7

Robert Boyle, the Empire over Nature

7.1 Nothing Is Necessary: Benjamin Worsley Revisited

Robert Boyle's immersion in the life of an experimental chemist seems to have been preceded by his encounter as a teenager with the virtuoso Benjamin Worsley and strengthened by the enthusiastic support of Samuel Hartlib. Boyle's early correspondence shows that his personality partook of much of Hartlib's capacity for inquiry and for sharing scientific matters with others, and therefore that he had the potential to be a key player in the realm of science himself. An important number of writings showing his inclination to theory from an early age indicate, as we have seen, that Boyle was already a (moral) philosopher. However, according to Michael Hunter, Worsley was 'his evident mentor' in such matters as chemistry and experiments.[1] It may have been the case that Boyle's social status and wealth prevented a more common student/mentor relationship. Nonetheless, Worsley's intellectual ascendancy over Boyle is visible in their early correspondence. And then there is, of course, the Irish connection. Worsley was working in Ireland by 1640 and Boyle himself was born at the iconic Lismore Castle. Boyle's father, the First Earl of Cork, was one of the main seventeenth-century English planters in Ireland, and Boyle was his youngest son; Cork and his second wife Catherine Fenton (1588–1630) had 15 children. Cork's legacy in the history of Ireland was impressive though controversial, mainly due to his activities as a land grabber. Nicholas Canny has argued that Boyle's bent towards practical science as a divine command, advancement of social discipline and broad Protestantism, neither sectarian nor marked by absolute conformity, were characteristics inherited from his father. Boyle would pursue the trajectory indicated by these tendencies with growing confidence and erudition throughout his career. Canny's suggestion was that the encounter with the Hartlib circle was a propitious

[1] Hunter, *Boyle: Between God and Science*, p. 70; see also, Harwood, 'Introduction' in *The Early Essays and Ethics of Robert Boyle*, p. lxiii.

circumstance in Boyle's scientific career, but not much more, for the seed was planted in Ireland.[2] This seems accurate also in view of the pains his father took to provide him with an exquisite social and intellectual education, in England (Eton) and, in particular, in Florence, Rome and Geneva.[3] Thanks to his wealth Boyle was very soon acknowledged as a 'mecenas' by other important scientists, and only after that as a scientist. It was in terms of patronage that a young William Petty (1623–1687) wrote to an even younger Boyle. The physician and economist Petty (to whom we will return later) was four years Boyle's senior and engaged in a rivalry with Worsley in the management of certain Irish affairs that would signify a permanent disadvantage for the latter. Boyle's admission, at a precocious age, to the Hartlib circle probably stems from his extraordinary position in society.[4] Interestingly, Canny also mentions the possibilities of experimentation and creativity offered by Ireland. Every new administrator thought himself to be destined to improve on what others had done before, and Boyle's father seems to have been only one of the most entrepreneurial of them. Meanwhile, the natives looked on in resignation or rebelled in their misery.[5]

Thomas Leng points out that Worsley's part-time practitioner scientist approach would be overridden by the impending Scientific Revolution, which involved the ever more sophisticated standards of method, experiment and exposition that Boyle represents.[6] Although Worsley was only nine years older than Boyle, they belonged to different generations of scientists, and even different worlds, in this respect. Another difference – and a feature of Boyle I want to highlight in this chapter – is how well-read in the most modern philosophy of the time he was. Partly as a consequence of his aristocratic and opulent upbringing and partly of his own erudition, criticism of and active struggle against the 'vulgar' – understood as that which has not been subjected to proper critical reflection – is a key thread that runs through his writings.[7] *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, analysed in the following text, represents the culmination of this

[2] Nicholas Canny, *The Upstart Earl. A Study of the Social and Mental World of Richard Boyle, First Earl of Cork, 1566–1643* (Cambridge: Cambridge University Press, 1982), pp. 139–150.

[3] His family connections propitiously allied themselves with the Parliamentarians after the War. This biographical information in Hunter, *Boyle: Between God and Science.*

[4] Hunter, *Boyle: Between God and Science*, p. 51; Harwood, 'Introduction', p. xxii.

[5] Canny, *The Upstart Earl.*

[6] Leng, *Benjamin Worsley (1618–1677) Trade, Interest and the Spirit in Revolutionary England.*

[7] Michael Hunter notes several times the lavishing expenses for his children by the First Earl of Cork that must have left a character trace in Boyle, Hunter, *Boyle: Between God and Science*, p. 27. The social station of Boyle may be illustrated by the correspondence cited by Michael Hunter between the first Earl of Cork and the tutor in Geneva of Francis and

critical endeavour and shows its fruitfulness as well as the risks involved in the wielding of Boyle's elitist razor.[8] Certainly, he was an experimental philosopher, with equal stress on each of those words. Moreover, he belonged to an intellectual network that allowed him to meet personally many philosophers, scientists and virtuosi, and, strikingly, also to know well and admire the work of the Epicurean Pierre Gassendi when he was barely 20 years old.[9] For instance, on 9 May 1648 Hartlib copied for Boyle an extract from a letter from Sir Charles Cavendish to William Petty, in which Cavendish – in addition to noting how much Hobbes had liked a letter from Petty and describing an important experiment as to whether vacuums exist – wrote as follows about Gassendi's forthcoming book on the life of Epicurus:

> your worthy friend and mine Mr. Gassendi is reasonable (*sic!)* well, and hath printed a book of the life and manners of Epicurus since your going from hence. He hath now in the press at *Lyons* the philosophy of Epicurus, in which I believe we shall have much of his own philosophy, which doubtless will be an excellent work.[10]

Robert Boyle, Isaac Marcombes. Marcombes urged Cork not to allow that the boys got a too clear grasp of their "greatness" and wrote to him that "every one thinks that because I belong to my Lord of Corke I must have the Philosophical stone" Hunter, *Boyle: Between God and Science*, p. 45; John Harwood highlights the years of financial strain during the civil wars, in which the Earl died and his landed property and inheritance to his children remained in an uncertain position. Harwood, 'Introduction' in *The Early Essays and Ethics of Robert Boyle*. By 1645, when he returned to England, Boyle could have access to his immense inheritance, considering in particular that (although a favourite) he was just the youngest of many children. Michael Hunter reports that Boyle, a teenager, inherited rentals of about 3.000 pounds a year, which made him the equivalent to a millionaire of the twenty first century. His fortune required a great deal of administration, and trouble. Not the least of it caused by the fact that extensive parts of Boyle's land had been confiscated from the Church by his father. Since the money of those rentals could have been employed to help spreading the Gospel and in the cure of souls, this would prove to be later a source of anxiety for the conscience of the pious Boyle. Hunter, *Boyle: Between God and Science*, p. 40 and generally Chapter 2, and Hunter, 'The Conscience of Robert Boyle'.

[8] Already for instance in the unpublished *Aretology* that he wrote as a teenager: 'And by Seeming Vertus I heere understand, Certin splendid and less observed Vices, opposed to other Vices more generally taken Notice of and Condemn'd, which therefore the Ignorant Vulgar mistake for reall Vertus.' Boyle, 'The Aretology', p. 135.

[9] Boyle writes that the counsels Hartlib gave to the tutor John Pawson for applications 'to make to those three mathematicians, can promise a great deal of probability for their success: specially *Gassendus*, a great favourite of mine, I take to be a very profound mathematican, as well as an excellent astronomer, and one, that has collected a very ample treasury of numerous and accurate observations of all, that belongs to the abstruse science of those sublime bodies.' 'Robert Boyle to Samuel Hartlib, 8 May 1647', *The Correspondence of Robert Boyle*, vol. 1, 1636–1661, p. 59.

[10] Samuel Hartlib to Robert Boyle to 9 May 1648, *The Correspondence of Robert Boyle*, vol. 1, p. 66.

This was the sort of information that interested Boyle. If Boyle was from the beginning a philosopher, Worsley and Boyle's interests in common – in terms of nature and in relation to esoteric principles and economic ideas – may be summarized in few words: trade and plantations, alchemy, medicine and astrology. Lawrence Principe has shown that Boyle never abandoned his pursuit of the philosopher's stone, and has enumerated his changing motives in relation to that activity 'as a tool for dissecting nature', for the production of medicines and for enabling his philosophy of nature to ascertain the truths of theology.[11] These motives indicate that Boyle followed in Worsley's footsteps and also frame the recurring topics that prompted the Scientific Revolution. They comprise the achievement of a flourishing public economy, care of the human body, veneration of the spirit and an avidness in the pursuit of knowledge about nature.

7.1.1 Mentoring Boyle

Three of Worsley's letters, which take the form of essays imparting knowledge, particularly show the heritage that the administrator, scientist and millenarian shared with Boyle, the wealthy aristocrat, enlightened scientist and governor of the New England Company. None of them have an identified recipient and only the first two identify Worsley as the author.[12] The editors of Boyle's correspondence considered that the author of the third and longest letter written in late 1658 or early 1659 was also Worsley and the recipient Boyle. John T. Young remarks that Hartlib was circulating these two letters as there are several copies of it among his papers, and he describes them as 'something of a manifesto of natural philosophy', as indeed they are.[13] The tone of the second letter is rather casual, as if written to a close friend; the overall content points with some probability to Boyle also being the recipient. Common themes such as microscopes, names – such as Ahasuerus Fromanteel (1607–1693) the glass and watchmaker – the key themes of 'air' and the purpose of natural philosophy, at once high and useful, recur throughout the three letters.[14] Worsley also thanked the

[11] Lawrence M. Principe, *The Aspiring Adept. Robert Boyle and His Alchemica Quest* (Princeton: Princeton University Press, 1998), p. 7.

[12] The first two letters of June and July 1648, that is, of more than a decade earlier are found also among Hartlib's papers copied in a single document with Worsley indicated as his author and with no recipient.

[13] Young, *Faith, Medical Alchemy and Natural Philosophy*, p. 222, n. 54.

[14] Antonio Clericuzio's study on some papers contained in Boyle's *History of Air*, that were in reality authored by Worsley proved that the latter's role on the development of Boyle's

recipient for the copy of a letter from 'Dr. Goddard' – probably the physician Jonathan Goddard (1617–1675) whom Quentin Skinner paired with Boyle as 'the religious forces' among the Founding Fellows of the Royal Society.[15] It was in Goddard's lodgings, moreover, that the first embryonic group of what was to become the early Royal Society was to meet after 1645, because he had a machine for grinding glasses for telescopes and microscopes.[16] Boyle was associated with this group at least since 1646.[17]

In the first letter, Worsley described a certain glass for the microscope that Fromanteel had given to him that after special rubbing and grinding magnified the vision of things to a measure hitherto unknown to him. Worsley commented that the microscope was as good as some made in France, of whom 'Mr. Petty' (William Petty) had assured him that he possessed one, 'Mr Hobbes of Paris giving it to him'. Worsley then begged his addressee to bring up the topic of optics when he met with Petty and to try to see the latter's microscope, so that they could later compare it with Fromanteel's. In the second letter, written in Amsterdam, Worsley explained at length why Fromanteel's glasses were of such importance – in a nutshell, they buttressed the design argument of nature.[18] In an environment of convinced atomists, by showing the beauty of creation to its most minuscule aspect, they proved that God was its designer, and that nature was not the outcome of mere chance. The first philosophical and theological reason for this was that they helped to prove the maxim by which, above any other method, the wisdom of God might be ascertained.

natural philosophy was more important than thought previously. Antonio Clericuzio, 'New Light on Benjamin Worsley's Natural Philosophy' in *Samuel Hartlib and Universal Reformation. Studies in Intellectual Communication* (Cambridge: Cambridge University Press, 1994).

[15] Quentin Skinner, 'Thomas Hobbes and the Nature of the Early Royal Society' in 12 *The Historical Journal* (1969), p. 225.

[16] This was the account of the mathematician John Wallis (1716–1703) describing the members of the meetings and the places where they met, quoted in Thomas Birch, 'The Life of the Honourable Robert Boyle', in *Works of the Honourable Robert Boyle* (London: Pr. For J and F. Rivington et al. 1772), v. I, p. xlii.

[17] In his biography of Boyle Thomas Birch made the link between the cryptic 'Invisible' or 'philosophical college' which Boyle mentioned sometimes in this period between 1646 and 1649, and this first group of scientists. The Invisible College could not be the Hartlib circle, as also noted by Michael Hunter, for the very reason that Boyle reported to him about it in a letter to satisfy his curiosity, Hunter, *Boyle: Between God and Science*, p. 66. On the Invisible College see also section 4.2.1.

