

The Scientific Revolution and *The Death of Nature*

By Carolyn Merchant*

ABSTRACT

The Death of Nature: Women, Ecology, and the Scientific Revolution, published in 1980, presented a view of the Scientific Revolution that challenged the hegemony of mechanistic science as a marker of progress. It argued that seventeenth-century science could be implicated in the ecological crisis, the domination of nature, and the devaluation of women in the production of scientific knowledge. This essay offers a twenty-five-year retrospective of the book's contributions to ecofeminism, environmental history, and reassessments of the Scientific Revolution. It also responds to challenges to the argument that Francis Bacon's rhetoric legitimated the control of nature. Although Bacon did not use terms such as "the torture of nature," his followers, with some justification, interpreted his rhetoric in that light.

I N 1980, the year *The Death of Nature* appeared, Congress passed the Superfund Act, ecofeminists held their first nationwide conference, and environmentalists celebrated the tenth anniversary of Earth Day. *The Death of Nature*, subtitled "Women, Ecology, and the Scientific Revolution," spoke to all three events. The chemicals that polluted the soil and water symbolized nature's death from the very success of mechanistic science. The 1980 conference "Women and Life on Earth: Ecofeminism in the '80s" heralded women's efforts to reverse that death. Earth Day celebrated a decade of recognition that humans and ecology were deeply intertwined. The essays in this *Isis* Focus section on the twenty-fifth anniversary of *The Death of Nature* reflect the themes of the book's subtitle, and I shall comment on each of them in that order. I shall also elaborate on my analysis of Francis Bacon's rhetoric on the domination and control of nature.¹

* Department of Environmental Science, Policy, and Management, University of California, Berkeley, California 94720.

Earlier versions of this essay were presented at the conference "The Scientific Revolution: Between Renaissance and Enlightenment," University of Florida, Gainesville, February 2005 (Pts. II and III), and as part of the session "Getting Back to *The Death of Nature*: Rereading Carolyn Merchant" at the annual meeting of the History of Science Society, Minneapolis, Minnesota, 4 November 2005, sponsored by the Women's Caucus. I thank the reviewers, commentators, and participants at both conferences and Robert Hatch, Roger Hahn, David Kubrin, Wilber Applebaum, and Bernard Lightman for their insights and suggestions.

¹ Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (1980; San Francisco:

Isis, 2006, 97:513–533

©2006 by The History of Science Society. All rights reserved.

0021-1753/2006/9703-0008\$10.00

I

Charis Thompson's provocative, well-argued paper deals with the connections between women and nature and the foundations of and responses to ecofeminism. When *The Death of Nature* appeared in 1980 the concept of ecofeminism was just emerging. The 1980 conference organized by Ynestra King and others seemed to me to offer an antidote to the death of nature and the basis for an activist movement to undo the problems that the Scientific Revolution had raised for contemporary culture in the form of the environmental crisis. Moreover, it connected the effects of nuclear fallout and chemical pollutants on women's (and men's) reproductive systems to the relations between production and reproduction I had discussed in the book.²

Thompson notes that ecofeminism linked the domination of women with the domination of nature and recognized the values and activities associated with women, including child-bearing and nurturing. She correctly points out that during the 1980s and 1990s ecofeminism faced a critique by academic women that it was essentialist in its conflation of women with nature, implying not only that women's nature is to nurture but also that women's role is to clean up the environmental mess made by men. Women who, as ecofeminists, came to the defense of nature were actually cementing their own oppression in the very hierarchies that (as the anthropologist Sherry Ortner had argued) identified men with culture and women with nature.³

My own efforts to deal with the problems of essentialism and nature/culture dualism led me to develop a form of socialist ecofeminism rooted not in dualism but in the dialectics of production and reproduction that I had articulated in *The Death of Nature*. There I had argued that nature cast in the female gender, when stripped of activity and rendered passive, could be dominated by science, technology, and capitalist production. During the transition to early modern capitalism, women lost ground in the sphere of production (through curtailment of their roles in the trades), while in the sphere of reproduction William Harvey

HarperCollins, 1990) (hereafter cited as **Merchant, *Death of Nature***). For a list of reviews and commentaries on the book from 1980 to 1998 see Merchant, "The Death of Nature: A Retrospective," in "Symposium on Carolyn Merchant's *The Death of Nature*: Citation Classics and Foundational Works," *Organization and Environment*, 1998, 11:180–206 (the retrospective is on pp. 198–206); this symposium featured commentaries by Linda C. Forbes, John M. Jermier, Robyn Eckersley, Karen J. Warren, Max Oelschlaeger, and Sverker Sörlin. See also Kevin C. Armitage, "A Dialectic of Domination: Carolyn Merchant's *The Death of Nature: Women, Ecology, and the Scientific Revolution*, 2000, online, reviewed for H-Ideas' Retrospective Reviews of "books published during the twentieth century which have been deemed to be among the most important contributions to the field of intellectual history." See also Noël Sturgeon, Donald Worster, and Vera Norwood, "Retrospective Reviews on the Twenty-fifth Anniversary of *The Death of Nature*," *Environmental History*, 2005, 10:805–815.

² Sherry Ortner's foundational article, "Is Female to Male as Nature Is to Culture?" in *Woman, Culture, and Society*, ed. Michelle Rosaldo and Louise Lamphere (Stanford, Calif.: Stanford Univ. Press, 1974), pp. 67–87, influenced my thinking about women's relationships to nature and culture. I was also influenced by Rosemary Radford Ruether, "Women's Liberation, Ecology, and Social Revolution," *WIN*, 4 Oct. 1973, 9:4–7; and Ruether, *New Woman/New Earth: Sexist Ideologies and Human Liberation* (New York: Seabury, 1975). Susan Griffin consulted me on some of her ideas while writing *Woman and Nature: The Roaring Inside Her* (New York: HarperCollins, 1978). Although Françoise d'Eaubonne had used the term "ecofeminism" in 1974 in "The Time for Ecofeminism," few scholars in the United States had heard the word at that time: Françoise d'Eaubonne, *Le féminisme ou la mort* (Paris: Horay, 1974), pp. 215–252. Ynestra King taught a course on "Ecofeminism" at the Institute for Social Ecology in Plainfield, Vermont, about 1976.

