ARISTOTELIAN DYNAMICS IN THE 2ND CENTURY SCHOOL DEBATES: GALEN AND ALEXANDER OF APHRODISIAS ON ORGANIC POWERS AND MOVEMENTS

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This paper has to do with the explanation of the nature of organic movements by Galen and Alexander. I shall avoid the controversial subject of direct contacts between the two men,[1] and focus instead on the analysis of some doctrinal parallels in their respective use of Aristotelian background. A particular question to be examined in each case is how the material constitution of living beings and operation of lower living functions is explained.

This question has been recognised as important at all periods of history of ancient philosophy and medicine.[2] It has special significance in a complex story of relations between Peripatetic school doctrine and theoretical medicine in the post-classical period. It has been observed that Hellenistic medicine derives its inspiration for anatomical studies from Aristotelian biology,[3] where such studies received methodological grounding in terms of a functionalist approach. The question of the structure and properties of 'living matter' constitutive of the organs endowed with functions remained a theoretical problem for this system: Aristotle did discuss it in several of his works and sketched out a solution based on his theory of elements, but this solution raised a whole number of new questions, both of physical and metaphysical order. The answers provided to these questions in Hellenistic medical philosophy involved a complete or partial rejection of the teleological import of the theory of elements.

Galen, in several works, undertakes a new defence of the qualitative theory of elements, developing his concept of natural power in polemic against the 'mechanistic' legacy of Hellenistic medical philosophy. In the course of his polemic he makes frequent appeals to Aristotle. His technique of debate and use of authorities have been much discussed as a part of his overall historiographical strategy.[4] In what follows, I re-examine the link between his historiographical method and his doctrine of natural powers, focussing on the

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[1] For the state of the question, sources and bibliography, see Pines 1961; Marmura and Rescher 1965; Moraux 1973-2001, vol. 2, 362 and n. 6; Todd 1995; most recently Fazzo 2002, 109-44.

[2] Cf. Solmsen 1968, 502; Kullmann 1982.

[3] Cf. Vegetti 1998, 78-81.

[4] Lloyd 1993; von Staden 1997 and 2000; Vegetti 1999.

interpretation he gives to the Aristotelian physics in his effort to reconcile the new, anatomy-based model of the organism, with the humouralism of traditional medicine.

Galen's treatment of the elements has a number of parallels in the work of Alexander of Aphrodisias, where the question of elemental constitution of a living organism occupies an important place. In his treatise *De anima* Alexander reformulates Aristotle's hylomorphic theory so as to include the four elements as examples of substances, and defines soul as a form or power supervenient on a certain type of elemental mixture. This, particularly the latter formulation, is often taken to be a reductionist step, and even the most generous scholarly discussions of Alexander's Aristotelianism inevitably put a question-mark against such places.[5] The problem has been addressed in several recent studies, where the argument has been made to the effect that Alexander's views are not necessarily reductionist insofar as he recognises the priority of final and formal causation over the material one.[6] These arguments, in my view, still have to answer the objections of those who claim that this recognition is merely verbal, and as such, far from salvaging Alexander's position, only makes it inconsistent.[7] That Alexander is aware of this internal tension in his doctrine is suggested by the emphasis he puts on the causal role of form with respect to material constituents of a living body.[8] In order to understand the overall logic of Alexander's position, it is useful to consider the way the elements work in his explanation of organic powers, taking into account the fact that this explanation may reflect not only his exegesis of Aristotle's text, but also some later discussions and adaptations of Aristotle's theory of elements. Galen's discussion of elements in particular can supply an intellectual context to Alexander's approach, because it makes clear that in contemporary debates in medical philosophy Aristotle's theory of elements was used for the purposes of criticising 'mechanistic' tendencies.

The paper falls into three parts. I begin by looking at the relation of the concepts of organic and inorganic in the explanation of the mechanism of growth as found in the Aristotelian corpus, and identifying some problems left unresolved by Aristotle that were taken up by later thinkers. In the second part, I review Galen's discussion of the nature of organic powers in *On natural faculties*, reconstructing some theoretical motives behind his use of Aristotle's theory of elements and mixture as a part of his physiological doctrine. In the third part, I focus on Alexander's explanation of the mechanism of growth, and discuss the role of his version of the theory of elements in his exposition of the concepts of power and motion in Aristotle's system of natural philosophy.

I.

Aristotle discusses various aspects of physics and mechanics of organic movements in a number of works of his physical corpus. In his theory of change, growth and diminution are treated as a paradigm of quantitative change,[9] whereas material addition serves as only

[5] Moraux 1942; cf. Moraux 1973-2001, vol. 3, 356; Robinson 1991. On a more balanced side: Donini 1971; Accattino 1995, Sharples 1994.

[6] Sharples 1994; Caston 1997.

[7] Cf. Moraux 1942 and Robinson 1991.

[8] Eg. his criticism of 'harmony' theory of soul in *De anima* 24,18-26,30 Bruns; (cf. Caston 1997 and Caston 2001); argument against the notion that soul resides in body as an 'accident' in *Mantissa* 5 (cf. Ellis 1994).

[9] For classification of changes, see *Physics* III 1: 201a9-15; IV 4: 211a14-15; IV 14: 223b30-32; V 1: 225b5-9; V 2: 226a23-226b10; cf. V 6: 230a18-29; VI 10: 241a26-b8; VII 2: 243a35-9; *GC* I 4: 319b31-320a7. Cf. *Phys.* VIII 7: 260a29-33.

a derivative model of quantitative increase.[10] This difficult view is elaborated in biological works and gains its full significance in the light of hylomorphic theory of substance in the first philosophy.

In the treatise *On Generation and Corruption* [=*GC*] I 5, Aristotle deals with the problem of the nature of biological constraints upon the physical mechanism of increase.[11] Although he certainly alludes to the distinction between animate and inanimate cases, a number of features in his account of the mechanism of increase make it clear that this analysis is intended to cover the biological case as well as the non-biological one.[12] Aristotle formulates three types of basic facts (ὑπάρχοντα) to be accounted for by a sound theory of growth: (a) there is an influx of nourishment from outside; (b) there must be something persistent and unaffected by the flux of change; (c) a growing thing must grow equally in every perceptible part. These conditions spell out what Aristotle thinks must be the right concept of growth: not a mechanistic one, and yet completely analysable in terms of physical theory.[13]

In his solution to the problem of the subject of growth, Aristotle builds on the conceptual apparatus of his hylomorphic theory, introducing the distinction between form and matter: form is the persistent part in the process, and matter is flowing and unstable.[14] He distinguishes between uniform (homogeneous) and non-uniform (functionally articulated) parts of the body, and explains that non-uniform parts grow in their underlying uniform parts,[15] and in uniform parts, too, form and matter can be distinguished.[16] Growth, further, involves the alteration of nourishment by the growing thing, and a process of mixture.[17]

The details of the physical mechanism of increase proper are only outlined by Aristotle. The main physical agency at work is internal heat resident in the heart, where nourishment is concocted and from where it is distributed to organs and tissues.[18] The distribution is carried out by the proper movements of the heart.[19] Apart from concoction, heat is operating in the organic traction by which nourishment (blood) is carried through the

[10] *Phys.* I 7: 190b6: τὰ δὲ προσθέσει οἷον τὰ αὐξανόμενα.

[11] Cf. *GC* I 5: 320a10-25, a27-b34.

[12] In his important paper, Prof. Kullmann has argued that in *GC* Aristotle has not yet arrived at this distinction, whereas in *PA* it is explicitly drawn (Kullmann 1982, 217-8). I think this needs a qualification: in *GC*, Aristotle is certainly aware of the special status of the 'animate' case, which in fact serves as a benchmark in his assessment of the Pre-Socratic theories of material constitution and growth (cf. the opening section of I 5, critique of Empedocles in II 6, and especially his discussion of formation of homoiomers in II 7). The omission of a distinction between the physical mechanisms of increase at work in two cases might be deliberate, indicating his plan to develop a unified physical model of growth, with biological case as a paradigm, yet fully explanatory of non-biological analogues. As far as the physical mechanism is concerned, this position is not overridden by the accounts we find in *PA* and *Meteor.*, on which see below.

[13] *GC* I 5: 321b11-16.

[14] *GC* I 5: 321b22-28

[15] Cf. *PA* II 1: 646b13ff. The biological origin of distinction might be another indication of the nature of Aristotle's theoretical concerns in this work.

[16] *GC* I 5: 321b28-34.

[17] *GC* I 5: 321b35-322a10.

[18] For the definition of the functions of heat and coldness in terms of combination and separation, see *GC* II 2: 329b26-32; *Meteor.* IV 1: 378b15 -17; discussions in Furley 1989; Althoff 1992; cf. Solmsen 1960, 362 and n. 38.

[19] Aristotle says that they have a character of contraction and relaxation, and compares heart in this respect to a living creature inside the body that contains it. *PA* III 4: 666b14-18.

vascular system towards the organs.[20] The assimilation of processed food by tissues is compared with sedimentation or silting.[21]

This theory of growth does give an answer to the question of relation between mechanical aggregation and biological growth. Mechanical aggregation can account for the material bulk of a growing thing, but not for the enhancement of its functional aptitude. Preservation of structure and growth proper are the functions of the form of the growing thing. This answer is entirely satisfactory from the viewpoint of hylomorphic metaphysics. The less clear part of Aristotle's account has to do with the question of the qualitative difference between animate and inanimate material structure.

In Aristotle's system, the only way to describe a given physical compound as 'animate' is by referring to its function within a living body, this latter being described again by reference to a set of specific functions (nourishment, growth, reproduction being the most basic ones).[22] This is how the role of physical constituents of bodily organs is described in his biological works: the four elements and their mixtures possess a wide range of physical properties; the properties at work in each particular case are the ones that are functionally relevant.[23] *Generic* difference between animate and inanimate, taken as two different types of material structure, seems to be rather elusive, on this account.[24] Where this kind of difference comes into question, Aristotle's analysis invokes two co-ordinated sets of parameters: (a) functional: higher functions, such as sensation, more clearly correspond to 'animate' state than the lower ones;[25] (b) physical: animate operations are characterised by preserving the physical structure of higher functions, having the internal constraints imposed on them by the nature of the whole.[26]

In a way, then, it is only the whole living being that counts as 'animate'. It is not possible to specify a homoiomerous part as 'animate' without a reference to a functional whole. This approach, while being certainly philosophically sound, does generate some genuine difficulties in physiological theory, where the main interest is precisely to know which material structures are in charge of which organic functions. Aristotle is fully aware of this tension between the two theoretical levels, as he never tires of pointing out that higher functions (such as sensation and locomotion) have more articulate organic structures, whereas in the case of 'homoiomers' such as flesh and blood, their respective functions are more difficult to track down. In *PA* II 1, perhaps not accidentally, uniform parts include humours and residues as well as tissues.[27] As far as their formative

[20] *Meteor.* IV 12: 390b2-14, discussed in Furley 1989.

[21] Cf. *GC* I 5: 322a20-33, *PA* II 1: 647b1-10; the analogy of irrigation going back at least to Plato *Tim.* 77c6-9.

[22] Cf. *Meteor.* IV 12: 389b29 - 390b2, especially 390a10-20.

[23] This has been excellently shown in detail in Althoff's case study (Althoff 1992). For discussions of the problem of constitution of a living body out of the elements, see Kullmann 1982; also Lewis and Bolton 1996; Oderberg 1999.

[24] W. Kullmann regards the difference of composition pointed out by Aristotle as an equivalent of such distinction between animate and inanimate ('Aristoteles hat erkannt daß Biomasse etwas anderes ist als die anorganischen Stoffe, die uns umgeben, sich aber aus ihnen aufbaut' [Kullmann 1982, 217-18]), but this, I think, still goes back ultimately to a functional distinction, not providing us with a physical criterion (the problem of 'border'-cases such as organic residues still remains).

[25] This point is made by Furley 1994, 12-13, on the basis of the analysis of *Phys.* VIII 5.

