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Vitalism and teleology in the natural philosophy of Nehemiah Grew (1641–1712)

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Abstract. This essay examines some aspects of the early history of the vitalism/mechanism controversies by examining the work of Nehemiah Grew (1641–1712) in relation to that of Henry More (1614–87), Francis Glisson (1599–1677) and the more mechanistically inclined members of the Royal Society. I compliment and critically comment on John Henry's exploration of active principles in pre-Newtonian mechanist thought. The postulation of 'active matter' can be seen as an important support for the new experimental philosophy, but it has theological drawbacks, allowing for a self-sufficient nature relatively independent of God. Grew resists this view and, like Henry More, advocates the need for a vital principle to direct material nature towards its ends. I illustrate the connection Grew sees between teleology and vitalism and the paper closes with Pierre Bayle's reaction to Grew's attempt to support his religious commitments by appeal to vital principles.

> So many Arts, hath the Divine Wisdom put together; only
> for the hull and tackle, of a sensible and Thinking creature.
>
> Nehemiah Grew, *Cosmologia*

Until the late 1920s life, mind and matter were commonly thought to be distinct fundamental properties. Indeed, for many contemporary philosophers, consciousness, if not cognition, still holds out against materialist reduction. But not life. Vitalism is dead and buried as a serious theory of the 'vital' phenomena: self-motion, nutrition, growth and reproduction. But the history and logic of vitalism is still instructive, if only as a cautionary tale. Recent philosophical arguments regarding the alleged irreducibility of consciousness need to take the history of vitalist arguments more seriously. In this paper I shall examine a small part of the early history of the vitalism/mechanism controversies by examining the work of Nehemiah Grew (1641–1712) in relation to that of Henry More (1614–87), Francis Glisson (1599–1677) and the more mechanistically inclined members of the Royal Society.

The plan of the paper is as follows. I present Grew's arguments from his *Cosmologia Sacra* (1701)[1] against the materialist and mechanistic understanding of life common among many of the first-generation members of the Royal Society. Situating Grew's views and influences helps us understand the debates over the limits of matter and

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1 Nehemiah Grew, *Cosmologia Sacra: Or a Discourse of the Universe as it is the Creature and Kingdom of God*, London, 1701.

mechanism, debates that raged in the late seventeenth century. I shall explain Grew's reactions to Francis Glisson, Descartes and Willis. Near the end of this section I offer some circumstantial evidence regarding More's influence on Grew.[2] That influence lies in Grew's later views regarding the peristaltic motion of sap.[3] More general similarities between the two thinkers, specifically their rejection of voluntarism, will also be noted. My discussion reveals the considerable influence that More (and neo-Platonism generally) had among naturalists, and indicates that the reception of Cartesianism in England had much to do with the overlap found between aspects of neo-Platonism and Cartesian philosophy.[4] Grew rejected Descartes's and Willis's materialist conception of life, but went further to reject Francis Glisson's concept of life as a superadded property of matter. Not only is life itself incorporeal, the variously shaped corporeal atoms constituting the bodies of things are not themselves the proper subject for life. According to Grew, only incorporeal principles are alive.

In the second section, I compliment and critically comment on John Henry's excellent discussion and exploration of active principles in pre-Newtonian mechanist thought.[5] That there was a tradition of mechanist thinkers wedded in a variety of ways to understanding matter as either intrinsically or extrinsically active is difficult to deny. Grew, like Henry More, agrees with Descartes's conception of passive matter, and is thus a critic of the English 'active-matter mechanist' tradition(s) identified by Henry.[6] And like More and the mechanists identified by Henry, Grew rejects the Cartesian promise to explain natural phenomena by reference to passive matter and the laws of motion. The debate over mechanism and vitalism was, naturally, a debate over the meaning of mechanism. English mechanist thought, despite its acceptance of active principles, was, according to the older Grew, insufficient to account for vital phenomena. Finally, in the third section, I briefly discuss Pierre Bayle's reaction to Grew and Cudworth. Bayle reveals the irony of the debate. Grew's conception of a vital directive principle plays into the hands of the atheist, undercutting the best arguments for God's existence.

The seventeenth-century debate over vital phenomena has more than just a historical interest. Contemporary analytic philosopher David Chalmers defends an argument for the irreducibility of consciousness that is strikingly similar to Grew's regarding life.[7] Chalmers claims that he can conceive of a creature physically indiscernible from himself

2 Rupert Hall suggests that More influenced Grew, but he offers no specific reason for thinking so. See his *Henry More*, Oxford, 1990, 260.

3 Thomas Birch, *History of the Royal Society of London*, reprinted, 4 vols., New York, 1968, iv, 56, originally published 1672: 'Dr. Grew was put in mind to see, what might be discovered of the peristaltic motion in plants, asserted by Signor Malhighi.'

4 See J. F. M. and F. D. Hoeniger, *The Development of Natural History in Tudor England*, Charlottesville, 1969.

5 John Henry, 'Occult qualities and the experimental philosophy: active principles in pre-Newtonian matter theory', *History of Science* (1986), **24**, 335–81.

6 See Alan Gabbey, 'Henry More and the limits of mechanism', in *Henry More Tercentenary Studies* (ed. Sarah Hutton), Dordrecht, 1990, 136–57. For disagreement see Alexander Jacob's introduction to More's *Enchiridium Metaphysicum*, Zurich, 1995.

7 See David Chalmers, *The Conscious Mind*, Oxford, 1996. For further discussion, including issues regarding the analogy between vitalist arguments and Chalmers's arguments about consciousness, see Jonathan Shear (ed.), *Explaining Consciousness: The Hard Problem*, Cambridge, MA, 1998.

which nevertheless lacks consciousness. Grew argues that he can conceive of a physical system – what he calls a 'Bartholomew baby' – that lacks life (and mind). Both thinkers take it that the genuine possibility of such beings shows that consciousness (for Chalmers) and life (according to Grew) is an extra fact over and above the physical facts. The physical facts are insufficient to account for the vital phenomena. Indeed it could be claimed that this similarity in argumentative structure is cause for some embarrassment for contemporary thinkers concerned to argue for the irreducibility of consciousness. Given that vitalism is no longer a viable option for biology, reliance on arguments analogous to those of the vitalists would appear to be bad methodology. The history of vitalism is, therefore, instructive for those concerned with debates within contemporary analytic philosophy, if only as a cautionary tale.[8]

The subtle, the organical and the vital

The physician Nehemiah Grew (1641–1712) is best known for his microscopical work on plant anatomy.[9] Grew read a number of papers to the Royal Society beginning in 1671 with 'The Anatomy of Plants Begun' (1671). He became a fellow of the Royal Society in the same year and in 1677 upon the death of Henry Oldenburg he, along with Robert Hooke, became secretary to the Society. His papers were collected and published in 1682 as the *Anatomy of Plants*. Less read, however, is his *Cosmologia Sacra: or a Discourse of the Universe as it is the Creature and Kingdom of God*, written late in his life and published in 1701. In this apologetic work Grew intended to reply to the 'many Leud Opinions, especially those of Anti-scriptualists, which have been published of late Years; by Spinoza and some others'. Although the anti-scriptualists were his stated target, Grew also expressed his opinions on a whole host of his older contemporaries' views.