[18] Thomas Leng thinks that the addressee was Hartlib; but the editors of Hartlib's papers still keep it open. As I wrote above, I think that it might be Boyle. Copy Letters, Benjamin Worsley to?, 22 June 1648, 27 July 1648, Ref. 42/1/1A-2B: 2B Blank, in *The Hartlib Papers.*

Looking at the singular individuals of any species through the glasses, one might observe that they had 'not only a numericall forme as the schooles say, but an outward visible externall character or difference to distinguish them one from another'. Not only every man, but every animal, and in Worsley's example 'every sand is knowne by its name'. The glasses had helped him see that every grain of sand was different in colour, form and shape, although they all seemed round in the hand. The second motive was that in the bigger project of classifying plants, the microscope greatly facilitated investigation into 'seeds and flowers'. Worsley considered that 'this [little] Atlantis', and 'Unknown part of the Creation', unexplored at the time could fill many scientific volumes in the future.[19] With regard to his scientific manifesto, also touching on the rejection of the vulgar, Worsley was straightforward:

> For I now having abdicated much reading of Bookes, vulgare received Traditions & common or Schoole opinion, have divided knowledge into Divine & humane. For divine I acknowledge none to be the necessary Rule of faith but what the spiritt of god hath sett doune plainely, in simple & univocall tearmes & easy to the understanding of any, looking upon all poynts contreoverted, as the opinions but at best, if not the Inventions & pryde of men … For humane knowledge I honour only that which is immediately deduced from or built upon Reall, & certayne Experiments; & those so many as to make an infallible universall; seeing according to the Schooles, science is not of particulars.[20]

Worsley's manifesto on natural sciences was a petition for theological independence, with no 'necessary rule of faith' or philosophical principle beyond faith in experimentation on a vast scale. His argument was that among 'good men' there ought not to be 'difference of opinion', since the Spirit of God was 'one' – a statement that seems rather terse and even eccentric in his ideological and political context.[21] However, it is possible that Worsley's charm lay precisely in that capacity to urge a mental state oblivious of the surrounding reality, an attitude that probably imparted much creative freedom to Boyle. The aim was practical: a 'natural history' or observations and description of the geography and

[19] Benjamin Worsley to?, 22 June 1648, 27 July 1648, in *The Hartlib Papers*. The grain of sand as an explanans was apparently a common trope of seventeenth-century atomists, see e.g. in Thomas M. Lennon, *The Battle of the Gods and Giants: Legacies of Descartes and Gassendi. 1655–1715* (Princeton: Princeton University Press, 2014 (1993)), p. 142.

[20] Benjamin Boyle to?, 22 June 1648, 27 July 1648, in *The Hartlib Papers*.

[21] Copy Letters, Benjamin Worsley to?, 22 June 1648, 27 July 1648' in *The Hartlib Papers*.

peoples of the world, in the style of the geographical editor and compiler Samuel Purchas (1575–1626), but infused with the new scientific spirit.[22] Great knowledge would be thus produced on (among many other things that he listed) the fruits and products of nature, plants, fish and minerals, 'convenient or pleasurable for mans use or in things hurtfull & inconvenient' and, on whether '[i]ts use medicinall, oeconomicall & mechanicall either by Inhabitants or by other Countries' could be advanced.[23] No better example of what Vera Keller has called 'the wish list' may be found: a dramatized enumeration of knowledge, reconceptualized as shared desires, projected as an alluring future and thus transformed into public interest.[24]

Moreover, for the industrious Worsley, these were not theoretical or utopian proposals. He would ascend on several occasions to the highest echelons of the only institutions that could make something of them during his lifetime. We saw in Chapter 4 that he was closely involved, during the Interregnum, in the Council of Trade and Commonwealth in promoting trade scientifically through the Navigation Acts. Thomas Leng has traced, by reference to Worsley's expert reports, copied by John Locke in his *Notebook*, the way in which Worsley planned – in the Council of Trade of 1668 and, later in the Council for Trade and Foreign Plantations (1670–73) – the regulation of trade from the late 1660s onwards. He achieved his aims by promoting single commodities, and in particular sugar. Thus, he wrote a substantial report to the Duke of Buckingham (1628–1687) in the summer of 1668, in which he noted that through the reduction of taxes, encouragement of cultivation and careful management it was feasible for the plantations of the West Indies 'to make us the sole Masters of Sugar to all the world'. He opined, according to Leng somewhat over-optimistically, that the sugar trade could soon amount to 1 million pounds.[25] Worsley's was indeed a good example of how to undertake applied science.

[22] Worsley specifically praises the possibilities that Purchas' works offered. Copy Letters, Benjamin Worsley to?, 22 June 1648, 27 July 1648' in *The Hartlib Papers*; see also David Armitage, 'Samuel Purchas (bap. 1577, d.1626), geographical editor and compiler and Church of England clergyman', *Oxford Dictionary of National Biography*, https://doi.org/10.1093/ref:odnb/22898.

[23] Copy Letters, Benjamin Worsley to?, 22 June 1648, 27 July 1648, *The Hartlib Papers*.

[24] Keller, *Knowledge and the Public Interest, 1575–1725*.

[25] Thomas Leng notes that two centuries later sugar's trade produced still half that figure, Leng, *Benjamin Worsley (1618–1677) Trade, Interest and the Spirit in Revolutionary England*, p. 150.

7.1.2 *Worsley the Prophet*

The style of Worsley's third letter is much more prophetic, perhaps cabalistic.[26] In it he disclosed to Boyle the 'Great Instauration and Reformation' of medicine, his reasoning swiftly jumping, without philosophical elaboration, from 'physicks' to 'Scripture'. As a rule, Worsley promised results impatiently, even results of the most extraordinary kind, and despite his erudition, his writing style was that of the memorandum writer.[27] This letter is no exception. The theme of the letter was about the 'nature & essence of Health', inquiring about 'what may dissolve this natural & well constituted Oeconomy of nature', by which he referred to a healthy human body. The key question was whether death was 'laid upon us by a fatality or necessity or no' and his remarkable answer was that *it was not*.[28]

After a brief introduction, he recommended robust knowledge of aetiology, the doctrine of causes of distempers, and the production of 'hystoryes' of the best 'methods used in Medicine in all ages and nations'.[29] In sum, his substantial argument amounted to attributing the cause and power of human beings' death to the Devil and to human worldly desire:

> Death as it had no entrance at the beginning into Adam, soe noe power fatality or necessity over the Posterity of Adam since. by or from any Law or Decree of God originally or Inevitably occasioning of it He (not soe far as we read in his word) either appointing of Death, or requiring any thing of his Creature, tending or leading in the least to Death.[30]

If death was unnecessary, God, the 'great buylder of nature', was not responsible for human deaths and could not be charged with having

[26] Worsley puts in parallel 'the science of a Schooleman, of a Caballist of an Universall Scholar with that of an Ideot or a common Clowne', 'Worsley to Boyle, (late 1658-early 1659)', in *The Correspondence of Robert Boyle*, v. 1, p. 309; for Christian Kabbalah though not dealing with seventeenth-century England, see Peter J. Forshaw, 'Christian Kabbalah' in Glenn Alexander Magee (ed.), *The Cambridge Handbook of Western Mysticism and Esotericism*, (Cambridge: Cambridge University Press, 2016).

[27] The size of his library also speaks about his erudition. It counted 1857 books, sold after his death, Leng, *Benjamin Worsley*, p. 174.

[28] Worsley pointed here to some sort of secret society: 'Liberation from the common state of mortality & corruption: which state there are some perhaps in the earth (though not knowne save unto some few) who presume & that not without ground they shall see.' 'Worsley to Boyle, (late 1658-early 1659)', *The Correspondence of Robert Boyle*, v. 1, p. 308; p. 310.

[29] 'Worsley to Boyle, (late 1658-early 1659)', *The Correspondence of Robert Boyle*, v. 1, p. 307.

[30] 'Worsley to Boyle, (late 1658-early 1659)' *The Correspondence of Robert Boyle*, v. 1, p. 312.

produced a 'system' that was disproportionate or allowed 'Deorganization into the body'.[31] On the contrary God had promised human beings the spirit of life. The 'Rarefaction & Coagulation' that occurred in the human body was attributable to the devil, who was a lier, and 'Lye' himself.[32] 'Satan' had the power to 'alter the whole frame and Oeconomy of this our outward & humourall substance'. Death followed the 'rule & Dominion permitted to him in the Aire'. Boyle's lifelong interest in the study of air is perhaps illuminated by Worsley's following claim:

> Now if man have a power in his spirit greater then that of the Divell who is no more than a spirit, nor so much indeed as one of our spirits. If man also through the wisedome of his spirit knoweth how to temper the aire how so to correct it or medicate it as to avoid the evill influences of it … All which wee must plainely say we beleeve Possible, then Death for this Reason as well as for the former is not fatall.[33]

The argument made was that the 'causes of death' were 'partly Physical partly mysticall or Theosophicall'.[34] In that vein, Worsley proceeded to enumerate a strict 'Traine' of causation the result of which was the death of human beings at the end of the chain. First, 'the pretious spirit' in a human being consented to be subjected to the flesh, the light of sense and the light of his imagination – i.e. the 'light created by the spiritus mundi' – and thus was 'throwne downe from it owne true station and seate'. In a second stage a *desire* for the world appeared. This subjection of the spirit to flesh 'introducing & kindling a lust in the spirit of man to a union with the spirit of the world'. In Worsley's account it was human desire for the world that ultimately caused natural death:

> And for as much as the desire giveth Increment to the soul every soul or spirit growing both in bulke as its desire is more or lesse powerful & strong & growing in nature according to the nature of that with which & Into which its desire is fixed & placed Through this desire or lust therefore of the pretious mind or spirit of man after an union with the outward light glory or goodly appearance of the spirit of the world (which desire or lust the scripture calls sin as being the roote of all sin) the spirit or mind itselfe doth insensably & by degrees transforme it selfe & is become transformed into the very Nature of the spirit of the world soe loosing & by degree insensably puting of its own nature which is a spirit of light.[35]

[31] 'Worsley to Boyle, (late 1658-early 1659)', *The Correspondence of Robert Boyle*, v. 1, p. 314; p. 315.
[32] 'Worsley to Boyle, (late 1658-early 1659)', *The Correspondence of Robert Boyle*, v. 1, p. 313.
[33] 'Worsley to Boyle, (late 1658-early 1659)', *The Correspondence of Robert Boyle*, v. 1, p. 311; p. 312.
[34] 'Worsley to Boyle, (late 1658-early 1659)', *The Correspondence of Robert Boyle*, v. 1, p. 317.
[35] 'Worsley to Boyle, (late 1658-early 1659)', *The Correspondence of Robert Boyle*, v. 1, p. 315.

Finally, by this transformation of their spirit, human beings became subject to any inconvenient motion that produce bodily corruption and distempers. Therefore, 'Death' had no 'power of soveraignity of absolute necessity from it selfe' or from 'some unknowne Accident or Fate'. The wisdom needed to overcome death must therefore come from above.[36]

Was the pious Boyle allured or scandalized by the declaration about the possibility of eternal life on earth? While it would be idle to attempt to guess Boyle's state of mind after reading this remarkable letter, strikingly, Alexander Wragge-Morley has recently argued that Boyle's experiments concerning the transmutation of camphor included an ambitious theological programme to explain the process undergone by the corpuscles in a human body when dying and also when resurrecting: the potential presented by experimental science lay, for him, in knowing *how* God had resurrected human beings.[37] It may also be noted that during the years of correspondence with Worsley on earthly desire as the cause of human death, Boyle, as we have seen, was developing the topic of the usefulness of experimental philosophy to supply and satisfy the multifold and unlimited human desires that he sanctioned. Furthermore, according to Worsley, there was nothing to detain the march of humanity towards making a paradise on earth. Worsley himself was a riddle when one attempts to reconcile his lifelong and vigorous pursuit of trade, prosperity for his country and mastery of the knowledge about the particulars of nature and its material benefits (admittedly involving much personal inconvenience to him) with his principled rejection of the *desire for the things of the world* and his definition, presented earlier, of the materialist spirit as the true cause of human death. Was this a fragmentation of the Reformers' personality, the inevitable outcome of their Neoplatonist division between the earthly and spiritual life? Or perhaps mid-seventeenth-century Puritan consciousness was still too strong, and an edict to refrain from the satisfaction of desire was the price Reformers had to pay for pursuing the politics of science that promised to satisfy all desires?

