

Bears in Eden, or, this is not the garden you're looking for: Margaret Cavendish, Robert Hooke and the limits of natural philosophy

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Abstract. This paper investigates Margaret Cavendish's characterization of experimental philosophers as hybrids of bears and men in her 1666 story *The Description of a New World, Called the Blazing World*. By associating experimental philosophers, in particular Robert Hooke and his microscope, with animals familiar to her readers from the sport of bear-baiting, Cavendish constructed an identity for the fellows of the Royal Society of London quite unlike that which they imagined for themselves. Recent scholarship has illustrated well how Cavendish's opposition to experimental philosophy is linked to her different natural-philosophical, political and anthropological ideas. My contribution to this literature is to examine the meanings both of bears in early modern England and of microscopes in experimental rhetoric, in order to illustrate the connection that Cavendish implies between the two. She parodied Hooke's idea that his microscope extended his limited human senses, and mocked his aim that by so doing he could produce useful knowledge. The bear-men reflect inhuman ambition and provide a caution against ignoring both the order of English society and the place of humans in nature.

Beyond human limits

In Margaret Cavendish's 1666 fantasy *The Description of a New World, Called the Blazing World*, a newly crowned Empress orders a group of bear-men philosophers to break their telescopes. 'I do plainly perceive', she interrupts their arguing, 'that your Glasses are false Informers, and instead of discovering the Truth, delude your Senses'. She suggests that instead of using instruments, they 'let the Bird-men (astronomers) trust onely to their natural eyes' when observing celestial objects.¹

The episode can be read as the Duchess of Newcastle indirectly instructing the newly established Royal Society of London that their instruments and experiments were not useful for investigating the world. The bear-men were the experimental philosophers of the *Blazing World*, just as the Royal Society institutionalized experimental natural philosophy in Restoration England. During their conversation with the Empress,

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¹ Margaret Cavendish, *The Description of a New World, Called the Blazing World*, in Cavendish, *Observations upon Experimental Philosophy: To which is added, the Description of a New Blazing World*, 2nd edn, London, 1668, pp. 1–158, 27.

which prefigures the duchess's visit to the fellows in London the following year, the bears show her their telescopes and microscopes, and the observations they have made with them. These observations were lifted directly from Robert Hooke's *Micrographia* (1665), a celebration of the microscope which the Royal Society had published only the previous year. As she made clear in her *Observations upon Experimental Philosophy*, published alongside *The Blazing World*, Cavendish did not consider it an instrument worth celebrating:

those that invented Microscopes, and such like Dioptrical Glasses, at first, did, in my opinion, the World more injury than benefit; for this Art has intoxicated so many Mens brains, and wholly employed their thoughts and bodily actions about Phenomena, or the Exterior Figures of Objects, as all better Arts and Studies are laid aside ... But though there be numerous Books written of the wonders of these Glasses, yet I cannot perceive any such, and at best, they are but superficial wonders.²

This is a damning appraisal of both Hooke's work and Henry Power's 1664 *Experimental Philosophy*, which also included microscopical observations. Cavendish saw these books not as natural-philosophical works but as distractions from the many more important things which faced England as it recovered from the upheaval of civil war and Cromwell's Protectorate. Cavendish thought that her contemporaries, as well as the bear-men, ought to put aside their magnifying lenses.

In this paper I will discuss how the duchess's inventive characterization of experimental philosophers as hybrids of bears and men constructs for them an identity and a place in Restoration England quite unlike that which they imagined for themselves. The relationship between microscopes and bears is a complicated one. Lisa Sarasohn has noted Cavendish's 'cultural canniness and sense of humour' in representing Hooke and his colleagues as creatures familiar to her readers as objects of mockery and entertainment in the bear gardens of Elizabethan and early Stuart England.³ In these arenas, bears were chained to stakes and made to fight waves of dogs. What did it mean to cast Hooke as such a figure? As Sujata Iyengar, Catherine Gallagher and Lisa Walters have all emphasized, Cavendish's criticism of experiment is not purely epistemic, but intimately tied to her views on social and political order.⁴ And as Cristina Malcolmson has discussed, the various races who comprise the philosophers in the *Blazing World* represent an alternative to the assumption which the experimenters made about the connection between knowledge and human nature.⁵ As I will show below, these threads come neatly together in the scene of an Empress discussing microscopy with bear-men. The

2 Margaret Cavendish, *Observations upon Experimental Philosophy*, in Cavendish, *Observations upon Experimental Philosophy*, op. cit. (1), pp. 1–392, 10.

3 Lisa T. Sarasohn, *The Natural Philosophy of Margaret Cavendish: Reason and Fancy during the Scientific Revolution*, Baltimore: Johns Hopkins University Press, 2010, p. 165.

4 Sujata Iyengar, 'Royalist, romancist, racialist: rank, gender, and race in the science and fiction of Margaret Cavendish', *ELH* (2002) 69, pp. 649–672; Catherine Gallagher, 'Embracing the absolute: the politics of the female subject in seventeenth-century England', *Genders* (1988) 1, pp. 24–39; Lisa Walters, *Margaret Cavendish: Gender, Science and Politics*, Cambridge: Cambridge University Press, 2014.

5 Cristina Malcolmson, *Studies of Skin Color in the Early Royal Society: Boyle, Cavendish, Swift*, Farnham: Ashgate, 2013.

distraction and play of the bear garden was a complex spectacle, in which violence and danger were held at bay only by a particular order of things. Through the course of this paper I will argue that Cavendish's imagery plays both on the very idea of what it was to be human in seventeenth-century England, and on Hooke's own idea that the microscope extended the natural limits of human senses.

The experimenters wrote as if the microscope was an obvious boon for natural philosophy. As John Wilkins wrote in 1648, it showed the limits of human sense, and in doing so provided evidence that existing philosophy was in error:

we see what strange discoveries of extream minute bodies, (as lice, wheal-worms, mites, and the like) are made by the *Microscope*, wherein their severall parts (which are altogether invisible to the bare eye) will distinctly appear: and perhaps there may be other insects that live upon them as they doe upon us. 'Tis certain that our senses are extreamly disproportioned for comprehending the whole compasse and latitude of things.⁶

Tiny creatures, invisible to the naked eye but revealed thriving and wriggling through a lens, not only were missing from the old natural histories of Aristotle or Pliny, but also embodied Francis Bacon's warning that 'the testimony and information of the sense is always made to the measure of man and not the universe'.⁷ Bacon himself had been unsure about the merits of the microscope, but by the middle of the century Hooke and Power excitedly promised that the new instrument would rectify the imperfections of human sight, and close the gap between the limits of human knowledge and the vast extent of nature.⁸ Useful works and improvements to the English estate would flow from the resulting completion of natural philosophy. Power rhapsodized, 'How much therefore are we oblig'd to modern Industry, that of late hath discover'd this advantageous Artifice of Glasses[?]'.⁹

Such unambiguous gratitude for the 'darling art' of microscopy fell flat with Margaret Cavendish.¹⁰ 'I will not say, but Art may help to mend some defects, errors, or irregularities in Nature', she allowed. 'But not make better that which Nature has made perfect already.'¹¹ How limited eyesight could be 'perfect' she makes clear by continuing with a

6 John Wilkins, *Mathematical Magick. Or, The Wonders That may be performed by Mechanicall Geometry*, London, 1648, pp. 115–116.

7 Francis Bacon, *The Plan of the Work*, in *The Oxford Francis Bacon*, vol. 11: *The Instauration Magna Part II: Novum Organum and Associated Texts* (ed. Graham Rees and Maria Wakely), Oxford: Oxford University Press, 2004, pp. 26–47, 34.

8 For more on this epistemology of the microscope see especially Catherine Wilson, *The Invisible World: Early Modern Philosophy and the Invention of the Microscope*, Princeton: Princeton University Press, 1995; Christoph Lüthy, 'Atomism, Lynceus, and the fate of seventeenth-century microscopy', *Early Science and Medicine* (1996) 1, pp. 1–27; Marian Fournier, *The Fabric of Life: Microscopy in the Seventeenth Century*, Baltimore: Johns Hopkins University Press, 1996; Edward Ruestow, *The Microscope in the Dutch Republic*, Cambridge: Cambridge University Press, 1996.

9 Henry Power, *Experimental Philosophy in Three Books: containing New Experiments Microscopical, Mercurial, Magnetical*, London, 1664, C2r–v.

10 Power, op. cit. (9), C2v, p. 155. Power was inspired enough to write a poem 'In Commendation of ye Microscope', for which see Thomas Cowles, 'Dr. Henry Power's Poem on the Microscope', *Isis* (1934) 21, pp. 71–80.

11 Cavendish, op. cit. (2), p. 32. This invective may well have been directed squarely at Hooke – he had expressed aerial ambitions in *Micrographia*, which was the main target of Cavendish's lengthy critique of

useful analogy: ‘Neither can we say, Man is defective, because he cannot flie as Birds: for flying is not his Natural and proper Motion; We should rather account that Man monstrous that could flie’. In contrast to the idea that lenses were a mundane improvement to the human eye, Cavendish thought that such artifice would instead make sight inhuman, and was therefore incapable of leading to true knowledge. Her preferred, broadly rationalist, methodology was founded in an organic materialist natural philosophy. Humans, like everything else, were finite parts of an infinite Nature which was a self-knowing, self-organizing whole.¹² As such, Eve Keller has written, for Cavendish ‘man is inextricably a part of the nature he seeks to know’, and artifice can never remove his limits and grant universal knowledge.¹³ Philosophy which proceeded through reason and the unaided senses could lead to valuable artifice, she agreed, but artifice could never lead to natural philosophy.