Grew was a Presbyterian, the son of a Nonconformist, and his views on life reflect a certain nonconformity with perhaps the majority of the prominent members of the Royal Society. What makes Grew interesting is his simultaneous commitment to atomistic and mechanistic explanation regarding matter, along with the somewhat panpsychist view that all material bodies, but certainly vegetative bodies, are associated with a vital principle. Further, Grew denies voluntarism, which John Henry describes as the view that 'whatever order and structure there is in the world is not inherent in the nature of things but is merely contingent upon God's fiat'.[10] Grew's denial of voluntarism is evident

8 I explore this cautionary tale elsewhere in 'What the history of vitalism teaches us about consciousness and the "hard problem"'. Unpublished MS available on request.

9 For discussion of Grew's works see Jeanne Bolan, 'The botanical works of Nehemiah Grew', *Notes & Records of the Royal Society London* (1973), **27**, 219–31; Conway Zirkle, 'Introduction', in N. Grew, *The Anatomy of Plants. Sources of Science, No. 2*, New York, 1965, pp. i–xxvi; Michael Hunter, 'Early problems in professionalizing scientific research: Nehemiah Grew (1641–1712) and the Royal Society, with an unpublished letter to Henry Oldenburg', *Notes & Records of the Royal Society London* (1982), **36**, 189–209; William LeFanu, *Nehemiah Grew: A Study and Bibliography of his Writings*, Detroit, 1990; Agnes Arber, 'From medieval herbalism to the birth of modern botany', reprinted in Arber's *Herbals*, 3rd edn., Cambridge, 1985 (1st edition 1912).

10 John Henry, 'Occult qualities and the experimental philosophy: active principles in pre-Newtonian matter theory', *History of Science* (1986), **24**, 365, 335–81.

in his claims regarding God's goodness constraining His activity,[11] and in his claims, to be discussed below, regarding how matter could not have life superadded. Not even God, according to Grew, can make living matter. The idea of matter and the idea of life are not compatible ideas in the mind of God.

Both of these views find Grew more aligned with Henry More and John Ray than with Robert Hooke and Robert Boyle, although he refers admiringly to both. The nonconformist Grew believed that the 'Universe consisteth, of the Corporeal and the Vital World … I shall prove that, That there is a Vital Substance in Nature, distinct from a Body'.[12] But the existence of the vital substance is obscure: it may have

> some sort of Existence, analogous to Corporeal Extension: tho' we have no adequate Conception hereof; nor therefore any proper Word, whereby to express it. For every Motion, is in some sort co-extended with the Body moved. Yet we cannot say, that Motion is Thick or Thin, or otherwise Great or Small, as is a Body.[13]

Grew's belief in a substantial principle, the 'proper subject of life', was supported by an a-priori ontological argument. God must be understood as vital and incorporeal, for to think that God is corporeal (as 'leud' Spinoza does) 'is to make him no more than a Limb of the World'. But if God is vital, then it is reasonable to believe that he has 'Made, that which is more, and nearer in Likeness to Himself'.[14] But Grew's deeper and more interesting reasons were based on the failures of mechanism to account for vital phenomena:

> it is Necessary, that it should Exist. That is to say, without a Substantial principle, as the proper Subject of Life, distinct from Body: There could be no Living, much less any Sensible, Thinking, or Reasonable Thing: Whereof I shall make proof, in the Description of the several Species of Life.[15]

At first this seems somewhat puzzling given Grew's own enthusiasm for mechanistic explanation. In his 1674 *Discourse Concerning the Nature, Causes and Power of Mixture*, Grew gave a stereotypically atomistic, mechanistic and utilitarian account of mixed bodies. He aims to 'make *Artificial* bodies in Imitation of those of *Natures* own production … To discover their Use, and the Manner of their Medicinal Operations'.[16] He took principles to be physically indivisible immutable atoms, their differences in kind reducible to their differences in size and shape. Change in mixed bodies was simply the dissolution or reorganization of the fundamental material principles.[17] Grew was also committed to the identification of nature with art: 'If all that Nature maketh, be but Mixture; and all this Mixture be but Contact 'tis then evident, That Natural and Artificial Mixture, are the Same.'[18] On these issues Grew appears typically mechanistic,

11 Grew, op. cit. (1), 31.
12 Grew, op. cit. (1), 31.
13 Grew, op. cit. (1), 31.
14 Grew, op. cit. (1), 32.
15 Grew, op. cit. (1), 32.
16 Grew, op. cit. (1), 32.
17 See Walter Charleton, *Physiologia*, 1654 facsimile reprint edited by Robert Kargon, New York, 1966.
18 Grew, op. cit. (1), 228.

but in the *Cosmologia* Grew refers to his earlier discussion of mixture as an argument against materialists. Mixture, he thinks, is just a mode of corporeal body and will never be sufficient for life. Although vitalist in his thinking, Grew retains one of the mechanist's core metaphors, that of the artificiality of natural objects:

> Nor are the Works of Nature, ever the less Artificial, because of the Cooperation of the Vital Principle, with the Corporeal. For as the Corporeal, cannot measure their own Motion and Mixture: so neither could the Vital do it, were not the Corporeal thereunto fitted by the Artifice of their Figure.[19]

If adherence to the artificiality of nature were sufficient to be counted as a mechanist, Grew would be a 'vital mechanist', and indeed his commitment to the canons of enquiry followed by the Royal Society might incline us towards this otherwise paradoxical description of his views.[20]

The issue for Grew is the subject of life. We are offered two possibilities, the corporeal principles or atoms, or the incorporeal principles, or souls. Which is, literally speaking, alive? Grew maintains an analogy between corporeal atoms and their motion, and incorporeal principles and their life. Diverse motion is mirrored in the vital world by diverse forms of life: vegetative, sensitive and intellectual. The corporeal and incorporeal principles have commerce via their modes, motion and life.[21]

But to reach such conclusions Grew must dispose of the popular alternatives. Five alternatives present themselves. If the body is alive, then it is so either as (i) subtilized (ii) organized (iii) mixed (iv) moved, or (v) as endowed with life, 'as another proper and immediate Adjunct thereof; superadded unto Motion'.[22] Each of these, however, is insufficient to explain life.

Let us begin with the first idea. Grew singles out Willis and Descartes as his targets. Both hold life to be subtilized matter, perhaps an igneous fluid. But Grew could have chosen any number of seventeenth-century authors. The general idea that life, or the vital spirits, could be identified with heat, itself to be understood as analogous to the heat of fermentation, and thus a form of physico-chemical process, had been mooted by Bacon, Harvey, Willis and Descartes. Although the exact details in each case were different – Descartes's *feu sans lumière*, for example, did not seem to be fanned by the air of the

19 Grew, op. cit. (1), 26.

20 Compare Robert Hooke, *Micrographia*, 133–4 where Hooke allows for the epistemic possibility that generation may exist without seed and be guided by a vegetative principle. Hooke otherwise favours the more mechanistic and materialist approach.