[26] Cf. the way in which Aristotle accounts for the difference between combustion and burning and the natural processes of growth and nutrition in *De anima* II 4: 416a10-19: the key concepts here, as in *Meteor.* IV 12 cited above, are 'limit and proportion' displayed by organic processes as opposed to inorganic. Cf. Althoff 1992, 52-53, 68-69.

[27] Cf. Harris 1973, 137-39; on the nature of residues, cf. Hankinson 1998, 150.

mechanisms are concerned, these classes of homoiomers do not differ. The account given in *Meteor.* IV, where the formation of animate homoiomers is subsumed by the same physical principles as that of inanimate, is therefore consistent with the account of homoiomers found in the biological works.

One distinction that Aristotle draws in *PA* II 2 may be particularly instructive for understanding his perspective on 'animation' in animate tissues. In the course of his discussion of 'many ways' in which one thing is said to be 'warmer' than another, he says that blood is warm 'in nature' (ἐν τῇ φύσει), i.e. when it forms a part of a living body, and cold when it is separated (χωριζόμενον). The first way of being warm is accounted for by heat 'derivative from without' (ἀλλότρια), the second one by a thing's 'own' (οἰκεία) heat (648b36 – 49a1). The same analysis applies to all the other uniform parts (*PA* II 3), in respect of all the elemental qualities.[28] The ontological status of the quality of heat in blood is in a way similar to that of the heat inherent in boiling water: both are derivative and accidental. But the case of blood is different in that its 'derivative' property of heat cannot be 'detached' from it, not even conceptually, as far as the process of generation is concerned.[29]

'Organic' homoiomers thus seem to have a double ontological status. They are first generated and maintained within the animate compounds by physical mechanisms which endow them with physical properties defined by the nature of the whole. The process of generation and maintenance involves some sort of coming to terms with their 'own' physical properties, on behalf of the whole: these properties are either accommodated by the nascent structure or modified by it. We might say that uniform parts derive their complete teleological value from the function they possess in the organic system of which they are a part. Apart from this complete teleological value by virtue of which they count as animate when they are parts of a living body, they also possess what we might term an 'incomplete' teleological value, i.e. a set of teleologically significant characteristics they have in their 'free' state, when detached from their functional links with the organic whole. This 'incomplete' teleological value of homoiomers accounts for the role complete substance plays in the 'animation' of tissues.

Spontaneous generation, treated by both Aristotle and Theophrastus as a regular parallel to the biogenetic reproduction for some species, can be an illustration of the process where a rudimentary 'incomplete' teleological value present in some natural substances is 'completed' and brought to an 'animate' state by natural factors not bound by any particular living substance. The possibility in principle of such 'completion' is allowed for by Aristotelian physics and 'first philosophy'.

Theophrastus discusses spontaneous generation in his works on plants, where he demonstrates, along with his acceptance of the possibility of seedless reproduction, a sober critical approach to facts.[30] The same tendency can be seen in the extant fragments

[28] Cf. the use of this distinction in *Meteor.* IV, in explanation of decay, IV 1: 379a17-b9; and concoction, IV 2: 379b18.

[29] A question may be raised here whether we should not press the distinction between 'living' and 'non-living' in the case of homoiomers in the same strict way in which it is pressed by Aristotle for the case of anhomoiomers (cf. an eye which has lost the capacity to see in *DA* II 1 412b20-2). It seems to me that there is a way to maintain the distinction between the two kinds of bodily components even on the level of functional analysis, precisely because of the nature of the functions in each case: homoiomers, such as blood and flesh, when they cease to be a part of an organic whole may still maintain some of the functions which are accounted for by their organic provenance (flesh and blood may be used as food by some predators, and even bodily residues can form a part of the next organic cycle by virtue of their organic functions, as the eye or the hand cannot).

[30] Balme's argument designed to reduce the metaphysical import of this theory in Aristotle as opposed to Theophrastus (Balme 1962), ingenious as it is, still does not convince me. Theophrastus' work on plants is

of his lost treatise 'On animals that appear all at once',[31] where he critically discusses the reported facts of generation and dismisses as false some instances of 'spontaneous' generation.[32] The problem of a natural boundary between animate and inanimate, and the nature and physical mechanisms of 'animation' evidently attracts a good deal of interest among the later Peripatetics, and it seems to remain an Aristotelian legacy in the later philosophical tradition.[33]

II.

The problem of demarcation between animate and inanimate has a facet potentially of very great interest to medicine, where the understanding of 'border'-cases is closely linked with curative practices. Medical doxographical tradition has preserved evidence of discussions of the main causal factors at work in the organic processes of nutrition and growth.[34] Galen with his treatise *On natural faculties* [= *nat. fac.*] enters the tradition of long standing.

There are many philosophical problems on which Galen chooses to suspend his ultimate judgement, professing agnosticism in the issues outside the proper scope of medicine.[35] Therefore it may be particularly rewarding, in terms of understanding his philosophical position, to find a tenet with which he never parts during his literary career: this has to do

completed after Aristotle's death, so Balme's suggestion of an earlier date for Aristotle's *Metaphysics* on the basis of its being contemporary with the work of Theophrastus (Balme 1962, 104) begs a question. Theophrastus' methodological standards in respect of evidence are certainly no lower than those of Aristotle's *GA* and *HA*. (cf. *CP*.I 1.2 (= *HP* III.1.2-3), where he corrects Aristotle's view stated in *GA* I 18 (726a6-7) that the reproduction of the willow is seedless; his general criticism of 'false' spontaneous generations in *CP* I.5.1 (= *HP* III.1.6)). The 'crucial' parallel between Aristotle's *Metaph. Z*: 1032a31 and Theophrastus *CP* I.1.2 adduced by Balme can be due to uncritical resort to the tradition in each case. On Theophrastus' treatment of unclear and reported evidence in 'lower' strata of natural philosophy, see Vallance 1988.

[31] Περὶ τῶν ἀθρόον φαινομένων α' (D.L. 5.42), Περὶ τῶν ἀθρόως φαινομένων ζώων (Photius, *Bibliotheca* 278, 527b11), and Περὶ τῶν αὐτομάτων ζώων (D.L. 5.46) (fr. 350(a)-(c) FHSG). I take ἀθρόον and ἀθρόως in the titles to refer not just to the quantities of generated creatures ('swarms'), but also to the fact that there is no ostensible process leading to their generation. On the titles, see Sharples 1995, 43-44.

[32] Of frogs and grasshoppers (see fr. 359A ll.6-11, 28-32 FHSG). Theophrastus seems to admit 'spontaneous' generation of blowflies whose cause is said to be 'dung and rotting' (ibid., ll.2-5).

[33] Such interest has been described by scholars as a specific feature of school writings in the Hellenistic period (cf. Vallance 1988, 39). One can note Strato's titles Περὶ τῶν ἀπορουμένων ζώων, Περὶ τῶν μυθολογουμένων ζώων (frgs.92-3 Wehrli = D.L. 5.59), with Wehrli's explanation ad loc., cross-referring to *HA* 580b14 (μυῶν γένεσις ἀπορεῖται); a report of Clearchus: τῶν δὲ φυσικῶν τὰ μὲν ἔχει ζωήν, τὰ δ' οὐκ ἔχει. τίνα δὲ λέγομεν τὴν ζωὴν ἔφθημεν εἰπόντες, ὅτι τὴν δι' ἑαυτοῦ τροφήν τε καὶ αὔξησιν. ταῦτα δὲ ἦν τὰ ζῷα καὶ τὰ φυτά. τὰ γὰρ λεγόμενα στοιχεῖα φυσικὰ μέν, ὅτι κινήσεως ἀρχὴν ἔχει, οὐ ζῶντα δὲ, ὅτι μὴ τρέφεται δι' ἑαυτῶν. ἡ γὰρ τῶν λίθων αὔξησις ὁμολογούμενον ὅτι προσθήκη. ἢ εἴπερ καὶ οἱ λίθοι δι' ὅλου αὔξονται, εἴη ἂν ἐν τούτοις εἶδος ζωῆς, ἀλλὰ λίαν γε ἀμυδρᾶς, ἐπεὶ καὶ γεννᾶν τινὲς λίθοι λέγονται, ὡς Κλέαρχός φησιν. (fr.99 Wehrli = Them. *in An.* II 1, 41, 36-37 Heinze; cf. Theophrastus' mention, among the miraculous powers of various minerals (τοῖς χρώμασιν ἐξομοιοῦν... τὸ ὕδωρ, ἀπολιθοῦν τὰ τιθέμενα εἰς ἑαυτούς, ὀλκὴν ποιεῖν, βασανίζειν τὸν χρυσὸν καὶ τὸν ἄργυρον *De lapid.* 4, Caley and Richards) of the power to give birth (θαυμασιωτάτη δὲ καὶ μεγίστη δύναμις, εἴπερ ἀληθές, ἡ τῶν τικτόντων, *De lapid.* 5 and Caley and Richards ad loc.) εἴπερ ἀληθές is an important qualification: there can be little doubt that for Theophrastus all such half-credible stories present a 'database' of phenomena subject to further critical examination.

[34] Cf. *Anon. Lond.* XXIV 27-42 Diels; Celsus, *De medicina, prooem.* 20-22 Mudry.

[35] For example, the questions of creation and the 'substance of the deity' (*Propr. plac.* 2, 56,12 -58,21 Nutton), the substance of the soul and 'whether it is mortal' (*Propr. plac.* 3, 60,3-7 Nutton) or celestial bodies (*propr. plac.* 4, 62,18-19 Nutton); on Galen's 'agnosticism' see Nutton's commentary ad ll.cc. and Moraux 1973-2001. vol. 2, 785-91; for most recent discussion of Galen's metaphilosophy, see Frede 2003.

with the elemental constitution of a living body. In several of his works of the second Roman sojourn[36] he develops arguments defending the following set of claims: (a) corporeal principle of things is matter, continuous and changeable throughout; (b) all physical bodies are constituted by the four elements as described by Aristotle; (c) living bodies are constituted by the four humours which are analogous to the elements; (d) all the elements change into one another and interact with one another (e) complex physical properties of bodily organs are all determined by their physical constitution, down to the level of the elements making up their texture.

This set of tenets is presented by Galen as a part of his *ad hoc* doxography on the subject of natural design. His chief authority for this is Hippocrates;[37] Aristotle and the Stoics, allies in this case, are treated as modern expositors of this venerable ancient view. The 'wrong' side of the *diairesis* is associated with atomism with its mechanistic vision of the cosmos;[38] everyone who is suspected of the same is described as defecting from the right path 'by the Garden gate'.[39] Galen criticises two versions of the mechanist thesis: the 'stronger' one that he attributes to Asclepiades, who explicitly denied teleology; and the 'weaker' one endorsed by Erasistratus who did not. Galen's order of exposition is the reverse of chronological: first Asclepiades, then Erasistratus. The purpose of this may be to impress the reader by showing up the more dangerous fruits of the rejection of humours first: these have to do not just with Asclepiades' factual errors which he exposes, but more importantly with the logic of mechanistic reduction which, Galen warns, by reducing the anatomical complexity to the level of simple structures would dispose of the whole variety of anatomical and physiological phenomena, and thus undermine the very idea of anatomy which was at the core of Erasistratus' research programme.

Asclepiades of Bithynia apparently adopted a version of corpuscular theory, according to which an organism is a balanced dynamic system of microscopic corpuscles and passages,[40] with all changes explained by contractions and dilatations of passages,[41] disease being a result of 'impaction', and health, the right mutual arrangement of these corpuscles and channels allowing the unimpeded functioning of the organism. The relation between Asclepiades' dynamics and atomistic doctrine has been a matter of controversy. A strong case for a non-atomistic interpretation of corpuscles (construed as infinitely divisible particles rather than 'atoms') and pores (construed as structural properties of compounds rather than areas of 'void') has been recently made by J.T. Vallance.[42] Corpuscular movement is explained by Asclepiades as a function of 'flux' formed by 'loosened' particles. Such 'flux' is said to be carried towards 'that which is

[36] Ie. between 169 and 180, under Marcus Aurelius. For chronology, see still Ilberg 1892; cf. Accattino 1987, 458 n.19; for an analysis of Galen's chronology and writings, see Smith 1979, 97-123.

