

The Origin and the Instrument of Animal Motion - De Motu Animalium Chapters 9 and 10.

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De Motu Animalium, Chapters 9 and 10

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1. Introduction

One of the general aims of the treatise *De Motu Animalium* is to test and verify the principle that self-motion originates from something unmoved. ‘One must grasp this not only by a general account, but also with respect to the perceptible particulars,’ says Aristotle in Chapter 1, 698^a11-14. In the first half of the treatise, the principle is tested on two types of self-movers, animals and the heavens, since all other things are moved by them. Animals cannot displace themselves without there being something external to them which is at rest and against which they can support their limbs. Moreover, animals cannot move their limbs without there being internal points at rest against which moving sections of the limbs can support themselves. So the mechanics of animal motion requires an external thing at rest and joints which make flexing and extending movements possible by being divided into a part which is moved and a part which is at rest.

It is not only the mechanics of animal motion that requires something fixed outside as well as inside the animal. Focusing on voluntary motions, Aristotle observes that animals move their limbs and displace themselves only if there is something, typically an external object of pursuit or avoidance, which moves them without itself being moved. Nothing can be an object of pursuit or avoidance, however, without being an object of the animal’s cognition and conation. Since it is the soul that enables animals to perceive or represent objects and to desire them, and the soul is something essentially unmoved, it follows that animals displace themselves relative to an external unmoved factor whose motive power crucially depends on the internal unmoved factor, the soul. So the requirement that there be something external and something internal at rest is borne out not only in considerations that have to do with the mechanics of animal motion, but also in considerations that have to do with the psychology of animal motion. Indeed, as I shall argue, Aristotle finds the very origin of the mechanics of animal motion in the psychology of animal motion.

The opening of Chapter 6 reminds the reader of Aristotle’s discussions of the questions of mobility of the soul, presumably referring back to *De Anima* I.3-4, where he has shown that the soul cannot be moved except accidentally, insofar as the body in which it inheres moves. This immediately raises two programmatic questions for the rest of our treatise: ‘It remains to consider (i) how the soul moves the body, and (ii) what is the origin

of animal motion' (700^b10-11). Although there are various ways of seeing these two questions at work in Chapters 6 to 11, I take it that the second half of Chapter 8 and Chapter 9 are part of Aristotle's answer to the second question, whereas Chapter 10 is part of his answer to the first question.

Chapter 8 opens with the claim, referring back to what has been said previously in Chapters 6 and 7, that the object of pursuit or avoidance is the goal and an external origin of animal motion, that which moves the animal without itself being moved. In the first half of Chapter 8 (701^b33-702^a21) Aristotle explains why that is the case. Briefly, the object of pursuit is something pleasant and the object of avoidance is something painful, and representations of pleasant and painful things are necessarily accompanied by heatings and chillings. Aristotle then supplies evidence for this explanation and, appealing to his theory of action and passion, goes on to argue that the body is constituted in such a way that a representation of an object of pursuit or avoidance—be this representation noetic or perceptual—causes a swift and effortless chain of physiological changes that lead to the motion of the limbs and eventually to the displacement of the whole animal.

In the second half of Chapter 8 (702^a21^{ff.}) and in Chapter 9, Aristotle turns to the internal origin of animal motion. He starts his discussion with the following premiss: 'That which first moves the animal must necessarily be in some origin.'

'That which *first* moves the animal' (τὸ κινεῖν πρῶτον τὸ ζῶον), I take it, is the soul. Few philosophers in antiquity would object to the view that 'the soul is what imparts motion most importantly and primarily',¹ though of course different philosophers had different conceptions of the soul and of the way it moves the body. Moreover, in the rest of Chapter 8, Aristotle goes on to speak about the 'motion-imparting origin of the soul' (ἡ ἀρχὴ τῆς ψυχῆς ἢ κινουσα, 702^a32; cf. 702^a36, ^b2, 16), which indicates that the subject of investigation is the soul, or more precisely the soul insofar as it is the principle of motion. It is supposed to be self-evident, in need of no further elaboration, that the soul-principle of motion is in some origin, that is in some part of the body from which motion starts, and Aristotle's task is to determine which part that is.

This task is executed in three steps. In the first step (the second half of Chapter 8, 702^a21-^b11), it is established that the soul-principle of motion cannot be in any of the

¹ καὶ μάλιστα καὶ πρῶτως ψυχὴν εἶναι τὸ κινεῖν, *DA* I.2 403^b28-9.

² For a discussion of this argument, see Nussbaum 1978, 364-8, and R. J. Hankinson's contribution in this volume.

³ I think that the traditional division of the *MA* into chapters is inadequate at more than one place. Certainly the second half of Chapter 8 and Chapter 9 (i.e. 702^a21-703^a3) deal with the same question and form a continuous line of argumentation which is artificially split into two chapters.

⁴ This was gestured at in Ch. 7, 701^b29, and made explicit in Ch. 10, 703^a14.

internal resting points, that is the joints. Aristotle shows this with his controversial argument of the hand holding a stick. The argument seems to rely on the idea that if the soul cannot be at the juncture of a soulless stick and the hand, which is supposed to be intuitively absurd, it cannot be at any other similar juncture in which the resting part is only relatively unmoved, that is unmoved for the purpose of producing one set of motions but moved along with a larger section of the body when another set of motions is produced.² This argument rules out all joints, those connecting sections of the limbs as well as those connecting the limbs to the trunk, but it cannot further specify where the soul-principle of animal motion is. In the second step (the first half of Chapter 9, 702^b12-25), Aristotle shows that the soul-principle of animal motion must be in the middle of the body. Finally, in the third step (the second half of Chapter 9, 702^b25-703^a3), he argues that the middle of the body, or any extended thing for that matter, cannot be the absolute origin of animal motion; the absolute origin of animal motion must be something unextended, that is the soul—as Aristotle conceives of it.³

2. The middle part of the body (Chapter 9, Part One: 702^b12-25)

The first half of Chapter 9 demonstrates that the soul-principle of animal motion must be in the middle part of the body, or more precisely in the heart or its analogue in bloodless animals.⁴ The argument has three premises and a necessary consequent: given that (i) the left and the right sides of animal bodies are similar, and (ii) that these opposite sides can be moved simultaneously – so that it is ruled out that one is moving by way of supporting itself against the other which is at rest – and given (iii) that the origin is always in something ‘further up’ from both, it follows that the ‘the origin of the motion-imparting soul is necessarily in the middle’ of the body (702^b15-16). The gist of the argument is tolerably clear, but there are problems in points of detail.

The first premiss (i) is formulated rather awkwardly. It is unclear what the subject of the clause in line ^b12 is, what sort of similarity is meant, and what is the point of the construction ἀπὸ τῶν ἀριστερῶν καὶ ἀπὸ τῶν δεξιῶν. Louis thinks that the subject is

² For a discussion of this argument, see Nussbaum 1978, 364-8, and R. J. Hankinson’s contribution in this volume.

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⁴ This was gestured at in Ch. 7, 701^b29, and made explicit in Ch. 10, 703^a14.

motion, probably in analogy with what Aristotle says six lines down, where he speaks of motions from above and from below (κινήσεις...ἀπὸ τοῦ ἄνω καὶ κάτω, ^b18), that is from the upper and from the lower parts of the body. According to this reading, the first antecedent would be saying something about *motions* coming from the parts on the left and on the right side of the body. However, in lines ^b13-14 it is the left or the right side of the body (τὸ δεξιόν, τὸ ἀριστερόν) that is said to be in motion while the other is at rest, so on this reading Aristotle would be shifting in the same sentence from the talk about opposite motions to the talk about the opposite sides of the body.⁵

More plausibly, Farquharson suggests that the tacit subject of the opening clause is the animal,⁶ in which case premiss (i) asserts that the animal is similar from the left and from the right. This is naturally taken to mean that the animal body is similarly structured when viewed from the left and from the right side, which essentially means that it is symmetrical along the vertical plane which divides the body into the left and the right half. However, Aristotle was perfectly aware that there were animals whose left and right halves are not symmetrical, e.g. ‘the crayfish and the crabs all have the right claw larger and stronger’ (*PA* IV.8, 684^a27).

This difficulty can be met if we suppose that in developing his argument at the beginning of Chapter 9 Aristotle has in mind an idealized schematic model, much like the one in the latter part of Chapter 9 and at several other places in this treatise.⁷ In this model, the left and the right side are fully symmetrical and they are identically related to the centre of the body, so that the soul-principle of motion can indeed be traced there with the help of the remaining premisses. The fact that the model is only imperfectly accommodated by real bodies of animals is of little consequence, since the model enables Aristotle to establish a general truth about animals without going into the details that vary from species to species. And although these details may reveal local departures from the model, Aristotle would think that they do not threaten the model, and hence that the use of the model is not unjustified.⁸

In the second premiss (ii), Aristotle makes the claim that the opposite sides of the body can be moved simultaneously. It is not clear what kind of motion Aristotle has in

⁵ I assume that the talk must be of the opposite sides *of the trunk*, rather than of the limbs on the opposite sides, because Aristotle has already established in the second half of Chapter 8 that the origin of the soul-principle of motion cannot be in any of the joints, be they in the limbs or in the trunk.

⁶ See Farquharson’s note *ad loc.* Michael (122.28-31) interprets the clause as if the subject is the heart.

⁷ This is what Nussbaum suggests in her comments on pp. 369-70.