7.2 The Transmutator of Nature

Boyle did not share Worsley's millenarian radicalism, nor was he such an extreme relativist. Paradoxically, one of the greatest experimentalists

[36] 'Worsley to Boyle, (late 1658-early 1659)', *The Correspondence of Robert Boyle*, v. 1, p. 317.
[37] Wragge-Morley, *Aesthetic Science. Representing Nature in the Royal Society of London, 1650–1720*, pp. 40–60.

in history did not have complete confidence in the sufficiency of experiment alone, and rather considered that the pursuit of theoretical natural philosophy was fundamental, as his extensive theoretical work shows. In that sense, Hobbes's critique of experimentalists, and especially of Boyle, was overstated.[38] For the undeniable fact was, in Boyle's view, that natural reality was not merely an atomist compound that had resulted from chaos. In the important *The Origine of Formes and Qualities according to the Corpuscular Philosophy* (published in 1665 but, according to the publisher, written much earlier), Boyle located his corpuscularist philosophy between materialist atomism and Aristotelianism and its particular ways of acknowledging purpose in the physical world.[39]

7.2.1 God's Concurrence

Atomism accurately represented the underlying structure of matter, according to Boyle, but its premise that the natural world was the result of only repeated and occasional chance in the motion of atoms was flawed. Aristotelianism explained intelligence in matter by introducing substantial forms that were able to keep nature as it was; for instance, heated water would always return to coldness, and to reproduce the same nature. Similarly, it was a matter of observation that species had the capacity to reproduce themselves maintaining the same nature. But while in Boyle's view atomism could not convincingly explain the reality and beauty of nature, he found that there was also 'no necessity of admitting substantial forms' of the Aristotelian type, since accidents and matter alone could explain the phenomena of nature.[40] This statement is better understood by turning to his own theory. The only thing of which

[38] See about Hobbes's critique, Shaffer and Shapin, *Leviathan and the Air Pump*, p. 151. On Boyle as a theoretician, see Anstey, *Robert Boyle Natural Philosophy*; Peter Alexander, *Ideas, Qualities and Corpuscles. Locke and Boyle on the External World* (Cambridge University Press, 1985); and generally Jan-Erik Jones, ed. *The Bloomsbury Companion to Robert Boyle* (London, New York, Oxford, New Delhi, Sydney: Bloomsbury Academic, 2020).

[39] Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5; on Boyle and final causes see, Boyle, 'A Disquisition about the Final Causes of Natural Things, in *The Works of Robert Boyle*, v. 11, p. 87, note 95. And Antonio Clericuzio 'God and the Physical World in Boyle's Thought' in Humbertus Busche (ed.) with collaboration by Stefan Heßbrüggen-Walter, *Departure for Modern Europe / Aufbruch in das moderne Europa. A Handbook of Early Modern Philosophy (1400–1700)* (Hamburg: Felix Meiner Verlag, 2011), p. 1041.

[40] Robert Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5; A. C. Crombie, *Science, Art and Nature in Medieval and Modern Thought* (London and Rio Grande: The Hambledon Press, 1996) p. 69.

Boyle seemed to be completely certain was of the *necessity* that God had once created the world as now it is:

> So that according to my apprehension, it was *at the beginning* necessary, that an Intelligent and Wise Agent should contrive the Universal Matter into the World, (and especially some Portions of it into Seminal Organs and Principles,) and settle the Laws, according to which the Motions and Actions of its parts upon one another should be regulated.[41]

Unlike the 'Cartesian Laws of Motion' Boyle's use of 'laws' here seems to refer to a law that operated only within *the jurisdiction of a microcosm*, as to form the innumerable structures and bodies in nature through mechanical affections. Unlike Epicurus, who conceived the world as 'brute and unguided matter', for him there existed a *regulation* of order, and even more, a certain *governance*.[42] God had put the world in motion, but not only that. Boyle accepted, with only a few reservations, that the Creator had established a certain order or system of nature that was guaranteed continuity by imbuing some species, mainly plants and animals, with the information (the seminal principles) that would enable them to reproduce themselves and continue in nature. Timothy Shanahan, Peter R. Anstey and Antonio Clericuzio have discussed Boyle's theory on God's 'general concourse' for 'the conservation and efficacy of every particular physical agent' at length.[43] This theory can be summarized as

[41] Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 354.

[42] 'I do not at all believe, that either these *Cartesian Laws of Motion*, or the *Epicurean casual Concourse* of Atoms, could bring meer Matter into so orderly and well contriv'd a Fabrick as This World; and therefore I think, that the wise Author of Nature did not onely *put Matter into Motion*, but when he resolv'd to make the World, did so regulate and *guide the Motions* of the small parts of the Universal Matter, as to reduce the greater Systems of them into the Order they were to continue in; and did more particularly contrive some portions of that Matter into Seminal Rudiments or Principles, lodg'd in convenient Receptacles, (and as it were Wombs,) and others into the Bodies of Plants and Animals', Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 353. For the more general late seventeenth and eighteenth century 'nomological image of nature' as 'a collection of laws and law-governed entities', or as a system, see also specially, Catherine Wilson, 'From Limits to Laws: the Construction of the Nomological Image of Nature in Early Modern Philosophy' in Lorraine Daston and Michael Stolleis (eds.) *Natural Law and Laws of Nature in Early Modern Europe. Jurisprudence, Theology, Moral and Natural Philosophy* (Surrey, Burlington: Ashgate 2008), p. 13; also Oakley 'The Rise of the Concept of Laws of Nature Revisited'.

[43] Timothy Shanahan, 'God and Nature in the Thought of Robert Boyle' in 26 *Journal of the History of Philosophy* (1988); Anstey, *The Philosophy of Robert Boyle*, ch. 7; Clericuzio, 'God and the Physical World in Boyle's Thought', p. 1042.

meaning that it is God's active involvement in the world that guarantees the efficacy of the laws of motion.[44] The idea is consonant with Boyle's voluntarist conception of laws as an act of will, as discussed in chapter 6. I agree with Peter Anstey that Boyle's natural philosophy is an elaborated and cautious *via media* between occasionalists, who viewed God as acting constantly in each event in a world devoid of causal agents, and deists, who regarded the world as working after the Creation only through natural laws.[45]

Multiple sources have been suggested as the originators of these ideas of Boyle.[46] However, whatever the specific sources involved, it is plain that Boyle's active God in nature and his God-fearing tone when he was writing as a theologian is much toned down in his two most important works on natural philosophy, *The Origine of Formes and Qualities according to the Corpuscular Philosophy* and *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, which described interdependent systems of motion. These works conveyed the message that the scientist ought to have lordship and dominion over the natural world and traditional Aristotelian theories were preventing that conquest. There is hardly any other way of reading Boyle's oscillation between the position of a pious theologian of nature and that of an ambitious natural scientist than to read him as struggling with internal conflict. For it is the work of God, as Boyle acknowledged, that he aimed at once to know and praise – and to undo. Human beings were, in his thinking, potential managers of the physical world and in order to understand how the system of nature was constituted, the only things necessary were experiments and God. Experiments were needed as the only way to his constant double aim: 'discover the cause of her (nature's) Phenomena, or to imploy her productions', that is acquiring

[44] Anstey, *The Philosophy of Robert Boyle*, p. 168, and generally Chapter 7.

[45] Anstey, *The Philosophy of Robert Boyle*, ch. 7; Shanahan, 'God and Nature in the Thought of Robert Boyle, 26 *Journal of the History of Philosophy* (1988); also in Finnish, Jouni Huhtanen, 'Robert Boyle, luonto ja luonnonlaki' 31 *Tieteessä tapahtuu* (2013).

[46] Recently Edward B. Davis has traced Boyle's sources for natural theology and the main principle that 'the voice of nature is the voice of truth' to the Huguenot jurist, statesman and apologist Philippe de Mornay (1549–1623), and through him to Thomas Aquinas, whom de Mournay, however never mentioned. Davis writes that we cannot fully understand Boyle's philosophy of religion apart from this central fact [of the 'formative' and 'formidable' influence of de Mornay].' Davis, 'Boyle's Philosophy of Religion', pp. 259. The Earl of Cork, the three Reformers, Hartlib, Dury and Comenius, his Eton education and Gassendi are mentioned as sources of Boyle's voluntarism in Wojcik, *Robert Boyle and the Limits of Reason*, p. 201; Peter R. Anstey suggests William of Ockham, Anstey, *The Philosophy of Robert Boyle*, p. 174; p. 179.

knowledge and multiplying production.[47] To develop science, metaphysical questions that simply sought to cover up ignorance must be avoided.

7.2.2 *The Uncertain Boundaries of Natures*

Continuity in nature is probably the issue that most fascinated Boyle and was, significantly, what offered the Anglo-Irish chemist the most potential for manipulation. The 'natural state' of bodies he considered to be a 'most usual state', not an absolutely fixed one. Therefore, by the law of nature, the accidents of a body would remain, unless a competent destructive cause operated. If that cause operated – for instance, if fire was applied to wood – no supposedly (Aristotelian) substantial form would be able to prevent it from happening and preserve all those accidents in a body.[48] Hence the central meaning of chemistry emerged in *The Origine of Formes and Qualities* as that of a science of transmutation of natures.

Boyle confessed to being agnostic about whether there were 'sufficient and necessary' boundaries limiting the species of natural bodies.[49] The only

[47] 'I recon it among the felicities of the present Age, that in Philosophical Inquiries, Experience is not now, as in the Schools it formerly was, either wholly neglected or for the most part rested (?) to comport with Theoryes, that were framed without regard had to it. But I am sorry I see cause to add to what I have been saying that as much as we magnify the necessity of Experiments in our conceits with the Peripateticks about nature, we seem not yet to be sensible of this acknowledged necessity, when we contest with the particular difficulties that frequently occur, when we our selves are to discover the cause of her Phenomena, or to imploy her productions.' *Royal Society*, 'Boyle Papers', vol. 9, fol 1r. Boyle Manuscripts online, in the *Robert Boyle Project*, www.bbk.ac.uk/boyle.

[48] 'And as, when there is no competent destructive Cause, the Accidents of a Body will by the Law of Nature remain such as they were, so if there be, it cannot with reason be pretended, that the substantial Form is able to preserve all those Accidents of a Body, that are said to flow from it, and to be as it were under its care and tuition; for if, for instance, you expose a Sphaere or Bullet of Lead to a strong fire, it will quickly loose (not to mention its Figure) both its Coldness, its Consistence, its Malleableness, its Colour, (for 'twill appear of the colour of fire,) its Flexibility, and some other Qualities, and all this in spight of the imaginary substantial Form, which, according to the Peripatetical Principles, in this case must still remain in it without being able to help it.' Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 347.

[49] 'For I confesse, that I have not yet, either in *Aristotle*, or any other Writer, met with any genuine and sufficient Diagnostick and Boundary, for the Discriminating and limiting the *Species* of Things, or to speak more plainly, I have not found, that any Naturalist has laid down a determinate Number and sort of Qualities, or other Attributes, which is *sufficient* and *necessary* to constitute all portions of Matter, endow'd with them, distinct Kinds of Natural Bodies.' Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 356; see also Jan-Erik Jones, 'Boyle's Natural Kind Realism' in Jan-Erik Jones (ed.), *The Bloomsbury Companion to Robert Boyle*, p. 211.

requirement he ascertained in nature was that of the system or *oeconomy* of the universe with (some) matter possessing the seminal information and its motion being regulated by mechanical affections (powers affecting and sustaining the nature or structure of things) that constituted the laws of motion. The chief goal of chemistry became 'the mechanical production' of natures. Chemistry was understood to be a practical science, a useful science but, in Boyle's conception, also a philosophical science. Sometimes experiments might be made that were not profitable, but only instructive, and only a *mere alchemist* would resist that form of unprofitable activity.[50] Nevertheless, the purpose of chemistry was mainly to be useful in relation to the multiplication of nature. Manipulating the particular natures of anything in the world for transmutation, reproducing natures through matter and increasing the number of active bodies artificially would in Boyle's words result in an increase of 'the Inventory of Mankind's Goods'.[51]

The volatility of nature that Boyle described overlapped with other disciplines, and also impacted on culture and society, thus destabilizing long-established truths. As he explained, if a base metal were to be transmuted into one that displayed all the accidents of gold, in terms of its content or 'Stamp', people would 'take it for true Gold without scruple', use it in economic transactions without further ado, and let academics dispute among themselves whether it was real gold.[52] In an important sense, morality and social sciences were thus made plausibly dependent on chemistry and its potential of transmutation. The world was a 'self-moving engine' composed of small particles of diverse sizes, and the various combinations, figures or stamps that could appear in it were 'almost innumerable' – as were, accordingly, the possible transmutations. Boyle asserted that *anything* could eventually be transformed into *anything*. Following the Reformers of the previous generation, his programme for the science of chemistry was precisely that: to try to put the components of the world into motion and thereby into new orders:

> So that though I would not say, that Any thing can immediately be made of Every thing, as a Gold Ring of a *Wedge* of Gold, or Oyl, or Fire of Water; yet since Bodies, having but one common Matter, can be differenc'd but by Accidents, which seem all of them to be the Effects and Consequents

[50] 'But a Transmutation is neverthelesse more or lesse real, for being or not being Lucriferous, and since That may inrich a Brain, that may impoverish a Purse, I must look upon your humour as that of an Alchymist, rather then of a Philosopher, if I durst not expect that the Instructiveness in such an Experiment will suffice to recommend it to You.' Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 423.