³ Ortner, "Is Female to Male as Nature Is to Culture?" For a history of theories associated with ecofeminism see Carolyn Merchant, *Radical Ecology: The Search for a Livable World* (1992; New York: Routledge, 2005), Ch. 8. Thompson's own recent work shows why issues of reproduction so important to the origins of early modern science continue to be vitally significant today. See Charis Thompson, *Making Parents: The Ontological Choreography of Reproductive Technologies* (Cambridge, Mass.: MIT Press, 2005).

and other male physicians were instrumental in undermining women's traditional roles in midwifery and hence women's control over their own bodies.⁴ During the same period, Francis Bacon advocated extracting nature's secrets from "her" bosom through science and technology. The subjugation of nature as female, I argued, was thus integral to the scientific method as power over nature: "As woman's womb had symbolically yielded to the forceps, so nature's womb harbored secrets that through technology could be wrested from her grasp for use in the improvement of the human condition."⁵

The dialectical relationships between production and reproduction became for me the basis for a socialist ecofeminism grounded in material change. I also addressed the related problem of the depiction of nature as female, and its conflation with women, by advocating the removal of gendered terminology from the description of nature and the substitution of the gender-neutral term "partner." This led me to articulate an ethic of partnership with nature in which nature was no longer symbolized as mother, virgin, or witch but instead as an active partner with humanity.⁶

I don't believe, however, that Thompson's statement that "by the early to mid 1990s ecofeminism had largely been relegated to a marginal position in feminist theory in the academy" is quite accurate. During the 1990s and 2000s, ecofeminists dealt with the problem of essentialism by articulating new theories that acknowledged the variable, gendered, raced subject and the socially constructed character of nature. All were deeply cognizant of the critiques of essentialism and identity politics and moved beyond them to argue for ethically responsible, situated, relational subjects engaged in ecofeminist political actions.⁷

The role of ecology in the Scientific Revolution was the second of the three themes in *The Death of Nature's* subtitle, "Women, Ecology, and the Scientific Revolution." In his well-argued theoretical paper on the intersections between environmental history and the history of science, Gregg Mitman raises the critical question of the linkages between the two fields, represented professionally by the American Society for Environmental History,

⁴ Harvey argued that the semen of the male, as the most perfect animal, was the efficient cause of conception, while the egg was mere matter. In fact, he held that the male semen was so powerful that impregnation of the egg could occur without contact with the sperm. "How," he wrote, "should such a fluid [the female's] get the better of another concocted under the influence of a heat so fostering, of vessels so elaborate, and endowed with such vital energy? —how should such a fluid as the male semen be made to play the part of mere matter?" William Harvey, *Works* (London: Sydenham Society, 1847), pp. 298, 299, quoted in Merchant, *Death of Nature*, p. 159. For a recent assessment of scholarship on midwifery see Monica H. Green, "Bodies, Gender, Health, Disease: Recent Work on Medieval Women's Medicine," *Studies in Medieval and Renaissance History*, 3rd Ser., 2005, 2:1–46 (I thank Katharine Park for this reference).

⁵ Merchant, *Death of Nature*, p. 169. See also p. 172: "For Bacon as for Harvey, sexual politics helped to structure the nature of the empirical method" as power over nature.

⁶ On socialist feminism see Merchant, *Radical Ecology* (cit. n. 3), Ch. 8; on partnership with nature see Carolyn Merchant, *Reinventing Eden: The Fate of Nature in Western Culture* (New York: Routledge, 2003), Ch. 11.

⁷ These theoretical works included Val Plumwood's *Feminism and the Mastery of Nature* (New York: Routledge, 1993), which proposed a form of social ecofeminism that dealt with problems of domination and difference by positing the relational self, and Noël Sturgeon's *Ecofeminist Natures: Race, Gender, Feminist Theory, and Political Action* (New York: Routledge, 1997), which dealt explicitly with the argument of the rejection of ecofeminism by the academy while validating women's on-the-ground activism. Likewise, Mary Mellor's *Feminism and Ecology* (New York: New York Univ. Press, 1997) and Ariel Kay Salleh's *Ecofeminism as Politics* (London: Zed, 1997) proposed socialist feminist approaches to ecofeminism as political positions. Chris Cuomo's *Feminism and Ecological Communities* (New York: Routledge, 1998) dealt with issues of race and ecofeminism, while Karen Warren's *Ecofeminist Philosophy* (Lanham, Md.: Rowman & Littlefield, 2000) proposed a multi-cultural, relational ethic of care.

founded in 1976, and the History of Science Society. Indeed, Mitman's own work has been at the forefront of these linkages.⁸

In *The Death of Nature*, a bridge between the history of science and environmental history was developed most explicitly in Chapter 2, "Farm, Fen, and Forest," on the ecological and economic changes taking place in Western Europe during the period of the rise of mercantile capitalism and the nation-state.⁹ The chapter argues that ecological and technological changes in the late sixteenth and early seventeenth centuries helped to create material conditions that made new ideas plausible. As both Thompson and Mitman point out, I do not argue that material or ecological changes *cause* or *determine* ideological changes. Rather, they make some ideas prevalent at a given time seem more plausible than others. Some ideas die out or become less compelling (in this case those associated with natural magic and the organic worldview), while others are developed and accepted, in particular (in this case) those that led to mechanical explanations for phenomena and the mechanistic worldview. *The Death of Nature* moved back and forth between material and social conditions and ideas about nature and science. Thus ecological and material changes are seen as fundamental to understanding the rise of mechanism and to the argument for the links between environmental history and the history of science.¹⁰

Mitman states that "*The Death of Nature* presents us with a materialist history of environmental change that pointed toward, but never quite embraced, an ecological history of material, cultural, and social relations through which nature became not universal, but many." While it is true that in *The Death of Nature* I focused on nature symbolized as female, I do not believe that nature is necessarily a universal force. Rather, nature is characterized by ecological laws and processes described by the laws of thermodynamics and by energy exchanges among biotic and abiotic components of an ecosystem. Any of these components can become an actor or actors in an environmental history of a particular place. In my 1989 book *Ecological Revolutions* I developed a theory of ecology, production, reproduction, and consciousness in which, as Mitman puts it, "material, cultural, and social relations" are all interacting parts of ecological history. While I would still argue that the drivers of change are material (bacteria, insects, plants, and animals—including humans) and economic (explorations, colonization, markets, and capital), new ideas can support and legitimate new directions and actions taken by groups of people, societies, and nations.¹¹

The Scientific Revolution is the third theme in the book's subtitle and the one addressed most cogently by Katharine Park's essay. *The Death of Nature* in general had an arresting impact in many fields and was used widely in courses; why, Park asks, was it not embraced

⁸ See esp. Gregg Mitman, *The State of Nature: Ecology, Community, and American Social Thought, 1900–1950* (Chicago: Univ. Chicago Press, 1992).