⁸ A model-based approach is well suited for the task of providing a general account of an attribute which belongs to many different species (cf. *PA* I.1, 639^a15-^b5). Animal motion is just such an attribute, and providing a general account of it seems to be Aristotle’s task in the *MA*; cf. 698^a1-7.

mind—perhaps the shrugging movement of the shoulders?—or that he has any particular kind of motion in mind, if indeed he is operating with a schematic model. Nevertheless, the motivation for this premiss is clearly stated in lines ^b13-14, and it is to rule out the scenario that one side is moving by way of supporting itself against the other side which is at rest. In such a scenario, the side at rest could be identified as the origin of motion, and Aristotle's progress toward the conclusion that the origin cannot be in either of the opposite sides would be blocked.

The third premiss (iii) extends the rule established earlier, in the argument with the hand holding a stick from the second half of Chapter 8, to the case of the opposite sides of the body moved simultaneously. The rule can be formulated as follows: for any given part of the body in motion, if the fixed point supporting this motion belongs to a part of the body which can itself be moved against another fixed point in the body, the soul-principle of animal motion should be sought 'further up'. For instance, motion of the hand is supported by a fixed point in the wrist, but since the wrist belongs to the lower arm which can be moved, the soul-principle should be sought above the wrist; now the lower arm is moved by supporting itself against a fixed point in the elbow, but since elbow belongs to the upper arm which can be moved, the soul-principle should be sought above the elbow, and so forth. Applying this rule to the simultaneous motion of the left and the right side of the body, then, we necessarily end up somewhere in the middle of the body where the two meet, 'for the middle is the limit of both extremes' (702^b16-17).

This tells us only that the soul-principle of animal motion is in the middle between the left and the right side, that is somewhere along the vertical plane of the body, nothing more specific. We find a further specification in the following lines, 702^b17-18, where Aristotle says that the middle is similarly related to motions coming from above and from below. This situates the middle along the horizontal plane of the body, thus giving it a more definite location. However, given that Aristotle's example of motions from above are 'motions from the head', presumably nodding or shaking one's head, the most likely example of motions from below would be movements of the feet, which defines the horizontal plane. And the location of the middle at the intersection of the two planes, close to the centre of gravity, does not quite match the desired place of the heart or its analogue. This seems to be remedied if we read the text at 702^b19 with *καί* before *πρός*, so as to introduce motions from the spinal column as yet another set of motions to which the middle

is said to be similarly related.⁹ Now if the middle is similarly related to the motions coming from the spine—similarly, that is, to the way it is related to the motions from above and from below, and to the way it is related to the motions of the left and the right side of the body—and motions coming from the spine are taken to be motions involved in bending of the trunk, the sought middle would be placed above the centre of gravity and closer to the centre of the trunk, more or less where the heart or its analogue typically is.¹⁰

The conclusion of the argument, namely that the soul-principle of animal motion must be in the middle of the body, is additionally supported by Aristotle's well-attested view that the heart or its analogue is where perception takes place.¹¹

It is reasonable that this should be so: for we claim that the perceptual faculty (τὸ αἰσθητικόν) is located there too, so that when the region around the origin is altered through perception and changed, the adjacent parts change with it, expanding and contracting, so that by these means animal motion necessarily comes about. (702^b21-5)

Without going into much detail before addressing Chapter 10, the idea here is that perceptions, which were said to be 'at once alterations of a sort' (Ch. 7, 701^b17-19), may be such that they are accompanied by further qualitative changes, namely heatings and chillings in the heart,¹² which in turn cause the connate *pneuma* in the heart to expand and contract, thus creating mechanical impulse that leads to the motion of the limbs.¹³ This will be elaborated when we get to Chapter 10.

I would like to end this section by noting that the observation about the perceptual faculty being located in the middle of the body neatly connects the causal story of animal motion from the preceding chapters, where perceptual alterations were said to stand at the beginning of the causal chain (Ch. 6, 701^a4-6 and Ch. 7, 701^b16-19, 29), with the argument for the central location of the soul-principle of motion. And, needless to say, the argument

⁹ This is the text adopted by Nussbaum and by Primavesi, following mss. X, m^A and N. For a discussion of the alternative (and less plausible) manuscript readings of lines ^b18-19, see Nussbaum 1976, 154-5 and 1978, 371.

¹⁰ Cf. *PA* III.4, 665^b18-21, 666^b5-10; *HA* II.17, 506^b32-507^a1.

¹¹ See, e.g., *Somn.* 2, 455^a33-4; *Juv.* 1, 467^b28; 3, 469^a10-12; *PA* II.10, 656^a28; III.3, 665^a10-12; III.4, 666^a11-13, 34-5. For the ambiguity in the term τὸ αἰσθητικόν, and for reasons one should prefer to take it with reference to the perceptual faculty, see Lorenz 2007, 192-9. More details on Aristotle's picture of the heart and the rest of the sensorium can be found in Gregoric 2007, 40-51.

¹² I think καὶ μεταβάλλοντος in line 702^b22 is not expegetic of the preceding ἀλλοιουμένου, but gestures to a distinct factor in the story, namely thermic alterations. All perceptions are alterations, but not all of them are accompanied by thermic alterations. Thermic alterations accompany those perceptual alterations which are caused by objects that are good or bad for the animal; more on this below.

¹³ The scope of ἐξ ἀνάγκης in line 702^b24 can be construed differently, with διὰ ταῦτα ('motion comes about necessarily though these means') or with γίνεσθαι ('through these means motion necessarily comes about'). With all translators, I prefer the latter reading, and I take it to be the simple material necessity that Aristotle has in mind. It can be spelled out with reference to what has been said in Ch. 8, 702^a7-21, where Aristotle explains why motion follows swiftly upon suitable cognitive input.

reinforces Aristotle's position that the central organ is the heart or its analogue in bloodless animals, as opposed to the rival medical and philosophical theories, especially Plato's in the *Timaeus*, according to which the central organ is the brain.

3. The absolute origin of animal motion (Chapter 9, Part Two: 702^b25-703^a3)

Having located the soul-principle of animal motion in the middle of the body, in the second half of Chapter 9 Aristotle proceeds to show that the ultimate origin of animal motion cannot be the middle part of the body, or indeed any extended magnitude, but has to be the soul as he understands it, that is an unextended entity which can operate only as an unmoved mover.

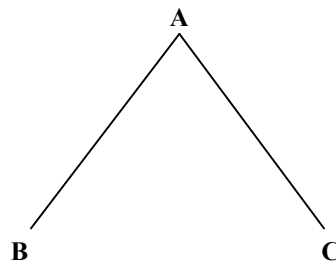
This is the central point of the whole Chapter 9. It marks Aristotle's departure from two rival theories of animal motion, both of which assume that the soul moves the body by being itself in motion. According to one such theory, that of the atomists, the soul is some sort of stuff whose motions are mechanically transferred to the rest of the body. In this picture, animal motion is determined by motions of the soul-stuff which are in turn determined by motions in the rest of the body and the environment, and that seems to disqualify animals from being self-movers in any genuine sense. It would appear that, on such a theory, animals merely react to what is going on in their environment, though the complexity of their reactions may depend on the complexity of their bodies and their soul-stuffs. According to the other theory, that of Plato in the *Timaeus*, the soul is not a body, but given that it has inherent circular motion which is somehow transferred to the body with which the soul is 'interwoven',¹⁴ Aristotle assumes that it must have a magnitude. In this picture, animal motion is the result of the soul's spontaneity, which makes animals self-movers in an unqualified sense. This theory seems to make animals more independent from the world's causal structure than Aristotle would find it acceptable in the light of his arguments for the necessity of one eternal unmoved mover of the universe, advanced in *Physics* VIII.¹⁵ So Aristotle should seek a middle position, one in which animals are neither mechanical automata nor radically spontaneous self-movers. And he achieves this position by showing that the ultimate origin of animal motion is the soul as he understands

¹⁴ *DA* I.4, 406^b26ff.

¹⁵ See *Phys.* VIII.2, 252^b21-253^a22; VIII.6, 259^b1-20 and Furley 1978, 177.

it, that is as the form of a certain kind of body, something that has no magnitude and that cannot impart motion by being moved, but only as an unmoved mover.

The argument in the second half of Chapter 9 starts with the claim that ‘the middle part of the body is potentially one, but in actuality necessarily becomes many’ (702^b25-6). To illustrate this claim, Aristotle considers two cases, the case of one limb being moved while the other is at rest, and the case of both limbs being moved simultaneously. Aristotle avails himself of the following diagram to elucidate his argument, where A is the middle of the body from which motion originates, and B and C are the extremities of the limbs:



In the first case, B is moved and C is at rest. As B moves along the circumference, clearly the whole radius AB moves. However, if A is to be the origin that imparts motion, it must be at rest. This means that A has to be divided in actuality, namely into the part which moves together with B and the part at rest from which the motion originates. ‘Although A is potentially one, it becomes two in actuality, so that it must be not a point but some magnitude’ (702^b30-1).

What is the relevant difference between a geometrical point (στυγμή) and a magnitude? The difference is that in geometry, point A can remain one single and undivided point while being used as both, that which is moved with B and that which is at rest with C.¹⁶ One should not think, however—and that is what Aristotle seems to be signalling here—that because one single geometrical point can have such two functions, there can be one single and undivided part of the body which serves as both the resting origin of motion and the first thing that is moved. In the physical world, if A is to be the origin that imparts motion to B, A has to become actually divided into two and remain one only in potentiality.¹⁷ Given that A can impart motion to B only if A is actually divided into

¹⁶ For ‘using’ one and the same geometrical point in different ways, i.e. taking it to perform different geometrical functions, see *Phys.* IV.11, 220^a9-20; VIII.8, 263^a23-5; *DA* III.2, 427^a9-14.

¹⁷ Cf. Ch. 1, 698^a16-698^b1.

two—the part which is moved by way of supporting itself against another part which is at rest—it follows that A must be something inherently divisible, that is a magnitude.