[37] On the character of Galen's hippocratism, see Smith 1979, 61-176; Lloyd 1993, 104-06; Jouanna 2003, 229-69.

[38] For Democritean influences in the Hippocratic corpus, see A. Stückelberger 1984, 53; for a more reserved view, see Vallance 1990, 50, 58.

[39] *Nat. fac.* II 6: 172, 17-18 H.: τῇ κηπαίᾳ κατὰ τὴν παροιμίαν, of certain Erasistrateans who maintained the discontinuity of basic vessels. Cf. Pigeaud 1980, 194 n.7); on the proverb, cf. the Yale scholiast in Moraux 1977, 24 (IA, 427-33).

[40] On Asclepiades, see Vallance 1990 and Vallance 1993; Harig 1983; Rawson 1982.

[41] *Nat. fac.* I 13: 129, 9-24 H.

[42] Vallance 1990. For arguments in favour of affinity between Asclepiades and atomic theory, see Gottschalk 1980, 55-56; cf. Pigeaud 1980; Stückelberger 1984, 89-123.

fine' (hence PTLP – πρὸς τὸ λεπτομερὲς φορά), i.e. to the area of low density.[43] All physiological processes are explained on the basis of this theory.[44] For all its differences from classical atomism, this dynamics could still be regarded by Galen as sufficiently 'atomistic', because of its explicit rejection of teleology in favour of mechanistic explanation.[45]

Galen criticises Asclepiades' physiological theory for its multiple theoretical and methodological failures. Natural dynamics is a special issue, where he goes into some detail. His views on this subject are illustrated in his discussion of the magnet. Rejecting Epicurus' explanation of magnetic attraction by interlocking of the atoms of iron with the atoms of the magnet,[46] he points out that the Epicurean theory at least retains the concept of 'attraction', while Asclepiades denies it altogether, presumably replacing it by φορά.[47] Galen compares the power of magnet with the power of cathartic drugs and natural antidotes to attract certain humours in accordance with their proper nature. The motion of iron is caused by the attractive power immanent in the material of the magnet in the same way in which the power of a medicinal drug is immanent in the underlying chemical combination.[48]

We shall return to Galen's concept of attraction shortly. For the moment, let us note the following point Galen wants to make: Asclepiades' mechanism is not sufficiently flexible to account for a rich variety of physiological functions manifest in experience, and the only sound methodological alternative can be an account where dynamic properties of organs are explained on the basis of their qualitative structure as presented to us in experience.[49] Therefore Asclepiades' theoretical system fails to answer the questions raised by medical experience. Galen will find the same fault with Erasistratus, whose system of physiology he generally appreciates much more than that of Asclepiades.

[43] Vallance 1990, 82, points out a possible link between Asclepiades' theory and Plato's theory of περίωσις in the explanation of respiration in *Tim.* 79a5-c7 on which see below.

[44] On the mechanism of digestion (denying any role to concoction and natural heat), see Caelius Aurelianus, *De morbis acutis* I 113; *Anon. Lond.* XXV 24 Diels. On urine production, Galen, *nat. fac* I 13: 123,23-124,25 H., cf. Vallance 1990, 54-56; Fischer, 1982.

[45] *Nat. fac.* I 13: 126, 14-15 H.: καὶ λοιδοροῦνται ἔτι μάτην ὑπ' αὐτῆς (scil. φύσεως) ἄλλα τε πολλὰ καὶ τοὺς νεφροὺς γεγονέναι φάσκοντες. This denial of artistic faculty to nature is perilous for the practice of cure and drug prescription, adds Galen maliciously, *caveat emptor*! (I 13:130, 20-24) Galen's examples in *nat.fac.* I 13 (131, 13-132, 3 H.) suggest, however, that Asclepiades' practice of prescription of medicines does not differ significantly from those of other sects and of Galen himself. On the sources of Asclepiades' pharmacology, see Vallance 1993, 704-07.

[46] *Nat. fac.* I 14 is our source for this theory of Epicurus, which is only briefly mentioned in the account found in Lucretius (*rer. nat.* 6.1087-98).

[47] I agree with Vallance's explanation of this passage (Vallance 1990, 62-63; cf. Pigeaud 1980, 193)

[48] *Nat. fac.* I 14: 139, 26-140,24 Helmreich. For this juxtaposition of magnetic attraction with other types of attraction (including chemical, cf. Lucretius, *Rer. nat.* 6) in iatrosophistic literature, cf. [Alex. Aphrod.] *Probl.* I, 4, 7-5,16, where the questions of the nature of such attraction are described as 'insoluble' and 'impassable', and not a suitable subject of a causal account, because their solution depends on the 'ineffable idiosyncracies' (ἰδιότητες ἄρρητοι) of things known only through experience (4,36-37 Ideler). Cf. Galen's own description of the problem of magnet as ἀδολεσχία in *Nat. fac.* I 14, 133,11-16 H.

[49] It has been noted that Galen does use the concept of λεπτομερές in his pharmacological works to account for the dynamic properties of substances (such as attraction), but a crucial difference between his and Asclepiadean concepts is that while Asclepiades refers to 'theoretical' density, abstracting altogether from the ostensible qualities of the substance in question, Galen's λεπτομερές is a part of ostensible qualitative structure, referring to the texture of a given tissue. See Debru 1997; cf. Vallance 1990, 59.

Many ancient sources, including Galen himself, put Erasistratus in a close relation with the Aristotelian school.[50] Yet Galen thinks that Erasistratus in his physiological doctrines departs from Aristotle's teleology. A number of recent studies have shown that these alleged departures are not so easy to pin down.[51] In a way, Erasistratus' rejection of Hippocratic physiology of humours and his apparent insistence on applying the principle of structure at the bottom level of the hierarchy of organic components can be seen as being in line with the functionalism of Aristotle's biology and metaphysics; but by the same token he is departing from Aristotle's theories of 'internal heat', 'connate pneuma', tissues as formed by elemental mixture, and generally from all the major teleological commitments in the theory of elements. The difficulty of defining his position with respect to the school 'orthodoxy' may be a sign of internal tension between these two tendencies within Aristotelian system of biology.[52]

In his physiology, Erasistratus distinguishes two classes of tissues: the *homogeneous* ones, formed by sedimentation of blood, called παρεγχύματα τῆς τροφῆς; and the *organs* proper whose microstructure is formed by the minuscule triplets of vein, artery and nerve, τριπλοκίαι τῶν ἀγγείων, invisible, theoretical entities (τὸ λόγῳ θεωρητόν).[53] The vessels are filled with πνεῦμα (arteries and nerves) and blood (veins), the stuffs described as ὕλαι in one of the sources.[54] A body formed by triplets has the microstructure of a living body in the most proper sense, being endowed with sensation and having articulate functional mechanism. This living body can no longer be mistaken for a non-living one which has similar qualitative characteristics, because the two bodies, animate and inanimate, have different structure.

The movement of stuffs in the vessels is based on the principle of 'proceeding towards the place being emptied' (πρὸς τὸ κενούμενον ἀκολουθία, PTKA)[55]. This principle, in conjunction with the theory of ἀποφοραί, evacuation by constant minute effluences of matter from the surface and inner organs of the body, is used by Erasistratus to explain the mechanism of nutrition and growth. There is no room for innate heat in the process of nourishment. It is replaced by adventitious heat resulting, in the case of digestion, from

[50] Sext. *Math.* I 258 (= fr.5 Garofalo), D.L. V 557 (= fr. 7 Garofalo), Plin. *HN* XXIX 5 (= fr. 8 Garofalo); cf. Galen, *Nat. fac.* II 5 (= fr.6 Garofalo), on 'Erasistrateans'; Garofalo 1988, 17-22; Fraser 1969; Lloyd 1975; von Staden 2000; Lonie 1964, 441 and n. 53.

[51] Cf. Garofalo 1988, 45-46; von Staden 2000; Cambiano 2000. Cf. the teleological account incorporating the theory of 'passages': fr. 77 Garofalo (*Anon. Lond.* XXXIX 16-32).

[52] Cf. analysis by Vegetti 1998, 100-03.

[53] *Nat. fac.* II 6: 171,9-10 Helmreich. On the τριπλοκία, see Garofalo 1988, 31-43. For the analysis of philosophical implications of Erasistratean theory, see von Staden 2000, 92-96. For a list of parallels between Galen's and Erasistratus' psycho-physiology, see ibid., 112.

[54] [Gal]. *Introductio* XIV 697.8 K. = fr. 86 Garofalo: καὶ Ἐρασίστρατος δὲ ὡς ἀρχὰς καὶ στοιχεῖα τοῦ ὅλου σώματος ὑποτιθέμενος τὴν τριπλοκίαν τῶν ἀγγείων, νεῦρα καὶ φλέβας καὶ ἀρτηρίας, παραλείπει τά τε ὑγρὰ καὶ τὰ πνεύματα. δυσὶ γὰρ ὕλαις ταύταις διοικεῖσθαι λέγει τὸ ζῷον. τῷ μὲν αἵματι ὡς τροφῇ, τῷ δὲ πνεύματι ὡς συνεργῷ εἰς τὰς φυσικὰς ἐνεργείας. οὐ παραλαμβάνει δὲ αὐτὰς ὡς ἀρχάς. πολλὰ δὲ καὶ ἄλλα τῶν σωμάτων εἶδη εὑρίσκεται, οὐκ ἐκ τῆς τριπλοκίας συγκείμενα, οἷον εὐθὺς ὁ ἐγκέφαλος καὶ ὁ μυελὸς καὶ πάντα τὰ ὀστᾶ. τὸν μὲν οὖν ἐγκέφαλον ἢ τὸν μυελὸν παρέγχυμα τροφῆς τολμᾷ λέγειν, ὡς τὴν πιμελήν, καὶ τοῦ ἥπατος καὶ σπληνὸς καὶ πνεύμονος τὴν σύστασιν. τὰ δὲ ὀστέα οὔτε παρέγχυμα τῆς τροφῆς δύναιτ' ἂν λέγειν, οὔτ' ἐκ τῶν προειρημένων τριγενῶν ἀγγείων πεπλέχθαι. Garofalo notes that, according to this account, form is bestowed on 'matter' by the τριπλοκία.

[55] Cf Garofalo 1988, 33 *et passim*; Vallance 1990 *passim*; cf. von Staden 2000, 92, n.32; on links with Peripatetic theories, Berryman 1997, 147-57; Lehoux 1999.

peristaltic motion in the stomach; this adventitious heat is not sufficient to produce the concoction of nourishment.[56]

Galen's target is the mechanistic character of Erasistratus' theory. He complains that Erasistratus 'imagines that animals grow like webs, ropes, sacks or baskets, each of which has, woven on to its end or margin, other material similar to that of which it was originally composed'.[57] He even accuses Erasistratus of inconsistency, suggesting that not being able to explain the nourishment of elementary nerve he departs from the PTKA principle and has to admit, tacitly, the natural power of attraction; but this seems to be another eristic manoeuvre.[58]

Galen introduces his alternative explanation of growth with the help of the analogy of balloon blowing: the idea is that growth of a living body consists in its 'becoming extended in all directions and at the same time receiving nourishment' (*nat. fac.* II 3, 164,1-2 Helmreich). The example, repeated by Galen several times in the treatise,[59] is supposed to emphasise the regularity and continuity of the process of growth which presumably cannot be adequately grasped by any mechanical model. In order to explain this kind of a process, one has to work out a different, non-mechanistic concept of nature. This theoretical goal determines the direction in which Galen takes his exegesis of Aristotle.

As I indicated above, the validity of Galen's criticisms of Erasistratus has been called into question in several recent studies. It has been pointed out that Aristotle's teleology is not 'total without gaps' in the Galenic sense, and that the Aristotelian notion of hypothetical necessity may in fact *require* a gradation of teleological values within a given natural system; so there is nothing un-Aristotelian, either in spirit or in letter, in denying independent natural purpose to *some* bodily parts.[60] Galen himself notably recognises two kinds of attraction: attraction by quality, which is attraction in a proper sense, and attraction 'by space'.[61] All of this indicates the need for a further investigation of the nature of Galen's interpretation of Aristotle.