⁹ I elaborated on these connections at the History of Technology meeting (a 4S meeting) in Toronto in 1980 and in a 1982 article: Carolyn Merchant, "Hydraulic Technologies and the Agricultural Transformation of the English Fens," *Environmental Review*, 1982, 7:165–177.

¹⁰ Merchant, *Death of Nature*, p. 68: "As European cities grew and forested areas became more remote, as fens were drained and geometric patterns of channels imposed on the landscape, as large powerful waterwheels, furnaces, forges, cranes, and treadmills began increasingly to dominate the work environment, more and more people began to experience nature as altered and manipulated by machine technology. A slow but unidirectional alienation from the immediate daily organic relationship that had formed the basis of human experience from earliest times was occurring. Accompanying these changes were alterations in both the theories and experiential bases of social organization which had formed an integral part of the organic cosmos."

¹¹ Carolyn Merchant, *Ecological Revolutions: Nature, Gender, and Science in New England* (Chapel Hill: Univ. North Carolina Press, 1989).

more warmly by historians of early modern science? From evidence over the years, it would seem to me that the book did indeed have a substantial audience among historians of science and was read in numerous classes.¹² But if it was not awarded accolades by more of the field's heavyweights (although I would take Everett Mendelsohn, Walter Pagel, and Frances Yates as fully sufficient and most satisfying), I think its reception had less to do with hyperprofessionalism than with the book's challenge to the pedestal on which historians had tended to place the Scientific Revolution. The book questioned the grand narrative of the Scientific Revolution as progress and undermined the valorization of the most revered fathers of modern science—such as Harvey, Bacon, Descartes, and Newton. It argued that seventeenth-century mechanistic science itself contributed to the most pressing ecological and social problems of our day and dared to suggest that women were as much the victims as the beneficiaries of the progress of science. The book contributed to a growing body of scholarship that led to the historian of science's interest in the social construction of nature and authority and the importance of the role of women in science and to the questioning of grand narratives and the ways that science was implicated in ideologies of progress.

Park is correct that I did not challenge the idea of the Scientific Revolution itself. I focused on the major transformations in science and society that occurred during the sixteenth and seventeenth centuries (1500–1700), from Copernicus to Newton, from Renaissance natural magic to the mechanical worldview, and from the breakup of feudalism to the rise of mercantile capitalism and the nation-state. I could well have emphasized the explorations of the New World (depicted as female) as a source of natural resources for the emerging European economies, connections I later developed in *Ecological Revolutions* and *Reinventing Eden*. Our understanding of the ways that “early modern science” engaged with the everyday world has been enriched by Park's own work on metaphors and emblems of female nature and the body, as well as studies of scientific patronage and practice and the witnessing of experiments.¹³

Yet the notion of a “Scientific Revolution” in the sixteenth and seventeenth centuries is part of a larger mainstream narrative of Western culture that has propelled science, technology, and capitalism's efforts to “master” nature—a narrative into which most Westerners have unconsciously been socialized and within which we ourselves have become actors in a storyline of upward progress. Demoting the “Scientific Revolution” to the mere nomenclature of “early modern science” obscures the power of the dominant narratives of colonialism and imperialism that have helped to shape Western culture since the seventeenth century at the expense of nature, women, minorities, and indigenous peoples. This move hides the political power of scientific narratives in remaking the earth and its natural resources as objects for human use.¹⁴

But not only did *The Death of Nature* invoke mechanistic science in the destruction of nature; it further suggested that the scientific method as power over nature, exemplified in

¹² Merchant, “*Death of Nature: A Retrospective*” (cit. n. 1), pp. 198–206.

¹³ Merchant, *Death of Nature*, pp. 131–132, 288; Merchant, *Ecological Revolutions* (cit. n. 11), pp. 55–56; Merchant, *Reinventing Eden* (cit. n. 6), pp. 117–123; Katharine Park, “Nature in Person: Medieval and Renaissance Allegories and Emblems,” in *The Moral Authority of Nature*, ed. Lorraine Daston and Fernando Vidal (Chicago: Univ. Chicago Press, 1994), pp. 50–73; Daston and Park, *Wonders and the Order of Nature, 1150–1750* (Cambridge, Mass.: MIT Press, 1998); Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: Univ. Chicago Press, 1993); and Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, N.J.: Princeton Univ. Press, 1985).

¹⁴ Merchant, *Reinventing Eden*, pp. 1–8.

the rhetoric of Francis Bacon, implied the constraint and even the torture of nature.¹⁵ The most heated critiques of the book have come from those whom Park has called the FOBs (Friends of Bacon). These critics have argued that the feminist project to reframe Bacon's thought has seriously misread his intentions and his accomplishments. I shall spend the rest of this essay looking at their arguments.

II

Francis Bacon's influence and reputation as a founder of modern science have been the subject of debate in recent years. Here I revisit Bacon's impact as portrayed in *The Death of Nature*, responding to the defenders of Bacon who question feminist readings of his rhetoric, absolve him of advocating the torture of nature, and maintain that he was not a slave driver but a humble servant of nature.¹⁶ I argue that Bacon's goal was to use constraint and force to extract truths from nature. His choice of words was part of a larger project to create a new method that would allow humanity to control and dominate the natural world.