This allows us to appreciate the difference between the two cases, the case of one limb being moved while the other is at rest, and the case in which both limbs are moved at the same time. In the first case, point A is actually divided into the part which moves with B (radius AB) and the part which rests with C (radius AC). The part of A which rests with C, one could claim, is the unmoved thing against which radius AB moves. But what when both radii move?

Surely C can be moved simultaneously with B, so that both of the origins in A must of necessity impart motion while being moved. Consequently, there must be something else besides these that imparts motion but is not moved. Otherwise the extremities or origins in A would support themselves against each other when being moved, just as men would move their legs while standing back to back. (702^b32-703^a1)

When both radii move, point A is actually divided into two parts, both of which are moved, leaving no part of A which is at rest.¹⁸ Here we face a dilemma: either we must assume that something else besides the two moved parts of A is required, such that it imparts motion without itself being moved, or else we must assume that nothing else, no further unmoved factor, is required, since the two moved parts of A can use one another to support themselves.¹⁹

The second option is likened to the situation in which two men move their legs while standing back to back. Although there are different ways to spell out this analogy, I take it that two men standing back to back ‘move their legs’ in the sense that they are pushing against the ground. If they do so with equal force, they remain standing at one place, and if with unequal force, they both move in the direction determined by the man exerting greater force with his legs. This would be analogous to the situation in which two limbs move simultaneously as a result of the opposition of forces that set them into motion. That is, the two limbs moving in opposite directions would be using one another as support. In such a situation, the part of A which is moved with B and the part of A which is moved

¹⁸ Aristotle does not seem to contemplate the possibility that point A, in the second case, is actually divided into three parts: the part which moves with B, the part which moves with C, and the part which is the resting origin of motion for the former two parts. Perhaps he does not contemplate this possibility because it smacks of infinite regress, as one can well imagine that the third, resting part of A, may be the beginning of yet another radius, say AD, which represents another limb. Since that limb can also be moved simultaneously with the other two, a division of point A into four parts is then required, and so forth.

¹⁹ The dilemma is not explicitly stated in Aristotle’s text, but clearly forms the underlying structure of his thought at 702^b32-703^b3.

with C would support one another insofar as they move in two opposite directions—without requiring anything else which is at rest.

Although this option is not conceptually impossible, it seems inapplicable to most cases of simultaneous motion of limbs, since we move our limbs simultaneously in all sorts of ways, sometimes in a finely coordinated fashion, sometimes independently of one another. One could hardly explain such cases with reference to counterbalancing of opposed motions or forces. More to the point, such an explanation seems to imply that simultaneous movement of two limbs requires considerable effort and conscious coordination, much like two men standing back to back could move in their agreed direction only if they both invest much effort and careful coordination into their movements. Movements of our limbs, by contrast, be they simultaneous or not, are mostly rather effortless and often automatic, as Aristotle explained in Ch. 8, 702^a10-21.

So the analogy with two men standing back to back, I take it, is meant to make the second option look unpalatable. Indeed, the second option is grammatically formulated as a counterfactual, which clearly suggests that it should be rejected in favour of the first option. We must assume, then, that simultaneous motion of two limbs requires something else that imparts motion without itself being moved.

The conclusion of the passage, however, goes further than that:

There must be something that imparts motion to both—and that is the soul—which is different from such a magnitude, yet which is in it. (703^a1-3)

What entitles Aristotle to this conclusion? Having eliminated the second horn of the dilemma, he can affirm the first horn, namely that there has to be something else, besides the two moved parts of A, that imparts motion without being itself moved. But what makes him confident that this further thing which imparts motion without being itself moved—is the soul?

Assuming that dividing point A into more than two parts is not an option in Aristotle's example, and I have suggested that this is not an option for threat of infinite regress, the only remaining possibility is that there is something *unextended* in A that moves whatever parts of A happen to be moved. Because the soul is unextended, it cannot be a relative origin of motion, that is the origin of motion which is at rest for the purpose of effecting some motions and moved for the purpose of effecting others, but has to be an *absolute* origin of motion, one which can function solely as an unmoved mover. Although this absolute origin of motion is different from the magnitude represented by A in

Aristotle's diagram, that is the middle part of the body, it must be in that magnitude.²⁰ So much has been established by the argument in the second half of Chapter 9. I shall say more about the claim that the soul is in the heart when I come to the city analogy at the end of Chapter 10, in the last section.

I should like to pause here to consider briefly a textual matter. I trust I have shown that the received text of the conclusion of Chapter 9 makes good sense:

ἀλλὰ τὸ κινουὺν ἄμφω ἀναγκαῖον εἶναι, τοῦτο δ' ἐστὶν ἡ ψυχὴ, ἕτερον μὲν οὔσα τοῦ μεγέθους τοῦ τοιούτου, ἐν τούτῳ δ' οὔσα. (703a1-3)²¹

Very briefly, having established that there must be something unmoved which moves both parts of A (the part of A which moves with B and the part of A which moves with C), the point of the conclusion is that this something must be the soul as Aristotle understands it, i.e. something unextended, different from the magnitude represented by A, yet in it.

A number of editors and interpreters have found this reading unsatisfactory. I suppose they thought that εἶναι requires a predicate. Jaeger emended the sentence by inserting ἀκίνητον before ἀναγκαῖον, without any textual support, thus suggesting that the point of the conclusion is that the thing which moves both parts of A must be unmoved. Nussbaum rightly objects that 'then this is just a repetition of ^b34-35'.²² Nevertheless, Jaeger's emendation seems to have been motivated by the correct idea that the conclusion in 703^a1-3 aims to introduce the absolute origin of animal motion, which is the soul as an *unmoved* mover. In other words, once it is clear that the mover of both parts of A must of necessity be unmoved (τὸ κινουὺν ἄμφω ἀκίνητον ἀναγκαῖον εἶναι), one can immediately see that this unmoved mover can only be the soul.

Farquharson, Torraca, and Nussbaum, on the other hand, read ἐν after ἀναγκαῖον, with support from the Latin translation of William of Moerbeke and a comment of Albertus Magnus.²³ This reading seems to be motivated by a different understanding of the analogy with two men standing back to back. One could plausibly argue that the point of the analogy is to show that as long as there is no *one* thing that moves both parts of A, this is not really a case of self-motion, but at best some combination of two self-motions, exemplified by two men standing back to back and pushing their legs. To rule out this

²⁰ In some sense of being 'in'; cf. *Phys.* IV.3, 210^a14-24 and below Section 5.

²¹ The received text is accepted by Primavesi, Louis and Forster. I follow Primavesi's punctuation, whereas Louis and Forster put a full-stop after εἶναι.

²² Nussbaum 1976, 156.

²³ In the second treatise of *Liber de motibus progressivis*, in *B. Alberti Magni Opera Omnia*, ed. A. Borgnet, vol. X, Paris, 1891, p. 343.

scenario, it would be necessary to suppose that the mover of both parts of A is a genuine unity, and that would naturally lead to the suggestion that the mover is the soul, since forms account for the unity of hylomorphic compounds.

Though the second emendation makes good sense and has some textual evidence, I see no sufficient reason to prefer it over the received text.

To sum up. Aristotle's exploration of the internal unmoved origin of animal motion has led him from (i) the joints, with their relative origins which are unmoved in some cases but moved in others, to (ii) the middle part of the body; and then from the middle part of the body to (iii) the Aristotelian soul, an unextended entity which is the absolute origin of animal motion. This implies that animal motion begins with the soul, the internal unmoved origin. The object of desire, which has been identified earlier as the external unmoved origin, clearly presupposes the internal unmoved origin, since no external object can ever set an animal in motion unless it be represented and desired, and this is something that the animal does on account of its soul. So the soul sets limits to the mechanics of animal motion. It determines when the mechanism of the animal body is activated and it guides the mechanism towards some external objects and away from others, typically until the former objects are obtained and the latter successfully avoided.

Between the soul, whose activity is such as to enable the animal to represent an object and find it desirable or repulsive, and the object itself, a complex mechanical story takes place. Several components of that story have been outlined in the preceding chapters of the *De Motu Animalium*. The most intriguing part of this story, however, is the juncture between the internal unmoved mover and the first moved mover. Understanding this juncture is the key to answering the question how the soul moves the body, and that is the subject of Chapter 10.

4. The instrument of animal motion (Chapter 10, Part One: 703^a4-28)

Chapter 10 seems to make a fresh start with a back-reference to Chapter 6 (700^b35-701^a2), where a tripartite analysis of factors involved in animal motion was provided, familiar also from *De Anima* III.10 (433^b13-27):

According to the account that states the cause of motion, desire is the middle, which imparts motion being moved. (703^a4-5)

This is a surprising statement. Chapter 9 has just established that the soul is an absolute origin of animal motion and an unmoved mover, and now we are told that desire (ὄρεξις), which is supposed to be a capacity of the soul, is a *moved* mover.

The standard response to this problem is that Aristotle does not mean to say that desire is moved *stricto sensu*, i.e. that it undergoes a process whereby one state is replaced by an opposite or some intermediate state. Rather, desire is ‘moved’ only in the extended sense that the desiderative capacity of the soul is brought into actuality. This actualization of a capacity of the soul is not motion in the relevant sense, and hence Aristotle’s view that the soul is an unmoved mover is not contradicted. Realizing that the actualization of the desiderative capacity of the soul does not amount to a complete explanation of animal motion, Aristotle needs to add at 703^a5-6 that in animal bodies there has to be some bodily stuff that imparts motion being moved, that is a mover which *is* itself moved in the strict sense. So in Chapter 10, it is assumed, we get an account of this stuff which functions as the first moved mover of other physiological processes that lead to the motion of the limbs. This function is assigned to a special stuff called ‘connate *pneuma*’ (σύμφυτον πνεῦμα), which is sometimes thought to stand in relation to the desiderative capacity of the soul as matter to form, thus providing bodily output to the soul’s input. However, Aristotle’s own words on the subject fall short of lending unequivocal support to this line of interpretation. Just how special stuff the connate *pneuma* is, what exactly its role in the explanation of animal motion is, and how it is related to desire—all of these questions have been disputed.