We have already seen that Galen opens several of his works by a programmatic summary of his views, with a doxographical overview where Aristotle's position is presented as a part of single tradition started by Hippocrates. It may be useful now to take a closer look at some characteristic details of these summaries.

The main tenet of Aristotle's position relevant in the controversy over natural design is that of the unity and continuity of matter, because only matter so understood can be a proper substrate of change. Galen's worry is that a particulate theory of matter does not make enough provisions to ensure that no part of matter is actually exempt from change – either on the level of a living organism, or on the level of the cosmos at large.[62] Thus, the

[56] cf. Garofalo fr. 119-132.

[57] *Nat. fac.* II 3, 164,12-15 Helmreich, trans. Brock.

[58] Galen cites Erasistratus: τοῖς δ' ἐσχάτοις τε καὶ ἁπλοῖς, λεπτοῖς τε καὶ στενοῖς οὖσιν, ἐκ τῶν παρακειμένων ἀγγείων ἡ πρόσθεσις συμβαίνει εἰς τὰ κενώματα τῶν ἀπενεχθέντων κατὰ τὰ πλάγια τῶν ἀγγείων ἑλκομένης τῆς τροφῆς καὶ καταχωριζομένης. (*Nat. fac.* II 6: 177, 13-178, 4 H. = Garofalo fr. 148). As Garofalo points out, Galen interprets the attraction κατὰ τὰ πλάγια as a function of the elemental mixture of the coat of the nerve, whereas in fact the mechanism intended by Erasistratus in the fragment is that of PTKA. Cf. Vallance 1990, 75.

[59] *Nat. fac.* I 7: 112,23-113,15; II 3, 164,2-5 Helmreich.

[60] See von Staden 2000, 197-99; Cambiano 2000; cf. Vegetti 2002.

[61] See n.77 below.

[62] Cf. in particular the argument in *Elem. sec. Hipp.* 2-3 with Aristotle's critique of Empedocles in *GC* II 6-7.

question hotly debated by modern Aristotle scholars, whether Aristotle has the concept of prime matter, is answered by Galen in the affirmative.

In his theory of elements, Galen builds on Aristotle's account of elemental transformations in *GC* II 2-4.[63] The primary cosmic elements, earth, fire, water, air, are made up by pairs of primordial qualities (hot, cold, dry, moist). The 'microcosm' of an animal body has its own elements, the four humours of the Hippocratic 'humouralist' tradition;[64] Galen treats them as organic equivalents of four elemental qualities, 'proximate' elements'.[65] These are in fact mixtures with a distinct prevalence of one of the four elemental qualities.[66] Proximate elements serve as material in the formation of 'homeomerous' parts of body, of which, in turn, the organs proper are made. One can see in this account some traces of Aristotle's tiered morphological scheme in *PA* II 1, as well as of the traditional theory of humours, but the whole is certainly of more recent vintage. Aristotle does not treat 'humours' as elements, nor does Hippocrates, Galen's principal medical authority, concern himself with the cosmic elements. Galen's goal in bringing the two together is to provide a philosophical background to his own physiological system.

There is, further, some evidence of elaboration of Aristotle's theory of change in Galen's summary. In Aristotle's classification,[67] Galen distinguishes between 'simple' changes (these include locomotion and alteration) and 'complex' ones (generation/corruption and growth/diminution). This subdivision might be suggested by Aristotle's treatment of growth and generation; but it is not found in Aristotle in this form. It may be of interest to compare it with the main subdivision of organic changes made in the physiology of the so-called 'pneumatic' school into 'flow' (ῥύσις) (which might stand for 'local motion') and alteration (ἀλλοίωσις).[68]

The concept of alteration plays an important role in Galen's explanation of 'natural powers', since the most basic natural powers are the ones that produce alterations. They are properties of certain types of elemental mixture. Each living body, Galen says, has as many alterative powers as it has homoiomerous parts.[69] Alterative powers are at work in the process of assimilating nourishment. The mechanism of alteration was explained in the theories which adopted this concept with the help of the notion of κρᾶσις δι' ὅλου. This notion had a special philosophical significance in the Stoic physics. Apparently, debates over this notion were characteristic not only of philosophical, but also of medical school literature. As Galen tells us, Asclepiades in his treatise 'On the elements' developed an argument against this notion, and it is under the pressure of this argument that Galen amends the notion κρᾶσις δι' ὅλου that he himself uses resorting to the

[63] Cf. the theory of mixture in *Temp.* I 1-6; on Galen's theory of elements and qualities, Harig 1974, 35-76.

[64] Galen fathers this tradition on Hippocrates, athetising or ignoring non-humouralist Hippocratic texts such as *VM*; on Galen's relations with earlier humoural theories, see van der Eijk, 2000-01, vol. 2, 48f.

[65] *Elem. sec. Hipp.* 10, 1-7 De Lacy

[66] *Elem. sec. Hipp.* 11 De Lacy

[67] See n.9 above

[68] See Wellmann 1895, 134-37.

[69] *Nat. fac.* I.6.12, 109,18-110,15 Helmreich (citing as examples bone-producing, nerve-producing, cartilage-producing powers, etc.). Galen gives a detailed systematic description of tissues in the treatise preserved in Arabic, where he distinguishes 45 different kinds. See Strohmaier 1970, 93.

Peripatetic version of the theory of blending according to which it is qualities that blend while bodies are juxtaposed.[70]

The most basic local movements within the organism, the ones that are 'natural', i.e. induced without participation of either will or intellect, are based on natural powers inherent in each organ and tissue. At the primordial level of tissues we find the most basic instance of inherent dynamic tendencies, namely 'powers of attraction and repulsion'. These properties, attributed by Galen to each natural composite, have an unusually broad theoretical scope; the class of phenomena they are supposed to explain may strike us as profoundly lacking in theoretical uniformity. Selective attraction and repulsion explain: magnetism; the curative action of medicines; the mechanism of natural processes of nutrition, growth, and decay that take place in a living organism.[71] It is also clear from his exposition that all these instances are just partial manifestations of a more general principle:

> Nature is not posterior to the bodies, but is a long way prior to them and older than they; and therefore in their view it is Nature which puts together the bodies both of plants and animals; *and this she does by virtue of certain powers that she possesses – these being, on the one hand, attractive and assimilative of what is appropriate, and, on the other, expulsive of what is foreign.* Further, she skilfully moulds everything during the stage of genesis; and she also provides for the creatures after birth, employing here other faculties again, namely one of affection and forethought for offspring, and one of sociability and friendship for kindred. (*nat. fac.* I 12, 120,30-121,9 Helmreich, trans. Brock, modified, my emphasis)

Although the idea of attraction and repulsion as basic powers of any natural thing cannot be found in Aristotle in this form, Galen may feel entitled to claiming Aristotle as his source for this. In *Physics* VII 2, the text which Galen should certainly know,[72] we find a classification of movements, according to which all local motions can be reduced to two most basic kinds: pulling (ἕλξις) and pushing (ὦσις).[73] The purpose of this classification in Aristotle is to argue in an exhaustive way that a mover (*qua* efficient cause) is in contact with the thing moved in all three types of movement (κίνησις understood here in a technical sense of 'change'), including all the possible cases of local motion (φορά). This prepares ground for the demonstration of the type of causality exercised by the first unmoved mover.

Aristotle's classification of movements under these two headings can be contrasted with *Tim.* 79, where Plato makes an explicit attempt to get rid of one of the two classes, namely 'pulling', or 'attraction' (ὁλκή), and treat all movements traditionally accounted for by it (most importantly respiration, but also suction by 'cupping glasses', the process of swallowing, attraction by magnet and amber, and the movement of projectiles) as instances of mechanical propulsion, more specifically of 'circular thrust' (περίωσις) of air.[74]

[70] *Elem. sec. Hipp.* ch. 9, section 35-39 de Lacy. Elsewhere, when not pressed by polemical goals, he confesses his indifference towards the Stoic-Peripatetic quibbling over the issue (*propr. plac.* 15,1 Nutton, *Nat. fac.* I 5, 104,11-15 Helmreich).

[71] Cf. Lucretius on juxtaposition of various phenomena, above n. 48.

[72] On Galen's references to Aristotle's *Physics*, see Moraux 1973-2001, vol. 2, 729 and n.170.

[73] For a detailed discussion of two versions of classification, see Wardy 1990, 121-39.

[74] For detailed discussion see Cornford 1935; Opsomer 1999.

Aristotle does not state his motives for introducing a pair of basic movements instead of one, but he cites as an example the case of respiration, where inhaling illustrates attraction, and exhaling repulsion.[75] Plato's theory of respiration, not mentioned in *Phys.* VII 2, is criticised by Aristotle in *Resp.* 5 (472b7-23), where the argument for his analysis of inhalation as attraction is based on its natural priority and on the alternate character of the two movements.[76] To Galen, all of this would be sufficient as a signal that Aristotle's theory of movement is different from the 'mechanistic' teachings he has been criticising, because the inclusion of ἕλξις already indicates the acceptance of some sort of immanent cause of local motion. Galen does not leave this fact unnoticed in his *Timaeus* commentary, criticising Plato for his failure to do justice to attraction by quality, while noting that this is almost the only point on which Plato differs from Hippocrates.[77]

The way in which Galen interprets 'attraction' and 'repulsion' is of course different from their treatment in Aristotle's text. Aristotle's primary concern is with kinds of *movements*. Galen is interested in *powers* of attraction and repulsion as specific kinetic propensities inherent in all natural things and dependent on perceptible qualitative characteristics of these things. These powers apparently can operate both by contact and at a distance, as in the case of magnet.

His 'natural powers' form a primordial teleological system which characterises virtually every natural thing, animate or not:

> Thus, as was said at the beginning, all the observed facts testify that there must exist in almost all parts of the animal a certain inclination towards, or, so to speak, an appetite for their own special quality, and an aversion to, or, as it were, a hatred of the foreign quality. And it is natural that when they feel an inclination they should attract, and that when they feel aversion they should expel. From these facts, then, again, both the attractive and the propulsive faculties have been demonstrated to exist in everything. (*nat. fac.* III 6, 216,17-24 Helmreich, trans. Brock)

Galen points out that the scope of 'natural powers' so understood is not to be limited to the physiological processes in the body; rather, organic teleology is just one instance of universal teleology. Denial of the former entails denial of the latter:

[75] *Phys.* VII 2, 243b12-15: ἔτι δ' ἡ μὲν εἰσπνοὴ ἕλξις, ἡ δ' ἐκπνοὴ ὦσις. ὁμοίως δὲ καὶ ἡ πτύσις, καὶ ὅσαι ἄλλαι διὰ τοῦ σώματος ἢ ἐκκριτικαὶ ἢ ληπτικαὶ κινήσεις· αἱ μὲν γὰρ ἕλξεις εἰσίν, αἱ δ' ἀπώσεις. On different readings in α and β, see Wardy 1990, 128-32. The 'biological' nature of examples used by Aristotle was noticed by commentators early on. Cf. Wardy 1990, 126 and n.8 (quoting Simplicius and Wicksteed-Cornford).

[76] *Resp.* 5: 472b21-3: συμβαίνει δὲ τοῖς οὕτως οἰομένοις πρότερον τὴν ἐκπνοὴν γίνεσθαι τῆς εἰσπνοῆς. ἔστι δὲ τοὐναντίον. σημεῖον δὲ· γίνεται μὲν γὰρ ἀλλήλοις ταῦτα παρ' ἄλληλα, τελευτῶντες δὲ ἐκπνέουσιν, ὥστ' ἀναγκαῖον εἶναι τὴν ἀρχὴν εἰσπνοήν. For discussion, see Fritzsche 1902, 378 and n.21.