In *The Death of Nature*, I stated that "much of the imagery [Bacon] used in delineating his new scientific objectives and methods derives from the courtroom, and, because it treats nature as a female to be tortured through mechanical inventions, strongly suggests the interrogations of the witch trials and the mechanical devices used to torture witches," and I quoted a passage from Bacon's *De Dignitate et Augmentis Scientiarum* (*Of the Dignity and Advancement of Learning*) (see Table 1, col. 2). I also suggested that "the strong sexual implications of the last sentence can be interpreted in the light of the investigation of the supposed sexual crimes and practices of witches." I summed up Bacon's approach to the domination of nature with the sentence: "The interrogation of witches as symbol of the interrogation of nature, the courtroom as model for its inquisition, and torture through mechanical devices as a tool of the subjugation of disorder were fundamental to the scientific method as power."¹⁷

Bacon did not use the phrases "torture nature" or "putting nature on the rack" (nor did I claim in *The Death of Nature* that he did so). He believed that everything in nature should be studied, including those valid things that witches might indeed know about nature. But nature was nevertheless to be studied through interrogation. The goal, as Peter Pesic argues, was to extract the truth. The critics read the methods of interrogation Bacon advocated as a benign means of obtaining knowledge, whereas I read them as legitimation for the domination of nature.

The passage in Table 1 was just a small part of the larger argument I made that Bacon's treatment of nature as female legitimated the control of nature through science and tech-

¹⁵ Merchant, *Death of Nature*, pp. 168, 172.

¹⁶ Alan Soble, "In Defense of Bacon," *Philosophy of the Social Sciences*, 1995, 25:192–215, rpt. with additions and corrections in *A House Built on Sand: Exposing Postmodernist Myths about Science*, ed. Noretta Koertge (New York: Oxford Univ. Press, 1998), pp. 195–215, esp. pp. 203–206 (subsequent references to the essay will be to this later version); William R. Newman, "Alchemy, Domination, and Gender," *ibid.*, pp. 216–239; Nieves H. De Madariaga Mathews, *Francis Bacon: The History of a Character Assassination* (New Haven, Conn.: Yale Univ. Press, 1996), Chs. 24, 33; Mathews, "Francis Bacon, Slave-Driver or Servant of Nature? Is Bacon to Blame for the Evils of Our Polluted Age?" <http://itis.volta.alessandria.it/episteme/madar1.html>; Peter Pesic, "Nature on the Rack: Leibniz's Attitude towards Judicial Torture and the 'Torture' of Nature," *Studia Leibnitiana*, 1997, 39:189–197; Pesic, "Wrestling with Proteus: Francis Bacon and the 'Torture' of Nature," *Isis*, 1999, 90:81–94; Iddo Landau, "Feminist Criticisms of Metaphors in Bacon's Philosophy of Science," *Philosophy*, 1998, 73:47–61; and Perez Zagorin, *Francis Bacon* (Princeton, N.J.: Princeton Univ. Press, 1998), pp. 121–122.

¹⁷ Merchant, *Death of Nature*, pp. 168–169, 172.

nology. It is nevertheless instructive to reexamine the context out of which that passage arose and the views of James VI of Scotland (who in 1603 became James I of England [1566–1625]) and Francis Bacon (1561–1626) on torture.

Table 1 compares the relevant passage from the original 1605 English edition of *The Advancement of Learning* with the same passage from the 1875 (and identical 1870) English translation of the expanded version of the essay, *De Dignitate et Augmentis Scientiarum* (1623); the original Latin edition of 1623 (republished in 1858); and the French translation of 1624. With regard to the 1858 Latin edition of *De Dignitate et Augmentis Scientiarum*, James Spedding, Robert Leslie Ellis, and Douglas Devon Heath state in their note to the phrase “quod et Majestas tua exemplo proprio confirmavit” (“as your Majesty has shown in your own example”): “The allusion is to King James’ *Daemonologie*, a work in three books, consisting of dialogues between Philomathes and Epistemon; the latter of whom represents the king’s opinions on witchcraft.”¹⁸

In an effort to exonerate Bacon and James I of any negative implications for science, nature, and women that a reader might draw from their writings, Alan Soble states, “Bacon is not alluding to cruel methods of inquisition, but is pointing out that James I was willing to get his hands dirty by studying witchcraft. What James I ‘show[ed] in his own example,’ says Bacon, is that everything in nature is an appropriate object for scientific study—one of Bacon’s principles—not that science should torture nature as if it were a witch.” In the *Daemonologie* James did indeed distinguish between “Astronomie and Astrologie” and noted the differences between “naturall reason” and “unlawful charmes, without natural causes.” But he did not, as Soble claims, “study witchcraft” to see what within it might have been “an appropriate object for scientific study.” On the contrary, the book reveals James’s involvement in both the torture of witches and the sexual aspects of the witch trials.¹⁹

Although torture was officially banned in English common law from the time of the Magna Carta, it was nevertheless used during the reigns of the Tudors (Henry VII, Henry VIII, Mary, and Elizabeth I) and Stuarts (James I and James II). Under those monarchs, the Court of the Star Chamber ordered hangings, whippings, mutilations, and the pillory. James I believed that witches had powers over people and nature, knew secrets, and could be forced to confess those secrets if interrogated under torture or shown the instruments of torture. In the *Daemonologie* he denounced witchcraft and advocated the death of witches by fire. The devil, he wrote, “makes them to renunce their God and *Baptisme* directlie, and giues them his marke vpon some secreit place of their bodie.” Witches could be detected by probing for that insensible part on the body in order to find the devil’s mark, ducking them in water to see if they would float (if they floated they were guilty,

¹⁸ Francis Bacon, *De Dignitate et Augmentis Scientiarum* (1623), in *Works*, ed. James Spedding, Robert Leslie Ellis, and Douglas Devon Heath, 14 vols. (London: Longmans Green, 1857–1874, 1875–1881) (hereafter cited as *Works*, in parentheses, with volume and page numbers), Vol. 1, pp. 496, 498. The note is inserted by the editors at the end of the quoted passage; they refer to King James the First, *Daemonologie* (1597) (New York: Dutton, 1924).