In this section I will add to the controversy and offer a different response to the problem outlined above. However, I shall first say something about the nature of the connate *pneuma*, its properties and behaviour, because I believe I can give a reasonably coherent account of what is said about the connate *pneuma* in Chapter 10, an account which does is independent of the more controversial claims I shall make in this section.

The notion of *pneuma* plays a prominent part in the history of western philosophy and medicine, and it has been studied in detail in modern times.²⁴ I take it that Aristotle’s notion of the connate *pneuma*, together with some other related physiological ideas, was influenced by, if not borrowed from, the medical theories of his time, and it was suitably modified to fit his larger theoretical framework.²⁵ Apart from its role in animal motion,

²⁴ For a list of modern studies, see Freudenthal 1995, 107 nn. 2 and 3, to which I would add Berryman 2002, Corcilius 2008, 332-43 and Buddensiek 2009.

²⁵ See Jaeger 1913, esp. 50-2; Solmsen 1957, 120; Verbeke 1978, 207 and 208-9 n. 1.

described in Chapter 10, the connate *pneuma* has an important role in the generation of animals, and there are some passages indicating that it has a role in perception too, notably in connecting the heart with the peripheral sense organs, thus enabling perceptual alterations to take place in the heart. Aristotle himself says that *pneuma* functions as a versatile instrument: ‘Some tools in crafts serve many purposes, just as hammer and anvil do in smithery, so does *pneuma* in things constituted by nature.’²⁶ It is uncertain whether or not Aristotle had a worked-out theory of *pneuma*, but the fact is that we do not find a unified account of it among his extant works.²⁷ Moreover, the surviving remarks are not always consistent with one another and with other Aristotelian doctrines, which all together conspires to make *pneuma* an extremely difficult subject. Also, the comparison of *pneuma*’s nature with aether in *GA* II.3, 736^b37-737^a1, has proved especially conducive to making fanciful claims about it.

Here I shall restrict myself to the role of the connate *pneuma* in animal motion, and proceed on the deflationary assumption that the connate *pneuma* is essentially warm air, as Aristotle states in *GA* II.2, 736^a1. It is generated together with the individual animal and kept inside it, primarily in the heart. It is called ‘connate’ (σύμφυτον), I take it, in order to differentiate it from the air drawn from the outside by breathing, in which not all animals engage, and the reason it is called ‘*pneuma*’, rather than just ‘air’ (ἀέρ), is simply that the Greek word πνεῦμα is used for breath in common parlance, so that any air which is found inside the animal, whether drawn in from the outside or not, would naturally be called *pneuma*.

Having stated at 703^a5-6 that in ensouled bodies there must be some stuff which imparts motion by itself being moved, Aristotle posits some properties that such stuff needs to possess. Insofar as it is moved, it has to be susceptible to external influence, but insofar as it is a mover, it also needs to be able to exert influence on its part. Now the connate *pneuma* is a stuff found in all animals without exception, Aristotle claims, and it is what supplies animals with strength (ἰσχὺς), that is the power to produce or withstand motion in another body. The basis for the connection between the *pneuma* and strength seems to rest on the empirical observation that people hold their breath when they exert much force. As Aristotle writes: ‘Without strength it is impossible to move anything or to do anything, and

²⁶ *GA* V.8, 789^b9-12; cf. II.3, 736^b29-35.

²⁷ The treatise *Περὶ πνεύματος* (*De Spiritu*) is almost universally considered a later addition to the corpus of Aristotle’s works. Scholars have found a reference to it in the parenthetical remark at 703^a10-11, from which some of them boldly inferred that the *MA* is not a genuine work of Aristotle. The parenthetical remark can, however, plausibly refer to several passages in Aristotle’s extant works; cf. Nussbaum 1978, 3, 6-7, 375-7.

the holding of the *pneuma* produces strength (for animals that breathe, holding of *pneuma* from the outside, and for animals that do not breathe, holding of the connate *pneuma*).²⁸ This need not be taken to imply that the connate *pneuma* plays no role in the motion of animals that breathe, but only that holding one's breath (i.e. *pneuma* taken in from the outside) produces strength in addition to that produced by the connate *pneuma*.

Aristotle locates the connate *pneuma* in the heart solely on the basis of analogy with a joint at 703^a11-16. I shall return to this analogy later in this section, whereas here I wish to note that its point is not to restrict the connate *pneuma* to the heart, but only to affirm its presence in the heart. It is reasonable to suppose, however, that the connate *pneuma* is found in the heart in a prior sense, or in a greater degree, than in the rest of the body.²⁹ In the heart, *pneuma* is in contact with blood and tissues, especially the tendons on which *pneuma* acts. As Aristotle writes in *PA* III.4, 666^b13-16: 'The heart also has many tendons, and this is reasonable. For the movements are from this part, and are accomplished through pulling and relaxing; so the heart needs such equipment and strength.'³⁰ The tendons (τὰ νεῦρα) are hard, elongated and fibrous structures attached to the bones. 'The tendon's nature is such that it can be split lengthwise, but not crosswise, and it admits of great tension.'³¹ Unlike the bones, which are hard and brittle, tendons are said to be hard and flexible, or 'pullable' (ἐλκτόν, *GA* II.6, 743^b5). They produce motion of the limb in one direction by being pulled, and they get relaxed to allow the bone to be pulled by other tendons in another direction, much like we understand muscles to operate.³² At 701^b9 tendons are said to be like στρέβλαι, admittedly ropes wound round a wheel or roller, the release of which sets automata in motion, whereas bones are like wood and iron.³³

Since the basic locomotive operations are pushing and pulling (τὰ ἔργα τῆς κινήσεως, 703^a19-20),³⁴ Aristotle informs us that the instrument of motion has to be capable of expanding and contracting. The idea is that, by expanding, the instrument should exert centrifugal force so as to push and thus relax the tendons, whereas by contracting it

²⁸ *Somn.* 2, 456^a15-17; cf. *GA* II.4, 737^b32-738^a1; V.7, 787^b10-788^a16.

²⁹ The parenthetical remark at 703^a16-18 which follows the joint analogy suggests that the connate *pneuma* is regenerated in the same way as the other parts of the body, through the digestive process whereby nutriment is turned into blood and other residues; so Verbeke 1978, 196 and Freudenthal 1995, 109.

³⁰ Cf. *HA* I.17, 496^a13; III.5, 515^a27-30; *GA* V.7, 787^b10-788^a16.

³¹ *HA* III.5, 515^b14-16

³² Although some of Aristotle's statements about tendons, especially in *HA* III.5, suggest that they include muscles, that is highly doubtful, not least because tendons are said to be solid and hard homogeneous parts, whereas muscles are soft, supple, and vascularized. Curiously, Aristotle shows no awareness of the actual function of skeletal muscles in producing limb motion; see Gregoric and Kuhar 2013.

³³ Cf. Nussbaum 1976, 146-152 and De Groot 2008, 54-5.

³⁴ All locomotion in the sublunary sphere, according to Aristotle, boils down to pushing and pulling; cf. *Phys.* VII.2, 243^b12-244^b22; *DA* III.10, 433^b25-6; *IA* 1, 704^b22.

should exert centripetal force so as to pull the tendons. Now Aristotle claims (703^a18 *ff.*) that *pneuma* is naturally suited for the task. It is both heavy in comparison with the fiery element in the surrounding parts, and light in comparison with the earthy element in the surrounding parts. This enables the connate *pneuma* to keep its position inside the heart, surrounded by blood and tissues, and to produce pushing as well as pulling. Otherwise, if it were heavier, it would have the tendency to go down and affiliate with the earthy element in the surrounding parts, and if it were lighter, it would have the tendency to go up and affiliate with the fiery element in the surrounding parts.

The point of saying that the connate *pneuma* is unforced (ἀβίαστος, 703^a22) when it contracts is, I take it, to clarify that the *pneuma* does not contract as a result of being overpowered by the heavier and colder earthy element in the surrounding parts and thus squeezed. Rather, it contracts as a result of its natural motion whereby the relevant surrounding parts, namely the tendons, are pulled. The point of adding καὶ βιαστική at 703^a22 is to indicate that the *pneuma*, when it contracts in an unforced way, nevertheless produces force, namely the force involved in pulling the tendons.³⁵ Similarly, I suppose, the *pneuma* does not expand as a result of being overpowered by the lighter and hotter fiery element in the surrounding parts and thus dispersed, but again as a result of its natural motion whereby the tendons are pushed with some force. The *pneuma* must be resilient to being overpowered by the surrounding parts not only to do its job properly—to push as well as to pull the tendons—but also to do so repeatedly. Other stuffs can effect pushing or pulling by being overpowered, e.g. when water is turned into steam, but then a given portion of stuff can either push or pull, and do so only once, not repeatedly.³⁶ The connate *pneuma* has to do both, and to do so repeatedly.

In addition, the connate *pneuma* has to be stable, which means that it should not be affected by the surrounding parts in such a way as to be transformed into some other sort of stuff. This does not imply, however, that *pneuma* must be entirely unaffected by the surrounding parts; indeed, as we shall presently see, it is affected by heatings and chillings in the heart. By saying that *pneuma* imparts motion ‘not by alteration’ (μὴ ἀλλοιώσει, 703^a25), Aristotle is not claiming that *pneuma* does not undergo alteration, as one reads in

³⁵ I follow the manuscript reading and the punctuation in Primavesi’s edition, with a comma after καὶ βιαστική. Bekker and Louis also accept the manuscript reading, but they put the comma before rather than after καὶ βιαστική, thus linking βιαστική more closely with ὄστική. Nussbaum accepts Farquharson’s emendations; cf. Nussbaum 1976, 156-7.