21 Compare with Ficino, *Theologi Platonica de Immortalitate Aninorum* (ed. and tr. M. Allen and J. Hankins), Cambridge, MA, 2001:

> there has to be some mutable nature which of its own accord turns towards inactive bodies and rouses them. Always alert, it experiences changes in itself before producing them in body, with the results that, just as corporeal substance is made by spiritual substance, so corporeal movement is produced by spiritual movement.

Ficino continues, quoting from Plato, *Laws*, 10.895A–B and *Phaedrus*, 245C–D.

22 Grew op. cit. (1), 33.

lungs,[23] whereas it could be for Willis – the identification of life with heat was common, along with a naturalist gloss of its nature. Even Aristotle had spoken of the vital heat,[24] but had denied that it was the heat of fire.

Appeals to a vital heat in the blood, and to animal spirits in the nerves and pores, were rampant among physicians and anatomists familiar to Grew.[25] The nature of the vital fire was of considerable medical interest, being the key to longevity. In 1638 Bacon, fantasizing over youth, wrote in his *Historie of Life and Death*,

> And youthfull Spirits convey'd into an old Body, would like a great wheele turning about the lesser, make Nature move backward and old folks become young.
>
> In all Consumption by Fire, or age, the more moisture that the spirit or heate doth devoure, the lesse durable is the substance.[26]

Discussion of the innate heat led to some bizarre ideas. Fire, after all, consumes and the physician has to find the right balance of heat over consumption. If he does not, life will slowly eat the body, drying it out in the consumption. Thus Bacon writes, 'The spirits working temperately, should not drinke or devoure, but sip the moisture of the body.'[27] This cycle of cannibalism and refreshment of the body's vital heat is taken up by Harvey's pupil Francis Glisson (1599–1677). 'I offer to consideration whether the eater becomes meat, even to the very parts which it continually preys upon and devours?'[28] To which Glisson responds negatively. The heat of the blood consumes the more solid parts of the body, thus requiring further nourishment for the organs. But if these organs take in nourishment, then they too 'may be deemed the eater'. The body is an economy of consumption, the lesser being consumed by the superior:

> The wolf preys upon the lamb, but the lamb is too weak to prey upon the wolf, but must be contented with milk or grass, such food as it is able to conquer. Wherefore the blood being the eater in respect of the solid parts, it cannot be the food to the same.[29]

Glisson is advocating a plurality of nourishing spirits. The blood being the eater of the solid parts is not therefore nourishing those parts. That nourishment must be done by animal spirits, found circulating in the nerves.

The animal spirits were invoked in a series of arguments over the nature of nerves and of muscular contraction. Harvey's discovery of the blood's circulation had encouraged the proliferation of circulatory models. The circulation of sap through the tree and the movement of spirits through the nerves were both postulated. Descartes had even postulated valves in the nerves analogous to the valves in the arteries. William Croone

23 See Dennis Des Chenes, *Spirits and Clocks*, Ithaca, 2001, 30.

24 See Aristotle, *Generation of Animals*, 737a1, in which he denies that the vital heat is the heat of fire.

25 See Robert G. Frank, *Harvey and the Oxford Physiologists*, Los Angeles, 1980; Thomas S. Hall, *History of General Physiology*, Chicago, 1969; Everett Mendelsohn, *Heat and Life: The Development of the Theory of Animal Heat*, Cambridge, MA, 1964.

26 Francis Bacon, *Historie of Life and Death*, 1638, 144.

27 Bacon, op. cit. (26), 145.

28 Francis Glisson, *Anatomia Hepatis* (1654, ed. Andrew Cunningham), Cambridge, 1993, 410–11.

29 Glisson, op. cit. (28), 411.

(1633–84),[30] revealing the influence of Descartes, Harvey and Glisson, writes in his *On the Reason of the Movement of the Muscles* (1664),

> Relying on the testimony of my eyes, I will do what our great Harvey held that he must do when dealing with the vital spirits. He denied that there are such things outside the blood since he found them nowhere in his dissections. Thus, whenever I speak of animal spirits, I mean this very subtle liquor of the nerves, very lively and extremely volatile, exactly as we speak of spirit of wine or of salt …[31]

These were all naturalist models, for the nature of the vital heat is its agitation. Croone is quite explicit: 'This agitation itself is exactly what we call life.'[32] Descartes compared the nerves with pipes for the spirits to flow through and the metaphor of the pipe became common for the pores found in plants. We see the metaphor taken up by Hooke and Grew in their discussions of the circulation of the sap.

Dennis Des Chenes has remarked that Descartes's denial of the vegetative (and sensitive) soul amounts to the elimination of life as a natural kind. The physician and botanist Nehemiah Grew could hardly tolerate that. Grew seems to take the attempted naturalist reduction of life to subtle agitation as tantamount to eliminativism. Grew objects to the evident materialism of these views. 'Body', he writes, 'by being subtilized, can loose nothing of its Corporeity'. Further, if body, by being subtilized, could produce life, then presumably more or less subtlety would produce more or less life. But since everything is subtilized to some extent then, 'So the Steams of Animals, the Drops of a Mist, a Heap of sand … will all have some Life; but being less and less subtle, will have less: Which is all Subtle Nonsense.'[33]

Grew has a point – it is difficult to see how tiny bustling corporeal principles could be sufficient for life. But the problem does not go away by insisting that these principles need to be organized in some manner. The organization of a body relies on size, figure and mixture, but just as size or subtlety cannot be sufficient for life nor can figure or mixture. The same reductio applies: if figure is sufficient then everything is alive, and if mixture is sufficient then again, since all bodies but the principles are mixed bodies, all mixed bodies are alive.

Grew offers a significant argument from mechanism against the corporeal, and what we might call the functionalist, or organized, view of life:

> The Variety of the Mixture, will not suffice to produce Life … Nor will its being mechanically Artificial. Unless the Parts of a Watch, set, as they ought to be, together; may be said to be more Vital, than when they lye in a confused Heap. Nor its being Natural. There being no difference, between the Organs of Art and Nature; saving, that those of Nature are most of all Artificial. So that an Ear, can no more hear, by being an Organ; than an Artificial Ear would do … And although we add the Auditory nerves to the Ear, the Brain to the Nerves, and the Spirits to the Brain; yet is it still but adding Body to Body, Art to Subtility, and Engine or Art to Art: Which, howsoever Curious, and Many; can never bring Life out of themselves, nor make one another to be Vital.[34]

30 See William Croone, *On the Reason of the Movement of the Muscles* (tr. Paul Maquet), Philadelphia, 2000.

31 Croone, op. cit. (30), 73.

32 Croone, op. cit. (30), 71.

33 Croone, op. cit. (30), 33.

34 Croone, op. cit. (30), 33.

Still, we could go further. What if we added motion to the machine? Would we not then have a living machine? This is Descartes's body-machine. Descartes intended to deny the existence of the living soul, but to retain the appearances by showing just how the machine could move and maintain itself. Nevertheless, Grew is not himself moved by this: 'Were then, a Man, … nothing else but an Organized Body … Variously and Regularly moved: Yet after all, he would be no more, than a finer sort of Bartholmew-Baby.'[35]