¹⁹ Soble, “In Defense of Bacon” (cit. n. 16), p. 203; and James I, *Daemonologie*, pp. 11, 33 (quotation), 77–81. Soble argues that inserting the words I omitted in the passage on sorceries, witchcrafts, charms, etc., from *De Dignitate et Augmentis Scientiarum* changes the meaning of the passage quoted in Table 1, col. 2—i.e., the [bracketed] words “For it is not yet known in what cases, and how far, effects attributed to superstition participate of natural causes, and therefore” and “(if they be diligently unravelled).” Inserting these words does strengthen the idea that witches, sorcerers, alchemists, and natural magicians might have valid knowledge of nature, but it does not change Bacon’s goals, as stated in the passage, of finding this knowledge by “hound[ing] nature in her wanderings” and of “further disclosing the secrets of nature.”

Table 1 Francis Bacon's *Advancement of Learning*

<i>The Advancement of Learning</i> , 1605	<i>De Dignitate et Augmentis Scientiarum</i> , English, 1875	<i>De Dignitate et Augmentis Scientiarum</i> , Latin, 1623	<i>Le Progrez et avancement aux sciences</i> , French, 1624
<p>History of Nature is of three sorts; of nature in course, of nature erring or varying, and of nature altered or wrought; that is, history of Creatures, history of Marvels, and history of Arts.</p> <p>... from the wonders of nature is the nearest intelligence and passage towards the wonders of art: for it is no more but by following and as it were hounding Nature in her wanderings, to be able to lead her afterwards to the same place again. Neither am I of opinion, in this History of Marvels, that superstitious narrations of sorceries, witchcrafts, dreams, divinations, and the like, where there is an assurance and clear evidence of the fact, be altogether excluded. For it is not yet known in what cases, and how far, effects attributed to superstition do participate of natural causes; and therefore howsoever the practice of such things is to be condemned, yet from the speculation and consideration of them light may be taken, not only for the discerning of the offences, but for the further disclosing of nature. Neither ought a man to make scruple of entering into these things for inquiry of truth, as your Majesty hath shewed in your own example; who with the two clear eyes of religion and natural philosophy have looked deeply and wisely</p>	<p>The division which I will make of Natural History is founded upon the state and condition of nature herself. For I find nature in three different states, and subject to three different conditions of existence. She is either free, and follows her ordinary course of development; as in the heavens, in the animal and vegetable creation, and in the general array of the universe; or she is the perverseness, insolence, and fro-wardness [<i>sic!</i>] of matter, and violence of impediments; as in the case of monsters; or lastly, she is put in constraint, moulded, and made as it were new by art and the hand of man; as in things artificial. . . . Of these the first treats of the Freedom of Nature, the second of her Errors, the third of her Bonds. . . . from the wonders of nature is the most clear and open passage to the wonders of art. For you have but to follow and as it were hound nature in her wanderings, and you will be able, when you like, to lead and drive her afterward to the same place again. Neither am I of opinion in this history of marvels, that superstitious narratives of sorceries, witchcrafts, charms, dreams, divinations, and the like, where there is an assurance and clear evidence of the fact, should be altogether excluded. [For it is not yet known in what cases,</p>	<p>Partitionem <i>Historiae Naturalis</i> molierum ex statu et conditione ipsius Naturae, quae in triplici statu posita inventiuntur, et tanquam regimen trium subit. Aut enim libera est natura et cursu consueto se explicans, ut in coelis, animalibus, plantis, et universo naturae apparatu; aut a pravitatibus et insolentis materiae contumacis et ab impedimentorum violentia de statu suo detruditur, ut in monstris; aut denique ab arte et opera humana constringitur et fingitur, et tanquam novatur, ut in artificialibus. . . . Harum prima <i>Liberitatem Naturae</i> tractat; secunda <i>Errores</i>; tertia <i>Vincula</i>. . . . quod a miraculis naturae ad miracula artis expeditus sit transitus et perivius. Neque enim huic rei plus inest negotii, praeterquam ut naturae vestigia persequaris sagaciter, cum ipsa sponte abberret; ut hoc pacto postea, cum tibi libuerit, eam eodem loci deducere et compellere possis. Neque vero praecipim ut ex historia ista mirabilium superstitiosae narrationes de maleficiis, fascinationibus, incantationibus, somnis, divinationibus, et similibus, prorsus excludantur, ubi de facto et re gesta liquido constet. Nondum enim innotuit quibus in rebus, et quousque, effectus superstitioni attribuitur ex causis naturalibus participant. Ideoque licet huiusmodi artium usum et praxim merito damnandum censeamus, tamen a</p>	<p>L'Histoire Naturelle, est de trois sortes: De la Nature en son cours, de la Nature errante et variante, et de la Nature alteree et travaillie, c'est à dire l'Histoire de creatures, l'Histoire de merveilles, et l'Histoire des Arts. La premiere d'icelle est son double manifeste & en bonne perfection: les deux dernieres sont traitiees si faiblement, que je suis contraint de les noter comme defectueuses. . . . L'autre à cause que des merveilles de la nature, l'intelligence & le passage vers les merveilles de l'art en sont plus proches: car ce n'est autre chose qu'en suivant & comme chassant la nature en ses fourvoiemens, etre par après capable de la conduire en la même place. Je ne suis pas aussi d'opinion en cette <i>Histoire de merveilles</i>, que les superstitieuses narrations de songes, de divinations & d'autres choses semblables, où il y a une assurance & claire evidence du fait, soient du tout exclues. Car on ne sçait pas encore en quel cas & de combien les effets attribués à la superstition participent des causes naturelles: Et partant encore que la pratique de telles choses soit à condamner, toutefois de la speculation & consideration d'icelles, l'on peut prendre de la confiance, mais pour d'avantage de secourir la nature: Ny l'on ne doit pas faire scrupule d'entrer en ces choses pour la recherche de la verité, come votre</p>