I will discuss the anthropomorphic character of the bear in seventeenth-century England and the anthropological implications of an Empress conversing with animal-philosophers to illustrate both the epistemic and the political aspects of Cavendish’s anti-experimentalism. The microscope becomes not an uncontroversial asset but a symbol of disagreement about the relationship between scientific inquiry and social progress. First, though, I will introduce the bear-men of Cavendish’s story, and then the microscope in Hooke’s work.

Bear-men experimenters

The Blazing World is a dense nest of hypotheticals, invented worlds, and fictional counterparts. Anna Battigelli has argued that the very form of the work critiques the iterative, inductive philosophy of Hooke and the Royal Society, and Cavendish frequently references real-world contemporaries in imaginative ways which criticize the intellectual climate of Cavendish’s England.¹⁴ The protagonist (whom it is difficult to resist

the experimental philosophy. See Robert Hooke, *Micrographia: or some Physiological Descriptions of Minute Bodies made by Magnifying Glasses*, London, 1665, D1v. See also Viktoria Tkaczyk’s work on early modern flight: ‘Ready for takeoff’, *Cabinet* (2007) 27, available at <http://cabinetmagazine/issues/27/tkacsyk.php>, accessed 24 June 2015; Viktoria Tkaczyk, *Himmels-Falten: zur Theatralität des Fliegens in der Frühen Neuzeit*, Paderborn: Wilhem Fink, 2011.

12 For more on Cavendish’s natural philosophy generally see Anna Battigelli, *Margaret Cavendish and the Exiles of the Mind*, Lexington: University of Kentucky Press, 1998; Sarasohn, op. cit. (3); Steven Clucas (ed.), *A Princely Brave Woman: Essays on Margaret Cavendish, Duchess of Newcastle*, Farnham: Ashgate, 2003; Peter Dear, ‘A philosophical duchess: understanding Margaret Cavendish’, in Juliet Cummins and David Burchell (eds.), *Science, Literature and Rhetoric in Early Modern England*, Aldershot: Ashgate, 2007, pp. 125–144.

13 Eve Keller, ‘Producing petty gods: Margaret Cavendish’s critique of experimental science’, *ELH* (1997) 64, pp. 447–471, 457, original emphasis.

14 Battigelli suggests that the radical invention of the narrative is an indirect rebuttal to Hooke’s famous ‘sincere hand and faithful eye’; the methodical, automated empiricism of the Royal Society. If whole worlds of difference are created in the flippant and eccentric mind, how could a method of meticulous collaboration among observers produce reliable, unified knowledge? Anna Battigelli, ‘Between the glass and the hand: the eye in Margaret Cavendish’s *Blazing World*, 1650–1850: *Ideas, Aesthetics, and Inquiries in the Early Modern Era* (1996) 2, pp. 25–38. The importance of rhetoric and imagination in Cavendish’s works is well established and well discussed, since Marjorie Nicolson passed over the ‘ponderous tome’ in her *Voyages to the Moon*, New York: MacMillan, 1948, p. 224. See, for instance, Keller, op. cit. (13);

reading as Cavendish's avatar) imagines the Duchess of Newcastle herself into the story world to act as her amanuensis, and other (real) contemporary authors are indirectly mentioned in various asides and scenes. Robert Hooke appearing as a bear-man is one of the clearest such moments.

Before meeting the bear-man Hooke, the reader is introduced to his world, which is home to Cavendish's foundational metaphysics. The story begins when the protagonist, a young Lady from a seaside town, is abducted by a travelling merchant. He is below her in birth and wealth, but his passion drives him to snatch her away while she gathers shells on a beach. Out at sea, a swelling storm forces his ship off course and toward the North Pole. Here the ship enters the Blazing World, a different world connected to the Lady's at their respective poles. As Elizabeth Spiller notes, neither world is ours – both are imagined places which instantiate different metaphysical hypotheses. The Lady's world echoes Hobbesian mechanism – the merchant's actions, driven by his passions, are only overpowered by the greater violence of the storm.¹⁵ But in the Blazing World, action is ruled by essences and qualities. As the ship glides through precipices of ice, the merchant and crew all freeze to death, but the Lady, protected by 'the Light of her Beauty' and 'the heat of her Youth', survives. Her inner nature interrupts the mechanistic cause and effect of the freezing cold.¹⁶ The world is governed by Cavendish's organic materialism: matter is not inert and moved only by external forces, but rather moved and organized by itself. Though nature is a unified whole, distinctions between objects and kinds exist as the results of matter's own self-knowledge and self-movement. Objects are organized from within, and know how to react to the world around them. For example, a ball moves not because it is propelled by a throwing hand, but because it knows itself as a ball, perceives the hand's motion, and knows the appropriate way in which to move itself.¹⁷ Without internal, defining knowledge, the world 'would run into Confusion: for, there could be neither Order nor Method, in Ignorant motion; neither would there be distinct kinds or sorts of Creatures'.¹⁸ Thus knowledge and kinds are inseparably linked – knowledge creates kind, and kinds have a particular domain of knowledge. This idea is made manifest by the animal-philosophers the Lady soon meets.

Her boat is pulled to shore by a group of 'strange Creatures, in shape like Bears, only they went upright as men'.¹⁹ In fact, all the inhabitants of the Blazing World are hybrids of human and other: sentient and civil, yet physically suited to their environment.²⁰ The

Elizabeth Spiller, *Science, Reading, and Renaissance Literature: The Art of Making Knowledge, 1580–1670*, Cambridge: Cambridge University Press, 2004; Battigelli, op. cit. (12), especially Chapter 4; Sylvia Bowerbank, 'The spider's delight: Margaret Cavendish and the "female" imagination', *English Literary Renaissance* (1984) 14, pp. 392–408; Kate Lilley's introduction to Margaret Cavendish, *The Description of a New World, Called the Blazing World, and Other Writings*, London: William Pickering, 1992.

15 Spiller, op. cit. (14), p. 168.

16 Cavendish, op. cit. (1), p. 2.

17 See Kourken Michaelian, 'Margaret Cavendish's epistemology', *British Journal for the History of Philosophy* (2009) 17, pp. 31–53.

18 Margaret Cavendish, *Grounds of Natural Philosophy*, London, 1668, p. 7.

19 Cavendish, op. cit. (1), p. 4.

20 The racialist implications of Arctic-dwelling bear-people have been discussed by Line Cottegnies, 'Utopia, millenarianism, and the Baconian programme of Margaret Cavendish's *The Blazing World*', in Chloë Houston

Lady travels south from the bear-men's cold home and meets bird-men on islands, satyrs in forests, worm-men, giants and people with green or azure skin. Like Hooke looking through a microscope, she is awed and bewildered by the novelty and variety of the new world. At last she meets the Emperor, who offers to worship her as a goddess. When she refuses he marries her instead and vanishes from the story.²¹ As Empress she gains absolute governance over the world, and with this political power comes epistemic privilege. Her position brings her the attention and loyalty of the animal-men, who all turn out to be knowledgeable about their various habitats. As Cavendish wrote in an earlier work,

what Man knows, whether Fish do not Know more of the nature of Water, and ebbing and flowing, and the saltness of the Sea? or whether Birds do not know more of the nature and degrees of Air, or the cause of Tempests? or whether Worms do not know more of the nature of Earth, and how Plants are produced? or Bees of the several sorts of juices of Flowers, then Men? And whether they do not make there Aphorismes and Theoremes by their manner of Intelligence? For, though they have not the speech of Man, yet thence doth not follow, that they have no Intelligence at all.²²

The imaginative aspect of the Blazing World's animal-philosophers is not animal knowledge itself, but the translation of their 'aphorisms and theorems' into the 'speech of Man' so it could be shared by someone not of their kind. The Empress assists the transformation of animal knowledge into human philosophy with an administrative decree: she founds schools and institutes to help them with their studies. Each animal-man's profession was to be 'most proper for the nature of their Species':

The Bear-men were to be her Experimental Philosophers, the Bird-men her Astronomers, the Fly- Worm- and Fish-men her Natural Philosophers, the Ape-men her Chymists, the Satyrs her Galenick Physicians, the Fox-men her Politicians, the Spider- and Lice-men her Mathematicians, the Jackdaw- Magpie- and Parrot-men her Orators and Logicians, the Gyants her Architects, &c.²³

She takes a tour around the schools to learn from them, but approves of some more than others. The insectile natural philosophers are a particular hit, offering intimate knowledge of the air, sea and earth in which their tiny bodies are built to live. But she dismisses the ape-men's chymical assumptions about the world out of hand, and while the bird-men's observations are acceptable, they veer into flighty speculation too often for her

(ed.), *New Worlds Reflected: Travel and Utopia in the Early Modern Period*, Farnham: Ashgate, 2010, pp. 71–94; Malcolmson, op. cit. (5), Chapter 4; Iyengar, op. cit. (4).