[77] οὐκ οἶδα τί δόξαν αὐτῷ τὴν τῆς περιώσεως δόξαν ἀντὶ τῆς ὁλκῆς εἵλετο κατὰ τοῦτο μόνον σχεδὸν ἀποστὰς Ἱπποκράτους (25, 21-2 Schroeder). Galen says further that the fact that attraction is the most important of natural powers has been proved in the treatise *On natural faculties*, but is also manifestly seen before it comes to a long-winded demonstration. The example that he cites here is that of (voluntary) suction: when we are sipping water through a straw, it is our will that causes the attraction (of water). But the heart, too, he adds, even when separated from an animal, preserves its movement of diastole and systole for a long time. As in a systole it clearly expels the contents, so in the diastole, *by the proceeding towards what is being emptied* (τῇ πρὸς τὸ κενούμενον ἀκολουθίᾳ) it pulls that which will fill up that of it which is being emptied (τὸ ἀναπληρῶσον τὸ κενούμενον αὐτῆς ἐπισπᾶται). (25,25-26,2 Schroeder) It is remarkable that the PTKA principle is mentioned here in a single breath with the principle of attraction: Galen apparently regards the former as a mechanism through which the 'attractive' power of the heart operates.

> According to the other school, none of these things exist in the natures, nor is there in the soul any original innate idea, whether of agreement or difference, of separation or synthesis, of justice or injustice, of beautiful or ugly; all such things, they say, arise in us from sensation and through sensation, and animals are steered by certain images and memories. (*nat. fac.* I 12, 121, 9-16 Helmreich, trans. Brock)

This move is facilitated by the way Galen chooses to use the notion of φύσις in this treatise. In the beginning, Galen uses this term to signify the Aristotelian 'vegetative soul', and argues that his usage is in a better agreement with common idiom. [78] A few pages later he uses the same term in a more general meaning of *natura creatrix*, designing agency behind any natural mechanisms (including those of 'natural powers' in a narrow sense).[79] It has been noticed that the exact force of Galen's 'design' claim for the 'animate' matter of living organisms is not entirely clear: it is hard to distinguish between nature providing for a particular tissue from nature providing for a particular tissue *qua* part of an organism. In his physiological theory, Galen himself shows awareness of relative autonomy of the mechanisms operating at each of the three levels of organic hierarchy ('nature' subsuming vegetative operations and life-like properties of 'inanimate' natural compounds, 'animation' proper, subsuming voluntary acts in all animals, and 'rational soul' that can exercise control over the behaviour of rational animals). He is also aware of a whole number of 'overlapping' cases, bodily movements which cannot be accounted by physiological mechanisms corresponding to just one level; in the treatise *De motibus dubiis* he studies a number of 'aporetic' cases like that.[80] Thus, on this view, 'natural movements' within an organic whole are still 'completed' by a whole in respect of their function. However, in Galen we also find a tendency to describe the internal design of each part of a living being in terms of immanent selective propensities which possess some sort of autonomy within the whole: in this respect, there is no difference between lower and higher functions, nor indeed between living and non-living natural substances. In this way he attempts to account for a variety of conditions in a living organism which together form an animate structure.[81]

We shall now look at the way the problem of animate powers and movements is dealt with in the works of Alexander of Aphrodisias.

[78] *Nat. fac.* I 1, 101, 1-15 Helmreich. For an alternative approach used by Galen in other works, cf. Galen *prop. plac.* 62, 12-15 Nutton; Nutton ad loc.; F. Kovacic 2001, 89-113.

[79] For this meaning of 'nature' in Galen, see a recent discussion by Jouanna 2002.

[80] See Larrain 1994 and 1997; Debru 2002, 79-86. A new critical edition of this text is currently being prepared by Prof. Vivian Nutton.

[81] Galen's position with respect to Aristotle's thesis being established in *Phys.* VII 1, 'everything moved is moved by something (else)' has to be treated with caution. It may be tempting to conclude from his descriptions of attraction and repulsion as immanent powers, in conjunction with his criticisms of Aristotle's argument in VII 1, that he commits himself to a denial of this thesis. But neither his doctrine nor his criticism warrant this conclusion. 'Attraction' and 'repulsion' are indeed immanent, but this may mean only that their mechanism, once activated, depends for its operation on the organism itself, not on any external factor. This need not upset Aristotle's thesis: these powers are still activated in the presence of a relevant *object* which will then be regarded as a 'mover' in the sense of a 'triggering' cause activating the immanent operation in a particular way. (Cf. a discussion of alteration by Philoponus, *in GC* 1.5, 98,19-99,6 Vitelli). Galen's criticism of Aristotle's thesis in *Phys.* VII 1 reported by Simplicius (*in Phys.* 1039,13-1040,12 Diels) and in the Arabic treatise (Marmura and Rescher 1965) attributed to Alexander, has to do with logical form of the argument and not with the claim itself (cf. Fazzo 2002, 134-35, Frede 2002, 83). I am grateful to Rebecca Flemming and Riccardo Chiaradonna for discussion of this issue.

III.

Alexander, like Galen, is a strong adherent of the qualitative analysis of the elements. He says that there are four basic primordial substances, corresponding to the four elements of traditional cosmology. Their matter is prime matter, and their forms are constituted by a pair of tangible qualities (hot/cold, moist/dry) and a supervening dynamic characteristic (light/heavy).[82] More complex bodies, all the way up Nature's ladder, are mixtures of these, their forms becoming all the more complex with the increasing variety of the underlying elements.[83] Soul is thus a 'form of forms' of the elemental ingredients of bodily mixture.[84] Even those who did not think this theory is un-Aristotelian admitted its unusual tenor. P. L. Donini in his seminal paper said of Alexander:

> In any case, he did not follow this line of research which we might define as 'biological', but another line, which might be termed 'physico-chemical', the one according to which the soul is indeed connected with the body, but this latter is regarded for the most part as a compound of elementary bodies which act and react upon each other.[85]

We have just seen that by Alexander's time the 'biological line' itself is claimed by several competing schools of thought in both the medical and philosophical traditions; the main choice for a physical theory is between mechanical and chemical accounts of organic powers. In the light of this, it is no surprise that Alexander devotes such attention to the problem of elemental constitution of an organic body. Does this commit him to a reductivist view of soul as the principle of life? I am now going to show that Alexander develops a conceptual scheme which could accommodate both accounts within a common teleological framework.

The treatise *De mixtione* opens with a doxographical outline where the main principle of division within the *diaphônia* is the same as in Galen's doxographical summary, to do with unity, continuity, and changeability of matter. Stoics and Peripatetics are said to be allies on all these points, against the atomists.[86] But the rest of the treatise is devoted to showing why the alliance with the Stoics will not work, after all.[87]

Alexander's main concern in this discussion is precisely with the issues on which Galen is somewhat vague: the mechanisms of mixture and movement in the continua, and more specifically, the nature of movements involved in the process of organic growth. Alexander's discussion of the mechanism of proportionate growth deserves attention as a good example of his use of Aristotle's arguments in contemporary school debates. The target of his criticism is the alleged Stoic thesis that the mechanism of growth involves complete pervasion by the body of the incoming nourishment through the growing body resulting in their mutual co-extension (ἀντιπαρέκτασις). Against this he says that the addition of matter does not have to happen in every part of a growing body in order for

[82] Alexander, *De an.* 3,21-4,4 Bruns.

[83] Alexander, *De an.* 4, 4-27; 8, 5-25 Bruns.

[84] Alexander, *De an.* 8,12f. For critical assessments, cf. Moraux 1942, 31ff; Moraux 1973-2001, vol. 3, 354-60; Accattino and Donini ad loc.

[85] Donini 1971, 82.

[86] *Mixt.* I: 213.15-214.9 Bruns.

[87] *Mixt.* III: 216.4-13 Bruns on close relations between Stoics and Peripatetics.

the body to be growing in every part. It will suffice if the *shape* of a growing thing is retained in the process of growth,[88] and this can be achieved by means of ἀντιπερίστασις, mutual replacement of the bodily components of a growing structure.

> For something is preserved in a principal sense when it is retained together with everything that belongs to it by nature, such as shape. *For every ensouled thing itself possesses some proper shape, and so does each of its parts*, which preserves its shape in case when having added from food it does not remain keeping the place in which it was added to and being attached to it, but pushes forward the part which is before it, and that in turn the part before itself, until each of the parts having got an equal increase from food causing growth which has been applied in a due proportion, remains having the same shape which it had before the addition of nourishment. (*Mixt.* 236,32-237,5 Bruns, my emphasis)

Alexander does speak of the shape of both uniform and non-uniform parts.[89] The mechanism by which the persistence of shape is maintained is described in terms of 'propulsion' (προώθησις): minute components of bodily texture, when pressed on by the incoming nourishment, move around, pushing the ones in front of themselves, until each part receives a proportionate increase in volume, retaining the same contour.

To explain the nature of this propulsive movement which emerges in the growing organ, Alexander invokes Aristotle's argument for the sphericity of the earth in *cael.* II 14. Aristotle argues that the spherical shape of the earth depends on the centripetal character of natural movement of the solids. All solid bodies are moving downwards, i.e. towards the centre of the universe, with equal force; the centripetal tendency generates a mutual pressure of the parts within an aggregate. As a result, the parts which exercise equal pressure come to be equidistant from the centre. The shape of the whole is thus necessarily a sphere.

The point of the analogy is that the increase of bulk in the process of growth is characterised by internal regularity which depends on the character of movements carrying out the process; these movements depend on the nature of the underlying material substrate, tissues and solid parts undergoing growth. To this extent the analogy can be compared with Galen's example of balloon blowing. But whereas Galen's example, perhaps deliberately, does not go beyond the level of a metaphor (the regularity of blowing is ascribed to nature straightforwardly, without going into the details of exact mechanism), Alexander undertakes an analysis of movements involved in the process of growth in terms of hylomorphic theory of substance. His point apparently is that just as in

[88] *Mixt.* XVI: 'And although the accretion does *not* happen in every part, growth does happen in every part, because it is a proper characteristic of the nutritive faculty which alters the nourishment, assimilates and attaches it to that which is nourished, to both preserve that which is nourished by it and keep it with its proper shape; or better, "preserving" follows upon this' (236, 26-30 Bruns). I retain the initial μή secluded by Ideler and Todd. Cf. Philoponus *in GC* 117, 17-22 Vitelli.

[89] Alexander says that 'a proper shape' (οἰκεῖον σχῆμα) characterises every living body, *and all of its parts*. It is clear from the text that not only the non-uniform, but also uniform parts of a living body possess their 'proper shape'. ὡς γὰρ αὔξεταί τε καὶ φυλάσσεται τὰ τῶν ὁμοιομερῶν τοῦ τρεφομένου σχήματα ἐν τῇ τῶν ὁμοιομερῶν αὐξήσει, οὕτως καὶ τὰ τῶν ἀνομοιομερῶν ὑπολεπτέον φυλάσσεται σχήματα τῆς κατὰ μόρια προσκρινομένης αὐτοῖς τροφῆς ὑπὸ τῆς ἐν αὐτοῖς θρεπτικῆς δυνάμεως εἰς πάντα αὐτὰ ἀγομένης ἀναλόγως. 'Indeed just as the shapes of the uniform parts of the body that is nourished grow and are maintained by growth in these parts, so must it be understood that the shapes of the non-uniform parts are maintained when nutriment is assimilated part by part and distributed to all of them proportionately by their nutritive faculty' (237,20-25 trans. Todd).

Aristotle's thought experiment the shape of the earth depends on natural movements of the elements whose character is defined by the structure of the universe (i.e. the central position of the earth), so in living bodies, the shape of the organs is dependent on the movements of the elemental constituents of the organic tissues, whose character is fixed by the structure of the organism, i.e. ultimately defined by its specific form. The immediate active source of this movement in a growing organ is its natural heat which is the instrument of the soul, as Alexander explains in his *De anima.*[90] The heat as such is a cause of indefinite movement. Order, definition and certain determinate 'path' come from the soul,[91] i.e. the principle which regulates direction and measure of attraction exercised by heat.

