has been heated by something hot, heats the part next to it, and this propagates the affection onwards to the starting point'.<sup>142</sup>

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<sup>139</sup> Meteor I 3 341a26

<sup>140</sup> Meteor I 3 341a29-31

<sup>141</sup> GC I 9 327a4-6

<sup>142</sup> On Dreams 2 459a28-b2; also De Sensu 6 447a3-5

How could this work? We are told that naturally all heat tends upwards.<sup>143</sup> (Though we could ask where it can go if it is generated at the level between the upper sphere of earth and the heavens.) It is sometimes pushed downwards by the condensation and contraction of the moister exhalation or air, but its natural movement is upwards; this account is not going to help. The nature of air is the hot and the wet; I suppose that since the mean of intermediate mixtures is wide, the air could suffer action qua wet, and be heated up so that it became more like fire, closer to the hot and dry, and then act qua hot and eject the hot principle by contraction and expulsion on contact with something colder than itself. Does this explanation leave the air taking on a quality and then parting with some matter? This would seem rather inequitable, but it need not be quite like this; after all, the heat-charged air is now rather like fire, and is in contact with the object, so we should ask how fire heats on contact.

We are told that everything that has been exposed to fire contains heat potentially.<sup>144</sup> What is the potential here - surely it actually does contain heat? Perhaps it means that there is the potential for perceiving the heat; heat in the second of the senses outlined above. When the fire heats because it is in contact, there is no medium; the power of the hot overcomes whatever it meets, and turns the coldness of the other object into warmth. (We have to assume that the hot overcomes all, otherwise the kettle of cold water would put out the fire.)

What about the perception of heat? Surely this is only a special case of transmission. Heat (*thermon*) is a tangible quality<sup>145</sup> perceived by something interior

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<sup>143</sup> Meteor I 4 342a15

<sup>144</sup> Meteor II 3 358b8; IV 11 389b4

<sup>145</sup> Meteor I 3 341a16; IV 8 385a3; De An III 13 435b14

that is potentially such as its object is actually: i.e. something potentially hot (that is, hotter than the body). The organ of perception is a mean in temperature, but the organ of touch must be neither hot nor cold. This cannot mean that the organ is of no temperature unless we suppose that Aristotle held that the organ is wholly immaterial; it is an Aristotelian commonplace that all bodies have some heat. Since this is not a real possibility, I think that Aristotle must mean that the organ is 'at a mean'; the hot is what is hot to the touch, i.e. hotter than the hand, and the cold is what is colder than the hand. He does talk about the hot being what feels hot, and also says that the state of the perceiver can affect what feels hot. However, it is true that possession of perceived heat is but one of the senses in which something can be hot.

A third sense of hot that Aristotle distinguished was heat retention: a body is hotter than another if it stays hot longer, or if it heats up faster. There must be something in the idea that after the qualities have formed the elements, and the elements some compound, that compound retains some of the properties of the elements that are its makeup.

'Every body shows the quality of that element which predominates in it.'<sup>146</sup>

The compound, say, is hot. This is demonstrated by its possession of heat, which is a power to interact with other things, such as a finger or a piece of wood, and cause them to heat up, overcoming the cold in them. Thus a substance which has more of the hot principle in its composition is, in this sense, hotter than one which has less.

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<sup>146</sup> Meteor IV 4 382a5-6

The remaining distinction between kinds of heat that Aristotle mentioned is whether the heat is natural (or internal) or external. Internal heat is very different from the heat of the non-living world, and is crucial in all the aspects of change in biological organisms, including functions of *psuche*, which form the subject matter of the rest of this thesis. I have already claimed that in living creatures the vital heat is material, a stuff peculiar to and essential to them. While it has the powers that external heat has, it also has other special capacities which I will discuss at length below. But, as an example, GA II 3 736b35 tells us that vital heat is not fire or any such force, but is analogous to the element of the stars (interesting, since Aristotle seems to be unsure as to whether the stars themselves are hot or not). Again, fire does not generate any animal, though the heat of the sun and of animals does generate, so the heat in animals neither is fire nor derives its origin from fire. Further, GA V 2 781b26 claims that natural heat decreases in sickness, though Aristotle certainly knew about fevers; and cooking with fire does not digest the food or turn blood into fat. (We also know that these heats can be in conflict.<sup>147</sup>) But they are analogous in that the heat requires refueling, is stronger (usually) than other principles, and provides certain powers.<sup>148</sup>

So what can we conclude about the general nature of the hot and heat? I have claimed that though *thermon* must be enmattered, it is neither truly substantial nor qualitative, being a fundamental principle. Further, when an object is hot, i.e. has *to thermon*, it possesses the powers of fire, which are to heat other objects. In so doing, what happens is that the imbalance between the principles possessed by one

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<sup>147</sup> GC I 7 323b8; I 8 326a12; Meteor IV 1 379a16-17; On Youth 5 469b30-31

<sup>148</sup> PA IV 5 682a24

object and another in contact with it is rectified; they reach a mean. Because fire is the most powerful of the principles, this mean is biased in favour of heat; however, to keep this balance of power, fire needs constant refueling.

Heat (*thermotes*) is not material; there is no transmission of any 'elastic material fluid'. Nor is there transmission of any force, at least as I understand the word; rather, there is a balancing of the principles, or powers. This 'balancing of the principles' is a recurrent notion in his explanation of various biological changes, to which I shall turn in the next chapter.

## Conception

### Two Accounts of Conception

At conception, the semen and the catamenia come together, and 'the first mixture of male and female' is formed, containing principles derived from both parents.<sup>1</sup> From this primary mixture, the fetation, will develop the new individual.

In chapters 19-20 of GA I, Aristotle discusses the principles which make up the fetation, asking such questions as whether they are contained in, or are identical to, the semen and the catamenia, and what exactly the contribution of each is to generation. By the end of Book I, he has reached an account of conception which claims, briefly, that the male contributes the form of the new individual by means of the movement contained in the semen, and that the catamenia contributed by the female becomes the matter of the fetation. No matter is contributed to the embryo by the semen; nor is any form imparted by the catamenia:

'What the male contributes to generation is the form and the efficient cause, while the female contributes the material'.<sup>2</sup>

In this very strict and aesthetically pleasing view, the matter is wholly passive and is worked on by the semen until 'informed' by the form of the new individual.

Such is - roughly - the account that Aristotle publicly acknowledges as his own<sup>3</sup>, and which I shall call the strict account of conception. However, more detailed

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<sup>1</sup> GA I 20 728b35

<sup>2</sup> GA I 20 729a10

<sup>3</sup> GA I 21

discussion in Books II and IV of GA reveals difficulties in this account, and I believe that a more moderate account of the roles of male and female contributions to generation can be found in these books. It is, however, only implicitly used in explanation, and is never explicitly accepted by Aristotle as his official view.

This more moderate account runs roughly as follows: several distinct movements (jointly responsible for the form of the embryo) are at work in each of the contributions; some of these movements compete for dominance, and the sex and appearance of the child depends upon the relative strengths of these movements. Other movements, those of the 'levels' of *psuche*, are not in competition: the female contribution provides the nutritive *psuche* of the new individual, while the sensitive *psuche* and the characteristic function (insofar as the latter differs from the functions of the nutritive *psuche*) are supplied via the semen. An important element in conception is the *pneuma* in the semen, which becomes a material part of the embryo. Thus, both contributions supply form and matter in varying degrees. This account I shall term the split donor account.<sup>4</sup>

Before discussion of the roles played by the male and female contributions, and argument for the split donor account, I want to look briefly at conception in general as an example of change.

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<sup>4</sup> It is not an entirely new suggestion, though rather unorthodox; Peck (1953), Preus (Science and Philosophy 1975) and Morsink (1982, p.138) recognise that there must be some formal donation from the female. Indeed, Preus (1977) claims Galen recognised that GA grants (some) efficient causality to the female and that *pneuma* in the semen is transferred to the embryo, though he thought it provided material for the nerves and bloodvessels. Balme (1970) says that the female contributes the nutritive form, and in (1972) that the *pneuma* in the semen conveys heat of a special quality; but as we saw in the previous chapter, it does not follow that this is a material transmission, and indeed Balme (1984) denies that matter is transmitted via the semen. But Morsink says that *pneuma* is 'internalised' by the female matter (p.113).

### Conception and the standard account of change

All the usual examples of changes given to illuminate the standard account are examples of a substance changing its attributes, where the substance may be a living substance or an artefact, or are examples of underlying matter having different forms imposed upon it, and in this case the examples are exclusively of artefact-manufacture. Although Aristotle relies heavily upon an analogy that he draws between art and nature, conception is not entirely analogous to craft, as will become clear.<sup>5</sup> Nor is it a simple matter of a single substratum having different forms imposed upon it.

In the standard account of change, one substratum persists, underlying different forms at different times. While this is unproblematic for the original strict account of conception (the catamenia persist, having first one form, and then another, that of the new individual), it is less clearcut for the split donor account. Here there are two principles - the semen and the catamenia - combining to form one, each responsible for part of the resultant object.

Again, in conception, on either account, both principles lose their natures in the process of the change: the female contribution, the catamenia, becomes the matter of the fetation, and the body of the semen, which has not been incorporated into the fetation, evaporates after transmission of the *psuche* principle which it carries. In describing and wielding the standard account of change, Aristotle frequently uses the analogy of a craftsman or a medic; it is not usually the case here, or in nonsubstantial change, that the efficient cause loses its nature. When a carpenter transmits form to matter using a chisel, the chisel - the element of the analogy

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<sup>5</sup> Examples of Aristotle's use of *techne* as an analogy in GA include I 4 717a33; I 18 723b30, 725a26; I 22 730b8-32; II 1 734b20-735a29; II 4 740b25-741a4; II 6 743a20, b18-24; III 11 762a17; IV 2 767a20; IV 7 776a1; V 8 789b8-15

supposedly parallel to semen, being a tool - is unaffected; it does not usually lose its nature, though it is true that it may be blunted or broken. In any case, it does not lose its nature as an essential result of the change it brings about. In the case of conception, in contrast, the efficient cause (the semen) necessarily loses its nature, or form: each unit of semen can only bring about conception once; since conception involves the transmission of heat and of the *psuche* principle, if the semen does not lose its nature, conception has failed to take place.

It might be thought that the change here at least in the strict donor version is closer to that of chemical combination, in which two or more homoeomers combine to produce a third, or two elements combine to produce a compound or homoeomer.

Such combinations are brought about by virtue of the natures of the elements involved which are contrasting forms of one and the same matter<sup>6</sup>: the elements possess opposing qualities which act upon each other when the elements are brought into contact. Thus earth is cold and dry; water cold and wet; air hot and wet; and fire is hot and dry. The elements change into one another, or combine to form compounds, according to the relative prevalence of these qualities.

Each quality is, in relation to its contrary, active in that it tends to convert it into itself, and passive in that it is liable to be converted. If neither contrary is present in sufficient force to prevail completely then a compound results: an imperfect one if only two qualities conflict, a complete one if all four are in conflict. Which compound or homoeomer results depends upon the relative intensities of the conflicting qualities. An example of chemical combination, rather than transformation, would be cooking, in which varying amounts of, say, eggs,

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<sup>6</sup> Perhaps prime matter, though the acceptance or not of this is not important to my thesis.

milk, fat, flour and sugar can produce things as different as pancakes, a soufflé or a spongecake.

Thus, if fire (hot and dry) and air (hot and wet) come into contact, the 'dry' and the 'wet' interact. If the 'wet' prevails completely, the fire is converted into air; if not, a compound midway between the extreme dryness of fire and the extreme wetness of air is formed. If all four qualities were in conflict, the process would be a little complicated by the fact that the compound resulting from the modification of the hot and the cold would bring about the modification of the dry and the wet through the heat internal to it.<sup>7</sup>

However, these combinations are not exactly like conception in that in these all the ingredients combine wholly, while in conception one is used wholly, as matter for the form borne by the other (or by them both) to act upon, while (most of) the matter of the other, the semen, is not involved in the resultant fetation, but is left over.<sup>8</sup> Conception is much more like the use of a vanilla pod in rice pudding, which imparts flavour to the resultant pudding, but can be discarded after cooking.

Aristotle offers several cooking analogies in explanation: fig-juice (or rennet) and milk, for example. Milk is curdled by fig-juice, but (apparently) the fig-juice forms no part of the resulting curds or whey.<sup>9</sup> Indeed, the cooking analogy is quite close, and his examples are carefully chosen: the heat involved in the transformation of elements and biological change is internal, while in cooking the heat is usually external, applied by a cook (the craftsman again) to serve his own ends; however,

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<sup>7</sup> GC II 7-8; Meteor IV 1-3

<sup>8</sup> The bracketed phrases here refer to the second of the two accounts of conception.

<sup>9</sup> Meteor IV 7 384a16-23; GA I 20 729a12; II 3 737a15; II 4 739b21-25; IV 4 771b25, 772a23-25

because the fig-juice and rennet are 'live', as yeast is, and hence have internal vital heat, the analogy is a better fit than that of the craftsman.<sup>10</sup>

Still, neither the Physics account nor the chemical account of change is entirely adequate for biological change, in which two homoeomers combine to produce a fetation and some left-over watery matter. But each contains elements of a satisfactory account: the craftsman analogy indicating the use of semen as a tool for transmitting movements from the craftsman (the father) to the artefact (the fetation), and the cooking analogy stressing the action of the semen on the catamenia and the importance of heat in the interaction.<sup>11</sup>

The differences in the accounts can best be seen, perhaps, in diagrammatic form. (f = form; m = matter; x indicates an action that is not a simple +; \* indicates a relation that is not a simple form/matter relation.)

**The standard account of change:**

f1	x	f2*	=	f2	x	f2*
m1		m2		m1		m2

example: marble block + chisel/workman = statue + chisel/workman

m1 is a substratum, persisting throughout the change, which involves f1 being replaced by f2. f2/m2 is the agent, which (normally) remains unchanged.

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<sup>10</sup> The rennet is 'live' in the sense that it comes from an animal, and still contains vital heat: GA II 4 739b22. Figjuice too comes from a living thing; though as Ogle (1897, p.9) says, Aristotle has no evidence of the natural heat of plants.

<sup>11</sup> Note that the analogy used of the mother is also that of a craftsman, but that in this case it is a potter, who works in contact with the material, not at a distance.

**Chemical combination:**

$$\begin{array}{ccccc} f1 & & f2 & & f3 \\ & + & & = & \\ m1 & & m2 & & m3 \end{array}$$

example:

wine + water = 'an intermediate with properties common to both'<sup>12</sup>

**Conception:**

$$\begin{array}{ccccccccc} f1 & & f2 & & f3 & & f4 \\ & + & & = & & + & \\ m1 & & m2 & & mx & & my \end{array}$$

example: catamenia + semen = fetation + 'leftover matter'

According to the strict account of conception, f4/my would merely be the agent, the semen, though it would be altered, given the peculiar nature of this change, in that it can no longer cause conception. On the other account, it is also the altered agent, but there is no *pneuma* remaining (for that has entered the fetation), merely the earthy matter and some water.

I have left variables (mx, my) in this equation because I want eventually to discuss the rival accounts of conception, which put different matters into these positions. On the strict account of conception mx is the catamenia; on the more moderate account some matter from the semen is included in the fetation: mx varies. Hence the 'leftover matter' will also vary according to the account of conception that one accepts; it is not, of course, to be identified with the semen, since in surrendering the form of the new individual-to-be, the semen loses its own nature - each unit of semen can only bring about conception once.

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<sup>12</sup> GC I 10 328a31

Before turning to the rival accounts of conception, however, I want to discuss some more general aspects of conception, and in particular the production of the generative secretions.

### The production of the generative secretions

We are told that the semen and the catamenia are analogous, and that each is a homoeomerous secretion of useful nutriment<sup>13</sup>; that is, both are residues of blood, concocted to varying degrees.

At this stage, we may ask whether it is a difference in the blood of the two sexes that enables the semen to impart the form - or the higher levels of form - while the catamenia cannot do so. Now Aristotle certainly believed that blood differs between species, in temperature, viscosity and clarity, and between parts of the same animal, and that the heat of the blood affects the character, temperament and abilities of animals.<sup>14</sup> But the blood is not itself hot; rather, it is heated by the vital heat, which is based in the heart.<sup>15</sup> So it is vital heat on which temperament and capacities depend. Man, according to Aristotle, is hotter than woman, and is therefore able to concoct his blood to a higher degree; the blood may not vary in itself, but its temperature and viscosity, at least, would depend upon the vital heat of the animal.

So, it is upon his greater degree of vital heat that the male's ability to concoct blood and so communicate *psuche* depends. Concoction is all-important; it is not

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<sup>13</sup> GA I 18 724b29-725a13, 726a26-8. Milk is similar: GA I 19 726b30, 727a3; V 8 777a7, a12

<sup>14</sup> PA II 2 647b31-648a15; II 4 esp. 651a13

<sup>15</sup> PA II 2 649a18

true of just any sample of blood that it has the potential to impart form of an appropriate kind<sup>16</sup>, (although it does have the potential to be further concocted).

'Concoction is a process in which the natural and proper heat of an object perfects the corresponding passive qualities, which are the proper matter of any given object. For when concoction has taken place we say that a thing has been perfected and has come to be itself. It is the proper heat of a thing that sets up this perfecting, though external influences may contribute in some degree to its fulfilment ... In some cases of concoction the end of the process is the nature of the thing - nature, that is, in the sense of the form and essence'.<sup>17</sup>

While this key passage is ostensibly describing concoction, one can see a parallel with the description of the immanent action of the hot modified in chemical combination, and with an account of conception. Moreover, we are given a connection between perfection and nature which we will see to be significant later.

It seems that concoction of the blood is a process in which the vital heat perfects (or actualises) the passive qualities (or the potentialities) of the matter, thereby bringing to be the natures of the catamenia and the semen, which are to contribute form and matter to the embryo (though identification of the exact contribution of each has not yet been made).

This is probably the place to point to a distinction that Aristotle makes between senses of 'potentiality' and 'actuality'. 'Actuality', De An tells us, has two senses, corresponding to possession of knowledge and exercise of knowledge.<sup>18</sup> Similarly, there are two senses of 'potentiality', corresponding to potential for learning, and potential for using, once learnt. It will be seen that there is some overlap (2=3i).

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<sup>16</sup> It could, presumably, produce low-level animals such as lice through spontaneous generation. See chapter VII.

<sup>17</sup> Meteor IV 2 379b18-26

<sup>18</sup> De An II 1 412a22; II 5 417a21-b2

- 1/. Infant potentially-1 has the capacity to speak Greek
- 2/. Adult potentially-2 has the capacity to speak Greek
- 3/. Adult actually has the capacity to speak Greek
  - i/. Adult actually-1 has the capacity to speak Greek (but is not using it)
  - ii/. Adult actually-2 has the capacity to speak Greek (and is speaking Greek)

The final concoction of the semen, in man, occurs only during copulation<sup>19</sup>, and has nothing corresponding to it in the perfection of the catamenia. The final concoction cannot be simply the actualisation of the potentialities possessed by the semen, i.e. the act of instilling *psuche* into the embryo (actuality-2), as one might have expected, since some animals, e.g. fish, complete concoction even before copulation.<sup>20</sup> It must be a process of bringing into being the potentialities of the semen, that is, actualising or perfecting the semen by enabling it to perform its function (actuality-1). The semen certainly contributes more form to the embryo than the catamenia, on any account of conception; is this when the 'extra' comes to be possessed by semen?

Now, semen consists largely of *pneuma* and water (its colour and texture are due to this mixture<sup>21</sup>), and the semen and *pneuma* come together prior to emission.<sup>22</sup> This could mean either that extra *pneuma* enters the semen as the final stage in preparation, or that *pneuma* and water come together to form semen as required; the

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<sup>19</sup> GA I 5 717b25; Balme (1972) notes that this puts the Hippocratic view rejected at 724b36; but Aristotle agrees that concoction is only completed during coition, even though his reason for this is not friction heating up the penis, as the Hippocratic author thought.

<sup>20</sup> GA I 5 717b25; II 6 718a6-9; cf. HA III 20 521b20

<sup>21</sup> GA II 2 735b10, b23, 736a10

<sup>22</sup> GA I 20 728a10-11; II 2 735b33-736a2, a10

former seems to be intended since it is due to the addition of *pneuma* that the semen is finally concocted and emitted.<sup>23</sup>

Moreover, not just any portion of blood will generate, though it has vital heat, and 'in a sense all things are full of *psuche*'.<sup>24</sup> A concentration of vital heat is needed in both sexual and spontaneous generation; semen is 'distilled' blood, but the additional *pneuma* increases the concentration of vital heat: semen contains *to thermon*<sup>25</sup>; *thermotes* is added later<sup>26</sup>. One might think that the latter was not necessarily added to hot semen; however, we know that semen is hot by nature, so *thermotes* is superadded to the semen, as we saw above; sex is the loss of *thermotes*<sup>27</sup>.

The account of the preparation of the semen for its task, then, is that the blood is concocted, by the vital heat within it, into the material of the semen.<sup>28</sup> (This is not simply water, though it is of a watery nature; there are varying amounts of earthy matter in it.<sup>29</sup>) Then the final form of the semen, the ability to transmit *psuche*, is added at the last moment in *pneuma*. It is this addition that is the final concoction of the semen, and it differs from the concoction of the blood, which brought the matter up to an appropriate level of perfection. This, then, is the

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<sup>23</sup> GA I 5 717b24, I 20 728a10-12; II 4 738a1

<sup>24</sup> GA III 11 762a20

<sup>25</sup> Meteor IV 11 389b10-13; GA II 2 735b6, 735b34; II 3 736b35

<sup>26</sup> GA II 7 747a19

<sup>27</sup> GA V 3 783b30

<sup>28</sup> GA II 3 736b34-37. It is secreted from the region around the diaphragm because that is where the principle of life is located: GA II 4 738b15; II 7 747a20.

<sup>29</sup> GA II 2 735b37, 736a7

difference between the semen and the catamenia; woman has not enough vital heat to concoct blood to a level sufficient for addition of further *pneuma*.

This account of the preparation of the generative secretions presupposes neither account of conception; just what the difference means in terms of contribution to the embryo has not yet been specified, but this will, I hope, become clear in discussion of the rival accounts of conception.

However, before turning at last to these rival accounts, I want to point out that this account of the production of the generative principles helps to solve a minor worry about the status of semen and catamenia. In developing the potential for transmission of *psuche*, it might seem that the secretion responsible for this function must lose its homoeomeric nature.

In a homoeomer, each part is identical in structure and kind to all other possible parts, and to the whole. Therefore each has similar powers, these powers being part of the *logos* of the homoeomer. Now, although Aristotle holds that semen and catamenia are homoeomers, there may seem to be good reasons why this cannot be so. The generative principles cannot be infinitely subdivided, as a true homoeomer can, while retaining their powers. Moreover, if this is so, it is another reason for the failure of chemical combination to suffice as an account of conception.

Aristotle certainly thinks that there can be too little semen to produce an embryo, and that, just as in growth, where there are limits to size, so, too:

'the generative material from which each animal is formed is not without a quantitative limit in both directions, nor can it be formed from any quantity you please'.<sup>30</sup>

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<sup>30</sup> GA IV 4 772a2-4, a28

It might be thought that HA X 5 contradicts my claim that one unit of semen is necessary for each conception, for it says that sometimes more than enough for conception is emitted, and that conception does not require all the semen.<sup>31</sup> However, this passage is reaffirming that there are limits to the amount of semen required and the example offered is that of the production of many offspring in a litter.

It is true that in animals that produce many young at a time 'the semen emitted by the male has power, being divided, to form several embryos'<sup>32</sup>, and that man sometimes produces more than one child. However, usually what is secreted by large animals which produce only one (among which man is to be counted) is naturally just enough for one embryo alone to be formed from it.<sup>33</sup> Further, even in the case of animals which usually produce many, their semen is not indefinitely divisible while still retaining its powers.

These cases produce difficulties for the strict theory of semen as homoeomer and as sole donor of form in any case: for in all cases except that of identical twins, the offspring differ from each other (a litter of labrador pups may be a mixture of black and golden dogs and bitches); but if embryos are formed from different parts of the same homoeomerous 'unit' of semen, then the embryos should have similar properties, of, for example, sex or colour.

The account of the production of the generative secretions described above solves these difficulties. The semen and catamenia keep their homoeomerous natures in that the material of which they are composed is homoeomerous, but we

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<sup>31</sup> HA X 5 637a4-10

<sup>32</sup> As does the catamenia in these cases; GA IV 4 772a20-22

<sup>33</sup> GA IV 4 772a30-36

can say that the secretions are divided into 'units' (the appropriate amount for conception of one offspring) by the amount of *pneuma* or vital heat present. The importance of vital heat in conception will become clearer as Aristotle's account is elaborated. I shall now turn to discussion of the relative merits of the rival accounts of conception.

### The rival accounts of conception

On the strict account, the female secretion is passive, acting as matter only, while the male secretion bears the form of the individual-to-be. No formal contribution at all is made by the female; even the nutritive *psuche*, responsible for nutrition, growth and development, is provided by the male. Hence the matter donated by the female is entirely passive, not even providing minimal formal restrictions such as shape, extension or density. Difficulties arise for this strict account when properties other than species-membership are considered, i.e. those of sex-membership and 'accidental' forms such as colour of eyes or hair, as we saw above, and as I shall now argue.

Crudely, the story concerning these forms, on either account of conception, seems to be that if the male principle prevail not over the female principle, the embryo will be female; and if the principle of the father (i.e. the individual man) prevail not over the principle of the mother (the individual woman) then the embryo will resemble the mother. It can also happen that the resemblance moves back a generation, the embryo resembles no-one in particular, or the embryo fails even to be of the correct species-type.<sup>34</sup> The strict theorist must maintain that these principles and the battle for dominance between them must all be contained within

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<sup>34</sup> Mutants pose interesting problems; see chapter VIII.

the semen. I think that a weaker account of these topics is discernable in GA according to which, while the semen carries movements for animal-type, maleness and father-resemblance, the catamenia carries only plant-type, femaleness and mother-resemblance.<sup>35</sup> I shall quote the relevant passage at length before discussing it:

'If the generative residue in the menstrual fluids is properly concocted, the movement imparted by the male will make the form of the embryo in the likeness of itself ... Thus if this movement prevail, it will make the embryo male and not female, like the father and not like the mother; if it prevail not, the embryo is deficient in that faculty in which it has not prevailed. By 'each faculty' I mean this. That which generates is not only male but also a certain sort of male, e.g. Coriscus or Socrates, and it is not only Coriscus but also a man. In this way some of the characteristics of the father are more near to him, others more remote from him considered simply as a parent and not in reference to his accidental qualities (as for instance if the parent is a scholar or the neighbour of some particular person). Now the peculiar and individual has always more force in generation. Coriscus is both a man and an animal, but his manhood is nearer to what is peculiar to him than is his animal-hood. In generation both the individual and the class are operative, but the individual is the more so of the two, for this is the substance. And the offspring is produced indeed of a certain quality, but also as a certain 'this', and this latter is the substance. Therefore it is from the forces of all such things that the movements come which exist in the semen; potentially from remoter ancestors but in a higher degree from whatever individual is nearer (and by the individual I mean e.g. Coriscus or Socrates). Now since everything changes not into anything haphazard but into its opposite, therefore also that which is not prevailed over in generation must change and become the opposite, in respect of that particular force in which the generative and moving element has not prevailed. If then it has not prevailed in so far as it is male, the offspring becomes female; if in so far as it is Coriscus or Socrates, the offspring does not resemble the father but the mother. For as father and mother are opposed in general, so also the individual father is opposed to the individual mother. The like applies also to the forces that come next in order, for the offspring always changes rather into the likeness of the nearer ancestor, both in the paternal and in the maternal line.

Some of the movements exist actually, others potentially; actually, those of the father and the general type, as man and animal; potentially, those of the female and the remoter ancestors. Now if it lose its own nature, it changes to its opposites, but the movements which form the embryo relapse into those nearly connected with them; for instance, if the movement of the male parent relapses, it changes by a very slight difference into that of

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<sup>35</sup> Where 'parent-resemblance' is to be understood as including resemblance to ancestors on the side of the parent mentioned.

his father, and in the next instance into that of his grandfather; and in this way in the female line too the movement of the female parent changes into that of her mother, and, if not into this, then into that of her grandmother; and similarly also with the more remote ancestors'.<sup>36</sup>

There is some contrast drawn here between the male principle, which on loss of nature changes into its opposite, and the movements which form the embryo, which on loss of nature change into those most nearly connected with them. (The latter is, of course, to do with resemblance, and not with the universal species-form.) However, both changes have a similar cause: insufficient heat in the agent. In the cases of relapse into the movements of the ancestors, the agent is acted upon, and so is altered to some extent; in the case of departure from type the agent is completely defeated by its opponent and changes into its opposite. This harks back to the description of transmutation of elements into one another; qualities are active in converting another to be like themselves, passive in being converted, and the extent to which one is converted to the other depends on the intensity and the vital heat of the elements involved.<sup>37</sup>

It is clear that there must be several levels on which the battle for dominance may be waged in conception, and that the battles may be independent of each other; that is, a male child does not necessarily resemble his father, though it is probable that he will do so.<sup>38</sup>

Aristotle obviously regards the female as a departure from perfection as embodied in the type of the male adult, though he does acknowledge that it is a

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<sup>36</sup> GA IV 3 767b15-768a21

<sup>37</sup> GA IV 3 768b16-24

<sup>38</sup> GA IV 3 768a24-32

necessary one.<sup>39</sup> If the female is a departure from type, then is it likely that every unit of semen carries the potential female form? It has been suggested that there is some sort of necessity in a parallel case, that of the generation of monsters: that the matter of which humans are made can be otherwise; a potentiality for not being must be actualised at some time; so monsters must sometimes be generated.<sup>40</sup> The parallel argument would conclude that females must sometimes be generated. However, the necessity for females is a rather different one, since while any potentiality for monsters that there may be need only be actualised once, the actualisation of the potentiality for females occurs on least fifty percent of occasions. So there is some sense in which there is a permanent possibility of female-generation, but it is not clear that this is carried solely by the semen. I think it evident that the catamenia are in some way involved in this duel, not least because it is these that must be 'mastered'.<sup>41</sup> The female principles exist potentially in the semen in that the male principles therein are potentially convertible into female, and exist actually in the catamenia. Indeed, GA IV 3 refers to movements coming from the mother.<sup>42</sup>

It seems pretty clear from the text that the most the female could impart would be the nutritive *psuche* and the shape, if female; it is emphasised that the male contributes the species-form or the type (which could mean the characteristic function) and the sensitive *psuche*.<sup>43</sup> However, there are several passages which

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<sup>39</sup> GA II 3 737a28; IV 3 767b8-13; IV 6 775a15

<sup>40</sup> Preus ('Aristotle's Natural Necessity', 1969)

<sup>41</sup> GA IV 3 768b26

<sup>42</sup> GA IV 3 768a20, a35

<sup>43</sup> GA II 5 741a18-30, 741b6; III 7 757b14-30

suggest that the female can impart the more basic elements of nutritive *psuche* and shape.<sup>44</sup>

For example, the female, we are told, can generate up to a certain point unaided, and that what is generated, called a wind-egg, possesses the nutritive *psuche* in actuality, since it performs the nutritive functions.<sup>45</sup> This cannot, though, progress to the animal state without the aid of the male, for the male alone can transmit the sensitive *psuche*. This point is repeated elsewhere: GA II 3, for example, says that the unfertilised embryo possesses nutritive *psuche*, and necessarily possesses this before the sensitive *psuche*.<sup>46</sup>

If we look at the causes of windeggs, we can see that they

'... come into being because while seminal material exists in the female, birds have no menstrual discharge like viviparous sanguinea ... The same applies to fish as to birds, and so in them too is found an embryonic formation without impregnation ... The secretion corresponding to the menstrual fluid of vivipara is formed in birds at the appropriate season for the discharge of residue, and, because the region near the hypozoma is hot, it is perfected as far as size is concerned, but in birds and fishes alike it is imperfect for generation without the seminal fluid of the male'.<sup>47</sup>

We should note that wind-eggs are double coloured, just as normal eggs are (i.e. with yolk and white); this double coloration indicates that one part of it is more

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<sup>44</sup> One might think that the female could produce a plant. However, it would be such a poor specimen of plant (being unable to reproduce, for instance) that perhaps this is sufficient to explain why it is not strictly a plant, according to Aristotle, merely plant-like. But this is true also of certain low-level animals (see chapter VII).

Moraux (1985) claims Galen, believing that he was following Aristotle, held that powers of the soul flow from the temperament of the maternal blood. Regrettably, I do not have space to discuss Galen's account of reproduction and its relationship with Aristotle's.

<sup>45</sup> GA II 5 741a18-30

<sup>46</sup> GA II 3 736a36-b1 (see De An II 4), 737a30-33; III 7 757b15-20

<sup>47</sup> GA III 1 750b4-15

formal than the other.<sup>48</sup> This, then, demonstrates that the female makes at least some formal contribution, since wind-eggs are produced by females alone.

In the case of resemblance as well, there is reason to suppose that the contribution of the mother carries at least some potential influence over the embryo. For if the female component of the generation, supposedly the matter of the generation only, were wholly passive, then there would be no reason for the mother's characteristics to be perpetuated rather than any other woman's, or indeed, those of any other person of either sex. So the female contribution is not purely passive in at least this respect, as GA IV 3 768a35 tells us when it speaks of the movement coming from the mother.

Now, how many movements are involved in conception? Let us consider the semen, since this is Aristotle's favoured candidate as form-bearer: there seems to be a minimum of three 'forces' at work in this alone. (Note the plurality of movements mentioned in 767b25-768a1 quoted above.) Contributing to these are: animal; man; individual man; ancestor's characteristics. These, I suggest, cause two or three movements: one from the species and genus forces, producing an animal of a particular type; one producing a male or female of that type; and one producing particular characteristics in the individual, formed from the force of the father's characteristics actually, and the ancestor's characteristics potentially.<sup>49</sup>

The last two movements are certainly distinct: consider 768a29-30.

'But if the movement coming from the male principle prevails while that coming from Socrates does not, or vice versa ...'.<sup>50</sup>

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<sup>48</sup> HA VI 2; GA III 1 751a33-b11; III 2 753a34

<sup>49</sup> GA IV 3 767b16-768a22

<sup>50</sup> GA IV 3 768a29-30

This allows for female children resembling their fathers and male children their mothers, which the identification of the two movements would not. The principle coming from the individual Socrates produces accidental characteristics; the characteristic of sex-membership is an essential one.<sup>51</sup> This provides a further reason for believing the two to be distinct.

Are the type-movement and the gender-movement distinct? It is tempting to suppose not, since Aristotle believes the male to exemplify the type and the female to be a deviation from it. However, they must be distinct for there to be female-movement in the catamenia without type-movement, or indeed for females to exist at all.

There is, then, no battle of type-movement as the male donation of sensitive *psuche* is an addition to, not a replacement of, the female donation of nutritive *psuche*. Semen without catamenia does not get as far as structure; catamenia without semen may have some structure through the nutritive *psuche*, but cannot have sensitive *psuche*, or, indeed, any independent life.

So, while the semen carries movements for animal-type, maleness and father-resemblance, the catamenia carries only plant-type, femaleness and mother-resemblance. I think that we can conclude that these three movements are distinct from each other and differ in the two contributions.

We are told that the semen contributes the form of the new individual (though this cannot be true of the semen alone); how many of these movements are entitled to be described as 'form'? I believe that these movements are to be understood in

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<sup>51</sup> That sex is an essential characteristic is, I know, debatable. See GA I 2 716a18, b10; I 20 729a24-29; II 1 732a2-10.

the following way. The type-movement provide the species form; all individuals conceived by two individuals of type X have certain characteristics in common, enabling us to say that they too belong to type X. This movement, in conjunction with the gender-movement, provide the essence of the individual. This distinction between species form and essence seems to me to be the best way to understand Aristotle's statements that male and female differ in essence but belong to the same species. These two movements together with the third provide the form of the individual. The third movement carries the potential form of accidents, which, while not individually essential to the new individual, are so generically: the new individual must have some size and colour though none in particular.

As for the differences between the movements in the semen and those in the catamenia, the semen carries the full animal type form and can produce a perfect animal, and the catamenia carry only a plant type form, producing on their own something with the status of a plant only, or in conjunction with the male principle, a female animal resembling the mother, should those movements prevail.

What is the status of these movements? That is, are these particular or universal forms? I do not have space for a full discussion of this problem, but suspect that the answer may be that there are both species and individual forms: the father supplies the species form - we know that he provides the characteristic function of the animal. Matter plays a large part in determining the individual form, and this is supplied by both parents (even if one does not accept the split donor account, one must accept that the accidental characteristics of the offspring depend on both parents).<sup>52</sup>

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<sup>52</sup> See below, chapter VIII for discussion of the ways in which matter affects the form of the individual.

I want now to argue that only on the split donor thesis can certain elements of Aristotle's account of conception and its causes be accommodated, and therefore that the split donor interpretation is to be preferred.

Aristotle asks:

'what is the material cause of man? The menstrual fluid. What is the moving cause? The semen. The formal cause? His essence. The final cause? His end. But perhaps the latter two are the same'.<sup>53</sup>

Elsewhere, Aristotle offers other candidates for the moving cause, commonly the father, though the sun and the Deity are also possibilities.<sup>54</sup> In GA II 1 733b23-735a29 he examines the moving cause of generation in some detail.

First, 733b23-734a17 argue that the agent is a part of the embryo which exists in the semen from the beginning: it must be internal to the embryo, since contact is needed, and it must persist throughout the change. However, by 734b3, Aristotle has concluded that this part cannot exist ready-made in the semen, since

'if it exists in it from the first, it was made by that which made the semen. But semen must be made first, and that is the function of the generating parent'.

To resolve this dilemma Aristotle suggests that, like clockwork, X sets up motion in Y which sets up motion in Z. Thus, the male sets up motion in the semen which sets up motion in the embryo. Aristotle then points to the principle that a thing is made by something actually existing out of that which is potentially the same as the finished product. The male parent is in actuality what the

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<sup>53</sup> Meta VIII 4 1044a33-35

<sup>54</sup> Meta XII 4 1070b30-35; XII 5 1071a13-17; Physics II 2 194b14, GC II 10 336a32-337a1. The sun is cause for seasonal generators and for spontaneously generated animals. See chapter VII.

catamenia is potentially, and the movements are transmitted to the embryo, thus becoming 'internal' to it.

So the dilemma is to be resolved by concluding that the agent is not a material part but 'movements', existing before the change in the semen and during the change in the fetation, thus persisting throughout the change, and internal to both. The efficient cause is these 'movements'. It is the problem resulting from this identification of movements and form that I think the split donor theorist accounts for better than the strict theorist.

By identifying the efficient cause, or movements, with the (potential) form, we identify them with the (potential) internal principle of change: the problem is that the semen 'has not within itself that which makes the parts'<sup>55</sup>, the internal principle of change, though it is the movements that are responsible for the production of the embryo. Are we to accept that semen contains the potential form responsible for the production of the embryo, but not for the production of its parts, thus divorcing form and internal principle of change?