<p>into these shadows, and yet proved yourself to be of the nature of the sun, which passeth through pollutions and itself remains as pure as before. But this I hold fit, that these narrations which have mixture with superstition be sorted by themselves, and not to be mingled with the narrations which are merely and sincerely natural.¹</p>	<p>and how far, effects attributed to superstition participate of natural causes, and therefore] howsoever the use and practice of such arts is to be condemned, yet from the speculation and consideration of them [if they be diligently unravelled] a useful light may be gained, not only for a true judgment of the offenses of persons charged with such practices, but likewise for the further disclosing of the secrets of nature. Neither ought a man to make scruple of entering and penetrating into these holes and corners, when the inquisition of truth is his [sole] object—as your Majesty has shown in your own example; who, with the two clear and acute eyes of religion and natural philosophy, have looked deeply and wisely into those shadows, and yet proved yourself to be truly of the nature of the sun, which passes through pollutions and is not defiled. I would recommend however that those narrations which are tinged with superstition be sorted by themselves, and not mingled with those which are purely and sincerely natural.²</p>	<p>speculatione et consideratione ipsarum (si strenue excutiantur) notitiam haud inutilem consequemur, non solum ad delicta in hoc genere reorum rite dijudicanda, sed etiam ad naturae secreta ulterius rimanda. Neque certe haesitantium de ingressu et penetratione intrahujusmodi antra et recessus, si quis sibi unicam veritatis inquisitionem proponat; quod et Majestas tua exemplo proprio confirmavit. Tu enim duobus illis clarissimis et acutissimis religionis ac naturalis philosophiae oculis, tales umbras prudenter ac perspicaciter perlustrasti; ut te Soli simillimum probaveris, qui polluta loca ingreditur, nec tamen inquinatur. Caeterum illud monuerim, narrationes istas cum rebus superstitionis conjunctas seorsum componi, neque cum puris et sinceris naturalibus commisceri oportere.³</p>	<p>Majesté a montré par son exemple, qui avec les yeux clairs de la Religion & de la Philosophie naturelle, a regardé profondément & sagement dans ces ombres, & toutefois s'est montrée être du naturel du soleil, qui passe par toutes les ordures, & demeure aussi pur que devant. Or je tiens qu'il est convenable que les Narrations qui ont un mélange avec la superstition, soient assorties d'elles mêmes, & non pas pour être mêlées avec les narrations, qui sont purement & sincèrement naturelles, pour les narrations qui concernent les prodiges & les miracles des Religions, ou non pas naturelles, & partant impertinentes pour l'Histoire de la nature.⁴</p>
--	---	---	---

¹ Francis Bacon, *The Advancement of Learning* (1605), in *Works*, ed. James Spedding, Robert Leslie Ellis, and Douglas Devon Heath, 14 vols. (London: Longmans Green, 1870), Vol. 3, pp. 330–331. Note Bacon's use of nature in the female gender in his own English first edition, written in 1605.

² Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (1980; San Francisco: HarperCollins, 1990), p. 168; and Francis Bacon, *The Dignitate et Augmentis Scientiarum* (1623) (*Works*, Vol. 4, pp. 294, 296). Words in brackets omitted in *The Death of Nature*; "whole" in *The Death of Nature*, corrected to "sole."

³ Bacon, *De Dignitate et Augmentis Scientiarum* (*Works*, Vol. 1, pp. 496, 498). Note inserted at penultimate sentence of quoted passage by Spedding, Ellis, and Heath: "The allusion is to King James's *Daemonologie*, a work in three books, consisting of dialogues between Philomathes and Epistemon; the latter of whom represents the king's opinions on witchcraft."

⁴ Francis Bacon, *Le Progrez et avancement aux sciences diuines & humaines* (Paris: Pierre Billaine, 1624), Bk. 2, Ch. 2, pp. 197, 199–201 (French modernized, with the exception of the title). I thank Roger Hahn for assistance with the transcription.

since the water would receive “in her bosom” those who had been baptized but not those whose impiety had caused them to renounce baptism, hence God), and threatening or torturing them to see if they would repent (crocodile tears indicating a false repentance).²⁰

James VI’s personal involvement with the questioning of the accused and his obsession with witchcraft are revealed in the 1591 tract *Newes from Scotland, Declaring the Damnable Life and Death of Doctor Fian, a Notable Sorcerer Who Was Burned at Edenbrough in January Last*. The trial came about when Fian (John Cunningham), along with Agnis Sampson and Agnes Tompson of Edinburgh, was accused of causing a devastating storm during the return passage of James and his fiancé from Norway to Scotland. Agnis Sampson was brought before the king and other nobility, where she was interrogated and refused to confess. She was taken to prison and searched for the devil’s mark on her private parts. According to the author of the *Newes*,

It has lately been found that the Devil do generally mark them with a private mark, by reason the Witches have confessed themselves, that the Devil do lick them with his tongue in some private part of their body, before he receives them to be his servants, which mark commonly is given them under the hair in some part of their body, whereby it may not easily be found out or seen, although they be searched: and generally so long as the mark is not seen to those which search them, so long the parties that have the mark will never confess anything. Therefore by special commandment this Agnis Sampson had all her hair shaven off, in each part of her body, and her head thrown with a rope according to the custom of that country, being a paine most grievous, which she continued almost an hour, during which time she would not confess anything until the Devil’s mark was found upon her privates, then she immediately confessed whatsoever was demanded of her, and justifying those persons aforesaid to be notorious witches.²¹

To convince James that she spoke the truth, Agnis Sampson took him aside and revealed the very words that he and his wife had uttered on the first night of their marriage. James acknowledged that her words were accurate and believed the rest of what she told him.

²⁰ L. A. Parry, *The History of Torture in England* (1934; Montclair, N.J.: Patterson Smith, 1975), pp. 1–3, 7; and James I, *Daemonologie*, pp. 11, 33 (quotation), 77–81. According to James: “There are two other good helpes that may be vsed for their trial; the one is the finding of their marke, and the trying the insensibleness thereof. The other is their fleeting on the water: for as in a secret murther, if the deade carcase be at any time thereafter handled by the murtherer, it wil gush out of bloud, as if the blud wer crying to the heavuen for reuenge of the murtherer, God hauing appoynted that secret super-naturall signe, for tryall of that secrete vnnaturall crime, so it appeares that God hath appoynted (for a super-naturall signe of the monstrous impietie of the Witches) that the water shal refuse to receiue them in her bosom, that haue shaken off them the sacred Water of Baptisme, and wilfullie refused the benefite thereof; No not so much as their eyes are able to shed teares (thretten and torture them as ye please) while first they repent (God not permitting them to dissemble their obstinacie in so horrible a crime) albeit the women kinde especially, be able other-waies to shed teares at euery light occasion when they will, yea, although it were dissemblingly like the Crocodile” (p. 81).