21 Sujata Iyengar, op. cit. (4), discusses the possibility of male and female monarchism for Cavendish. Cavendish's feminism generally has been a point of contention, and has been discussed by, among others, Lisa T. Sarasohn, 'A science turned upside down: feminism and the natural philosophy of Margaret Cavendish', *Huntington Library Quarterly* (1984), 47, pp. 289–307; Deborah Boyle, 'Margaret Cavendish's nonfeminist natural philosophy', *Configurations* (2004), 12, pp. 195–227; Dear, op. cit. (12); Keller, op. cit. (13); Gallagher, op. cit. (4).

22 Margaret Cavendish, *Philosophical Letters: or, Modest Reflections Upon some Opinions in Natural Philosophy, Maintained by several Famous and Learned Authors of this Age, Expressed by way of Letters*, London, 1664, pp. 40–41.

23 Cavendish, op. cit. (1), pp. 15–16.

liking.²⁴ When she meets again her generous arctic hosts, the bear-men experimenters, she engages them in an extended argument.

The bear-men are eager to show off their optical instruments, and they recount observations from Hooke's *Micrographia* – surprising visions of lice as big as elephants, mites like whales, eyes that look like pearls. The bear-men show the Empress that nothing is as it seems to the naked eye.²⁵ For them, as for Hooke and Power, this was, of course, the point of the instrument. When the Empress baits them by suggesting that 'perhaps their Microscopes did not truly inform them', they grow coy and 'smilingly answer' that perhaps the Empress did not fully understand the microscope? It does not deceive, but 'rectifie[s]and inform[s] the Senses'. Echoing Hooke, they say, 'the World ... would be blind without them, as it has been in former ages'.²⁶ Cavendish was clearly familiar with Hooke's rhetoric as well as his observations. But the Empress remains unmoved, and tears apart the bear-men's conclusions about charcoal, stinging nettles, fleas and lice.²⁷

Many species have an obvious resonance with their profession, and others have their resonance made clear by their conversations with the Empress. Mid-sized and mammalian, bears have neither a radically different insight into nature than do humans, nor any particular skill in manipulating instruments. To see the importance of the bear-men we must look to the meaning of bears for Cavendish's seventeenth-century English readers. As Sarasohn suggests, the portrayal of the Royal Society members as animals used for brutal entertainment in London bear gardens 'collaps[es] the cultural pretensions of the experimental philosophers'.²⁸ Yet the lesson goes beyond simple mockery. Bears had a very particular character in seventeenth-century England, and the experimenters conceptualized microscopy in a specific way also. By associating the two, Cavendish's story burlesques Hooke's own self-presentation. Hooke saw lens use as the answer to human imperfections, and the animal caricature leans on his experimental ambition willfully and deliberately to transgress human limits. As I will show below, the implication is that while Hooke laboured gradually for the improvement of the human condition, Cavendish shows that he remained constrained to his finite place in self-organizing nature. The furry forms of Cavendish's story reverse the expected direction of enquiry: we do not learn about nature from the Empress's conversation with the bear-men, but about the experimenters and the experimental space. To draw out this point, I will first show how Hooke presented his microscopy, and then investigate the way bear-baiting was understood in Cavendish's England.

24 See William R. Newman, *Promethean Ambitions: Alchemy and the Quest to Perfect Nature*, Chicago: The University of Chicago Press, 2008, pp. 286–287, for the parallel between her criticism of chymistry and those of earlier writers. Sarasohn, op. cit. (3), p. 167, also discusses the similarity.

25 Cavendish, op. cit. (1), p. 29. For the corresponding observations in Hooke's work see Hooke, op. cit. (11), pp. 211, 205, 175.

26 Cavendish, op. cit. (1), p. 30. See, for parallels, Power, op. cit. (9), A4v–B1v; Hooke, op. cit. (11), D1v.

27 Cavendish, op. cit. (1), pp. 31–32. See also her *Observations upon Experimental Philosophy*, op. cit. (1), p. 9. Again see Hooke, op. cit. (11), pp. 100, 142, 210, 211.

28 Sarasohn, op. cit. (3), p. 165.

Seeing with a microscope

Experimenters often wrote about the view through their optical instruments as an experience either of transportation or of transformation. Wilkins wrote of ‘scaling the heavens’ with a telescope, Hooke discovered a ‘new visible World’ through his microscope, and he and Power both extended their sight with ‘artificial Eys’.²⁹ Such naturalistic analogies all deliberately obscured the difficulties of the intricate art of lens use, but it was Hooke’s *Micrographia* which particularly presented the microworld as an accessible and natural wonder. The work was an explicit example of how an experimenter could step outside his human limits.³⁰ The first of the book’s thirty-eight images is of the microscope itself (Figure 1). It is an impressive system, and Hooke explains something of its operation and construction. Thereafter in the book many images appear presented on specimen slides or enclosed by circular frames: now we know how it works, we the readers look down through its lenses, effortlessly partaking in the experience of the experimenter.³¹

Often, Hooke’s images emphasize the transformation that has taken place in vision – our experiences come drawn to a scale, and labelled with letters for reference in the accompanying text. Take note, he tells his readers, of the things hidden in an eighth of an inch. This is the world, but not as you usually see it.

Hooke’s celebration of the power of the instrument and its ease of use also, upon occasion, renders it completely transparent. In Scheme 18, thyme seeds spill across the page, uncontained by a lens or specimen mount. The climactic images of the ant, the flea and the louse cannot be contained by the book’s bindings themselves – the last of these (Figure 2) folds out to four times the size of the large folio book.³² As Michael Dennis has written, Hooke’s ‘microscopes and circumstances vanished into the page’s white background’.³³ We are immersed in the microworld and completely unaware of the instrumental mechanism behind the image.

In the description accompanying this louse, Hooke describes his elaborate microscope as simply ‘my faithful *Mercury*’: a messenger which unproblematically ‘bring[s] me other

29 John Wilkins, *A Discourse concerning a New World & Another Planet, in 2 Bookes*, London, 1640, p. 86; Hooke, op. cit. (11), A2v; Power, op. cit. (9), C2v. See Hooke, op. cit. (11), A2r, for his famous phrase about adding ‘artificial Organs to the natural’. See also the frontispiece to Wilkins’s *Discourse concerning A New World*, which sees Galileo’s telescope fulfilling Kepler’s wish that he had wings on which to travel through the solar system.

30 See the book’s preface for Hooke’s discussion of overcoming limited sense. To the extent that *Micrographia* can be read as a defense of the methods of the whole newly founded Royal Society see John Harwood, ‘Rhetoric and graphics in *Micrographia*’, in Michael Hunter and Simon Schaffer (eds.), *Robert Hooke: New Studies*, Woodbridge: The Boydell Press, 1989, pp. 119–148.

31 See for instance Schemes 2, 3, 5, 7, 9, 10, 11, 12, 14, 15, 21, 23. The parallel with the first book of telescopic observations is notable: as Spiller, op. cit. (14), p. 110, says, in Galileo’s *Sidereus Nuncius* the telescope also ‘stretches out beyond the text [and] the reader and the viewer’s sites are aligned’.

32 Maxwell Power has taken the change in drawing styles to indicate that Christopher Wren, Hooke’s close friend and colleague, drew *Micrographia*’s most iconic images. See Maxwell Power, ‘Sir Christopher Wren and the *Micrographia*’, *Transactions of the Connecticut Academy of the Arts and Sciences* (1945) 36, pp. 37–44. Regardless of the provenance of the images, Hooke certainly presents the book as the result of a single author, and more important here is the way the book is viewed, rather than how it was created.

33 Michael Aaron Dennis, ‘Graphic understanding: instruments and interpretation in Robert Hooke’s *Micrographia*’, *Science in Context* (1989) 3, pp. 309–364, 341.

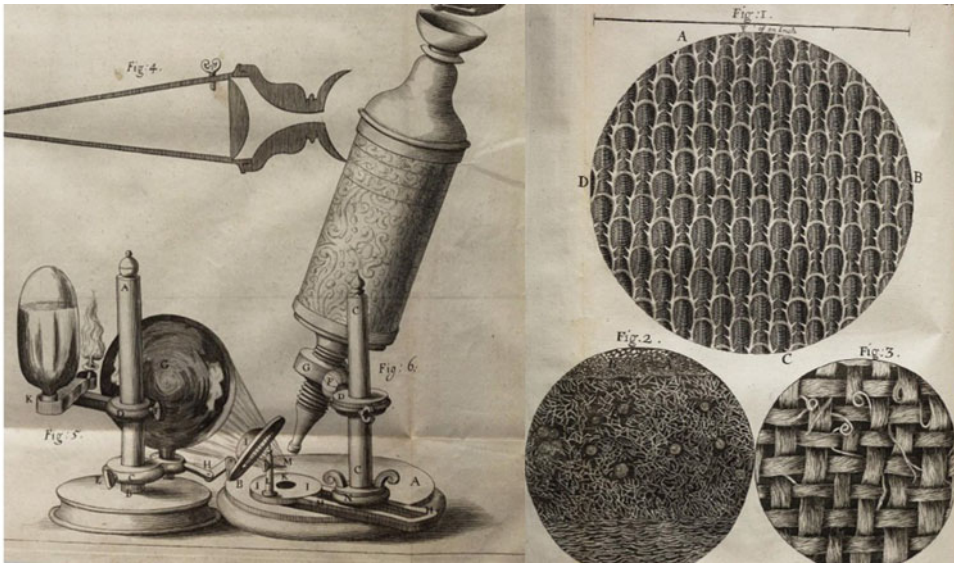


Figure 1. Left, Hooke's microscope. Robert Hooke, *Micrographia*, London, 1665, Scheme 1, opposite sig. G2v. Right, surfaces of seaweed, rosemary leaf and fine lawn. *Ibid.*, Scheme 14, opposite p. 141.

information'.³⁴ Hooke again collapses microscopes and travel, but looking at the images it is hard to resist the idea that what has been transported is ourselves: we are propelled down the tube and into the microworld. The diagrammatic letters that cling to the formidable creatures are small reminders that the images are pedagogical, but our perspective has changed – we no longer experience them as humans would, but as incongruent equals. Hooke writes of 'the strength and beauty' of a flea, the 'great claws' of crustaceans, the 'horns' of a gnat 'almost like the horns of an Oxe'.³⁵ These are the qualities not of insects but of the oversized beasts of the schemes. Written through transformed eyes, Hooke's book does not reflect human sensibility.