[51] Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 373.

[52] Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 323.

> of Local Motion, I see not, why it should be absurd to think, that (at least among Inanimate Bodies) by the Intervention of some very small *Addition* or *Substraction* of Matter, (which yet in most cases will scarce be needed,) and of an orderly *Series of Alterations*, disposing by degrees the Matter to be transmuted, almost of any thing, may at length be made Any thing.[53]

The empiricist-chemist accordingly became the re-maker of nature. For nature must be useful. In this sense, it is clear that nowadays 'futurist' writers with transhumanist leanings display the same 'science-fictional emphasis' about (human) nature.[54] In particular, the ends of the science of chemistry were eminently pragmatic. Knowledge had also the aim of acquiring (economic) power to 'exercise the little Empire, that we have either acquir'd or regain'd over the creatures', and to carry out practical business.[55] But the business was different from the science. In this sense, the transmutation, by some mechanical means, of a base metal into gold, differed from the plan or projection for turning some hundred or thousand parts of baser metal into gold or silver, with the help of one part of powder of gold. Hence, 'though Projection includes Transmutation, yet Transmutation is not all one with Projection'.[56]

Boyle's corpuscularisn did not mean that he renounced the principle of necessity altogether. For 'the secret correspondencies and Alliances' between bodies that Boyle could not fail to observe constituted, in his view, the *oeconomy* or system of nature. In this regard, despite the complex combinations discussed in the previous chapter by which he excepted human beings from participation in natural laws, these natural laws appeared in Boyle's case immanent in nature and not imposed by the will of God – ultimately inspired more by Aquinas, as Davis has suggested, than by Ockham.[57] Boyle's

[53] Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 332.

[54] See William T. Lynch's review of Steve Fuller, *Knowledge: The Philosophical Quest in History*, in William T. Lynch, 'Social Epistemology Transformed: Steve Fuller's Account of Knowledge as a Divine Spark for Human Domination' in 3 *Symposion* (2016), pp. 191–205.

[55] Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 298

[56] Boyle, *The Origine of Formes and Qualities* in *The Works of Robert Boyle*, vol. 5, p. 365.

[57] This is not to tell that Davis draws a link between Aquinas and Boyle's mechanical laws. Instead, he suggests a rather loosely and indeed visible inspiration in the physical world as a source of truth, Davis, 'Boyle's Philosophy of Religion'. A classic view that saw a more radical break after the Scientific Revolution appears e.g. in Francis Oakley, 'Christian Theology and the Newtonian Science: The Rise of the Concept of the Laws of Nature' in 30 *Church History* (1961). Aquinas balanced his position also responding to the necessitarianism of Averroes, Maimonides and Avicenna in the *Questiones disputatae de potentia Dei*, q. 1, a. 5: 'And this is where they erred, for they thought that the created order was commensurate with divine goodness, as if apart from that order divine order could not have been

mechanical laws of nature and his notion of nature seemed so original partly due to the absence of human beings. But while Boyle was adamant that the physical world is a source of truth, the core of his project of knowledge is to put forward the dominion of human beings to manipulate and to remake that truth. In his writings on natural philosophy, what human beings utilize and transmute became an impersonal system or economy of nature that possessed an occult harmony of secret alliances and mechanical affections between clusters of corpuscles that had been established by the design of the Creator.

7.2.3 God's Arbitrary Will and Humans' Right Reasoning

Boyle's proposal for a working notion of nature was that of a minimal metaphysical *constitution*, a system or *oeconomy*. The idea of the *oeconomy* of nature originated, as we saw, in Kenelm Digby's *Two Treatises on The Nature of Body and on the Nature of Mans Soul*.[58] The notion had a manifold meaning of interconnectedness and unity for Digby.[59] It was a certain order and settled course that existed in nature, as well as a sort of agency that 'hath set on foot due and plain causes to produce known effects'.[60] Moreover, it amounted to a sufficiently strong basis on which the 'searcher of nature' could understand natural causes without jumping to supernatural explanations. It would be irreverent to engage 'the Almighty Architect' any time a particular effect in nature was to be explained. For with the first foundation of nature's design, figures of plants and animals had been already produced. That was the *oeconomy* of nature: a 'complex assemblement, or chain of all the causes that concur to produce this effect', a language by which to decipher the 'wise Author of nature in the masterpiece of the creature'.[61] Moreover, the *oeconomy* of nature was distributive,

expressed. It is clear then that God absolutely can do otherwise than he has done.' See, Pernoud, 'The Theory of Potentia de Dei According to Aquinas, Scotus and Ockham', p. 73. I discuss in section 7.2.4 the debate between Peter Harrison and John Henry on voluntarism in the scientific context of Boyle.

[58] Digby, *Two Treatises*; Remien, *The Concept of Nature in Early English Modern Literature*.

[59] To which might be related his faith in the powder of sympathy that cured wounds at a distance. The following quote is an example of the ideas of forces operating at a distance: 'For nature hath so ordered the matter, that when dense parts stick close together, and make the length composed of them to be very stiff; one cannot be moved but that all the rest (which are in that line) must likewise be thereby moved: so that if all the world were composed of atoms close sticking together, the least motion imaginable must drive on all that were in a straight line, to the very end of the world'; see also his discussion of the principle 'No corporeall nature can operari in distans' Digby, *Two Treatises*, p. 104; pp. 172–174.

[60] Digby, *Two Treatises*, p. 43; p. 104.

[61] Digby, *Two Treatises*, p. 124; p. 179; p. 214; p. 283; p. 289.

and entailed specific material causes that produced a conjuncture of the required effects for the propagation of species. Therefore, 'no such supplements' – by which Digby meant anthropomorphic signifiers – were needed in explanations of natural philosophy. The 'distribution of nature' was enough and notions such as the *compassion* of the elements, when the Halcyon laid her eggs at sea, were superfluous and non-philosophical.[62]

All these elements of Digby's *Two Treatises* – the *oeconomy* of nature, the intellectualist understanding of the Creation, the rejection of anthropomorphic intrusions and an unspecified concourse of a divine agent in the effects occurring within the natural system – also appeared in Boyle's thought, albeit in a perfected and developed form. The single most important difference between Digby and Boyle was that the latter did not include moral natural law in that rational oeconomy of nature, and instead held a radical voluntarist understanding of the moral law given through Revelation.

That is not to say that Boyle's right reason was not rationalist or moral. Some years ago, John Spurr described the definitive transformation of the notion of 'right reason' in late seventeenth-century England from 'the faculty which fused man's knowledge of what is good with his desire to be good' that 'so raised him towards knowledge of and participation in the nature of God', to the 'sterile, morally-neutral notion of "discursive reason"'.[63] As mentioned before Sorana Corneanu has broadened and enriched this view and described Boyle's specific redescription of the classic notion. The right reason as an instrument of the intellectual soul to discover, through the light of nature and practical virtue, the moral principles of moral natural law, became in the work of Boyle and others a complex combination of attitudes. But it is true that in Boyle's work right reason mainly signifies *correct* reasoning assisted by Revelation.[64] As explained by Corneanu, in knowing the richness of the physical world

[62] Digby, *Two Treatises*, p. 398.

[63] Spurr, '"Rational Religion" in Restoration England', p. 570.

[64] Boyle's peculiar understanding of right reason, e.g. in the 'Appendix to The Christian Virtuoso': 'Right reason may be looked upon as a catholick principle, of which philosophy is but an application, and the dictates of particular philosophies, such as the Peripatetik, the Platonick, the Epicurean, etc, are but particular corollaries, which are not always truly drawn, and on that account may always be questioned or examined, and may, I fear, oftentimes be justly rejected; and this holds, especially, when in the examen, he that makes it is assisted by the discoveries made by revelation from whose heavenly light, in reference to divers subjects, the intellect may receive such a benefit, as the air does in a clear day from the beams of the sun, by which it is both enlightened and expanded.' Boyle, 'The Christian Virtuoso I. Appendix' in *The Works of Robert Boyle*, v. 12, p. 423.

through experimental work, discursive reason displayed moral connotations when aided by self-mastery in view of passions, difficulties and pains during the repeated exercise of experiment, and by modesty and docility in order to cultivate a continuous attitude of openness to new information. In sum, its moral goals comprise education of the mind in the path to truth and growth in virtue.[65] Therefore, Boyle's right reasoning has a moral dimension, albeit one that was relatively novel and idiosyncratic at the time. The ambiguous premises of *virtuosity*, despite not being in principle aimed solely at elite thinkers, appeared in this light and charges of elitism abounded.[66] This understanding of right reasoning was reinforced by Boyle's weak standpoint on innate ideas.[67] The 'light' of Revelation was then to provide benefit to right reason 'as the air does in a clear day from the beams of the sun, by which it is both enlightened and expanded'.[68]

This section and the next show that the Anglo-Irish natural philosopher produced a revolution in thinking about natural law when he theorized, as both a lay theologian and as a natural philosopher, an intelligible physical world that runs in parallel to his voluntarist conception of moral natural laws. In the movement of their natures, the natural elements of the world had a purpose, whereas the moral purpose of human beings' actions was not accessible from within our nature – we rather obey the law of the commander. The insight that there was a disconnect between the right reason of God and that of human beings had been characteristic of Protestant thought since Luther, and the ensuing Protestant rejection of the production of rational accounts of human morality by reference to divine eternal

[65] Corneanu, *Regimens of the Mind*, p. 127–129, and generally ch. 4; Thomas Holden, 'Robert Boyle on Things Above Reason' in 15 *British Journal for the History of Philosophy* (2007), p. 290.

[66] Corneanu pairs Boyle and Locke in their inspiration in Bacon's and the Royal Society virtuosi' experimental program and the early modern *cultura animi* tradition, drawing from classical Skeptic, Stoic, Galenist and Augustinian sources. Corneanu, *Regimens of the Mind*. The elitism of the experimentalists of Gresham College was an issue at the period, importantly for Hobbes who criticized the fact that they set a limit of members, 50 men plus Barons and above and so on, see Schapin and Shaffer, *Leviathan and the Air Pump*, ch. 4; and for Margaret Cavendish, see Sarasohn, 'A Science Turned Upside Down'.

[67] Boyle admits 'innate, or at least primitive *Ideas* and Rules of true and false' in the context of the rules that enable the operation of the intellectual reason, but his position is not so clear on practical reason. Boyle, *A Discourse of Things above Reason*, p. 73. Holden notes that 'Boyle systematically resists committing himself in the debate over the existence of innate ideas but concedes that the mind has innate dispositions to assent to certain propositions and to reject others' … 'such as the law of noncontradiction and other fundamental principles governing logical and mathematical (and perhaps ethical) thought'. See Holden, 'Robert Boyle on Things Above Reason', p. 288.

[68] Boyle, 'The Christian Virtuoso I. Appendix' in *The Works of Robert Boyle*, v. 12, p. 423.

law.[69] Boyle added to it the undoing or deconstruction of the more general notion of the *nature* that human beings and the rest of physical nature were previously understood to have in common, also in Anglican theology. From the perspective of inanimate and irrational nature, J. R. Milton notes that that 'kind of intimate blend of the moral with the physical would have seemed entirely natural' to the readers of Richard Hooker's *Laws of Ecclesiastical Polity*, whose definition of natural law includes irrational creatures, as did Aquinas's and the Roman tradition.[70] As late as 1672 the aim of the influential *An Inquiry into the Laws of Nature* by the Anglican divine Richard Cumberland was to use natural philosophy as a means of showing that moral natural law was obligatory – albeit he employed already a modern notion of 'laws' and of 'nature', as we will see.[71] Boyle's deconstruction of the notion of physical nature not only reached a climax in the fading tradition of right reason, but also served his ambitious utilitarian project concerning economy and knowledge, for human beings were presented as free agents in dominion of nature and of the laws of nature.

7.2.4 The Viewpoint in Boyle's Laws of Nature

In view of Boyle's dualism in considering human and physical nature to be apart, it is possible to argue that Boyle was a voluntarist moral theologian and an intellectualist natural theologian. Descartes' thought has been

[69] Luther articulated this discontinuity in *The Bondage of the Will*, see for this Quentin Skinner, *The Foundations of Modern Political Thought* (Cambridge: Cambridge University Press, 1978), vol. II, p. 5 and generally ch. 1; on the Protestant position more generally see Knud Haakonssen, 'Divine/Natural Law Theories in Ethics' in Daniel Garber and Michael Ayers (eds.) *The Cambridge History of Seventeenth Century Philosophy* (1998) vol II, 1317–1357; p. 1325.