It is the nutritive *psuche* that is responsible in a practical sense for growth, development and nutrition, using the *pneuma* and based in the heart.<sup>56</sup> According to the strict account of conception, this comes from the semen; the split donor theorist locates it in the catamenia. Clearly, on the latter account, we can accept the implication that the aspect of form responsible for the production of the parts does not come with the semen, while on the strict account of conception we cannot.

The (unacceptable) divorce of form and internal principle of change resulting from this is only apparent. Though the nutritive *psuche* comes from the catamenia,

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<sup>55</sup> GA II 1 734b3

<sup>56</sup> GA II 6 741b37. See chapter IV.

the final 'recipe' is dictated by movements from both generative secretions. Thus form comes from both secretions, to different degrees, and that element of it responsible for development of the parts comes from the catamenia. The internal principle of change, identified by Aristotle with the form, also comes from both secretions in that the 'instructions' that determine the limits of the change come from both, while that directly responsible for the change comes from the catamenia.

We were told that that which makes the parts does not exist as a definite object; it is not a complete part in the semen from the beginning.<sup>57</sup> That which makes the parts, being the internal principle of change, or the form, is not an object in any sense, though it is located in the heart, and is dependent upon the *pneuma* for its proper functioning. Hence it is dependent upon matter and material objects to be able to function. The internal principle of change exists in the semen not as a definite or complete object, but in that some of the boundary conditions to be placed on the growth of the fetation exist as movements in the semen, and in that the *pneuma* in the semen will be transferred to the fetation and used in its development. Argument for this aspect of the split donor thesis will be provided in chapter V; in the next chapter, I want to examine the process of foetal development.

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<sup>57</sup> GA II 1 734b17-19

## Foetal Development

We know that foetal development is very similar in all animals, in that the animal passes through a stage of being 'plantish', before acquiring animal characteristics, and finally the characteristics peculiar to that kind of animal<sup>1</sup>; we also know that the nature of foetal development differs between animals in that in some animals, the new individual is perfect before birth, and in others the animal goes through a chrysalid stage, or an egg stage, depending on the nature and heat of the animal.

'The more perfect and hotter animals produce their young perfect in respect of quality ... and these generate living animals within themselves from the first. The second class do not generate perfect animals within themselves from the first (for they are only viviparous after first laying eggs), but still they are externally viviparous. The third class do not produce a perfect animal, but an egg, and this egg is perfect. Those whose nature is still colder than these produce an egg, but an imperfect one, which is perfected outside the body ... The fifth and coldest class does not even lay an egg from itself ... For insects produce a grub first; the grub after developing becomes egg-like (for the so-called chrysalis is equivalent to an egg); then from this it is that a perfect animal comes into being, reaching the end of its development in the third change.'<sup>2</sup>

Since there are great similarities between animals, I shall take those animals which Aristotle describes at length as standard examples, and note any differences in other animals. In HA VI 3 he describes the development of the embryo of the

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<sup>1</sup> GA III 2 753b25-9

<sup>2</sup> GA II 1 733b1-16

chick<sup>3</sup>; I think this can be taken as representative of the development of all birds, and even, to quite a large extent, of all animals.

### History of Animals VI 3

With the common hen after three days and three nights there is the first indication of the embryo; with larger birds the interval being longer, with smaller birds shorter.

We should note throughout this description that the time periods vary between animals, depending on the size of the animal, among other things, including the heat of the season.<sup>4</sup>

In a passage preceding this one, we were told that after copulation, the semen of the male is drawn up by the female to just below her midriff, where it grows and changes colour from white through red to yellow. Then the yolk and the white separate.<sup>5</sup> Now this is a very interesting passage, in that it is the semen of the male that apparently becomes the material element of the egg; this is in accordance with the split donor theory of conception I suggested above, but conflicts with the standard theory. In GA III 1, Aristotle says that both the yolk and the white are derived from the female; the semen 'sets' the fetation, so the fetation is small and white at first, but becomes yellow as it advances and more bloodlike matter is mixed with it, and finally, as *to thermon* separates off, the white settles around the outside.<sup>6</sup>

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<sup>3</sup> HA VI 3 561a5-562a21; cf. GA III 1-2

<sup>4</sup> HA VI 2 560a1, b20; GA III 2 753a17

<sup>5</sup> HA VI 2 559b6-12

<sup>6</sup> GA III 1 751b32-752a4

What is the explanation of this separation? The eggs of birds have two colours, while those of fishes have but one.<sup>7</sup> In birds' eggs, one part of the egg, *to thermon*, is closer to the form of the developing creatures, the other is further removed, and provides the matter.<sup>8</sup> What is surprising, to a modern<sup>9</sup>, is that he thought the former was the white and the latter the yolk. He did of course have reasons for thinking this: one is the similarity of white to semen, and the other is that (as he later goes on to say) just as when a liquid boils, as *to thermon* is separated off, the white settles around the outside.<sup>10</sup> So, since the hot is separated off, that which separates off outwardly must be the hot and the principle.<sup>11</sup> Note that the white separates off all round, while the yellow earthy part separates off within; that is, both separate, not merely the white from the yolk. We should also note the reference to boiling liquid - the very analogy under discussion: if *to thermon* is separated off in boiling liquid, and this is analogous to the separation of principle, what kind of separation is this? Evaporation? I think this is an unlikely explanation of the separation of *psuche*-heat. Far more likely is the emphasis on separation of two stuffs; imagine that the liquid that is being boiled is not pure water but jam: the scum rises to the top.

Why are yolk and white separate in birds and not in fish? Presumably because birds are hotter than fish, and therefore so will their eggs be, though this is an insufficient explanation. In colder animals, such as fish, *to thermon* cannot separate

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<sup>7</sup> GA III 1 751b15-17

<sup>8</sup> GA III 1 751b2-7

<sup>9</sup> and also to most Greeks: GA III 2 752b24-26

<sup>10</sup> GA III 1 752a1; see On Youth 26 479b31

<sup>11</sup> GA III 1 751b1-11, b20-752a10

off, because there is not a significant amount of it, and so the eggs are of one colour only.<sup>12</sup>

The semen is drawn up by the female into her womb because of the heat in her womb, just as cone-shaped vessels, when washed with hot water, draw water into themselves when turned upside down.<sup>13</sup> (HA X claims that the womb draws the semen in with the *pneuma*, like a nose.<sup>14</sup>) And

'after the seed reaches the womb and remains there for a while, a membrane forms around it; for when it happens to escape before it is distinctly formed, it looks like an egg enveloped in its membrane after removal of the eggshell; and the membrane is full of veins'.<sup>15</sup>

The location of the uterus varies from animal to animal<sup>16</sup>, being high, near the diaphragm, in those which lay perfect eggs and low in those that lay imperfect eggs, or are viviparous; this is due to the vital heat of the area around the diaphragm. Note that Aristotle is innocent of the myth of the wandering womb.

Presumably the change in colour and nature of the semen is due to concoction; the area round the diaphragm is hot and vital.<sup>17</sup> Certainly concoction is necessary to

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<sup>12</sup> HA VI 2 559a18; VI 10 564b25-7; GA III 1 751a31-752a10

<sup>13</sup> GA II 4 739b1-15; III 1 751a2

<sup>14</sup> HA X 2 634b35; X 3 636a5-8; X 5 637a18-21

<sup>15</sup> HA VII 7 586a19-22. On membranes, see HA V 27 555b24; VI 3 561b24; PA IV 3; GA II 3 737a35; II 4 739b25-30; II 6 743b5-10

<sup>16</sup> GA I 3 716b32-717a3; I 8 718a37-b5, b20-27; I 11 719a3-30; I 13 720a12-20

<sup>17</sup> GA III 1 750b14

the development of the embryo, though it need not be the concoction of a parent: it may be performed by the heat of the earth.<sup>18</sup>

Meanwhile the yolk comes into being, rising towards the sharp end, where the primal element of the egg is situated, and where the egg gets hatched; and the heart appears, like a speck of blood, in the white of the egg. This point beats and moves as though endowed with life, and from it, as it grows, two vein-ducts with blood in them trend in a convoluted course towards each of the two circumjacent integuments; and a membrane carrying bloody fibres now envelops the white<sup>19</sup>, leading off from the vein-ducts.

Platt suggests that Aristotle always cracked his eggs at the 'little end', since this is where he located the embryo<sup>20</sup> (in early stages of development the embryo floats to the surface wherever one cracks the egg; in later stages the chick's head is in fact at the broad - i.e. the other, less noble - end). When Aristotle writes that the young serpent grows on the surface of the soft-skinned egg, and is born inside a membrane, he must mean below the surface, but around the outside, with the 'yolk-sac' underneath it, just like the young chick.<sup>21</sup>

We know that the heart is the first part of the body to be formed, and that the blood is formed with it.<sup>22</sup> It, or the analogous organ in bloodless animals, is not only the principle of growth but of all *psuche*:

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<sup>18</sup> GA I 12 719a34; III 2 752b15-17, b29-34, 753a20

<sup>19</sup> D'Arcy W. Thompson (1910) has 'yolk', conjecturing *lekithon* in place of *leukon*. However, given the account of development in which the white forms the chick while the yolk feeds it, 'white' here makes more sense.

<sup>20</sup> Platt (1910); GA III 2 752a11-23

<sup>21</sup> HA V 34 558a26-8

<sup>22</sup> GA II 1 735a16-26; II 4 740a4-24, II 5 741b15-22, II 6 742b35-743a1, 743b26; IV 1 766a35-b3

'the heart or its analogue is the first principle (*arche*) of a natural body'.<sup>23</sup>

This is compared with the generation of plants: seeds also contain the first principle of growth in themselves, and when this has been actualised, the shoot and the root are developed, and it is by the root that the plant gets nourishment.<sup>24</sup> This is clearly parallel to the umbilicus. GA III 2 reiterates this, saying that there is a similarity between plants and animals in that the part of the embryo attached to the parent is where the principle is located. Then the rest of the body is formed, the blood vessels forming a framework to hold it together.<sup>25</sup>

A little afterwards the body is differentiated, at first very small and white. The head is clearly distinguished, and in it the eyes, swollen out to a great extent. This condition lasts on for a good while, as it is only by degrees that they diminish in size and contract.

First the parts above the hypozoma are differentiated, and are bigger in all animals in which the distinction of upper and lower exists including plants (note, incidentally, that this means that the roots appear before the shoots; the head of animals corresponds to the roots in plants).<sup>26</sup> Aristotle claims that this is because there must first exist some part in which is the principle of movement, next the whole and the end, and finally the organic parts serving these for various uses. Since the lower parts are for the sake of the upper, they are developed later.<sup>27</sup> We

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<sup>23</sup> GA II 4 738b17; II 5 741b15-22

<sup>24</sup> GA II 4 739b34-740a5, 740a25-35, b10; II 7 745b25

<sup>25</sup> PA III 5 668b20-8; GA II 3 737a36-b4; II 6 743a1-3

<sup>26</sup> GA II 6 741b25-35

<sup>27</sup> GA II 6 742a28-b18

should also remember the assumptions that Aristotle is working with, that right is better than left, and upper better than lower.

'The agency by which the parts of animals are differentiated is *pneuma*, not however, that of the mother, nor yet of the embryo itself'.<sup>28</sup>

Now, the embryo cannot inhale any breath-*pneuma*, though it could create *pneuma*, once it starts producing blood, so the differentiation of at least the heart has to be done by the *pneuma* from the semen. However:

'the heat exists in the seminal residue, and the movement and activity in it is sufficient in kind and in quantity to correspond to each of the parts'.<sup>29</sup>

The development of the parts of the body is done by heat and cold, nature using *pneuma* as a tool.<sup>30</sup> The second part of the body, after the heart, to be formed is the head, since the brain is to act as a counterpoise to the heat of the heart.<sup>31</sup> The parts of the body are formed out of the first nutriment, which oozes through the blood-vessels and is formed into flesh and bone where appropriate by the internal heat. The noblest parts, those which participate in the sovereign principle, are formed from the first and purest nutriment; those which are merely necessary for the functioning of these are formed from the inferior nutriment. So the sense-organs are formed from the best nutriment, bones and sinews from the second-best. Those parts of the nutriment which are too earthy cool as the moisture evaporates and are laid down as nails, horns, hoofs and beaks.

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<sup>28</sup> GA II 6 741b36-8

<sup>29</sup> GA II 6 743a26-9

<sup>30</sup> GA II 4 740b30; II 6 743a1-745b20; V 8 789b8

<sup>31</sup> GA II 6 743b25-32

Now, there are two kinds of nutriment, the first and the second. One is nutritious, being that which brings into being the whole and the parts, the other is concerned with growth in the sense of quantitative increase.<sup>32</sup> Sinews and bones are formed out of the seminal and nutritious residue; nails and hoofs out of the later nutriment, that which is derived from the mother, or from the outer world. Now, from where is the first nutriment derived? From the mother's generative secretion, in which case the contrast is between the catamenia and the milk, or from the semen, in which case the contrast is between this and the catamenia? According to both theories of conception, there is no nutritive matter derived from the semen; the most that is transmitted is *pneuma*, and so the first nutriment must be derived from the mother's secretion, concocted by the *pneuma*. This is confirmed if we look at a passage describing the two kinds of nourishment in eggs:

'nature not only places the material of the creature in the egg but also the nourishment sufficient for its growth ... Whereas the nourishment, what is called milk, is produced for the young of vivipara in another part, in the breasts, nature does this for birds in the egg.'<sup>33</sup>

This nourishment is not the white, but the yolk<sup>34</sup>, which becomes more fluid as it is heated.<sup>35</sup> This is essential, as the nourishment must be available in liquid form.

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<sup>32</sup> GA II 6 744b31-35. Peck implies (1953) that there is a distinction between these two sorts of nutriment throughout life, but there is no evidence for this.

<sup>33</sup> GA III 2 752b19-24, 753b22-29

<sup>34</sup> This was clearly a current debate: Aristotle says that most people, including Alcmaeon of Croton, thought the nourishment was the white; he thinks they were misled by the milky colour. Needham (1959) claims that Aristotle was closer to the truth on this point. Platt (1910) suggests the white was seen as more formal because of the principle that the more fluid is hotter than the more solid.

<sup>35</sup> GA III 2 753b1-3, b25

Though the eyes appear large to begin with, they are the last of the parts to be formed completely; this is because the brain requires so much concoction, and because the movement must be very strong before it can affect such cold parts.<sup>36</sup>

This is true also for fish.<sup>37</sup>

At the outset the under portion of the body appears insignificant in comparison with the upper portion. Of the two ducts that lead from the heart, the one proceeds towards the circumjacent integument, and the other, like a navel-string, towards the yolk. The origin of the chick is in the white of the egg, and the nutriment comes through the navel-string out of the yolk.

The navel-string, in chicks as in humans, provides for nourishment and is analogous to the first root of a plant, as we saw above. Fish embryos do not have two navel-strings but one, which in birds leads to the yolk, but which leads to the whole of the egg in fish (because the fish-eggs are of one colour, and the matter is mixed). However, its role and behaviour is the same in fish as in birds.<sup>38</sup> In cuttlefish, the 'navel-string' is attached to the head, but, just as in birds, the white substance in the egg diminishes as the young cuttlefish grows.<sup>39</sup> Interestingly, Aristotle says that the nutriment inside the stomach of the fish is white and yellow, though as we have seen, the eggs are not bicoloured. This is because, as we shall see below in the case of chicks, the white is a residue, not part of the egg-white (which has, of course, formed the embryo).

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<sup>36</sup> GA II 6 743b32-744b10

<sup>37</sup> HA VI 13 567b28-34; VI 14 568b3-7

<sup>38</sup> HA VI 10 564b28-565a12; GA III 3 754b5

<sup>39</sup> HA V 18 550a18-24

The navel-string consists of blood-vessels in a sheath, more numerous in the larger animals, down to one in the smallest animals.<sup>40</sup> Through this the embryo receives nourishment in the form of blood. Now, eggs are a little different: when inside the mother, the egg is enclosed in a soft membrane, one end of which resembles the umbilical cord in animals; when the egg is perfected, this becomes the sharp end, and this end of the egg is where the principle is located.<sup>41</sup>

Just as in plant-seeds there is a milky substance which serves as first nutriment, so there is superfluous matter to serve as first nourishment for the animal embryo. One wonders whether this milky substance is the same as that found in the eggs of insects, which are described as hard eggs like seeds with juice inside; he later says that the thin white juice in the grub of the spider is the same as the juice in the young spider.<sup>42</sup> It is interesting to reflect that Aristotle must have squeezed eggs, grubs and spiders, ripped the heads and wings off young bees and other insects, and even eaten cicadas in the interests of science (he noted the taste of these: we should observe that his opinion that the females taste better after copulation may be due to his belief that things taste better concocted).<sup>43</sup>

When the egg is now ten days old the chick and all its parts are distinctly visible. The head is still larger than the rest of its body, and the eyes larger than the head, but still devoid of vision. At this time the eyes become projecting, larger than beans, and black; if the cuticle be peeled off them there is a white and cold liquid inside, quite glittering in the sunlight, but

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<sup>40</sup> GA II 7 745b25-7

<sup>41</sup> GA III 2 752a11

<sup>42</sup> HA IV 1 525a4; V 19 550b27; V 27 555b7; PA IV 11 692a14

<sup>43</sup> HA III 12 519a27; V 22 554b4; V 30 556b5-15; V 32 557b20; GA III 1 750b23-5

there is no hard substance whatsoever. Such is the condition of the head and eyes.<sup>44</sup>

This passage certainly indicates that Aristotle, or one of his school, did some dissections of chick embryos; HA VII 3 583b15-30 indicates that aborted human embryos were also dissected.<sup>45</sup>

At this time also the internal organs are visible, as also the stomach and the arrangement of the viscera; and the veins that seem to proceed from the heart are now close to the navel. From the navel there stretch a pair of veins; one towards the membrane that envelops the yolk (and the yolk is now liquid, or more bulky than is normal), and the other towards that membrane which envelops collectively the membrane wherein the chick lies, the membrane of the yolk, and the intervening liquid.

In larger animals, that produce more than one offspring at a time, Aristotle notes that each embryo is enclosed in its own membranes, as indeed are the yolk and the white.<sup>46</sup> Membranes are formed by heat and cold, like the rest of the body; indeed,

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<sup>44</sup> Cf. De Sensu 2 438a19

<sup>45</sup> PA III 4 665a34-b1, 666a21; GA II 7 745b23-746a29; V 1 779a9 refer to aborted embryos, but not specifically human ones. Peck (1983) points out that PA III 9 671b7, which refers to human kidneys, is true not of adults but of foetuses; it is unlikely that he would have performed dissections on adult humans. D'Arcy W. Thompson (1910) says of HA I 17 497a13 that Aristotle is describing the iliac arteries as seen in quadrupeds, not man. (See also Clarke and Stannard (1963) on the transference of knowledge from the turtle to man, HA II 16; PA III 9 671b5). Elsewhere it is clear that Aristotle dissected animals (he gives advice on how best to kill them HA III 3 513a13-15), and he also seems to have gained knowledge from sacrificial victims (PA III 4 667b3).

According to Lones (1912, ch. VIII), Aristotle dissected 12 mammals, 9 birds, 4 reptiles, 2 amphibians, 10 fish, 1 ascidian, 7 molluscs, 3 arthropods and a sea-urchin. Aristotle gives anatomical details of about 110 dissected animals, but not all these were necessarily done by him.

See HA III 2 511b14-20. For references to Anatomies see HA I 17 497a32; IV 1 525a7; VI 11 566a15; PA IV 8 684b5; GA II 7 746a15.

<sup>46</sup> GA II 7 746a16-19; III 2 753b14; HA VI 2 560a27

in Aristotle's description of conception by concoction, we can see the development of the first membrane.<sup>47</sup>

For as the chick grows, little by little one part of the yolk goes upward, and another part downward, and the white liquid is between them, and the white of the egg is underneath the lower part of the yolk, as it was at the outset. On the tenth day the white is at the extreme outer surface, reduced in amount, glutinous, firm in substance, and sallow in colour.

This passage has been excised by at least one editor (Dittmeier, D'Arcy W. Thompson and Peck bracket it); I am not sure that I can make sense of it unless it is misplaced. If it is taken seriously, it appears to be describing events after the principle is differentiated, and before the chick and all its parts are distinctly visible, i.e. before the tenth day. It would then be better located at 561a25f. The white is reduced because it has been partly used up in forming the chick, which is growing around the yolk<sup>48</sup>; the yolk-sac is elongating as the chick forms and begins to use it up.

The disposition of the several constituent parts is as follows. First and outermost, next to the shell, comes the membrane of the egg, not that of the shell, but underneath it. Inside this membrane is a white liquid; then comes the chick, and a membrane round about it, separating it off so as to keep the chick free from the liquid; next after the chick comes the yolk into which one of the two veins was described as leading, the other one leading into the enveloping white substance. A membrane with a liquid resembling serum envelops the entire structure. Then comes another membrane right round the embryo, as has been described, separating it from the liquid. Underneath this comes the yolk, enveloped into another membrane (into which yolk proceeds the navel-string that leads from the heart and the big vein) so as to keep the embryo free of both liquids.<sup>49</sup>

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<sup>47</sup> GA II 3 737a35-b7

<sup>48</sup> Like 'a sort of thin plate on top of the yolk', according to Peck (GA); his diagram, p.369, is useful.

<sup>49</sup> Dittmeier excises from 'into which' to 'both liquids'.

The shell varies from animal to animal, from species to species, in colour, and in hardness and softness. Birds' eggshells are hard, while those of lizards and snakes are soft.<sup>50</sup> This is because they do not have sufficient heat to complete the process of drying the egg-shell; however, to protect the eggs, they do not produce them externally. Of course, even the shells of birds' eggs are soft before they are laid.<sup>51</sup>

However, within the shell, the disposition is very similar, varying in that in birds there is a yolk and two navel-strings, while in colder animals there is not.

As for the eggs of insects, they change noticeably after fertilisation. In some the eggs harden, in others they become granular, or change colour, or even shape, and develop a membrane.<sup>52</sup> But most interestingly, from our point of view, some eggs increase in size.<sup>53</sup> GA III 4 confirms this, saying the reason is similar to that of the growth of yeast, for yeast also grows as the more solid part liquefies and the liquid becomes *pneuma*.<sup>54</sup> In animals this is due to the nature of the vital heat, but the process must be similar.

Above, I quoted GA II 1 733a32-b16, the last sentence of which says of insects that they first produce a grub, which after developing becomes egg-like, and it is from this that a perfect animal comes into being, for example, butterflies.<sup>55</sup> GA III 9 goes further than this, and suggests that

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<sup>50</sup> HA V 34 558a27; VI 2 559a15; GA I 11 718b37-719a2; III 3 754a30-b1

<sup>51</sup> HA VI 2 559b14-15

<sup>52</sup> HA V 12 544a3; V 18 549b30, 550a16, a28; V 27 555b24

<sup>53</sup> HA V 18 550a15

<sup>54</sup> GA III 4 755a17-20

<sup>55</sup> HA V 19 551a14-552b5; V 30 556a30-b15; GA III 9 758b15-28

'pretty much all creatures seem in a certain way to produce a grub first, since the most imperfect embryo is of such a nature; and in all animals, even the viviparous and those that lay a perfect egg, the first embryo grows in size while still undifferentiated into parts; now such is the nature of the grub. After this stage some of the ovipara produce the egg in a perfect condition, others in an imperfect, but it is perfected outside as has been often stated of fish. With animals internally viviparous, the embryo becomes egg-like in a certain sense after its original formation, for the liquid is contained in a fine membrane, just as if we should take away the shell of the egg'.<sup>56</sup>

So just as Aristotle suggests that animals are 'plantish' before developing their own characteristics, demonstrating the similarities between plants and animals, there is also a suggestion that all animals develop in a similar way, demonstrating the analogies between animals of different kinds.

About the twentieth day, if you open the egg and touch the chick, it moves inside and chirps; and it is already coming to be covered with down, when, after the twentieth day is past, the chick begins to break the shell.

Kember suggests that 'if you open it and touch it' and 'after the twentieth day the eggs begin to hatch out' should be excised, because they must be additions made by someone who had not performed the experiment, since they are not true. However, the noise referred to exists, though Kember thinks it is not a chirp but the heart beat (the verb is also used at 562a17).

When can it be said that the animal has 'sense and life' (Pol VIII 16 1335b24)? Possession of the nutritive *psuche* leads us to speak of things as living, but it is possession of the sensitive *psuche* that leads us to speak of them as animals.<sup>57</sup> Oppenheimer (1975) suggests that Aristotle thought possession of the sensitive

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<sup>56</sup> GA III 9 758a31-b5

<sup>57</sup> De An II 2 413b1; GA II 3 736b1

*psuche* is betrayed by movement: he said that the first movement of the human embryo occurs on about the fortieth day if it is male, and the ninetieth if female.<sup>58</sup>

The head is situated over the right leg close to the flank, and the wing is placed over the head; and about this time is plain to be seen the membrane resembling an after-birth that comes next after the outermost membrane of the shell, into which membrane the one of the navel-strings was described as leading (and the chick in its entirety is now within it) and so also is the other membrane resembling an after-birth, namely that surrounding the yolk, into which the second navel-string was described as leading; and both of them were described as being connected with the heart and the big vein.

HA VII 8 describes the positions of other embryos in the womb: fourfooted animals lie stretched out, and the footless animals lie on their sides, but twolegged animals lie bent, and humans have their nose between the knees and their eyes on their knees. All animals have their heads upwards to start with, but when ready for birth, they rotate, and birth usually takes place head first. Even the eggs of fish shift their position as they grow; in some fish, of course, the eggs 'hatch' within the mother, and the young are born live. If this occurs, then the eggs move down from near the diaphragm.<sup>59</sup>

At this time the navel-string that leads to the outer after-birth collapses and becomes detached from the chick, and the membrane that leads into the yolk is fastened onto the thin gut of the creature, and by this time a considerable amount of the yolk is inside the chick and a yellow sediment is in its stomach. About this time it discharges residuum in the direction of the outer after-birth, and has residuum inside its stomach; and the outer residuum is white and there comes a white substance inside. By and by the yolk, diminishing gradually in size, at length becomes entirely used up and comprehended within the chick (so that, ten days after hatching, if you cut open the chick, a small remnant of the yolk is still left in connection with the gut), but it is detached from the navel, and there is nothing in the interval between, but it has been used up entirely.

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<sup>58</sup> HA VII 3 583b2-5. In fact it occurs about the middle of the seventh week, i.e. 45-6 days.

<sup>59</sup> HA VI 10 564b24, 565a18-20, 565b12

If we compare this passage with the corresponding one in GA, we learn that the first cord to collapse is the one which connects to the chorion because that is the point at which the young animal will have to make its way out.<sup>60</sup>

The yolk goes into the chick in this fashion because the chick must have nourishment as soon as it is hatched, and its mother does not nurse it (nature having put the nourishment inside the egg<sup>61</sup>) and it will not be able to fend for itself immediately.

During the period above referred to the chick sleeps, but if it is moved it wakes, looks up and chirps; and the heart and the navel together palpitate as though the creature were respiring. So much as to generation from the egg in the case of birds.

This must be the period before the chick hatches. Aristotle is interested in the state of the animal at the time of birth, describing how the infant animal spends much of its time asleep.<sup>62</sup> Birth occurs when the mother can no longer supply nourishment and the blood vessels in the umbilical cord collapse.<sup>63</sup>

### Birth as Change

I shall now briefly discuss birth as change. Perhaps conception is unsatisfactory as the end-point of the change that brings a member of the natural kind man into

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<sup>60</sup> GA III 2 754a10-15

<sup>61</sup> GA III 2 752b23-4

<sup>62</sup> GA V 1 778b20-779a25

<sup>63</sup> GA IV 8 777a22-8

being (since that which is coming to be is not of a kind at that time<sup>64</sup>); and perhaps the manifestation of the intellect is unsatisfactory, because it occurs late in the life of what we think of as a substance - but what is wrong with birth as this end-point? I do not think that Aristotle holds birth to be a significant change, and shall now offer some evidence in support of this claim.

I must distinguish two senses of 'perfect', to keep the discussion clear. One is the sense in which it is an adjective describing something flawless, the other that in which it is a verb, meaning 'to complete'; thus, 'perfection' may mean either 'faultlessness' or 'completion'. I shall term the first sense 'perfect-1', the second 'perfect-2'. In Aristotle, 'perfect-1' may describe the Deity, or, in a weaker sense, the species at the top of the hierarchy, and 'perfect-2' describes the mature individual of any species. Both these senses admit of degree.<sup>65</sup>

There is ample reason to suppose that Aristotle believed an animal was not perfect-2 for some time after birth. First, though, I mention a passage which might be offered in support of the claim that the new entity is 'of a kind' before birth.

This passage is GA II 4, which says that a fetation is perfect by the time that it is either male or female<sup>66</sup>, which distinction is certainly made before birth. However, against this one may quote GA IV 1:

'while the animal is still imperfect in its kind the distinction is already made between male and female'.<sup>67</sup>

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<sup>64</sup> GA II 3 736b2-4

<sup>65</sup> GA III 2 753a9-11; IV 4 771a10; IV 6 775a17-23

<sup>66</sup> GA II 4 737b12

<sup>67</sup> GA IV 1 763b26

These are to be reconciled by a certain qualification; the embryo may be perfect qua embryo, but not yet perfect qua substance-type X, or in its kind.<sup>68</sup> GA IV 1 seems to imply that when the heart is formed, in which the first principle 'resides', it is already determined which sex the potential animal should be.<sup>69</sup> Does this mean that the embryo is perfect once the heart is formed? If so, 'perfect qua embryo' must mean that all the forces in the male and female contributions are balanced and the form of the potential individual is completely determined. The future properties of the individual could be predicted if it were possible to determine the victorious movements within the fetation. However, I want now to argue that 'perfection qua X' occurs after birth.

The more perfect-1 the animal, the more perfect-2 its offspring at the moment it is separated from its mother.

'Some animals bring to perfection and produce into the world a creature like themselves, as all those which bring their young into the world alive; others produce something undeveloped which has not yet acquired its own form'.<sup>70</sup>

Thus eggs are less perfect-2 than live offspring - in the stricter sense of perfect-2, for they may be perfect-2 as eggs.<sup>71</sup> We have already seen how Aristotle's sense of order extends even to this matter.<sup>72</sup> However, it seems to me that even the more perfect-1 animals do not produce their young perfect-2 in their kind:

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<sup>68</sup> GA IV 8 776b1

<sup>69</sup> GA IV 1 766a30-b8

<sup>70</sup> GA II 1 732a25-28

<sup>71</sup> GA II 1 733a1-8; III 7 757b19, b24-8

<sup>72</sup> GA II 1 733b1-11

745b11-13 tells us explicitly that some lesser animals are more perfect than man at birth because they have teeth and man does not.<sup>73</sup> This clearly indicates that man is not perfect-2 at birth.

753a9-14 speaks of the differing degrees of care that the mothers of varying species give to their offspring.<sup>74</sup> It says that in humans, care continues to be given to the young until they are perfect, as with some lesser animals, and also after they are perfect; I think that this, too, indicates that Aristotle does not think that the young are perfect-2 at birth.

Pol I 13 says that the child is imperfect.<sup>75</sup> This occurs in a passage discussing degrees of intelligence; something I believe that Aristotle holds is a measure of perfection in both senses. That is, the more perfect-1 the animal-type, the more capacity for reason the individuals display, and the more capacity for reason a particular individual comes to display, the more perfect-2 he is. In this case, the child, being imperfect-2, though a member of a perfect-1 species, has not yet reached his full intellectual capacity or perfection.

We have established that neither the account of chemical combination nor the standard account of change as described above is wholly satisfactory in the case of conception, which is to be thought of as a kind of concoction in which the vital heat of the semen perfects the potentialities of the matter. I hope we have also seen that the split donor account of conception is to be preferred to the strict account; that is, that the catamenia provide the bulk of the matter and the nutritive

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<sup>73</sup> GA II 6 745b11-13

<sup>74</sup> GA III 2 753a9-14

<sup>75</sup> Pol I 13 1260a31

*psuche* to the fetation, and the semen provides the sensitive *psuche*. Argument for the claim that it also provides some *pneuma*, or vital heat must wait until chapter V; in the next chapter I want to discuss the nutritive and sensitive elements of the *psuche*, and the connection between *psuche* and *pneuma*.

## Nutritive psuche, sensitive psuche, and pneuma

In the preceding chapter, it was made clear that heat and *pneuma* are centrally important in generation, which is one of the functions of the nutritive *psuche*. The other functions are, of course, nutrition, respiration and growth. I shall discuss growth at length later; here I shall point out the significance of heat and *pneuma* in the nutritive and respirative processes, beginning with respiration. Heat and *pneuma* are also important in the sensitive *psuche*; I shall discuss *pneuma* and perception.

### Pneuma and respiration

There are at least three, and possibly more, uses of *pneuma* in Aristotle; in some passages it is in the world, usually meaning wind<sup>1</sup>, and a number of passages tell us that wine has *pneuma* in it, or is *pneuma*-like.<sup>2</sup> In the biological works, in some cases the *pneuma* is merely breath, entering by the mouth, passing down the windpipe to the lungs, whence it is distributed to the hollow parts of the lung<sup>3</sup>, and

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<sup>1</sup> Topics IV 5 127a4; VI 8 146b29; Meteor I 4 341b9, b11, b22; I 7 344b27; I 13 349a12; II 4 361b8; II 8 366a1, b4, b7; IV 3 380b16; IV 9 387a29; [De Mundo] 4 395a5, b31; HA IV 4 530a17; IV 8 535a20; IV 9 536b21; [Mechanics] 7 851b7; [Prob] XXIII 5 932a13; XXIII 11 932b30; XXV 4 938a28; XXVI 2 940b7; XXVI 3 940b15; XXVI 12 941b11; XXVI 21 942b8; XXVI 31 943b28, 944a2; XXVI 33 944a11; XXVI 34 944a26; XXVI 35 944a32; XXVI 36 944b4, b20; XXVI 48 945b8; XXVI 52 946a22; XXVI 54 946a35; XXVI 55 946b29; Pol IV 3 1290a14, 18; VII 16 1335b1

<sup>2</sup> On Sleep 3 457a17; [Prob] XXX 1 953b27, 955a35; this is presumably because it is heating.

<sup>3</sup> Meteor II 8 369b1; De An II 8 420b20; On Sleep 2 456a16; On Youth 9 471a27; 10 472a35; 11 473a2; [On Breath] 4 482b14, 483a18; 5 483a25, 483b13, b18; HA I 16 495b9; I 17 496a30; II 11 503b23; VIII 9 587a4; PA I 1 640a17; III 3

in other passages it is connate *pneuma*, crucially connected with the life of the animal that possesses it<sup>4</sup>; the relation between these two sorts of *pneuma* is not yet clear.<sup>5</sup> And at [De Mundo] 4 394b10, the author distinguishes senses of *pneuma*, including the substance found in animals and plants that brings life and generation. Though this is not an Aristotelian passage, GA II 6 741b37 also points to a real distinction between *pneuma* as wind or breath, and as generative stuff.

Now, the lungs act mechanically, filling up like a pair of bellows, and their purpose is to cool the body.<sup>6</sup> The brain is also necessary to cool the body, being the coldest of the parts of the body, and bloodless in its proper substance<sup>7</sup>; what is the difference in the two organs, and how does the cooling work? If the breath is held, heat is created, and so presumably, exhalation removes this buildup of heat; we know that at some point *pneuma* leaves from the mouth.<sup>8</sup> The brain cools the body by tempering the seething of the heart; does the brain cool the connate *pneuma* only, and therefore act in a complementary fashion to the lungs?

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664a17-18, a27, b27; III 6 669a15-17; IV 11 691b27; GA I 6 718a3; II 2 735b23; II 7 747a8; IV 6 775b1; [Prob] II 1 866b9; XXXIII 5 962a11

<sup>4</sup> For example: De Somno 2 456a12, a16, a19; [On Breath] 1 481a1, a10, a25; 2 481a29, 481b14, 482a27; 3 482a33; HA VII 7 586a15; PA II 16 659b18; III 6 669a1; De Motu 10 703a10, a11, a16, a21; GA II 6 744a3. Several passages connect *pneuma* with semen: HA VII 7 586a15; GA I 20 728a10; II 2 736a9; II 3 737b37. This is presumably innate *pneuma*; however, this will become clear later.

<sup>5</sup> There is clearly a degree of confusion: HA V 5 541a27-32 suggests that female partridges can be impregnated by the voice or the breath of the male, or if he is to windward of her. Dittmeier excises this; I too shall ignore it as unAristotelian.

<sup>6</sup> De An II 8 420b20; On Youth 11 473a1; PA III 6 668b33-669a15

<sup>7</sup> PA II 7 652b20, b26, 653a33

<sup>8</sup> Meteor II 8 367b1; On Youth 11 472b19, b30; 27 480b5; GA II 7 747a8

It is important to be clear about the physical processes that Aristotle thought were going on. When the air is breathed in, where does it first go? To the lungs or to the heart? There is a connection from the windpipe to the heart, but this is merely fat, gristle and sinew, though there is a hollow at the point of juncture; the windpipe has two branches which extend to the lungs, and these fill with air when the windpipe does.<sup>9</sup> But it is also attached to the great bloodvessel and the aorta, and, in the larger animals at least, the entrance of the air into the heart is perceptible. This I find difficult to understand, unless it means that the air rushes straight through the lungs into the blood vessels to the heart; it seems quite clear that the windpipe 'bifurcates into each of the two divisions of the lung', which leaves no room for another passage direct to the heart; so it seems unlikely that the air goes direct to the heart.

This means that when Aristotle says that a passage goes from the heart to the lung, and there divides into many smaller passages, which lie alongside the pipes from the windpipe<sup>10</sup>, he must be interpreted as saying that the passage is used by blood travelling from the heart to the lungs, and by something else travelling from the lungs to the heart. However, *pneuma* goes to the heart from the lungs.<sup>11</sup> So does Aristotle think that there is bidirectional flow through this passage (blood one way, *pneuma* the other) or that there are two sets of channels? This is never clearly explained, but the problem also crops up when discussing how the bloodflow

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<sup>9</sup> HA I 16 495b4-14; PA III 3 665a21. Ogle (1911) notes that it is not necessary to infer that Aristotle thought that the heart and windpipe communicated directly, for he supposed air could pass without any such direct channel: HA I 16 495b8; I 17 496a28.

<sup>10</sup> HA III 3 513b11-25

<sup>11</sup> HA I 17 496a30

(downwards) and the movement of *pneuma* and sensation (upwards) can coincide. The most likely account is that he thought of the process as bidirectional flow, as he does not describe two sets of channels.

So, *pneuma* is carried from the lungs to the heart, yet we are also told that the cause of breathing is in the heart and that pneumatisation occurs here.<sup>12</sup> This would seem to imply that at least some *pneuma* is manufactured in the heart, and possibly that the *pneuma* from outside is involved in this manufacture.