What human senses were had recently undergone a dramatic conceptual shift. As Ofer Gal and Raz Chen-Morris have recently shown, in the early decades of the seventeenth century, Kepler and Descartes redescribed the mechanism of vision in a way which allowed optical instruments to be naturalized as parts of the body of the experimenter. These authors made it clear that vision did not, as had previously been thought, operate through the transmission of three-dimensional 'species' which emanated from objects

34 Hooke, *op. cit.* (11), p. 211. The presence of John Wilkins is lurking behind the Roman messenger god. In 1641 Wilkins anonymously published *Mercury, or the Secret and Swift Messenger*, apparently inspired (as with his other other-worldly speculations) by Francis Godwin, whose *Nuncius Inanimatus* (1629) was about the transmission of messages over long distances. Hooke himself would later devise a similar telegraphy scheme of symbols to be viewed through spyglasses: see William Derham, *Philosophical Experiments and Observations of the late Eminent Dr. Robert Hooke ...*, London, 1726, pp. 142–150.

35 Hooke, *op. cit.* (11), pp. 210, 178, 185.

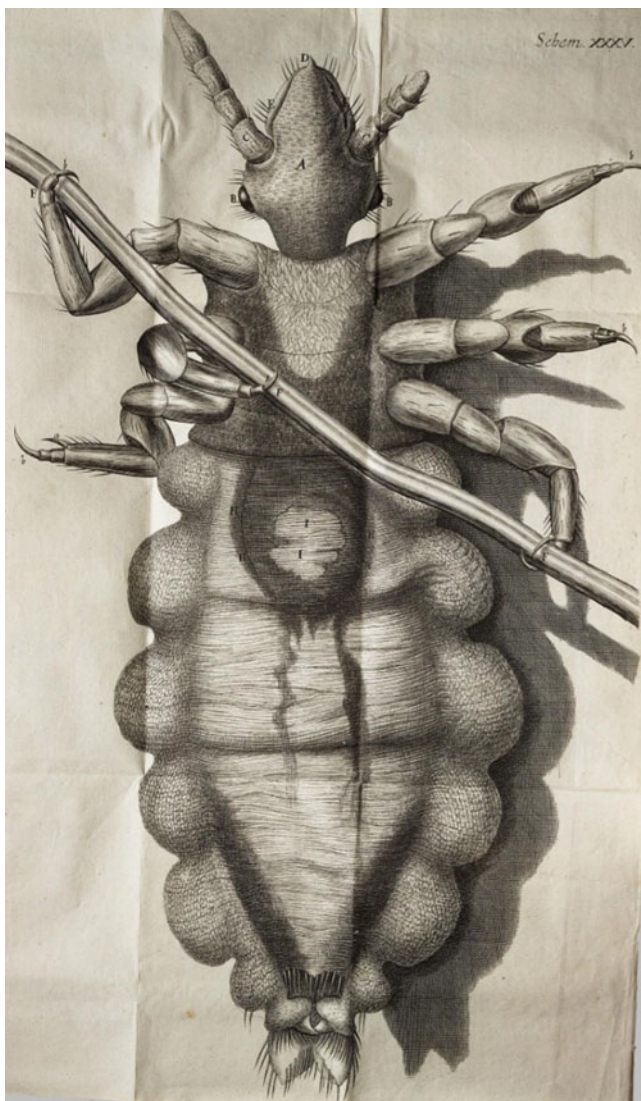


Figure 2. Scheme 35, louse gripping a human hair. Hooke, op. cit., opposite p. 211.

and were presented to the intellect via a sensitive humour in the middle of the eye.³⁶ Instead, light was the medium of vision, and it painted images on the retina as it did on the screen of a *camera obscura*. The soul or intellect of the observer was divorced

36 Ofer Gal and Raz Chen-Morris, *Baroque Science*, Chicago and London: The University of Chicago Press, 2013, p. 43. For the argument at large, see the whole of Chapter 1. The point is especially clear in the fourth discourse of Descartes's *Dioptrique*. See also David C. Lindberg, *Theories of Vision from Al-Kindi to Kepler*, Chicago: The University of Chicago Press, 1976.

from the mechanism of vision. The eye was just a lens and a screen – an optical instrument, like the microscope, and it was ‘used’ by someone who remained outside it, not part of the optical process.³⁷ This new, mediated idea of the senses implied that they were not designed to grant directly knowledge of forms or essences in the world, but could only respond to certain qualities in it. As Power wrote, the senses were for ‘manag[ing] this particular Engine we call the Body’, and were constituted to ‘best agree with the place of our habitation’.³⁸ According to Hooke, the eye discovered ‘Conveniences and Inconveniences at a greater Distance as well as near at hand: The Ear receiv[ed] Warning or Information from Sound, where the Eye could not assist’.³⁹ He drew out the epistemic conclusion about knowledge gained through observation: ‘Had we other kinds of Organs, we should have other kinds of Conceptions’. What is more, ‘if there were another Species of Intelligent Creatures in the World, they might have quite another kind of Apprehension of the same thing[s in the world]’.⁴⁰ Cavendish would no doubt have agreed. It was the senses of their ‘particular Engines’ which gave her worm-men knowledge of the earth and fish-men knowledge of the sea. Her bear-shaped burlesque was directed at the further implication of the microscopists: that by adding ‘artificial Organs to the natural’, Hooke could act out his counterfactual and become a new species of observer, constructed not only from reason and senses, but from lenses and images.⁴¹

When Christopher Wren became professor of astronomy at Gresham College in 1657, he wondered ‘how much the ancient laborious Enquirers would envy us ... that a Time would come, when Men should be able to stretch out their Eyes, as Snails do, and extend them to fifty Feet in length?’⁴² Behind the joke was a serious point – in looking through a fifty-foot telescope the eye was really altered away from its human form. Descartes had similarly concluded that when looking down a tube of liquid, ‘sight will take place in the same way as if Nature had made the eye longer than it is’.⁴³ A generation later, the English experimenters wrote of the explicitly inhuman – even animalian – form of the instrument-user. Magnifying lenses overcame the limits of human sight in a way which already existed in nature. Cavendish’s bear-men embody the futility, as she saw it, of this as a philosophical method.

37 Gal and Chen-Morris, op. cit. (36), p. 42. See also their references for the epistemological unease this bequeathed subsequent philosophy, and their Chapter 3 for more on Hooke’s ‘radical instrumentalization’.

38 Power, op. cit. (9), B1r.

39 Robert Hooke, *A General Scheme, or Idea of the Present State of Natural Philosophy, and How its Defects may be Remedied by a Methodical Proceeding in the making Experiments and collecting Observations*, in *The Posthumous Works of Robert Hooke, containing his Cutlerian Lectures, and other Discourses, Read at the Meetings of the Illustrious Royal Society* (ed. Richard Waller), 2nd edn, London, 1971 [1705], p. 8.

40 Hooke, op. cit. (39), p. 9.

41 Hooke, op. cit. (11), A2r.

42 The accession speech is reproduced in full in Stephen Wren, *Parentalia: or, Memoirs of the Family of Wrens; viz. of Mathew Bishop of Ely, Christopher Dean of Windsor, &c. but chiefly of Sir Christopher Wren ...*, London, 1750, pp. 200–206. The snail eyes appear on p. 205, as Wren is discussing Seneca’s prophecy of the discovery of the New World, again comparing travel with optic glasses as sources of discovery.

43 René Descartes, *Optics*, in Descartes, *Discourse on Method, Optics, Geometry, and Meteorology* (trans. Paul J. Olscamp), revised edn, Indianapolis and Cambridge: Hackett Publishing Company, 2001, pp. 63–173, 120.