³⁶ To be sure, the art of mechanics operates with devices of translating a single push into a pull, or vice versa, as well as with devices of enhancing, delaying, or sequencing the effect of a single push or pull, which is how sophisticated automata achieve semblance of self-motion.

Nussbaum's translation and commentary, but only that it is not by means of alteration that it imparts motion.³⁷ As we shall see presently, it imparts motion by a sort of quantitative change, namely by expansion or contraction.

In Chapter 7 we are told that animals have some one thing 'which has the capacity to become both larger and smaller, and to change shapes as its parts expand and contract because of heat and chilling, i.e. as they undergo alteration' (701^b13-16).³⁸ Assuming that this one thing which has the capacity to become both larger and smaller is the *pneuma* in the heart, its 'changing shapes' suggests that it does not expand and contract inside the heart uniformly, that is evenly in all directions, but that in some regions it expands while in others it contracts, thus assuming different 'shapes'. This suggestion is attractive because it explains how the *pneuma* can achieve simultaneous pushing and pulling of the tendons in the heart so as to produce complex movements of the limbs.³⁹ At any rate, the quoted passage at 701^b13-16 makes it clear that the expansion and contraction of the *pneuma* are caused by heating and chilling that take place in the heart.

Now heating and chilling in the heart are caused by certain cognitive states: 'Alteration is caused by representations and perceptions and thoughts; for perceptions are at once alterations of a sort, whereas representation and thought have the power of the actual things' (701^b16-19). However, not all perceptions, representations and thoughts cause heating and chilling, but only those directed at objects of pursuit and avoidance, which has something to do with the fact that the animal finds objects of its pursuit and avoidance, at least typically, pleasant and painful:

Of necessity the thought and representation of these <viz. objects of pursuit or avoidance> are accompanied by heating and chilling. For the painful is avoided and the pleasant pursued, and <the thought and representation of> the painful and the pleasant are nearly always accompanied by chilling and heating. (701^b34-702^a2)

I will have more to say about the relation between perceptual alteration, as the most basic cognitive state, feelings of pleasure and pain, and thermic alterations that cause the expansion and contraction of the *pneuma*. What we can conclude from the discussion thus far is that the role of the connate *pneuma* is to convert qualitative into quantitative

³⁷ See Nussbaum 1978, 146, 161, 162. Other scholars also think that the connate *pneuma* does not undergo qualitative change at all, e.g. Peck 1942, 579, 589, Peck 1953, 118 and Freudenthal 1995, 167. This is corrected by Berryman 2002, 95.

³⁸ The translation follows Primavesi's text. I take it that the μόρια which expand and contract due to heat and chilling are parts or regions of the *pneuma* in the heart, and that καὶ ἀλλοιούμενων is epexegetic of 'heat and chilling'.

³⁹ Cf. Gregoric and Kuhar 2013.

change—thermic alterations into expansion and contraction—thereby producing mechanical impulse in both directions, i.e. acts of pulling and acts of pushing. The mechanical impulse operates on the tendons in the heart, so as to tighten and relax them. Though this is by no means a trivial feat, it seems to lie firmly within the boundaries of Aristotelian physics.⁴⁰

Now if the connate *pneuma* indeed reacts to thermic alterations in the heart, it is false to think that the physiological processes leading to the motion of the limbs start with the workings of the *pneuma*. The physiological processes start with those alterations involved in perception, representation and thought that are accompanied by heating and chilling. Consequently, Aristotle’s reason for introducing the connate *pneuma* as the moved mover in Chapter 10 cannot be the one suggested by the standard interpretation, namely to bridge the gap between the actualization of the desiring capacity of the soul and the physical processes in the body. I have argued that thermic alterations which accompany perceptual alterations causally precede the workings of the connate *pneuma* in the heart, so the reason for introducing the connate *pneuma* in Chapter 10 must be different. And the reason is, as I have just suggested, that the connate *pneuma* is the instrument of conversion of qualitative change into mechanical impulse, without which no self-motion would be possible. This is why the connate *pneuma* is aptly described at *DA* III.10, 433^b19-22 as the ‘instrument with which desire imparts motion’ (ὃ κινεῖ ὀργάνῳ ἢ ὀρεξιῖς) and the ‘instrumental mover’ (τὸ κινουῦν ὀργανικῶς).⁴¹

Granted that the connate *pneuma* reacts to thermic alterations in the heart, one is left wondering what these thermic alterations really are. In a recent paper, Klaus Corcilius and I develop an interpretation of Aristotle’s theory of animal motion where we argue that the thermic alterations are, in the most basic cases, bodily reactions to perceptions of certain objects.⁴² We take it that animal bodies are constituted in such a way that, upon perceiving objects which are conducive or detrimental to keeping their bodies in a natural state, they react so as to pursue the former and avoid the latter. The feelings of pleasure and pain, as well as the inclinations to pursue the pleasant and avoid the painful, are the way animal bodies are built to react when they encounter objects that are objectively good or bad for them, i.e. conducive or detrimental to the natural state of their bodies. So, depending on the

⁴⁰ So Berryman 2002 and Corcilius 2008, 332-43.

⁴¹ Though Aristotle does not explicitly mention the connate *pneuma* in *DA* III.10, it is widely assumed to be the referent of the quoted Greek expressions; cf. Hicks 1907, 563-4, Polansky 2007, 521-3, and p. XXX below.

⁴² See Corcilius and Gregoric 2013.

object and on the state of the animal's body, the perception of the object will be either pleasant or painful or neither. If the perception of the object is pleasant or painful, the perceptual alteration in the heart is accompanied respectively by heating or chilling in the heart. These thermic alterations underlie the feelings of pleasure and pain that accompany perception of certain objects, and at the same time they underlie the inclinations to pursue objects whose perception is pleasant and to avoid objects whose perception is painful. Thus the feelings of pleasure and pain and desires, at least at the most basic level of analysis, do not have intentional content distinct from what is available to the animal through the senses. Rather, they are bodily reactions to objects in their environment. Such reactions, we take it, invest perceptions with certain subjective qualities that they otherwise would not have, namely qualities of being pleasant or painful, attractive or repulsive. Once a perception of an object is pleasant or painful and there is an inclination to pursue or avoid the object, i.e. once perceptual alterations in the heart involve thermic alterations, the connate *pneuma* expands or contracts, thus creating a mechanical impulse that brings about the motion of the limbs. If a perception is neither pleasant nor painful and generates no inclination, i.e. if a perceptual alteration does not involve also a thermic alteration, the connate *pneuma* does not expand or contract, no mechanical impulse is created, and the animal stays put.

Our view that thermic alterations, which accompany perceptual alterations in the heart, underlie feelings of pleasure and pain as well as desires, is largely based on our reading of *DA* III.7, 431^a8-17 and are likely to be controversial. I cannot defend this view here, but I should point out that it yields three distinct advantages directly relevant for an understanding of Chapter 10.

First, we do not have to assume that the connate *pneuma* stands in direct hylomorphic relationship with the desiderative capacity of the soul, as some scholars have proposed.⁴³ This is a problematic assumption on several accounts. For one, it would be very difficult to explain why Aristotle fails to mention this relationship in the *De Anima*.⁴⁴ All that we find in the *De Anima*, notably in III.10, 433^b19-27, is a short summary of the 'instrumental mover' in which one clearly recognizes some crucial points from the *De Motu*

⁴³ See, e.g., Peck 1942 and 1953, Nussbaum's Essay 3 in her 1978, Bos 2003, Buddensiek 2009.

⁴⁴ Bos 2003 argues that this relationship *is* mentioned in the *De Anima*, namely in all those places in which all other scholars find Aristotle to be talking about the relationship between the soul and the whole body of a living being.

Animalium, especially from our Chapter 10.⁴⁵ Moreover, if the connate *pneuma* is the material correlate of the desiderative capacity of the soul, how come that desiring is regularly associated with heating and chilling, and never with expanding and contracting, the operative functions of the connate *pneuma* that are connected with its very nature (703^a21-3)?

Second, if the desiderative capacity of the soul has its own distinct material realization, it is difficult to understand why Aristotle proceeds in his discussion of that capacity of the soul in *DA* III.9-10 the way he does, instead of making it one of the fundamental capacities of the soul, on a par with the nutritive, the perceptual and the thinking parts of the soul? And it is no less difficult to understand the explicit identification of the ὀρεκτικόν with the αἰσθητικόν in *DA* III.7, 431^a13-14.⁴⁶

Third, instead of a plurality of intentional states—perception, representation of objects ‘as’ desirable, feeling of pleasure and pain, desire—we get only one intentional state, that of perception. True, this one intentional state may come with subjective qualities describable in terms of pleasantness or painfulness, attractiveness or repulsiveness, but these can be explained with reference to the bodily processes that accompany perceptual alterations. What cannot be explained with reference to bodily processes is why some alterations are such that they have intentional content at all, allowing the animal to discriminate objects in its environment. The only way to explain perception is with reference to the soul. Very briefly, a suitably generated alteration in the heart becomes a *perceptual* alteration because it occurs in a body informed with a soul that has a perceptual part or capacity.