Alexander's choice of the paradigm of reasoning may be significant insofar as Aristotle in his argument emphasises that his is not the model of the 'like moving towards the like'. At *De caelo* 297a31 Aristotle discusses the following *aporia*, which could be raised against his idea that the shape of the earth is grounded in the direction of its natural movement. Suppose a several times greater weight were added to one of the hemispheres of our earth (spherical and centrally stationed). The earth either (a) will have to shift, or, (b) assuming it does not and remains at rest, it will be resting at a place where it would be natural for it to be in motion. (b) is unacceptable because it cancels the principle of natural movement: the heavy bodies have to be inclined to move towards the centre of the cosmos. (a) is problematic: the motion by which the part of the earth will be moved in the direction from the centre is left unaccounted. We cannot assume that it is 'simply' withdrawn from its place by a heavier body: this will mean that its natural motion will be overridden by the forced movement it will receive from a heavier part. In his solution, Aristotle explains that the law of aggregation by natural motion is: 'the larger portion must prevail until it possesses the centre with its own centre' (297b6, Guthrie trans.) The 'larger portion' (τὸ πλέον) has to be taken in the unspecified sense of magnitude (either mass or volume presumably can qualify to the 'prevalence' in some sense, but the idea is that lateral pressure will bring it about that 'the larger portion' in relation to the whole of a sphere will be in the centre). Aristotle says:

> Therefore whether the earth moved as a whole or in parts, it must have continued in motion until it occupied the centre evenly all round, the smaller parts being equalised by the greater under the forward pressure of their common impulse. (297b11-14, trans. Guthrie)[92]

It is the same, says Alexander, in the case of growth:

[90] ἡ δὲ κατὰ τὸ τρέφεσθαι ἐνέργεια γίνεται τῆς θρεπτικῆς ψυχῆς μεταβαλλούσης τὴν ἔξωθεν προσενεχθεῖσαν τροφὴν διὰ πέψεως καὶ ἐξομοιούσης καὶ προσκρινούσης τῷ σώματι, οὗ ἐστιν εἶδός τε καὶ δύναμις αὕτη. ὄργανον δ' αὐτῆ πρὸς τὰς τοιαύτας ἐνεργείας τε καὶ μεταβολὰς τὸ θερμόν (34, 27-35, 3 Bruns).

[91] Κινητικὸν μὲν γὰρ καὶ τὸ θερμόν, ἀλλ' οὔτε ὡρισμένη οὔτε τεταγμένη κίνησις, ἧς προηγουμένως ἀρχὴ τὸ θερμόν. Τὸ δὲ τρεφόμενον τάξει τινὶ καὶ ὁδῷ πρόεισιν καὶ ὅρον ἔχει τινά, ἃ οἰκεῖα ψυχῆς, ἀλλ' οὐ πυρός (35, 5-8 Bruns). Thus, Alexander would not agree with the interpretation of nutritive soul as identical with vital heat suggested by Freudenthal 1995. What makes heat 'vital' is not the function of heat, but of the soul which alone has 'informing' power over matter. Heat is an important, but not the only, instrument in this process.

[92] Simplicius tells us that Alexander in his commentary points out that natural movement does not transgress the centre. When the larger part of the aggregate has reached the centre it does not possess weight nor impulse to propel anything. But mutual propulsion happens because of the lack of space in the centre, so that many lighter parts that strive toward the centre are found on one surface (543, 15-27 Diels).

> It should be assumed that it is the same with the uniform bodies which grow by absorption from nourishment. *Simultaneously* with the absorption and assimilation of nourishment[93] by the nourished thing, from the very parts of the nourished body there comes to be a certain forward movement and migration where one part propels another, until the moment when the whole comes to be in the same shape in which it was before the addition of food. (237, 14-20 Bruns, my emphasis)

Mechanical motion here follows upon, indeed is 'simultaneous' with, the organic processes of assimilation and absorption of nourishment. Alexander's description of two kinds of processes as happening simultaneously in the course of organic process should be noted. Chemical and mechanical components of this complex process are complementary and depend on the organic structure and functions of the whole.

Thus, with respect to the dispute between the 'solidist' and 'humouralist' interpretations of the nature of organic powers in medical philosophy, Alexander seems inclined to steer a middle way. His account of formal constitution strongly relies on the 'chemical' principle of mixture used by 'humouralists'; but it also includes the notion of movement as a basic 'dynamic' characteristic distinct from tangible properties. His analysis of propulsion in terms of προωθησις emphasises the complementary nature of this kind of movement with relation to attraction. The cause of attraction is still the internal heat allocated by the principal organ to all the organs of the body in a due proportion. But this 'quality'-based motion produces, as its necessary concomitant, a different type of motion which emerges specifically among the parts of an aggregate, with relation to each other. Mechanical motion caused by this attraction in the living tissues is responsible for the shape of the growing organ. The shape of the living body thus reproduces the economy of organic motions constituted by the immanent activity of soul through its central organ. The mechanical character of motion, thus, does not conflict with teleological explanation; nor are the elemental qualities demoted to the rank of 'matters' as they are in Erasistratus' account. On the contrary, they do play a certain causal role in defining the dynamic characteristics of a composite. As far as a more general philosophical issue is concerned, Aristotle's principle of the priority of form as the essential design of a living thing over its material constitution seems to be firmly maintained. The cause of growth cannot be reduced either to chemistry or to the geometry of a natural compound. It is to be found on the level of functions grounded in the essential structure of a growing thing.

Two texts attributed to Alexander, *quaest.* II 23 and a passage quoted by Simplicius in his commentary on VII 2, contain discussions of the magnet.[94] In each case we are likely to be dealing with reported versions of Alexander's views, and have to allow for possible interpolations or distortions by the reporting source. But these reports can still be instructive for comparison with Galen and for getting a more general idea of Alexander's approach to the classification of primordial natural forces.

In *quaest.* II 23, the author begins his discussion of magnetic attraction with the exposition and criticism of three Presocratic theories, namely those of Empedocles, Democritus, and Diogenes of Apollonia.[95] Rose suggested that his source is Aristotle's

[93] Εὐθὺ τῇ προσκρίσει τε καὶ ἐξομοιώσει. For this use of εὐθύ(ς) with dative as an improper preposition in Alexander, cf. *De an.* 56, 18 Bruns; *Fat.* 198,2; *in Metaph.* 200, 11 H., *in Sens.* 110, 13; 123, 6-10; 124,5; 125, 17-25; 126, 9; 133, 5; 134, 12; *in Meteor.* 216, 2.

[94] Discussions in Radl: *quaest.* 2.23: 78-87; Simpl. 118-121 (118-9 Strato fragments, 120-21 on *Phys.* 7).

[95] Democritus 68A165 DK (cf. A33= B11k); Diogenes = Diog. A 33 DK; Empedocles = 31B89 DK. Alexander's *quaestio* is apparently cited by Psellus (with Anaxagoras mentioned instead of Diogenes of Apollonia), in *De lapidum virtutibus*, ll.117-122 Galigani: τούτων δὲ τῶν παρὰ τοῖς λίθοις δυνάμεων

lost treatise περὶ λίθου α' mentioned in the lists of Aristotle's works by Diogenes Laertius and Hesychius;[96] Diels, that it might be Theophrastus' *Phys. Opin.* In any case, it seems likely that Alexander draws on the earlier Peripatetic tradition.[97]

After criticising the earlier explanations of magnetism, the author goes on to differentiate between various types of attraction on the basis of the 'mode of attraction'. The differentiation he has in mind seems to be twofold: first, one has to determine the status of each kind of attraction with respect to Aristotle's theory of motion. We are told that there are things which attract by force and by contact, and thus move while being moved. This is not the case with 'the stone', which moves while being itself unmoved, and without a contact with the iron.[98] This description of magnet's status *qua* mover signals a link with the discussion in *Physics* VII 2. There is, next, a differentiation of the kinds of attraction within each class of 'movers' based on specific mechanisms involved in each case. Magnetic attraction is shown to be distinct from that exercised by amber and cupping glasses (the cases analysed in the *Timaeus* and in Galen's commentary).[99] Further, the author states that organic attraction of seed by the womb and blood by the organs in the process of nourishment (Galen's stock cases) is accidental, presumably, in the same sense as the one intended in the two previous examples: the proper object of attraction in each case are liquids without a further specification.[100] Evaporation presents a different case altogether.[101]

Magnetic attraction is classed together with mental and intentional acts on the basis of two points of analogy: (i) Magnet affects the medium between itself and the iron, and the medium transmits the form of the magnet to the iron, in the same way as the object of sight affects the medium and through it conveys its form to the organ of sight. This analogy seems to presuppose a theory of vision found in Alexander's other works,

αἰτίας πολλοὶ ἐθάρρησαν ἀποδοῦναι, τῶν μὲν ἀρχαιοτέρων σοφῶν Ἀναξαγόρας καὶ Ἐμπεδοκλῆς καὶ Δημόκριτος, τῶν δὲ οὐ πολὺ πρὸ ἡμῶν ὁ τῆς Ἀφροδισιάδος Ἀλέξανδρος, ἄνθρωπος περὶ πάντων ἁπλῶς εἰπεῖν καὶ τῶν ἀπορρήτων τῆς φύσεως προχειρότατος. This is added as an appendix to the list of stones, and certainly does not mean that Alexander is a source of this list. One might wonder whether οὐ πολὺ πρὸ ἡμῶν is an anachronism, or whether it comes from Psellus' source.

[96] Rose 1863, 242-43. In Diogenes' list, this treatise appears among the 'hupomnematic' writings. In the extant writings, Aristotle seems to mention magnet twice, both times as ἡ λίθος: *De an.* I 2, 405a19-22 (the reported view of Thales, according to which 'the stone' has soul because it attracts iron) and *Phys.* VIII 10, 266b30-267a2, where it serves as an example of a mover which not only moves another thing but makes it capable of moving yet another thing, thus forming a chain of movers.

[97] This *quaestio* is our source for Empedocles' verse: <ὕδωρ> οἴνῳ μᾶλλον ἐναρίθμιον, αὐτὰρ ἐλαιῷ οὐκ ἐθέλει (72,26-7 Bruns = 31B91 DK), and this seems to be just one, rather anomalous, instance of Alexander quoting a 'new' verse of Empedocles (i.e. not occurring in our earlier sources; for general statistics on this, see Primavesi 2002; Alexander's direct knowledge of Empedocles is questioned by Frohn-Villeneuve 1980, 123-52). Notably, the epithet 'of Heraclea' is not present anywhere in the treatise, and appears only in its title, magnet being referred to simply as ἡ λίθος; on the other hand, the epithet σιδηρῖτις appears also in the report of Strato (ap. Simplic., *in Phys.* 652,18-25 Diels), who may be drawing on the same tradition (cf. Simplic. *in Phys.* 663,2-8 Diels).

[98] 74, 4-7 Bruns: ὁμοίως δὲ καθόλου ἀναγκαῖον τὸν περὶ τούτου λέγοντα πρῶτον ἐζητηκέναι τίς ὁ τῆς ὁλκῆς τρόπος. ἕλκει γὰρ τὰ μὲν βίᾳ καὶ ἀφῇ· ταῦτα αὐτὰ κινούμενα κινεῖ. οὐχ οὕτως δὲ ἡ λίθος· ἀκίνητος γάρ.

[99] 74, 8-14 Bruns: in these cases, the attraction caused by internal heat affects also the medium (the intervening air), as is not the case with the magnet.

[100] 74, 14-17 Bruns.

[101] 74,17-19 Bruns: the air is transformed by the heat of the sun and rises to its natural place above where the sun also is. But the stone does not transform the iron.

according to which the form of an object of sight is propagated by the incorporeal 'activities' of this object via the medium to the sight organ.[102]

(ii) Upon reception of this form, iron is attracted to the magnet by something like a desire of what it itself lacks and what magnet has. The author explains:

> For it is not only things endowed with sensation and animate that desire things that are natural for them, but many inanimate things are like this too (74.28-9 Br.).