The character of the bear

Erica Fudge has interpreted the bear gardens of Tudor and Stuart London as a place of direct contradictions, where both similarities and differences between humans and bears were revealed. Bears, along with bulls, dogs, apes and the occasional lion, were brutalized figuratively and literally – blinded and tortured and whipped, their animal status was emphasized in opposition to that of their human captors. It was a carnal assertion of the ability of human reason to overcome the body, even bodies as physically powerful as those of bears. But significant though the triumph of will over flesh was, it was a spectacle steeped in ambiguity.⁴⁴ The dehumanization of the captive animals suggested likewise the inner brute of the baying, bloodthirsty audience, and the animals were frequently considered anthropomorphically.⁴⁵ In 1575, a spectator described the fight between a bear and dogs as a discourse of queries and clever responses: the animals were made to ‘argu the pointz cum face to face. They had learn’d counsel also a’both partis. Very feers both t’one and t’other, and eager in argument’.⁴⁶ Their baiting was a form of theatre, often explicitly: Jason Scott-Warren has written that theatrical and bear-baiting shows ‘overlapped spatially and socially’, and even ‘came to share a representational mode’ in the early seventeenth century.⁴⁷ Bears were the protagonists in scripted narratives, and many gained fame and popularity. Their names – human names like George Stone and Harry Hunks – appeared often on flyers and advertisements and in reports.⁴⁸ The plain fact that particular bears were regular combatants implies that the premise of the violence was not a Manichean contrast of life with death, but a more nuanced story about the qualities which characterized that life.⁴⁹

These qualities were well established. *The Parable of the Bear-Baiting*, an anonymous pamphlet from 1691 which damned English bureaucracy during the Nine Years War, delivered its message entirely through animal characters. Many of the associations are still familiar – the jackals are cunning but cowardly, the ape slow and naive. The French navy was ‘a great overgrown French Bear, the greatest in the World, to be baited by English and Dutch Mastiffs, the best Mastiffs in the Universe’. As much as he was reviled as the enemy, the bear’s main crime was to be ‘overgrown’, and threaten the ‘Interest of *Europe*, and the Liberty of Christendom’.⁵⁰ Several of Shakespeare’s scenes invoke bear-baiting, and play on this same idea of bears as overstepping their proper place. In *Twelfth Night*, Sir Toby, speaking of the self-important steward

44 See Erica Fudge’s work on the construction of the animal as other in early modern England: Erica Fudge, *Perceiving Animals: Humans and Beasts in Early Modern English Culture*, Basingstoke: Macmillan, 2000.

45 Fudge, op. cit. (44), p. 19, and Chapter 1 more generally.

46 From an eyewitness report from 1575 reproduced in Horace Smith and Samuel Woodworth, *Festivals, Games and Amusements: Ancient and Modern*, New York: J. & J. Harper, 1832, p. 108.

47 Jason Scott-Warren, ‘When theaters were bear-gardens: or, what’s at stake in the comedy of humors’, *Shakespeare Quarterly* (2003) 54, pp. 63–82, 65. Many of the nuanced interpretations of the bear garden come from the connection between those entertainments and Tudor and Stuart theatre, and I draw heavily on Scott-Warren’s work for a sense of the development of the literature in this field.

48 See E.K. Chambers, *The Elizabethan Stage*, vol. 2, Oxford: Clarendon Press, 1923, p. 457.

49 This is also the contention of Scott-Warren, op. cit. (47), pp. 71–74.

50 *The Parable of the Bear-baiting*, London, 1691.

Malvolio, vows, ‘we’ll have the bear again, and we will fool him black and blue, shall we not, Sir Andrew?’ Malvolio cannot win the love of Olivia, but is goaded into trying by a letter which plays on his own conceits. In *The Merry Wives of Windsor*, Master Slender’s brag to the unimpressed Anne Page that he had seen Sackerson, the most famous bear of all, ‘loose twenty times’ captures something of the futile bluster of the bear garden.⁵¹ The bear evokes particular characteristics – slightly bumbling, and certainly self-important, forceful, and naive. Most crucially, perhaps, he is preoccupied with an immediate task, and unaware of his place in a larger order.

Cavendish read the experimenters’ talk of using instruments to force nature to reveal its true essence in a similar way.⁵² They were forgetting their own status as finite parts of the same nature. In *The Blazing World*, she associated experimental philosophers with creatures who, her audience knew, were taunted into attempting to escape the situation to which they were constrained by artifice – by chains, whips and gates. When the Empress baits the bear-men by asking to see their observations, it is their artifice which makes them overconfident in their philosophy. Thus, through the surprising, hybrid bodies of animalian philosophers, the experimenters’ intended lesson is reversed; we learn about their character, not about the objects of their investigations. Jacques Rancière has written of narrative in cinema that ‘the instrument that [has] derailed every fable’ has been burlesque.⁵³ ‘Fable’ he means in the Aristotelian sense: ‘the arrangement of necessary and verisimilar actions that lead the characters from fortune to misfortune, or vice versa’.⁵⁴ To the extent that the bear-men manifest exaggerated qualities of experimental philosophers, we can think of Cavendish’s imagery as a similar instrument, which has a similar effect. The very forms of the *Blazing World*’s characters undermine the assumptions we might make about how the experimental narrative will progress, and Cavendish introduces a new logic – one in line with her hylozoic metaphysics, rather than with Hooke’s mechanism. While the bear-men try to educate the Empress, she – and we the readers – see their bear-like shapes and know they will fail to impress her. The association with the bear garden transforms Hooke’s skilled artifice into a pointless and arrogant task by situating it in a larger context. Far from trapping nature with instruments, the experimenters themselves are trapped by forces beyond their control – human nature. Cristina Malcolmson has elegantly expressed this reversal: Cavendish ‘satirizes Robert Boyle’s claim to an “Empire of Man, as a Naturalist, over the Creatures” by turning naturalists into creatures’.⁵⁵

As objects of miserable fun, the bears teach us about the nature of the experimental space, and warn Hooke not to aggrandize his actions beyond their actual standing. The early modern bear garden limited the brutish power of the animals until it

51 See Scott-Warren, op. cit. (47). Slender’s line is from *The Merry Wives of Windsor*, in *The Riverside Shakespeare* (ed. G. Blakemore Evans), 2nd edn, Boston: Houghton Mifflin, 1996, 1.1.140.

52 Francis Bacon, *Preparative Towards a Natural and Experimental History*, in *The Works of Francis Bacon* (ed. James Spedding, Robert Leslie Ellis and Douglas Denon Heath), 15 vols., Boston: Houghton, Mifflin and Company, 1857–1870, vol. 8, pp. 351–371, 363; Hooke, op. cit. (11), p. 8.

53 Jacques Rancière, *Film Fables*, New York: Berg (2001 (English trans. 2006)), p. 12.

54 Rancière, op. cit. (53), p. 1.

55 Malcolmson, op. cit. (5), p. 123.

became entertaining. Cavendish's experimenters are likewise potentially damaging, but acceptable when within confines. After hearing their discussion turn quickly to argument about what they see through their telescopes, the Empress orders them to break their instruments to end dispute. The bear-men, horrified, kneel down 'in the humblest manner' and admit their real objective: they 'take more delight in Artificial delusions, then in Natural truths', and use lenses to amplify disagreement.⁵⁶ Far from harmonious conclusions on useful matters of fact, what they seek is the joy of argument and quarrel within their little community. The Empress relents: so long as they agree to keep their disputes inside their school and not disturb polite society, they are entertaining enough. Bumbling, humble, 'full of joy', the bear-men thank her. They can keep doing what is 'proper for the nature of their Species', but the price is to confess that this is not providing knowledge useful in improving the human condition. If what they see on stinging nettles are indeed poison sacs, then the question of why nettles should not be dangerous to eat they leave to physicians. When they look at the louse they do not try to prevent its bite: that worry is 'mechanical and below that noble study of Microscopical observations'.⁵⁷ At best they are child-like entertainers: 'Boys that play with watry Bubbles', their instruments 'pretty toys to employ idle time'.⁵⁸ The danger of pretending to be philosophers is that they could dangerously distort humanity's relationship with nature with their methods and instruments. I will return to this threat below.

The Royal Society has become the very thing they professed to be united against: an exclusive membership of disputation and debate, unconcerned with either the truth of their ideas or their application to the world outside the laboratory. It was the point of Thomas Sprat's 1667 *History of the Royal Society* to advertise exactly the opposite conception. This book, written under the guidance of Wilkins, was an official *apologia* for the society and its collaborative experimental philosophy. Sprat emphasized not only the collegial and constructive nature of the discussions they had in their meetings, but their public visibility and engagement with society and kingdom. Their work, he wrote, had important and wide-ranging applications: to the 'instruction of the minds of Men in general; to the *Christian Religion*; to the Church of *England*; to all *Manual Trades*; to *Physic*; to the *Nobility*, and *Gentry*; and the Universal Interest of the whole *Kingdom*'.⁵⁹

The very existence of Sprat's *History*, written so soon after the founding of the Royal Society, implies that the activities of the fellows were not universally seen as productive and worthwhile.⁶⁰ The playwright Thomas Shadwell also famously lampooned Hooke with a character, that of Nicholas Gimcrack – an experimenter whose household fell

56 Cavendish, op. cit. (1), p. 28.

57 Cavendish, op. cit. (1), pp. 31–32.

58 Cavendish, op. cit. (2), pp. 11, 102–103.

59 Thomas Sprat, *The History of the Royal Society of London For the Improving of Natural Knowledge*, London, 1667, pp. 322–323.