In the jargon of the contemporary consciousness debate, Grew is noting that Descartes's man is a lifeless 'zombie'. We can conceive of such a man, but that would not be the conception of a man endowed with life or consciousness. Life cannot be identified with motion, nor with an organized body in motion. An organized body in motion is merely a puppet, a bartholmew baby, but is not genuinely alive. On the other hand, Grew admits that organization is, at least, necessary for the presence of life.[36]

We come finally to the last and more metaphysical possibility: that life is an adjunct of matter. Why not think, on analogy with motion, that life is superadded to matter, rather than being an attribute of a noncorporeal atom? In 1668 Grew had become interested in microscopic work on plants after his half-brother Henry Sampson had encouraged him to take botanical work more seriously, 'Which he did, partly, by mentioning a very pertinent passage of Dr. Glisson's de Hepate.' In *Anatomia Hepatis* (1654) Glisson advocates the use of the microscope in anatomy and encourages the comparison of plants with animals, a comparison that Grew took up and developed.[37] Glisson's views on matter were striking, attributing perception to matter in his later 1672 work *De Natura Substantiae Energetica* (*On the Energetic Nature of Substance*). But in the earlier work we find Glisson advocating

> qualities which are superadded to things by way of exaltation or eminence, and those same elements of the chemists are more or less obnoxious to qualities of this kind; such as fixation, fluidity, volatility etc., through which they undergo a change both in virtue and in name without destroying the former common nature they had before. And thus perchance the natural spirits become vital, and the vital animal, by eminent impressions. And thus every plant has his peculiar spirit; though they all agree in their common nature …[38]

Glisson's notion of the plant spirit is physico-chemical. He goes on to note that they may be mixed with 'salt or subtle sulphur'. Grew, however, cannot agree. Yes, motion is superadded to matter. Grew writes of motion,

> Body is not self-existent; because it is not Self-movent: For Motion is not of the Essence of Body; because we may have a definitive Conception of Body, abstracted from that of Motion. Wherefore Motion is something else besides Body; and something, without which, a Body may be conceiv'd to Exist. If then Body could move it self, it would have the Power of Making

35 Croone, op. cit. (30), 33.

36 This is all in keeping with the Aristotelian notion of the vegetative and sensitive soul which were incapable of existing independent of matter.

37 For a discussion of Grew's comparative anatomy see François Delaporte, *Nature's Second Kingdom* (tr. Arthur Goldhammer), Cambridge, MA, 1982; F. J. Cole, *History of Comparative Anatomy*, New York, 1975 (first published London, 1949).

38 Glisson, op. cit. (28), 32.

> Something of Nothing. And one single Atom, by multiplying its own Motion Infinitely, would have been able in time to make all the Motion in the World.[39]

So although we can conceive of matter without motion and motion added to matter we cannot, apparently, conceive of life added to matter. Grew's discussion of motion and matter is clearly theologically motivated. If motion were intrinsic to matter then it would have the power to produce something of nothing, but to admit this would undercut any belief in God. Self-moving matter is an atheists' conceit.

But can we not conceive of life added to matter? Are bodies not alive? Grew writes,

> Were Life, an immediate Adjunct of Body, as Motion is; then, as all sorts of Bodies are capable of all sorts of Motion; so they would be capable of all sorts of Life; even Intellection itself. That is, every Atome, as an Atome, would be capable of being Intellectual. To avoid which Absurdity, we must allow the being of a Substantial Principle, distinct from Body, as the proper and immediate Subject of Life.[40]

Grew draws out his analogy explicitly: 'What therefore Motion is, to all Bodies; that Life is, Suo Modo, to all Species of Vital Substance.' Communication between the two substances goes by way of motion and life, 'Life and Motion being … the Two Instruments of Commerce, between the Vital and the Corporeal Worlds'. Not surprisingly, Grew offers little more by way of clarification of such commerce. Grew's argument here may seem particularly flimsy; after all, to conceive of life as a superadded property does not require that it is, in fact, superadded to all physical bodies, despite Glisson's inclination to the contrary. But it should be remembered that Grew has already dealt with the more substantive idea that life is a property of the subtilized or the organized. These views take a subclass of physical phenomena as the proper subject of life, yet they fail, apparently, to accommodate our concept of life. What Grew addresses here is the very general idea that matter can have life as one of its attributes. If the answer is yes, then we agree that it is possible for a single corpuscle to be alive, which surely is not plausible.[41] Organization is necessary to, although on its own it is insufficient for, commerce with life.

Grew makes it clear that the noncorporeal living principle, or soul, is needed in order to direct the motion and activity of matter to their appropriate ends.[42] Grew distinguishes the three familiar species of soul: vegetative, sensitive and intellectual. Keen to advocate the need for the vegetative soul, most likely in an attempt to counter Glisson's enthusiastic defence of the perceptive soul, he remarks that it is needed to explain the appropriate motion of the heart after the animal has died, and for the motions of plants that are 'unaptly' called sensitive, and for the movement of sap. (The reference to plants

39 Grew, op. cit. (1), 5.

40 Grew, op. cit. (1), 34.

41 Grew, op. cit. (1), 34. But Grew's appeal to common sense was certainly not heeded by the likes of Anne Conway and Leibniz.

42 The link between the end and an active sense of being guided by the vegetative soul is particularly neo-Platonic. Contrast this view with Boyle's more Aristotelian 'passive' or 'mechanical' account of the end. Boyle derives his understanding from Harvey. See Robert Boyle, *Disquisition About the Final Causes of Things*, London, 1688. See also Don Bates, 'Machine ex deo: William Harvey and the meaning of instrument', *Journal of the History of Ideas* (2001), **61**, 577–93.

'unaptly called sensitive' is certainly an allusion to Glisson's views on these matters.)[43] In this regard Grew's ideas seem closely aligned with More, Cudworth and Ray. Grew does not, however, use the phrase 'plastic nature', but his invocation of directive noncorporeal principles is certainly found in John Ray's own apologetic work *On the Wisdom of God* (1691), himself following Cudworth and More.

Henry More in his *Enchiridium Metaphysicum* (1679) had argued that 'the alimentary principle of plants argues an incorporeal principle'.[44] More was responding to the mechanists, and may have had Grew in mind here. By 1701 Grew was likely aware of this passage. Certainly the issue was one Grew had lent some thought to. Prior to More's publication of the *Enchiridium Metaphysicum*, the Royal Society asked Grew to look into the matter of peristaltic motion in plants.[45] Much in keeping with his tendency to comparative anatomy that began with the animal as its model, Grew agreed that the flow of sap could be accounted for in analogous terms to the circulation of blood among animals. The key was to find the equivalent of the heart and veins. But this quickly turned out to be elusive, although some analogies were still drawn.