This analogy might look good in a work by Galen; in Alexander it is rather odd. In his *De anima*, explaining the mechanism of desire, he points out that it is only things that have souls that can be moved in this way, i.e. by desire.[103] Generally, the term ἔφεσις is used to refer to animate (and often rational) desire.[104] There seems to be one occasion where broad construal of this term might be suggested. In the commentary on *Metaphysics* 5.2, Alexander explains Aristotle's use of the word παράδειγμα with reference to εἶδος:[105]

> He calls the form 'model' (παράδειγμα) not as do those who talk about the Ideas, for he certainly does not at all believe that any of the things generated naturally comes to be by reference to any model existing outside it. (For natural causes do not produce what they produce by first taking thought, as production takes place in the arts, unless perhaps one were to say that the thought (νόημα) is a model for the things that come to be according to it.) But here it is the form itself that comes to be in matter that he calls 'model', because nature aims at this form. For whatever produces for the sake of something produces what it does out of desire (ἔφεσις) for that [at which it aims]; hence it no longer continues to act once the thing for whose sake it was acting has been brought to completion. And all the things that are generated naturally are generated for the sake of something, i.e. for come definite form and completion, and when each of them has finally reached this completed state, its process of becoming is terminated. (349,6-16 Hayduck, trans. W. Dooley).

Here ἔφεσις seems to have a broader scope referring to the nature as a 'desiring' agency in each process of coming to be. Still, there is nothing to indicate that Alexander is prepared to make any specific stipulations to transfer this concept onto the inanimate realm as such. So the case of magnet seems to be an exception, which might be due either to a misstatement of the analogy between magnet and mental acts, or to the uncritical use of earlier tradition.

There seems to be a methodological difference between Alexander's and Galen's respective uses of the magnet. In Galen, magnet serves as a paradigm for *both* voluntary and involuntary motions, and as such requires no further explanation. For Alexander, on the contrary, the analogy between (inanimate) magnetic attraction and mental acts of perceiving and desiring is introduced in what seems to be an attempt to arrive at a satisfactory solution of a hard problem. The only ground for this analogy is the lack of

[102] Alexander, *De an.*, 42,4-46,19 Bruns; *Mantissa* 15 (141,30-147,25 Bruns); cf. *in sens.* 58,17-59,15 Wendland.

[103] *De an.* 79,10 Bruns.

[104] *quaest.* 1.1 (3,16-18; 4,2), cf.1.25 (40,11.14.15.25.26); 2.19 (63,20); *Eth. Probl.* 2 (120,19); 21 (142,29); 29 (158,12).

[105] *in Metaph.* 349, 6-16 Hayduck. Cf. *in Metaph.* 32,25 Hayduck.

contact between the magnet and the iron, and the analogy is restricted to magnet, all other types of attraction being explained effectively with the theory of natural heat.

Simplicius' report supports the impression that Alexander takes magnet to be an exception rather than a regular case of attraction. In Simplicius' *Physics* commentary, the examples of magnet attracting iron and amber attracting husks are supplied by way of expanding Aristotle's example of logs attracting fire.[106] The discussion of magnetic attraction in the commentary is constrained by Aristotle's agenda in this book, which consists in showing that every local motion in sublunary cosmos is brought about through bodily contact. Hence the case of the magnet should present a special difficulty.

> (i) But Alexander does well to raise a query in what way things that attract naturally, such as the Heraclean stone and others of this kind, pull the things they pull by touching them, and to say that although they do not themselves touch them, they still do touch them by the power through which they pull them. (ii) But it was not this that Aristotle set out to prove, i.e. that what pulls touches what is pulled by the incorporeal power, but [that it does so] by corporeal [power], so that there should be no body in-between. (iii) So what he says next is better: 'For either there are some corporeal effluences from things that are at rest and pull in this way, by touching and being meshed with which, as some say, things that are pulled are being pulled, or perhaps his discussion now is not about things pulled in this way (for what happens to them is unclear), but he said [this] about the logs which, while staying [in place], detain the fire around themselves, somehow pulling it and constraining its upward movement because it is kindled by them'. (1055, 24 – 1056, 7 Diels)

(i) Alexander raises the problem and cites a solution, according to which the magnet touches the iron by an incorporeal power which does not require contact for its operation.[107] It is possible that he is referring to a solution given to this problem in *quaest.* II 23 (specifically to the analogy (i) with sight), although no further details are given here about the nature of attraction exercised by such power. (ii) In the present context such a solution is found unsatisfactory, because the purpose of the text, as the commentator correctly observes, is to show that any movement of this type is brought about by the agent through bodily contact with the patient. The source of (ii) is not clear from our text.[108] In (iii) we find a dilemma which follows from further reflection on the possible

[106] Simplic. *in Phys.* VII 2, 1055,6-10 Diels: τὸν λόγον ἀποδοὺς τῆς ἕλξεως καὶ θάττονα ἐν αὐτῷ ἀποδοὺς τὴν κίνησιν τοῦ ἕλκοντος τῆς τοῦ ἑλκομένου κατὰ φύσιν κινήσεως ἐπέστησεν, ὅτι τινὰ τῶν ἑλκόντων δοκεῖ ἕλκειν μὴ κινούμενα αὐτά, ὥσπερ τὸ ξύλον ἕλκειν δοκεῖ τὸ πῦρ πρὸς ἑαυτό, καὶ ἔτι μᾶλλον ἡ 'Ηρακλεία λίθος τὸν σίδηρον καὶ τὸ ἤλεκτρον τὸ ἄχυρον οὐ κινούμενα αὐτά. καὶ ἔτι μᾶλλον introduces an addition (of a *better* example of attraction) whose source is not made clear by Simplicius; it can be quite early. In addition to *Tim.* 79c discussed above, cf. Theophrastus, *De lapid.* 28-29, also suggesting a common mechanism of attraction (αὕτη τε δὴ περιττὴ τῇ δυνάμει καὶ τὸ λυγγούριον· καὶ γὰρ ἐκ τούτου γλύφεται τὰ σφραγίδια καὶ ἔστι στερεωτάτη καθάπερ λίθος· ἕλκει γὰρ ὥσπερ τὸ ἤλεκτρον, οἱ δὲ φασιν οὐ μόνον κάρφη καὶ φύλλα ἀλλὰ καὶ χαλκὸν καὶ σίδηρον ἐὰν ᾖ λεπτός, ὥσπερ καὶ Διοκλῆς ἔλεγεν. ... ἐπεὶ δὲ καὶ τὸ ἤλεκτρον λίθος, καὶ γὰρ ὀρυκτὸν τὸ περὶ <τὴν> Λιγυστικήν, καὶ τούτῳ ἂν ἡ τοῦ ἕλκειν δύναμις ἀκολουθοίη. μάλιστα δὲ δηλονότι <ἕλκει> καὶ φανερώταθ' ἡ τὸν σίδηρον ἄγουσα.)

[107] It should perhaps be emphasised that on Alexander's analysis, *all* natural agent powers are incorporeal, insofar as they are distinct from corporeal substances in which they inhere. *All* of them are also inseparable from these bodies; and *some* of them have bodily contact as a necessary condition of their operation. So details in each case might be crucial. (See further Kupreeva 2003.)

[108] R. W. Sharples suggests that this point is raised by Simplicius as an interjection in Alexander's argument (Sharples 1990, 99). Simplicius may be taking his cue from Alexander (as he frequently does in this commentary): this would explain why, after having stated what elsewhere seems to be his preferred explanation

sorts of bodily contact in which the agent is unmoved. The theory of corporeal effluences has been criticised in *quaest.* II 23, on various grounds, none of which are mentioned here. The reason why this approach is ruled out here is either that these theories operate with unobservable entities, or, more generally, that the case is unclear (ἄδηλον γὰρ τὸ γινόμενον ἐπ' ἐκείνων). Thus, by elimination of implausible options, the solution to the exegetical problem is that Aristotle here is not thinking about magnetic attraction, but of a 'corporeal' attraction, as between logs and fire. The magnet thus does not belong to this classification of movers, and so does not provide a paradigmatic case of attraction the way it does for Galen.

We have seen that Galen and Alexander are confronted with similar theoretical problems and share many common features of Aristotelian background in their theories of matter and change. The differences in their respective approaches seem to do with the methodological strategies used to explain the operation of nature at its lowest structural levels. For Galen, natural powers and processes can be described in terms of inherent selective attitude implanted in matter by Nature the designer. Magnetic attraction is just a very clear case of such 'implanted' selective attitude; but the attitude itself is universal, even if less manifest in other cases. Such view of natural powers, as informed in a specific way by a purposeful agency, can find support in the rich descriptive literature concerning various natural phenomena (minerals, plants, natural cures, etc). In post-Aristotelian Peripatetic philosophy and science there is growing interest in such phenomena, but at the same time there is a clear tendency to develop uniform rational explanations whenever possible. Alexander's work shows both tendencies, along with an overriding concern with systematic coherence of Aristotle's physical theories that are used to explain these phenomena. Growth, reproduction, and other physiological and natural processes that involve attraction can be explained on the basis of Aristotle's hylomorphic metaphysics, theory of motion and theory of elemental qualities, without resorting to the analogy with mental processes. Specific features of design in natural bodies and their motions can be articulated in terms of their physical constitution and dynamics, in a perfectly functionalist way, without postulating any inherent selective attitudes the way Galen does. Therefore in Alexander's account of natural powers, magnet is a remarkable exception rather than a rule-setting paradigm, although the very presence of such an exception is perhaps an indication of the fact that the hylozoist option in the solution of the problem of natural powers was at some point at least pondered in the Aristotelian school.

Thus in Galen and Alexander we find two approaches to Aristotelian philosophy of nature: in each case, there is an adaptation of this philosophy to a specific intellectual and practical context. In the case of Galen, this context is defined by the tasks set by his medical philosophy; purely theoretical concerns are less important. In the case of Alexander, on the other hand, the priority is given to the coherence and theoretical soundness of the system. The comparison of the two can be instructive in that it shows the different means provided by each to the solution of one of the core problems within the Aristotelian philosophy.

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of magnetism, Alexander turns to different models (effluences, fire and logs). Alexander in this case would not be rejecting the explanation of magnetism as attraction by incorporeal power, but just taking this case out of the scope of the current exegesis where the main feature of attraction is that it should be by direct contact.

Bibliography

Accattino 1995 = Accattino, P. 'Generazione dell' anima in Alessandro di Afrodisia, *De anima*, 2.10-11.13?' *Phronesis* 40.2 (1995) 188-201.

Accattino 1987 = Accattino, P. 'Ematopoesi, malattia cardiaca e disturbi mentali in Galeno e in Alessandro di Afrodisia', *Hermes* 115 (1987) 454-73.

Althoff 1992 = Althoff, J. *Warm, Kalt, Flüssig und Fest bei Aristoteles. Die Elementarqualitäten in den zoologischen Schriften* (Stuttgart 1992).

Balme 1962 = Balme, D. M. 'Development of biology in Aristotle and Theophrastus: theory of spontaneous generation', *Phronesis* 8 (1962), 91-104.

Berryman 1997 = Berryman, S. 'Horror vacui in the third century B.C.: when is a theory not a theory?' *Aristotle and After* (*BICS* Supplement 68), ed. R. Sorabji (London 1997) 147-57.

Berryman 2002 = Berryman, S. 'Galen and mechanical philosophy', *Apeiron* 35.3 (2002) 235-53.

Cambiano 2000 = Cambiano, G. 'Galeno, Erasistrato e la teleologia di Aristotele', ed. D. Manetti, *Studi su Galeno: scienza, filosofia, retorica e filologia* (Florence 2000) 45-57.

Caston 1997 = Caston, V. 'Epiphenomenalisms, ancient and modern', *The Philosophical Review* 106.3 (1997) 309-63.

Caston 2001 = Caston, V. 'Dicaearchus' philosophy of mind', in *Dicaearchus of Messana: Text, Translation and Discussion*, ed. W.W. Fortenbaugh, E. Schütrumpf (New Brunswick 2001), 175 – 93.

Cornford 1935 = Cornford, F. M. *Plato's Cosmology*, (London 1935, repr. Indianapolis 1997) .