60 Cavendish was far from being their only critic. For Hobbes's view see especially Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, Princeton, NJ: Princeton University Press, 1985. More contemporary criticisms include Meric Casaubon, *A Letter of Meric Casaubon*, Cambridge, 1669; Henry Stubbe, *The 'Plus Ultra' Reduced to a 'non Plus'*, London, 1670, p. 13.

apart around him as he trained his pet spider.⁶¹ The character was easily recognized by the theatre-going public: ‘Damned dogs. *Vindica me Deus*. People almost pointed’, Hooke wrote in his diary after gamely seeing the show.⁶² But while Gimcrack also angered the ribbon-makers by threatening their livelihoods with his machine inventions, Cavendish was not opposed to the study of nature or to novel inventions which would ease labour and improve England’s estate.⁶³ In fact, the problem with experimentalism was that it would not do this:

before the Vulgar sort would learn to understand [experimental philosophers], the World would want Bread to eat, and Houses to dwell in, as also Clothes to keep them from the inconveniences of the inconstant weather. But truly, although Spinsters were most experienced in their Art, yet they will never be able to spin Silk, Thred, or Wool, &c. from loose Atoms; neither will Weavers weave a Web of Light from the Sun’s Rays; nor an Architect build an House of the Bubbles of Water and Air, (unless they be Poetical Spinsters, Weavers, and Architects.)⁶⁴

Surprisingly, *The Blazing World* reveals that it was the experimenters who were speculating imaginatively about distant, unattainable dreamlands. ‘The truth is, *My Lord*’, Cavendish wrote to her husband, ‘That most Men in these latter times, busie themselves more with other Worlds, than with this they live in’.⁶⁵ This seems like a strange criticism from the author of such fancy as *The Blazing World*, but by acknowledging that her work was explicitly fanciful, Cavendish was able to ridicule the ambition of Hooke to find philosophical knowledge through his microscope. Just as she imagined a world where she could discuss natural philosophy with animal-men, Hooke had only imagined a world of knowledge visible through his lens. His appearance as a bear-man in the *Blazing World* manifests the assumptions he made about the the kind of world he was in and humanity’s place in it.

Philosophy for humans

Assumptions of these kinds have implications for one’s views about the aims and methods of philosophy. Accordingly, Cavendish’s critique of experimentalism can be explained as a difference of view in line with Peter Harrison’s idea that the crux of seventeenth-century disputes about methodology and epistemology was often a disagreement about human nature and history.⁶⁶ With her ‘fable reversal’, Cavendish dislocated the

61 Thomas Shadwell, *The Virtuoso* (ed. Marjorie Nicolson and David Stuart Rhodes), Lincoln: University of Nebraska Press, 1966.

62 Robert Hooke, *The Diary of Robert Hooke*, vol. A (ed. Henry W. Robinson and Walter Adams), London: Taylor & Francis, 1935, p. 235.

63 Nick Wilding, ‘Graphic technologies’, in Michael Cooper and Michael Hunter (eds.), *Robert Hooke, Tercentennial Studies*, Aldershot: Ashgate, 2006, pp. 123–134, 133, has briefly traced the ribbon-makers’ discontent at industrially minded science to a culmination in Marx.

64 Cavendish, op. cit. (2), p. 11.

65 From the dedication ‘To His Grace the Duke of Newcastle’, Cavendish, op. cit. (2), A3r.

66 Peter Harrison, *The Fall of Man and the Foundations of Science*, Cambridge: Cambridge University Press, 2007, p. 8.

experimenters from one genealogy and placed them in another. What was at stake was the meaning of utility and truth.

The centrepiece of early modern anthropology is the narrative of Genesis: the creation of man, Adam's naming of the animals, and the Fall from Eden. In the early modern period, the Fall was a commonly accepted explanation of the possibility of error in providential Creation.⁶⁷ The Garden of Eden had been both a physical and an 'epistemological paradise', where the ideal philosopher, Adam, had enjoyed both dominion over nature and knowledge of natural essences, as implied by his naming of the creatures.⁶⁸ But with the Fall came ignorance, and a corruption of human faculties. The natural world became wild and unknown. As Abraham Cowley wrote in an ode which prefaced Sprat's *History*, early modern philosophy was a relic of Adamic knowledge:

the great and only Heir
Of all that Human Knowledge which has bin
Unforfeited by Mans rebellious Sin.⁶⁹

The Fall had made humans more like beasts: ignorant, overcome by passions, floundering in an unknown and hostile world. Francis Bacon held a particular view of the Fall which motivated empirical natural philosophy and instrument use.⁷⁰ He wrote,

by his fall man lost both his state of innocence and his command over created things. However, both of these losses can to some extent be made good even in this life, the former by religion and faith, the latter by the arts and sciences. For the curse did not quite put creation into a state of unremitting rebellion, but by virtue of that injunction 'In the sweat of thy face shalt thou eat thy bread', it is now by various labours (not for sure by disputations and the idle ceremonies of magic) at length and to some degree mitigated to allow man his bread or, in other words, for the use of human life.⁷¹

Survival outside Eden required labour. But through studying nature, Man's control over it would be improved, and something of his original dominion would be recovered. In fact, Bacon's Great Instauration slotted into a millenarian eschatology which held that the end of days would be brought about partly through the work of Man and an increase in Man's knowledge. 'Many shall pass to and fro, and science shall be increased', Bacon quoted from the book of Daniel, and interpreted the apocalyptic prophecy: 'as if the opening of the world by navigation and commerce and the further discovery of

67 See especially Charles Webster, *The Great Instauration: Science, Medicine and Reform, 1626–1660*, London: Duckworth, 1975, especially Chapter 5; J. A. Bennett and Scott Mandelbrote, *The Garden, the Ark, the Tower, the Temple: Biblical Metaphors of Knowledge in Early Modern Europe*, Oxford: The Bodleian Library, 1998; Joanna Picciotto, *Labors of Innocence in Early Modern England*, Cambridge, MA: Harvard University Press, 2010; Harrison, op. cit. (66).

68 Picciotto, op. cit. (67), p. 34 and Chapter 1 more generally.

69 Abraham Cowley, 'To the Royal Society', in Sprat, op. cit. (59), B1r.

70 See Harrison, op. cit. (66), for more on the distinction between, roughly, optimistic Catholic and pessimistic Calvinist views on the Fall and their consequences for the restitution of knowledge.

71 Francis Bacon, *Novum Organum*, Book 2, Aphorism 52, in Bacon, *The Oxford Francis Bacon*, op. cit. (7), p. 447.

knowledge should meet in one time or age'.⁷² The recent exploration of, and trade with, the Americas and South East Asia suggested that this was happening in the seventeenth century. The time was ripe for a reformation of natural philosophy.

Bacon's famous metaphor of the mind as a mirror, 'capable of the image of the universal world, joying to receive the signature thereof', suggests not only that it was humanity's rightful position to comprehend everything in Creation, but also the method appropriate to post-lapsarian philosophy.⁷³ The inner light of reason was dimmed by the Fall, and the mind was to receive the image of Creation by observation, rather than illuminate it with reason. Unfortunately, the senses were also limited and unreliable, as I discussed above, and how things appeared to us was not how they were objectively. As Joanna Picciotto has eloquently put it, humans were 'deficient, amputated creatures in need of prosthetic support' to reclaim their birthright.⁷⁴ Instrument-based experimental natural philosophy was important not only to recover something of Man's original position in earthly life; it would also herald the second coming, salvation, and an eternal restoration of humanity.

There were, of course, differences of opinion about these matters within the experimental community, for example regarding the extent of Adamic knowledge or the means by which he had attained it.⁷⁵ But they were united by the general conception that it was the 'great prerogative of Mankind above other Creatures', as Hooke put it, 'that we are not only able to *behold* the works of Nature, or barely *sustain* our lives by them, but we have also the power of *considering, comparing, altering, assisting,* and *improving* them to various uses'.⁷⁶ As the experimenters sought to reconstruct the ideal human via instruments and experiments, the kind of inhuman experience found in *Micrographia* would make humans more human.

Cavendish disagreed with their paradoxical rhetoric, and even expressed a very different idea of the Fall. Towards the end of *The Blazing World*, after the Empress has quizzed the animal-philosophers, she asks some spirits about more metaphysical and theological matters. She learns that Paradise was in the Blazing World, and the Hobbesian world whence she came was where Adam and Eve had lived in exile.⁷⁷

⁷² Bacon, *Novum Organum*, Book 1, Aphorism 93, in Bacon, *The Oxford Francis Bacon*, op. cit. (7), p. 32. See Harrison, op. cit. (66), Chapter 5.

⁷³ Francis Bacon, *Valerius Terminus of the Interpretation of Nature*, in Bacon, *The Works of Francis Bacon*, op. cit. (52), vol. 6, pp. 25–76, 32.

⁷⁴ Picciotto, op. cit. (67), p. 11. For a related point see Erica Fudge's discussion of a 'paradox in Bacon's methodology': in the maturation of the human from childlike ignorance to adult understanding, humanity is both defined by its formative, childlike state, and inadequately distinguished from animals by it. Erica Fudge, 'Calling creatures by their true names: Bacon, the new science and the beast in man', in Erica Fudge, Ruth Gilbert and Susan Wiseman (eds.), *At the Borders of the Human*, Basingstoke: Macmillan, 1999, pp. 91–109.