[70] See J. R. Milton, 'Laws of Nature' in Daniel Garber and Michael Ayers (eds.) *The Cambridge History of Seventeenth Century Philosophy* (Cambridge: Cambridge University Press, 1998) vol. I, p. 681; Francis Oakley, *Natural law, Laws of Nature, Natural Rights. Continuities and Discontinuities in the History of Ideas* (New York, London: Continuum, 2005) p. 70; Brett, *Liberty, Right and Nature*, p. 95; Jan Schröder, 'The Concept of (Natural) Law in the Doctrine of Law and Natural Law of the Early Modern Era', in *Natural Law and Laws of Nature in Early Modern Europe*; also pointing out Boyle's novelty, Anstey, *The Philosophy of Robert Boyle*, p. 158; Oakley, 'The Rise of the Concept of Laws of Nature Revisited', p. 25. On natural law as the participation of the eternal law: all laws participate in the right reason of God, and hence all laws derived from eternal law, in Aquinas, *Summa theologiae*, I-IIae, q. 91, a.2.co1; q. 93, a. 3.

[71] Richard Cumberland, *A Treatise of the Laws of Nature*, translated, with Introduction and Appendix, by John Maxwell (1727), with a Foreword by Jon Parkin (ed.) (Indianapolis: Liberty Fund, 2005); Jon Parkin, *Science, Religion, and Politics in Restoration England: Richard Cumberland's De Legibus Naturae* (Rochester, New York: The Boydell Press, 1999), ch. 6 and p. 7.

described by Edward B. Davis and Margaret Osler as displaying analogous complexities.[72] The fecundity of the debate between John Henry and Peter Harrison as to whether voluntarist theology was an important aspect of the origins of modern empirical science is useful, among other reasons, for the deeper insight into Boyle's project of 'undoing nature' that it provides, and is worth summarizing briefly here.

Henry and Harrison have both highlighted that the core issue for the experimentalists was a pragmatic approach by which to find a workable method for human reason, which everyone acknowledged to be very weak. Henry takes the view that the pre-eminence accorded by experimentalists to God's omnipotence meant that their ideas were defined as being the result of voluntarist theology.[73] Harrison, on the other hand, has analysed the emphasis placed during the seventeenth century on the damage caused to human beings' cognitive capacities by the Fall. He takes the view that focus on a postlapsarian reason (a reason darkened by original sin) illuminates phenomena that others have attributed to the explanatory force of the thesis of voluntarist theology.[74] However, Harrison has noted that Boyle was exceptional for his era in attributing a minor role to the Fall of Adam and Eve in the state of weakness of human reason: it appears that Boyle simply thought that God had created reason that way.[75] One may also add Corneanu's argument that Boyle's moral doctrine revolves around growth in knowledge: a sort of enlightenment obtained from observation and studies of the physical world, which presupposes rather than denies the role of reason.[76]

[72] Edward B. Davis, *Creation, Contingency, and Early Modern Science: The Impact of Voluntarist Theology on Seventeenth-Century Natural Philosophy* (PhD Dissertation, 1984, Indiana University), pp. 67–121; Osler, *Divine Will and the Mechanical Philosophy*, pp. 118–152.

[73] Whether for the seventeenth century scientists developing a novel idea of 'the laws of nature', voluntarist theology had explanatory power or only justificatory power is debated between John Henry and Francis Oakley, the latter emphasizing the explanatory nature and the continuation with the medieval theological tradition of God's absolute and ordained power. See generally Oakley, 'The Rise of the Concept of Laws of Nature Revisited'; Henry, 'Metaphysics and the Origins of Modern Science, p. 91, and recently, Lichtenstein, 'Revaluing Laws of Nature in Secularized Science'.

[74] Henry also makes the point that Harrison is studying more the abilities and powers of human beings' intellect and will within the context of theological anthropology and he was concerned with God's abilities and omnipotence. John Henry, 'Voluntarist Theology at the Origins of Modern Science', p. 104.

[75] Harrison notes that Boyle's Adam did not possess the wisdom of Heaven, but through Christian religion we may reach the perfect knowledge of natural philosophy, Peter Harrison, *The Fall of man and the Foundations of Science* (Cambridge: Cambridge University Press, 2007), p. 219; see also, Wojcik, *Boyle and the Limits of Reason*, p. 104

[76] Corneanu, *Regimens of the Mind*, p. 116.

The three positions taken by Henry, Harrison and Corneanu are helpful to my argument that Boyle urged a conception of a non-human physical world, instead of the holistic conception of nature common to both before and during his era. Boyle viewed the physical world as being at once sustained by the concurrence of God and perfectly rational. As Harrison noted in an early article, the 'arbitrary will of God' did not signify randomness for most authors writing during the seventeenth century. Certainly, for Boyle it implied rational design.[77] Moreover, it also precluded the necessitarianism of the Avicennan type we have seen employed by Hobbes.[78] What was crucial in Boyle's case, was whose point of view was adopted. Thus, 'the laws of nature as they were at first arbitrarily instituted by God, so, *in reference to him*, they are but arbitrary still'.[79]

[77] 'Indeed, the whole enterprise of physico-theology is premised upon that very possibility of discerning rational design in the cosmos which was called into question by earlier voluntarists.' Harrison, 'Voluntarism and Early Modern Science', p. 74; p. 78.

[78] Although Boyle seems to have benefitted from Avicenna sometimes, he skipped the references to him and other Islamic authors, as was apparently general custom in the period, and retained only Galen throughout. Another reason for his neglect of Avicenna, beyond the customary, might have been that the latter had declared categorically the impossibility of transmuting metals from a scientific and philosophical point of view. Moreover, the Arabic philosopher believed that human beings were not created by God, but by a separate principle, the giver of forms, and that there could be spontaneous generation of human beings without procreation, for instance after a natural disaster. Some Aristotelians from Northern Italy such as the Renaissance philosopher Pietro Pomponazzi and his students had valued these aspects of Avicenna. But despite his usual boldness, that particular idea did not go well with Boyle. In a letter to Henry Stubbe distancing himself from Stubbe's mockery of miracles, Boyle rejected the principles put forward by 'those Enemys to Christianity' (apparently referring to Pomponazzi), that declared that the planets by themselves may produce such influences as generation of human beings without the intervention of God. See on Avicenna and alchemy, Bruce T. Moran, 'Paracelsianism' in Glenn Alexander Magee (ed.) *The Cambridge Handbook of Western Mysticism and Esotericism*, (Cambridge: Cambridge University Press, 2016); Georges C. Anawati, 'Arabic Alchemy' in Roshdi Rashed (ed.) *Encyclopedia of the History of Arabic Science. Technology, Alchemy and Life Sciences*, vol. 3. In collaboration with Régis Morelon, (London, New York: Routledge, 1996), p. 877; I follow here on Avicenna and Pomponazzi, Dag Nikolaus Hasse, 'Arabic Philosophy and Averroism' in James Hankins (ed.) *The Cambridge Companion to Renaissance Philosophy* (Cambridge: Cambridge University Press, 2007); Stubbe was criticizing Valentine Greatrakes who claimed to have powers to cure; also the Anglican Church castigated him. See 'Boyle to Henry Stubbe. 9 March 1966', in *The Correspondence of Robert Boyle*, v. 3, p. 99. See on this question and miracles, Clericuzio, 'God and the Physical World in Boyle's Thought', p. 1045.

[79] Boyle, 'The Christian Virtuoso I. Appendix' in *The Works of Robert Boyle*, v. 12, p. 423. (emphasis mine) Osler noted with reference to this statement how 'Boyle was a thorough-going voluntarist'. Margaret J Osler 'Robert Boyle on Knowledge of Nature in the Afterlife' in James E. Force and Richard H. Popkin (eds.). *Millenarianism and Messianism in Early Modern Culture. Vol. III The Millenarian Turn: Millenarian Contexts of Science, Politics, and Everyday Anglo-American life in the Seventeenth and Eighteenth Centuries* (Springer, 2001), p. 46.

The physical world was neither necessary nor the best possible world. But that was irrelevant, since Boyle was concerned with understanding, as a path to the Designer and the acquisition of knowledge, the evident intelligence and harmony that it possessed.[80] From a human perspective, the physical world was rational, and perhaps necessary. Furthermore, it was Boyle's firm preference for a more scholastic understanding of God the Creator and sustainer of the world that gave his theory of a harmonious natural world a metaphysical foundation. It did not seem to Boyle to be inconsistent with a rational world endowed with a settled course or order that God concurred in what happened within it – a view bordering on occasionalism. On the contrary, only the limitless immensity of the wisdom of God could have endowed the world with what seemed from a human perspective to be a rational design. For instance, in a favourite example of his, a description of the composition of the fluids contained in an egg was very rational, but it tells us nothing about how the chick's muscles, feathers and body develop. The same could be said about outer space or how the minerals are produced in the 'Bowels of the Earth'.[81] Boyle's theology thus appears incompatible with an emphasis on a strong concept of the physical laws of motion, such as Descartes's.[82] Boyle's laws of motion are plainly God's work.[83]

[80] 'We may, indeed, know by the consideration of his works, and particularly those parts of them that we ourselves are, both *That he is*, and in a great measure *What he is not*; but to understand thoroughly *What he is*, is a task too great for any but his own infinite Intellect'. Robert Boyle, 'A Discourse of Things Above Reason. Inquiring Whether A Philosopher Should Admit There Are Any Such,' in *The Works of Robert Boyle*, v. 9, p. 367.

[81] Boyle, '*The Sceptical Chymist*' in *The Works of Robert Boyle*, v. 2, p. 296. How Locke followed Boyle in this Scriptural tradition of Solomonic scepticism, in Harrison, *The Fall of Man and the Foundations of Science*, p. 221.

[82] Thus, unlike Boyle's case, John Henry argues that the real stimulus to a development of secular theology by philosophers of nature during the Scientific Revolution 'was the need to justify the concept of laws of nature, with its awkward inherent implication that inanimate bodies are somehow capable of "obeying" such laws.' John Henry, 'Metaphysics and the Origins of Modern Science: Descartes and the Importance of Laws of Nature' in 9 *Early Science and Medicine* (2004), p. 96. In this question of the natural law common to human beings and persons Selden produces a thorough review of authors referring to animals' behaviour with natural law obligations, importantly against 'adultery'. He concludes, however, that animals do not have rights or obligations in the sense human beings have them in natural law terms, and – interestingly being himself a conscientious lawyer – that often the authors' words referring to 'laws' or other such notions with regard to animals are 'homonyms', e.g. in the case of Ulpian's *Institutiones*. Moreover, he notes that to state that natural law applies to animals – that cannot be just and cannot be unjust – in the same sense than to human beings would deny the existence of the honest and the vile, the good and the evil, Seldeni, *De Jure Naturali et Gentium Juxta Disciplinam Ebraeorum*, Book I, ch. 5, p. 73.

[83] John R. Milton, 'The Origin and Development of the Concept of the "Laws of Nature"' 22 *European Journal of Sociology* (1981); John Henry, 'The Theological Origins of the Concept of Laws of Nature and Its Subsequent Secularisation', in Neil Spurway (ed.), *Laws*

Here Harrison's thesis about theological debate occurring in politics and science being directed by diverse understandings of the consequences of the Fall is also helpful.[84] We have noted already that Boyle was remarkable among his English peers in ascribing but small importance to the Fall in relation to our reasoning capabilities, arguing instead that human reason was weak by Creation. In this regard, my suggestion is that Boyle represents a turning point in thinking about reason. His theory appears as a strategy to shift thinking about right reason away from theological controversy and darkness or obscurity of the light of reason towards the study of physical nature and Revelation, where one ought to find guidance for reasoning. Obviously, this standpoint also served the Royal Society's political programme of experiment and free enquiry for laymen more generally during the Restoration.[85]

7.2.5 Selden, Milton, Cumberland and Boyle on Weakness of Reason

In 1640 the great John Selden first propounded his theory of natural law and the law of nations based on the weakness of reason. Nevertheless, through his immense scholarship – which was, significantly, both scholastic and Jewish in character – Selden was able to complicate his understanding of right or natural reason as God's command deriving from voluntarist theology. Thereby he alternated between offering proof of the lack of consensus among peoples on the principles of natural law and acknowledging that the light of the 'active intellect' of a righteous person may ascertain evident truths. Selden was adamant that right reason, the reasoning of 'a non-depraved mind', deduced natural principles from nature about living well by reference to the honest and the good. He seemed to suggest that a non-corrupted mind received better the communications of God and angelic creatures, very much in the manner that Albert the Great had highlighted that for a person closer to God is easier to ascertain natural law.[86] And he showed that right reason was present in all historical sources, whether

of Nature, Laws of God? Proceedings of the Science and Religion Forum Conference 2014 (Newcastle upon Tyne: Cambridge Scholars Press, 2015).