²¹ Anonymous, *Newes from Scotland, Declaring the Damnable Life and Death of Doctor Fian, a Notable Sorcerer Who Was Burned at Edenbrough in January Last* (London: John Lane, 1591), bound with King James the First, *Daemonologie* (New York: Dutton, 1924), pp. 12–13. The original English reads: “it hath lately been found that the Deuill dooth generallye marke them with a priuie marke, by reason the Witches haue confessed themselues, that the Diuell dooth lick them with his tung in some priuy part of their bodie, before hee dooth receiue them to be his seruants, which marke commonly is giuen them vnder the haire in some part of their bodye, whereby it may not easily be found out or seene, although they be searched: and generally so long as the marke is not seene to those which search them, so long the parties that hath the marke will neuer confesse any thing. Therefore by special commaundement this Agnis Sampson had all her haire shauen of, in each parte of her bodie, and her head thrawen with a rope according to the custome of that Countrye, beeing a paine most greuous, which she continued almost an hower, during which time she would not confesse any thing vntill the Diuels marke was found vpon her priuities, then she immediatlye confessed whatsoever was demanded of her and justifying those persons aforesaid to be notorious witches.”

Following that, Agnes Tompson was questioned and confessed that a cat had been the cause of the storm. The women also “confessed that when the Devil received them for his servants, and that they had vowed themselves unto him, then he would carnally use them, albeit to their little pleasure, with respect of his cold nature.”²²

Then Doctor Fian, alias John Cunningham, was examined. According to Leonard A. Parry, in his *History of Torture in England*:

under the most terrible torture, he confessed his guilt, though he immediately afterwards retracted his confession. The bones of his leg were broken into small pieces in the boot. This was not enough. The King himself suggested a new device. “His nailes upon all his fingers were riven and pulled off with an instrument called in Scottish, a turkas, which in England we call a payre of pincers, and under everie nayle there was thrust in two needels over, even up to the head.” Notwithstanding all this, “so deeply had the devil entered into his heart, that hee utterly denied all that which he had before avouched.” He was burnt alive.²³

Throughout the proceedings, James was both a witness to and a full participant in selecting the means of torture. Both sexual torture and physical torture were integral components of the interrogation process.

When James VI became James I, King of England, in 1603, he instituted stricter death penalties for offenses attributed to witchcraft than had his predecessor Elizabeth I. His 1604 Witchcraft Act (in effect until 1736) repealed the milder law of Elizabeth and instituted more severe treatment. Individuals convicted of practicing witchcraft, enchantment, and sorcery or of harming the cattle or goods of any other person would be imprisoned for a year without bail and pilloried in a public place once a quarter for six hours. Those convicted of causing death or injury to another person would suffer the pain of death as felons and lose the privilege of clerical blessing. Parry notes, “This act was passed at a time when Coke was Attorney-General, Bacon a member of parliament, and twelve Bishops sat on the Commission to which it was referred! James I was a confirmed and whole-hearted believer in witchcraft.”²⁴

In summary, it is abundantly clear that in 1597, when James VI wrote the *Daemonologie*, he advocated torture to reveal the truth and condoned the examination of the private parts of the accused for evidence of witch marks. In 1604, when, as James I, he instituted his witchcraft law, he believed that witches should be imprisoned or put to death.

What were Bacon’s views about the torture of nature and of witches? It would be naive to believe that Bacon was ignorant of the most severe means of torture or of the methods of examining women’s bodies for evidence that they had consorted with the devil—or of James I’s early obsession and involvement with those methods. The European Inquisition, torture practices, and death were part of the context of his life and world and were certainly known by that widely read and influential man. In addition to the rack, the instruments and methods of torture included the breast strip, breast press, witches chair, ducking stool,

²² *Newes from Scotland*, p. 18. Original English: The women also “confessed that when the Diuell did receiue them for his seruants, and that they had vowed themselues vnto him, then he would Carnallye vse them, albeit to their little pleasure, in respect of his cold nature.”

²³ Parry, *History of Torture in England* (cit. n. 20), p. 180; and *Newes from Scotland*, pp. 27, 28, as quoted by Parry.

²⁴ “An Acte Against Coniuration Witchcrafte and Dealinge with Evill and Wicked Spirits,” 1604—1 Jas. I, c. 12; and Parry, *History of Torture in England*, p. 180. The last witch trial in England took place in 1712.

judas cradle, expanding vaginal pears, wheel, ladder, strangle, hanging strap, and funnel and water torture.²⁵

Bacon did not advocate the practice of torture or use of the rack on human beings. He nevertheless used imagery drawn from torture in his writings and believed that witchcraft and sorcery could reveal useful information. The use of torture rhetoric condones a transfer of methodological approaches used to extract information from the accused to extracting secrets from nature. The method of confining, controlling, and interrogating the human being becomes the method of the confined, controlled experiment used to interrogate nature. Torture should be used not on witches but on nature itself. The experimental method is superior to that developed by magicians to control nature. A question must be asked and an experiment designed to answer it. For the experimental method to succeed, the experiment must be a closed, isolated system in which variables are controlled and extraneous influences excluded. Witnessing is critical to the process. The trial—that is, the experiment—must be witnessed by others. Indeed, it was one of Bacon's singular contributions to realize that, to be understood, nature must be studied under constrained conditions that can be both witnessed and verified by others. Bacon used metaphor, rhetoric, and myth to develop his new method of interrogating nature. As Peter Pesic notes, "Since he was describing something not yet formed, he used a rich variety of rhetorical figures to express his vision."²⁶

Bacon promoted the study and interrogation of sorcerers and practitioners of the occult arts for clues as to how nature worked and how the devil worked through nature. In endeavoring to gain power over nature, he drew heavily on the alchemical and magical traditions for clues that would lead to the human control of nature. He accepted the goal and idea of control, but he sought new methods of extracting knowledge. What was true should be sorted out from what was erroneous. The problem with magic was that it was rooted in individual knowledge and judgment, rather than being subjected to a set of universal rules and agreements. As Paolo Rossi put it: "According to Bacon, magic endeavours to dominate and to improve nature; and for this it should be imitated. Where it needs revising is in its claim to use one man's inspiration instead of the organised efforts of the human race, and to make science serve individual ends rather than mankind."²⁷