⁷⁵ For example, compare the preface to Power's *Experimental Philosophy*, op. cit. (9), and Joseph Glanvill's *Plus Ultra: Or, The Progress and Advancement of Knowledge Since the Days of Aristotle*, London, 1668, pp. 5–6. Boyle reversed Bacon's method, and thought that knowledge of nature would come after salvation, not before. He and Hooke both expressed scepticism about the significance of Adam's names for the animals. See Harrison, op. cit. (66).

⁷⁶ Hooke, op. cit. (11), A1r. For more see Keith Thomas, *Man and the Natural World: Changing Attitudes in England 1500–1800*, London: Allen Lane, 1983.

⁷⁷ Cavendish, op. cit. (1), p. 72.

Malcolmson has noted the clear polygenetic implication of locating Eden in a world also populated by bear-, fish-, and lice-men: Adam was surely not the origin of all of these species, nor had he been privy to their knowledge. In the *Blazing World*, a place of essences made manifest and visible, we do see the true nature of experimental philosophers, but it is not the justificatory anthropology they might have imagined. In Cavendish's narrative they do not appear as Adamic philosophers living out humanity's birthright, but as bears, a finite part of nature constantly treading a line between being entertaining and being foolish.

As I mentioned above, for Cavendish the essential aspect of humans was that we are part of self-organizing, unified nature. We are made who we are not by a historical lineage, but by the self-knowledge inherent in matter, which defines us as a kind with certain relations to other creatures around us. Eve Keller has pointed out the powerful implications of this view for the nature and possibility of knowledge, in contrast with those of the experimenters' mechanism. The mechanical optics of Kepler, Descartes and Hooke which I outlined above severed the observer from the world, placing him always behind the screen of the eye. This licensed what Keller calls the 'humanist individual ... whose subjectivity need not enter into the evaluation of knowledge production'.⁷⁸ To know, on this view, was to describe objects as they are in themselves, rather than as they relate to humans. But for Cavendish there was no possibility of a 'consistent distinction between rational subject and disparate object'.⁷⁹ Knowledge is not possessed by an 'autonomous knower', an observer looking out onto the world, but by Nature itself, and is manifest in the distinctions between objects and kinds. Observation could never reveal such knowledge; observing only granted a situated, perspectival impression of how the world was to a particular subject:

a piece of Wood, Stone, or Metal, may have a perceptive knowledg of Man, yet it hath not a Man's perception; because it is a Vegetable, or Mineral, and cannot have an Animal-knowledg or perception, no more than the Eye patterning out a Tree or Stone, can be said to have a Vegetable or Mineral perception ... it is one thing to perceive exterior objects, and another to receive knowledg; for no part can give away to another its inherent and proper particular nature.⁸⁰

Knowledge is in nature, not constructed by observers. 'The result', concludes Keller, 'is a thorough skepticism about attaining certainty, even about "matters of fact"'.⁸¹ Cavendish admitted, 'Although each particular creature or part of Nature may have some conceptions of the Infinite parts of Nature, yet it can not know the truth of those Infinite parts, being but a finite part it self.'⁸² Artifice, the essential part of Royal Society methodology, only compounded the general disconnection between observation and knowledge. Hooke sought to construct knowledge of things themselves by

78 Keller, *op. cit.* (13), p. 457.

79 Keller, *op. cit.* (13), p. 457.

80 Cavendish, *op. cit.* (2), pp. 164–165.

81 Keller, *op. cit.* (13), p. 457.

82 Cavendish, *op. cit.* (2), p. 5.

compar[ing] the several Informations we receive of the same thing, from the several Impressions it makes on the several Organs of Sense and ... by degrees to find out its Nature, and thereby to inform the Intellect with a Notion of the thing; which is not according to this or that Sense, but by a comparative Act of the Understanding from all the various Informations 'tis capable of receiving, more immediately by any of the Senses, or more mediately by various other Observations or Experiments.⁸³

For Hooke the value of artificial organs like the microscope was the inhuman sensation and difference they provided. But for Cavendish, his method ignored the true relations between humans, artifice, and knowledge.⁸⁴ Just like everything else, optical instruments have their particular perception of the world, which cannot be shared by the experimenter. When a man looks in a mirror, the looking glass first 'patterns out the face of a Man', then the eye 'patterns again the copy from the Glass'. But the glass and the eye 'cannot be said to have the same perception; by reason a Glass, and an Animal, are different sorts of Creatures'.⁸⁵ In the case of straightforward reflection, the picture is at least accurate, even if perceptive knowledge is not shared. Magnifying lenses, though, 'present falsely the Picture of an Exterior Object'.⁸⁶ By way of example, her description of the picture of lice 'presented' by microscopes is particularly striking. The insects appear 'bigger and rounder than naturally they are ... mis-shapen from the Natural'. Each of their joints is 'a diseased, swell'd and tumid Body, ready and ripe for Incision'.⁸⁷ Cavendish's language is suggestively normative. Far from 'rectifying and informing' the senses, as the bear-men claimed to the Empress, the view through the microscope is unhealthy and in need of aid. We should always prefer to see things naturally rather than try to adopt a different perspective, because the natural perspective is both useful and true, as she makes clear:

if a Painter should draw a Lowse as big as a Crab, and of that shape as the Microscope presents, can any body imagine that a Beggar would believe it to be true? but if he did, what advantage would it be to the Beggar? for it doth neither instruct him how to avoid breeding them, or how to catch them, or to hinder them from biting.⁸⁸

We ought to turn to the beggar to evaluate the truth of such images, not the naturalist or the microscopist. Beggars are the people who, as people, are the most intimately familiar with lice, through their unaided human experience, and they ought to know that they are not as Hooke depicts them. And if they do not, if they believe the microscopist, it is their loss. Cavendish treats the concept of truth almost flippantly – there is no 'advantage' to persevering with talk of truth divorced from utility, and Hooke's louse is resolutely

83 Hooke, *op. cit.* (39), p. 9.

84 Cavendish, *op. cit.* (2), pp. 281–282.

85 Cavendish, *op. cit.* (2), p. 164.

86 Cavendish, *op. cit.* (2), p. 9. 'Patterning out' is a phrase she explains as 'imitating' (Cavendish, *op. cit.* (22), p. 420), and takes place during perception. Perception itself is a broad term, for '[t]here is a double perception in nature, the rational perception, and the sensitive' (Cavendish, *op. cit.* (18), p. 9). Perception is more like coming to know something one was previously ignorant of, by rational or sensible means, and contrasts with conception, which is gaining knowledge by inferring over or remembering previously held knowledge. See Michaelian, *op. cit.* (17).

87 Cavendish, *op. cit.* (2), pp. 8–9.

88 Cavendish, *op. cit.* (2), p. 11.

unuseful.⁸⁹ Her view contrasts directly with that of the experimental philosophers. As Paolo Rossi showed, Francis Bacon held that ‘things as they really are, considered not from the viewpoint of appearance but from that of existence, not in relation to man but in relation to the universe, offer conjointly truth and utility’.⁹⁰ Cavendish, though, denied the possibility of distinguishing between appearance and existence, and for her it was knowing how things related to humans which would provide utility. Given the impossibility of ‘objective’ knowledge, this perspective should be labelled ‘true’.

For the Empress of the Blazing World, the knowledge of the animal-men led to valuable works and improvements. The worm-men and bird-men tell the Empress about special stones which shine like the sun, for example, which she then uses to build awe-inspiring churches. ‘[B]y Art, and her own Ingenuity’, she thus unified religion.⁹¹ Even the bear-men’s lenses were useful when they used them to spy far-off enemy ships rather than trying to learn about insects. But the experimenters’ method of ‘find[ing] out Nature by Art, not Art by Nature’, was back to front.⁹² Natural knowledge led to useful artifice, not the other way around.

Cavendish’s concerns

The sport of bear-baiting was to anger a dangerous beast, knowing that he was restrained from retaliating as powerfully as he would like. To conclude, I will briefly discuss the danger Cavendish saw in experimental philosophy, should its practitioners not admit their place as a troupe of entertainers. The idea of Nature as inert, mechanical and under the dominion of Man was for Cavendish akin to the fateful letter Maria writes for Malvolio. It is entertaining for the steward to believe it only because no one else does. Far from restoring humanity to its perfect state, it was aspiration to dominion over nature that caused the Fall:

[Man] would fain be supreme, and above all other Creatures, as more towards a Divine Nature: he would be a God ... at least God-like, as is evident by his Fall, which came meerly from an ambitious Mind of being like God.⁹³

That Cavendish writes of this Fall being from the Blazing World to the Empress’s more familiar, Hobbesian home has important political implications. The Blazing World was a place where nature’s self-knowledge is visible, manifested in the forms of the creatures who live there. It was also an ‘epistemological paradise’ for her, given her political sovereignty. Figuring, perhaps, as the ideal philosopher, she queried inhuman nature directly and was ‘very well satisfied’ and ‘wonderfully taken’ with what she heard.⁹⁴ Her

89 For more on Cavendish’s utilitarianism see Hilda Smith, ‘Margaret Cavendish and the microscope as play’, in Judith P. Zinsler (ed.), *Men, Women, and the Birthing of Modern Science*, DeKalb: Northern Illinois University Press, 2005, pp. 48–70.