It is clear that without certain alterations in the heart becoming perceptual alterations, there would be no way of discerning things that are good and things that are bad for the animal, that is (in the most basic cases) no feelings of pleasure and pain, no desire to go for or avoid things, and thus no object of pursuit or avoidance as the external unmoved origin of animal motion. In other words, without perception the whole intentional

⁴⁵ For points of contact with the *MA*, see Jaeger 1913, 41-2. The points of contact specifically with Chapter 10 are the following: (i) the tripartite analysis of animal motion; (ii) the instrumental body is found where the unmoved origin and the first moved bit meet; (iii) the example with a joint; (iv) pushing and pulling. The ball-and-socket joint (or the pivot-and-barrel joint, ὁ γγγλυμός) in *DA* III.10 takes place of the more general καμπή in the *MA*.

⁴⁶ One might entertain the idea that the connate *pneuma* is the material realization not only of the desiderative but also of the perceptual capacity of the soul, which would then be the basis for their identification. Although the *pneuma* does play a role in the reception and possibly transmission of some perceptible forms, this is insufficient evidence for the thesis that the connate *pneuma* is the material realization of the perceptual capacity of the soul.

dimension involved in animal motion would be at once thrown out (certainly for non-rational animals). At the same time, without perception the mechanics of animal motion would have no origin, since without perceptual alteration there would be no heating and chilling in the heart, no expansion and contraction of the *pneuma*, no pushing and pulling of the tendons, and consequently no motion of the limbs. All of this rests on perceptual alterations in the central organ, and these, according to my understanding of Aristotle's theory, admit of no explanation beyond the fact that the animal has a soul of a certain sort.

We are now in a position to take a closer look at the analogy with a joint:

It seems that the connate *pneuma* is related to the psychic origin in a similar way as the point in a joint which imparts motion while itself being moved is related to the point which is unmoved. And since the origin is for some animals in the heart and for others in an analogous part, it is clear that the connate *pneuma* is also there. (703^a11-16)

Though one might be tempted to interpret this analogy as evidence for the view that the connate *pneuma* stands in the hylomorphic relationship to the soul, I think the analogy tells us something else. It rests on the contrast between the unmoved mover (the fixed part in a joint : the soul) and the moved mover (the moving part in a joint : the connate *pneuma*). As in a joint, where motion of the moving part rests on the stability of the unmoved part, workings of the *pneuma* rest on the cognitive activities of the soul, namely those cognitive activities directed at something good or bad (be it real or apparent good or bad), i.e. those cognitive activities that are accompanied by feelings of pleasure or pain and inclinations to pursue or avoid the things thus cognized. Perception or representation of some such thing is the inner limit of the mechanism of animal motion, what this mechanism 'rests on'. In other words, the analogy suggests that the soul, as the source of cognitive activities—that which makes some alterations in the heart such that they have intentional content—is the absolute origin of animal motion, the first internal supporting point necessary for the whole mechanics of animal motion. The connate *pneuma*, by contrast, is the first internal moved mover—that which reacts to qualitative changes by changing quantitatively (expanding or contracting) and thus creating mechanical impulse—the main instrument of animal motion.

Let us now take a fresh look at the problem with which I started this section. The problem was this: having established in Chapter 9 that the soul is an absolute origin of animal motion and an unmoved mover, Aristotle tells us at the opening of Chapter 10 that desire, which is supposed to be a capacity of the soul, is a moved mover. The standard response is that this problem is only apparent, for it takes desire to be moved only in the

extended sense that a capacity of the soul is brought into actuality. This immediately calls for an explanation of how the actuality of the psychical capacity brings about bodily motion, which motivates the discussion of the connate *pneuma*, the stuff supposedly related to desire as matter to form.

I agree that the initial problem is only apparent, but I have paved the way for a different response. I have argued that the middle term of the analysis of the causes of animal motion from the opening sentence of Chapter 10—‘desire, which imparts motion being moved’ (ἡ ὄρεξις τὸ μέσον, ὃ κινεῖ κινούμενον)—refers to the episodes of having inclinations to go for a perceived object or to avoid it, and these are essentially the thermic alterations that accompany perceptual alterations in the heart. These thermic alterations are ‘moved’ quite literally, for they clearly are motions or changes caused by perceptual alterations. And also they ‘impart motion’ quite literally, for they affect the connate *pneuma* which expands or contracts in reaction. The reason why the connate *pneuma* receives special attention in Chapter 10 is because it explains how qualitative changes, thermic alterations, can be converted into mechanical impulses which then bring about movements of the limbs. That is what the connate *pneuma*’s instrumentality amounts to, nothing more and nothing less.

Having identified desire, in the sense of the moved mover from the beginning of Chapter 10, with thermic alterations in the heart, rather than with the desiderative capacity of the soul, the conclusion from the end of Chapter 9 is no longer problematic: the soul is indeed the absolute origin of animal motion as an unmoved mover. Observe that nothing I have said challenges the view that it is crucial for the desiderative capacity of the soul to be actualized for the animal to move itself. Indeed, unless the animal experiences pleasure or pain when perceiving or representing an object, and feels attracted or repulsed by it, the animal will not move itself voluntarily. What I challenge is the idea that we should explain the soul’s status of an *unmoved* mover with reference to the fact that the actualization of the soul’s desiderative capacity is not motion *stricto sensu*. Rather, it should be explained with reference to the fact that the soul enters the account of animal motion as an internal supporting point for the entire mechanism, namely as that which makes some alterations *perceptual* alterations. It is the perceptual alterations that get accompanied, depending on the objects perceived and the state of the animal’s body, by thermic alterations to which the connate *pneuma* reacts by expanding and contracting. So it is the perceptual alterations that are the starting points of the causal chains that lead to movements of the limbs. And what

explains perceptual alterations is the soul, or more precisely the actualization of its perceptual part or capacity.

Before I conclude this section, I should mention for the sake of completeness that heatings and chillings in the heart do not cause only the connate *pneuma* to expand and contract, but seem to have yet another effect relevant for Aristotle's explanation of animal motion. We have seen that flexion and extension require that one portion of the joint be fixed for the other portion to be moved against it ('the joint must be actually two and only potentially one'). By contrast, movements that involve no flexing or extending, e.g. when we move the whole straightened arm, require that there be no such differentiation of the joint ('the joint must be actually one and only potentially two'). So the body must be equipped with parts whose job is to prepare the joints for different kinds of movements. Aristotle seems to refer to such parts in Chapter 8, at 702^a7-10: 'It is reasonable that the inner parts and those around the origins of the instrumental parts are constructed so as to change from solid to supple and from supple to solid, from soft to hard and *vice versa*.' The 'parts around the origins' that change from solid and hard to supple and soft are most probably chunks of flesh around the joints, or what we would identify as muscles.⁴⁷ And it is plausible that the chunks of flesh change their state because of heatings and chillings produced in the heart and conveyed by blood.

The animal body, then, is set up in such a way that a perception, representation or thought of something good or bad for the animal is accompanied by heating or chilling in the heart, which makes the connate *pneuma* expand or contract, thus pushing or pulling the tendons in the heart. From there, the mechanical impulse somehow spreads over the system of bones and tendons.⁴⁸ The parallel effect of chilling and heating in the heart is that the flesh around the joints becomes hard or soft, thus setting up and dissolving fixed portions of the joints so as to enable the limbs to be moved in various ways. The reason why tiny thermic alterations, taking place in imperceptibly small regions of the heart, have such great and versatile effects is the same as why a tiny shift of the rudder changes the direction of

⁴⁷ So, if muscles play any role in animal motion, according to Aristotle, it is to prepare the joints for different kinds of movements, that is to create and dissolve fixed portions of the joints by hardening and softening, depending on whether or not flexing and extending movements are to take place; see n. 32 above and Gregoric and Kuhar 2013 for more details.

⁴⁸ A serious problem with Aristotle's picture is that it is difficult to see how the tendons in the heart are connected with the rest of the locomotory system. On the problem of discontinuity of that system, see Frampton 1996, 321-5 and Gregoric and Kuhar 2013.

the whole ship: we have leverage at work.⁴⁹ This is confirmed by an otherwise mysterious remark in *Physics* VIII.6 that the soul moves the body by leverage (τῆ μοχλείᾳ, 259^b18-20).

To put it succinctly, the animal body is structured in such a way that it exploits the lever principle, presumably at different places and in sophisticated ways, so that small thermic alterations, converted by the connate *pneuma* into mechanical impulses in the centre of the body, immediately produce large and versatile local motions at the periphery. What this complex mechanism of the animal body ultimately rests on, as we have seen, is the soul.

5. The city analogy (Chapter 10, Part Two: 703^a28-^b2)

Having discussed the connate *pneuma*, the part in virtue of whose motion the soul moves the body (ὃ μὲν οὖν κινεῖ κινουμένῳ μορίῳ ἢ ψυχῇ, 703^a28-9), Aristotle rounds up his discussion of voluntary motion with an interesting analogy. I quote the whole passage:

We should take the animal to be constituted like a city well-governed by laws. For once order is set up in the city, it does not at all require a separate monarch, who has to oversee each particular affair, but every individual does his work as things are ordered, and one thing happens after another due to habit. In animals the same happens due to nature, that is because each of the parts thus organized is naturally disposed to perform its function, so that there is no need for a soul in each part. Rather, the soul being in some origin of the body, other parts live by being naturally attached <to the origin of the body>, and do their task because of their nature. (703^a29-^b2)

This analogy has been taken to present a view of the relationship between soul and body which is incompatible with the view found in the *De Anima*. The idea that there is a part of the body, namely the heart, which stands in a privileged relation to the soul, whereas the other parts perform their functions on account of being ‘outgrowths’ from the heart, seems to conflict with the idea that the soul is the form of the whole body equipped with organs. Some scholars adduced this conflict as evidence of the treatise’s inauthenticity, others as evidence of two distinct stages of Aristotle’s development.⁵⁰ I do not think that those two ideas are incompatible, though they certainly call for an explanation.