We know that *pneuma* is defined at one point as hot air; we also know that there is a degree of moisture in *pneuma*.<sup>13</sup> *Pneuma* is created by heat, which produces *pneuma* from liquid<sup>14</sup>; this involves an increase in volume.<sup>15</sup> Boiling occurs when the liquid is pneumatised by *to thermon*; pulsation is pneumatisation of the heat in liquid.<sup>16</sup>

Now, some of these passages mean simply evaporation; what is the pneumatisation that goes on in the heart? Peck seems to regard it as the addition of *pneuma* to the blood; Preus as the production of *pneuma* from the blood; Verbeke also thinks it is formed by the evaporation of blood in the heart.<sup>17</sup> We should also note that *pneuma* goes from the lungs to the heart, one passage to each of the two

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<sup>12</sup> On Sleep 2 456a7

<sup>13</sup> De Sensu 5 443b4; PA IV 5 682a25

<sup>14</sup> De Caelo III 7 305b14; On Youth 26 479b33; GA II 2 735b16; [Prob] XXIV 10 937a5; XXVI 33 944a14; XXVII 9 948b25; XXXIII 5 962a8; XXXIII 15 963a18

<sup>15</sup> De Caelo III 7 305b10-15; GA III 4 755a19

<sup>16</sup> On Youth 26 479b32, 480a15

<sup>17</sup> Peck (GA) p.lxiv; Preus (Science and Philosophy 1975) p.116; Verbeke (1978) p.195.

outer cavities<sup>18</sup>, that there is some separation of purer elements of the blood from the less pure, and that this occurs in the middle cavity of the heart. The blood here is intermediate in heat and quantity, but of the purest quality, and the most tranquil<sup>19</sup>, and there seem to be two sorts of blood, differing in quality but also in location: the purer is in the head.

What goes on in the heart? There is some confusion as to whether the final concoction of the nutriment goes on here or not, but it is clear that the aspect of nutrition that we are interested in here, pneumatisation, occurs in the heart.

'*Pneuma* must be present because heat and moisture are present, the former acting and the latter being acted upon'.<sup>20</sup>

Preus claims that either a/. the heat and *pneuma* in the heart separate further *pneuma* from the liquid nourishment, or b/. they change the fluid nourishment into further *pneuma*. He believes that though the first is supported by Aristotle's assertion that *pneuma* is present in all water it is the second suggestion that is correct.<sup>21</sup> That is, he claims that pneumatisation is a change, not a separation of

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<sup>18</sup> HA I 17 496a30

<sup>19</sup> On Sleep 3 458a19-20; On Dreams 3 461a25; PA III 4 667a1-5; the account Aristotle gave of the structure of the heart has been the subject of much discussion. If an animal were killed as Aristotle recommends (HA III 3 513a13-15), the right-hand-side of the heart and the blood system would be found gorged with dark blood while the left-hand-side would be almost empty, and the left ventricle flat. This not only explains why only the two right-hand-side cavities and the larger of the left-hand-side were observed, but also why he thought the blood on the right-hand-side was more abundant, less pure, and denser than on the left. See Harris (1973) pp.125-132 for further discussion.

Apparently, Aristotle's claim that large animals have heart bones (HA II 11, PA III 4) is correct; see Lones (1912, pp.125-6).

<sup>20</sup> GA II 6 742a15; cf. GC II 4 331b16

<sup>21</sup> On Youth 26 479b27-480a16; GA III 11 762a20. Preus (1975) pp.114-118.

elements, because pneumatisation is compared to boiling. If boiling were simply a separation of elements one couldn't boil away all the water in a pot. So, he suggests that when Aristotle says that *pneuma* is present in water, he means only that this is so potentially, and points out that Aristotle goes on to say that as liquids are heated a frothy bubble is formed - the froth is *pneuma* which was not present in a gaseous form until the liquid was heated.<sup>22</sup>

Preus offers several passages in support of his interpretation.<sup>23</sup> However, they are not very satisfactory as evidence. In two of the passages he offers, it is the transformation of water into air at an elemental level that is under discussion, not *pneuma*.<sup>24</sup> In the third,

'boiling is due to the *pneuma* generated by fire; but it is impossible for it to exist in the water beforehand'.<sup>25</sup>

'It' here refers to the boiling, not to the *pneuma*. Though the fourth says that semen is composed of *pneuma* and water, this is not support for his theory. However, though Preus' evidence is not acceptable, there are other passages that could be offered in its place.

Aristotle objects to the followers of Empedocles and Democritus that they make the generation of elements out of one another a process of excretion from a body of what was in it all the time.<sup>26</sup> Moreover, he says, such an account must maintain

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<sup>22</sup> GA III 11 762a24-5

<sup>23</sup> Phys IV 5 213a2; Meteor I 3 339b1; II 9 370a7; GA II 2 736a1

<sup>24</sup> Phys IV 5 213a2; Meteor I 3 339b1

<sup>25</sup> Meteor II 9 370a7

<sup>26</sup> De Caelo III 7

that a mass of matter is made heavier by compression, and cannot explain why when water turns into air, the space occupied is increased, or why the cycle of generation continues infinitely. He therefore rejects the idea that the coming to be of one element from another occurs by means of excretion.

This would seem to be strong evidence that pneumatisation and boiling are not separations but transformations; however, these may not be pure elements, as in true generations, which might make a difference. A pure generation occurs when:

'... nothing perceptible persists in its identity as a substratum, and the thing changes as a whole (when e.g. the seed as a whole is converted into blood, or water into air, or air as a whole into water), such an occurrence is a coming-to-be of one substance and a passing-away of the other'.<sup>27</sup>

In the case of pneumatisation of blood, at least, there would be residues of earthy matter if all the liquid were removed; but these residues cannot be considered as a substratum. Similarly, it is not clear that Aristotle believes pure water is obtainable, but any residue is not substratum. And he offers a practical example of such coming to be, which suggests that the impurity of matter involved is not important: the theory that there is fire in the clouds is like supposing that water, snow and hail existed all along, and emerged when the time came and were not generated at all, as if the atmosphere brought each to hand out of its stock from time to time.<sup>28</sup> Evidently the impurity of matter in such changes is irrelevant to the application of the theory, and there is indeed strong evidence that pneumatisation and boiling are not separations but transformations.

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<sup>27</sup> GC I 4 319b14-17

<sup>28</sup> held by Empedocles and Anaxagoras; Meteor II 9 369b28

He also objects to the view of Anaxagoras that all things are present in one another and do not come into being but are constituents which are separated out.<sup>29</sup> His reasons for this are, first, that every finite body is exhausted by the repeated abstraction of a finite body, so either the abstraction process will come to an end, or there will be an infinite multitude of finite parts in a finite quantity. Secondly, since every body must diminish in size when something is taken from it, and since there is a minimum quantity of X, from that minimum quantity no body can be separated out, for the remaining X would be less than the minimum quantity. Thirdly, it would follow that contraries could be predicated of the same subject, for when Anaxagoras says that a portion of everything is in everything, he says nothing is sweet any more than it is bitter, since everything is present actually and separately.

Though these arguments may not be entirely satisfactory, it is clear that Aristotle is rejecting the view that X is present actually in Y and may be obtained from Y by separation. This too seems to suggest that pneumatisation and boiling should be regarded as transformations rather than separations.

In the chapter on heat, we identified several different kinds of separation; a physical separation, the reverse of synthesis; a chemical separation due to concoction and usually used in the biological works of bodily residues and secretions; separation in the sense of differentiation of the foetus; a separation because of change of state, for example, evaporation; a separation because of the nature of the mixture - a natural, or even 'self-moved', filtering; and a kind of chemical breakdown.

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<sup>29</sup> Phys I 4; Meta I 8 989b6-14; XI 6 1063b25-30

The process here seems closest to separation because of change of state, or the biological separation. Some eggs are small when they are separated off, but grow, like yeast, because the more solid portion turns fluid, and this turns into *pneuma*. This is due to the *psuche*-heat in the case of animals and to *thermotes* in yeast.<sup>30</sup>

This process is like pneumatisation; the verb here is usually translated 'evaporate', and is used (among other things) to describe the rising of dough, the cause of belching and farting, and the 'disappearance' of the semen (it becomes *pneuma*).<sup>31</sup> This last will have to be examined more closely, but here it is important to note that it is also used to describe the cause of the pulsation in the heart and of boiling.<sup>32</sup> Is it fair to say of these last that they are evaporation? I don't think that it is, at least in our sense of 'evaporate'; it is now clear that pneumatisation and boiling are not separation in any physical sense, but are transformations. So here I am following Preus and Verbeke, rather than Peck.

Now that that has been established, we can look back at the subject that brought up this issue: the physical processes involved in breathing. We can now see that the breath-*pneuma* is carried from the lungs to the heart, and that there is also *pneuma*, probably what is known as the connate *pneuma*, created in the heart from the nutriment. The questions that must now be examined are: why are both needed? What are they responsible for? And what is the relation between *pneuma* and heat?

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<sup>30</sup> GA II 1 732b7; III 4 755a16-25

<sup>31</sup> De Caelo III 7 305b14; GA II 3 737a11; [Prob] XXI 9 927b37; XXVI 52 946a22; XXXIII 5 962a8-9; XXXIII 15 963a18; XXXVII 3 966a1

<sup>32</sup> On Youth 26 479b31, 480a15

*Pneuma* is necessary for certain bodily functions, but whether this is breath-*pneuma*, or connate *pneuma* is not yet clear. Some animals, the non-breathing ones, have only connate *pneuma*, and for them, this is sufficient for their needs.<sup>33</sup> For the larger animals, it is certainly insufficient for their cooling needs; is it also insufficient for their other needs? These include providing strength when not exhaled<sup>34</sup>, as well as enabling the animal to eat, move, reproduce, perceive and so on.<sup>35</sup>

Jaeger suggests that when Aristotle talks of connate *pneuma* he means more than merely 'connate': rather, 'of the very being or essence'. He thinks that *pneuma* is the driving force of the nutritive *psuche*, and says that *pneuma* is essential for the self-sufficiency of the animal and for its essence. So far, I am in agreement with him. But interestingly, he goes on to say that connate *pneuma* must be a substitute medium for the breath as the driving mechanism for the heart, and that when the animal becomes adult, some of the functions of the body are dependent on the breath and some are still dependent on the connate *pneuma*:

'but now the functions of moving the whole organism and cooling the blood of the heart are divided between these two *pneumata* ... The lungs transport the latter [the breath-*pneuma*] to the heart and its goal is according to Aristotle exclusively the cooling of the heat'.<sup>36</sup>

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<sup>33</sup> On Sleep 2 456a12, a16; HA IV 9 535b23

<sup>34</sup> On Sleep 2 456a16; HA VII 9 587a5; [Prob] XXVII 9 948b33; Pol VII 17 1336a38

<sup>35</sup> De Sensu 5 445a26; [On Breath] 8 485a7; HA VII 7 586a17; PA II 16 659b18; GA II 6 744a3; V 2 781a24-35

<sup>36</sup> Jaeger (1913) p.45. Translation by Jonathan Barnes.

Now this is an interesting suggestion, but I'm not sure that it is correct. There are some ambiguities in his phraseology, but it is clear that those passages he offers as evidence of the exclusivity of breath *pneuma* as coolant are not conclusive.<sup>37</sup> Rather, it seems that all animals require the inborn *pneuma* for cooling, and that in addition, it serves to permit movement for those non-embryonic animals, or breathing animals.<sup>38</sup>

What about other activities; which *pneuma* do they require? This is not an easy question to answer, not least because it depends, as Jaeger pointed out, on the kind of animal. So breathing animals use their breath *pneuma* for the sense of smell, while non-breathing animals, of course, have to rely on their connate *pneuma*.

What about generation, growth and nutrition?

Preus claims that Aristotle never calls the *pneuma* involved in generation *sumphuton*. It is true that in some places<sup>39</sup> the discussion involving *sumphuton pneuma* is limited to nonbreathing animals, but this does not mean that the *pneuma* itself is so limited, and there are several others where *sumphuton pneuma* is not.<sup>40</sup>

When the embryo is first formed, it is the heart that is the first organ developed. This is developed simultaneously with the blood in it. This is then responsible for the development of the rest of the embryo, presumably by *pneuma*: the parts of animals are differentiated by *pneuma*, though not that of the mother, nor of the

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<sup>37</sup> On Youth 22 478a30; PA I 1 642a31-b1

<sup>38</sup> PA II 16 659b17-18

<sup>39</sup> On Sleep 2 456a12; PA II 16 659b18; III 6 669a1

<sup>40</sup> Preus (Aristotle's Biological Works 1975) p.117 n.22. De Motu 9 703a9-27; GA II 6 744a3; V 2 781a24. Also [On Breath] 1 481a1, a27; 3 482a33 (though this is thought to be non-Aristotelian, it is interesting to see that the connate breath pervades the whole body, and the inspired not).

embryo itself.<sup>41</sup> Is the *pneuma* which differentiates the parts the *pneuma* from the semen? Peck claims that it is; but Preus thinks this would create an infinite regress: *pneuma* would have to be present in man and his semen in quantity if all the *pneuma* in man is inborn. But only a small percentage can be passed on each time, and a small percentage of a small percentage of a ... quickly becomes very small indeed. I am inclined to follow Peck here, and shall argue for this position below.

### Pneuma and nutrition

Since it is man that I am chiefly interested in, I shall concentrate on his digestive processes, but Aristotle is aware that these are similar in other animals, and he even draws analogies between plants and animals in this respect, though of course the similarities are fewer.<sup>42</sup>

Since all animals must take food, and the concoction and transformation of it is effected by the agency of *to thermon*, all animals must have a natural source of heat - this, of course, is the heart.<sup>43</sup> However, there is a suggestion that nutriment is a source of fuel for this heat; certainly we are not to suppose that respiration provides fuel for it.

On Youth 23 appears to deny that *to thermon* is replenished during life, saying that by old age, 'most of it has been breathed away'.<sup>44</sup> On the other hand, On Youth 27 says:

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<sup>41</sup> GA II 6 741b37

<sup>42</sup> On Length 6 467a18-b2; PA II 3 650a20-30; De Incessu 4 705b5; 5 706b5

<sup>43</sup> On Youth 4 469b6-13; PA II 3 650a3-8

<sup>44</sup> On Youth 23 479a16

'respiration takes place when the hot substance which is the seat of the nutritive principle increases. For it, like the rest of the body, requires nutrition'.<sup>45</sup>

Not that respiration provides it with nutrition; Aristotle is emphatic on that point. Rather, the expansion of *to thermon*, due to increased bulk, in turn causes the expansion of the chest, which causes the external air to rush in 'as into a bellows'; this causes the cooling and hence contraction of *to thermon* and the chest, and hence the expulsion of the external air again, now warm because it has been in contact with *to thermon*.

Evidently there has been no contact between the internal and the external *pneuma*. What causes the expansion of *to thermon* if not the pneumatisation? And what exactly is the relation between this pneumatisation and nutrition?

Aristotle's account of nutrition must be derived from many places; though we are often promised a book on nutrition, it is not extant, if it was, indeed, ever written.<sup>46</sup> However, we can learn quite a lot from these various passages.

Once the animal has caught its food, by whatever means, it eats it; the breaking up of the food in the mouth renders the action of the heat on it (concoction) easier.<sup>47</sup> The food travels to the stomach, where it is concocted by the heat in that area. This concoction, as we saw in the discussion of kinds of heat above, is

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<sup>45</sup> On Youth 27 480a16-19

<sup>46</sup> A treatise on nutrition is indicated at Meteor IV 3 381b13, De An II 4 416b31; De Somno 3 456b5; PA II 3 650b10; II 7 653b13; III 14 674a20; IV 4 678a19; GA V 4 784b2, sometimes as having been written, sometimes as a promise for the future. Louis (1952) suggests that these refer to two treatises, one early edition, which was incorporated into the first 11 chapters of HA VIII, and the second, revised edition, which unfortunately was never written.

<sup>47</sup> PA II 3 650a8-14

carried out by the natural heat.<sup>48</sup> So the natural heat concocts the nutriment, which provides fuel (in some way as yet unclear) for the sustenance of the natural heat. The solid and indigestible portion passes to the lower bowel, but the fluid portion (which alone is useful in nutrition) passes out of the stomach and into the blood vessels through the mesentery, which acts in the same way as plant roots do.<sup>49</sup> These blood vessels are like pores in jars of unbaked pottery that let water filter through.<sup>50</sup> From here it goes to various organs, several of which, such as the liver and the spleen, assist in the concoction of the food<sup>51</sup>: indeed, the heart and the liver are necessary to all animals, the first for provision of heat, and the second for concoction of the food.

The nutritive matter exhaled from the process of nutriment causes sleep; it rises, and then turns back to the heart, compressing the hot, which brings on sleep.<sup>52</sup> Then the person awakes when digestion is completed, that is, when the hot which had been compressed has prevailed, and a separation has been effected between the more corporeal and the purer blood. Is this nutritive matter the blood, and what is the role of the *pneuma*?

There is some degree of confusion and conflict both in the commentators' accounts of nutrition, and in the Aristotelian passages themselves. Quite clearly the

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<sup>48</sup> Meteor IV 3 381b8; De Sensu 4 442a5-6; PA II 3 650a8-14

<sup>49</sup> PA II 3 650a20-25; IV 4 678a4-16. Note that it is not yet blood.

<sup>50</sup> GA II 6 743a9

<sup>51</sup> PA III 7 670a21

<sup>52</sup> De Somno 3 456b21-28

result of working up the nutriment is the blood<sup>53</sup>, and according to De Somno the blood comes from food in the veins leading from the stomach to the heart:

'since the veins are the place of the blood, while the origin of these is the heart - this is clear from the dissections - it is manifest that, when the external nutriment enters the parts fitted for its reception, the exhalation enters into the veins and there, undergoing a change, is converted into blood, and makes its way to their source'.<sup>54</sup>

Here it is the product of the nutriment, an exhalation derived from the heart, which enters the veins and becomes blood.

But other passages tell us that the source of all the blood, or of the first blood, is the heart, which suggests that the heart makes the blood.<sup>55</sup>

Peck says that the food goes from the stomach to the heart, where it undergoes the main stage of its concoction whereby it is turned into blood - which is the ultimate nourishment - and an important part of this is pneumatisation. Harris agrees that the nutritive elements concocted in the stomach and intestines are carried to the heart, but suggests that they are turned into blood in the exterior cavities, whose contents are passed into the middle where the separation of the two kinds of blood takes place.<sup>56</sup>

It is clear that the separation of the blood in the heart is crucial. On either account, it is clear that pneumatisation occurs to the blood before it is passed out to the parts of the body; as we have seen, this pneumatisation is a change of state of the blood, an 'empowering'.

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<sup>53</sup> De Somno 3 456b4; PA II 3 650a2-b4; GA IV 1 765b32-5

<sup>54</sup> De Somno 3 456b1-5

<sup>55</sup> De Somno 3 458a15; PA III 4 666b24

<sup>56</sup> Peck (GA) p.lxiv; Harris (1973) p.159.

The diaphragm ensures that the source of the sensory *psuche* (the heart) is not overwhelmed by the exhalation that comes up from the food when it is eaten, or by the amount of heat introduced into the system. Is this exhalation blood or nutriment residue; that is, where is the final concoction of the food performed? We should note that:

'the nutriment coming to each part of the body is concocted by the heat appropriate to the part'.<sup>57</sup>

Clearly, even if the nutriment is almost wholly concocted in the heart, the final concoction is done 'on site'.

How is the nutriment transported around the body? The diaphragm has 'suckers' which draw up the hot residual fluid; the spleen attracts the residual humours<sup>58</sup>; how, exactly, this occurs, is not made clear. Perhaps by heat? But 'each [residue] is conveyed to its proper place without any force from *pneuma* or compulsion of any other cause'.<sup>59</sup> I think we must accept that Aristotle has no firm idea of this process; the irrigation analogy suggests that the blood is moved by pressure from the blood behind it, the plant root analogy that it is moved by suction.

The answers to some of these questions have not yet been found; in attempt to get a clearer picture of the role of *pneuma* in *psuche*, I shall now go on to discuss some other aspects of the relation of the two.

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<sup>57</sup> GA V 4 784a33

<sup>58</sup> PA III 7 670b5; III 10 672b27-30

<sup>59</sup> GA II 4 737b30. Cf. HA X 5 637a19-21

**Pneuma and perception**

According to De An II 7, there is something akin to the fifth element which is essential for perception: in perception the transparent is set in motion, and

'of this substance light is the activity - the activity of what is transparent qua transparent ... Light is as it were the proper colour of what is transparent, and exists whenever the potentially transparent is excited to actuality by the influence of fire or something resembling the uppermost body; for fire too contains something which is one and the same with the substance in question'.<sup>60</sup>

And *pneuma* and this aetherlike substance are very closely related:

*to thermon* 'is not fire nor any such force, but it is the *pneuma* included in the semen and the foam-like, i.e. the natural principle in the *pneuma*, being analogous to the element of the stars'.<sup>61</sup>

It is clear that vital heat is essential to the functioning of the organs:

'by night, owing to the inaction of the senses, and their powerlessness to realise themselves, which arises from the reflux of the hot from the exterior parts to the interior, they are borne down to the source of sense perception'.<sup>62</sup>

However, we are told that the motion of the heat of blood destroys sensory activity; the sensory movements can be broken into other forms by collisions with obstacles, for instance, when excessive internal movements due to heat generated by food fractures the images. Pleasure and pain are accompanied by heat and this affects the sense-organs; and movements due to growth (another heat-related activity) can

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<sup>60</sup> De An II 7 418b1, b7, 418b9-14

<sup>61</sup> GA II 3 736b35-7

<sup>62</sup> On Dreams 3 461a4-6

also ruin the reception of the images of sensation.<sup>63</sup> This, incidentally, raises the question why creatures with hot, thin, pure blood should be more intelligent than those without, when heat breaks up sensory impressions, and so provides the perceiver with confused perceptions.<sup>64</sup> However, perhaps it is merely that heat is relative to the perceiver, so that what is a normal perception for one animal would be broken and confused for another, colder one.

Beare writes that internal and external media are homogeneous in that both are diaphanous; external light is continued in this way into the organ, and this is what is essential for vision.<sup>65</sup> But this does not really help with the medium of the body for the sense of touch (or indeed for the other senses). However, we know that the other senses have tubes full of *pneuma* leading toward the central organ, and that touch and taste are 'manifestly in connection with the heart'.<sup>66</sup> And this passage does suggest that some solid bodies may possess transparency; these need not only be jellyfish and glow-worms, but could include internal parts of externally opaque bodies.

What, then, is the physical explanation of sensation? Examination of the account of abnormal sensation - for example, dreaming and illusion - in De Som gives us some clues as to the process that occurs in normal sensation. During the day, there are numerous sensations received but unnoticed, being swamped by the vast input of sensation. At night these re-emerge - some potential, some actual - and are carried

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<sup>63</sup> PA II 10 656b5

<sup>64</sup> PA II 2 648a2-12

<sup>65</sup> Beare (1906) p.78-9. De Sensu 2 438a12

<sup>66</sup> PA II 10 656a30; On Youth 3 469a14

towards the central sensorium, the heart, accompanying the blood, which retreats towards the heart when one goes to sleep. These movements are

'within the soul potentially, but actualise themselves only when the impediment to their doing so has been relaxed; and according as they are thus set free, they begin to move in the blood which remains in the sensory organs, and which is now but scanty'.<sup>67</sup>

There is some question as to what exactly carries the sensations. Peck says it is clear that Aristotle thought that the movements were conveyed to the heart through the blood in the blood vessels, this blood being instinct with *pneuma*; in the case of some senses the first stage of the journey is covered not by vessels containing blood but passages containing *pneuma* only. On the other hand, Lloyd argues that since blood itself lacks sensation, though sensation is confined to those parts that have blood, one cannot accept that blood itself transmits movements. He holds that they are transmitted with the blood by the *pneuma* to the heart.<sup>68</sup>

Lloyd's argument presumably uses the principle that whatever is the cause of perception in the organism must itself be especially perceptive<sup>69</sup>, but it is not necessary that blood be sensitive for it to be able to carry the sensations. However, I think that his conclusion is correct; Aristotle's belief that the passages connected to some organs carry *pneuma* and not air means that he cannot have held that the *sensa* were carried exclusively by the blood. However, the sensations and the blood are

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<sup>67</sup> On Dreams 3 461b18-9

<sup>68</sup> Peck (GA) p.593; Lloyd (1978) fn. 35. PA II 10 656b19-22, III 4 666a16.

<sup>69</sup> Meta II 1 993b24-5; see PA II 10 656a23-5

'so related that if anything move the blood, some one sensory movement will emerge from it, while if this perishes another will take its place'.<sup>70</sup>

I suspect that the best explanation is that the sensations are carried by the *pneuma* whether this is mixed with the blood or not.

There is a problem with the transmission of the *sensa* whatever one believes carries them: the problem is with the carriage of the sensations by day, when the organs are still full of blood; Aristotle, it is said, has no circulatory system in his biology. The usual account is that the nourishment and the blood travel as water does in irrigation channels, being 'siphoned off' as it passes, and travelling more and more sluggishly as its volume decreases.<sup>71</sup> There is no return journey; once the nourishment is used by the body, there is nothing to be returned.

Webb (1982) argues for the instantaneous transmission of the perceptions to the heart on the grounds i/ that the internal and external media are parallel, and ii/ light travels instantaneously through the transparent.<sup>72</sup> He claims that it is not that the *pneuma* flows but that the perceptions move through the *pneuma*, hence avoiding the problem. This is attractive, and we should also note:

'the simultaneity and speed are due to the natural correspondence of the active and passive'.<sup>73</sup>

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<sup>70</sup> On Dreams 3 461b13-4

<sup>71</sup> PA II 1 647b1-3; III 5 668a14-b2

<sup>72</sup> De An II 7 418b21-7; De Sensu 6 446a20-b17, 446b27-447a11

<sup>73</sup> De Motu 8 702a20

However, since it seems that, in some cases at least, *pneuma* or the exhalations from the nutritive matter do travel against the flow of blood (notably in the explanation of sleep), the puzzle remains.

### *Pneuma* and movement

Nutrition is perhaps the most basic level of *psuche*; even those spontaneously generated animals that do not reproduce eat. Then there is respiration, which is not possessed by all animals. Perception and movement come together, on the whole (there are of course exceptions to this): a perceiving animal has the power of movement. What is the role of *pneuma* in movement?

'the living creature is moved and goes forward by reason of desire or purpose, when some alteration has been set going on the occasion of sensation or imagination'.<sup>74</sup>

Alteration is caused in the region of the heart<sup>75</sup>; the inner regions and those around the origins of the organic members change from solid to liquid, soft to hard and vice versa. This alteration is caused by sense perceptions and *phantasia* which are usually accompanied by chilling and heating. The hot is a motive power<sup>76</sup>: heat causes expansion and cold contraction; animals move when their sinews and bones are released and slackened by these changes. So:

'the organic parts are suitably prepared by the affections, these again by desire, and desire by imagination. Imagination in its turn depends either upon thinking or upon sense-perception'.<sup>77</sup>

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<sup>74</sup> De Motu 6 701a3-5

<sup>75</sup> De Motu 7 701b24-32

<sup>76</sup> GA II 1 732a20

<sup>77</sup> De Motu 8 702a18-20; Phys VIII 2 253a17; De An III 10 433b28

Heat is crucial in movement (as is perception, and we have seen the role of *pneuma* in that capacity); the larger the animal the more heat they need to permit movement; consequently they have a lung full of heat derived from the blood.<sup>78</sup> What is the role of *pneuma* in this account? *Pneuma* contains heat, and is like air, and therefore can contract and expand without constraint, and so can pull and push for the same reason.<sup>79</sup> It is heavy compared with the fiery element and light in comparison with the other elements, so since the light is overcome and kept down by the heavier, and the heavy kept up by the lighter, it can interact with them all. Evidently the role of *pneuma* is to cause the movement of the bones and sinews when expanded or contracted by the heat within it.

How does this contraction and expansion of the *pneuma* work? We have seen references to the *pneuma* being separated, and to pneumatisation of the blood; this contraction and expansion surely seem to be of the second kind. Indeed, in discussion of insects, Aristotle says that the connate *pneuma* puffs up and subsides in the part analogous to the heart.<sup>80</sup> But the relation of this action to movement is unclear since this action of the *pneuma* continues whether the insect is moving or not - indeed this is true of all creatures. There must be some further factor involved in movement: the element of desire or choice.

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<sup>78</sup> PA IV 13 697a26-9

<sup>79</sup> De Motu 10

<sup>80</sup> De Somno 2 456a11-14

Centralisation of the *psuche*

It is clear that, at a certain stage at least, Aristotle saw the heart as the centre of life, and the location of the *psuche*:

'in sanguineous animals the heart is the first organ developed ... in bloodless animals also what corresponds to the heart must develop first. We have already asserted in our treatise on the parts of animals that it is from the heart that the veins issue, and that in sanguineous animals the blood is the final nutriment from which the members are formed. Hence it is clear that there is one function in nutrition which the mouth has the faculty of performing, and a different one appertaining to the stomach. But it is the heart that has supreme control, exercising an additional and completing function. Hence in sanguineous animals the source both of the sensitive and the nutritive soul must be in the heart, for the functions relative to nutrition exercised by the other parts are ancillary to the activity of the heart. It is the part of the dominating organ to achieve the final result ... and not to be occupied with subordinate offices'.<sup>81</sup>

This passage speaks of the heart as taking a managerial, coordinating role; though each organ has its own function, this function is subsumed under the function of the organism as a whole. Just as a hand, when detached, is no longer strictly a hand, though it is still called such, each organ has no real purpose independently of its being part of that organism. And it is the heart which maintains the smooth functioning of the organs, directed towards the purpose of the organism. This notion can also be seen elsewhere:

'there is no need then of a soul in each part, but it resides in a kind of origin of the body, and the remaining parts live by being naturally connected'.<sup>82</sup>

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<sup>81</sup> On Youth 3 468b28-469a9; On Mem I 450a30; PA III 3 665a11-13; III 7 670a23-6

<sup>82</sup> De Motu 10 703a36-b1; On Youth 4 469a35

There are other passages discussing the role of the central organ; I shall discuss a few of them, with the aim of demonstrating that they all tend toward the same point.

De Motu 7 notes the contrast between the mechanisms of artifacts and of animals; there is a change of quality at the origin in the latter case:

'the movements of animals may be compared with those of automatic puppets, which are set going on the occasion of a tiny movement ... However, in the puppets and toy wagon there is no change of quality, since if the inner wheels became smaller and greater by turns there would be the same circular movement set up. In an animal the same part has the power of becoming now larger and now smaller, and changing its form, as the parts increase by warmth and again contract by cold and change their quality. This change of quality is caused by imaginations and sensations and by ideas.'<sup>83</sup>

The difference between animate and inanimate objects here is that the animate ones can react in different ways to this 'small motion'; this is the point of the contrast implicit in 'the movement [of the wheels] would still be circular'. Inanimate or automatic objects cannot react in any way other than their preprogramming allows; the difference may well come down to that of 'awareness'. Even plants react to their environment as rocks and rivers do not, though perception is a faculty of discrimination possessed by all animals and by no plants:

'plants cannot perceive, in spite of their having a portion of *psuche* in them and being affected by tangible objects themselves; for their temperature can be lowered or raised. The explanation is that they have no mean, and so no principle in them capable of taking on the forms of sensible objects but are affected together with their matter'.<sup>84</sup>

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<sup>83</sup> De Motu 7 701b2-17

<sup>84</sup> De An II 12 424a33-b4

Traditionally it is understood that Aristotle believes plants to receive both the form and the matter of the sense-objects, but that the reception of form is not perception because it is not received in the right way; the plant has no mean with which to judge. Other interpretations claim that it is the matter of the plant that is affected, or that it receives only the matter of the percept and not the form.

Whichever interpretation one accepts, it is clear that plants fail the material condition of perception; they do not receive the forms of the percepts in the right way since they do not have appropriate sense-organs. Do they also fail the formal condition of awareness? To qualify as 'aware', one would at least have to react to the environment; plants certainly do so, though Aristotle may not have known this: consider Venus fly traps, which react to pressure by closing up and entrapping their prey, or, more prosaically, sunflowers which turn to face the sun.<sup>85</sup> Plants can be affected by several sense-objects - for instance, by heat, light and gravity - reacting to their environment with motion; how is this different from sponges or limpets reacting to pressure by clinging to their rocks - a phenomenon of which Aristotle was certainly aware?<sup>86</sup>

Plants have no mean, no central organ, no origin as animals do. The 'origin' here is of course the heart:

'as the sensory faculty, the motor faculty, and the nutritive faculty are all lodged in one and the same part of the body, as was stated in a former treatise, it is necessary that the part which is the primary seat of these principles shall on the one hand, in its character of general sensory recipient,

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<sup>85</sup> Sprague (1977-8) points out that there is no reference to the opening and closing of the petals of flowers at dawn and dusk: it is true that Aristotle does not believe that plants sleep (On Sleep 1 454a15-17, 454b26-31; GA V 1 779a1-3) though they do have an analogue of sleep (GA V 1 779a4). It is interesting to note that nutritive *psuche* functions more in sleep, a plant-like state, when the sensitive *psuche* is inactive: De Somno I 454b31-455a2; NE I 13 1102b4; EE II 1 1219b22

<sup>86</sup> HA I 1 487b10-12; IV 6 531a33-b3; V 16 548b11-14; PA IV 5 681b1-6

be one of the simple parts; and on the other hand shall, in its motor and active character, be one of the heterogeneous parts. For this reason it is the heart which in sanguineous animals constitutes this central part, and in bloodless animals it is that which takes the place of a heart'.<sup>87</sup>

Insects can live for a while when divided, but not for long, having no organs and no ability to create new ones.<sup>88</sup> This implies that although there is *psuche* throughout the animal, only part of it is creative, and this we know to be the heart (or its analogue), as GA tells us that the heart brings into existence the other organs. However, the heart cannot maintain these creative abilities in sophisticated animals, for otherwise regeneration would be possible, as it is in lower species (it has the ability to create others of the same species, of course).<sup>89</sup>

Presumably any part of a divisible plant possesses this creative ability, though we should note that even plants grow out symmetrically from one point.<sup>90</sup> The difference between the nutritive *psuche* and the sensitive *psuche* in this respect does not lie solely in their divisibility, for both are actually single, but potentially plural:

'the sensory soul is in all animals actually one, so that the part in which it primarily abides must also be one. In sanguineous animals this oneness is not only actual but potential, whereas in some bloodless animals it is only actual. Hence in the selfsame place must necessarily be the source of heat; and this is the cause of the warmth and fluidity of the blood';  
'just as in the case of plants which when divided are observed to continue to live though separated from one another (thus showing that in their case the soul of each individual plant was actually one, potentially many), so we notice a similar result in other varieties of *psuche*, i.e. in insects which have been cut in two';

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<sup>87</sup> PA III 1 647a25-32

<sup>88</sup> On Length 6 467a21

<sup>89</sup> HA II 17 508b5-7; VI 5 563a15

<sup>90</sup> On Youth 3 468b19-21

'the nutritive *psuche*, in beings possessing it, while actually single, must be potentially plural. And so it is too with the principle of sensation'.<sup>91</sup>

The actuality (or potentiality) of the unity and plurality of *psuche* and its seat is related to the divisibility of the organism, and the hotter the animal, the greater its unity. So the difference is that the sensitive *psuche* demands a greater degree of unity in the organism; the higher the degree of *psuche* possessed, the more the organs have subsumed their own function in that of the unity. So much so that if the organism becomes divided, its parts fail to survive.

Interestingly, the boundary between plant and animal, acknowledged to be vague, is clarified by the fact that plants appear to have no centre in the way that animals do; they have no part analogous to the heart:

'every part of a plant contains potentially both root and stem'.<sup>92</sup>

Thus, plants can regenerate, where animals cannot:

'It is a fact of observation that plants and certain insects go on living when divided into segments; this means that each of the segments has a soul in it identical in species though not numerically; for both of the segments for a time possess the power of sensation and local movement. That this does not last is not surprising, for they no longer possess the organs necessary for self-maintenance. But all the same, in each of the parts there are present all the parts of soul, and the souls so present are homogeneous with one another and with the whole - the several parts of the soul being inseparable from one another, though the whole soul is divisible'.<sup>93</sup>

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<sup>91</sup> PA III 5 667b24-27; De An II 2 413b17-24; On Youth 2 468b3-4

<sup>92</sup> On Length 6 467a23; but On Youth 2 468a37

<sup>93</sup> De An I 5 411b19-26; see also De An I 4 409a8-10; On Length 6 467a18-29; On Youth 2 468a27; HA IV 7 531b30; Prog Anim 7 707a24

Is there a difference between the nutritive *psuche* of plants and that of animals? It might seem so, since in one the organs can survive alone while in the other they cannot; in the plant the nutritive *psuche* is not very centralised: any part of the plant contains the potential to produce a perfect new plant. Lower animals 'have not got one vital centre but many'<sup>94</sup>; they can, to some extent, survive when divided. The upper animals are unities in the highest sense, having only one vital centre; but, as we shall see, the organs even in the animal retain some psychical sensitivity.

The important point is that the animal does not die because it cannot regenerate lost organs, it dies because of the very lack of those organs: the functions of the parts of the body have become increasingly specialised, so that no longer can any unit sustain life, as units can in the lowest forms of life. Each part or faculty of the entity depends on, and is interrelated with, others.

One last strand in the idea of heart as centre and the indivisibility of the *psuche* must be described, and this is that, though it is tempting to say that Aristotle held the heart to be central in that it is essential (remove a leg, and the animal may survive, but remove the heart and it dies), there are apparently opposing passages: where we might talk of the motion of a chicken after its head had been cut off, Aristotle mentions tortoises:

'divisible animals are like a number of animals grown together, but animals of superior construction behave differently because their constitution is a unity of the highest possible kind. Hence some of the organs on division display slight sensitiveness because they retain some psychical susceptibility; the animals continue to move after the vitals have been abstracted: tortoises, for example, do so even after the heart has been removed'.<sup>95</sup>

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<sup>94</sup> PA IV 6 682b5, b26-34

<sup>95</sup> On Youth 2 468b10-15; 23 479a5-7; HA II 11 503b23

Other passages too refer to organs within an organism as like living creatures.<sup>96</sup>

What does this say about the location of the soul? And what is this psychological sensitivity? It is clearly time to discuss the nature of the organs, both the central organ and others, especially those of sense.