90 Paolo Rossi, ‘Francis Bacon’s idea of science’, in Markku Peltonen (ed.), *The Cambridge Companion to Francis Bacon*, Cambridge: Cambridge University Press, 1996, pp. 25–46, 36.

91 Cavendish, op. cit. (1), p. 63.

92 Cavendish, op. cit. (2), p. 281.

93 Cavendish, op. cit. (2), p. 280.

94 Cavendish, op. cit. (1), pp. 36, 43.

knowledge stemmed from her ability to recognize difference in nature and exercise administrative rule over it. Outside Eden, in the Empress's home world, as in our own, this knowledge still exists, but it is hidden and inaccessible to humans. The depravity of fallen Man is his inability to rule over natural difference as a sovereign. Yet such sovereignty was the only kind of dominion Cavendish recognized as legitimate.

For Cavendish, the self as knower and the self as political subject were intimately connected, as both were the result of self-knowing nature forming an individual in relation to other individuals.⁹⁵ To know oneself was to know one's place in an order. To think wrongly about one was to think wrongly about the other, and the potential danger of experimental philosophy was that it did exactly that. The theologico-metaphysical idea that the self existed outside nature but exercised mechanistic control over it had not only led to the Fall, but also more recently to regicide and war. Catherine Gallagher has argued that Cavendish only conceived of the self in two ways, as monarch and as subject.⁹⁶ As such, Cromwell's Protectorate – the construction of a new social order and the denial of absolute monarchy – rejected the pattern into which nature self-organized, which was the only possible stable society. After the Restoration of the British monarchy, the Royal Society took pains to present itself as an inclusive group, tolerant of religions, nationalities, Parliamentarians and Royalists.⁹⁷ Cavendish's response was more conservative, an affirmation of 'the supremacy of distinctions of rank above all other categories – race, gender, or religion', as Sujata Iyengar has noted.⁹⁸ As a woman author and philosopher who frequently appeared in men's clothing, Cavendish was transgressive in many ways, but the idea of rank held for her a special immutable status.

Cavendish had been a maid-in-waiting to the exiled court of Henrietta Maria and her husband William was a defeated Royalist general. Both felt keenly the loss, violence, and change of the English civil wars.⁹⁹ Cavendish idealized a life uncrippled by war and unfettered by the Puritan ideas of works and progress: a happy, aristocratic return to old festivals and familiar entertainments.¹⁰⁰ Even the emblematic image of progress and learning that Bacon chose as the frontispiece for his *Novum Organum* – a ship on the high seas – Cavendish likened instead to a lord navigating civil unrest. Calm seas and masts echo meadows and maypoles, but

[t]he rough *Seas*, whom highly *Wendes* inrage,
Assault a *Ship*, and in fierce *War* ingage.

95 See again Keller, op. cit. (13), p. 457.

96 Gallagher, op. cit. (4), p. 28. Iyengar, op. cit. (4), p. 659

97 See Sprat, op. cit. (59).

98 Iyengar, op. cit. (4), p. 651.

99 Cavendish wrote biographies of both herself and her husband: *A True Relation of My Birth, Breeding and Life*, published as an addendum to *Nature's Pictures Drawn by Fancies Pencil to the Life*, London, 1656; *The Life of the Thrice Noble, High, and Puissant Prince William Cavendishe*, London, 1667. See also Kate Lilley's introduction to her edition of *The Blazing World*, op. cit. (14).

100 See Picciotto, op. cit. (67), pp. 87–104, for more on the idea of 'making progress' and its conflict with the old cyclical calendar of festivals and yearly events.

Or like rude *Multitudes*, whom *Factions* swell,
With rancled *Spleen*, which makes them to rebell.¹⁰¹

When William wrote to Charles II after the Restoration calling for a reinstatement of ‘Maye Games, Moris Danses [and] Thrashings off Hens att Shrove-tite’, he was asking for a return to the ‘Merrye Englande’ of the king’s executed father.¹⁰² Charles I had legislated, against Puritan opposition, for a continuance of old calendar festivals and pastimes like shin-kicking contests and, topically, bear-baiting. This more recent historical paradise – ‘this other Eden’, as Shakespeare’s John of Gaunt described England – was the political foundation of Cavendish’s philosophy.¹⁰³

Epilogue: disagreement in the flesh

Cavendish’s famous visit to Arundel House on 30 May 1667 provides *in vivo* a peek at her view of the Royal Society. She was already their critic in print, and the prospect of demonstrating its work to her seems to have caused the society some anxiety. The visit was proposed by a fellow, Cavendish’s friend Walter Charleton, but the Council debated hotly before allowing her visit, believing that it would undermine their *gravitas* and that ‘the town [would] be full of ballads of it’. As it was, when she finally arrived Samuel Pepys did not hear ‘her say any thing that was worth hearing, but that she was full of admiration, all admiration’. Then, ‘after they had shown her many experiments, and she cried still she was full of admiration, she departed’.¹⁰⁴ The only ballad written was by one of their own, John Evelyn.¹⁰⁵ The occasion was not mentioned again, and the whole affair has an air of much ado about nothing.

It is fascinating to speculate on the complex dynamics of Cavendish’s visit glossed by Pepys’s apparent disappointment.¹⁰⁶ Hooke, a more laconic note-taker than Pepys, recorded perhaps somewhat wishfully, ‘Dutchess of newcastle intertayned wth weighing the air in a glasse’.¹⁰⁷ This was of course exactly the experiment laughed at by Charles II, and in fact the experiments prepared for Cavendish were mostly the same as those mooted

101 Margaret Cavendish, *Similizing the Sea to Meadowes, and Pastures, the Marriners to Shepheards, the Mast to a May-pole, Fishes to Beasts and Comparing Waves, & a Ship to Rebellion*, in Cavendish, *Poems and Fancies*, London, 1653, pp. 146–148.

102 The letter is quoted at length in Picciotto, *op. cit.* (67), pp. 100–101.

103 William Shakespeare, *Richard II*, in *The Riverside Shakespeare*, *op. cit.* (51), 2.1.724.

104 Samuel Pepys, *The Diary of Samuel Pepys* (ed. Robert Latham and William Matthews), 11 vols., Berkeley: University of California Press, 2000, vol. 8, 30 May 1667.

105 Evelyn’s ballad is quoted at some length in Douglas Grant, *Margaret the First: A Biography of Margaret Cavendish, Duchess of Newcastle 1623–1673*, London: Rupert Hart-Davis, 1957, pp. 24–26.

106 He seemed to have been so looking forward to meeting her too. In March, seeking to ‘understand her better’, he had been to see a play of hers (30 March 1667), and when she visited London next month, intrigued that ‘all she do is romantick’ (11 April 1667), he spent a good deal of time and energy trying to run into her (26 April 1667, 1 May 1667, 10 May 1667). But when he finally did, at Arundel House, she did not please him. ‘I do not like her at all’, he reported, and later called her a ‘mad, conceited, ridiculous woman’, and her husband mad to put up with her. Pepys, *op. cit.* (104), vol. 9, 18 March 1668.

107 Hooke Folio, Royal Society Archives MS/847, HF_064, available online at www.livesandletters.ac.uk/cell/Hooke/Hooke.html, accessed 24 June 2015.

to impress the king should he ever visit.¹⁰⁸ It was a list agonized over by the fellows, who attempted to tread a line between the often mundane and repetitive experiments which were illuminating to those who knew what they were looking for, and the spectacle of marvellous tricks which gave little insight into the causes of phenomena.¹⁰⁹ They hoped for discussion with visiting natural philosophers, and while Cavendish was a special case it would have been ideal if she had agreed with their ideas, or even engaged critically with their methods. But in early modern usage, ‘admiration’ had more to do with wonder and marvel than with intellectual engagement. That Pepys repeats the word three times perhaps implies that the fellows recognized that Cavendish considered instruments capable only of producing the tricks they sought to avoid, rather than useful philosophy. Although it is impossible to comprehensively interpret the interaction, the duchess arrived late, stayed for a polite time, and then left without (philosophical) comment. She brought her attendants, and was accompanied by lady friends and surrounded by earls. Boys played up and down in the aisle while she watched Hooke create a vacuum.¹¹⁰ Barred from appearing as an equal or an interested observer as a male visitor to the society might, it seems Cavendish treated her visit to Arundel House rather like any other London entertainment – a trip to the theatre or bear garden.¹¹¹

108 Pepys, *op. cit.* (104), vol. 5, 1 February 1663/4. Compare the two lists: the king’s in Thomas Birch, *History of the Royal Society*, 4 vols., London, 1756–1757, vol. 1, p. 312; the duchess’s in *ibid.*, vol. 2, p. 177.

109 See, for instance, a letter from Christopher Wren to Viscount Brounker, 30 July/9 August 1663, reproduced in Birch, *op. cit.* (108), vol. 1, p. 288.

110 Pepys, *op. cit.* (104), vol. 8, 30 May 1667.

111 For a rather different interpretation see Samuel Mintz, ‘The Duchess of Newcastle’s visit to the Royal Society’, *Journal of English and Germanic Philology* (1952) 51, pp. 168–176.