In his *An Account of the Vegetation of Trunks* (1675)[46] Grew offers us an account of the motion and course of the sap. The bleeding of plants is possible due to the internal pressure forcing the plant to yield its sap when cut. But the circulation of the sap is not exactly like that of the circulation of the blood. First, Grew observes that there are no valves due to the fact that 'the Trunk or Branch of any Plant being cut, it always bleeds at both ends'.[47] The pressure required for the rising of the sap needs an explanation, and Grew appeals to a combination of factors:

> First, That considering to what height and plenty, the Sap sometimes ascends; it is not intelligible, how it should thus ascend, by virtue of any one Part of the Plant, alone; that is neither by virtue of the Parenchyma, nor by virtue of the Vessels, alone. Not by the Parenchyma alone. For this, as it hath the Nature of a Sponge or Filtre, to suck up the Sap; so likewise, to suck it up but to a certain height, as perhaps, about an Inch, or two, and no more.
>
> Nor by the Vessels alone, for the same reason … We must therefore joyn the Vessels and the Parenchyma both together in this service.[48]

Grew appeals to the sponge-like quality of the parenchyma to explain the sap's circulation.

> For the pith and other Parencyhmous Parts of a Plant, upon the reception of Liquor, have always a Conatus to dilate themselves. As is manifest from Sponges, which are a Substance of the same Nature, and have a somewhat like structure … I say therefore, that the Parenchyma being fill'd and swell'd with sap, hath thereby a continual Conatus to dilate itself; and in the same degree to press together or contract the vessels which it surroundeth. And the said vessels being cut, their actual Contraction and the Eruption of the sap, do both immediately follow.[49]

43 See Charles Webster, 'The recognition of plant sensitivity by English botanists in the seventeenth century', *Isis* (1966), 57, 5–23.

44 Henry More, *Enchiridium Metaphysicum*, tr. and ed. Alexander Jacob as *Henry More's Manual of Metaphysics Part 2*, New York, 1995, 212.

45 Birch, op. cit. (3), 54.

46 N. Grew, *The Anatomy of Plants. Sources of Science, No. 2*, New York, 1965, 124.

47 Grew, op. cit. (46), 125.

48 Grew, op. cit. (46), 126.

49 Grew, op. cit. (46), 125.

Grew's explanation appears to be mechanistic, at least insofar as it appeals to pressure as the cause of the sap's motion. On the other hand, we are left with the sponge-like conatus as fundamental to the explanation.[50]

More's reflections on the sap lead him, predictably, to the Hylarchic principle or Spirit of Nature, for it is

> impossible that the alimentary sap ascend by some purely mechanical force to the top of such tall trees, when it is by itself sufficiently heavy in consistency, nor is such a heat found in trees which may attenuate and agitate and rarefy it to such an extent that it would seek, by virtue of that agitation and tenuity itself, the upper passages through the most narrow pores.[51]

But More also reflects on the need for the Hylarchic principle due to the remarkable fact that a tree comes formed from such a simple seed. That a directive force is needed to explain such development and growth seems evident to More and it appears that Grew too must appeal to the directive force of the vegetative soul.

So in Grew's earlier work we find a determined effort to offer mechanistic interpretations of phenomena, but by 1701 in the *Cosmologia* Grew writes that the vegetative soul is required to explain the beating of the heart and the circulation of sap. This change may well reflect the influence of More upon Grew's later, more apologetic thoughts. Grew may well have read More's criticisms of Boylean and Cartesian mechanism and perhaps was even moved by More's scepticism and his demand for a 'plastic nature' to account for the sap's circulation. Grew was deeply involved in the investigation of plants and the circulation of sap was one of his main concerns. We cannot be certain of More's influence. The assumption is a reasonable one, although it is perhaps more likely that Grew was following John Ray[52] rather than More directly, especially given the well-known disputes between More and Boyle. However, the eminent Ray scholar Charles E. Raven, writing in 1925, notes that

> it is curious that we know almost nothing of the relations existing between the two men who contributed most to Botany in England at this time … Grew's book [the *Cosmologia*], though its arguments are often identical, contains no clear evidence of connection with Ray's work, and may well be wholly independent.[53]

Atheism and active principles

What can we learn from Grew regarding the role of active matter in seventeenth-century English thought? John Henry has argued that the 'use of active principles in pre-Newtonian matter theory represents a clear and undeniable tradition in English mechanical philosophy'.[54]

Henry marshals considerable textual evidence to support this opinion, quoting from Hale, Glisson, Charleton, Hooke and Powers to name just a few. Henry's concern is to

50 Robert Hooke, *Micrographia* (1665), New York, 1961, 135, 21.

51 Henry More, *Enchiridium Metaphysicum*, Zurich, 1995, 212.

52 A. Rupert Hall in *Henry More*, Oxford, 1990, 260 suggests that More influenced Grew, but he offers no specific reason for thinking so.

53 Charles Raven, *John Ray*, Cambridge, 1942, 201.

54 Henry, op. cit. (10), 365.

correct overly enthusiastic readings of Newton's achievements. Contrary to some,[55] Newton did not make a radical break from his mechanistic colleagues by reintroducing 'occult' active principles into natural philosophy. According to Henry, the Cartesian claim that matter is wholly inert was by no means the predominant view among English thinkers of the 1650s and 1660s.[56] Henry singles out two important motives for the postulation of active matter. Active principles could be used to advocate the new experimental philosophy and to avoid theological problems:

> the claims about the possible existence of occult active principles in matter was an important aspect of the promotion of the experimental method. The occult qualities or principle of matter, so important for understanding the true nature of God's creation, could only be evinced, it was claimed, by experimental procedures.[57]
>
> Active principles … could be used to avoid the theological difficulties which were perceived to stem from systems of passive matter moving merely inertially. If God was no longer required to supervise the running of the universal machine, the atheist might argue that God had never been required since the universe may have existed eternally.[58]

Getting clear on the logic and motives behind the postulation of active principles is important to understanding the arguments for vitalism. Certainly, the postulation of active matter was supportive of and supported by the English distrust of Cartesian apriorism. The postulation of life as a vital, nonmaterial principle is due to the perceived failure of materialist and mechanist alternatives. Both theoretical postulations (that matter is active and that there exists a noncorporeal principle) are empirical in that they are justified by their alleged necessity for a sufficient explanation of nature. Cartesian inert matter appears insufficient to explain the phenomena of gravity and magnetism, and thus a more active notion of matter is required. According to the vitalist Grew, matter, active or otherwise, is insufficient to explain the empirical vital phenomena, and thus an incorporeal principle is required.

The threat of Cartesian atheism was felt by More in 1667 when he was asked to refute the philosophy he had introduced to Cambridge and had helped make popular.[59] But More's refutation of Cartesian philosophy is not the repudiation of inert matter; it is rather the refutation of Descartes's pretensions to explain all natural phenomena by appeal to the laws of mechanics. Matter is indeed inert, according to More, but this leaves us lacking an explanation for natural phenomena. The gap is filled by More's infamous Spirit of Nature.[60]

55 See R. S. Westfall, 'Newton and the hermetic tradition', in *Science, Medicine and Society in the Renaissance* (ed. A. G. Debus), New York, 1972.

56 I follow Henry in thinking that mechanism must be defined sufficiently broadly to include both those who were less enthusiastic over the postulation of active principles, such as Robert Boyle, and those who appear more so, such as Walter Charleton. This is in contrast to the view that we might take, which claims that the mechanists' mechanist rhetoric and explanatory practice were not consistent.