[84] Harrison, *The Fall of Man and the Foundations of Science.*

[85] See on 'freedom of inquiry' as a common Restoration theme among laymen, Spurr, '"Rational Religion" in Restoration England', p. 566.

[86] See J.P. Sommerville, 'John Selden, the Law of Nature, and the Origins of Government', 27 *The Historical Journal* (1984), p. 440.

theological, philosophical or legal in nature – a right reason that he was careful to distinguish from 'utility'. However, right reason was uncertain and one ought always to be cautious about it, as evidenced by the fact that people around the world often appeared to follow evil customs and laws, apparently out of ignorance. Moreover, it was impossible to extract a legitimate cause of obligation simply from 'the nakedness of free reason'.[87] If, as the ancient philosophers had done, a state of nature in which human beings both lived in 'the love of freedom' and 'the use of reason' were to be simulated, how would one establish what distinguished the licit from the illicit or how to enforce compliance with obligation? One may always back out of any contract without consequences. Hence, Selden thought that right reason must be supported with authority.[88]

Robert Sommerville White has described the evolution of right reason in John Milton's thinking in the years of the Interregnum. White argues that Milton initially adhered to a more benign type of reason that took inspiration from Aquinas and entailed a natural impulse to comply with natural law as the work of justice and moral good. Following more negative events in the political life of the Commonwealth, Milton became increasingly pessimistic about the capability of right reason to ascertain natural law obligations. What also transpires from White's analysis is that the perception that after the Fall, with only a dim light of conscience, 'we are on our own, without God's direct guidance' is a constant principle in Milton's work.[89]

The case of the divine Richard Cumberland (1631–1718) is interesting. Already writing within the context of the New Science, he attempted to reinsert human beings into the framework of created nature alongside animals and physical nature. Cumberland's response to Hobbes's natural law of self-preservation appears as an original utilitarian understanding of the common good, as preservation of all, and the notion of a common system composed of a rational God, nature and rational human beings. If our first

[87] '*ex nudo rationis liberae*'. Seldeni, *De Jure Naturali et Gentium Juxta Disciplinam Ebraeorum*, pp. 81; 89–91 and generally Book I and ch. 6 and 7.

[88] Seldeni, *De Jure Naturali et Gentium Juxta Disciplinam Ebraeorum*, p. 91. On Selden and right reason see also Haivry, *John Selden and the Western Political Traditions*, p. 225. Selden's integration of nature, law and history in Harold J. Berman and John Witte, Jr. 'The Integrative Christian Jurisprudence of John Selden', in R. H. Helmholz and Mark Hill (eds.), *Great Christian Jurists in English History* (Cambridge: Cambridge University Press, 2017); Sommerville, 'John Selden, the Law of Nature, and the Origins of Government'.

[89] White, *Natural Law in English Renaissance Literature*, p. 228 and generally ch. 9.

parents would have 'deliberated', they could have understood from 'the Nature of Man' that we experience 'the greatest Advantages' from 'mutual Assistance in a Social State.' Piety to God and their parents and benevolence should have been the way to promote 'true happines' to their children, which could not be achieved 'by initiating' human beings in the Mysteries of Atheism, and exhorting each to claim everything to himself and so immediately "to commence Robbers and Murderers of one another."[90]

Jon Parkin describes *A Treatise of the Laws of Nature* 'as one of the founding and possibly most enduring texts of Anglican rationalism'.[91] Cumberland was conversant with Pufendorf, who found inspiration in the former's idea of God's punishment and rewards having effects during the lives of human beings on earth.[92]

> But the good and bad Consequences (thus naturally known from the Nature of Things) of such human Actions, because they are fore shewn by God, to Men deliberating concerning their Actions, in order to incline them to, or deter them from, Action, are intirely in the Nature of Rewards and Punishments, by which a Law receives its Sanction.[93]

The structure of natural laws coincided then with the earthly rewards and punishments. According to Cumberland, happiness founded on utilitarian principles is the reward of the Author of nature when an individual acts with benevolence, which is one of his key concepts. 'Advantages and Disadvantages, which God himself pronounces annex'd to human Actions, and by which we are admonish'd to pursue those, and avoid these, are really and truly Rewards and Punishments.'[94] The evidence of these rewards and punishments when an individual acts or does not according to his or her nature prove the existence of the natural laws.[95] The nature of the thing 'represents' to reason what is best to do, and from the idea of God, one understands that this was a divine command. Thus was the voluntarism of divine

[90] Cumberland, *A Treatise of the Laws of Nature*, p. 181; Parkin, *Science, Religion, and Politics in Restoration England: Richard Cumberland's De Legibus Naturae;* Jon Parkin, 'Richard Cumberland', Oxford Dictionary of National Biography, https://doi-org.libproxy.helsinki.fi/10.1093/ref:odnb/6887; Knud Haakonssen, 'The Character and Obligation of Natural Law According to Richard Cumberland' in M. A. Stewart (ed.), *English Philosophy in the Age of Locke*, v. 3 (Oxford: Clarendon Press, 2000), pp. 29–48; Roger Crisp, *Sacrifice Regained. Morality and Self-interest in British Moral Philosophy from Hobbes to Bentham* (Oxford: Clarendon Press, 2019), p. 33; *Linda Kirk, Richard Cumberland and Natural Law. Secularisation of Thought in 17th Century England* (Cambridge: James Clark & Co, 2022) 29–45.

[91] Parkin, *Science, Religion, and Politics in Restoration England*, p. 173.

[92] Parkin, *Science, Religion, and Politics in Restoration England*, pp. 205–211.

[93] Cumberland, *A Treatise of the Laws of Nature*, p. 181

[94] Cumberland, *A Treatise of the Laws of Nature*, p. 183.

[95] Crisp, *Sacrifice Regained*, p. 39.

law tempered. With his insistence on recovering the notion of the common good shared by human beings and physical nature, Cumberland was primarily reacting to Hobbes's natural right to everything in the state of nature.[96] His target was Hobbes's comparison of the benefit and concord existing among animals, where, unlike in the case of human beings (so Hobbes) no strife about honour, or acknowledgement of precedence or wisdom existed.[97] Cumberland's language of natural philosophy is at points remarkably close to Digby's and, especially, to Boyle's.[98] His main thesis deals with the existence of a system in which everybody and every agent influences others.

Cumberland concluded 'from this Order among the Laws of Nature' – meaning the laws of motion – that this principle operated both among human beings and in physical nature. Therefore, he placed the 'intellectual system' of rational creatures alongside the laws of mechanics of the 'material system'.[99] Its location within this map of ideas provides Cumberland's right reason with a basis on which to judge the 'nature of the thing', according to which the laws of motion also worked. Hence, 'the Command' or 'the Permission, of the Law of Nature', amounted to 'right Reason, pronouncing concerning those things which are necessary to the common Good, according to the Nature of Things'.[100]

Boyle did not absolutely reject the metaphysical notion of the nature of things. However, he did not consider that the right reason had immediate capacity to judge, according to the nature of things, either in relation to morality or matters of natural philosophy. Moreover, as articulated in Jan Wojcik's *Robert Boyle and the Limits of Reason*, Boyle was steadfast in contending that the obscurity of reason is creational and that therefore theologians and sects could contribute little to the matter. In fact, as I have noted earlier in view of his challenging goal of knowing the deep structure of the material world, his main contribution was to incorporate the theological point as to the darkness of reason into natural philosophy and to find alternative ways to overcome it – famously, through the experimental method.

[96] Cumberland, *A Treatise of the Laws of Nature*, p. 211; Haakonssen, 'The Character and Obligation of Natural Law According to Richard Cumberland', p. 34. About the common good tradition, see Kempshall, *The Common Good in Late Medieval Political Thought*.

[97] Patricia Springborg, 'Hobbes's Materialism and Epicurean Mechanism, 24 *British Journal for the History of Philosophy* (2016), p. 828.

[98] Cumberland, *A Treatise of the Laws of Nature*, p. 185. Haakonssen considered that his main influence were the Cambridge Platonists, but also mentions Boyle in passim, see Haakonssen, 'The Character and Obligation of Natural Law According to Richard Cumberland', p. 32.

[99] Cumberland, *A Treatise of the Laws of Nature*, p. 185.

[100] Cumberland, *A Treatise of the Laws of Nature*, p. 214.

I would contend that when he employed theological language Boyle's interest mostly lay in highlighting our ignorance in order to urge the continued search for more truth or more knowledge about the physical world, and to eradicate many of the dogmas that existed at the time. This nescient attitude triggered boldness in building hypotheses and industriousness in experiment. Further, it also helped to attain moral perfection through growth in knowledge.[101] Specifically, the assumption that God the Maker concurred in the activity of the laws of motion went a long way to showing the extent to which the harmony of the physical world remained unknown. Thus, as Boyle argued, no valid proof had been presented against occasionalism thus far. In this regard, no one could prove that it was unwarranted 'to have recourse, without necessity to the first Cause'.[102]

It is possible to argue that Boyle's aim in *The Origine of Formes and Qualities* was to establish the proof he regarded as being missing: that qualities such as bulk, figure, rest, situation and texture were second causes of motion, which could eventually replace recourse to occasionalism.[103] Boyle's novelty was to stress that the rationality of the world was not accessible to us immediately and neither was it available solely through abstract reasoning of the Aristotelian sort, nor indeed that of Hobbes, but mainly through experiments.[104] As discussed earlier, Boyle made explicit his voluntarism in morality in *The Christian Virtuoso*. Although his pursuit of knowledge had a moral aspect, moral law was accessible to human beings almost exclusively through Revelation. Darkness

[101] Corneanu, *Regimens of the Mind*, p. 129. Hobbes could not stand this attitude: 'If the profession of causal nescience was acceptable to, even celebrated by, experimentalists, to Hobbes it constituted a damning admission that the experimental programme was not philosophical.' Schaffer and Shapin, *Leviathan and the Air Pump*, p. 141.

[102] Boyle does not mention Digby, but seems a fair opponent here. Digby adopted a position against presuming occasionalism.

[103] 'If these (bodies) have no inherent motion and power to communicate it, they have really and properly no power to act, but only are Instruments acted and mov'd by the first cause. I will not now examine, whiter tho motion be granted to be the chief of second Causes, some other things, such as Bulk, figure, rest, Situation and Contexture, may not entitle Natural bodys to the name of Phisical Agents, especially according to Cartesius, who will have rest to be, not a privation, but a positive thing in Nature, as well as Motion. But whatever become of this question, in Answer to the Objection, I say, that we ought to be far more carefull that our Notions be agreeable to the nature of things, than to the Opinions of Men, or Termes of Art. (…) And I thinke it may be considered, whiter it be not more safe, as well as pious, in a doubtful case, to Attribute a power that <must> be lodg'd some where, rather to an omnipotent Spirit, than to senseless Matter, it being a less dangerous error to derogate from bodys, than from God.' *Boyle Papers* volume 10, folios 38–40 edited in Peter Anstey, 'Boyle on Occasionalism: An Unexamined Source' 60 *Journal of the History of Ideas* (1999).

[104] That Hobbes was disqualified as dogmatic by Boyle and other members of the Royal Society, in Shapin and Schaffer, *Leviathan and the Air Pump*, pp. 129–139.

therefore reigned not outside, in the corpuscular world that would eventually be revealed to us through experiment, but inside us.

In his study addressing why the natural philosophers became secular theologians, John Henry demonstrates how crucial it was for seventeenth-century natural philosophers to discover the laws governing the natural world. Descartes, who was the forerunner in respect of this approach, made it clear that the laws of nature were innate to human beings: 'They [the laws of nature] are all inborn in our minds just as a king would imprint his laws on the hearts of all his subjects if he had enough power to do so.'[105] Boyle was evasive about that type of imprint or participation, or of any participation of natural laws in human nature. The change of perspective was crucial in his natural philosophy and psychology. The relevant attitude was to search for the pristine rationality of the physical world through external enquiry.[106] Due to their free will, human beings were exceptional creatures within the physical world and, as it were, stayed in the new science outside nature. Robert Boyle was the natural philosopher who possibly most effectively and with the most far-reaching influence developed a description of how physical nature worked – nature being the outcome of a divine design – without employing a robust notion of natural law or of the laws of nature.

7.3 Undoing Nature

Boyle wrote in 1666, but only published in 1685, his famous critique and deconstruction of classic substantiations and personifications of Nature, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, which Michael Hunter and Edward Davis have described as 'one of the key texts of the Scientific Revolution'.[107] As he often did, Boyle drew on several traditions. At the same time his approach is original and impressive, reflects his adoption of the perspective of the natural scientist who studies matter over the perspective of a theologian, and entails rejection of animistic

[105] Descartes quoted in Henry and see generally, Henry, 'Metaphysics and the Origins of Modern Science', p. 102; Steinle, 'From Principles to Regularities: Tracing 'Laws of Nature' in Early Modern France and England' in *Natural Law and Laws of Nature in Early Modern Europe*, p. 226.