Debru 1997 = Debru, A. 'Philosophie et pharmacologie: la dynamique des substances leptomères chez Galien', in *Galen on Pharmacology: Philosophy, History and Medicine*, ed. A. Debru (Leiden – New York – Köln 1997) 85-102.

Debru 2002 = Debru, A. 'Galen *On the unclear movements*' in *The Unknown Galen*, ed. V. Nutton (London 2002) 79 – 86.

Donini 1971 = Donini, P. L. 'L'anima e gli elementi nel *De anima* di Alessandro di Afrodisia', *Atti della Accademia delle Scienze di Torino.* II Classe di scienze morale, storiche e filologiche, vol. 105 (1971) 61-107.

van der Eijk 2000-01 = van der Eijk, Ph. J. (ed.), *Diocles of Carystus: a Collection of the Fragments with Translation and Commentary*, 2 vols (Leiden 2000-01).

Ellis 1994 = Ellis, J. 'Alexander's defence of Aristotle's *Categories*', *Phronesis* 39.1 (1994) 69-89.

Fazzo 2002 = Fazzo, S. 'Alexandre d'Aphrodise contre Galien: la naissance d'une légende', *Philosophie Antique. Problèmes, Renaissances, Usages* 2 (2002) 109-44.

Fischer 1982 = Fischer, K. D. 'Der Weg des Urins bei Asklepiades von Bithynien und in der Schrift *De opificio Dei* des Kirchenvaters Lactantius', *Mémoires IIII. Médecins et médecine dans l'Antiquité*, ed. G. Sabbah (Saint-Étienne 1982) 43-54.

Fraser 1969 = Fraser, P. M. 'The career of Erasistratus of Ceos', *Rendiconti* (Istituto Lombardo – Accademia di Scienze e Lettere, Classe di Lettere), vol. 103 (1969) 518-37.

Frede 2003 = Frede, M. 'Galen's theology', in *Galien et la Philosophie (Entretiens Hardt 49)*, ed. J. Barnes and J. Jouanna (Vandœuvres – Geneva 2003) 73-129.

Freudenthal 1995 = Freudenthal, G. *Aristotle's Theory of Material Substance* (Oxford 1995).

Fritzsche 1902 = Fritzsche, R. A. 'Der Magnet und die Athmung in antiken Theorien', *Rheinisches Museum für Philologie*, N. F. 57 (1902) 363-91.

Frohn-Villeneuve 1980 = Frohn-Villeneuve, W. *The Sources of Alexander of Aphrodisias for the Presocratics*, Ph.D. thesis, Laval University (1980).

Furley 1984 = Furley, D. J. 'Self-movers', in *Self-Motion: From Aristotle to Newton*, ed. M.L. Gill and J. Lennox (Princeton 1994) 3-14.

Furley 1989 = Furley, D. J. 'The mechanics of *Meteorologica* IV: a prolegomenon to biology', *Cosmic Problems* (Cambridge 1989) 132-48.

Garofalo 1988 = Garofalo, I. *Erasistrati fragmenta* (Pisa 1988).

Gottschalk 1980 = Gottschalk, H. B. *Heraclides of Pontus* (Oxford 1980).

Harig 1974 = Harig, G. *Bestimmung der Intensität im medizinischen System Galens: ein Beitrag zur theoretischen Pharmakologie, Nosologie und Therapie in der Galenischen Medizin* (Berlin 1974).

Harig 1983 = Harig, G. 'Die philosophischen Grundlagen des medizinischen Systems des Asklepiades von Bithynien', *Philologus* 127 (1983) 43-60.

Harris 1973 = Harris, C. R. S. *The Heart and Vascular System in Ancient Greek Medicine from Alcmaeon to Galen* (Oxford 1973).

Hankinson 1998 = Hankinson, R. J. *Cause and Explanation in Ancient Greek Thought* (Oxford 1998).

Ilberg 1892 = Ilberg, J. 'Über die Schriftstellerei des Klaudios Galenos: II', *Rheinisches Museum für Philologie* N.F. 47 (1892) 489-514.

Jouanna 2003 = Jouanna, J. 'La notion de nature chez Galien', in *Galien et la Philosophie (Entretiens Hardt 49)*, ed. J. Barnes and J. Jouanna (Vandœuvres – Geneva 2003) 229-69.

Kovacic 2001 = Kovacic, F. *Der Begriff der Physis bei Galen vor dem Hintergrund seiner Vorgänger* (Stuttgart 2001).

Kullmann 1982 = Kullmann, W. 'Aristoteles' Grundgedanken zu Aufbau und Funktion der Körpergewebe', *Sudhoffs Archiv*, Bd.66, Heft 3 (1982) 209-38.

Kupreeva 2003 = Kupreeva, I. 'Qualities and bodies: Alexander against the Stoics', *OSAP* 25 (2003) 297-345.

Larrain 1994 = Larrain, C. A. 'Galen, *de motibus dubiis*: die lateinische Übersetzung des Niccolò da Reggio', *Traditio* 49 (1994) 171-233.

Larrain 1997 = Larrain, C. A. 'Kommentar zu Galen *de motibus dubiis* in der mittelalterlichen Übersetzung des Niccolò da Reggio', *Traditio* 52 (1997) 1-41.

Lehoux 1999 = Lehoux, D. 'All voids large and small, being a discussion of void in Strato of Lampsacus's matter theory', *Apeiron* 32.1 (1999) 1-36.

Lewis and Bolton 1996 = Lewis, F.A. and Bolton, R. (eds.), *Form, Matter, and Mixture in Aristotle* (Oxford 1996).

Lloyd 1975 = Lloyd, G. E. R. 'A note on Erasistratus of Ceos', *Journal of Hellenic Studies* 95 (1975) 172-75.

Lloyd 1993 = Lloyd, G. E. R. 'Galen on Hellenistics and Hippocrateans: contemporary battles and past authorities', in *Galen und das hellenistische Erbe*, ed. J. Kollesch, D. Nickel, *Sudhoffs Archiv Beihefte* 32 (1993) 125-43.

Lonie 1964 = Lonie, I. M. 'Erasistratus, the Erasistrateans, and Aristotle', *Bulletin of the History of Medicine* 38 (1964) 426-43.

Marmura and Rescher 1965 = Marmura, M. E. and Rescher, N. *The Refutation by Alexander of Aphrodisias of Galen's Treatise of the Theory of Motion* (Islamabad 1965).

Moraux 1942 = Moraux, P. *Alexandre d'Aphrodise Exégète de la Noétique d'Aristote* (Liège – Paris 1942).

Moraux 1973-2001 = Moraux, P. *Der Aristotelismus bei den Griechen. Von Andronikos bis Alexander von Aphrodisias*, 'Peripatoi' 5, 6, 7/1, 3 vols to date (Berlin 1973, 1984, 2001).

Moraux 1977 = Moraux, P. 'Unbekannte Galen-Scholien', *ZPE* 27(1977) 1-63.

Oderberg 1999 = Oderberg, D. S. (ed.), *Form and Matter. Themes in Contemporary Metaphysics* (Oxford 1999).

Opsomer 1999 = Opsomer, J. '*ANTIPERISTASIS*: A Platonic theory', in *Plutarco, Platón y Aristóteles*, ed. A. Pérez Jiménez, J. García López and R. M. Aguilar (Madrid 1999) 417-29.

Pigeaud 1980 = Pigeaud, J. 'La physiologie de Lucrèce', *Revue des Études Latines* 58 (1980) 177-200

Pines 1961 = S. Pines, '*Omne quod movetur necesse est ab aliquod moveri*: A refutation of Galen by Alexander of Aphrodisias and the Theory of Motion', *Isis* 52 (1961) 21-54.

Primavesi 2002 = Primavesi, O. 'Lecteurs antiques et byzantins d'Empédocle. De Zénon à Tzétzès', in *Qu'est-ce que la philosophie présocratique? / What is Presocratic Philosophy?*, ed. A. Laks and C. Louguet, (Villeneuve d'Ascq, Nord 2002) 183-204.

Radl 1988 = Radl, A. *Der Magnetstein in der Antike. Quellen und Zusammenhänge* (Stuttgart 1988).

Rawson 1982 = Rawson, E. 'The life and death of Asclepiades of Bithynia', *Classical Quarterly* NS 32 (1982) 358-70.

Robinson 1991 = Robinson, H. M. 'Form and the immateriality of intellect from Aristotle to Aquinas', in *Aristotle and the Later Tradition*, ed. H. Blumenthal and H. Robinson (Oxford 1991) 207-26.

Rose 1863 = Rose, V. *Aristoteles Pseudepigraphus* (Leipzig 1863).

Sharples 1990 = Sharples, R. W. 'The school of Alexander?', in *Aristotle Transformed*, ed. R. Sorabji, (London 1990) 83-111.

Sharples 1994 = Sharples, R. W. 'On body, soul and generation in Alexander of Aphrodisias', *Apeiron* 27 (1994) 163-70.

Sharples 1995 = Sharples, R. W. *Theophrastus of Eresus: Sources for his life, writings, thought and influence*, commentary vol. 5 (Leiden 1995).

Smith 1979 = Smith, W. D. *The Hippocratic Tradition* (Ithaca 1979).

Solmsen 1960 = Solmsen, F. *Aristotle's System of Natural World* (Ithaca 1960).

Solmsen 1968 = Solmsen, F. 'Tissues and the soul. Philosophical contributions to physiology', *Kleine Schriften* I (Hildesheim 1968) (repr. from *Philosophical Review* 59 [1950]), 502-35.

von Staden 1997 = von Staden, H. 'Teleology and mechanism: Aristotelian biology and early Hellenistic medicine', in *Aristotelische Biologie: Intentionen, Methoden, Ergebnisse*, ed. W. Kullmann and S. Föllinger (Stuttgart 1997) 183-208.

von Staden 2000 = von Staden, H. 'Hellenistic theories of body and soul', in *Psyche and Soma. Physicians and metaphysicians on the mind-body problem from Antiquity to Enlightenment*, ed. J. P. Wright and P. Potter (Oxford 2000) 79-116.

Strohmaier 1970 = Strohmaier, G. (ed., trans.), Galen, *Über die Verschiedenheit der homoiomeren Körperteile* (Berlin 1970).

Stückelberger 1984 = Stückelberger, A. *Vestigia Democritea. Die Rezeption der Lehre von den Atomen in der antiken Naturwissenschaft und Medizin* (Basel 1984).

Todd 1995 = Todd, R. B. 'Peripatetic epistemology before Alexander of Aphrodisias: the case of Alexander of Damascus', *Eranos* 93 (1995) 122-28.

Vallance 1988 = Vallance, J. T. 'Theophrastus and the study of the intractable: scientific method in *De lapidibus* and *De igne*', in *Theophrastean Studies: On Natural Science, Physics and Metaphysics, Ethics, Religion, and Rhetoric*, ed. W. W. Fortenbaugh, R. W. Sharples (*RUSCH III*) (New Brunswick, Oxford 1988) 25-40.

Vallance 1990 = Vallance, J. T. *The Lost Theory of Asclepiades of Bithynia* (Oxford 1990).

Vallance 1993 = Vallance, J. T. 'The medical system of Asclepiades of Bithynia', *Aufstieg und Niedergang der römischen Welt* II 37.1 (Berlin, NY 1993) 693-727.

Vegetti 1998 = Vegetti, M. 'Between knowledge and practice: Hellenistic medicine', in *Western Medical Thought from Antiquity to the Middle Ages*, ed. M.D. Grmek (Cambridge, MA – London 1998) 72-103.

Vegetti 1999 = Vegetti, M. 'Historiographical strategies in Galen's physiology (*De usu partium, De naturalibus facultatibus*)', in *Ancient Histories of Medicine: Essays in Medical Doxography and Historiography in Classical Antiquity*, ed. Ph. Van der Eijk (Leiden 1999) 383-96.

Wardy 1990 = Wardy, R. *The Chain of Change: A study of Aristotle's Physics VII* (Cambridge 1990).

Wellmann 1895 = Wellmann, M. *Die pneumatische Schule bis auf Archigenes* (Berlin 1895).