Let us first examine the analogy. What does Aristotle mean by a ‘city well-governed by laws’ (πόλις εὐνομουμένη)? We know that Aristotle makes a distinction between the

⁴⁹ Compare *MA* 7, 701^b24-8 with *Mech.* 850^b28-851^a37; cf. De Groot 2008, esp. 53-4.

⁵⁰ The former group of scholars include Kampe 1870, 16 n. 5, Poppelreuter 1892, 10 n. 2 and Rolfes 1924, 4. The latter group includes Nuyens 1945, 55, 247; Mansion 1948, ix-x; Ross 1957, 65-7; Louis 1973, xvii-xviii. For an overview of the reception of Nuyens’s work by the late 60’s, see Fortenbaugh 1967, 318-20 and Tracy 1985. For a discussion of the authenticity of the *MA*, see Nussbaum 1978, 3-12.

lawfulness (εὐνομία) of a city in which the established laws are obeyed, regardless of whether these laws are good or bad, and the lawfulness of a city in which it is the *good* laws that are established and obeyed. Moreover, ‘laws’ refer not only to the rules set out in writing, but also to those set out in customs, where the latter are said to be ‘more important and about more important things’ (*Pol.* III.16, 1287^b5-8). Finally, Aristotle’s idea of respect for law goes far beyond mere adherence to law, e.g. for fear of punishment: ‘There is no benefit in the most beneficial laws, even though ratified by all who are active politically, unless people are habituated (εἰθισμένοι) and educated in the constitution.’⁵¹ In other words, Aristotle thinks that citizens should be brought up and habituated in the spirit of the laws of their community, so that obedience to the laws comes naturally to them.⁵² Presumably, in our analogy the ‘city well-governed by laws’ is one with a good system of written rules and unwritten customs obedience to which is based on the character and habits of the citizens.

Generally speaking, the laws specify what citizens, depending on their status, office and circumstance, have to do in various situations. This is nicely described by the author of the *De Mundo*: ‘The law of a city, though itself immobile in the souls of those who observe it, disposes all the activities of the state; for following the law the magistrates go to their offices, the judges to their appropriate courts, the councillors and members of the assembly to their appointed meeting-places, etc.’⁵³ Once the laws are instituted and, more importantly, the citizens are accustomed to them, order (τάξις) is set up in the city. Activities of the citizens, at any rate political activities relevant for the life of the city, now follow one after another in an orderly way. Indeed, if the laws are good, this is necessarily a good order.⁵⁴ A city well-governed by laws, then, is well-ordered, which means that each citizen does what is required of him by the laws (ὡς τέτακται), and the activities of all citizens are harmonized so as to contribute to the prosperity of the city. In such a city, Aristotle claims, there is no need for a separate monarch to oversee each particular activity, since each citizen does out of habit what he is supposed to do.

⁵¹ *Pol.* V.9, 1310^a14-17; tr. D. Keyt.

⁵² Compare this with the three senses of εὐνομία distinguished in Diogenes Laertius (III.103) and associated with the so-called *Divisiones Aristoteleae* 32.15-33.6 (Mutschmann).

⁵³ *De Mundo* 6, 400^b13-20. Farquharson refers to this passage as an elaboration of our analogy from *MA* 10, but that cannot be right. Although the law is said to be immobile (ἀκίνητον), which would indeed be a relevant point of comparison with the soul, the law is also said to be present in the soul of each citizen who performs his duty, whereas the point of our analogy is to show that the soul is *not* present in each bodily part that performs its function. For the character and role of the law analogy in Ch. 6 of the *De Mundo*, see Betegh and Gregoric 2014.

⁵⁴ Cf. *Pol.* VII.4, 1326^a29-31.

Where citizens are not habituated to perform their tasks in accordance with law, a person of authority may be needed to oversee the execution of particular tasks, from the most simple to the most complex ones. Such a person would be extremely busy, his personal involvement with many of the tasks would undermine his dignity, and it is questionable if he could secure the proper functioning of the city for very long. And even if he could, he would achieve that only extrinsically, as a factor of coercion. Indeed, it is doubtful whether such a person would be an intrinsic part of the whole, which is what I take to be indicated by calling him a ‘separate monarch’ (κεχωρισμενος μόναρχος).⁵⁵

The denial of the need for a separate monarch in a city well-governed by law does not logically imply that that some other kind of monarch is needed, or indeed that any monarch is needed in a city well-governed by law. However, given what we know about Aristotle’s political views, he would probably think that it is apposite, or even necessary, for a city well-governed by law to have a monarch. Of course, this would not be because the monarch should run around the city making sure that everyone does their task and obeys the law, but because the monarch is the fountainhead of the good constitution of the city. The idea is nicely captured in the words of King Louis XV of France: ‘In my person only does the sovereign power rest, of which the distinctive character is the spirit of counsel, justice and reason. From me alone do my courts derive their existence and their authority... By my authority alone do the officers of my courts proceed, not to the formation of law, but to its registration, publication and execution... Public order in its entirety emanates from me, etc.’⁵⁶ Such a monarch does not mingle with the citizens and meddle with their activities. He lives quietly in his citadel, rarely seen by anyone save his closest and most trusted subordinates. They report to him on the gravest issues and receive his commands related to these and other issues crucial for the wellbeing of the city. This is what a true monarch is like.⁵⁷ In fact, such a monarch can very well be considered the *telos* of his city, since the good constitution essentially depends on him. He is much like the military general

⁵⁵ Tracy 1985, 336-7 has a curious interpretation of the analogy. He supposes that the point of the analogy is to deny ‘several separate monarchs’ in a well-ordered city. However, this is not a real possibility anyway, on etymological grounds to begin with. Moreover, in the denial of a plurality of separate monarchs Tracy sees Aristotle’s commitment to a single monarch in a well-ordered city and a tacit criticism of ‘other thinkers (Plato?) who postulate more than one control center in the animal’. Aristotle may well be committed to a single monarch, but the point of the analogy is clearly to deny that it is a *separate* monarch.

⁵⁶ The royal speech of 3 March 1766, known in the French annals as the *séance de la flagellation*, quoted after Palmer 1959, 96.

⁵⁷ The central analogy of *De Mundo* 6, in which God’s dignity and *modus operandi* is compared with that of the Great King of Persia (398^a6-^b12), is instructive on this point; cf. Betegh and Gregoric 2014.

who is said in *Metaphysics* Λ.10 to be ‘the good’ of his army even more than the order of the army ranks, since the order depends on him, not vice versa.⁵⁸

Now to the other side of the analogy. We should think of the animal as being constituted like a city well-governed by law, which implies that the animal is similarly well-ordered, as the activities of various parts of the body follow one after another in an orderly and harmonized fashion, contributing to the survival and well-being of the whole. And just as a well-ordered city does not need a separate monarch to oversee each particular activity, the animal does not need a soul in each and every part of the body. Why not? Presumably, because each part of the animal, given certain preconditions, performs its function on account of being composed and organized in a certain way, i.e. because of its nature (διὰ τὴν φύσιν), just as each citizen does his job because of his habit (διὰ τὸ ἔθος).

The operative parallel in the analogy is that between the order based on the habits of the citizens in a well-governed city by law and the order based on the nature and organization of the parts of animal body. This parallel is sufficient to make the negative point that, just as the city does not need a separate monarch to oversee each particular affair, the animal does not need a soul in every part of the body to make it perform its function. Instead, and these are the positive points, it suffices for the animal (i) to have the soul in some origin of the body and (ii) to have the other parts naturally attached to it (προσπεφυκέναι).

To take the second positive point first, Aristotle thinks that the other bodily parts have to be organically connected with the origin. Of course, not every part is in direct contact with the heart or its analogue. However, every part is differentiated and developed by the agency of the heart in the embryo, and after birth every part of the animal receives nourishment and grows by means of the blood supplied by the heart, which is what seems to be meant by saying that the other parts ‘live’ (ζῆν) by being naturally attached to the origin. The other parts are, quite literally, ‘outgrowths’ or ‘offshoots’ of the heart, much like embryo is said to derive its growth from the body ‘by being naturally attached’ to it (τῷ προσπεφυκέναι, *Met.* Δ.4, 1014^b20-2). By being naturally attached, then, the other parts are sustained throughout the individual’s life, and once they are sufficiently grown, they can perform their functions. And they do not perform their functions because there is a soul in them, but because they are composed and organized in a certain way, admittedly so that ‘at once one acts and the other is acted upon’ (*MA* 8, 702^a15). Note that the earlier example

⁵⁸ 1075^a14-15. I thank Stephen Menn for bringing *Metaphysics* Λ.10 to my attention in this context.

with the stick and the hand, from the end of Chapter 8, works on the supposition that the soul-principle of animal motion is *not* in the hand. For, as far as the place of the soul-principle is concerned, ‘it makes no difference whether the part is naturally attached to the body or not’ (702^b4-5). The soul-principle cannot be in any of the ‘naturally attached’ parts, but only in that part to which all the others are naturally attached, that is the heart or its analogue in bloodless animals. In any case, the nature of the parts of animal body, compared with the habit of the citizens in a city well-governed by laws, seems to encapsulate much of what has been said in the second half of Chapter 7 and the first half of Chapter 8. Very briefly, the parts of the body of an animal are of such a nature and arrangement that a tiny change at the origin causes a series of quick, effortless and automatic reactions that bring about movements of the limbs—much like citizens in a city well-governed by laws have their character and habits developed in such a way that they do their tasks promptly and readily, thus bringing about the proper functioning of the city’s institutions.