57 Henry, op. cit. (5), 338.

58 Henry, op. cit. (5), 337.

59 For the reception of Cartesianism at Cambridge see Ian G. Stewart, '"Fleshy books": Isaac Barrow and the orational critique of Cartesian natural philosophy', *History of Universities* (2000), **26**, 5–37.

60 See Alan Gombay, 'Henry More and the limits of mechanism', in *Henry More: Tercentenary Studies* (ed. Sarah Hutton), Dordrecht, 1990, 136–57.

But what of the active principles we find in many mechanist thinkers? The worry about atheism is not lessened by alleging the success of the hypothesis of active matter over Cartesian inert matter. It is difficult to see how the postulation of active matter is supposed to combat atheism. Unless that activity is interpreted as divine in some manner, the threat remains, for the issue is whether we need God in our explanation of the universe and its features. But the activity of matter that we find in Charleton's work, for example, does not have this divine or incorporeal nature. Charleton summarizes his modified Epicureanism as follows:

> (1) That Atoms were produced ex nihilo, or created by God, as the sufficient Materials of the World, in that part of Eternity, which seemed opportune to his Infinite Wisdom; (2) That, at their Creation, God invigorated or impregnated them with an Internal Energy, or Faculty Motive, which may be conceived as the First Cause of all Natural Actions, or Motions performed in the World; (3) that their gravity cannot subsist without a Centre; (4) that their internal Motive Virtue necessitates their perceptual Commotion among themselves, from the moment of its infusion, to the expiration of Natures lease.[61]

The Epicurean commitment to the eternal existence of atoms, and of their innate motion, is Charleton's concern. The Christian Epicurean must deny that atoms are eternal, and hence also that their motion is eternal. Charleton adds that at their creation the atoms are impregnated with an internal energy responsible for their continual action. Charleton makes it clear that the atoms' gravity, responsible for their motion, is an essential feature of the atoms.[62] Although motion is impregnated by God this motion is not analogous to the vital soul or More's plastic nature.

Charleton, however, makes life difficult for the interpreter for he appears to say incompatible things. He claims that motion (due to the essential gravity of atoms) is itself essential to the atoms,[63] and hence he appears to be a clear candidate for the active-matter tradition. Yet Charleton also tells us that motion is superadded to these atoms at the creation, which would imply that motion, although ubiquitous, is not essential to matter. But these claims do not appear to be consistent. If matter is essentially passive, requiring the superadditon of movement, then he should not attribute to the atoms' essence gravity, conceived as the cause of motion. Knowing the threat presented by the Epicurean claim regarding the eternity of the universe and its principles, Charleton insists that motion must be superadded – but if so, we might wonder why such matter is to be called 'active'. Indeed, Descartes also believed that matter had motion superadded by God, but Descartes is not to be included in an active-matter tradition.

The true reason that the mechanists avoid atheism is not so much because motion must be referred to God, for they can explain natural phenomena by reference to the innate motion of the principles, but because they are created in evident accordance with God's wisdom. However, this is not to deny the appeal of the argument from motion for God's existence among seventeenth-century natural philosophers. This argument was old and venerable and most readily found in Aquinas' work. No theist, mechanist or

61 Charleton, op. cit. (17), 126.

62 Charleton, op. cit. (17), 111.

63 Charleton, op. cit. (17), 112 lists four essential attributes of atoms, the last being: '(4) Gravity, or Weight; which is also coessential to them in respect to their solidity, and the principle of their Motion'.

otherwise, would shy away from appealing to it. However, that the argument was not itself deeply linked to mechanism or atomism reveals that it was not much support for the new philosophy. Neither was the argument empirically founded.[64] The existence of motion was empirically evident, but whether that revealed God's existence was another matter. The arguments from motion to God were distinctly a priori and awfully familiar to those trained in scholasticism. But the core metaphor of the new philosophy fitted beautifully with the argument from design (as it was later called).

More, Cudworth and the botanist John Ray can be seen as adhering to the inertness of matter in order to further their arguments for a plastic principle, or spirit of nature, guiding natural processes.[65] But for these thinkers the hypothesis of active matter must be shown to be insufficient, if the activity is understood naturalistically. More took up this challenge against Harvey's pupil Francis Glisson and, as we saw above, so too did Grew. Glisson was well known for his *Anatomia Hepatis* (1654), in which we find his corporeal account of life, and for his 1672 *Tractatus de natura substantiae energetica*. As noted above, in the latter, metaphysical work, Glisson attributed a form of perception to matter to explain its motion. But the success of such a system detracts from the need for a spirit of nature, or for Grew's incorporeal principles. In More's eyes it leads us back towards a self-sufficient nature lacking evidence of its dependence on God. Grew certainly saw the threat, confronting it head-on, arguing that no amount of organization, subtlety or motion is sufficient to make a body alive.

Considerations like these make me doubt whether the postulation of active matter by thinkers such as Glisson, Charleton, Power and Hooke was intended as a response to the threat of atheism. Henry has the emphasis misplaced. Active matter was postulated as a remedy to the paucity of purely Cartesian mechanical explanation, but not really as an antidote to atheism. Many who advocated active matter did so within the context of corporeal mechanism.[66] As we have seen, Grew objects to the attempted reduction of the vital to active, moving, or organized matter. The appeal to active matter is, according to Grew, part of the materialist, and hence atheists', attempt to prise nature from God.

Although I cannot do full justice to this claim here, I take it that the main weapon against atheism, shared by vitalist and nonvitalist alike, was the evident existence of final causes in the world mechanism.[67] The argument from motion to God's existence was not particularly mechanistic, nor particularly empirical in its structure and content, but the argument from finality to God's existence was well suited to the empirical requirements of the new philosophy and to its core ontological metaphor. The dissolution of Aristotle's distinction between natural and artificial things, and the adherence

64 I do not mean to suggest that only neo-Epicureans and mechanists count as members of the new philosophy. A commitment to experiment and Baconian methodology were also important. But even here, there was considerable disagreement regarding the role of reason, observation and experiment within the new philosophy.

65 John Henry makes this point in 'Medicine and pneumatology: Henry More, Richard Baxter and Francis Glisson's treatise on the energetic nature of substance', *Medical History* (1987), **31**, 15–40.

66 But not all of those who defended active matter did so within the context of corporeal mechanism, for Glisson does not count as a defender of mechanism.

67 See Boyle, op. cit. (42); Margaret J. Osler, 'Whose ends? Teleology in early modern natural philosophy', *Osiris* (2001), **16**, 151–68.

to the existence and knowability of their final causes, is the best weapon used by mechanists against atheists.[68] Alluding to Descartes, Cudworth writes in his monumental *True Intellectual System of the Universe*:[69]

> some professed Theists of later times, who might notwithstanding have an undiscerned tang of the mechanic Atheism, hanging about them, in that their so confident rejecting of all final and intending causality in nature, and admitting no other causes of things, as philosophical, save the material and mechanical only; this being really to banish all mental, and consequently divine causality, quite out of the world; and to make the whole world to be nothing else but a mere heap of dust, fortuitously agitated, or a dead cadaverous thing, that hath no signatures of mind and understanding, counsel and wisdom at all upon it; nor indeed any other vitality acting in it, than only the production of a certain quantity of local motion.