[106] Richard Rorty, *Philosophy and the Mirror of Nature* (Princeton: Princeton University Press, 1979), p. 137.

[107] The date is given by Boyle in the Preface, see Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*. Hunter and Davis, 'The Making of Robert Boyle's "Free Enquiry into the Vulgarly Recevi'd Notion of Nature" (1686), p. 204. J. E. McGuire, 'Boyle's Conception of Nature' 33 *Journal of the History of Ideas* (1972) 523–542; Osler, 'The Intellectual Sources of Robert Boyle's Philosophy of Nature; Anstey, *Robert Boyle Natural Philosophy*.

explanations of the activity of matter.[108] I argue next that Boyle moved constantly between a self-sufficient and mechanistic idea of the physical world and recourse to an infinitely wise God as a guide to human knowledge. He disintegrated in the process a metaphysical concept – nature – that had been part of Western culture at least since the time of the great Greek philosophers.

7.3.1 The Unlimited Reason

The crucial epistemological point for Boyle was that only God knew perfectly all the possible contingency 'conjunctures of Circumstances, into which *Matter*' could be put, divided and moved, in accordance with divine laws. The world was an 'Automaton' and attributing the cause of a particular operation or quality 'to the nature of things' was to avoid recognizing our ignorance, while attributing the glitches in the system – the 'Anomalities' – to chaos was equally unhelpful in the search for knowledge, and detrimental to religion.[109] As Jan Wojcik put it '*God's infinite* understanding', the intelligence of the Creator is thus probably the fundamental axiom of Boyle's natural philosophy:[110]

> For the Characters and Impressions of Wisdom, that are Conspicuous in the curious Fabrick and orderly Train of Things, can, with no probability, be referr'd to blind Chance, but must be to a most Intelligent and Designing Agent.[111]

God was 'Supream and Absolute Lord, and if I may so speak, proprietor of the Whole Creation' who had a 'Sovereign Right' to dispose of what exists in the world. He was 'Independent, Free and Wise', a 'Just Agent' that may 'by the Irregularities and Exhorbitance in the world' punish the wicked. We know some of God's ends in making the world, while others are 'hid in the Abyss of the divine Wisdom and Counsels'.[112] In

[108] See on this, depicting perhaps a slightly too naïve Boyle, Jane E. Jenkins, 'Arguing about Nothing: Henry More and Robert Boyle on the Theological Implications of the Void' in Margaret J. Osler ed. *Rethinking the Scientific Revolution* (Cambridge: Cambridge University Press, 2000), pp. 153–179.

[109] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 493.

[110] Wojcik, *Robert Boyle and the Limits of Reason*, p. 213 (emphasis Wojcik).

[111] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 519.

[112] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, pp. 493–494.

Boyle's view, for all we know about theology, God could be chastening human beings through physical nature – not arbitrarily, but wisely. He suggested that exceptional events, though often beyond human understanding, did not strictly deprive the world of its rationality *from the perspective of God*: the Creator may well have a reason that we do not know about. Granted that he worked on the basis of the sceptical reason of the experimentalists, it is nevertheless illuminating to regard Boyle's practical project of knowledge and utility of nature as being rooted more in God's infinite wisdom, as a firm springboard for launching research above apparently rational but limited possibilities, than in human beings' limited reason. Providence was a surer way to knowledge and reality than nature.[113] In this sense, I am inclined to adopt the opposite pair of the equation set out in Jan Wojcik's, *Robert Boyle and the Limits of Reason*. Instead of focusing solely on humanity's limited reason, Boyle's thought is interpreted here by reference to his belief in the unlimited richness of the world God had created, of which so much remained still to be discovered.[114] Even the fact that 'some objects are disproportionate to her (reason)' serves Boyle in his urge and curiosity to understand the world and how it works:[115]

> As when we attentively consider the dimensions of space, or … those of the Universe, we may by tryal perceive that we cannot conceive them so great, but that they may be yet greater, or if you please may exceed the bounds, how remote soever, which our former conception presum'd to assign them.[116]

[113] 'I shall, at present, only observe to you, that the Case is very differing between Providence and Nature, and therefore there is no necessity, that the Objections, I have made against the Later, should hold against the Former.' Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 493.

[114] 'And besides the inscrutable Perfections of God, some of his Works are such, that, notwithstanding the compleat Knowledge of them surpasses our Forces; yet there remains so many things, as well worthy to be known, as possible to be attained by us, that they will allow Exercise enough to the Wits of all the Philosophers in the World.' See also on the principle of non-contradiction, Boyle refers e.g. to true propositions that 'we may think to be contradictory that really are not so' emphasising not only the limits of reason but sometimes the mismanagement and mis application of reason, and generally the immense possibilities of knowledge. On accepting apparent, not real contradiction see, Holden, 'Robert Boyle on Things Above Reason' pp. 302–308; also Corneanu, *Regimens of the Mind*, p. 216.

[115] On 'emotional excitement' as one important factor behind the Scientific Revolution, Margaret J. Osler, 'The Canonical Imperative: Rethinking the Scientific Revolution' in the same (ed.) *Rethinking the Scientific Revolution* (Cambridge: Cambridge University Press, 2000), pp. 3–22.

[116] Boyle, 'A Discourse of Things above Reason' in *The Works of Robert Boyle*, v. 9, p. 386.

Due to his conviction that human beings have limited reason, Boyle can certainly not be regarded as a scientist of 'extreme modesty', but as a bold thinker, imitating the 'boldness' of 'Verulam' (Bacon), eager to learn from the unlimited wisdom of God:[117]

> For in the Divine Nature, Power, Wisdom, and other Attributes, there is a Faecundity that has produc'd a World of Contrivances, Laws and other things, that exceedingly surpass both the Number and Variety, that the dim and limited Intellect of Man could reach to, by framing and compounding *Ideas*, without the assistance of the Patterns afforded by the Works and Declarations of God.[118]

His faith in an infinitely wise designer led Boyle to be open as a matter of principle to the possibility of something similar to what Kyle Stanford has termed 'unconceived alternatives' by which to understand the physical world – alternative lines of thought to a scientist's line of investigation, that are for him or her as a rule, quite hard to accept, despite their seriousness and even their confirmation through evidence.[119] I take Boyle's standpoint to be one of the situations in the history of science in which, in the words of Peter Harrison, invocation of the supernatural has been a 'key presupposition for scientific investigation' of '"successful" scientific theories'.[120] Boyle's ambitious project of knowledge involved the view that the consistent observation of everything – including both normal and anomalous events – offered opportunities to gather information about the physical world. It is instructive to read his correspondence with Locke on this point: the latter reported from France in 1677 and 1678 meticulously in respect of on one key argument of *A Free Enquiry* that concerned denial of the Aristotelian teleology of nature: the existence of 'anomalies' and 'monsters', in other words, irregularities – this is a topic recurrent in Boyle's correspondence also with other students. Locke, for instance, had studied a case in which a French youth had grown claws instead of nails after a bout of smallpox, and had even met the youth in question.[121] This

[117] Wojcik, *Robert Boyle and the Limits of Reason*, p. 219. About Bacon's boldness see Boyle, 'A Discourse of Things above Reason' in *The Works of Robert Boyle*, v. 9, p. 382.

[118] Boyle, 'The Christian Virtuoso', v. 12, 325; see also Corneanu, *Regimens of the Mind*, p. 136.

[119] See for instance in P. Kyle Stanford, 'Darwin's Pangenesis and the Problem of Unconceived Alternatives' 57 *British Journal for the Philosophy of Science* (2006), 121–144, and at book length in P. Kyle Stanford, *Exceeding Our Grasp: Science, History, and the Problem of Unconceived Alternatives* (Oxford: Oxford University Press, 2006). See also, Shapin and Schaffer, *Leviathan and the Air Pump*, pp. 147–148.

[120] Peter Harrison, 'Naturalism and the Success of Science' 56 *Religious Studies* (2020), p. 276.

[121] 'Locke to Robert Boyle, 6 August 1678' in *The Correspondence of John Locke in 8 volumes*, E. S. de Beer (ed.) (Oxford: Clarendon Press, 1976), v. I, p. 599.

absence of regularity made clear to scientists their ignorance about the phenomena. This in turn motivated them towards greater study, thereby coming closer to the Creator and, significantly, acquiring greater mastery of the physical world.

Moving constantly, between God and Science, as Michael Hunter has argued, Boyle retreated again towards a stronger form of natural law with respect to 'powers', and by the end of the *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, he boldly concluded that the world possessed a certain constitution endowed upon it by God.[122] For it 'became the Divine Author of the Universe to give it such a Structure, and such Powers, and to establish among its Parts such general and constant Laws' that were best suited 'with his Purposes in creating the world'.[123] And in what appears to be a proposed theory of God's government of the world founded on empirical observation, Boyle observed that ensuring the welfare of human beings and other creatures was God's aim in making the world:

> First, though Men, and other animals be furnish'd with Faculties or Powers, and other Requisites, to enable them to preserve themselves, and procure what is necessary for their own welfare, yet this Provision … is made with reference to what regularly, or most usually happens to Beings of that Species or Sort that they belong to.[124]

The provision or welfare was again an incentive to think the unthinkable: the supernatural and the preternatural. Very often, when pointing to preternatural events, people only described a particular situation without grasping the wider laws of motion involved. Hence, cold air was a natural agent agreeable to the 'Catholick laws of motion' both when it turned rain into snow and when it caused disease – both cases displayed the infinite wisdom of God.[125] Moreover, by maintaining a tension between the freedom of God and the constitution of the physical world, Boyle's argument become objective. Only God knew everything: he was the Absolute Lord and proprietor and

[122] Hunter, Boyle: *Between God and Science.*

[123] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, 399.

[124] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 496.

[125] 'The two foregoing Observations may be farther illustrated, by considering, in what sense Men speak of things which they call *Praeter-natural*, or else *Contrary to Nature.* For divers, if not most, of their Expressions of this kind, argue, that *Nature* is in Them taken for the Particular and Subordinate, or, as it were, the Municipal Laws establish'd among Bodies.' Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 524.

had sovereign rights over his Creation.[126] Nevertheless, the laws of motion seemed to be above God's will in Boyle's view. The laws of motion seemed immutable and when it appeared that they did not work, that was only an illusion generated merely by our ignorance of divine wisdom.[127] Boyle addressed this issue in quite a convoluted manner, as was common among mechanic philosophers who took a strong stand in rejecting the suggestion of spiritual activity in nature. For Boyle, God's governance of the world was thus constitutional - as in political theory - with powers and laws distributed both to inanimate and animate beings. The thrust of his argument was to cast doubt on the possibility that the course of nature could be altered by means of miracles and angels rather than by human beings. However, he admitted supernatural interventions when human beings were concerned.[128]

7.3.2 *The 'Unnecessariness' of Nature*[129]

The discussion set out above helps to assess the broad scope of Boyle's project of natural law, which had moral, theological and epistemological foundations. I will conclude the chapter by briefly noting the utilitarian

[126] 'I shall only tell you in general, that I see no necessity, that Intelligibility to a *humane Understanding* should be necessary to the Truth or Existence of a thing; any more then that Visibility to a *Humane* Eye, should be necessary to the existence of an Atome, or of a Corpuscle of Air.' Boyle, 'Some Advices about Judging of Things Said to Transcend Reason' in *The Works of Robert Boyle*, v. 9, p. 398.

[127] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 567.

[128] 'And *tho'* I think it probable, that in the Conduct of that far greatest Part of the Universe, which is merely Corporeal, the Wise Author of it does seldom *manifestly* procure a Recession from the settled Course of the Universe, and especially from the most Catholick Laws of Motion: *Yet*, where Men, who are Creatures, that He is pleas'd to indow with Free Wills, (at least in reference to things not Spiritual,) are nearly and highly concern'd; I think he has, not only sometimes by those *signal* and *manifest* Interpositions we call *Miracles*, acted by a Supernatural way, but, as the Sovereign Lord and Governor of the World, doth divers times, (and perhaps oftner than mere Philosophers imagine) give by the Intervention of Rational Minds, as well united, as not united, to human Bodies, divers such determinations to the Motion of Parts in those Bodies, and of Others, which may be affected by Them, as by Laws merely Mechanical, those Parts of Matter would not have had: By which Motions, so determin'd, either Salutary or Fatal *Crises's*, and many other Things, conducive to the Welfare or Detriment of Men, are produc'd.' Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 517.