In the Parva Naturalia, Aristotle indubitably believes in the idea of a common sense:

'all sanguineous animals have the supreme organ of the sense faculties in the heart, for it is here that we must look for the common sensorium belonging to all the sense-organs. These in two cases, taste and touch, can be clearly seen to extend to the heart, and hence the others also must lead to it, for in it the other organs may possibly initiate changes, whereas with the upper region of the body taste and touch have no connection. Apart from these considerations, if the life is always located in this part, evidently the principle of sensation must be situated there too, for it is qua animal that a body is said to be a living thing, and it is called animal because endowed with sensation'.<sup>97</sup>

Note that the sense-organ is said to extend into the body to the heart in at least two cases; this suggests that the sense-organ itself goes back that far, rather than that the organ is connected by passages to the heart. And, as we know, other sense-organs have tubes full of *pneuma* extending back into the body, and the ones that do not obviously have such passages are also said to be in connection with the heart (or its analogue).<sup>98</sup> Again, On Dreams tells us that the affection continues in the sensory organs, both in their deeper and in their more superficial parts not

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<sup>96</sup> PA III 4 666b16-17; De Motu 11 703b21-25

<sup>97</sup> On Youth 3 469a10-19; De Sensu 7 449a9-11; De An III 2 426b15; De Sensu 2 438b8; PA IV 5 678b4

<sup>98</sup> De An II 8 420a4-5; PA II 10 656a29, 656b17; GA II 6 743b35-744a5, V 2 781a19-25. Webb (1982), following Neuhäuser, argues that the central sense-organ is constituted by the natural heat, or by the *pneuma* which has it. It is true that this 'organ' is in the heart, not identical with it, but that heat or *pneuma* should be perceptive, any more than blood, seems unlikely.

merely while engaged in perceiving but also after.<sup>99</sup> All this may imply that the organ is not an 'independent' entity located on the surface of the body, but is essentially connected to the heart: each organ of sense includes the heart as part of the organ; the heart 'contains the origins of the senses' in a literal sense.<sup>100</sup> Such a doctrine has obvious connections with doctrines of the unity of the entity and the psychical sensitivity of its organs.

Does De Anima contain elements of this theory? That it does could be argued for on several grounds. One such is that it contains argument for one central discriminatory agency.<sup>101</sup> Another is a passage on acting with the sensitive mean; again, this implies that there is some central sensorium.<sup>102</sup>

Then we have De An III 7, which speaks of thinking as being a process

'like that in which the air modifies the pupil in this or that way and the pupil transmits the modification to some third thing (and similarly in hearing) while the ultimate point of arrival is one, a single mean, with different manners of being'.<sup>103</sup>

Here again, the idea that all perceptions arrive at some central point is taken to be so acceptable that it can be used as an analogy for some other, more difficult idea.

And we saw that plants lack a central organ, and so are divisible. So it could be argued that De Anima refers to a central organ of sense for animals on the grounds that while plants cannot perceive because their temperature can be raised

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<sup>99</sup> On Dreams 2 459b1-25

<sup>100</sup> De Motu 11 703b24

<sup>101</sup> De An III 2 426b17-29; II 11 423b23; III 4 429a26; III 7 431b5

<sup>102</sup> De An III 7 431a10

<sup>103</sup> De An III 7 431a15-19

and lowered, they have no mean, and no principle within them capable of taking on form, none of this is true of animals, because animals possess a heart.<sup>104</sup> Animals can perceive precisely because they possess some central mean or organ.

Interestingly, the centralisation of the vital principle is also necessary for movement, providing an axis point. This explains why plants cannot move, lacking centralisation. It will be objected that the *psuche* of insects is also less centralised, yet they can move. However, these insects are insected, with a pair of legs or wings in each section.<sup>105</sup>

Now that centralisation has been discussed, the answers to some of the puzzles may be clearer. The faculties of sensation, motion and nutrition are situated in the same part of the body, i.e. the vital centre: the heart or its analogue.<sup>106</sup> The heart is the starting point of the vessels and contains the force by which the blood is first fashioned.<sup>107</sup> All the viscera are composed of the same material because they are situated on the channels of the blood vessels and on the points of ramification; the viscera are like deposits left by the current of blood in the bloodvessels.

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<sup>104</sup> De An II 12 424a32-b3

<sup>105</sup> PA IV 6 682b4-6, b29

<sup>106</sup> De Somno 2 456a1-5; On Youth 1 467b34; 2 468a23; PA IV 5 681a35, 682a2-8

<sup>107</sup> PA II 1 647b2-7; GA IV 1 766a12. Boylan (1984) thinks that this implies that the blood has creative ability, but as Peck points out (GA), this is a further reference to the two kinds of nourishment.

The heart must retain, to some degree, this original force: after all, some parts of the body can be regenerated if necessary.<sup>108</sup> The heart and the blood are first to be formed: the blood is prior to the organs.<sup>109</sup> Presumably at this stage only the nutritive *psuche* has been developed; there are no organs yet for the sensitive *psuche* (as we know, the organs and the faculties are developed simultaneously<sup>110</sup>), so there is nutritive *psuche* throughout the body, just as in plants. Then, with the introduction of the sensitive *psuche*, centralization occurs in some way, and the parts of the body lose the creative ability possessed by the lower animals. The heart retains its position as the guiding centre of the nutritive and sensitive functions of the *psuche*. In the next chapter, I want to discuss the remaining function of the *psuche*: rationality.

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<sup>108</sup> The eyelids, the jaw and the foreskin cannot: HA I 13 493a27-9; III 11 518a2; PA II 13 657b4; membranes do not: HA III 12 519a27; III 13 519b5; 15 519b17; plants certainly regenerate: On Length 6 467a12; GA I 18 722a14

<sup>109</sup> GA IV 1 764b32-6

<sup>110</sup> GA IV 1 766a5-7

## Rational psuche and pneuma

So far the transmission of the nutritive and the sensitive elements of the *psuche* of man alone have been discussed; I now turn to the third, rational *psuche*. This is characteristic of man, who may be, indeed, identifiable with this rather than with any other part of him.<sup>1</sup> It is of peculiar importance in this discussion because the point at which an individual comes to possess a function characteristic of a kind may well be the point at which that substantial change is complete:

'because the end is developed last, and the peculiar character of the species is the end of the generation of each individual'.<sup>2</sup>

As Aristotle says, the acquisition and source of the rational faculty in particular is a very difficult problem.

There are many important issues in Aristotle's psychology and philosophy of mind that I shall be forced to mention only briefly, or to ignore entirely; however, brief as my discussion must be, consideration of some aspects of Aristotle's philosophy of mind concerned with rationality is needed to gain a clear picture of the place of the intellect in his account of the development of living substance, which is itself necessary in discussion of substantial change.<sup>3</sup>

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<sup>1</sup> NE IX 4 1166a17, a23; IX 8 1168b30-1169a2; X 7 1178a1-7

<sup>2</sup> GA II 3 736b3-4

<sup>3</sup> It is an account of the development of the characteristic function of man that is sought; this will differ in animals of lesser order.

Transmission of the *psuche*

I shall begin by discussing the source of the intellect; inevitably, the question of its nature will arise in the course of the discussion. My claim will be that, like the sensitive *psuche*, the rational *psuche* is dependent on the semen for entrance into the fetation, but that, unlike the sensitive *psuche*, it is not the movements within the semen that transmit it (or not directly): it is dependent on the *pneuma* or vital heat in the semen.

In GA II 3 Aristotle tackles this question:

'When and how and whence is a share in reason acquired by those animals that participate in this principle?'.<sup>4</sup>

He offers a discussion of the possible sources of the faculties of the *psuche*<sup>5</sup>:

the faculties appear in the fetation either

- I/ without coming from outside
- or II/ coming from outside either A/ independently of matter  
or B/ in the semen.

If IIB/, then the faculties appear in the male, or in the semen,

- 1/ without coming from outside
- 2/ coming from outside either a/ independently of matter  
or b/ in matter.

Those elements of the *psuche* inseparable from the body can at no stage exist apart from the body; they can neither exist before it nor enter from outside, but must be generated in the embryo.

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<sup>4</sup> GA II 3 736b5-8

<sup>5</sup> GA II 3 736b15-21

On a first reading of this passage, it appears that Aristotle believes the nutritive and sensitive elements to be inseparable, but that reason is not only separable from the body, but from all matter, entering the fetation from outside.<sup>6</sup> A second look, though, may lead one to distrust this interpretation, and I intend to discuss this chapter in some detail in an attempt to make matters clear.

'Coming from outside' might mean one of several things: the intellect might originate outside the fetation, entering it either in some immaterial fashion (in the 'divine semen' of the Brentano interpretation, perhaps<sup>7</sup>), or with the semen. And if it enters with the semen, then the question arises again; where did it originate? It might have originated outside the semen, and enter that in some fashion, material or immaterial, or it might have originated in the semen. True, GA II 1 taught that no part, no organ, of the embryo can preexist in the semen; but intellect is not a faculty that possesses an organ, so it could 'come from outside' in some way in which the sensitive faculties could not.

It has been suggested that the discussion of intellect coming from outside is not accepted by Aristotle, but is exposition of an opponent's position set out for the purpose of dialectic.<sup>8</sup> In such a case, the intellect too, is, in Aristotle's view, generated in the fetation without coming from outside. While this is attractive, and, I think, true in part, I do not think that it quite captures the complexity or the emphasis of GA II 3, which I shall now examine.

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<sup>6</sup> GA II 3 736b28-9

<sup>7</sup> As Brentano does, (1977) p.135. Indeed, Brentano (1978) goes so far as to say (p.111) that there exist two semens, an incorporeal one as well as a corporeal. There is no evidence for such a view in the biological works; moreover, that the transmission of rational *psuche* is due to action of the Deity is quite alien to Aristotle's usual view of the Deity, in which he is not concerned with human affairs.

<sup>8</sup> by Moraux (1955)

736a25 Aristotle begins by assuming something for which he argued earlier (in GA I 21): that semen is not an ingredient in the fetation, but performs its function by means of the principle that it contains. He then asks what becomes of the physical part of the semen.

To answer this, apparently we need to know two things: a/ whether the fetation incorporates any part of the semen; b/i/ whether *psuche* is in the semen and the fetation to begin with, and ii/ where it comes from.

Now, why should Aristotle need to raise the first question again? It has already been answered, and indeed is part of the assumption just made, the consequences of which he is examining. I suggest it is that discussion of question b/ will result in a modification of the previous answer to a/, and hence of the original assumption. Discussion of the rational *psuche* and its connection with matter will elicit the conclusion that some matter is transmitted from the semen into the fetation. (This is the one part of the split donor thesis that has not yet been discussed.)

After raising these questions, Aristotle immediately begins to answer b/. At first he begins with a rather crude analysis, but soon notices a problem:

736a35 semen and fetations possess nutritive *psuche*

736b1 while developing, they acquire sensitive *psuche*

736b5 questions concerning the acquisition of the rational *psuche* are more difficult to answer because the characteristic function is acquired last.

Why should this be a particular difficulty? Moraux suggests that it is because Aristotle holds that the development of reason is conditioned by the physical development of the individual, while tempted by the view that the intellect is radically independent of the body, even in its origins. This, I think, is more of a

solution to the question of the nature of the acquisition of the intellect than a statement of the difficulty of the question. Aristotle has told us that the questions are difficult because the characteristic function is acquired last; the puzzle is why, if the intellect enters the fetus at the same time as the other faculties, it is not manifested until so much later; and if it does not enter with the other faculties, when, and how, it is acquired.

Aristotle starts again, aiming for greater accuracy, and produces an answer to *bi/*. 736b9 semen and fetations which are not separated from the parent possess nutritive *psuche* potentially, but not actually.

736b14 indeed, each *psuche* must be possessed potentially before being possessed actually.

*Psuche* is in the semen and the fetus potentially. I do not think that this can be the final answer to *bi/*, since he will later assume that the catamenia, or unfertilized embryo, possess the nutritive *psuche* in actuality.<sup>9</sup> Still, we can observe the modifications to the first attempt: being inseparable, the nutritive and sensitive elements must come into being in the embryo without existing previously outside it - in actuality at least; the movements responsible for the sensitive *psuche* are transmitted via the semen. We can also see that he has resolved part of the puzzle of the intellect, since it must be possessed potentially before being manifested.

Aristotle proceeds to discuss *bii/*, setting out the possible routes for entrance of the faculties into the embryo<sup>10</sup>, concluding:

736b24 those principles whose activity is physical cannot come from outside.

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<sup>9</sup> See chapter II.

<sup>10</sup> GA II 3 736b15-21

The transmission of the nutritive and sensitive elements of the *psuche* has been dealt with: reason remains. The various possibilities concerning the origin of the intellect have not yet been excluded. Although it has been ascertained that the intellect must be possessed in potentiality for some time before its manifestation, the possibilities remain that the potential for rational *psuche* is either acquired at conception, with the material semen or without it, or later than conception in some unfathomable immaterial way. (A material entrance is, of course, limited to the moment of conception.) I suggest that the passages which follow, by claiming a material basis for the intellect, and by describing its entrance into the fetation at conception, are designed to limit these possibilities; and in so doing, they provide an answer to the questions raised at the beginning of the chapter. That is, I suggest that the potential rational *psuche* is dependent upon matter in its acquisition by the fetation; the commonly accepted view is that, like the potential sensitive *psuche*, the potential intellect is borne by the semen, but is transmitted in the form of movements, with no transmission of material. I quote the controversial passages at some length:

736b27 'It remains, then, for the reason alone so to enter and alone to be divine, for no bodily activity has any connection with the activity of reason.

736b29 Now it is true that the faculty of all kinds of *psuche* seems to have a connexion with a matter different from and more divine than the so-called elements; but as one *psuche* differs from another in honour and dishonour, so differs also the nature of the corresponding matter. All have in their semen that which causes it to be productive; I mean what is called vital heat. This is not fire nor any such force, but it is the *pneuma* included in the semen and the foam-like, i.e. the natural principle in the *pneuma*, being analogous to the element of the stars. Hence, whereas fire generates no animal and we do not find any living thing forming in either solids or liquids under the influence of fire, the heat of the sun and that of animals does generate them. Not only is this true of the heat that works through the semen, but whatever other residue of the animal nature there may be, this also has still a vital principle in it. From such considerations it is clear that the heat in animals neither is fire nor derives its origin from fire.

737a7 Let us return to the material of the semen, in and with which is emitted the principle of *psuche*. Of this principle there are two kinds; the one is not

connected with matter, and belongs to those animals in which is included something divine (to wit, what is called the reason), while the other is inseparable from matter. This material of the semen dissolves and evaporates because it has a liquid and watery nature. Therefore we ought not to expect it always to come out again from the female or to form any part of the embryo that has taken shape from it; the case resembles that of the fig-juice which curdles milk, for this too changes without becoming any part of the curdling masses.<sup>11</sup>

Morax holds that the difficulty peculiar to discussion of the acquisition of the rational *psuche* is that while its development is conditioned by the physical development of the individual, it is radically independent of the body, even in its origin. He concludes that 736b15-b29 describes the second horn of this dilemma, and that 736b30ff revises it by pointing out that reason too has a connection with matter.

I think that there is some truth in this interpretation, in that the ability to reason is dependent on the development of the body, and that 736b30-737a7 does correct the view that the rational *psuche* is radically independent of the body. However, I am not sure that Aristotle is, in 736b15-b29, describing the view of a Platonic opponent; I have above suggested that 736b15-b29 is an essential part of Aristotle's discussion of the origin of the faculties of the *psuche*. 736b28-b29 is the only sentence which could be read as a statement of an opposing view, and this is surely a statement of one of the possibilities of origin. It is not peculiarly Platonic; Aristotle himself may feel some temptation to accept this, but is dissuaded by the subsequent argument.

Having misunderstood the nature of the problem peculiar to the rational *psuche*, Morax is led to misinterpret the structure of the passage designed to solve it. Instead of being aimed solely at revision of the view that reason is radically

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<sup>11</sup> GA II 3 736b27-737a16

independent of matter, these passages are designed to answer the questions raised at the beginning of the chapter. The structure of these passages can be glossed as: 'the one remaining possibility is that reason comes from outside; however, since reason too is connected to matter, this cannot be the case; like the movements for the sensitive *psuche*, the potentiality for rational *psuche* is carried by the semen and transmitted when the semen gives up its *pneuma*'.

I must now provide some argument for this claim. I shall argue first for the claim that the intellect has some material basis, and secondly, for the claim that the material basis of the intellect is transmitted via the semen to the fetation. Finally, I must provide some account of the intellect with respect to its material basis.

### *Pneuma and the rational psuche*

What is the significance of the correspondence between quality of matter and quality of *psuche*? The most honourable essence is rationality, which the Deity possesses in perfection. We know that the sensitive *psuche* is inseparable from matter, and that the pure rational *psuche* as manifested in the Deity is immaterial; what of the human intellect, which is midway between these in value?

The introduction of the infamous fifth element here must be of significance, providing a solution to the problem of the source of reason, and the solution must lie in the connection between this 'more divine' matter and *psuche*. That there is a connection is clear: Aristotle moves from 'all kinds of *psuche* seem to have a connection with a matter different from and more divine than the so-called elements' to 'all semen contains *pneuma* and its principle, which is analogous to the fifth element'. GA III 11, on spontaneous generation, also indicates a connection

between the honour or value of the living thing and the matter of which it is composed.<sup>12</sup>

*Pneuma* is connected with vital heat in this passage<sup>13</sup>, and, as I have claimed above, I think that we may understand vital heat to be the form of *pneuma*, being 'the natural principle' within it. The vital heat is analogous to the fifth element in that it is that which makes the semen productive; this is a reference to the generative heat of the heavenly bodies, particularly the sun, which is quite unlike fire. However, these two heats are not quite analogous, since vital heat is liable to decay, and the fifth element is not.<sup>14</sup>

Blood is composed of water, earth and *pneuma*, as is semen<sup>15</sup>; but the ratio of *pneuma* to water is greater in semen, since semen is concocted blood (hence, of course, its generative power). It is the vital heat contained within the *pneuma* that is most essential to the nature of blood; blood and semen are hot only so long as they retain their nature. Once this is lost, they have lost their heat, and all that is left is their matter, which is nothing but earth and water.<sup>16</sup>

All animals possess *pneuma*; it enables them to perform their functions, including perception, motion and reproduction.<sup>17</sup> The amount of vital heat possessed by an animal affects the quality of its blood, and:

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<sup>12</sup> GA III 11 762a19-27

<sup>13</sup> GA II 3 736b35-6

<sup>14</sup> De Caelo I 3

<sup>15</sup> Meteor IV 10 389a20; GA II 2

<sup>16</sup> Meteor IV 11 389b10-12

<sup>17</sup> De An II 8 420a3-12; GA II 3 736b34-37; II 6 741b37, 744a3; III 11 762a19-28, V 2 781a25; De Motu 10

'the character of the blood affects both the temperament and the sensory faculties of animals in many ways'.<sup>18</sup>

Animals possessing thick blood will be strong and courageous, since the fibrous earthy matter in their blood will be easily heated. Those animals with thinner blood will have more intelligence and sensitivity, though they tend to be timid (their blood has fewer fibres, and so does not heat up so easily<sup>19</sup>). The best blend is hot and thin blood, which allows for intelligence, sensitivity and courage, and this is possessed by man: that this is so is shown by his possession of intellect.<sup>20</sup> So a certain quantity of vital heat is a condition of the manifestation of the rational *psuche*, and the more *pneuma* an animal possesses, the higher the value and complexity of its own *psuche*, and of that it can impart in its semen.

One of the conditions for the existence and proper functioning of the lower levels of *psuche* is the development (by the *pneuma*) of physical organs enabling the organism to function at these levels; these organs are of course composed of the standard four material elements. Rationality does not require any particular organ; but it does require that the organism be sufficiently developed in other respects - that is, that it possess perception, imagination, memory and so on, and these require bodily organs.

Conditions of the manifestation of the rational *psuche*, then, are possession of a sufficient degree of vital heat, or amount of *pneuma*, and possession of lower levels

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<sup>18</sup> PA II 4 651a12-13

<sup>19</sup> An important example of this is the deer. In animals which have been coursed, the blood coagulates imperfectly; it would be natural to conclude on capture that their blood was of a different kind to that of oxen. Meteor IV 7 384a25-29; HA III 6; III 19 520b24; PA II 4 650b14-651a7. (See D'Arcy W Thompson 1910, Ogle 1911).

<sup>20</sup> PA II 2 648a2-11; GA II 6 744a28-30

of *psuche*, for which also a certain level of *pneuma* is needed. Imperfect animals, and indeed the semen, either have not got enough *pneuma* or are not sufficiently developed at a lower level of *psuche* to be able to manifest rationality.<sup>21</sup>

The *pneuma* is not identifiable with the intellect; the intellect has no bodily organ. However, it (or a certain amount of it) is a necessary precondition of the manifestation of intellectual capacities. so I suggest that 'the faculty of *psuche* of every kind has to do with some physical substance which is different from the so-called 'elements' and more divine than they are' is to be understood in this sense: for the manifestation of abilities at all three levels of *psuche*, *pneuma* is needed; indeed, *pneuma*, heat and the concept of life or living substance are strongly connected.<sup>22</sup> Reason, though, has a connection with this kind of matter alone, not having an organ. Pure rationality is wholly immaterial; the sensitive *psuche* is connected to the four common material elements, in that it requires a body composed of them. *Pneuma* plays an important part in both the rational and the sensitive *psuche*; the human intellect is not entirely immaterial, both because of its relation to *pneuma*, and because it is realised in human bodies, i.e. the four sublunary elements. *Pneuma* is different from, and more divine than, the heat of fire (hence, though *pneuma* is hot air<sup>23</sup>, it is not merely fire and air), being like the generative heat of the heavenly bodies.

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<sup>21</sup> The account of semen given above claimed that there is extra *pneuma* added to the semen just before emission; perhaps we can now see a reason for this addition, and for the difference between men and fish in this respect. See GA I 6 718a2-10.

<sup>22</sup> De An II 1 412a13; II 2 413a20-25; II 8 420b20; III 12 434a22-6; De Iuv IV 469b6-20; VI 470a20; De Resp VIII 474a25-8, b10-24; De Vita I 478b21-479b5; PA II 7 652b7-16; GA III 11 762a19-28

<sup>23</sup> GA II 2 736a2

One might well expect there to be some such connection between reason and the fifth element, which is the element of the stars. The fifth element fills the space between our world and the outermost heaven, varying in degree of purity and of kind in proportion to its distance from our world.<sup>24</sup> Hence it is purest when composing the heavenly bodies, which are thinking substances, desirous of imitating the Deity<sup>25</sup>, which is the most perfect thinking substance, and wholly immaterial.

I am here only putting forward the relatively uncontroversial statement that the rational *psuche* can only be manifested in organisms of a certain material type, i.e. those with organs in a certain state, and with a certain degree of internal heat and *pneuma*. I shall later examine the more controversial claim that *pneuma* is necessary in the thought processes, and not just as a precondition for thought. This will not be necessary to the main thrust of my argument in this chapter, which is that it is the *pneuma* within the semen which is responsible for the transmission of rational *psuche*, and that this *pneuma* becomes part of the fetation; however, there is good reason to believe that *pneuma* plays an important part in the physical explanation of the nutritive *psuche* and the sensitive *psuche*, and so the suggestion that it is significant in the workings of the rational *psuche* should also be examined, and taken seriously, if not, in the end, accepted. However, first, I want to discuss the way in which the rational *psuche* is transmitted to the embryo.

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<sup>24</sup> De Caelo I 2; Meteor I 3 340a17, b6-11, b31. There is some suggestion that the transparent, whether it is air or water, is so because it contains some of this fifth element. See De An II 7 esp. 418b7-14; GA II 3 736b37; III 11 762a19-20.

<sup>25</sup> Meta XII 7 1072a21-35

### The transmission of the rational *psuche*

We have seen that after raising the possibility (736b28) that reason enters from outside, being immaterial, Aristotle concludes (by 737a7) that reason has a material basis, the *pneuma* or vital heat. It is now time to discuss that aspect of the split donor thesis which claimed that *pneuma* is transmitted from the semen to the fetation, together with the last section of the controversial passage, GA II 3 737a8-18.

'Let us return to the material of the semen' writes Aristotle. At last we return to the original question raised at the beginning of GA II 3: what happens to the physical part of the semen? Two things are of note here: first, that the movements within the semen may be inseparable from matter. Nowhere else has Aristotle suggested this; 736b25, which might be thought to do so, must be talking of ready-made faculties, since he asserts that they cannot enter in matter, since semen is (merely) a residue. If this were read as referring to the movements, it would make nonsense of the theory of generation expressed by GA.

Secondly, the physical part of the semen is distinguished by Aristotle in this passage from the matter from which some of the movements are inseparable. This physical part 'dissolves and evaporates', and, as fig-juice does in curdling milk, it undergoes a change and does not remain as part of the bulk which is curdled.

Earlier, Aristotle had said that semen lost its internal vital heat by evaporation (or loss of *pneuma*).<sup>26</sup> The vital heat, we know, is what renders the semen fertile. I think we can conclude that the change occurring to the semen in conception is also one of 'loss of *pneuma*' or 'evaporation'.

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<sup>26</sup> GA II 2 735b35, 736a2

The account of the change involved in conception is, as we saw in the last chapter, similar to that involved in concoction as described in Meteor<sup>27</sup>; the vital heat of an object perfects the passive qualities which are the matter, and the end result is the nature of the thing. The semen and catamenia mix<sup>28</sup>; the natural and proper heat of the semen perfects the potentialities of the matter, and thus the embryo comes to be, and to possess a nature.

Now, concoction is an immanent action, performed by the heat proper to the thing being concocted. So, in the case of the embryo, the heat of the semen which concocts is also proper to the embryo. This vital heat perfects the passive qualities, i.e. the potentialities latent in that which acts as matter. But it cannot do this as an external agent, and in the process of concoction becomes proper to the embryo that it is producing. Perfection of the embryo is continued by its own vital heat and internal source of change, which is based in the heart.<sup>29</sup>

The important point is the transfer of vital heat from semen to embryo. We have been told at length that the catamenia are not hot enough to sustain the sensitive *psuche*; evidently the semen, in concocting the catamenia (and itself) must impart the vital heat necessary to the embryo.

To conclude from the fact that semen contributes vital heat to the fetation that there is some material contribution may seem overswift, but at 736b35-737a1 Aristotle identifies the vital heat either with *pneuma*, which is hot air, and therefore material, or with the natural principle in the *pneuma*, which is analogous to the element of the stars, and so, again, material. And, as was mentioned earlier, blood

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<sup>27</sup> Meteor IV 2 379b18-26

<sup>28</sup> GA I 20 728b34

<sup>29</sup> PA III 7 670a24; GA IV 1 766a33-b4

and semen, both composed of water, earth and *pneuma*, lose their natures when they lose their heat; and all that is left is earth and water.<sup>30</sup>

The objection that from the fact that X heats Y one cannot infer that it contributes matter to Y is based on a confusion of vital heat with that heat brought about by the influence of fire. Fire generates no animal, and so the heat in animals neither is fire nor derives its origin from fire<sup>31</sup>; the heats are of different kinds. Vital heat has a material basis, that is, it is *to thermon*, where this is a special stuff that is transmitted. In the usual case of heating, as we saw in chapter I, a balance of powers is brought about and nothing material is transmitted.

Preus suggests that the contribution of *pneuma* to the fetation by the male is not counted as a contribution of matter by Aristotle because the *pneuma* changes its nature.<sup>32</sup> One might well ask, then, why the contribution of the catamenia is counted as a contribution of matter. Preus does not discuss this, but I think that it could be answered that the catamenia does not change its nature in the same way: while the semen transmits form, the catamenia has form (of a lower level) already. While the principle of form transmitted by the semen must move from potentiality to actuality, the catamenia already has the nutritive *psuche* in actuality, and hence no change is needed.

Another argument for the thesis that semen makes some material contribution to the embryo is that we are told semen has *psuche* and is *psuche* potentially.<sup>33</sup> In a

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<sup>30</sup> Meteor IV 11 389b9-11

<sup>31</sup> GA II 3 737a1-8

<sup>32</sup> Preus (1970) p.44

<sup>33</sup> GA II 1 735a9. Balme (1977) claims this should be translated 'has *psuche* and is [animal] potentially'. I do not see why this is to be preferred.

change from potentiality to actuality, that which is X potentially is usually matter in the change and therefore persists throughout the change. Some material element in the semen, then, is potentially *psuche* and becomes actually *psuche* in conception. I do not want to identify *pneuma* and *psuche*, but I do not see how to understand this without supposing that the *pneuma* carrying the inseparable movements and the vital heat is transferred to the fetation and becomes 'of its nature'.

I claim, then, that this section of the chapter answers question bii/, telling us that the movements of the sensitive *psuche*, inseparable from matter, and the vital heat which will perfect these, producing the intellect, are transmitted in the *pneuma* to the fetation. The semen renders up its vital heat in the *pneuma*, and it is the remaining physical part of the semen - some earthy elements and water - which does not become part of the fetation.

The consequence of this reading is that the original assumption, that the semen forms no physical part of the fetation, has to be modified: no compound of the standard four elements, nor any of the four elements themselves is transmitted from the semen to the fetation. However, *pneuma* is so transmitted. In this chapter, Aristotle has begun the process of modifying the original strict theory of conception.

So the structure of GA II 3 is:

1. an assumption of the strict account of conception: no matter is transmitted from the semen to the fetation (736a25)
2. a question - what happens to the matter of the semen?
3. further questions arising from this:
  - a/. whether the fetation incorporates any part of the semen
  - b/. i/ whether *psuche* is in the semen and the fetation to begin with  
ii/ where it comes from
4. an answer to bi/: *psuche* is possessed potentially before being possessed actually (736b15)

5. an answer to bii/: all *psuche* is connected to matter, and so does not 'come from outside' other than in potential (737a7)
6. an answer to a/: the *pneuma* of the semen enters the fetation; the water and earth do not (737a16)
7. hence, a modification of the original assumption, and a move towards the split donor thesis
8. a discussion of the nature of conception.

Moraux argued that 737b30-a8 was a modification of the position that reason is radically independent of the body; I agree with him, but have placed this section in a wider context, and, I hope, shown that its emphasis is not as he thought.

### Matter and the rational *psuche*

'the faculty of all kinds of *psuche* seems to have a connexion with a matter different from and more divine than the so-called elements'.<sup>34</sup>

In what way is the rational *psuche* connected to this kind of matter? We have seen that the rational *psuche* is instilled by the semen in that the semen renders up sufficient vital heat to actualise the potentialities of the sensitive *psuche*, and, in the preceding chapter, I examined the importance of *pneuma* to the operation of the sensitive *psuche*. I must now briefly discuss the nature of the rational *psuche* once developed, examining the suggestion that *pneuma* is necessary for thought.

Can we accept the following as Aristotle's own thought on the matter?

'We may admit to the full that being pained or pleased, or thinking, are movements (each of them being a moved), and that the movement is originated by the *psuche*. For example we may regard anger or fear as such and such movements of the heart, and thinking as such and such another movement of that organ or of some other; these modifications may arise

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<sup>34</sup> GA II 3 736b29-30

either from changes of place in certain parts or from qualitative alterations'.<sup>35</sup>

If we can, then the clear implication is that thought has a material element.

There is another passage in De An which seems to say very firmly that thinking is a process

'like that in which the air modifies the pupil in this or that way and the pupil transmits the modification to some third thing (and similarly in hearing) while the ultimate point of arrival is one, a single mean, with different manners of being'

and hence implying that thinking is a material process.<sup>36</sup>

Memory and sensation certainly involve a physical process; if the body is too moist or too hard, the imprint fails to take or is quickly forgotten. Again, the 'receiving surface' might be frayed, or the impression spoilt because of excessive movement due to heat.<sup>37</sup> And

'that the affection is corporeal, i.e. that recollection is a searching for an image in a corporeal substrate, is proved by the fact that in some persons, when, despite the most strenuous application of thought they have been unable to recollect, feel discomfort ... the reason why the effect of recollection is not under the control of their will is that, as those who throw a stone cannot stop it at their will when thrown, so he who tries to recollect and hunts sets up a process in a material part, in which resides the affection'.<sup>38</sup>

Once the idea which was sought for has presented itself the movement subsides.

There are a few passages which speak of matter as a hindrance to intelligence:

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<sup>35</sup> De An I 4 408b1-11. 'Or some other' is perhaps a reference to the heart/brain controversy.

<sup>36</sup> De An III 7 431a17-19

<sup>37</sup> De Mem 1 450a28-b11

<sup>38</sup> De Mem 2 453a14-23

'it is the function of the god-like to think and to be wise; and no easy task were this under the burden of a heavy body, pressing down from above, and obstructing by its weight the motions of the intellect and of the general sense'.<sup>39</sup>

It is true that the context of this quote is a very odd passage, but there are others with similar suggestions: man is the best of all animals in respect of judging differences because the sense-organ is pure and least earthy and material<sup>40</sup>; and whenever the diaphragm draws up the hot residual fluid, this at once causes a disturbance of the intelligence and of sensation.<sup>41</sup>

From GA we have learnt that possession of sufficient internal vital heat and sufficiently developed organs are prerequisite for manifestation of the intellect. I (tentatively) suggest that the active intellect is the actualisation of the passive intellect; that the extra vital heat brings to perfection the potentialities of the faculties of the sensitive *psuche*, and that this brings into actuality the intellect. Thus, just as the form (actuality) brings the matter (potentiality) into actuality (compound), the active intellect brings the passive into actuality (compound intellect); neither can function alone qua intellect.

That the active intellect actualises the passive intellect is a common theme in interpretations of intellect, but just what does this mean? I do not want it supposed that I am attempting to identify the active intellect and the vital heat or *pneuma* in saying that the vital heat in the semen brings the intellect into actuality. Rather, the active intellect is the actualisation of the potentialities of the sensitive *psuche*,

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<sup>39</sup> PA IV 10 686a29-31, b27

<sup>40</sup> GA V 2 781b20. Cf. De An III 13 435b1-3

<sup>41</sup> PA III 10 672b28-31

brought about by the vital heat; the change involved is one of perfection of potentialities. Reason, or the active intellect, is not itself transmitted in the semen, not being a separable substance but a perfection to be achieved; what is transmitted is the material preconditions and potentiality for reason in the form of the movements for the sensitive *psuche* and extra vital heat.

GA II 1 concluded that no physical part of the embryo preexists in the semen. Yet I have suggested, as part of the split donor thesis, that the *pneuma* in the semen is transmitted to the embryo, and that to this extent there is some material donation. What is transmitted is the extra *pneuma* or vital heat sufficient for the actualisation of the potentialities of the sensitive *psuche*. That not all possessors of the sensitive *psuche* potentially possess the rational *psuche* is because members of species lower than mankind do not and cannot possess sufficient vital heat to concoct their blood and hence their semen sufficiently far. Not even all members of the human species have sufficient vital heat:

'although the parts of the soul are present in all of them, they are present in different degrees. For the slave has no deliberative faculty at all; the woman has, but it is without authority, and the child has, but it is immature.'<sup>42</sup>

The slave participates in rational principle only enough to apprehend, but not to have, such a principle<sup>43</sup>; women, too, will never have sufficient vital heat for the intellect proper.<sup>44</sup> Children (male children of citizens, at least), lack intellect because they are not yet fully developed; children have not yet developed reason, merely

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<sup>42</sup> Pol I 13 1260a11-15

<sup>43</sup> Pol I 5 1254b22

<sup>44</sup> Horowitz (1976) points out that *akuron* is used both of a woman's biological weakness, which leads to her inability to produce form-carrying semen, and of her impotent deliberative faculty.

desire.<sup>45</sup> We should also note that their heat (*to thermon*) is not yet perfect<sup>46</sup>, and it is possible to lose the capacity for thought if one's heat diminishes as one grows older.<sup>47</sup> The intellect 'comes from outside' in that the conditions for its manifestation are additional to the concoction of the semen (see chapter III), and is spoken of as divine by analogy<sup>48</sup>, just as the vital heat is called divine; both the active and the divine intellect participate in the divine activity of reason. The analogy is imperfect: the active intellect is not wholly perfect, as the divine intellect is, since it is dependent on matter when manifest in mankind, being dependent on the passive intellect; also we are not capable of perpetual contemplation, the perfect activity, as the Deity is - possibly because of our material nature. However, possession of the intellect makes possible man's share in the divine activity, and renders man the perishable material substance most like the Deity; hence he is the most perfect of animals.

#### to thermon and the split donor account

In the first chapter, I claimed that when an object is hot, i.e. has some of *to thermon*, it can heat other objects, not by transmission of *to thermon*, but by alteration of the powers of the other object. That is, the cold in the other object

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<sup>45</sup> Pol VII 15 1334b15-25. The progression of an animal through the various levels of psuche as it matures is interesting, and similar to the recent theory of recapitulation; when in the womb, the animal is plant-like, then as a child, the man is animal-like, before the development of the characteristic function.

<sup>46</sup> GA IV 2 766b30

<sup>47</sup> De An I 4 408b18-25; On Length 5; On Youth 4 469b1-20; 5; 14; 23 478a31-26

<sup>48</sup> De An I 4 408b30; GA II 3 736b26-30, 737a10; NE VII 13 1153b33; X 7 1177a13-18; EE VII 14 1248a25-27

has certain powers, but if overcome by the hot these lose their potency, and if this proceeds far enough, the cold possessed by the other object becomes the hot, with all the powers of the hot.

Now, this raises some very interesting questions with respect to the theory of concoction and development suggested. For in that, I have claimed that the male contribution to the new substance is the sensitive *psuche* and some *pneuma*, both transmitted by the semen to the contribution of the female, matter and nutritive *psuche*, and that the rational *psuche* is dependent on the possession of vital heat, and so is contributed by the male (this occurs in humans only). The relation between the *pneuma*, heat and *psuche* will have to be made clear, as well as the nature of the transmission of *psuche* and *pneuma*. Also, concoction is crucial to my interpretation of these changes, and concoction is a process that is caused by heat; so that too will have to be discussed in the light of the discussion of heat.

It seems clear that the *pneuma* contains *to thermon*; this is enclosed within it, and is its nature.<sup>49</sup> If this can be taken seriously, then the powers of *pneuma* are the same as those of *to thermon*. But if this is so, the question why generation does not occur wherever *to thermon* is found comes up.<sup>50</sup> For example, water and oil mixed together contain some *pneuma* because of the friction of mixing<sup>51</sup>; yet oil and water are not generative, even of spontaneous organisms. So what is the relation between *pneuma*, heat and generation?

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<sup>49</sup> GA II 3 736b34-737a1

<sup>50</sup> See chapter VIII. Not all *pneuma* is generative; nor is all heat vital.

<sup>51</sup> GA II 2 735b21-25

Solmsen says that when GA II 1-3 speak of semen as a compound of *pneuma* and water, *pneuma* is nothing more than air<sup>52</sup>; he also claims that here Aristotle says vital heat is not identical with fire, but that other passages identify them.<sup>53</sup> I think he is mistaken; *pneuma* is not merely air here, but it is hot air - this is an important difference, involving a difference in powers. Moreover, of his evidence, 652b7-11 deliberately points out that the *psuche* is not fire, but is incorporate in some substance of a fiery character; 469b11-17 says the *psuche* is 'as it were' aglow with fire, which merely says, like 652b7-11, that the natural heat is similar to fire, not identical to it; 473a4 does speak of the internal fire, as does 474b10-13, but these follow 469b11-17, using similarity between fire and internal heat to help explain the processes of life. None of them need be read as asserting a definite identity between vital heat and fire.<sup>54</sup> So, *pneuma* and vital heat are not identical with each other, nor with fire.