The postulation of active matter was, primarily, an attempt to remain mechanistic, while avoiding the obvious paucity of explanation derivable from Cartesian matter and laws of motion. But for Grew, More and Cudworth, this attempt to save mechanism plays into the hands of the atheists, who would deprive nature of God, or of God's closest representative, his 'plastic' principles. Cudworth requires 'signatures of mind and understanding, counsel and wisdom' which he then interprets as vital phenomena. Such signatures of intelligence were also evident to those keen to eliminate the trinity of souls retained by the 'Schoolmen'. After all, the commitment to nature as an artefact, engine or machine, even if interpreted as a 'vital mechanism', all but entails that each part has an end, or purpose.[70] This fundamental metaphor, required to legitimate and encourage the new philosophy, was itself one that could not be maintained without commitment to final causes. Furthermore, the commitment to final causes appeared to be empirically well grounded. Empirical observation and description of living phenomena was nearly impossible without implicit support for the ends and 'uses' of the mechanisms in question. Thus we find Henry Power writing eloquently of the flea:

> his head, body, and limbs also, be all of blackish armourwork, shining and polished with jemmar's, most excellently contrived for the nimble motion of all the parts: nature having armed him thus Cap-a-pe like a Curiazer in warr, that he might not be hurt by the great leaps he takes; to which purpose also he hath so excellent an eye, the better to look before he leap ...[71]

In the concluding pages of *Experimental Philosophy* Power advocates the mechanist picture:

> These are the days that must lay a new Foundation of a more Magnificent Philosophy, never to be overthrown: that will Empirically and Sensibly canvass the Phaenomena of Nature, deducing the Causes of things from such Originals in Nature, as we observe are producible by Art, and the infallible demonstration of Mechanicks: and certainly, this is the way, and no other, to build a true and permanent Philosophy: For Art, being the Imitation of Nature (or, Nature at Second Hand) it is but a sensible expression of effects, dependent on the same (though more remote Causes;) and therefore the works of the one, must prove the most reasonable

68 See John Redwood, *Reason, Ridicule and Religion: The Age of Enlightenment in England 1660–1750*, London, 1976, 54.

69 Ralph Cudworth, *True Intellectual System of the Universe* (tr. John Harrison), London, 1845.

70 The entailment is plausible only if we assume, as most did, that the architect does not act 'on a whim'.

71 Henry Power, *Experimental Philosophy* (1664 facsimile reprint ed. Marie Boas Hall), New York, 1966, 2.

> discoveries of the other. And to speak more closely to the point, I think it is no Rhetorication to say, That all things are Artificial; for Nature it self is nothing else but the Art of God ...[72]

Still, it is plausible that Cudworth's criticism was to include the English mechanists and not only Descartes.[73] Walter Charleton, for example, makes no reference to final causes in his *Physiologia*, but it should be remembered that Gassendi, who was Charleton's inspiration, had not himself rejected the existence of final causes.[74]

Gassendi's Christianized neo-Epicureanism could not make much sense without the parts of God's mechanism having a purpose.[75] In the early years of establishing the new philosophy the existence of final causes was, understandably, not a priority, their association with Scholasticism being too close for comfort. Charleton, for example, is more concerned with the revival of Epicurean explanations than with explicit defence of theism. In his *Physiologia* of 1654 Charleton is not so concerned with theological arguments, and does not utilize the argument from motion or the argument from design to persuade the reader of the theological credentials of his neo-Epicureanism.[76] But by the 1680s Robert Boyle finally confronted the issue in print in *The Disquisition About the Final Causes of Natural Things* (1687). Boyle remarks on his admiration for Descartes but rejects Descartes's view that the ends of things are unknowable. Boyle points out that Descartes himself appears to make assumptions of finality in his physics.[77] Furthermore, the great Harvey was also committed to their existence. Boyle is highly critical of renaissance thinkers that construed finality as anthropocentric, and he admits that it is obscure what the final causes might be in astronomy and mechanicks, but he cannot deny the evidence of his senses when it comes to the more animate parts of nature. Descartes's epistemological repudiation of final causes was giving credence to the suspicion of atheism, but the mechanical philosophy had no need for restraint on this matter, and its theological credentials could be established by making explicit, as Boyle did, the existence of God's intentions in nature.

Teleology and passivity: Bayle's critique of Grew and Cudworth

The appeal of vitalism was long-lasting, but the arguments that inclined a thinker to the postulation of life as a distinct principle were not. Grew's conceptual arguments were not likely to last in an age that had already become increasingly suspicious of the dictates of pure reason. One argument remains constant, however: the inability of reigning mechanist models to account for vital phenomena, in particular the phenomena of

72 Power, op. cit. (71), 192.

73 My thanks to the anonymous referee for this point.

74 Boyle notes that Gassendi and other recent Epicureans recognize final causes. See the preface in Boyle, op. cit. (42).

75 See François Duchesneau, *Les Modèles du vivant de Descartes à Leibniz*, Paris, 1998, Chapter 3, and Margaret Osler, op. cit. (67).

76 But he does allude to such arguments and does utilize a number of arguments against atheism in *The Darknes of Atheism Dispelled by the Light of Nature*, London, 1654 (which he refers the reader to). Here he utilizes the teleological argument from order. Order is the product of intelligence, for it cannot be the result of chance.

77 Boyle, op. cit. (42), 11.

coordinated action of diverse parts towards, in Robert Boyle's phrase, 'a suppos'd End'. Religious concerns were not always explicit in later thinkers, but teleological phenomena have often been a source of inspiration for vitalists. As Pierre Bayle's critique of Grew and Cudworth reveals, much work was needed, and is still needed, to sort out the relations between teleology, vitalism and the theological implications of active matter.

In part one of *Cosmologia Sacra* Grew discusses 'The uses of things'. The discussion is clearly theologically motivated, illustrating the power and wisdom of God in his corporeal creation. But vital principles are not mentioned at this point, leaving the reader with the suspicion that vitality and teleology are separate concerns. Indeed, they could well be separate, since it is by no means clear that we cannot have a non-vital yet purposively designed machine. By 1701 the pocket watch was the most common and tired example, and of course Descartes's denial of the vegetative soul implied just this image of a world-machine. But such first impressions must be put aside, for in the very next book, devoted to the vital world, Grew draws out the connection. Having rejected on broadly a-priori grounds the materialist attempts to identify life with matter-in-motion, subtlety, organization and so on, Grew claims that vital principles are required to make sense of teleological phenomena. Indeed, Grew comes close to identifying the phenomena:

> On the Directive Power of the former [vital principles] and the Regularity of the latter [corporeal bodies], whereby it is capable of Direction; depends the Generation of all Bodies. The said Power, being one and same Vegetable Life, infused into all the Parts of Corporeal Nature; but more remarkably into Plants and Animals.[78]

Comments like these make Grew sound very much like a panpsychist. From the last sentence we have the impression that all bodies are associated with a vital principle, but in plants and animals this is simply much more evident. Grew continues,

> In the consideration of Plants, I have set down the Method of Generation, step by step, as far as the Regularity of Principles will go. But for the performance of this Work, a Vital or Directive Principle, seemeth of necessity to be assistant to the Corporeal. For as no Generation can be made, without Principles regularly figur'd: So, it seemeth, that no Principles, without being assisted to a determinate Motion, can be Regularly, that is, in due Order and Proportion, brought and united together.[79]

A 'Vital or Directive Principle', writes Grew. To have the parts of an animal come together appropriately, we need to postulate a vital directive principle. Teleology, according to Grew, requires vitality.