[129] Boyle's second reason to oppose the notion of a nature that deserves any kind of 'veneration' is 'the unnecessariness of such a nature'. The hypothesis supporting his argument in this case is that the common matter of all bodies having been divided into innumerable minute parts by 'the wise author of nature' and disposed in the order that now is constituted, which could be done by 'mere local motion of matter (not left to itself, but skilfully guided at the

and economic implications of turning the physical world into a philosophical system in which human beings are assigned the role of external managers – which amounts to an attempt to replace God. Boyle's romantic language of 1647, when he intended 'to court nature', changed drastically over the next two decades into a possessive passion that literally and figuratively led him to the desire to 'Range, Anatomize, and Ransack' nature.[130] The differences between his understanding of 'nature' in the early 1650s and that which he expressed in this later text are important. In the 1650s he saw nature as an 'agent' of God, 'his greate Substitute' that could be compared for its prudence to a 'Wise man'.[131] However, 15 years later he sought to pull apart this idea of nature as a mediator of God in his *A Free Enquiry*. Contemporaries understood the text also in this way.[132] To return to Digby's important *Two Treatises*, despite his expressed aim, they still contained plenty of expressions that seemed to give prominence to 'Nature', thus masking a lack of knowledge as to the causes of certain phenomena, as Boyle pointedly noted. Expressions exhibiting that personification are abundant: 'nature worked by the like instruments as art useth'; 'nature teacheth us that gravity is no quality'; 'the way most practiced by nature'; 'nature doth the same'; 'the oeconomy of the wise nature'.[133]

However, Boyle did not only undertake terminological purifications. In *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature* his stance reflected a double paradox: (a) a natural scientist seeking to deny the existence of 'nature' and (b) employing dozens of experiments – not abstract thinking – in order to establish theological principles, such as his theory of the existence of a universal system, or of the universe as a 'Fabrick' created

beginning of the world) – if (I say) we suppose these things together with God's ordinary and general concourse, which we very reasonably may, I see not why the same phenomena that we now observe in the world should not be produced, without taking in any such powerful and intelligent being, distinct from God, as nature is represented to be.' Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 485.

130 Carolyn Merchant's study on Bacon and the ransacking of nature indicates that here Boyle was borrowing from him, Carolyn Merchant, 'The Scientific Revolution and *The Death of Nature*' 96 *Isis* (2006).

131 'God's 'greate Substitute Nature (which is nothing but The Active Power & Law by him plac't in the World, & all the Ingredients of it) moves to hir Ends with the compleatest prudence imaginable: (being upon that account justly compar'd y Aristotle, to a Wise man)' Robert Boyle, *Study of the Book of Nature*, in *The Works of Robert Boyle*, vol. 13, p. 170.

132 'I therefore look upon this work as the new system of a new philosophy which fundamentally overthrows the foundation – namely, Nature, – of all views hitherto held in philosophical matters.' The summary is by David Abercromby, physician and Boyle's protegé, quoted in Hunter and Davis, 'The Making of Robert Boyle's "Free Enquiry into the Vulgarly Recevi'd Notion of Nature" (1686), p. 204.

133 Digby, *Two Treatises*, p. 123; p. 167; p. 187.

initially by God. In short, his message was that the 'Atomical Hypothesis' meant that one could do away with the concept of nature.[134] The alternative he proposed was the idea of a mechanical system of bodies affected by 'the power of Contiguous bodies', composed of atoms of matter lacking any intelligent principle of their own.[135] In the strictest Epicurean style Boyle encouraged disbelief in the existence of 'nature', since there was 'no proof' of it. It was a matter of 'Philosophy, where we ought not to take up any thing upon Trust, or believe it without Proof'.[136] In common with other mechanical philosophers and theologians, his aim was to expose the ambiguities of the vulgar notion of nature, and in particular, all the metaphysics embedded in an abstract notion which obscured the real knowledge of natural phenomena.[137] The vulgar notion of nature took, according to Boyle, a so-called 'nature' as cause, an agent, a mediator, and in the worst case a semi-deity. The 'commodious forms of speech' on 'nature' supposed the 'truth of it' rather than proving anything. Axioms such as 'nature does not make anything in vain' or 'nature abhors a vacuum' functioned like a blanket covering the fact that the scientist did not know the truth of the matter.[138] 'For to vouch Nature for a Cause, is an Expedient, that scarce be wanting to any Man, upon any occasion, to seem to know what he can indeed render no good reason for'.[139] To attribute either to nature or to chaos the design of the world was an empty signifier in both cases – it was in a sense more scientifically honest, in Boyle's view, to avoid answering metaphysical questions when so little knowledge was at the disposal of the scientist. The experimental scientist ought to be more cautious in the activity of hypothesizing than had hitherto been the case.[140] Boyle took the view that a divinized notion of 'nature'

[134] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 535.

[135] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, 505.

[136] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 484. To put it in Epicurus's own words, in the translation by David Sedley, Boyle carried out a 'reasoning based on empirical data' David Sedley, 'Epicurus *On Nature Book XXVIII*' 3 *Chronache Ercolanesi*, pp. 5–83, p. 27.

[137] The study of similar endeavours by the Belgian Arnold Geulinck (1624–1669) and Balthasar Bekker (1634–1698) in van Ruler, 'The Nature of Cartesian Disenchantment'.

[138] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 462; p. 464.

[139] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 451.

[140] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 465. See on how Boyle view his own standpoint employing the experimental

was unnecessary metaphysics, and even prejudicial to the glory of God. Moreover, as noted above, attempts to imitate or dissect nature created 'scruples of conscience' in the activity of transmutation:

> For many have not only looked upon it, as an *impossible* thing to compass, but as something of *impious* to attempt, the removing of those Boundaries which *Nature* seems to have put and setled among her Productions. And whilst they look upon her as such a venerable thing, some make a kind of scruple of Conscience, to endevour so to emulate any of her Works, as to excel them.[141]

Joel Mokyr has written that 'Irreverence is a key to progress'.[142] And it might be the irreverence of the most devout that brings about a more radical change.

The conclusion of *Of the Usefulness of Experimentall Natural Philosophy* shows the broad vision that the author had about the utilitarian possibilities offered by a disaggregated nature.[143] Boyle's activity moved between the natural and the artificial unproblematically, since anything and everything in nature, states and processes included, could be used as resources to be exploited. Nevertheless, as far as the history of international law is concerned, the most striking insight to be drawn from Boyle's *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature* is that Boyle both undid nature and did not shatter the boundaries of natural law. Natural law remained a key concept, which, through his critique and deconstruction of nature, became entrenched as a way of scientific thinking. Apart from defining nature as a 'Cosmical mechanism' and the particular

method in a manner promoting that the scientist did not rush into hypothesis, Shapin and Schaffer, *Leviathan and the Air-Pump. Hobbes, Boyle, and the Experimental Life*, pp. 22–79.

[141] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 450

[142] Joel Mokyr, *A Culture of Growth: The Origins of the Modern Economy* (Princeton: Princeton University Press 2016), p. 17.

[143] 'Though what I have hitherto discours'd, hath almost solely related to the neglected uses of Particular Bodies: yet I would not have You thence take occasion to imagine, that there are not other Natural things whereof divers Uses may be made, that men have hitherto either ignored, or overseen. By *other Natural things* I mean *the* different *states* of Matter, or of Bodies, (such as Rarity and Density, Fluidity and Firmness, Putrefaction and Fermentation, may seem to be,) as also *the* more operative qualities, such as Heat, Cold, Gravity, & c. *the* Laws of Local Motion among the parts of Matter; and *the* present Fabrick of the Universe, and specially that of our Terrestrial Globe and its Effluviums; to which might be added other things in Nature, that are not properly *Bodies* in the usual sense of that word, but may be called *Things Corporeal* as they belong to Bodies, and entirely depend on them.' Boyle, 'The Usefulness of Natural Philosophy II, sect. 2 (1671)', in *The Works of Robert Boyle*, vol. 6, p. 540.

nature as 'the individual mechanism', the laws of nature *as laws of motion* remained key to his main definition of nature.[144]

Bodies were 'determined to act' not by any 'inherent Appetite or Inbred Knowledge' but 'by virtue of the Original Frame of Things and established Laws of Motion'.[145] In this definition, the *laws of motion* were the *laws of nature* and what was natural now was identified with strict matter in such a way that 'the natural' became severed from any realist notion of rightful or just order that had been among the assets of Western philosophical thought since the early Greek era.[146] Hence there was no 'nature', but a macrocosm and a microcosm. The great system of the universe was universal and particular. This automaton – the earth – whose laws were mechanical was a 'fabrick' in which nothing acted in isolation, but upon the influence of the power of contiguous bodies, especially of air.[147] Boyle's way of depersonalizing nature and the same time generating objectivity was, as we saw, to describe nature as a system or *oeconomy*.[148] What had previously been 'nature' was now identified with the original sense of the Greek word *oikonomia*, the idea of an environment that comprised a complex system capable of being administered successfully.[149]

[144] 'If I were to propose a Notion, as less unfit than any I have met with, to pass for the *principal Notion of Nature*, with regard to which, many Axioms and Expressions, relating to that Word, may be not inconveniently understood, I should distinguish between the *universal*, and the *particular* Nature of things … *Nature*, in general, is The *Result* of the *Universal* Matter, or *Corporeal Substance of the Universe, considered as it is contrived into the present Structure and Constitution of the World, whereby all the Bodies, that compose it, are inabled to act upon, and fitted to suffer from, one another, according to the settled Laws of Motion … the particular Nature*, of an *Individual Body*, consists in the *general* Nature, *apply'd to a distinct portion of the Universe*. Or rather, supposing it to be plac'd, as it is, in a World, fram'd by God, like Ours, it consists in a *Convention of the Mechanical affections* (such as Bigness, Figure, Order, Situations, Contexture, and Local Motion) *of its parts*, (whether sensible or insensible) *convenient and sufficient to constitute in*, or *to entitle* to, *its particular Species or Denominations, the particular Body they make up, as the Concourse of all these is considered as the Principle of Motion, Rest and Change in that Body*.' Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, pp. 466–467.

[145] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 528.

[146] For a review see Crombie, *Science, Art and Nature in Medieval and Modern Thought*, pp. 67–87.

[147] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 521.

[148] Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 469.

[149] Carlo Natali, 'Oikonomia in Hellenistic Political Thought', in André Laks and Malcolm Schofield (eds.), *Justice and Generosity* (Cambridge: Cambridge University Press, 1995), p. 95; p. 98; Tribe, *The Economy of the Word*; Maifreda, *From Oikonomia to Political Economy*.

Chapters 6 and 7 have described two interrelated aspects of Robert Boyle's scientific programme: its goal of serving the economy of nation and empire through science and its transformation of the metaphysical foundations and principles of the traditional notion of nature. My suggestion is that Boyle was inspired in these endeavours by the previous generation of Reformers, and in particular by his former mentor and friend Benjamin Worsley. Robert Boyle was probably the most important thinker in England in displacing Aristotelian principles and replacing them with atomist ones. Apart from Creation by God, metaphysical principles were rendered unnecessary in the constitution of the physical world which was, in Boyle's account, of the atomist-corpuscular type. Moreover, only the epistemological method of experiment remained necessary. The horizon of knowledge could be always broader, deeper, and more thorough than at present – an attitude that was maintained by the profession of permanent doubt and an attitude marked by the desire for deconstruction. In Boyle's conception of the world, human beings are a fact, and he judged human beings' peculiar way of knowing the material world – evidently not directly through its atomic structure – markedly irrelevant in relation to the revolution in knowledge that was underway.

Nature became an impersonal system or an *oeconomy* for human beings to know, to administer and to exploit. In this approach humanity is the manager of that *oeconomy*. The natural system is considered a means to worship God and to human beings' growth in knowledge and material goods.[150] All in all, Boyle emerges as both an extraordinary scientist and an analytical philosopher. Nevertheless, he employed a utopian theology that lacked a critical anthropological perspective and he held conflicting positions that moved from expressions of awe towards God, towards possessiveness and recklessness, in respect of divine Creation. While Boyle seemed uncompromising in undoing notions of nature and in putting the system of nature at the service of economic profit, the natural lawyer John Locke, with a more realistic view about the effects of human greed, would distance himself from some of Boyle's most radical positions.

[150] 'And I further conceive, that he settled such Laws or Rules, of Local Motion, among the parts of the Universal Matter, that by his ordinary and preserving Concourse, the several parts of the Universe, thus once completed, should be able to maintain the great construction, or System and Oeconomy, of the Mundane Bodies, and propagate the Species of Living Creatures'. The woman's body and human beings' body more generally are also an *oeconomy*. 'the Oeconomy of the human body is so constituted by the Divine Author of it, that it is usually fitted to last many Years, if the more General Laws, settled by the same author of the Universe, will permit it.' Boyle refers to the 'Oeconomy of the Womans Body' in relation to the plentiful resort of milk to the breasts after giving birth that might produce fever. Boyle, *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, in *The Works of Robert Boyle*, v. 10, p. 469; p. 542; p. 545.