The final concoction of the semen, in man, occurs only during copulation<sup>55</sup>; that is, it then becomes perfect, able to perform its function. The blood is concocted by the vital heat within it into the material of the semen, which is *pneuma*, water and some earthy elements too. Above, I claimed that the final form of the semen, the ability to transmit *psuche*, is added at the last moment by the addition of some extra *pneuma*.

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<sup>52</sup> Solmsen (1957) p.120. GA II 2 735a30-b14, 736a1

<sup>53</sup> On Youth 4 469b11-17; 12 473a4; 14 474b10-13; PA II 7 652b7-11

<sup>54</sup> Ross (1955) p.41 says that the view that innate heat and *pneuma* are identical is based on De An II 8 420b16-22 and De Somno 2 456a8-10. However, both of these merely say that *pneuma* (here breath) is used to conserve the inner heat; they in no way identify the two.

<sup>55</sup> GA I 5 717b25

*Pneuma* is clearly essential: among other things, we are told that sexual desire is due to the presence of *pneuma*, that the penis expands and contracts, admitting *pneuma* into itself, and that pleasure is due to the fact that not only semen but also *pneuma* is emitted.<sup>56</sup> The emission of semen is accompanied by the collecting of *pneuma*; a man must hold the *pneuma* in order to emit semen, and the semen is thick and white because there is *pneuma* mixed with it.<sup>57</sup> Afterwards, the physical part of the semen evaporates.<sup>58</sup> But perhaps most importantly,

'all have in their semen that which causes it to be productive; I mean what is called vital heat. This is not fire nor any such force, but it is the *pneuma* included in the semen and the foam-like, i.e. the natural principle in the *pneuma*, being analogous to the element of the stars'.<sup>59</sup>

So, semen contains *pneuma*; *pneuma* contains *thermon*.

How, then, are the heat and *pneuma* in the semen transmitted? I have claimed that in conception there is transmission of matter, since the *pneuma* is transmitted, and also that in the transmission of heat there is no transmission of matter. There is no conflict here: sex is loss of *thermon*. As the semen and catamenia are interacting, the *pneuma* and heat from the male get enclosed and a bubble or membrane forms, presumably also enclosing some or all of the catamenia. This will eventually become the embryo, the *pneuma* from the male now being inside the fetation, and beginning to differentiate it.<sup>60</sup> Within this bubble, separation of the

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<sup>56</sup> PA IV 10 689a30; GA I 20 728a10; [Prob] IV 15 878b9; XXX 1 953b34-954a1

<sup>57</sup> GA I 6 718a3; II 2 736a9; II 4 737b35

<sup>58</sup> GA II 3 737a11

<sup>59</sup> GA II 3 736b34-737a1

<sup>60</sup> See chapter III.

catamenia continues to occur, producing two nutriments, one more formal, from which the embryo will form, and one more material, to nourish it.<sup>61</sup>

### The split donor account

I have claimed that there are two theories of conception in GA: a strict account, which Aristotle explicitly states; and a second, which I have called the split donor account, and which is not explicitly stated anywhere. Is there a development in Aristotle's thought from one to the other, or are these two incompatible views held simultaneously?

I claim that the split donor thesis can be seen in GA as a result of Aristotle's deliberations on conception and development, which run as follows.

In GA II 1 he turns away from the theory of sexual generation briefly to classify the various methods of generation depending on heat and perfection of the animal before returning to give more details of the theory of sexual generation in the rest of GA.

The first problem raised is that of the transmission of the principle to the matter, and this involves the first modification to the original strict account: the introduction of the *pneuma* to carry the rational *psuche*, and the statement that the catamenia contain all the parts of the body potentially, though lacking the sentient *psuche*.

The rest of Book II describes generation in the perfect animals, ending in a discussion of sterility, hybrids and monsters. In Book III he goes through the other methods of generation, which raise the further problems of wind-eggs, which demonstrate that the female has certain formal capacities in her contribution, and

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<sup>61</sup> See chapter III. See also chapter VIII.

spontaneous generation. This is followed in IV by the theory of resemblance and sex differentiation, which further modifies the original strict account of conception.

Is this account susceptible to any of the objections to his opponents raised by Aristotle in Book I? The split donor thesis has no problems with the question of growth, multiple offspring, or resemblance; spontaneous generation does pose a problem, in that the identification of the formal cause is difficult, but it is more of a problem for the strict account; I shall discuss this in detail below. The more immediate problems that arise for the split donor thesis are those passages which suggest that there are animals which transmit no semen at all, but simply movements, directly implanted:

'It is plain then that it is not necessary that anything at all should come away from the male and if anything does come away it does not follow that this gives rise to the embryo as being in the embryo, but only as that which imparts the motion and as the form ...'

'... some males which unite with the female do not, it appears, insert any part of themselves into the female, but on the contrary, the female inserts a part of herself into the male ...'

'... the effect produced by the semen in the female is produced in the case of these insects by the heat [thermotēs] and power in the male animal itself when the female inserts that part of herself which receives the residue'.<sup>62</sup>

That the female inserts a part into the male rather than vice versa is irrelevant; the important point is that there is no material transmission from the male to the female. However, we should note that there is still heat transferred to the female (or at least to 'that part which receives the residue').

A second problem is the evidence offered concerning birds and fishes: if a hen is producing wind-eggs, and is trodden by a cock, then the eggs become fertile; if

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<sup>62</sup> GA I 21 729b17-27; see also GA I 22 730b10; II 4 738b10-15

she is then trodden by another cock, the chicks resemble the second cock.<sup>63</sup> Aristotle argues that this shows that the cocks do not add material (for if they did, the chicks would be monstrous, having twice as many parts) but do, by the force of heat and concoction, give a certain quality to the material. In the case of fish, only those eggs are fertilized which the milt reaches when it is sprinkled over them; Aristotle thinks that this shows the male does not contribute anything to the quantity, only to the quality of the embryo.<sup>64</sup>

At this stage he is arguing against the thesis that the semen becomes part of the fetation, in favour of the claim that it is in virtue of the heat and power that the semen possesses that an individual of a specific character or form is produced.

The arguments themselves are poor. As far as the fish argument goes, it shows nothing of the sort; he has not offered any reason for supposing that the milt, or some portion of it, is not combined with the eggs. A similar point is true of the bird argument too; birds require constant refertilization to bring the eggs to completion,<sup>65</sup> but what is said is that the eggs do not increase in size unless copulation is repeated. This could be construed as an argument for the thesis that semen adds material to the embryo, not against it; however, I wish to claim only that heat and *pneuma* are transmitted, not that the semen itself becomes part of the embryo. Neither argument is any more a problem for the split donor thesis than for the strict account, but the bird argument is interesting.

The mention of wind-eggs is irrelevant: the point is that fertilized eggs may have their characters changed by addition of further heat and power from a different cock.

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<sup>63</sup> GA I 21 730a4-17

<sup>64</sup> GA I 21 730a17-21

<sup>65</sup> HA VI 2 560a17-20; GA III 7 757b5

'... it is by its force that the semen of the male gives a certain quality to the material and the nutriment in the female, for the second semen added to the first can produce this effect by heat and concoction, as the egg acquires nutriment so long as it is growing.'<sup>66</sup>

This is a curious passage because Aristotle usually claims that semen comes in 'units', each sufficient for one generation, and that any extra is used in generating a second embryo (either at the time of original conception or by superfoetation).

One possible solution is that the additional heat and power have an effect on the nutriment of the embryo: as we have seen, this seminal or first nutriment forms the nobler parts of the embryo. Thus, putting a second cock to the hen may improve the quality of this nutriment and hence of the embryo.

Another solution is that the power in the semen of the second cock overcomes the power of the first; since they are of the same species, the species movements do not destroy each other, but the resulting embryo resembles the better quality cock.<sup>67</sup>

In either case, it is evidently heat and power that is significant; I do not think this is a counter example to the split donor thesis.

Even in GA I exceptions to the strict account are noted: in the lines following, he writes that the female needs a principle, i.e. something to begin the movement in the embryo and to define the form it is to assume.

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<sup>66</sup> GA I 21 730a14-17

<sup>67</sup> See GA II 8 748a32-3: the colder semen destroys the warmer; the warmer does not destroy the colder, but, presumably, overcomes it.

'Yet in some animals, as birds, the nature of the female unassisted can generate to a certain extent, for they do form something, only it is incomplete; I mean the so-called windeggs'.<sup>68</sup>

There are a number of passages in GA which make statements incompatible with the split donor account.

'the male contributes the principle of movement and the female the material'  
'... the secretion of the male does not give any material at all to the embryo'  
'Whether the semen of the male contributes to the material of the embryo by itself becoming a part of it and mixing with the semen of the female, or whether, as we say, it does not act in this way ...'<sup>69</sup>

These passages are spread throughout GA. Even if it were possible to determine which sections in GA were early and which late, it is not clear that the later sections would include all and only the passages suggesting the split donor account. Although Aristotle discusses various issues related to the theory of conception, and his solutions can be read as providing a split donor account, I do not think that he can be said to be deliberately working towards it. The split donor account is never explicitly stated, and the strict account appears always to be Aristotle's official theory.

Therefore, I think we must say that Aristotle did not see where his deliberations on resemblance theory, spontaneous generation and so on were leading him, and that his theory of conception, officially the strict account, was not fully worked out. Had it been, I suggest that he would have moved toward the split donor account as a better explanation of the factors he was considering.

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<sup>68</sup> GA I 21 730a30-31

<sup>69</sup> GA I 21 730a27; II 1 732a5-12; II 4 738b25, 740b25; II 8 748b33; IV 1 764b10, 766b11-15; IV 4 771b20-25

In the last chapters we have seen that when the infant is born, it possesses both sense-perception and knowledge potentially<sup>70</sup>; the potential for sense-perception is actualised long before that for knowledge.<sup>71</sup> According to the account given, the ability to reason depends on the heat and the level of development of the individual physical organism; the development of the *psuche* is a question of the body reaching a sufficient state of development to be able to manifest the intellect. So we now need a further discussion of physical development, and an answer to the question; is substantial change completed when the intellect is fully developed or earlier; that is, when the body has reached a level of development sufficient for the manifestation of intellect, or at conception?

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<sup>70</sup> De An II 5 417b18

<sup>71</sup> EE II 8 1224b30-31; Pol I 13 1260a10-15; VII 15 1334b17-28

## Growth and Development

I want now to examine the nature of the change involved in the development of the new individual, in the belief that what has been discovered above is relevant here too. That is, by examining the process of development, and determining the account Aristotle provides of it, we shall discover that there are certain important features of this kind of change, peculiar to living beings, that are not adequately accounted for on the standard account of change.

For example, the substance/accident distinction is taken to be exhaustive, and, indeed, the standard account of change is derived on just this basis:

'we must distinguish the substratum, and the property whose nature it is to be predicated of the substratum; and since change of each of these occurs; there is alteration when the substratum is perceptible and persists, but changes in its own properties ... But when nothing perceptible persists in its identity as a substratum, and the thing changes as a whole ... such an occurrence is a coming-to-be.'<sup>1</sup>

Classification of development, however, is not as simple as it might seem. If development is an accidental change, then the substance underlying the change is already in existence; while if development is part of the process of substantial change, then the substance is, presumably, not in existence until the completion of the change. However, there are reasons to think that neither of these is wholly appropriate to development.

The transition in human reproduction from semen through foetus to child is substantial change, and the question of at what point exactly the change occurs is an

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<sup>1</sup> GC I 4 319b8-18; see introduction.

interesting one.<sup>2</sup> The foetus does not start off with a human form, in Aristotle's view, but with a 'plantish' *psuche*, and it gradually develops a more complex form, culminating in intellect at some stage, after which it surely counts as human.<sup>3</sup> At what point does the fetation belong to the species man?

Our intuitions tell us that there is no substantial change occurring between childhood and adulthood, since it is the same individual: Xanthippe at three years old is, intuitively, the same individual as she is at thirty-three. It is unimportant that the matter composing Xanthippe is 'flowing in and out' as Aristotle puts it<sup>4</sup>; the type remains constant, there is some continuity, and so the individual compound remains the same. It would seem to be safe to say that substantial change brings the individual into existence and moves him out of existence later; all changes that occur to that individual in between these two substantial changes are accidental: except, it would seem, for development. Development involves change in capacities, as well as change in size. As the child progresses towards manhood, he becomes capable of more things, and these are not trivialities which could perhaps be assigned to nonsubstantial change, such as being able to hit a cricket-ball further; rather, the changes are major and are essential properties of the adult - for instance, and notably, the ability to reproduce. The child has the potential for this capacity, certainly, but the adult actually has the capacity, although he may not be using it. Such a property is an essential property of the adult; while it is not listed in the

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<sup>2</sup> And relevant to other questions, for instance, 'if couples have children in excess, let abortion be procured before sense and life have begun; what may or may not be lawfully done in these cases depends on the question of life and sensation' Pol VII 16 1335b24.

<sup>3</sup> Brentano (1978) believes the acquisition of *nous* is the completion of the foetus (p.115). However, this is only potential at the embryonic stage.

<sup>4</sup> GC I 5 321b26

definition, it is one of the properties due to the essence: man is rational animal, and animals possess the ability to reproduce.<sup>5</sup> Another example is rationality: children are not capable of abstract thought until they are several years old; their intellect is immature.<sup>6</sup> Here is another capacity which does not reach actuality until the individual has been that particular individual for several years, and though children lack mature rationality, they are still members of the kind 'man', and rationality is used as a defining characteristic.<sup>7</sup>

On the standard account of change, completion of a full set of defining properties is substantial change; possession of only half a set is not sufficient to distinguish between different types of animals. At conception, the fetus does not have a full set of these properties; it is 'plantish'. On reaching adulthood, the full set has been attained: the individual is 'of a type', man. If substantial change is the coming into being of an individual of a certain type, i.e. possessing a certain set of characteristics, the problem of development is obvious: what can we say about these changes; does the individual possess the form of man before reaching adulthood or not? If not, then the substantial change occurs not at some stage between semen and birth, but at some point between child and man. Aristotle says:

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<sup>5</sup> HA VIII 1 588b27. Not all animals do so - consider the mule, though this is a deformed animal. Perhaps reproduction is to be considered an essential characteristic of the animal genus, not of a particular species or of an individual? Pellegrin (1985) argues that reproduction, unlike locomotion, is not an essential ability since some animals do not reproduce but are spontaneously generated. Scott Atran (1985) objects that it is essential to every animal which does reproduce; however, it is not if some animals can reproduce either way.

<sup>6</sup> Pol I 13 1260a11-15

<sup>7</sup> The problem is even more acute for women and slaves: at least children have the potential to become individuals truly defined by 'rational animal'. See Lange (1983).

'man is prior to boy and human being to seed, for the one already has its form and the other has not'.<sup>8</sup>

If the child does not have the form of man, then it is not a substance of that kind; either it is of a different kind or it is not a substance at all. In either case, the child is not the same individual substance as the man; to be the same substance, an individual must possess the same substantial form throughout its existence.

If instead we say that the substantial change occurred some time before birth, and that the individual counts as man from this time, then the full definition of man does not apply to him at that stage, for he has these capacities, and hence the full substantial form, only potentially. Yet we know that nothing exists without a form.

My claim, in what follows, will be that development is neither substantial nor nonsubstantial change as described in the standard account of change, but the perfection of potentialities through concoction; the standard account of change is inappropriate for the development of living substance, as we saw it to be for conception. And if concoction is the explanation of developmental change, as it is of conception, then clearly heat and *pneuma* are crucial here too.

### Development and Change

In On Generation and Corruption Aristotle distinguishes three main types of change where one might expect to find only the two obvious types, substantial and accidental change. The third kind, distinguished from both the others in GC I 4-5, is growth.

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<sup>8</sup>

Meta IX 8 1050a5

GC: substantial change  
 alteration  
 growth

In the Physics and Metaphysics, Aristotle also distinguishes types of change other than the two main types, but these are merely subclasses of them, not entirely different kinds of change. Thus:

Physics: substantial change  
 nonsubstantial change: alteration  
 increase/decrease  
 locomotion

Where, in such a classification, can we fit development?

First, perhaps, we should be clear as to what we mean by development. Obviously, the change from being a child to being an adult involves increase in size, but it also involves the gain of new abilities, such as the ability to reproduce. It is this second aspect that raises the problems mentioned above, and so, to distinguish between simple increase in size, and increase plus new abilities, I shall call the first 'growth' and the second 'development'.

Does Aristotle acknowledge such a distinction? Examination of the occurrences of *auxe* and *auxesis* reveals very little. There seems to be no distinction in use of the two words, though *auxesis* is the more common; there are only a few occurrences of *auxe* outside the Physics. Both are used of change in quantity,

where it is clear that it is simple increase and decrease that is under discussion<sup>9</sup>, but when Aristotle is listing kinds of change possible, it is *auxesis* that is used.<sup>10</sup> *Auxesis* is used of the simple increase in size of animals<sup>11</sup>, but there are several passages where it is not immediately clear whether he is thinking of simple increase or whether he is also thinking of development, including two where *auxe* is used.<sup>12</sup> For example, passages which talk about growth in terms of 'completion' or 'perfection'<sup>13</sup>; and passages discussing how the body changes as the individual reaches maturity.<sup>14</sup> So although Aristotle never makes a distinction between the two senses of growth explicitly, he does seem to recognise one implicitly. It is of course development that I am primarily interested in here.

So where can we fit development? There would appear to be three possibilities:

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<sup>9</sup> Phys II 1 201a13; III 6 206b28, b32; III 7 207b29; III 8 208a22; IV 4 211a15; IV 14 223b20; V 2 226a23-25; V 4 228b21; VI 10 241a33; VIII 7 260a27-29; GC I 4 319b32; I 5 320a14, b30; II 6 333a35; HA II 1 500b22; [Prob] XV 5 911a15; XVII 1 916a11; Meta VIII 1 1042a36; XIV 1 1088a31

<sup>10</sup> Cats 14 15a14; Phys V 2 226a29; VII 2 243a9; VII 2 245a15; De An I 3 406a13; Meta XII 2 1069b11

<sup>11</sup> HA V 10 543a21; V 15 547b30; VI 12 566b18; GA I 8 718b8; II 1 733b3; II 6 743b19

<sup>12</sup> De An I 5 411a29; HA VII 1 581b4; VII 2 582b21; GA II 4 740b9, b30; III 1 749a26; III 2 752a24, b18, 753b12, 753b29; IV 4 771a28; IV 6 775b20; NE III 12 1119b4

<sup>13</sup> GA I 8 718b8; III 2 752a28, b18; IV 4 771a10

<sup>14</sup> HA II 1 500b34; GA II 6 744b29



First, GC I 5 is concerned to distinguish growth and generation, and offers good reason to accept such a distinction: while generation is a change from a potential to an actual substance, alteration and growth are changes from a potential affection or size to an actual one. Aristotle is here pointing to the fact that in alteration and growth, the substratum of the change is a substance which remains in existence; in substantial change the substance comes into or goes out of existence.<sup>15</sup> In these passages, Aristotle is explicitly referring to growth in the sense of increase and decrease; if we apply this distinction to development, we find that though the substratum - the individual - remains throughout development, as in nonsubstantial change, and so the standard account of substantial change is inappropriate, the question remains whether development, the gain of essential properties, is a change from a potential to an actual substance or not, and hence whether or not it is a kind of substantial change, to which some other account must be applied.

Nor is schema I satisfactory, at least in the case of natural substances. Development in natural substances is more than just change in quantity or magnitude; if schema I is accepted, simple increase and decrease is excluded from the range of changes possible, unless located under alteration, and GC has distinguished alteration and change in magnitude. Development involves change in capacities, and, if these capacities are essential to the animal, as I have argued that they are, this may seem more like substantial change than like any of the other types of change.

In GC Aristotle seems to be considering growth only in the simple sense of increase in size, rather than in that of development, but he is aware that development occurs - he uses it as an analogy when discussing the development of

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<sup>15</sup> GC I 5 320a10-15, b25-34, 321a22-5

the tragedy, or of cities.<sup>16</sup> He does not explicitly discuss development with respect to the problems that are under discussion, but I think we can infer what he would have thought from what he says about related matters.<sup>17</sup>

Because of the differences between these two senses of growth, the characteristic suggested as peculiar to growth - that it necessarily involves change of place, while generation and alteration do not - is not useful to us in characterising development. Here Aristotle is presumably considering change in size alone; it could not be said that development necessarily involved change in spatial location. It might well involve change in spatial organization, though this is not a necessary condition; not all new capacities involve material reorganization, and nor does increase in size.

None of the three possibilities seem immediately acceptable, although II, which said that development was a kind of substantial change, may have seemed the best of the three. In the discussion which follows, I shall note a way of distinguishing development and alteration which will reveal some interesting elements of the nature of the change involved in development.

### A distinction between development and alteration; change in form

GC I 5 offers a hint of a distinction between alteration and development:

'Flesh is said to have been altered if, while its character and essence remain, some property which was not there before, now qualifies it in its own right; on the other hand, that whereby it has been altered may have undergone no change, though sometimes it too has been affected. The altering agent, however, and the source of the process are in the growing thing and in that which is being altered; for the mover is in these.'<sup>18</sup>

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<sup>16</sup> Pol I 2 1252b30-33; Poetics 4 1449a14

<sup>17</sup> For an example of the sense of growth as development, see GA III 9 758b34-36.

<sup>18</sup> GC I 5 321b2-7

The first half of this statement appears to describe the very type of change under discussion, development, and to identify it as a type of alteration; Aristotle then qualifies this, distinguishing between types of change in which the agent of change has also been changed as a result of the change, and those in which the agent remains unaltered. The second sentence provides an explanation for this distinction, saying that if the efficient cause is internal, then it, too, will be changed by the change.

I think that this means that in alteration, the agent of change undergoes no change of necessity, while in growth it does so; the agent of change is necessarily internal in growth - though not in alteration - since what is changed is the whole individual and the originative principle of growth is 'in' the individual (being its form). The originative principle of alteration may also be in the individual, but need not be, or may be distinct from that aspect of the individual which is altered.

So, there is at least this much of a distinction to be drawn, that the principle of growth is of necessity in the growing thing, and so will undergo change itself, while this need not be so in the case of alteration. Growth is not alteration because the principle of growth undergoes change while that of alteration need not; growth is not an accidental property of the substance but is a property derivable from its essence. This is true of both senses of growth; in both it is the form of the individual - the internal principle of change - which is responsible for the changes occurring to that individual.

Once conception has occurred, the embryo begins to develop and to grow. From conception, the embryo possesses the nutritive *psuche* enabling it to feed, and an internal principle of change enabling it to develop. Indeed, the nutritive *psuche* is

responsible for both nutrition and development, at least to begin with<sup>19</sup>; but it cannot be wholly identifiable with the internal principle of change because this will later bring about the sensitive and rational elements of the *psuche*: elements of a higher order than the nutritive *psuche*. In what way, then, does the internal principle of change exist? Before maturity, the embryo - or even the infant - does not yet possess enough capacities of an animal, or of an animal of that kind, to count as a member of that kind, yet it must possess the internal principle of change, and hence the form. Perhaps the form exists only as a potential; but even if this is so, the embryo is still not yet of a substantial kind. Does this mean that the substantial change has not yet occurred?

In substantial change, or at least coming-to-be, we are told that the form or actuality brings the matter into actuality and that the actuality of the two, which is one and the same, is the compound substance. 'Actuality', we know, has two senses, corresponding to possession of knowledge and exercise of knowledge.<sup>20</sup> The *psuche* is actuality in the first sense, that of capacities possessed but not used at the time in question (potentiality-2 = actuality-1). This passage explains how it can be that we do not function at maximum capacity all the time; can it also explain how it is that a child can be called 'man' while not possessing the properties of a man? For if we could say that the child possesses the capacities in the first sense, i.e. without using them, the problem would be removed, for the form would then be actuality entirely, rather than, as it seems it must be, partially potentiality.

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<sup>19</sup> De An II 4; GA II 4 740b30-34

<sup>20</sup> De An II 1 412a23-7; II 5 417a21-b1.

Unfortunately we cannot, for the child does not possess the capacities at all: all the child has is the potential for certain capacities. There must be some sense in which the form can be said to be potential within the compound which it informs.

Substantial change, while bringing the matter into actuality, does not bring about actualization of all the potentialities of the new compound at that time. It brings the potentialities into actuality, that is, there is now a potentiality-1, rather than merely a potential for this potentiality (matter has this sort of loose potentiality), but does not actualise them. This may cause no problem if such a capacity as 'speaking Greek' is considered (especially if Greek is someone's second or third language; 'speaking a language' might be thought to be part of his essence). But if a capacity that is part of the essence of man is considered, then it seems that the substance is not yet fully actualised. Growth is needed before the substance can be said to have reached maximum actualization. (Growth in both senses here: to use some capacities, the individual has to be larger than he is at birth, and to have others at all, development is needed). In what sense, then, could the substantial form be potential and enmattered?

Semen contributes the characteristic function and the form by bringing the matter up to a state of potentiality-1, through concoction, hence producing an embryo with nutritive *psuche* and an internal principle of change. The full substantial form is present only in a thin sense: the range of potential that mere matter possesses has been narrowed to potentiality-1; and the principle of change, in the shape of the balanced movements and the vital heat within the *pneuma*, contains 'instructions' which, provided no external force hinders them, will bring about a mature individual of type X. The structure and abilities of such an individual are not yet present in actuality-1, only in potentiality-1, but time only is required to bring about the full

actualization; it is fully causally determined. I suggest, then, that the full substantial form of X is present in the undeveloped fetation in the sense that X is wholly determined.<sup>21</sup>

Waterlow objects to such a theory that the substance could lose its mature structure C while retaining the essential power of giving rise to C.<sup>22</sup> Her objection is that if mature form and source of development are not identical, they may diverge, and what is no longer man could nonetheless generate man. She believes Aristotle must hold that these two are identical at all stages, and, presumably, that the substantial form is present in a thick sense.

However, I think that this identification is too strong, and that Aristotle accepts a theory of the kind I have outlined. It is just not the case that an embryo or an infant possesses the full range of capacities of an adult, as Aristotle frequently acknowledges. For example, he says of a thing's nature that it 'proceeds towards nature'.<sup>23</sup> That is, it is part of a thing's nature to be such that it will develop thus and so, to become of such and such a kind. It is of the nature of a kitten to develop into a cat, and the nature of the two is the same: it is the nature of cats.

Still, there is a difficulty with this account. The standard account of change aligns form with actuality and matter with potentiality; on this account the form is potential in the sense that it is not yet fully actualised. Is this acceptable? And if so, is substantial change complete after conception, when the future form is fully determined, or not?

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<sup>21</sup> EE II 8 1224b29-31

<sup>22</sup> Waterlow (1982) p.66

<sup>23</sup> Phys II 1 193b13

As I pointed out above, the degrees of potentiality differ; while some of the capacities composing the form may be possessed by the individual only in potentiality-1, matter is of a lower level of potentiality, which we could call potentiality-0. If it is built into the notion of form of a living substance that the substance should undergo development, only attaining the full range of capacities of the substantial form at maturity, I do not see why this notion of form as potential while enmattered should be unacceptable. As for the second question here, which is, after all, the central question under discussion, I should like to postpone answering this until I have further discussed the nature of the change involved in development. Even so, we can see that the possibility of potential enmattered form will enable us to sidestep the dilemma raised by the assumption that all change is either strict substantial change or alteration.

Earlier, I claimed that the distinction between growth and alteration was that the principle of growth undergoes change while that of alteration need not. Given that the principle of growth must be identifiable with the internal principle of change, and hence with the form, does this mean that I claim that the form 'changes'?

This may sound nonsensical, but it does appear that Aristotle thinks that the form can 'grow', both in the case of simple increase in magnitude, and in the case of development.

'in one sense it is true that any and every part of the flesh has grown; but in another sense it is false. For there has been an accession to every part of the flesh in respect of its form, but not in respect of its matter.'<sup>24</sup>

This is not a very clear passage: Sprague suggests that this is a way in which Aristotle can explain growth which does not suggest that there are two bodies in the

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<sup>24</sup> GC I 5 321b32-4

same place (i.e. the food and the animal): the two matters are not in the same place (the food is 'added to' the animal); there is an increase in the form because there is more of the animal.<sup>25</sup> This seems a sensible reading: in any case, the form, in a sense, increases.

Again, GA IV 3 768b31 speaks of one of the functions of the nature as being to increase and arrange the form symmetrically.

The suggestion that it is the form which changes is an odd one, given the usual picture of changes, in which either the substantial form comes into existence or the accidental form does so. Alterations are not alterations in the substantial form, but are kinds of nonsubstantial change, being alterations in the compound. Yet even when we consider change in size alone to be growth, 'change' in the form seems a central feature. When change in capacities is added to change in size, 'change' in the form is unavoidable, for this involves actualizations of potentialities, and hence an increase in the capacities that an individual possesses in actuality, and a 'change' occurring to the form. A better way of describing this is as an actualization, or realization, of the form, since I have above spoken of a sense in which form is 'potential' within the compound. I shall use 'actualization' for preference, since it is an actualization of the potentialities instilled at conception that is in question.

Presumably, in the case of simple increase, we should conclude that 'change' in the form does not involve substantial change. The change is due to the addition of matter, and since matter is constantly 'flowing in and out', to hold that this led to substantial change would make Aristotelian substances very shortlived indeed. But can we conclude that 'change' in form other than change in magnitude is not

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<sup>25</sup> Sprague (1979)

substantial change? That is, that change in essential properties need not be substantial change?

The nature of the change involved in development is not exactly like either substantial or accidental change, but is an 'alteration' that occurs to the substantial form while it remains in existence. The problem is that if growth cannot be properly and satisfactorily identified as a type of change, it would seem that even substantial change - as normally considered, occurring sometime before birth - is not full actualization of the new substance, and we are pushed into saying that substantial change is only completed when the new individual reaches maturity.

### Development and substantial change

I have argued that development is not an alteration: the form is responsible for development, and is changed by the development that it brings about, while it does not undergo alteration in the strict sense. Even if growth is restricted to increase and decrease alone, the principle of growth, the form, undergoes change. It seems clear, then, that schema I can be rejected: growth in the sense of development is not a type of alteration.

Two possibilities remain: that development is a kind of substantial change, or that it is a third kind of change. It was said that development is not substantial change because the growing thing persists through the change. This is true, as far as it goes; the individual man persists throughout his growing. But his growing involves a 'change' in the substantial form: not a complete replacement of the form, but an actualization or realization of it. Is this a substantial change, or can we say that the substantial change was complete when the potential of the individual was determined at conception, when the movements were balanced? If the latter is the

case, development must be a third kind of change not described in the standard account of change.

The question at issue, then, comes down to this: is the actualization of essential properties a kind of substantial change?

There are two passages in which Aristotle seems to acknowledge that development does not fit his standard account of change, and which will, I hope, provide an answer to this question: De An II 5 417b2-15 and Physics VII 3.

De An distinguishes two senses of alteration:

'the expression 'to be acted upon' has more than one meaning; it may mean either the extinction of one of two contraries by the other, or the maintenance of what is potential by the agency of what is actual and already like what is acted upon, as actual to potential. For what possesses knowledge becomes an actual knower by a transition which is either not an alteration of it at all (being in reality a development into its true self or actuality) or at least an alteration in a quite different sense.

Hence it is wrong to speak of a wise man as being 'altered' when he uses his wisdom, just as it would be absurd to speak of a builder as being altered when he is using his skill in building a house.

What in the case of thinking or understanding leads from potentiality to actuality ought not to be called teaching but something else. That which starting with the power to know learns or acquires knowledge through the agency of one who actually knows and has the power of teaching, either ought not to be said 'to be acted upon' at all - or else we must recognise two senses of alteration, viz. the change to conditions of privation and the change to a thing's dispositions and to its nature.'<sup>26</sup>

In the preceding discussion we have seen reason to reject the possibility that development, which is certainly what is under discussion in this passage, is a kind of alteration. This passage indicates that Aristotle is aware that schema I is unsatisfactory: he now suggests that there are two kinds of alteration. The kind referred to in I is 'a change to conditions of privation'; the accidental change described in the standard account of change. The other kind of change (and he is

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<sup>26</sup> De An II 5 417b2-15

here undecided whether this should be called an alteration or not) is the development of something into its true self or actuality, for example, when a wise man contemplates. This is a move from actuality-1 to actuality-2 (or potentiality-2 to actuality-2), and is the type of change under discussion in this chapter.

Physics VII 3 adds weight to this, claiming that the acquisition of states, whether of the body or the *psuche* or the rational *psuche* in particular, is neither alteration nor becoming.<sup>27</sup> Acquired states are excellences or defects, and excellences are perfections:

'for when anything acquires its proper excellence, we call it perfect since it is then really in its natural state'.<sup>28</sup>

Something's proper excellence is its *ergon*, and *ergon* and *psuche* are closely related. So:

'excellences are perfections ... consequently they are not alterations'.<sup>29</sup>

This sounds very much like the notion of development that I have been considering, the achievement of maximum actualization, since nature is identified by Aristotle with form.

The schemata with which we began, then, can be sketched more precisely:

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<sup>27</sup> Phys VII 3 246a10, 247a1, 247b1

<sup>28</sup> Phys VII 3 246a13-14

<sup>29</sup> Phys VII 3 246b1

II*	substantial change:	strict generation
		development = perfection-2 <sup>30</sup>
	nonsubstantial change:	alteration
		increase/decrease
		locomotion
III*	substantial change	
	nonsubstantial change:	alteration
		increase/decrease
		locomotion
	attainment of perfection	

What then is the true picture of development? Development is perfection of a thing's nature, not alteration, though:

'it may be true that every such becoming is necessarily the result of something's being altered, the result, for example, of the matter's being condensed or rarefied or heated or cooled'.<sup>31</sup>

It is an attainment of perfection, a process by which a form comes to maximum actualization (that is, all the potentialities-1 are potentialities-2), by which an individual is enabled to perform its peculiar *ergon* properly.

The implication of this result of our examination of the nature of change involved in development, and of the way that form can be potential while enmattered, is that we should accept III\*: development is a kind of change quite outside the standard account which Aristotle gives. Thus the imperfect individual is

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<sup>30</sup> See p.70.

<sup>31</sup> Phys VII 3 246a6-8

already 'of a kind'; though the characteristics peculiar to an X may not yet have developed, they are fully determined.

Physics VIII 7 suggests that II\* is appropriate:

'that which is becoming appears as something imperfect and proceeding to a principle'.<sup>32</sup>

Natural development or perfection is a process admitting of degree.<sup>33</sup> These passages could suggest that that which is becoming is not in existence until it is perfect; that attaining perfection is a kind of substantial change. However, they can also be read as saying that the substance is already in existence, although not yet perfect; the process of perfection is occurring to an existing being.

There is a distinction Aristotle makes between essential properties (those in the definition plus some), properties (those which are necessary, but derived from the first kind) and accidents.<sup>34</sup> I suggest that in minimal coming-to-be, a core of essential properties and potentialities for other properties come to be. These are sufficient for us to claim that there is a new substance. In development, or full coming-to-be, these potentialities become actualised. When this is complete, the coming-to-be is complete, and the individual is a perfected member of the species. This allows for the commonsense view that the basic substantial change occurs before birth, and the view that the substance is not complete until the individual possesses all the appropriate essential capacities. The individual possesses a minimal form of man before reaching adulthood, and hence is called by the species-name

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<sup>32</sup> Phys VIII 7 261a13

<sup>33</sup> Phys VIII 7 261a14-19

<sup>34</sup> Topics I 5 102a18, b4-8, b25-27

before he is a perfected member (perhaps: he is man, though he is not yet a man), and possesses a fuller, maximal, form on attaining adulthood.

There are several scenarios that are worrying for an essentialist:

- i/. the individual does not achieve adulthood.
- ii/. the individual grows to adulthood but never reproduces (or never reasons).
- iii/. the individual grows to adulthood, can and does, reason and reproduce, but then loses the ability to do these things.

None of these are any more problematic for my thesis than for the standard account.

If every thing must be of some species, then it must be possible to say of a child that dies in her teens, a barren woman or a subnormal man that they are of a species, and indeed that they are of the species man, even if they are imperfect members of it. Note the word 'imperfect' here: my suggestion allows us to say that they were of a kind but did not perfect their potential.

Again, it must be possible to say of a senile man, or a woman past the menopause, that they are of the kind 'man'. These too are imperfect members, although the imperfection is of a slightly different kind. Here, they did actualise their potentialities to reason and to reproduce, but have now fallen away from perfection - almost certainly because of a lack of heat, as the body ages. Once more, we see the effect of the matter on the form.

It could be said that my thesis has the advantage of offering an explanation of the mutability of mortals, in that it says that the form of substantial beings is such that capacities and functions develop and decay as the individual ages, and explains that this is in large part due to the relationship of form and matter. The properties named in the definition, such as rationality, are possessed by the individual when

young, but cannot be used or actualized until the individual's body is adult. Just as the embryo is unable to walk or perceive, so the young child is unable to reason or reproduce, because it is not sufficiently developed. There is no gain of an essential property as the individual matures; rather, it is that the individual reaches perfection (of a kind) and becomes able to use that capacity.

One question remains: if the standard account of change fails to fit development, what account can we give?

The standard account, as described in the introduction, is given in terms of matter, form and privation, and analysed in terms of four causes. This lies uneasily with development, and for several reasons. It is the form that persists and yet 'changes'; the matter also persists. The compound, form and matter, acts as substratum for some aspects of the change, but at the same time the form 'changes'. In accidental change the individual acts as matter and the qualities change. In substantial change the matter acts as matter and the form changes. In development, the individual - form and matter - acts as matter; the form and the qualities change. The matter/form/privation account does not work; in some way the three principles are combined in one element, the form. Development involves the actualising of potentialities from potentiality-1 to potentiality-2 and this cannot be explained by the form/matter/privation account.

I suggest, then, that since development is set in motion by the change occurring at conception, we accept the same account of change for both: that of concoction.

Concoction is:

'a process in which the natural and proper heat of an object perfects the corresponding passive qualities, which are the proper matter of any given object. For when concoction has taken place, we say that a thing has been perfected and has come to be itself ... In some cases of concoction the end

of the process is the nature of the thing - nature, that is, in the sense of the formal cause and essence'.<sup>35</sup>

It should be clear that this fits the description of development as a process of perfection to a full substantial form given above; the internal heat proper to an individual is used by his form or internal principle of change to bring his potentialities into actuality. It also fits the account of the acquisition of the intellect, which claimed that the extra vital heat brought the potentialities of the sensitive *psuche* into actuality. When concoction is complete, the individual is perfect-2, and has come to be 'itself' in the fullest sense, since the end of the process is the full substantial form.

In this chapter, I have made two controversial claims: firstly, that development is neither substantial nor nonsubstantial change, but is a third kind, the nature of which is best explained by the account of concoction given in the Meteor. Secondly, I have claimed that development requires a sense in which the form can be potential while enmattered, against the usual view of form; it is the actualising of these potentialities of the form that is development.