It must be noted again, however, that it was already uncertain that teleological phenomena required vital phenomena. Robert Boyle in his *Disquisition About the Final Causes of Things* (1688) makes no use of vital principles, but defends the existence of teleological phenomena. For Boyle, God must make 'the original' of things and then sets them in motion, but there is no need for a directive principle in addition. In the *Cosmologia Sacra*, Grew, unlike John Ray in his *Wisdom of God*, fails to refer Boyle's

78 Grew, op. cit. (1), 35.
79 Grew, op. cit. (1), 26.

Disquisition, although Grew excuses his general lack of references with the familiar sentiment that the book of nature is his primary text. Still, one may wonder whether the omission signals an important disagreement with Boyle, who Grew earlier in his life could not but admire. My concern here, however, is to draw attention to Grew's vitalist teleology, for it is this feature that Bayle comments upon.

Three years after the publication of Grew's *Cosmologia Sacra* Pierre Bayle was in the middle of an ongoing debate with the rationalist Arminian Jean le Clerc.[80] Le Clerc, in his defence of theism, had translated tracts of Cudworth and Grew for his French audience. But the debate between Bayle and le Clerc is not my primary concern; indeed the proper interpretation of Bayle is no easy matter and I happily leave it to others.[81] We should also note that Bayle cannot here be taken as an authority on Grew or Cudworth. Bayle did not have a command of English, so his response to their views relied on le Clerc's translations. Nevertheless, Bayle's brief comments on Grew and Cudworth nicely reveal the issues discussed above.

Bayle's critique reveals just how passivity and activity were being utilized in the theological and scientific debates, and Bayle understands the issue well, arguing that Grew and Cudworth subvert their own intentions to defend theism. Cartesianism, pure and simple, is better suited to demolish atheism. Bayle begins,

> *Vous ne sauriez croire le tort qu'ils font à la bonne cause, sans que ce soit aucunement leur intention. Rien n'est plus embarassant pour les Athées que de se trouver réduits à donner la formation des animaux à une cause qui n'ait point l'idée de ce qu'elle fait, & qui exécute régulierement un plan sans savoir les loix qu'elle exécute. La forme plastique de Mr. Grew, sont cependant dans le même cas, & ainsi ils ôtent à cette objection contre les athées toute la force. Car si Dieu a pû donner une semblable vertu plastique, c'est une marque qu'il ne répugne point à la nature des choses qu'il y ait de tels agens; ils peuvent donc exister d'eux-mêmes, conclura-t-on.*

The problem is this: most embarrassing for the atheist is the evident existence of final causes – the formation of animals occurs without the animal (or anyone else for that matter) having knowledge of the laws that execute the plan. But then Cudworth's plastic nature and Grew's vital principles will themselves have the same problem. Postulating a vital principle to explain the teleological phenomena explains nothing, for the vital principle itself is also in need of direction, since the vital principles themselves lack the kind of knowledge required to construct an animal. The teleological objection to atheism will thus lose all its force. But the situation is even worse, for if we concede that the vital principle directs matter without knowledge of the end or knowledge of the principles it follows, then we could just as easily grant that the matter exists with this vital principle essential to it from the start.

80 For the debate see Pierre Bayle, *Oeuvres*, 4 vols., La Haye, 1727, iii, 216–17, 881, 996–7; also iv, 181, 184, 865, 873; 'L'Histoire des ouvrages des savants', in ibid., article 7 and 12 (1704); Jean le Clerc, *Bibliothèque choisie*, 29 vols., Amsterdam, 1714–30, v (article 4), vi (article 7), vii (article 7).

81 See Elizabeth Labrousse, *Bayle*, Oxford, 1983; Bayle, *Du Pays de foix à la cité d'Erasme*, The Hague, 1964; Bayle, *Hétérodoxie et rigorisme*, The Hague, 1967; E. D. James, 'Scepticism and fideism in Bayle's *Dictionnaire*', *French Studies* (1962), **26**, 307–24; Harry Bracken, 'Bayle not a skeptic', *Journal of the History of Ideas* (1964), **25**, 169–80; Thomas M. Lennon, *Reading Bayle*, Toronto, 1999.

> *La forme plastique de Mr. Grew, sont cependant dans le même cas, & ainsi ils ôtent à cette objection contre les athées toute la force. Car si Dieu a pû donner une semblable vertu plastique, c'est une marque qu'il ne répugne point à la nature des choses qu'il y ait de tels agens; ils peuvent donc exister d'eux-mêmes, conclura-t-on.*

Grew had argued that we could not have life superadded to matter and he had also argued that matter is essentially passive. But according to Bayle, if we appeal to a vital principle to explain teleological phenomena, and the vital principle also lacks knowledge of its end, then the atheist could just as well argue that vital matter existed from the beginning – and teleological phenomena would thus be accommodated. The postulation of a natural compatibility between, on the one hand, unknowing yet directive vital principles and, on the other, something like passive matter, allows the atheist to have a concept of active directive matter. But as we noted above it is exactly this conception of matter that Grew and Cudworth were keen to avoid. Bayle brings this out explicitly, writing,

> *Vous comprendrez ceci par une comparaison. Si la matiere peut recevoir de Dieu la force motrice, il y a une compatibilité naturelle entre la matiere & la force motrice. On peut donc suposer également & que la matiere existe par elle-même, & que la vertu motrice lui est propre essentiellement. Ceux qui suposent comme la plûpart des Cartésiens que la matiere est incapable d'être investie de la force de se mouvoir, & que Dieu seul peut produire le mouvement, sont beaucoup plus en état de démonter les Athées.*[82]

If we allow that God gives matter motion, then we must allow a natural compatibility between matter and motion. Thus, if we allow a vital principle directing matter we must allow a natural compatibility between the vital principle and matter. But if the vital principle is capable of directing matter, then we would be allowing the possibility of self-moving (directive) matter. Grew's view, it would seem, collapses into the position it was intended to avoid. Bayle ends with a sentiment that Grew would have found congenial: like most Cartesians Grew denies that matter can have the power of self-movement. But Grew has not realized that the postulation of a vital principle allows the atheist to assert the coherence of self-moving or directive matter after all. Poor Grew! His sensitivity to empirical phenomena reveals, as it did for many of his fellow Englishmen, the poverty of Cartesian explanations of living phenomena. His theological sensitivities require that he avoid the notion of active matter popular among many of his colleagues. But as Bayle points out, the postulation of a vital principle, naturally compatible with matter, and capable of directing matter, leaves the atheist with the conceptual resources to explain teleological phenomena without God. The atheist threat of active self-moving matter is not lessened by the appeal to Grew's vital principles and this irony was not lost on the theist Pierre Bayle.

82 See Pierre Bayle, *Oeuvres*, 4 vols., La Haye, 1727, iii, 216–17.