The first and the crucial positive point of the analogy—namely, that it suffices for the animal to have the soul in some origin of the body—neatly reinforces the conclusion of Chapter 9 that the soul is in the middle part of the body (the heart or its analogue, as specified in Chapter 10, 703^a14-15), and provides an effective closing to Chapters 6-10 which deal with voluntary motion. However, this is precisely the point at which Nuyens and Ross detect a notion of the soul as ‘a distinct entity which inhabits the body and has its seat in a particular organ’, which they take to be incompatible with the notion of the soul ‘as the form or first entelechy of the body, or, as we might say, the organizing principle of the body’.⁵⁹ Nuyens and Ross seem to think that if X is in some magnitude Y, then X must be ‘a separate entity’ from Y, a ‘deuxième chose’. But Aristotle explicitly says at 703^a2-3 that the soul, though in a magnitude, is not a magnitude. The soul is unextended and therefore it cannot be in any magnitude, whole or part, as one body is in another. On that score, at least, there is no conflict between Aristotle’s cardiocentrism and hylomorphism.

Nevertheless, hylomorphism does say that the soul is ‘in’ the whole body, whereas cardiocentrism says that the soul is ‘in’ no part of the body other than the heart, and that looks like a contradiction. Several authors have convincingly demonstrated, adducing a number of passages, that Aristotle himself saw no contradiction there.⁶⁰ And he saw no

⁵⁹ Ross 1957, 65.

⁶⁰ One example is *Metaphysics* Z.10, 1035^b14-31, adduced by Block 1961, 57; see also Hardie 1964.

contradiction, I suggest, because hylomorphism and cardiocentrism refer to the soul in two different roles.⁶¹

In the *De Motu Animalium* the soul plays the role of the efficient cause of animal motion. I have argued that it is the soul's activity, notably the activity of the perceptual part of the soul, that makes certain alterations in the heart *perceptual* alterations; when some of these perceptual alterations are accompanied by thermic alterations, the connate *pneuma* in the heart produces mechanical impulses which bring about movements of the limbs whereby the animal moves towards or away from the object. It is only to be expected that Aristotle's account of the soul in this role is cardiocentric. None of that, however, contradicts the account of the soul in its role as the animal's formal and final cause, as we find it in the *De Anima*. Such an account will not be concerned with episodes of psychic activities, some of which are necessary for an account of animal motion; rather, it will be concerned with the capacities of the soul—what they are, how they are organized, what their objects are, what their material conditions are, etc.—which is necessary for a systematic account of the bodies of living beings, i.e. for understanding the constitution and organization of their bodily parts. It is only natural that an account of the soul in this role is hylomorphic.

Let me conclude with an illustration of why I think that Aristotle can happily entertain both cardiocentrism and hylomorphism. It is much like saying that monarchy is in a whole nation, and saying also that monarchy is in the individual who lives in the citadel. Admittedly, one can make various general statements about nations which are monarchies, e.g. in contrast with nations that have republican constitutions, without saying much about the individuals who live in citadels or about their actions. However, if we want to know how monarchies function in their daily affairs, this will require, before all else, an account of the individuals who live in the citadels, of the way they make decisions and see that they are executed. Similarly, when we try to understand living beings by analyzing them into form and matter, we can make various general statements about the soul and its capacities, without saying much about the episodes of their exercise. But if we want to know how the soul moves the animal, we have to deal with the episodes of the soul's activities due to which some alterations become invested with intentional content, and

⁶¹ Cf. Corcilius and Gregoric 2013, 88-9. Some parts of this section go back to my presentation at the Berlin conference on cardiocentrism, held in May 2011. I have benefitted from the reactions of the audience, especially from Gabor Betegh's and Stephen Menn's input.

crucially also with the instrument which converts qualitative changes into mechanical impulse and thus brings about movements of the limbs.⁶²

REFERENCES

- Bekker, I. (ed.) (1831), *Aristotelis Opera*, Vol. 1, Berlin.
- Berryman, S. (2002), 'Aristotle on *Pneuma* and Animal Self-Motion', *Oxford Studies in Ancient Philosophy* 23, 85-97.
- Betegh, G. and P. Gregoric (2014), 'Multiple Analogy in Ps.Aristotle, *De mundo* Ch. 6', *Classical Quarterly*.
- Block, I. (1961), 'The Order of Aristotle's Psychological Writings', *American Journal of Philology* 82, 50-77.
- Bos, A. P. (2003), *The Soul and Its Instrumental Body: A Reinterpretation of Aristotle's Philosophy of Living Nature*, Leiden-Boston.
- Buddensiek, F. (2009), 'Aristoteles' Zirbeldrüse? Zum Verhältnis von Seele und *pneuma* in Aristoteles' Theorie der Ortsbewegung der Lebewesen', in D. Frede and B. Reis (eds.), *Body and Soul in Ancient Philosophy*, Berlin-New York, 309-29.
- Corcilius, K. (2008), *Streben und Bewegen: Aristoteles' Theorie der animalischen Ortsbewegung*, Berlin-New York.
- Corcilius, K. (2011), 'Aristotle's Definition of Non-Rational Pleasure & Pain and Desire', in J. Miller (ed.), *Aristotle's Nicomachean Ethics: A Critical Guide*, Cambridge, 117-43.
- Corcilius, K. and P. Gregoric (2013), 'Aristotle's Model of Animal Motion', *Phronesis* 58, 52-97.
- De Groot, J. (2008), 'Dunamis and the Science of Mechanics: Aristotle on Animal Motion', *Journal of the History of Philosophy* 46, 43-67.
- Farquharson, A. S. L. (ed.) (1912), *De Motu* and *De Incessu Animalium*, in *The Works of Aristotle Translated into English*, Vol. 5, Oxford.

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- Forster, E. S. (ed.) (1937), *Aristotle: Parts of Animals, Movement of Animals, Progression of Animals*, Cambridge, Mass. and London, 435-556.
- Fortenbaugh, W. W. (1967), 'Recent Scholarship on the Psychology of Aristotle', *Classical World* 60, 316-27.
- Frampton, M. (1991), 'Aristotle's Cardiocentric Model of Animal Locomotion', *Journal of the History of Biology*, 24: 291-330.
- Freudenthal, G. (1995), *Aristotle's Theory of Material Substance*, Oxford.
- Furley, D. (1978), 'Self-Movers', in G. E. R. Lloyd and G. E. L. Owen (eds.), *Aristotle on the Mind and on the Senses*, Cambridge, 165-79; reprinted in M. L. Gill and J. G. Lennox (eds.), *Self-Motion: From Aristotle to Newton*, Princeton, 1994, 3-14.
- Gregoric, P. (2007), *Aristotle on the Common Sense*, Oxford.
- Gregoric, P. and M. Kuhar (2013), 'Aristotle's Physiology of Animal Motion: On *Neura* and Muscles', *Apeiron*.
- Hardie, W. F. R. (1964), 'Aristotle's Treatment of the Relation Between the Soul and the Body', *The Philosophical Quarterly* 14, 53-72.
- Hicks, R. D. (ed.) (1907), *Aristotle: De Anima*, Cambridge.
- Jaeger, W. (1913), 'Das Pneuma im Lykeion', *Hermes* 48, 29-74.
- Jaeger, W. (ed.) (1913), *Aristotelis De animalium motione et De animalium incessu, Ps-Aristotelis De spiritu libellus*, Leipzig.
- Kahn, C. H. (1979), *The Art and Thought of Heraclitus*, Cambridge.
- Kampe, F. F. (1870), *Die Erkenntnislehre des Aristoteles*, Leipzig.
- Lorenz, H. (2007), 'The Assimilation of Sense to Sense-Object in Aristotle', *Oxford Studies in Ancient Philosophy* 33, 179-220.
- Louis, P. (ed.) (1973), *Aristote: Marche des animaux, Muvement des animaux*, Paris.
- Mansion, A. (1948), 'Préface' in F. Nuyens, *L'Évolution de la Psychologie d'Aristote*, 2nd edition, Louvain.
- Nussbaum, M. C. (1976), 'The Text of Aristotle's *De Motu Animalium*', *Harvard Studies in Classical Philology* 80, 111-59.
- Nussbaum, M. C. (1978), *Aristotle's De Motu Animalium*, Princeton; reprinted with corrections 1985.
- Nuyens, F. (1945), *L'Évolution de la Psychologie d'Aristote*, Louvain.

- Palmer, R. R. (1959), *The Age of the Democratic Revolution*, Princeton.
- Peck, A. L. (1942), 'Appendix B' in *Aristotle: Generation of Animals*, Cambridge Mass., 576-93.
- Peck, A. L. (1953), 'The Connate *Pneuma*: An Essential Factor in Aristotle's Solutions to the Problems of Reproduction and Sensation', in E. A. Underwood (ed.), *Science, Medicine, and History*, vol. 1, London, 111-21.
- Polansky, R. (2007), *Aristotle's De anima*, Cambridge.
- Poppelreuter, H. (1892), *Zur Psychologie des Aristoteles, Theophrast, Strato*, Leipzig.
- Rolfes, E. (1924), *Aristoteles: Kleine naturwissenschaftliche Schriften*, Leipzig.
- Ross, W. D. (1957), 'The Development of Aristotle's Thought', *Proceedings of the British Academy* 43, 63-78; reprinted in J. Barnes, M. Schofield and R. Sorabji (eds.), *Articles on Aristotle. Vol. 1: Science*, London, 1975, 1-13.
- Solmsen, F. (1957), 'The Vital Heat, The Inborn Pneuma and the Aether', *Journal of Hellenic Studies* 57, 119-23.
- Tracy, T. (1985), 'Heart and Soul in Aristotle', in J. Anton and A. Preus (eds.), *Essays in Ancient Greek Philosophy*, vol. 2, Albany, 321-39.
- Verbeke, G. (1978), 'Doctrine du pneuma et entéléchisme chez Aristote' in G.E.R. Lloyd and G. E. L. Owen, *Aristotle on Mind and the Senses*, Cambridge, 191-214.