Finally, as a result of these assertions, I have claimed that substantial change is complete, in one sense, at conception - since that is when a new individual is fully determined - and, in another sense, is not complete until that individual has reached his full potential, at maturity. The question with which I started - when has a new individual substance come to be? - is answered with the intuitive answer of 'at

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<sup>35</sup> Meteor I 2 379b18-26; see GA I 21 730a16 on development as concoction; also GA IV 6 775a18

conception' after all, but there is a qualification to be made: the individual is not perfect, nor 'of a kind', until it is mature.

In the last two chapters, I want to examine abnormal reproduction. This consists of two main groups which I shall call efficient abnormalities and final abnormalities.

If one applies the four-cause analysis to conception, the material cause is the catamenia, the formal cause the form of the father, the efficient cause the semen and the final cause the form of the new individual.<sup>36</sup> In certain cases, one or more of these causes may be lacking; in my remaining chapters, I shall discuss the ways in which these reproductions approximate to, and diverge from, the account of reproduction derived in the preceding discussion.

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<sup>36</sup> Meta VIII 4 1044a33-35

## Spontaneous Generation

'So with animals some spring from parent animals according to their kind, whilst others grow spontaneously and not from kindred stock; and of these some come from putrefying earth or vegetable matter, as is the case with a number of insects, while others are spontaneously generated in the inside of animals out of the secretions of their several organs'.<sup>1</sup>

### The problem

Sexual reproduction was not the only kind recognised by Aristotle; he also held that the females of some species could produce offspring without the aid of the male, and he believed in spontaneous generation, that is, the generation of animals (of a rather lowly sort) without parents. Plants are also generated spontaneously, but there seems to be little difference between the two cases; after all, at that level of development, there is not a great difference between the plant and the animal.<sup>2</sup> I shall concentrate here on the generation of animals.

Parthenogenesis is puzzling enough in the context of Aristotle's theory<sup>3</sup>, though is perhaps explicable in that the kinds of animal which generate in this way are of low level, approaching plants, in which the sexes are mixed; but chiefly I want to discuss spontaneous generation, which does not fit easily into the standard account of generation. Just as sexually induced conception fails to fit the standard account

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<sup>1</sup> HA V 1 539a21-25; GA I 1 715a24-b27

<sup>2</sup> HA V 1 539a18-20; GA I 1 715b25-716a1; I 18 726a7; III 11 762b18

<sup>3</sup> Though I believe it is true enough: I understand female greenfly and other such insects can produce other females for one generation at least. Needham (1959, p.212) says the tobacco virus, which is difficult to identify as either animate or inanimate, can be said to spontaneously generate.

of change in any straightforward fashion, so too does the spontaneous generation of certain animals and plants, though in a rather different way.

The experience of apparently spontaneous generation was of course overwhelming: it would have been commonplace to observe flies hatching on cowpats (or even just being present in large numbers) without observing the laying of eggs or arrival of flies from elsewhere. After all, it was not until the seventeenth century that this began to be disproved, species by species.<sup>4</sup> The kind of animal generated, Aristotle thought, depended upon the matter in which it was generated:

'As a general rule, then, all testaceans grow by spontaneous generation in mud, differing from one another according to the differences of the material; oysters growing in slime and cockles and the other testaceans above mentioned on sandy bottoms ...'.<sup>5</sup>

This idea, that some animals differ according to the matter, is a surprising thought for Aristotle to have, and constitutes the first problem: it runs contrary to his standard account, in which the material cause affects only the accidental attributes of the animal. That is, in the standard account of sexual conception discussed above, the formal cause is the form of the new individual imparted by the efficient cause, the semen, to the material cause, the catamenia, 'for' the final cause, the new individual. Occasionally the material cause overcomes the formal cause and aberrations occur: in the strict account these aberrations are limited to the accidental properties of the new individual; in my split donor account, this may include its sex.

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<sup>4</sup> And was not completely disproved until the second half of the nineteenth century, by Pasteur.

<sup>5</sup> HA V 15 547b12-15, b18-21; [Prob] XX 12 924a8

In spontaneous generation, the animals differ in kind as well as in accidental properties:

'the testacean is almost the only genus that throughout all its species is noncopulative'.<sup>6</sup>

Evidently there are various kinds of testacean, and this must be due to the conditions of spontaneous generation. Clearly the split donor account is closer than the standard account to explaining how it is that the material cause can produce different kinds of animal. But even this is inadequate: there is no individual formal cause from a parent here, to endow it with a specific form. How, then, can such animals belong to any species? One might wonder whether these animals were perhaps not of any proper species, and hence suggest that this is an improper question; perhaps some remaining Platonic influence says that there are no forms for such lowly organisms. But Aristotle refers without hesitation to the species and genus of various spontaneously generated animals, so this is no solution.<sup>7</sup>

An extension of the split donor thesis might claim that there is something special about the matter in which animals are generated spontaneously, in that it requires no additional formal input - consider the windegg. However, in the case of windeggs, the mother donates some form, though of a low degree; here there is not even that possibility. The problem is precisely the location of the formal cause in spontaneous generation.

Aristotle tells us that the matter in which animals are generated spontaneously is either putrefying matter or the insides of animals; for example, all deer have

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<sup>6</sup> HA V 15 546b17-18

<sup>7</sup> HA V 15 546b17-18, 547a4; V 16 548a24, a31; 19 551a9; GA III 11 761a20-24

maggots living inside the head. In other passages we learn that mud of different kinds produces animals of various sorts. Some insects are generated out of dew falling on leaves, others in decaying mud or dung, others in timber, green or dry, some in the hair or flesh of animals, and some in excrement, either before or after it has been voided. Still others are generated in wool and cheese.<sup>8</sup> In fact:

'As a general rule we may state that such animalcules are found in practically anything, both in dry things that are becoming moist and in moist things that are drying, provided they contain the conditions of life'.<sup>9</sup>

What must be established, then, is what exactly the conditions of life are. To this end, I shall examine Aristotle's chapter on spontaneous generation at some length.

### Generation of Animals III 11

761a14 Having inquired into the generation of all insects, let us speak of the testacea.

The facts about the generation of these is in some ways like and in other ways unlike the others. And this is what we should expect, for compared with animals, they resemble plants, compared with plants, they resemble animals, so that in a way it seems that they are generated from semen, but in another way not, and in one sense that they are spontaneously generated, in another that they are generated from themselves, or some by the one method, some by the other.

In this introductory paragraph Aristotle is pointing out that testacea are similar to plants in some ways and to animals in others. Testacea, dualising between true plants and true animals, manifest the characteristics of both. So one would expect

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<sup>8</sup> Meteor IV 1 379b7; IV 3 381b11; HA II 15 506a26; V 1 539b8; V 15 546b24, 547b18; V 16 548b16; V 19 551a1-14; V 31 556b27, 557a16; V 32 557b2, b6; VIII 20 602b26-30; IX 40 625a10; GA I 1 715b5; I 16 721a5-10; III 11 762a9-11

<sup>9</sup> HA V 32 557b10-14

that their method of generation would 'dualise': either that some are produced from semen, like animals, and others not, like plants, or that the method itself dualises, being due to some 'quasi-semen'. This is what Aristotle is going to discuss in this chapter. In fact, none of the testacea turn out to be true animals, with sexual reproduction; as we shall see, snails have been seen coupling, but Aristotle refrains from assuming that this is generative, since he has insufficient evidence.

761a20 Because testacea are by nature the counterpart of plants, none or few of this genus come into being in the earth (examples are snails, and any other such there may be, though there are not many), but in the sea and similar waters there are many, of all kinds of shapes. The genus of plants in the sea and such places are few, almost none at all, but all of such things grow in the earth. For the nature is analogous; as much as water and liquids are more life-giving than earth and solids, so much does the nature of testacea differ from that of plants, since in principle, the testacea are to water as plants are to the earth, as though plants were a sort of land-shellfish, and shellfish a sort of water-plant.

Here he claims that testacea are the counterpart of plants, where above the idea seemed to be that they were points on the same scale of being. However that might be, the important point is that the testacea are to water as plants are to earth: it is the medium of their life. So hardly any testacea generate in the earth, but rather in the sea, and hardly any plants generate in the sea, but almost all in the earth. And though testacea and plants are counterparts, the medium of the former is 'more life-giving' than that of the latter, and so the former are more 'lively', or higher up the scale of perfection - possessing more animal-type functions, say. In what sense is the sea more full of life? As we shall see below, this may mean no more than that the sea contains more of the conditions of life than the earth does: *pneuma*, heat, fluid and earthy elements.

761a33 Because of such a cause, the things in the water are more various in shape than those in the earth - for liquid is by nature more plastic than earth, and not much less material - especially the sorts of things in the sea, since fresh water, though sweet and nutritious, is less material and is cold. So, as many as are bloodless

and not hot by nature do not come to be in lakes nor in the fresher of brackish waters, with a few exceptions, such as the testacea, cephalopods and crustacea, all of which are bloodless and cold by nature, but they come to be in lagoons and by the mouths of rivers. For they seek at the same time warmth and food, and sea-water is much more fluid and material than fresh water and it is hot by nature, and it shares all the parts - of fluid, of *pneuma*, and of earth - so that it shares in all the things which grow in each.<sup>10</sup> For plants may be assigned to the earth, aquatic creatures to the water and land-animals to the air, but the more and the less and the nearer and the further make a big and surprising difference.

Not only are the water-bound beings more 'lively' than their corresponding earthbound correlates, there are also more kinds of them, again because their medium is more plastic. Seawater, being warmer, and having more earthy elements in it, produces a greater variety of testacea than freshwater. Indeed, seawater is a fine soup of elements appropriate to all kinds of things which grow, be they earthbound plants, waterbound creatures (plants or animals) or airbreathers. Note that though the sea is hot by nature, it does not contain any of the fourth element, fire. That sea-water should be hot by nature is rather surprising, given that the element 'water' is composed of the cold and the moist. Meteor II 3 358a7 tells us that the sea is warm because everything that has been exposed to fire contains heat potentially; this is a reference to the raincycle. Its warmth may also be derived from the *pneuma* in it, though why it should have more than fresh river water is not clear.

'The more and the less and the nearer and the further make a big and surprising difference'. The 'more and less' here may refer to the continuity of nature: some animals are amphibious, dualising between air and water; plants may be found - to some extent - in the sea. The 'nearer and further', then, would mean nearer and

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<sup>10</sup> I have omitted the phrase 'in the places of animals', which seems to me to make no sense here. Peck similarly brackets it, as does the Revised Oxford Translation.

further from the natural place of the element appropriate to that living being. The surprise may be the extent to which location affects the nature of the animal.<sup>11</sup>

Already we learn something of the conditions necessary for spontaneous generation: warmth, earthy material, water, and *pneuma*.

761b16      The fourth genus must not be sought in these regions, though there ought to be something corresponding to the position of fire, since that is reckoned as the fourth of the bodies. But fire never seems to have its own shape, but that of another of the bodies; for the burning object appears either as air or smoke or earth. Such a kind must be sought on the moon; for this seems to share in the fourth interval. But that is another story.

Since there is a fourth element, it would be appropriate if there were a fourth genus of beings, those whose medium is fire. However, Aristotle says, fire never assumes a form peculiar to it, but is always manifest in one of the others. Presumably this is meant as an explanation of why we see no animal whose element is fire, and plenty of animals whose element is one of the other three. How is this an explanation? It may simply mean that just as fire is manifest only in the form of another element, because this is not its appropriate level, so any animal would be at this level only in the guise of that of another element; thus to find a fire-animal, one must look to the upper spheres. It could be that Aristotle is not referring to fire as in bonfires here, but to the fourth element, the fourth level of the world, which is only 'fiery', and present at this level only in another form<sup>12</sup>; if so, his suggestion that we would have to seek for animals of this element in the upper levels makes more sense.

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<sup>11</sup> This is not meant literally, of course; I do not believe that Aristotle was any sort of evolutionist.

<sup>12</sup> See chapter I.

We should note HA V 19 552b10-12, which claims that certain winged creatures, slightly larger than flies, are generated in fire, and perish if removed from it. This, of course, contrasts with GA II 3 737a1-3, which says that fire generates no animal because it is not generative as the sun and animal heat are. Animals exist only on land and in water, which provide the matter from which their bodies are compounded, but not in air or fire.<sup>13</sup> It is not to be supposed that Aristotle is ignoring birds here; he is referring to the elements that animals can use as nutriment. There are no animals which use air or fire as nourishment. It is clear that he is not referring to the salamander, which might be suggested, for though HA V 19 says that this is an animal that fire cannot destroy, there is no suggestion that fire is its element, nor, indeed, is it clear that Aristotle is taking the fable about the salamander for truth.

761b24 The nature of the testacea is to form spontaneously or by emitting a certain generative substance from themselves though these too are often formed from a spontaneous formation. It is necessary to grasp the kinds of generation of plants. Some plants are formed from seed, some from sections planted out, others by sideshoots (e.g. the onion genus). Now this last is the way mussels are formed; smaller ones are always growing beside the original one. The whelks and purpurae and those which are said to honeycomb emit quantities of slimy fluid as if from something of a seminal substance. We must not, however, consider that any of these substances are real semen, but that such things share in the resemblance to plants in the way already mentioned. And that is why many of such creatures come to be once one has been produced, for all these can be produced spontaneously as well, and some being there, more come to be, as one would expect. For it is reasonable that a certain residue remains by each of the originals, from which each of the sideshoots springs up. And since the nourishment and this residue possess the power, it is likely that the stuff produced by the 'honeycombers' is similar to the original constitution; hence it is reasonable that they come from this.

Testacea either reproduce spontaneously or by a generative secretion; the latter may also reproduce spontaneously. Testacea are like plants: plants either reproduce

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<sup>13</sup> Meteor IV 4 382a4-6

by seed, by sections planted out or by sideshoots.<sup>14</sup> Mussels are like onions in that they reproduce by sideshoots; other testacea produce a generative secretion.<sup>15</sup> One might think these others reproduced by seed, as some plants do, but this is not true semen; rather, we must think that they resemble plants in the way that mussels do, as just described. So all testacea in fact reproduce either spontaneously or by sideshoots; 'sections planted out' is a reference to the action of gardeners and is not a possibility open to testacea. This is how new colonies form: once the first one is produced (spontaneously, since many of these animals do not move<sup>16</sup>), others are produced around it, since residue remains around the original, from which the sideshoots appear.

'such, then, of the testaceans as deposit the honeycomb are generated like all other testaceans, but they certainly come in greater abundance where their congeners have been living previously.'<sup>17</sup>

Just as in animals, this stuff is the residue of the nourishment, and is presumably more material in the sense that, like plants, there is no need of two sexes, since they are mixed in one being.<sup>18</sup> This may be because the difference between form and matter is less: they are inseparable, since the psychic functions are limited; in the same way, in egg-producing animals of lower order, the yolk and the white do

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<sup>14</sup> Theophrastus (De Causis Plantarum) mentions seed, spontaneous generation, and generation from parts. Since fragments and buds can both be counted as generation from parts, and Aristotle mentions plants spontaneously generating (e.g. GA I 1 715b25-27), there is no disagreement here.

<sup>15</sup> Note that mussels also produce honeycomb: HA V 15 547b11

<sup>16</sup> HA V 15 548a5-6; VIII 1 588b15; VIII 2 590a19; GA I 1 715b16

<sup>17</sup> HA V 15 546b26-28

<sup>18</sup> GA I 1 715b19-20; I 23 731b10-12

not separate. As the animal to be produced becomes more honourable, i.e. has a more complex *psuche*, it becomes necessary that the sexes are distinguished.<sup>19</sup>

Two kinds of beings produce residue and reproduce from that: those which produce sideshoots, and those which 'honeycomb'. HA V 15 tells us that the latter resemble a honeycomb, though it is not so neat and looks rather as though chickpea husks were stuck together.<sup>20</sup> The new individuals do not grow from this - Aristotle reminds us that they grow from mud - but when this honeycomb is deposited, a mucus appears, from which the honeycomb is formed, and then melts, and the contents - tiny new individuals - are deposited on the ground. Clearly the honeycomb structure is to permit the enclosure of the necessary conditions of life, which presumably include the mucus, and to form 'cells' for the new individuals to grow in. In a similar way, embryos produced by sexual generation are enclosed in membranes. There is a stage at which the honeycombers are too tiny to be differentiated in form: see also HA V 18 on baby octopuses so tiny as to be without organisation, yet able to move.

62a8 And the generation of those which neither produce sideshoots nor honeycomb, is spontaneous. And all which come to be in this way, either in the earth or in liquid clearly come to be with putrefaction and a mixture of rainwater. For the sweet ingredients separating off into the principle which is forming, the residue of this takes shape. Nothing comes to be by putrefaction, but by concoction: the putrefaction and the putrefied stuff are a residue of that which is concocted, for nothing comes to be from everything, any more than in the products of art; otherwise it would not be necessary to do anything, whereas in one case art removes the useless stuff, and in the other nature does.

The third kind of reproduction under discussion is spontaneous generation, which can occur either in earth or liquid. Essentially, this is due to concoction, just as we

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<sup>19</sup> GA II 1 731b24-732a10

<sup>20</sup> HA V 15 546b20-b34

saw the generation of animals to be, though it appears to be due to putrefaction because the residue of that which is concocted putrefies.<sup>21</sup> Of what is it concoction? We are told that the sweet (or nutritious) ingredients are separated off into the principle which is forming, and the residue of this takes shape.

If we look back to the discussion of eggs above, we can see that what is happening is that the conditions of life being present (though as yet unspecified), the more material and the more formal parts separate and the heart (or analogue) is formed.<sup>22</sup> The heart is of course the principle mentioned in the text as forming, and the sweet ingredients are the nutritional elements in the egg-like formation. Though the nutriment and its residue would seem to be no more than the earth and water, or some combination of these, it should be recalled that there are two kinds of nutriment.<sup>23</sup> We know that the heat in an egg causes the double colour, and that in the animal body the sweet is drawn away by the natural heat leaving the bitter and salt<sup>24</sup>; it is not unreasonable to apply a similar account here and understand that the sweet ingredients form the principle. As we saw above, this is the heart, which forms simultaneously with the blood or nutriment that forms the rest of the body in it: 'the residue takes shape'. All this is done by concoction, or proper heat, not putrefaction, which is an unwholesome heat. The putrefaction arises from the residue of the stuff which is forming the body, that is from the completely useless surplus matter.

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<sup>21</sup> Meteor IV 11 389a29-b6

<sup>22</sup> For discussion of separation, see p.45-53.

<sup>23</sup> GA II 6 744b31-5

<sup>24</sup> Meteor II 2 355b2-11

Further to the conditions of spontaneous generation, we should note that even if it occurs in liquid, rainwater seems to be necessary, since it is nutritious; more so than sea-water, which is surprising, since many fish migrate to the Euxine, where the seawater is unusually fresh, due to the number of rivers.<sup>25</sup> And we know that testacea which do not move filter seawater to obtain fresh water.<sup>26</sup> Clearly, seawater does not alone provide all the conditions for life.

762a19 Animals and plants come to be in the earth and in water because in earth water is present, and in water *pneuma*, and in all the latter *psuche*-heat, so that in a way all things are full of *psuche*; and that is why they quickly take shape once it has been enclosed. And when it gets enclosed, it becomes a sort of frothy bubble, the material liquids being heated. The thing which forms is more honourable or less honourable in kind and the differences are in the enclosure of the *psuche* principle. And the causes of this are the locations, and the matter which is enclosed. Now in the sea earthy matter is plentiful; that is why the nature of the testacea comes to be from such a composition; the earthy substance hardens all round and solidifies in the same way as bones and horns (for these are not melted by fire), while within it the body having the life becomes enclosed.

Now we turn to the conditions of life, and explain in a little more detail how the process works.

Spontaneous generation is possible in both earth and water because water and *pneuma* are to be found in both, though obviously in greater quantities in water than in earth (which may explain why water is more full of life). There is more *pneuma* in water than in earth because of the chemical process involved in its production; as Aristotle says, it is easier to produce something in a one-stage process than in a two-stage one, and:

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<sup>25</sup> HA VIII 19 601b9-19

<sup>26</sup> HA VIII 2 590a19-20

'*pneuma* must be present, because heat and moisture are present, the former acting and the latter being acted upon'.<sup>27</sup>

But the most important factor is that *pneuma* contains *psuche*-heat.

This is very interesting, particularly the suggestion that all *pneuma* contains this heat; previously it has seemed clear that there are two distinct kinds of *pneuma*. Now it seems that there is some generative vital heat everywhere. Where might it have come from? The most obvious source is of course sun-heat; we know that the sun is one of the causes of generation, and Aristotle is clearly pressing the analogy between vital heat and the element of the heavenly bodies very hard here, in attempting to solve the problem of spontaneous generation. However, I suspect he is ignoring (possibly deliberately) the problems that arise once such a suggestion is made, for instance, that of vitalism.

Animals and plants quickly form once the *psuche*-heat has been enclosed. Matter, *psuche*-heat and liquid being mixed, a foam arises and a skin forms over it from the matter and liquid mixture, just as in the process of conception, in which when

'the more solid part comes together, the liquid is separated off from it, and as the earthy parts solidify membranes form all round it; this is both a necessary result and for the sake of something, the former because the surface of a mass must solidify on heating as well as on cooling, the latter because the foetus must not be in a liquid but be separated from it.'<sup>28</sup>

Foam or froth is analogous to the semen, which is a foam of water and *pneuma*. Foam or froth is explicitly mentioned in several cases of spontaneous generation: small fry appear in the froth thrown up by heavy rains or by the sea; other animals,

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<sup>27</sup> GA II 6 742a15

<sup>28</sup> GA II 4 739b25-30; see II 3 737a35

such as barnacles, are generated in the frothy mud that collects on the underside of boats.<sup>29</sup> That the process, once initiated, should be similar to sexual conception is not really surprising; it is the initiation of spontaneous generation that is difficult to understand.

The living thing which forms depends on the matter enclosing the *psuche*-principle; this in turn, obviously, depends on the place where this occurs, and on the matter enclosed with the *psuche* heat. At GA III 11 762b16, separation is used in conjunction with (or possibly opposition to) enclosure: that portion of the *psuche* principle which gets enclosed or separated off within the *pneuma* forms a fetation. Other passages on this subject repeat the ideas of both enclosure and separation: *pneuma* or soulheat gets enclosed as the liquids are heated and a frothy bubble is formed; the first principle is separated off; the sweet is separated off into the principle.<sup>30</sup>

There may be a distinction here between *emperilambanomai* and *perilambanomai*, the former implying 'included in' and the latter 'enclosed within'.<sup>31</sup> So, animals and plants form once the vital heat is included (*emperilambanomai*) with the matter and liquid, which happens as the frothy bubble forms; the kind of animal which forms depends on the enclosure or shell (*perilambanomai*) which in turn depends on the matter enclosed (*perilambanomai*); the matter hardens around the outside, like shell or horn, while within it the body having life is enclosed (*perilambanomai*) just as for the honeycombers. This distinction may help to clarify Aristotle's thought on the process involved, but, though the importance of matter to spontaneous generation

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<sup>29</sup> HA VI 15 569b13-20; GA III 11 763a26-7

<sup>30</sup> GA III 11 762a20-33; also II 4 739b36; III 11 762a12

<sup>31</sup> I owe this suggestion to Jonathan Barnes.

is obvious, the crucial question as to how it can affect the resultant form is left unanswered.

Perhaps it will be useful to look at other occurrences of 'enclosure' here. *enapolambanesthai* is used at several places, in most of which the meaning is transparently that of literal enclosure (water in a bladder, for example).<sup>32</sup> The remaining two passages refer to the heat contained in air, and to the *psuche*-principle contained in the *pneuma*.<sup>33</sup> Other enclosing words are *emperilambanesthai* and *perilambanesthai*, which usually mean literal enclosure<sup>34</sup>, but again, some passages (including this one) refer to the enclosure of *psuche*-heat, and to the enclosure of something divine within some animals.<sup>35</sup>

In 736b36, where Aristotle is explaining the relationship between vital heat and *pneuma*, he uses *emperilambanomai*; if the distinction suggested above is satisfactory, then the heat is included in the *pneuma*, rather than merely enclosed within it. This is what we would expect, given that he then says that it is the nature of the *pneuma*. The divine element is similarly 'mixed' with the animal: *emperilambanomai*.

He uses *enapolambanomai*, at 762b16, of the *psuche* principle and *pneuma*. This suggests that 'enclosed or separated off' is not an alternative, but a further explanation: the *psuche* principle is 'set aside in' the *pneuma*. In what sense 'in'?

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<sup>32</sup> Meteor II 8 366b16; HA VII 37 580b11; [Prob] II 25 868b25; XI 44 904a17; XIV 8 914b11; XXV 1 937b31-34

<sup>33</sup> Meteor III 3 372b30-35; GA III 11 762b16,

<sup>34</sup> Meteor I 13 350a12; II 3 358a23; IV 10 388b21; HA III 1 510a22; III 3 514a21; V 28 555b24; VI 3 561b24, 562a14; PA II 6 652a5, a23; II 9 654b21; IV 10 687b20, 690b2; [Prob] XXXIV 6 964a6

<sup>35</sup> GA II 3 736b36; II 9 737a9

I suspect that this must be a literal enclosure, given the other occasions where this word is used, but it is not clear.

762a34 The genus of snails alone of this kind has been seen coupling. But whether their generation is from coupling or not has not yet been adequately observed.

An interesting methodological point. In the case of bees too, Aristotle admits that he has insufficient evidence to reach a conclusion.<sup>36</sup>

762a36 Anyone wishing to inquire rightly would inquire what, in these sorts of cases, the thing being formed is in respect of the material principle. For in females this is a residue from the animal, potentially such as that from which it came, by imparting movement to which the principle from the male perfects the animal. But here what must be said about such a thing? And from where and what is the moving cause corresponding to the male? It must be understood that also in the animals which generate, the *thermotes* of the animal, by separating and concocting, makes the residue, the cause of the fetation, out of the incoming food. Similarly in plants, except that in these and certain of the animals there is no need of the principle of the male for they have it mixed in themselves; but in most animals the residue does need it. The nourishment of some is water and earth, and of others the things from these, so that in them the heat in the animals perfects from food, and in the others the surrounding seasonal heat compounds and unites out of the sea and earth by concocting. And the vital principle which is enclosed or separated in the *pneuma* makes a fetation and puts movement in it. So of plants being spontaneously generated, the composition is uniform: they come from a part of something, and while some of it comes to be the principle, some of it comes to be the first nourishment of the shoots. And of the animals, they are brought forth as larvae, both the bloodless which do not come from living animals, and some sanguinea, such as a kind of mullet and other river fishes, and also the genus of eels; for all of these, although by nature having only a little blood, are nevertheless sanguinea and have a blood-like heart, which is the principle of the parts. And what are called 'earth's guts' have the nature of a larva; the body of the eels forms within them.

Aristotle is drawing parallels between the account of sexual generation derived in the earlier books and the account he is attempting to outline here. Reasonably, he refers first to the account appropriate for animals, and then to that appropriate for

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<sup>36</sup> GA III 10 760b33. See also HA I 17 496a10; PA IV 2 676b33; GA IV 1 765a25-28

plants, since the testacea dualise between the two. In both, *thermotes* makes the residue responsible for generation out of the nutrition; but in plants and certain animals this is sufficient for generation - an additional male principle is unnecessary. In most animals, the *thermotes* is their own; in the other beings, the *thermotes* is environmental.<sup>37</sup> But in both, the vital principle in the *pneuma* brings the new individual into being: this is puzzling in the case of spontaneous generation, and it is not clear that Aristotle explains it adequately.

It seems quite clear that he intends the earth and water, or some combination of these, to correspond to the catamenia in humans, the material principle. Other conditions include heat and the vital principle. The heat appears to correspond to the efficient cause in that it brings about the concoction, just as the heat in the semen does; but it is still not clear what the formal and the final causes are. However, even in spontaneous generation there is a distinction between two kinds of nourishment, the more formal which forms the principle and the body, and the more material which nourishes the thing formed.

Heat is a central notion in Aristotle's biology. All animals have some natural heat, but the vital heat of the animal in question is not the only heat available: there is also some input of external generative heat. We know that the heat of the sun is often mentioned as one of the causes, and that analogies between that and the generative heat are common.<sup>38</sup> Aristotle mentions, though does not discuss in any detail, seasonal generators, for instance:

'... in the latter case [*techne*] it is we who apply the heat in due measure for the motion required; in the former it is the nature of the male parent that

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<sup>37</sup> Note that eels are generated where the sunheat (*alea*) causes putrefaction: HA VI 16

<sup>38</sup> See e.g. HA VI 16 570a24-5; Meteor II; GA II 3 737a1-3

gives it, or with animals spontaneously generated it is the movement and heat imparted by the right season of the year that is the cause.'<sup>39</sup>

The hottest animals (*per se*), such as man, can generate at any time of the year; lower ones need the additional boost of the sun's generative heat. The lowest of the animals, generated spontaneously, can have only the seasonal heat, or 'secondhand' vital heat to initiate their generation. (Second-hand in that they generate on, or in, another animal which possesses sufficient vital heat.<sup>40</sup>)

On the question of heat and reproduction we should note the account of the reproduction of bees, which is very interesting, and to which I shall return later. For the moment let me just quote this passage:

'... in fine seasons much honey is collected and many drones are produced, but in rainy seasons a large brood of ordinary bees. For the wet causes more residual matter to be formed in the bodies of the leaders, the fine weather in that of the bees, for being smaller in size they need the fine weather more than the kings do.'<sup>41</sup>

The leaders produce the worker bees, and the workers the drones.

In this passage we can see a connection between matter, the wet, heat and size. Evidently there is a progression of value in the four elements, with fire being the least material and earth the most. The more material something is, the less perfect

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<sup>39</sup> GA II 6 743a35; see also HA V 33 558a1-4; V 8 542a20-31; V 11 543b19-24; GA III 2 753a17

<sup>40</sup> This might lead one to expect that the more vital heat an animal possessed, the more parasites it would possess; but Aristotle claims that men, who are hotter than women, have fewer lice (HA V 31 557a7). This is puzzling unless one restricts the lice to head-lice, in which case one could say that this is due to the difference in brain temperature: the brain of men, in order to counteract the greater heat of the heart, must be colder than that of women.

<sup>41</sup> GA III 10 760b2-7

it is<sup>42</sup>; part of the problem in locating the formal cause of the spontaneously generated animals is that it is apparently 'in' the matter.

A note on 'earthguts': Peck says they are the round-worm Gordius. D'Arcy W. Thompson believes them to be the larvae of the eel, and points out that Sicilian fishermen know the larva of the eel, and call it 'casentula'. Aristotle says the eel develops from *ges entera*, which is usually translated as the guts or bowels of the earth, and interpreted as earthworms. However, Thompson says, in Sicilian Doric *ges entera* would become *gas entera* and between 'gasentera' and 'casentula' there is little difference. 'So we may be permitted to suppose that here again Aristotle was singularly and accurately informed; and that he knew by sight and name the little larva of the eel, whose discovery and identification is one of the modest triumphs of recent investigation.'<sup>43</sup> However, we know that Aristotle thought:

'this entire species of blooded animals proceeds neither from pairing nor from the egg'<sup>44</sup>;

they are generated spontaneously. So though he may have known that the eel comes from this larva (he says:

'eels have at times been seen to emerge out of such earthworms, and on other occasions have been rendered visible when the earthworms were laid open by either scraping or cutting'<sup>45</sup>)

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<sup>42</sup> Cf. pp.40-45.

<sup>43</sup> D'Arcy W. Thompson (1940) p.57.

<sup>44</sup> HA IV 11 538a3; VI 16 570a6. This may be because no generative organs could be perceived; eels spawn in the depths of the ocean and only develop these organs when there. Platt (1910). Note that with reference to other animals, Aristotle points out that the genitals are only visible during the breeding season: HA VI 9 564b10; VI 11 566a8

<sup>45</sup> HA VI 16 570a17-18

he did not know that the larva comes from the eel.

762b27 And so, about the generation of men and quadrupeds, one would suppose, if once they were 'earthborn', as some say, that they came to be in one of two ways: either by a larva forming at first, or from eggs, since necessarily they either had the nourishment for their growth within themselves (and this sort of fetation is a larva) or they got it from elsewhere, and that means either from the mother or from part of the fetation; so that if the former is impossible, and it cannot flow out of the earth as to other animals from the mother, then it must have come from part of the fetation, and this sort of generation we say is from an egg.

This section is a bit of a digression; Aristotle is discussing the way in which the origin of all creatures could have occurred. He argues that there are three ways in which first nourishment is available; either from the fetation itself (larvae) or from the mother (viviparous animals) or from part of the fetation (egg). Since there can have been no mother, if these creatures were the first of their kind, and since animals do not come to be from eggs, the first 'earthborn' men would have had to come from larvae.

763a3 So that if for all animals there were one cause of generation, it is reasonable, clearly, that it be one of these two. But it is less reasonable from eggs, for we don't see this sort of generation of animals, but the other, both of the sanguinea I mentioned and the bloodless ones. Of these are some of the insects, and the testacea which are being discussed. For they do not come to be from a part of something, like the animals produced from eggs, and their growth occurs like the larvae, for larvae grow towards the upper parts and towards the 'principle', the nourishment for the upper parts being in the lower part. And this they have like the animals from eggs, except that the latter use up the whole, but in the larvae, when the upper part has grown by taking from the lower part, then the lower part becomes articulated out of what remains. The reason for this is that later, as well, the nourishment is produced in the part below the diaphragm in all animals.

Part of an egg is nourishment for the new individual, while part of it becomes the new individual; the whole of a larva is used to form the whole of the new

creature. Eggs and larvae also differ in that they represent different stages of development: insects first produce larvae, then these develop until they become egg-like, and then these form animals.<sup>46</sup>

763a18 That the grubs grow in this way is clear in the case of bees and the like, for their lower part is big from the start and the upper part small. The facts about growth in the testacea are in the same way. This is shown in the convolutions of the spiral-shelled creatures, for as they grow these always become larger towards the front and the head, as it is called.

Most animals are originally bottom-heavy, and their systems use up the extra nutriment lodged in the bottom half to feed and increase the top half; man, when young, has a top half larger than the lower, though this condition reverses as he grows, and when mature, his upper part is smaller than the lower.<sup>47</sup>

763a24 This practically completes our description of the ways of genesis both of these and of the others that are generated spontaneously.

763a25 That all the testacea are formed spontaneously is shown by these sorts of things: that they come to be on boats when the frothy slime putrefies; and in many places where nothing of this sort had been present before, after the place has become muddy because of lack of water, what are called lagoon-oysters, a kind of testacea, have formed, such as when a naval squadron cast anchor off Rhodes and threw some earthenware pots into the sea, and after a time, when mud had collected round them, oysters were found in them.

Evidence for spontaneous generation of the first creatures in a colony (i.e. where honeycombing is impossible).

763a35 And here is evidence that these sorts of animals emit no generative substance: certain Chians carried some live oysters across from Pyrrha in Lesbos, and put them in some sea-straits where the currents met. They did not come to be more numerous as time passed, but they grew greatly in size.

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<sup>46</sup> HA I 5 489b7-10; V 19 550b28-30; GA II 1 733b12-16

<sup>47</sup> HA II 1 500b26-501a8; PA IV 10 686b12

More evidence, this time that not all of these animals honeycomb. The point of the location, according to Peck, is that because of the force of the currents, no mud is deposited, and so there is no matter from which these sorts of animals could arise.

763b4 And the so-called eggs contribute nothing to generation, but are a sign of good nourishment, like fat in sanguinea; and that too is why they are tasty to eat at these seasons. A sign of this is that they always have such things, that is, the pinnae, whelks and purpurae, except sometimes they are larger, sometimes smaller. Others, such as pectens, mussels and the so-called lagoon-oysters, do not always, but do have them in spring; as the season advances they wane, and finally disappear altogether; the reason being that spring is favorable to their physical condition. In others - e.g. the seasquirts - nothing of the kind is to be detected.

And finally, evidence that these creatures do not lay eggs; what one sometimes calls eggs are in fact no such thing. Some of these animals do not possess them at all, and in those that do, the 'eggs' fluctuate in size. If they were eggs they would not diminish in size, but would develop into new individuals.

763b15 For an account dealing with these individually, and the places where they grow, the student should consult the History of Animals.

### Other efficient abnormalities

Further on the subject of efficient abnormalities, I should note a few other curiosities.

HA V 1 mentions several different ways in which fish reproduce.<sup>48</sup> Apart from fish which copulate, in which case there are always both male and female, he mentions:

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<sup>48</sup> HA V 1 539a26-b13; GA II 5 741a33-b4

1/. fish that are neither male nor female, which are identical generically with other fishes, but differ from them in species;

2/. fish that are isolated, presumably in both species and genus;

3/. fish which are always female, and produce windeggs just as birds do; though in the case of fish these are capable of development, either spontaneously or with the male.<sup>49</sup>

Kember (1974) suggests that the Arabic tradition, which lists only two of these (the first and the third), where the Greek tradition lists all three, is perhaps more likely. The dubious group is that of fish which are different in both genus and species; Peck names eels as examples of these fish, but Kember argues that none of the passages quoted<sup>50</sup> says that eels are entirely peculiar in this sense, merely that they are not male or female. This of course makes them members of the first group only.

The fish of group 1 must be those which generate spontaneously. The great majority of fish are formed out of eggs; nevertheless, some are formed from mud and sand, including some of those kinds which are also sexually generated - notably, the grey mullet.<sup>51</sup> As we saw above, rain and warm weather are crucial to the development of these fish. The so-called 'froth' of the small fry is formed out of sandy soil, and never grows or propagates.

If spontaneously generated animals do copulate, they do not breed true.

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<sup>49</sup> HA IV 11 538a20; V 1 539a31; VI 13 567a26-8; GA III 1 750b30; III 5 756a15-18. This is curious, for what is the distinction of sex based on if not reproductive capacities?

<sup>50</sup> HA IV 11 538a3; VI 16; GA II 5 741b1; III 11 762b22

<sup>51</sup> HA V 11 543b17; VI 15; GA II 5 741b1; III 11 762b23

'... whenever creatures are spontaneously generated ... and when such are generated male and female, then from the copulation of such spontaneously generated males and females there is generated a something - a something never identical in shape with the parents, but a something imperfect. For instance, the issue of copulation in lice is nits; in flies, grubs; in fleas grubs egglike in shape; and from these issues the parent species is never reproduced, nor is any animal produced at all, but the like things only'.<sup>52</sup>

Here again, one might want to claim that because these things cannot reproduce themselves, they should not count as of a kind, but Aristotle does not use reproduction as a species boundary. He thinks the limits on hybridisation are set by the size of animal, and by gestation periods.<sup>53</sup>

It might be objected that this claim, that spontaneously produced animals do not breed true, is not true of the testacea: the mussels which originate a colony are spontaneously generated, yet manage to produce creatures identical in species to themselves. However, these animals are not copulating, but are reproducing by sideshoots, by quasi-semen.

Fish are not alone in parthenogenesis (the third kind of generation mentioned above): worker bees do not generate their own kind; the leaders generate kinds distinct from their own, as do the workers.

'It remains then, as appears to be the case in certain fishes, that the bees should generate the drones without copulation, being indeed female in respect of generative power, but containing in themselves both sexes as plants do.'<sup>54</sup>

The connection with plants is important. Usually Aristotle is anxious to ascertain the role of the male in reproduction: for nature does nothing in vain, and especially

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<sup>52</sup> HA V 1 539b7-13; GA I 1 715a18-b8; II 1 732b13

<sup>53</sup> GA II 4 738b27-9; II 7 746a29-31; IV 3 769b22-25. See Balme (1970). Note that gestation periods are determined by the male: HA VI 23 577b10.

<sup>54</sup> GA III 10 759b28-30, 760a29-b6

not bring about the production of males. However, in the lower level animals and plants, because the level of *psuche* is very low, there need be no distinction of sex.<sup>55</sup> The reference to 'female' here is to 'reproduction within herself'; true females carry the offspring within their bodies. Plants do not, and so are not strictly female, but the lower level animals which, reproducing parthenogenetically, are of one sex only, are called female because they carry the eggs within themselves.

### Spontaneous Generation and Matter

'... things come into being either by art or by nature or by chance or by spontaneity. Now art is a principle of movement in something other than the thing moved, nature is a principle in the thing itself (for man begets man), and the other causes are privations of these two.'<sup>56</sup>

We should note the ambiguity of 'spontaneity': it could mean either 'without generators', or 'without purpose, by chance'. According to Phys:

'some things always come to pass in the same way, and others for the most part'.<sup>57</sup>

This is the way of nature, given that sublunary things are not eternal or perfect. Such things are not spontaneous so spontaneity is rare, according to Phys; but in GA it seems to be part of the nature of certain animals that they be generated spontaneously.

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<sup>55</sup> That this should apply to bees is surprising, since they are contenders for the title of 'most intelligent animal', as are elephants: Meta I 1 980b22; HA IX 46 630b22; GA III 10 761a5

<sup>56</sup> Meta XII 3 1070a5-9; Meta VII 7 1032a11

<sup>57</sup> Post An I 30 87b20; Phys II 5 196b10-17, 197a32; II 8 199a1; GC II 6 333b5

'Of things that come to be, some come to be for the sake of something, others not.'<sup>58</sup>

'events which belong to the general class of things that may come to pass for the sake of something, when they come to pass not for the sake of what actually results, and have an external cause, may be described by the phrase 'from spontaneity'''.<sup>59</sup>

Aristotle seems to say here that spontaneous events are among those which occur for the sake of something, yet this does not seem to be true of the spontaneous events that have so far been mentioned. Spontaneous generation of a testacean is not an event that is for something else; the problem is, indeed, that there seems to be no final cause involved.

Some things can be produced by more than one of these causes: Aristotle's example is health, which can be produced by art as well as spontaneously.<sup>60</sup> In cases of generation, we have the example of fish like the grey mullet, some species of which, according to Aristotle, are produced sexually, and others spontaneously.<sup>61</sup> This is because in some cases the matter is such as to be self-moving in the right respect:

'... the matter which determines the production ... and in which a part of the product is present, is such as to be set in motion by itself and in some cases is not of this nature, and of the former kind some can move itself in the particular way required, while other matter is incapable of this ...'.<sup>62</sup>

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<sup>58</sup> Phys II 5 196b17

<sup>59</sup> Phys II 6 197b18-21

<sup>60</sup> Meta VII 7 1032b23-26; VII 9 1034a10

<sup>61</sup> HA VI 15 569a11-25

<sup>62</sup> Meta VII 9 1034a11-15

According to the above quote from Meta XII 3, spontaneity is a privation of either 'movement in something other than the thing moved' or of 'a principle in the thing itself' or both. This seems a curiously negative way to define something: surely Aristotle does not want to suggest that things happen spontaneously whenever a higher principle ceases to operate? He thinks it natural for matter to rebel, to fall away from the form, but this suggests a most unruly world, with new life burgeoning whenever a higher form loses control.

Fortunately, Aristotle's world is not quite so fertile. While stones can move themselves in one way, i.e. down, they cannot move themselves in any other, such as generatively. Living organisms have more ways of moving themselves, in that they can move, eat, perceive and so on, according to their *psuche*. However, it is the matter that is here said to have the capacity to move itself in various ways, not the living animal. Is this an indication of animate matter?

It is true that no matter is matter alone; it is all informed to some degree, but it is surely not the case that it is a living being which is 'such as to be set in motion by itself' to produce a more complex one? During development, it is a less complex animal which gives rise to a more complex one, but it is the same animal throughout the development, and the semen which began the process was not a substantial being. However, there are passages which suggest that the catamenia are not entirely inert before being 'fixed' by the semen<sup>63</sup>; does this imply that the catamenia, being 'animate' matter, have several potentialities which the semen narrows by assigning just one actuality? For example, the catamenia of the mare could become either a horse or a mule. But even to a lesser extent, the catamenia has multiple potentialities, such as for male or female.

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<sup>63</sup> See chapter II.

I do not want to suggest that all matter is animate in the sense that it possesses *psuche*, but that there is a drive towards perfection, as evidenced by the reproductive urge, and that this is shared by all degrees of informed matter.<sup>64</sup> Plants, when they bud, are not conscious of this in any sense; nor need matter be.

'the natural things which (like some artificial objects) can be produced spontaneously are those whose matter can be moved even by itself in the way in which the seed usually moves it; but those things which have not such matter cannot be produced except by parents.'<sup>65</sup>

### A resolution of the problem?

The problem raised at the beginning of this chapter was that spontaneous generation did not fit the account of change that applies to sexual generation: there is a lack of obvious formal input, which in sexual generation comes from the parents. On the strict account, it comes from the father alone; on the split donor account it comes from both; but in spontaneous generation, there are no parents.

We have established that for spontaneous generation to occur, there must be present earthy material, water, at least some of which must be fresh water, and *pneuma*. Concoction occurs, due to the *psuche*-heat of the *pneuma* or to sun-heat, and these elements are enclosed. The process then continues much as in sexual conception and foetal development. Somewhere in this account is the explanation of where the form of each individual spontaneously generated comes from, and how the individuals can be of one species.

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<sup>64</sup> Phys I 8 192a16-24; GA II 1 731b24-34

<sup>65</sup> Meta VII 9 1034b4-7

There are two possible sources: matter apparently affects the form to a greater extent than in sexual generation, and the heat in the *pneuma* is *psuche*-heat. The matter corresponds to the catamenia, and the heat to the heat in the semen. Given two sources of form, there seem to be three possibilities: one is that the matter could provide the form. This would be going further than the split donor account does, but matter is never simply matter. Another possibility is that the *pneuma* could provide it: the heat in it is *psuche*-heat.<sup>66</sup> However, *pneuma* alone is insufficient to explain how different species of animal can come into being: each kind of animal does not have its own kind of *psuche*-heat. For this, the matter is required: we have seen that the testacea, at least, differ from one another according to the differences of the material.<sup>67</sup> This brings us to the final possibility: both matter and *pneuma* provide some kind of formal constraints.

Neither matter nor *pneuma* alone is sufficient to produce a living being. Matter together with any other kind of heat does not produce life (consider cooking); nor does matter with *pneuma* that does not contain vital heat (consider the oil and water mix). Generative *pneuma* without appropriate matter does not generate either: semen spilt on the ground does not even produce flies, and the location is important - even in sexual generation, the residues must be in the proper place.<sup>68</sup> Clearly there must be *pneuma* containing vital heat, together with matter appropriate for the kind X before X can be produced. Vital heat is necessary for life, of whatever kind; the kind that is produced is determined by the matter. *Pneuma* provides, as it were, the

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<sup>66</sup> Byl (1980) p.276 holds that the formal cause is the sun-heat or *pneuma*, on the basis of HA V 19 552a8-11, a28-9; GA II 6 743a35-6; III 11 762b12-18. Only the GA passages are adequate as evidence, but more explanation is, in any case, necessary.

<sup>67</sup> HA V 15 547b12-15

<sup>68</sup> GA II 4 739a2-4

conditions for 'living', the matter the conditions for 'being' (where 'being', this being an Aristotelean account, is always 'being X').

This has indeed extended the split donor account, claiming that matter can provide the entire form; still, the animals that are generated are of very low degree. It is still not clear how it is that matter can contain these conditions; the best explanation we can hope for is that they are carried in the potential that matter possesses. In the next chapter, I shall examine some other cases where matter takes a greater control over the reproduction than in the standard case.

## Abnormalities

'... some children resemble their parents, while others do not ... some, though resembling none of their relations, yet do at any rate resemble a human being, but others are not even like a human being but a monstrosity. For even he who does not resemble his parents is already in a certain sense a monstrosity; for in these cases nature has in a way departed from the type. The first departure indeed is that the offspring should become female instead of male; this, however, is a natural necessity.'<sup>1</sup>

In perfect reproduction the offspring would be male, resembling his father in every way. Any other result is a monstrosity to some degree, whether female, or like a grandparent, or like no-one in particular. (It has even been suggested that Aristotle thought that the birth of twins, to humans, constituted a monstrosity.<sup>2</sup>)

However, in these cases there might be thought to be, as Aristotle says, a natural necessity for their existence; there is a natural necessity for the female, for example, since the species must be continued. But in those cases where the offspring fails even to look human, there is clearly something wrong; after all, what of the essentialist premise that all living things belong to one species or another? And what is the explanation for such things, if nature does nothing in vain? Monstrosities, like spontaneous generation, cannot be explained teleologically. It is these oddities of reproduction that I am going to examine in this final chapter.

I am not interested here in fabulous animals, but in those animals which are abnormal in some way. These are of two main types: those which are monstrous as individuals, because in their generation the matter has so far gained mastery over the form that the result resembles no other animal of that type, but retains only the

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<sup>1</sup> GA IV 3 767a36-b9

<sup>2</sup> By Louis (1975) p.280 see HA VII 4 584b26-585a3

form of animal (presumably being of no species itself); and those whose entire species is described as 'deformed' in some sense. The former is really the more interesting from the point of view of this thesis.

I shall also discuss the various ways in which matter has an effect on the individual produced; especially, of course, with reference to the production of monsters. In the preceding chapters, I argued that the matter donated by the female plays a significant role in the genesis and formation of the new individual. For example, if the matter donated by the female overcomes the matter donated by the male, then the individual will become female rather than male, or will resemble the mother and/or her ancestors rather than the father and/or his ancestors. And I claimed that the matter from the female is also responsible for the nutritive element of the *psuche*. The effect that this has on the status of the form - whether the form is particular, for example - has yet to be discussed.<sup>3</sup> At least one part of this discussion depends on whether it is thought that matter plays a significant role in determining the form of the animal, rather than the form of the individual; and there does seem to be some such possibility, if we note that even in the production of monsters, where the matter, or catamenia, gains a great deal of mastery over the form, or semen, the result retains the form of animal. If the female donation of the matter is responsible for some formal element of the new individual qua animal, what is the extent of this responsibility? There are certain passages in Aristotle which might suggest that matter does indeed play a more formal role in characterising the animal than has been thought.

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<sup>3</sup> And I shall not be able to discuss it in the depth and detail that the question deserves.

However, I shall begin by discussing the various ways in which animals can be monstrous.

### Monstrosities

Aristotle distinguishes various ways in which animals can be monstrous as individuals.<sup>4</sup> First there are those in whom the movements from the male relapsed, and the material from the female was not mastered, leaving merely the 'animal'. The result looks as if it were, say, a calf with a child's head, or a sheep with an ox's head, but this is merely a resemblance; here Aristotle claims it is impossible for a real monstrosity to be formed in this way because of the differences in gestation periods. However, if animals are nearly of the same size and have periods of gestation of similar length, they will interbreed<sup>5</sup>, for example, the wolf and bitch, partridge and domestic fowl, the fox and dog, and even the tiger and bitch, and he refers to an old saying: 'always something fresh in Libya'. The result of such breeding is a young creature different in species from both parents<sup>6</sup>; if Aristotle really believes that such interbreeding is possible, as he certainly does in the case of the mule, if not of the tiger and dog, then a similar puzzle to that of spontaneous generation arises: how can new species come into existence? How can there be more than one individual in each new species created in this way? Not that the problem is that of the generation of an entirely new and eternal species, if the mule is sterile (and hence further generations are impossible); however, it is a recurrent

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<sup>4</sup> GA IV 3 769b11-30

<sup>5</sup> HA VIII 28 606b20-607a8; GA II 4 738b27-35; II 7 746a29-b12

<sup>6</sup> GA II 8 747b30-748a1

one, since there is a permanent possibility of generation of members of this species.<sup>7</sup>

This is further evidence for my split donor theory of conception: on the standard account of conception, the form comes entirely from the male, in which case, if interbreeding occurs, the offspring would be of the same species as the father, whatever that might be. This is clearly not what Aristotle believed; if my suggestion that at least some part of the form comes from the female is accepted, some part of this problem at least is solved. But even so, there is still a problem in that I claimed that the most the female could provide would be the nutritive *psuche*: we must suppose either that the nutritive *psuche* differs from animal to animal, but that this is all that the female donates, or that the nutritive faculties that the female provides do not differ from animal to animal, being merely 'the ability to eat', and so on, but that she also provides some of the other, more characteristic abilities. The first is perhaps more likely, because we know that the female can form the shape of the animal, but in either case, the donation of the female may be formal to a slightly greater extent than I earlier suggested.

It is interesting that Aristotle thinks crossbreeds tend to female.

'While the body is from the female, it is the *psuche* that is from the male, for the *psuche* is the substance of a particular body. For this reason if animals of a different kind are crossed ... the first cross has a common resemblance to both parents ... but as time goes on and one generation springs from another, the final result resembles the female in form, just as foreign seeds produce plants varying in accordance with the country in which they are sown. For it is the soil that gives to the seeds the material and the body of the plant.'<sup>8</sup>

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<sup>7</sup> And this in turn throws doubt on the usual interpretation of 'species'.

<sup>8</sup> GA II 4 738b25-35. Note that this may represent an early agricultural view of woman - the furrowed field theory. See introduction on the development of Aristotle's theory of generation.

This suggests, contra the standard account of conception, that the female can provide a certain degree of species form; note the importance of the matter (soil) to the resultant form. We saw in the last chapter, too, that the matter can play a significant role in the determination of the form.

Here it seems that crossbreeds can generate, just as certain spontaneously generated animals can. (This indicates again that Aristotle does not demarcate species by breeding groups.) However, his views on reproductive capacity vary: he does not think that the mule can reproduce.

The sterility of mules is due to the failure to complete development; it is not a failure of conception. Clearly, mules are more closely related to final than to efficient abnormalities. Once again, we find that this failure is due to heat, or rather, to the lack of it. The ass is a cold beast, and the mixture of the semen and material from a horse and an ass (in either combination) is unstable. Besides that, the females are naturally nearly infertile, the matter going rather to growth than to the womb, and the embryo may be undernourished and abort.

As for the relapsing of the movements to form monstrosities, we saw above, in the discussion of resemblance, that the cause of this too is insufficient heat in the male movement. Just as in the account of combination of elements, the four qualities operate on each other and form a 'compromise' compound, depending on the relative strengths of the qualities present, so, here, the result depends on the relative strengths of the seminal residues produced. Above, I claimed that there must be three 'movements': in the semen, animal-type, maleness and father-resemblance; in the catamenia, plant-type, femaleness and mother-resemblance. The first pair complement each other, the semen providing the additional heat to boost

the 'level' of the embryo from plant to animal<sup>9</sup>; the second pair 'tussle' for supremacy, and one will defeat the other in normal cases; the third pair tussle but may compromise.<sup>10</sup> Monstrosities may be formed as a result of failure of one gender movement to overcome the other adequately (forming hermaphrodites); or as a result of the failure of the type-movement to form an animal of a particular type adequately, presumably forming an animal of no particular type. Failure of the resemblance movement should result in a perfect animal of that type, but which resembles none of its kindred: this is not a monstrosity since nature has not deviated from the generic type, or only in the rather odd sense that anyone who does not resemble his parents is abnormal.

Then there is another kind of monstrosity: those who have additional parts of the body, being formed with extra feet or heads. Aristotle says, without explanation, that we ought to hold that the cause of these too is the material from the female (presumably on the basis of his original assumptions about perfection).<sup>11</sup> The example we are given here to explain how these arise is the hen: she is prolific, and so fetations lying too close to each other sometimes grow together. In twin eggs, if the yolks are kept apart by the membranes, two perfect chicks are formed; but if the yolks are not separated, the result has one body and one head, but four legs and wings. Apparently this formation of monster-chicks is common; Aristotle explains it as due to the way that the nourishment is dispensed; the upper parts are formed

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<sup>9</sup> That I now suggest that Aristotle may have thought the female provided some of the species form does not significantly change this: without this extra heat, the female cannot in any case continue the generation to produce a perfect animal.

<sup>10</sup> That Aristotle recognises different forms of 'combat' here is clear from the text, where he refers to different ways of capitulating: GA IV 3.

<sup>11</sup> GA IV 4 770a7

first, out of the white. It is not clear to me how this is to explain the formation of one body but eight limbs, and not any other combination of heads and limbs; after all, there ought to be two principles in the white. Such a formation of monsters should be common to all animals nourished from eggs, but in the next section, Aristotle says that a snake has been observed with two heads, and offers the same explanation.

As a rule, humans produce but one infant at a time, so these sorts of monstrosities are rare. The more prolific the animal, the more monstrosities may arise. Interestingly, Aristotle thinks that women are more prolific in Egypt - perhaps because of the impressive fertility of the land around the Nile.<sup>12</sup>

What about those animals which lack a part of the body? At GA IV 4 770b9 these are said to be monstrous, but no explanation of the cause is given until 772b36, where we are told that the cause is the same as that of the abortion of the whole of the forming creature, which, he says, frequently occurs. We must look elsewhere for the cause of this. We saw above that the mule can be aborted because of the cold of the womb of the mother, and because of the lack of nourishment; is this true for other animals? Not all animals are so cold, nor is nourishment always lacking, but some such reason as this must be given; the similarity between this and the cause of the deficiency of parts in some animals is just that if there is insufficient matter to be worked up into the body of the animal, it must be deficient in some part, or if there is insufficient heat to concoct the matter properly in that area, the part will not be properly developed.

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<sup>12</sup> GA IV 4 770a35; cf. HA VII 4 584b7, b31

He goes on to discuss malformations in internal parts of the body, asking whether the same cause is responsible for the production of one offspring and deficient parts, and for the production of many offspring and redundant parts.

In larger animals, few offspring are produced, because the nourishment gets used for the growth of the animal, while in the smaller animals, it can become seminal residue. And this greater amount of residue becomes several embryos, not one big one, because each embryo requires a certain amount of material, specified within certain limits. This also explains why the seminal residue of a large animal becomes one embryo, not several. In their case, if extra material is supplied, then twins are formed, and they are seen as monstrous, because their appearance is unusual, and contrary to the general rule (except in Egypt, or perhaps Libya).

The cause of redundancy of parts is the same as that of the production of twins: more material gets 'set' than is necessary.<sup>13</sup> Either the embryo has some part larger than normal, or, because the material is moved by some current,

'there may come into being more than one, as eddies do in rivers; as the water in these is carried along with a certain motion, if it dash against anything two systems come into being out of one, each retaining the same motion'<sup>14</sup>

and so the embryo develops two of that part. Usually, especially in the case of hermaphrodites, one of the two parts is inoperative; it is also smaller.

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<sup>13</sup> GA IV 4 772b15. Platt (1910) is so surprised by the notion that the embryo should organise the material that he suggests a new reading. But it is not really so surprising, since the embryo possesses form.

<sup>14</sup> GA IV 4 772b18-21; cf. On Dreams 3 461a8

This is a revealing passage; we learn that the movement responsible for development of the parts is localised, although the controlling influence is the heart.

The vital heat:

'exists in the seminal residue, and the movement and activity in it is sufficient in kind and in quantity to correspond to each of the parts. In so far as there is any deficiency or excess, the resulting product is in worse condition or physically defective'.<sup>15</sup>

This explains why, in the case of deficiency of parts due to insufficient matter, the product is not merely smaller: each part is concocted by the appropriate movement 'on site'. If the movement finds no matter, it can do nothing. Similarly, if there is too much matter, or insufficient power or heat, the movement fails.

Determining the type of monstrosity that a particular individual has suffered, i.e. whether it is one animal with redundant parts or two animals grown together, depends on the principle possessed by that animal, that is, whether it has one or two hearts.<sup>16</sup> We saw above how crucial the heart was to the individual; now we learn that it can be used as a criterion for individuation.

Then there is another kind of monstrosity, which arises when the offspring is deformed in the uterus, perhaps through disease.<sup>17</sup> This type of monstrosity arises through the corruption of some principle, for instance when the seed is defective; 'monstrosity is actually a kind of deformity'.<sup>18</sup> In humans, more males are born

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<sup>15</sup> GA II 6 743a27-30

<sup>16</sup> GA I 20 728b37; IV 4 773a8-13

<sup>17</sup> GA II 7 746b31-35; II 8 749a1-5; III 1 749a18

<sup>18</sup> Phys II 8 199b1-8; GA IV 3 769b30

deformed than females, because the male is so much hotter than the female, and so moves about more, and suffers more risk of damage.<sup>19</sup>

Monstrosities arise, then, for one of several reasons: if the type-movements relapse, merely the 'animal' is left; if the gender-movements fail, a hermaphrodite results; if the vital principle or the matter are deficient or excessive relative to each other or to the ideal (for limits are set by the type of animal<sup>20</sup>) then the product is deformed, either lacking parts or possessing extra parts; if a disease or other damage occurs the product may be deformed; or if miscegenation occurs, a creature not the same as its parents results. This is perhaps not a true monstrosity; we saw in the preceding chapter that not all animals generate animals identical to themselves (e.g. bees). However, in their case, that is the standard way to reproduce; in the case of the tiger and bitch, it is abnormal.

### Odd species

The other kind of abnormality includes those species which are 'deformed' in some sense. This is rather odd: how can something be against nature, when there is a whole natural species of the animals? Aristotle may be relying in some cases here on his assumption that man is the perfect animal, claiming that any animal that is not man (and the adult male of that species) is in some sense imperfect (imperfect-1) and deficient.

Man stands upright, in accordance with his god-like nature and substance; for he possesses the rational *psuche*, and this must not be weighed down by the body. All other animals are dwarf-like in form (or stunted) including children, and so no

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<sup>19</sup> GA IV 6 775a4-9

<sup>20</sup> GA IV 4 771b32-772a35

other animal is so intelligent, because their *psuche* principle is corporeal and impeded in its motions.<sup>21</sup> Indeed, man resembles the universe; in him all the parts are in correct alignment. That is, all beings have a superior and an inferior part, and this distinction is one of function, not just of position relatively to the earth and sky. The superior is that from which flows the distribution of nourishment and the process of growth, the inferior that to which the process flows and where it ends.<sup>22</sup> In plants, the roots are the superior part, and these are analogous to the mouth in animals; in a sense, plants are 'upside down'.<sup>23</sup> In the universe generally, as one of Aristotle's basic assumptions, we know that right is better than left, upper better than lower, and the front better than the back.<sup>24</sup> Man is perfect, because in him, the superior and inferior parts correspond to the alignment of the universe; man is natural in a higher degree than the other animals.<sup>25</sup> The nature of man is the most complete<sup>26</sup>; even women are a natural deformity.<sup>27</sup>

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<sup>21</sup> PA IV 10 686a25-b27, 689b25-27; IV 12 695a1-10; IV 13 695b2; Prog Anim 10 710b10-15; 19 714b8-14; On Memory 2 453a31; HA VIII 1 588b1. We should note that at On Length 6 467a32, Aristotle writes that males are more dwarf-like than females: this is unexpected, but it is because their upper parts are larger than the lower. This causes men to live longer than women, since it is the upper parts where the heat resides.

<sup>22</sup> Prog Anim 4

<sup>23</sup> De An II 1 412b3; II 4 416a6; On Youth 1 468a1; HA I 15 494a26; II 1 500b28; PA II 3 650a21-28; IV 7 683b19-24; Prog Anim 4 705b7; GA II 6 741b34-7. Kraak (1942) argues that in some passages at least, Aristotle can't have held that plants are upside down: PA II 3 650a15-30; 10 655b34; IV 4 678a10.

<sup>24</sup> Prog Anim 4 706a20-25

<sup>25</sup> On Youth 1 468a2-12; 19 477a19-23; HA I 15 494a26-34; PA II 10 656a5-14; Prog Anim 4 706a16-25

<sup>26</sup> HA IX 1 608b7

<sup>27</sup> GA I 20 728a18-21; II 1 732a1-10; II 3 737a28; IV 1 765b8-766a3, 766a30; IV 3 767b5-14

There are other kinds of deformity in species apart from those depending on the idea that man is perfect. Examples of these imperfectly formed beings include the mole, because it has no sight, and all viviparous animals should have sight<sup>28</sup>; the lobster, in which it is a matter of chance which claw is bigger<sup>29</sup>; and flatfish, which have their natural shape distorted.<sup>30</sup> Seals are deformed quadrupeds<sup>31</sup>; molluscs must be thought of as mutilated, because of their mode of movement, analogous to the seal and the bat, both of which are quadrupeds but misshapen.<sup>32</sup> Other deformed animals are mules, tortoises, fish and crocodiles.<sup>33</sup> In what sense can these animals be said to be deformed? This too must be with respect to some 'ideal' general form - here, of quadruped, or fish.

Other animals are abnormal in the sense that the species is ambivalent in some way. These are commonly called dualisers, being species that cross genus borders, or which are difficult to classify. Many of these species are those which are also called abnormal, as above, since they manifest unexpected characteristics. Examples are the crocodile, which is in a way a land animal and in a way a water animal<sup>34</sup>; the elephant, which has the double character of a land animal and of one which lives in swamps<sup>35</sup>; the seal, which is also ambivalent between land and water

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<sup>28</sup> HA I 9 491b25-34; IV 8 533a1-12; De An III 1 425a11

<sup>29</sup> PA IV 8 684a31-b1

<sup>30</sup> Prog Anim 17 714a6

<sup>31</sup> HA I 1 487b23; II 1 498a32; PA II 12 657a24; Prog Anim 19 714b10-15

<sup>32</sup> Prog Anim 19 714b10-15

<sup>33</sup> GA I 20 728b10; PA II 17 660b26-34; III 8 671a16; IV 13 695b2

<sup>34</sup> PA IV 11 690b22

<sup>35</sup> PA II 16 659a2-5

animals, and hence manifests some of the characteristics of each<sup>36</sup>; the bat, which is ambivalent between land and air animals<sup>37</sup>, and the ostrich, which dualises between birds and quadrupeds<sup>38</sup>; and apes, which share the properties of man and of quadrupeds.<sup>39</sup> Then there is the hermit crab, which is intermediate between the crustaceans and the testaceans<sup>40</sup>, and the swine, of which some species manifest one of a pair of defining characteristics (cloven hoofs) and some the other (solid hoofs).<sup>41</sup> Some species of snakes are land animals, and others are aquatic.<sup>42</sup> And man himself, despite being perfect, is said to dualise in one or two areas: he is both gregarious and solitary, and he sometimes produces one and sometimes many offspring at one birth.<sup>43</sup> Moreover, of course, he manifests some of the characteristics of the Deity, being rational, and some of the characteristics of animals. And at the other range of the animal spectrum, there are those that are

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<sup>36</sup> HA I 1 487b23; II 1 501a21; IV 12 566b27-567a12; PA II 12 657a22-4; IV 13 697a29-b6; Prog Anim 19 714b12; GA V 2 781b22-7

<sup>37</sup> PA IV 13 697b1-13

<sup>38</sup> PA IV 14 697b13-25

<sup>39</sup> HA II 8-9 502a16-b26; PA IV 10 689b32

<sup>40</sup> HA IV 4 529b20-24

<sup>41</sup> HA II 1 499b11, b21; GA IV 6 774b17-25. Similarly, in insects such as ants and glow-worms, the same genus is in some cases both winged and wingless: HA IV 1 523b20

<sup>42</sup> HA II 14 505b5-7

<sup>43</sup> HA I 1 488a7; HA VII 4 584b26-35; GA IV 4 772b1-5

ambiguous between animal and plant: the testacea, starfish and molluscs<sup>44</sup>, and the sea-anemones.<sup>45</sup>

Many of these animals dualise between two elements, usually water and air.

The nature of amphibious animals:

'appears in some kind of a way to have got warped, just as some male animals get to resemble the female, and some female animals the male. The fact is that animals, if they be subjected to a modification in minute organs, are liable to immense modifications in their general configuration. This phenomenon may be observed in the case of gelded animals: only a minute organ of the animal is mutilated, and the creature passes from the male to the female form. We may infer, then, that if in the primary conformation of the embryo an infinitesimally minute but essential organ sustain a change of magnitude, the animal will in one case turn to male and in the other to female; and also that, if the said organ be obliterated altogether, the animal will be of neither one sex nor the other. And so by the occurrence of modification in minute organs it comes to pass that one animal is terrestrial and another aquatic, in both senses of these terms. And again, some animals are ambivalent, whilst other animals are not ambivalent, owing to the circumstance that in their conformation while in the embryonic condition there got intermixed into them some portion of the matter of which their subsequent food is constituted; for, as was said above, what is in conformity with nature is to every animal agreeable.'<sup>46</sup>

This is an interesting passage. The reference to gelding is not unusual, and as we know, small changes in an essential part can alter the form of an animal:

'And as one part of first-rate importance changes, the whole system of the animal differs greatly in form along with it. This may be seen in the case of eunuchs, who, though mutilated in one part alone, depart so much from their original appearance and approximate closely to the female form'.<sup>47</sup>

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<sup>44</sup> Prog Anim 19 714b15; HA VIII 1 588b16-7; PA IV 5 681b8-13; GA I 23 731b8; III 11 761a13-31

<sup>45</sup> HA I 1 487a26; VIII 1 588b18-23; PA IV 5 681a37-b8

<sup>46</sup> HA VIII 2 589b27-590a13; GA I 2 716b3

<sup>47</sup> GA IV 1 766a23-6

Later, Aristotle says even more strongly that castration actually brings about a change from the male to the female condition.<sup>48</sup> However, the application of this kind of small change with large results to the natures of whole species of animals seems very unAristotelian. It is commonly held that, for Aristotle, species were eternal and immutable<sup>49</sup>; he is surely not suggesting that new species come into existence as a result of changes in the embryo, or that the existence of some species depends on such changes; that would be too Empedoclean.<sup>50</sup> Clark (1975) takes this passage very seriously indeed, arguing that Aristotle is a 'devolutionary transformist', i.e. that he believes all other animals really are imperfect humans.<sup>51</sup> I shall discuss this suggestion below, but want first to point out that the reference to nutrition and nature is also unexpected.

The relation between nutriment and element is not unfamiliar, but that the nutriment should have an effect on the nature of the animal is interesting. We saw above that there were two kinds of nutriment, one which developed the parts, and one which sustained them and caused them to grow, but both these are available at the embryonic stage, so it seems unlikely that this is relevant. Perhaps the nutriment in the egg or womb of the non-ambivalent animals is different in nature, being more heavily weighted in the direction of earth, or water, than that of the ambivalent animals, which is presumably evenly mixed.

Whatever the answer to this puzzle, this cause cannot operate on an individual basis, for there are whole species of ambivalent animals, so that, if this passage can

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<sup>48</sup> GA V 3 784a10; V 7 787b20

<sup>49</sup> See Lennox (1985) for an opposing view.

<sup>50</sup> PA I 1 640a20-24

<sup>51</sup> Clark (1975), chapter II.2

be taken seriously, there seems to be some suggestion that the matter involved in the generation plays some important role in the resultant species membership, or form.

I do not believe Aristotle would have accepted in any literal sense the devolutionary transformist account offered by Clark; while it is true that he says man alone 'has his parts in the natural place', paralleling the universe, and that all other animals are relatively dwarfish<sup>52</sup>, there is no real suggestion that other animals devolved from mankind. Even the brief mention Aristotle occasionally makes on the origins of men does not suggest that men were ever alone in the world; though he mentions the idea that they were born of the earth, referring to a mythical suggestion, the usual account is that the world is cyclic.<sup>53</sup> He is certainly not prepared to accept any account of the Golden Age.<sup>54</sup>

In all these passages Aristotle relies on the familiar assumptions: that right is naturally better than left; that upper is better than lower, front than back, male than female, and so on. Is there any real reason to suppose that his assumption that man is better (and Clark's claim that therefore the other animals are derived from man) is based on any greater reason than this, or that these passages refer to some literal devolution?

Clark does offer evidence for his claim, most notably PA IV 10, where Aristotle describes devolution. This is indeed a most curious passage, and worthy of some discussion. He writes:

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<sup>52</sup> On the Heavens II 2; On Youth 1 468a5; HA I 15 493b17, 494a27; PA II 10 656a7-14; III 6 669b5; IV 10 686a25-30; Prog Anim 4 706a18; 5 706b3-10

<sup>53</sup> Meta XII 8 1074b10-11; Pol VII 10 1329b25-7; On the Heavens I 3 270b19-20; Meteor I 3 339b28

<sup>54</sup> Pol II 8 1269a4-8

'In man the forelegs and forefeet are replaced by arms and by what we call hands. For of all animals man alone stands erect, in accordance with his god-like nature and substance. For it is the function of the god-like to think and to be wise; and no easy task were this under the burden of a heavy body, pressing down from above and obstructing by its weight the motions of the intellect and of the general sense. When, moreover, the weight and corporeal substance become excessive, the body must of necessity incline towards the ground. In such cases therefore nature, in order to give support to the body, has replaced the arms and hands by forefeet, and has thus converted the animal into a quadruped ... its body inclining downwards in front from the weight which its *psuche* cannot sustain. For all animals, man alone excepted, are dwarf-like in form ... even among men themselves if we compare children with adults, or such adults as are of dwarf-like shape with those that are not, we find that, whatever other superiority the former may possess, they are at any rate deficient as compared with the latter in intelligence. The explanation, as already stated, is that in many their psychical principle is corporeal and impeded in its motions. Let now a further decrease occur in the elevating heat, and a further increase in the earthly matter, and the animals become smaller in bulk and their feet more numerous, until at a later stage they become footless and extended full length on the ground. Then, by further small successions of change, they come to have their principal organ below; and at last the part which answers to a head becomes motionless and destitute of sensation. Thus the animal becomes a plant, that has its upper parts downwards and its lower parts above. For in plants the roots are the equivalents of mouth and head'.<sup>55</sup>

One very interesting idea here is that the intellect and sense-perception might be impeded by matter. That the senses should be so hindered is perhaps not surprising, since sleep, overeating and the like cause movements of matter in the blood passages, and hence changes in perceptive ability, but that the intellect should also be so affected - and not by such temporary matters, but by the body itself - is unexpected. However, this has been discussed elsewhere<sup>56</sup>; here it is the devolutionary suggestion that is most important.

The important factors here are the decrease in vital heat and increase in other matter. This parallels exactly the scale of perfection of animals given in other

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<sup>55</sup> PA IV 10 686a25-687a1

<sup>56</sup> See chapter V.

passages<sup>57</sup>, but there is no suggestion that this was a historical process, rather than an amusing account of the perfection chain. Clark also offers as evidence a passage on the chain of being and perfection<sup>58</sup>; and passages on the degenerate nature of the female.<sup>59</sup> None of these passages lend any weight to his account rather than to the standard one.

Then Clark refers to the passages about deformed animals, claiming that they show that deformities can be transmitted to one's children<sup>60</sup>, and that it is tempting to suppose that certain of the deformed groups were formed in this way. But these transmissible deformities are not of the same kind as those of the so-called deformed animals; rather, they are material, accidental. Clark cites the following passage as evidence.

'From deformed parents come deformed children ... children often resemble their parents in respect of their unnatural features and are born with similar marks, such as pimples or scars. Such things have been known to be handed down through three generations; for instance, a certain man had a mark on his arm which his son did not possess, but his grandson had it in the same spot, though not very distinct. Such cases however, are few; for the children of cripples are mostly sound'.<sup>61</sup>

Similar cases are reported elsewhere (the branded man at Chalcedon with a confusedly branded son; the white woman of Elis with the black grandchild) but in none of them is Aristotle reporting them with the voice of conviction; either he

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<sup>57</sup> e.g. GA II 1 733a1-733b16

<sup>58</sup> GA II 1 733b1-15

<sup>59</sup> HA IV 11 538a22, 538b1; GA I 20 728a17; II 3 737a28; IV 3 767b7, 769b30

<sup>60</sup> HA VII 6 585b28; GA I 17 721b28; I 18 724a3

<sup>61</sup> HA VII 6 585b30-35; see also GA I 17 721b28-34; I 18 724a3-5

reports it as some opponent's evidence, or qualifies it, for instance by saying that the young of mutilated parents are not always mutilated. Clearly, if some such feature is handed down, it is not distinct, and nor is such an event common. There is no suggestion that such events might form the basis for a new kind of animal.

And then he discusses genus and species, suggesting that intermediaries are hybrids, and that Aristotle's comparisons between species can be taken literally. On this last claim, we can point out that very few true hybrids (as opposed to dualisers) can breed, and that those that can usually revert to the form of the mother after a few generations; true dualisers are not hybrids, nor do hybrids form true kinds. Dualisers are distinct kinds, which are not easily classified; there is no suggestion that these are formed by interbreeding.

So there is no reason to suppose that Aristotle accepted any such transformist account as literally true.

### Matter and form

I shall now look at some of the other passages which might be thought to suggest that matter affects the form of an animal.

First there are the passages in PA III 2 in which Aristotle is discussing

'the character of the material nature whose necessary results have been employed by rational nature for a final cause'.<sup>62</sup>

'Nature invariably gives to one part what she subtracts from another'.<sup>63</sup>

There is an excess of earthy matter in the larger animals, and this is converted into weapons of defence, whether these be horns or teeth or hoofs. But there is only a

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<sup>62</sup> PA III 2 663b23-24

<sup>63</sup> PA II 14 658a36

limited amount of this matter, so that if an animal has horns, it does not also have front teeth, and if it does not have horns, it might have large teeth, especially tusks, or it might have hoofs of a certain kind, and all are for the preservation of the animal.

One of the defining differences between certain animals is the number, size or form of horn or foot, tooth or claw, hair or hide. This is usually thought to be the responsibility of the form, which presumably dictates the destination of the excess of matter. Yet matter is said to have necessary results, so the matter must be involved in some way: presumably the necessary results lie in that each type of matter is appropriate for different functions, being composed of different combinations of elements. Lots of earthy material means lots of hair can be produced; but it may be of no use at all in the formation of blood. So, generation and development require certain kinds of matter, whether this be for the formation of parts of the body, or for generation in the first place.<sup>64</sup> The matter available dictates the result to the extent that the result will be imperfect or will not occur at all if the matter is inappropriate.

If the form dictates the destination of the earthy matter, and if the resultant shape of the animal is part of the form, in what sense is there an excess? Any excess, according to what we learnt above, may become a monstrous part.

PA III 2 tells us that the surplus is a residue from the nutriment, and, as we already know, there are two degrees of nutriment, the first for development, the second for growth. Those structures which distinguish one animal from another, the number and shape of horns, hoofs and so on are not formed until last, and are

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<sup>64</sup> Generation does not occur unless appropriate matter is present: see chapter VII, fn. 8 on kinds of matter.

formed from the residue of the nutriment, the better portions having been siphoned off to create the sense organs, and the body as a whole. That they should not be formed until last is not surprising: Aristotle tells us that the animal is not of a kind until towards the end of its development.<sup>65</sup> But that they are not formed from the nutritious, generative nutriment, which 'brings into being the whole and the parts' but from the nutriment which is only concerned with growth, might be thought to be unexpected. Of course, the horns and hoofs do not determine the kind of animal, though they are signs of the kind of animal that it is. That the animal is not of a kind until late in its development, as we saw above, means that it is not yet perfected.

There are other passages which suggest that matter influences the form, both of the individual and of the species. Of athletes, Aristotle says:

'owing to the quantity of their food their nature is not able to master it in such a way that their form grows proportionately and remains symmetrical; therefore their limbs develop irregularly, sometimes indeed almost so much that no one of them resembles what it was before. Similar to this is also the disease known as satyriasis, in which the face appears like that of some other creature - a satyr - owing to a quantity of unconcocted *pneuma* being diverted into parts of the face'.<sup>66</sup>

Though these are individual cases, not cases of matter changing species form, yet matter is here altering the development of the individual's form.

In discussion of the reproduction of bees, Aristotle says that in fine weather more drones are produced, and in wet weather more worker-bees, because the residual matter (from which, of course, the seminal matters come) varies. Though this passage is important because of the connection with matter, it may show no

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<sup>65</sup> GA II 3 736b4

<sup>66</sup> GA IV 3 768b30-35

more than that there is seasonal variation in reproduction between kinds, for Aristotle does claim that the three types (leaders, workers and drones) are of different kinds.<sup>67</sup> However, since he also makes quite clear that all three are dependent on each other for their continued existence, in a way unique to bees<sup>68</sup>, it is difficult to see how they can be classified as different in species. He even says that they are the same in characteristic properties. (Peck glosses this as ability to generate, but this is most unsatisfactory; most animals have this property, so it can be characteristic of none. Perhaps the characteristic of bees is the divine element within them? This is never specified, but is theirs alone; not even wasps possess this.)

It seems then, that the bee is of one species but several different forms. And it is clear that which of these forms is developed, depends to at least some extent on the matter available. We saw something similar in the case of spontaneously generated animals.

We have already seen that matter helps to determine whether a male or female animal is developed, and that male and female have different forms but are of the same species.<sup>69</sup> In the next breath he says

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<sup>67</sup> HA V 21 describes four species of bee: the drone, two kinds of rulers, and the ordinary bee. HA IX 40 claims nine varieties of bee and similar insects, including the bee, the king-bee, and the drone-bee.

<sup>68</sup> GA III 10 760a4-b2

<sup>69</sup> We should also note that the female is defined in terms of the lack of a capacity that the male possesses: a negative definition, confirming that the male is seen as the positive pole, the female as suffering a privation. GA I 2 716a18; I 20 728a19; II 3 737a28; IV 6 775a15; V 3 784a11

'though we speak of the animal as a whole as male or female, yet really it is not male or female in virtue of the whole of itself, but only in virtue of a certain faculty and a certain part - just as with sight or locomotion'.<sup>70</sup>

Yet this difference in part, unlike sight or locomotion, effects great differences in other capacities, such as character and intelligence. Indeed, Aristotle decides that the distinction of sex is a first principle, referring to the changes that occur to a eunuch.<sup>71</sup>

We are told that

'there must needs be that which generates and that from which it generates; and even if these be one, still they must be distinct in form and their essence must be different'.<sup>72</sup>

This surely implies that they do differ in form, though he goes on to say that

'in those animals that have these powers separate in two sexes the body and nature of the active and the passive sex must also differ';

'In all animals which can move about, the sexes are separated, one individual being male and one female, though both are the same in species'.<sup>73</sup>

How can male and female be different in form but the same in species? And how can these generative powers be of distinct forms, yet be one, in plants?

He does give some sort of argument for this: to the essence of plants belongs only one function, reproduction. Since this is brought about by the union of male and female, nature has united them in one organism. But animals have more than this function, so when it has to reproduce, it unites and becomes like a plant. But

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<sup>70</sup> GA I 2 716a27-31

<sup>71</sup> HA VIII 2 589b29-590a4; GA I 2 716b10

<sup>72</sup> GA I 20 729a24-26

<sup>73</sup> GA I 20 729a27-9; I 23 730b32-3

we might ask why male and female must be distinct in animals, since an animal is male or female not in virtue of itself, but because of some small part of it, and the only answer that we are given is that

'as the first efficient or moving cause, to which belong the definition and the form, is better and more divine in its nature than the material on which it works, it is better that the superior principle should be separated from the inferior. Therefore, wherever it is possible and so far as it is possible, the male is separated from the female. For the first principle of the movement, whereby that which comes into being is male, is better and more divine, and the female is the matter. The male, however, comes together and mingles with the female for the work of generation, because this is common to both.'<sup>74</sup>

This argument goes back to the assumptions of formal perfections (the male is superior to the female) and is not helpful. It perhaps refers to the triad: male = rationality; female = matter; matter hinders rationality. What is clear is that it is the powers that have distinct forms; however, doesn't this result in the individuals possessing these also having distinct forms?

The answer to this question depends on one's decision as to the status of the form, i.e. whether it be universal or particular. If, as I suggest, there are both universal and particular movements involved in generation, then we can say that though two individuals may have different powers, and therefore different individual forms, they may possess the same species form. Just as in the case of bees, male and female possess different powers, and so are different in definition from that point of view, while at the same time they are both human, and so are the same in species. Indeed, both are necessary to the species.

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<sup>74</sup> GA II 1 732a3-11

In Meta, Aristotle says: one might ask why male and female do not differ in species, though this difference belongs to animal in virtue of its own nature, and not as whiteness or blackness does; both female and male belong to it qua animal.

'male and female are indeed modifications peculiar to animal, not however in virtue of its substance but in the matter, i.e. the body. This is why the same seed becomes female or male by being acted on in a certain way'.<sup>75</sup>

It seems that there are certain passages which suggest that matter is relevant to the form of the animal in more than the simple sense that the form requires matter. In spontaneous generation, it is matter that determines the kind of animal produced; in sexual generation, matter is influential in determining the individual form of the animal: whether it be male or female, who it resembles, and even whether it be perfect of its kind or not. Not that it is solely responsible for this; it is the relative strengths of the female and male secretions that determines these results.

Universal form, the form of man, is, in sexual generation, provided by the male, and is unaltered in conception unless a gross monstrosity is formed, when the result, even so, still retains the general form of 'animal'. However, the individual's own form is greatly affected by the particular circumstances present at conception, and the greatest of these circumstances is the relationship between the generative secretions of the parents.

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<sup>75</sup> Meta X 9 1058b21-24

It is this relationship, and the process of interaction, that I have attempted to clarify throughout this thesis, with the hope of demonstrating that a proper examination of biological change is of importance in considering Aristotle's metaphysics as a whole, since living things are paradigm examples of substance, and man is the most perfect of living things.

## Bibliography

The dates given are of first publication; where books have undergone revision with subsequent reprinting, the revision dates are noted.

### Translations

#### The Complete Works of Aristotle

Revised Oxford Translation, translators largely as in the Oxford Translation.  
Edited by Jonathan Barnes, Princeton University Press 1984.

#### The Complete Works of Aristotle translated into English

(Oxford Translation, edited by W.D. Ross and J.A. Smith, at the Clarendon Press)

##### Volume III:

Meteorologica trans. E.W. Webster (1923)

De Mundo trans. E.S. Forster (1914)

De Anima trans. J.A. Smith (1931)

Parva Naturalia (1908)

De Sensu, De Memoria, De Somno trans. J.I. Beare

On Length, On Youth, On Life, On Breath trans. G.R.T. Ross

De Spiritu trans. J.F. Dobson (1914)

##### Volume IV:

Historia Animalium trans. D'Arcy Wentworth Thompson (1910)

##### Volume V:

De Partibus Animalium trans. William Ogle (1911)

De Motu and De Incessu Animalium trans. A.S.L. Farquharson (1912)

De Generatione Animalium trans. Arthur Platt (1910)

#### The Clarendon Aristotle Series

(General editor J.L. Ackrill, Oxford: Clarendon Press)

##### Aristotle's De Generatione et Corruptione

trans. with notes by C.J.F. Williams (1982)

##### Aristotle's De Anima Books II, III

trans. with notes by D.W. Hamlyn (1968)

Aristotle's De Partibus Animalium I and De Generatione Animalium I trans. with notes by D.M. Balme (1972)

The Loeb Classical Library (London: William Heineman Ltd):

Meteorologica trans. H.D.P. Lee. (1952)

On the Soul, Parva Naturalia, On Breath

trans. W.S. Hett (1936, revised 1957)

Historia Animalium Books I-III trans. A.L. Peck (1965)

Historia Animalium Books IV-VI trans. A.L. Peck (1970)

Parts of Animals, Movement of Animals, Progression of Animals trans. A.L. Peck and E.S. Forster (First printed 1937, revised several times, the latest being 1983)

Generation of Animals trans. A.L. Peck (1942)

### General bibliography

- Ackrill, J.L. 'Aristotle's Definitions of *Psuche*' Proceedings of the Aristotelian Society 73 (1972-3)
- Atran, Scott 'Pre-Theoretical Aspects of Aristotelian Definition and Classification of Animals: The Case for Common Sense' Studies in the History and Philosophy of Science 16 (1985)
- Balme, D.M. 'Greek Science and Mechanism I: Aristotle on Nature and Chance' Classical Quarterly 33 (1939)
- \_\_\_\_\_, 'Development of Biology in Aristotle and Theophrastus: Theory of Spontaneous Generation' Phronesis 7 (1962)
- \_\_\_\_\_, 'τένος and εἶδος in Aristotle's Biology' Classical Quarterly 12 (1962)
- \_\_\_\_\_, 'Aristotle and the Beginnings of Zoology' Journal of the Society for the Bibliography of Natural History 5 (1968-71)
- \_\_\_\_\_, 'Aristotle: Natural History and Zoology' in Dictionary of Scientific Biography Vol. I ed. Charles Coulston Gillispie New York: Charles Scribner's Sons 1970
- \_\_\_\_\_, 'Biological Conceptions in Antiquity' in Dictionary of the History of Ideas Vol. I New York: Charles Scribner's Sons 1973
- \_\_\_\_\_, 'Aristotle's Use of Differentiae in Zoology' in Articles on Aristotle vol. 1, ed. J. Barnes, M. Schofield and R. Sorabji London: Duckworth 1975
- \_\_\_\_\_, review of A. Preus, Science and Philosophy in Aristotle's Biological Works, Journal of the History of Philosophy 15 (1977)
- \_\_\_\_\_, Aristotle's De Generatione Animalium I and De Partibus Animalium I Oxford: Clarendon Press 1972

- \_\_\_\_\_, 'Aristotle's biology was not essentialist' Archiv für Geschichte der Philosophie 62 (1980)
- \_\_\_\_\_, review of M.C. Nussbaum, Aristotle's De Motu Animalium Journal of the History of Philosophy 20 (1982)
- \_\_\_\_\_, 'The Snub' Ancient Philosophy 4 (1984)
- \_\_\_\_\_, 'Aristotle Historia Animalium Book Ten' Aristoteles Werk und Wirkung ed. J. Wiesner Berlin: W. de Gruyter 1985
- \_\_\_\_\_, 'Aristotle's Historia Animalium: date and authorship'. Unpublished.
- \_\_\_\_\_, 'Teleology and Necessity' Philosophical Issues in Aristotle's Biology ed. A. Gotthelf and J. Lennox Cambridge 1987
- Barnes, Jonathan 'Aristotle's Concept of Mind' Proceedings of The Aristotelian Society 72 (1971-2)
- \_\_\_\_\_, 'Aristotle and Women' review of Science folklore and Ideology by G.E.R. Lloyd London Review of Books 16-19 Feb. 1984
- Beare, John I. Greek Theories of Elementary Cognition Oxford: at the Clarendon Press 1906
- Block, Irving 'The Order of Aristotle's Psychological Writings' American Journal of Philology 82 (1961)
- Bodson, Liliane 'Aristotle's statement on the reproduction of sharks' Journal of the History of Biology 16 (1983)
- Bourgey, L. 'Observation and Experience in Analogical Explanation' Articles on Aristotle vol. 1 ed. Jonathan Barnes, Malcolm Schofield and Richard Sorabji London: Duckworth 1975
- Boylan, Michael 'Mechanism and Teleology in Aristotle's Biology' Apeiron 15 (1981)
- \_\_\_\_\_, 'The digestive and 'circulatory' systems in Aristotle's biology' Journal of the History of Biology 15 (1982)
- \_\_\_\_\_, Method and Practice in Aristotle's Biology Washington: University Press of America 1983
- \_\_\_\_\_, 'The Galenic and Hippocratic Challenges to Aristotle's Conception Theory' Journal of the History of Biology 17 (1984)
- \_\_\_\_\_, 'The Place of Nature in Aristotle's Teleology' Apeiron 18 (1984)
- \_\_\_\_\_, 'Galen's Conception Theory' Journal of the History of Biology 19 (1986)

- Brentano, Franz The Psychology of Aristotle ed/trans. Rolf George Berkeley: University of California Press 1977
- \_\_\_\_\_, Aristotle and his World View ed/trans. Rolf George and Roderick M. Chisholm Berkeley: University of California Press 1978
- Byl, Simon 'Note sur la place du cœur et la valorisation de la \_\_\_\_\_ dans la biologie d'Aristote' Antiquité Classique 37 (1968)
- \_\_\_\_\_, Recherches sur les grands traités biologiques d'Aristote: sources écrites et préjugés Bruxelles: Academie Royale de Belgique 1980
- Clark, Stephen R.L. Aristotle's Man Oxford: Clarendon Press 1975
- Clarke, Edwin 'Aristotelian concepts of the form and function of the brain' Bulletin of the History of Medicine 37 (1963)
- Clarke, Edwin and Stannard, Jerry 'Aristotle on the Anatomy of the Brain' Journal of the History of Medicine 18 (1963)
- Cohen, Sheldon 'Aristotle's Doctrine of the Material Substrate' Philosophical Review 93 (1984)
- Cole, F.J. A History of Comparative Anatomy London: Macmillan & Co. Ltd. 1944
- Cooper, John M. Reason and Human Good in Aristotle Cambridge, Mass.: Harvard University Press 1975
- \_\_\_\_\_, 'Aristotle on Natural Teleology' Language and Logos ed. Malcolm Schofield and Martha Craven Nussbaum Cambridge University Press 1982
- Cornford, F.M. From Religion to Philosophy New York: Harper and Brothers 1957
- Cournand, André 'Air and Blood' Circulation of the Blood: Men and Ideas ed. Alfred P. Fishman and Dickinson W. Richards Oxford University Press 1964
- De Ley, H. 'Pangenesi versus Panspermia' Hermes 108 (1980)
- Dickerman, Sherwood Owen 'Some Stock Illustrations of Animal Intelligence in Greek Psychology' Transactions of the American Philological Association 42 (1911)
- Düring, Ingemar 'Aristotle's method in biology: A note on De Part. An. I 1, 639b30-640a2' Symposium Aristotelicum: Aristote et les problèmes de méthode 2 (1960)
- \_\_\_\_\_, Aristotle's De Partibus Animalium London: Garland 1980 (reprint of 1943)
- \_\_\_\_\_, Aristotle's Chemical Treatise London: Garland 1980 (reprint of 1944)
- Easterling, H.J. 'A Note on De Anima 413a9' Phronesis 11 (1966)

- Edelstein, Ludwig 'The Relation of Ancient Philosophy to Medicine' Bulletin of the History of Medicine 26 (1952)
- Egerton, Frank N. 'Aristotle's Population Biology' Arethusa 8 (1975)
- Eichholz, D.E. 'Aristotle's Theory of the Formation of Metals and Minerals' Classical Quarterly 43 (1949)
- Elders, Leo Aristotle's Cosmology (Introduction) Assen, The Netherlands: Van Gorcum & Company 1965
- Eyben, Emiel 'Antiquity's View of Puberty' Latomus 31 (1972)
- Farrington, Benjamin Greek Science Penguin 1961
- \_\_\_\_\_, 'The Greeks and the Experimental Method' Discovery 18 (1957)
- Forbes, William T.M. 'The Silkworm of Aristotle' Classical Philology 25 (1930)
- Fortenbaugh, William W. 'Aristotle: Animals, Emotion and Moral Virtue' Arethusa 4 (1971)
- \_\_\_\_\_, 'Aristotle on Slaves and Women' Articles on Aristotle vol. 2 eds. Jonathan Barnes, Malcolm Schofield and Richard Sorabji London: Duckworth 1975
- \_\_\_\_\_, 'On the Antecedents of Aristotle's Bipartite Psychology' Essays in Ancient Greek Philosophy Volume II ed. John P. Anton and Anthony Preus Albany: State University of New York Press 1983
- Franklin, James 'Aristotle on Species Variation' Philosophy 61 (1986)
- Furley, David J. 'The Mechanics of Meteorologica IV' Zweifelhaftes im Corpus Aristotelicum ed. P. Moraux and J. Wiesner Berlin: Walter de Gruyter 1983
- \_\_\_\_\_, and Wilkie, J.S. Galen on Respiration and the Arteries Princeton University Press 1984
- Furth, Montgomery 'Transtemporal Stability in Aristotelian Substances' Journal of Philosophy 75 (1978)
- \_\_\_\_\_, Substance, Form and Psyche: An Aristotelian Metaphysics Cambridge University Press 1988
- Geddes, Anne 'The Philosophic Notion of Women in Antiquity' Antichthon 9 (1975)
- Gerson, L.P. 'Artifacts, Substances and Essences' Apeiron 18 (1984)
- Gotthelf, Allan 'Aristotle's Conception of Final Causality' Review of Metaphysics 30 (1976-7)

- \_\_\_\_\_, ed. Aristotle on Nature and Living Things Bristol: Bristol Classical Press and Mathesis Publications 1985
- \_\_\_\_\_, 'Notes towards a Study of Substance and Essence in Aristotle's Parts of Animals ii-iv' Aristotle on Nature and Living Things ed. Allan Gotthelf Bristol: Bristol Classical Press 1985
- \_\_\_\_\_, 'First Principles in Aristotle's Parts of Animals' Philosophical Issues in Aristotle's Biology eds. Allan Gotthelf and J.G. Lennox Cambridge University Press 1987
- Gottschalk, H.B. 'The authorship of Meteorologica, Book IV' Classical Quarterly 55 (1961)
- Graham, Daniel W. 'Some Myths about Aristotle's Biology' Journal of the History of Ideas 47 (1986)
- Granger, Herbert 'The Scala Naturae and the Continuity of Kinds' Phronesis 30 (1985)
- \_\_\_\_\_, 'Deformed Kinds and the Fixity of Species' Classical Quarterly 37 (1987)
- Grene, Marjorie A Portrait of Aristotle London: Faber and Faber 1963
- \_\_\_\_\_, 'Aristotle and Modern Biology' Journal of the History of Ideas 33 (1972)
- Haldane, J.D.S. 'Aristotle's account of bees' 'dances'' Journal of Hellenic Studies 75 (1955)
- Hardie, W.F.R. 'Aristotle's Treatment of the Relation between the Soul and the Body' Philosophical Quarterly 14 (1964)
- \_\_\_\_\_, 'Concepts of Consciousness in Aristotle' Mind 85 (1976)
- Harris, C.R.S. The Heart and the Vascular System in Ancient Greek Medicine Oxford: at the Clarendon Press 1973
- Hartman, Edwin Substance Body and Soul Princeton University Press 1977
- Horne, R.A. 'Aristotelean Chemistry' Chymia 11 (1966)
- Horowitz, Maryanne Cline 'Aristotle and Woman' Journal of the History of Biology 9 (1976)
- Huby, Pamela 'Theophrastus in the Aristotelian Corpus, with particular reference to Biological Problems' Aristotle on Nature and Living Things ed. Allan Gotthelf Bristol: Bristol Classical Press 1985
- Huxley, T.H. 'On Certain Errors Respecting the Structure of the Heart Attributed to Aristotle' Nature XXI (1879-80)
- Jacobs, William 'Art and Biology in Aristotle' Paideia special Aristotle issue (1978)

- Jaeger, W. 'Das Pneuma im Lykeion' Hermes 48 (1913)
- Joachim, Harold H. 'Aristotle's Conception of Chemical Combination' Journal of Philology 29 (1903-4)
- Jones, Barrington 'Aristotle's Introduction of Matter' Philosophical Review 83 1974
- Jones, W.H.S. Philosophy and Medicine in Ancient Greece Suppl. 8 to Bulletin of the History of Medicine 1946
- Kember, O.D. 'Aristotle and the Chick Embryo' Classical Quarterly 65 (1971)
- \_\_\_\_\_, 'Aristotle, *De Generatione Animalium* 761b35' Classical Review 22 (1972)
- \_\_\_\_\_, 'Aristotle, *Historia Animalium* v i, 539a27-31' Classical Review 24 (1974)
- King, Hugh R. 'Aristotle Without Prima Materia' Journal of the History of Ideas 17 (1956)
- Kosman, L.A. 'Animals and other beings in Aristotle' Philosophical Issues in Aristotle's Biology ed. Allan Gotthelf and James Lennox Cambridge 1987
- Kraak, W.K. 'Aristote est-il toujours resté fidèle à sa conception que la plante se tient la tête en bas?' Mnemosyne 10 (1942)
- Kung, Joan 'Some Aspects of Form in Aristotle's Biology' Nature and System 2 (1980)
- Landels, J.G. 'An ancient account of reproduction' Biology and Human Affairs 44 (1979)
- Lange, Lynda 'Woman is not a rational animal: on Aristotle's biology of reproduction' Discovering Reality ed. Sandra Harding and Merrill B. Hintikka Dordrecht: D. Reidel 1983
- Lee, H.D.P. 'Place-Names and the Date of Aristotle's Biological Works' Classical Quarterly 42 (1948)
- \_\_\_\_\_, 'The Fishes of Lesbos Again' Aristotle on Nature and Living Things ed. Allan Gotthelf Bristol: Bristol Classical Press 1985
- Lefèvre, Charles 'Sur le statut de l'âme dans le *De Anima* et les *Parva Naturalia*' Aristotle on Mind and the Senses ed. G.E.R. Lloyd and G.E.L Owen Cambridge University Press 1978
- Leicester, Henry M. 'Biochemical Concepts Among the Ancient Greeks' Chymia 7 (1961)
- Lennox, James 'Aristotle on Genera, Species and "the More and the Less"' Journal of the History of Biology 13 (1980)

- \_\_\_\_\_, 'Teleology, Chance and Aristotle's Theory of Spontaneous Generation' Journal of the History of Philosophy 20 (1982)
- \_\_\_\_\_, 'Recent Philosophical Studies of Aristotle's Biology' Ancient Philosophy 4 (1984)
- \_\_\_\_\_, 'Are Aristotelian Species Eternal?' Aristotle on Nature and Living Things ed. Allan Gotthelf Bristol: Bristol Classical Press 1985
- \_\_\_\_\_, 'Kinds, forms of kinds, and the more and the less in Aristotle's biology' Philosophical Issues in Aristotle's Biology ed. A. Gotthelf, and J. Lennox Cambridge 1987
- Lloyd, G.E.R. 'The Development of Aristotle's Theory of the Classification of Animals' Phronesis 6 (1961)
- \_\_\_\_\_, 'Right and Left in Greek Philosophy' Journal of Hellenic Studies 82 (1962)
- \_\_\_\_\_, 'The Hot and the Cold, the Dry and the Wet in Greek Philosophy' Journal of Hellenic Studies 84 (1964)
- \_\_\_\_\_, 'Experiment in Early Greek Philosophy and Medicine' Proceedings of the Cambridge Philological Society 190 (1964)
- \_\_\_\_\_, Polarity and Analogy Cambridge University Press 1966
- \_\_\_\_\_, 'The role of medical and biological analogies in Aristotle's ethics' Phronesis 13 (1968)
- \_\_\_\_\_, Aristotle: the growth and structure of his thought Cambridge University Press 1968
- \_\_\_\_\_, Early Greek Science: Thales to Aristotle London: Chatto and Windus 1970
- \_\_\_\_\_, Greek Science after Aristotle London: Chatto and Windus 1973
- \_\_\_\_\_, 'Aspects of the Interrelations of Medicine Magic and Philosophy in Ancient Greece' Apeiron 9 (1975)
- \_\_\_\_\_, 'Alcmaeon and the early history of dissection' Sudhoffs Archiv 59 (1975)
- \_\_\_\_\_, 'The empirical basis of the physiology of the *Parva Naturalia*' Aristotle on Mind and the Senses ed. G.E.R. Lloyd and G.E.L. Owen Cambridge University Press 1978
- \_\_\_\_\_, Magic, Reason and Experience Cambridge University Press 1979
- \_\_\_\_\_, Science, Folklore and Ideology Cambridge University Press 1983

- Lones, Thomas East Aristotle's Researches in Natural Science London: West, Newman and Co. 1912
- Longrigg, James 'A Seminal 'Debate' in the Fifth Century B.C.?' in Aristotle on Nature and Living Things ed. Allan Gotthelf Bristol: Bristol Classical Press 1985
- Louis, Pierre 'Le traité d'Aristote sur la nutrition' Revue de Philologie 26 (1952)
- \_\_\_\_\_, 'Remarques sur la classification des animaux chez Aristote' Autour d'Aristote Louvain: Publications Universitaires de Louvain 1955
- \_\_\_\_\_, 'Les animaux fabuleux chez Aristote' Revue des Études Grecques 80 (1967)
- \_\_\_\_\_, 'La génération spontanée chez Aristote' Actes du XIIe. Congrès International d'Histoire des Sciences IA (1968)
- \_\_\_\_\_, 'Monstres et Monstruosités dans la Biologie d'Aristote' Le Monde Grec: Hommages à Claire Préaux ed. J. Bingen, G. Cambier and G. Nachtergaeel Bruxelles: l'université de Bruxelles 1975
- Lulofs, H.J. Drossaart 'Aristotle's  $\tau\iota\epsilon\rho\iota\ \phi\upsilon\tau\omega\nu$ ' Journal of Hellenic Studies 77 (1957)
- Magner, Lois N. A History of the Life Sciences New York: Marcel Dekker Inc. 1979
- Manicas Peter T. 'Aristotle, Dispositions and Occult Powers' Review of Metaphysics 18 (1964-5)
- Mansion, S. 'Deux définitions différentes de la vie chez Aristote?' Revue Philosophique de Louvain 71 (1973)
- \_\_\_\_\_, 'Soul and Life in the *De Anima*' Aristotle on Mind and the Senses ed. G.E.R. Lloyd and G.E.L. Owen Cambridge University Press 1978
- Matthews, Gareth B. 'Gender and Essence in Aristotle' Australasian Journal of Philosophy supplement to 64 (1986)
- Modrak, D.M. 'An Aristotelian Theory of Consciousness?' Ancient Philosophy 1 (1981)
- Morau, Paul 'A propos du  $\nu\omicron\upsilon\varsigma\ \theta\acute{\upsilon}\rho\alpha\theta\epsilon\upsilon$  chez Aristote' Autour d'Aristote Louvain: Publications Universitaires de Louvain 1955
- \_\_\_\_\_, 'Galen and Aristotle's *De Partibus Animalium*' Aristotle on Nature and Living Things ed. Allan Gotthelf Bristol: Bristol Classical Press 1985
- Morsink, Johannes 'Was Aristotle's Biology Sexist?' Journal of the History of Biology 12 (1979)
- \_\_\_\_\_, Aristotle on the Generation of Animals New York: University Press of America 1982

- Needham, Joseph A History of Embryology Cambridge University Press 1934 (Second ed. 1959)
- Norman, Richard 'Aristotle's philosopher-god' Phronesis 14 (1969)
- Nussbaum, Martha Craven Aristotle's *De Motu Animalium* Princeton University Press 1978
- Ogle, W. Aristotle on Youth and Old Age, Life and Death, and Respiration (Introduction) London: Longmans, Green and Co. 1897
- \_\_\_\_\_, Aristotle on the Parts of Animals (Introduction) London: Kegan Paul, Trench and Co. 1882
- Oppenheimer, J.M. 'Aristotle as a Biologist' Scientia 106 (1971)
- \_\_\_\_\_, 'When Sense and Life Begin: Background for a Remark in Aristotle's Politics (1335b24)' Arethusa 8 (1975)
- Owens, Joseph 'Teleology of Nature in Aristotle' The Monist 52 (1968)
- Parker, Robert 'Sex, Women and Ambiguous Animals' a review of Science Folklore and Ideology by G.E.R. Lloyd Phronesis 18 (1984)
- Peck, Arthur L. 'The Connate Pneuma: an essential factor of Aristotle's solutions to the problems of reproduction and sensation' Science, Medicine and History vol. 1. ed. E.A. Underwood Oxford University Press 1953
- Pellegrin, Pierre La Classification des Animaux chez Aristote Paris: les Belles Lettres 1982
- \_\_\_\_\_, 'Aristotle: A Zoology without Species' in Aristotle on Nature and Living Things ed. Allan Gotthelf Bristol: Bristol Classical Press 1985
- Petit, Georges 'Aristote et la biologie marine: les cétacés avec remarques sur la classification des animaux dans l'oeuvre du Stagirite' Actes du XIe. Congrès International d'Histoire des Sciences V (1965)
- Platt, Arthur 'On the Indian Dog' Classical Quarterly 3 (1909)
- \_\_\_\_\_, 'Aristotle on the Heart' Studies in the History and Method of Science vol. II. ed. Charles Singer Oxford: at the Clarendon Press 1921
- Plochmann, George K. 'Nature and the Living Thing in Aristotle's Biology' Journal of the History of Ideas 14 (1953)
- Pomeroy, Sarah B. Goddesses, Whores, Wives and Slaves New York: Schocken 1975
- Pratt, Vernon 'The Essence of Aristotle's Zoology' Phronesis 18 (1984)

- Preus, Anthony 'On Dreams, 2 459b24-460a33 and Aristotle's  $\delta\psi\iota\varsigma$ ' Phronesis 13 (1968)
- \_\_\_\_\_, 'Aristotle's Natural Necessity' Studi Internazionali di Filosofia I (1969)
- \_\_\_\_\_, 'Aristotle's 'Nature uses ...'' Apeiron 3 (1969)
- \_\_\_\_\_, 'Science and Philosophy in Aristotle's Generation of Animals' Journal of the History of Biology 3 (1970)
- \_\_\_\_\_, 'Biomedical Techniques for Influencing Human Reproduction in the Fourth Century B.C.' Arethusa 8 (1975)
- \_\_\_\_\_, 'Galen's criticism of Aristotle's conception theory' Journal of the History of Biology 10 (1977)
- \_\_\_\_\_, 'Eidos as Norm in Aristotle's Biology' Essays in Ancient Greek Philosophy Volume II ed. J.P. Anton and A. Preus Albany: State University of New York Press 1983
- \_\_\_\_\_, 'Aristotle's *Parts of Animals* 2.16.659b13-19: is it authentic?' Classical Quarterly 18 (1968)
- \_\_\_\_\_, Science and Philosophy in Aristotle's Biological Works Hildesheim: George Olms 1975
- Quinn, Francis X. 'Theory of Spontaneous Generation According to the Ancients' Classical Bulletin 40 (1964)
- Regnéll, Hans Ancient Views on the Nature of Life Lund: CWK Gleerup 1967
- Reiche, Harald A.T. Empedocles' Mixture, Eudoxan Astronomy and Aristotle's Connate Pneuma Amsterdam: Hakkert, Adolf M. 1960
- \_\_\_\_\_, 'Aristotle on Breathing in the Timaeus' American Journal of Philology 86 (1965)
- Renehan, Robert 'The Greek Anthropocentric View of Man' Harvard Studies in Classical Philology 85 (1981)
- Reiche, Harald A.T. Empedocles' Mixture, Eudoxan Astronomy and Aristotle's Connate Pneuma Amsterdam 1960
- Rist, John M. 'Some Aspects of Aristotelian Teleology' Transactions and Proceedings of the American Philological Association 96 (1965)
- Ritter, William E. 'Why Aristotle invented the word entelecheia' Quarterly Review of Biology 7 (1932)
- Robinson, Trevor 'Theophrastos on Fire' Chymia 5 (1959)

- Rosen, S.H. 'Thought and Touch, a note on Aristotle's *de anima*' Phronesis 6 (1961)
- Ross, David Aristotle: Parva Naturalia (Introduction) Oxford: at the Clarendon Press 1955
- \_\_\_\_\_, 'The Development of Aristotle's Thought' Articles on Aristotle vol. 1 ed. Barnes, Schofield and Sorabji London: Duckworth 1975
- Roussel, Michel 'Physique et Biologie dans la 'Génération des Animaux' d'Aristote' Revue des Études Grecques 93 1980
- Rousselle, Aline 'Observation féminine et idéologie masculine: le corps de la femme d'après des médecins grecs' Annales 35 (1980)
- Russell, Bertrand History of Western Philosophy London: George Allen and Unwin 1961
- Sambursky S The Physical World of the Greeks London: Routledge and Kegan Paul 1956
- Sharples, R.W. 'Species, Form and Inheritance: Aristotle and After' in Aristotle on Nature and Living Things ed. Allan Gotthelf Bristol: Bristol Classical Press 1985
- Shute, Clarence The Psychology of Aristotle: An Analysis of the Living Being New York: Columbia University Press 1941
- Singer, Charles 'Greek biology and its relation to the rise of modern biology' Studies in the History and Method of Science Vol. II ed. Charles Singer Oxford: at the Clarendon Press 1921
- \_\_\_\_\_, Greek Biology and Greek Medicine Oxford: at the Clarendon Press 1922
- \_\_\_\_\_, A Short History of Scientific Ideas to 1900 Oxford University Press 1959
- Smith, Nicholas D. 'Plato and Aristotle on the Nature of Women' Journal of the History of Philosophy 21 (1983)
- Solmsen, Friedrich 'Tissues and the Soul' Philosophical Review 59 (1950)
- \_\_\_\_\_, 'The vital heat, the inborn pneuma and the aether' Journal of Hellenic Studies 77 (1957)
- \_\_\_\_\_, 'Aristotle and Prime Matter: a reply to Hugh R. King' Journal of the History of Ideas 19 (1958)
- \_\_\_\_\_, Aristotle's System of the Physical World New York: Cornell University Press 1960
- \_\_\_\_\_, 'Greek Philosophy and the Discovery of the Nerves' Museum Helveticum 17/18 (1960/61)

- \_\_\_\_\_, review of Empedocles' Mixture, Eudoxan Astronomy and Aristotle's Connate Pneuma by Harald Reiche American Journal of Philology 84 (1963)
- \_\_\_\_\_, 'Nature as Craftsman' Journal of the History of Ideas 24 (1963)
- \_\_\_\_\_, 'Platonic values in Aristotle's Science' Journal of the History of Ideas 39 (1978)
- \_\_\_\_\_, 'The fishes of Lesbos and their alleged significance for the development of Aristotle' Hermes 106 (1978)
- Sorabji, Richard 'Body and Soul in Aristotle' Philosophy 49 (1974)
- \_\_\_\_\_, Necessity Cause and Blame London: Duckworth 1980
- Sprague, Rosamund Kent 'The Four Causes: Aristotle's Exposition and Ours' The Monist 52 (1968)
- \_\_\_\_\_, 'Aristotle and the Metaphysics of Sleep' Review of Metaphysics 31 (1977-8)
- \_\_\_\_\_, 'Eating, Growth and Sophists' in The sophists and their legacy Proceedings of the 4th International Colloquium on Ancient Philosophy (1979) Wiesbaden: Steiner 1981
- \_\_\_\_\_, 'Metaphysics and Multiple Births' Apeiron 20 (1987)
- Stannard, Jerry and Clarke, Edwin 'Aristotle on the Anatomy of the Brain' Journal of the History of Medicine 18 (1963)
- Strang, Colin 'The Perception of Heat' Proceedings of the Aristotelian Society 61 (1960-61)
- Theophrastus De Causis Plantarum I translated by Benedict Einarson and G.K.K. Link Loeb edition London: William Heinemann Ltd 1976
- Thijssen, J.M 'Twins as Monsters: Albertus Magnus's theory of the generation of twins and its philosophical context' Bulletin of the History of Medicine 61 (1987)
- Thom, Paul 'Stiff cheese for women' Philosophical Forum 8 (1976)
- Thompson, D'Arcy W. 'Aristotle the Naturalist' Science and the Classics Oxford University Press 1940
- \_\_\_\_\_, 'ὄνος: ἄνορωπις' Classical Quarterly 39 (1945)
- Thorp, John 'The Luminousness of the Quintessence' Phoenix 36 (1982)
- Torrey, Harry Beal, and Felin, Frances 'Was Aristotle an Evolutionist?' Quarterly Review of Biology 12 (1937)

- Tracy, Theodore S.J. 'Heart and Soul in Aristotle' Essays In Ancient Greek Philosophy II ed. John P. Anton and A. Preus Albany: State University of New York Press 1983
- Turbayne, Colin Murray 'Aristotle's Androgynous Mind' Paideia special Aristotle issue (1978)
- Verbeke, G. 'Doctrine du pneuma et entéléchisme chez Aristote' Aristotle on Mind and the Senses ed. G.E.R. Lloyd and G.E.L. Owen, Cambridge University Press 1978
- Waterlow, Sarah Nature, Change and Agency Oxford: Clarendon Press 1982
- Webb, Philip 'Bodily Structure and Psychic Faculties in Aristotle's Theory of Perception' Hermes 110 (1982)
- Whitbeck, Caroline 'Theories of Sex Difference' Philosophical Forum 5 (1973-4)
- Whitfield, B.G. 'Aristotle and the Dance of the Bees' Classical Review 72 (1958)
- Wiesner, Jürgen 'The Unity of the *De Somno* and the Physiological Explanation of Sleep in Aristotle' in Aristotle on Mind and the Senses ed. G.E.R. Lloyd and G.E.L. Owen Cambridge University Press 1978
- Wijsenbeek-Wijler, H. Aristotle's Concept of Soul, Sleep and Dreams Amsterdam: Hakkert, Adolf M. 1978
- Wilkie, J.S. and Furley, David J. Galen on Respiration and the Arteries Princeton University Press 1984
- Witt, Charlotte 'Form, Reproduction and Inherited Characteristics in Aristotle's *Generation of Animals*' Phronesis 30 (1985)
- Woolam D.H.M. 'Concepts of the brain and its functions in classical antiquity' The Brain and its Functions: A Symposium Oxford: Blackwell 1958
- Zirkle, Conway 'Animals impregnated by the wind' Isis 25 (1936)