Even though Bacon opposed the practice of torture, his rhetoric and metaphors for the interrogation of nature under constraint come from the devices of torture that were part of his cultural milieu, including the rack. Being tortured on the rack was referred to as being "put to the question." The rack was introduced into England during the reign of Henry VI but was used only for cases of high treason, such as that ordered by James I after the Guy Fawkes Gunpowder Plot of 1605. It consisted of an oak frame three feet above the ground, on or under which the prisoner was placed on his back, with hands and feet bound to rollers and levers on each end. The levers were then moved to exert force on the joints and sockets until the prisoner responded to the interrogation. (See Figure 1.)²⁸

²⁵ Parry, *History of Torture in England*, pp. 76–87, 162–177, 182; George Ryley Scott, *The History of Torture throughout the Ages*, 2nd ed. (London: Kegan Paul, 2003), pp. 168–255; and Merchant, *Death of Nature*, pp. 168–172.

²⁶ Pesic, "Wrestling with Proteus" (cit. n. 16), p. 81. Pesic's goal in this article, however, is to argue that Bacon did not advocate torture or use torture as a model for the experimental method.

²⁷ Paolo Rossi, *Francis Bacon: From Magic to Science* (Chicago: Univ. Chicago Press, 1968), pp. 32–33, on p. 32.

²⁸ Parry, *History of Torture in England* (cit. n. 20), pp. 180–181 (on the use of the rack see pp. 41, 54, 76); Scott, *History of Torture throughout the Ages* (cit. n. 25), pp. 168–180; and Bacon, *De Dignitate et Augmentis Scientiarum* (*Works*, Vol. 4, p. 298).

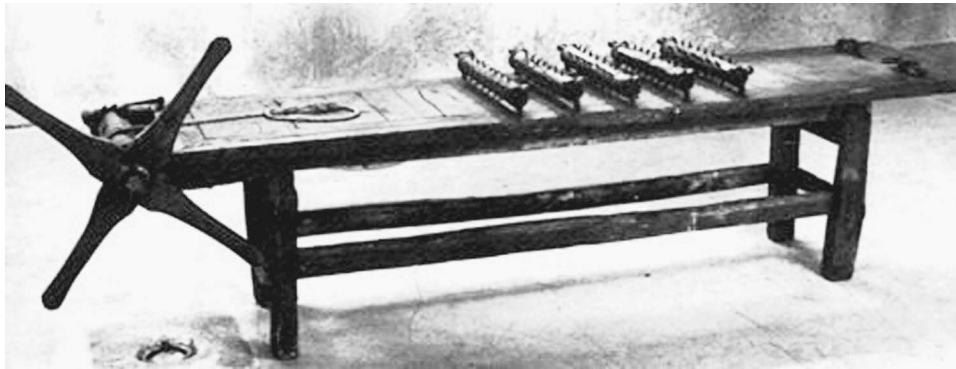


Figure 1. Replica of the rack, from a model in the Tower of London. From <http://geocities.com/christprise/> (in the public domain).

Concerning the rack, Bacon wrote that Elizabeth I consulted him about a plagiarized text by Sir John Haywarde that was dedicated to her mortal enemy, Lord Essex (Bacon's initial benefactor); he reports her saying, "with great indignation, that she would have him racked to produce his author; I replied nay, madam, he is a doctor, never rack his person, but rack his style: Let him have pen, ink, and paper, and help of books, and be enjoined to continue the story where it breaketh off, and I will undertake, by collating the styles, to judge whether he were the author or no." Bacon thus opposed using the rack literally yet advocated using it stylistically. In promoting his experimental method he used rhetoric that implied and even condoned torture—verbs such as "vex," "hound," "drive," "constrain," "straiten," "mold," "bind," "enslave," "spy on," and "transmute" were applied to nature. Such words were metaphors for the interrogation of nature (putting nature to the question), intended to reveal the truths of nature through experimentation.²⁹

In the time between the 1605 and 1623 editions of Bacon's *Advancement of Learning*, witch trials served as models of interrogation to reveal hidden secrets that could be used to convict the accused and levy the death sentence. On the Home Circuit between 1605 and 1626—during James's reign and Bacon's association with the Court—nineteen witches (fifteen women and four men) were convicted, twelve of whom (ten women and two men) were hanged. In the Lancashire (Pendle Forest) witch trials of 1612, in which ten witches were publicly hanged, several confessed under interrogation to have allowed the devil (in the form of a familiar) to suck on their body parts. James I, who continued his earlier interest in interrogating witches, intervened in two subsequent cases. In 1618 he interviewed John Smith, a boy who had accused nine witches who were subsequently hanged, decided that he was an impostor, and stopped the hanging of the remaining women the boy had accused. In 1621 he likewise interviewed Katherine Malpas, who had accused two women of bewitching her, an accusation later revealed to be a fabrication. Although James came to believe that many witches were either deluded or prevaricators, he did not repeal his 1604 witchcraft law, and it remained in effect until 1736. By the time of James's involvement in the Malpas case in 1621, however, Bacon had fallen out of favor with the king, having been accused earlier that year of accepting bribes, sentenced to the Tower of

²⁹ Bacon, quoted in Parry, *History of Torture in England*, p. 40.

London (where he served only two days), and banished both from holding office and from Parliament. When he wrote the expanded version of *The Advancement of Learning* in Latin in 1623 he was again hoping to curry favor with the king.³⁰

In the passage from the 1605 *The Advancement of Learning* quoted in Table 1, Bacon had written, “Neither ought a man to make scruple of entering into these things for inquisition of truth, as your Majesty hath shewed in your own example; who with the two clear eyes of religion and natural philosophy have looked deeply and wisely into these shadows, and yet proved yourself to be of the nature of the sun, which passeth through pollutions and itself remains as pure as before.” In 1623 he modified the first part of that sentence to read: “Neither ought a man to make scruple of entering and penetrating into these holes and corners, when the inquisition of truth is his sole object, —as your Majesty has shown in your own example.” He added “and acute” to the phrase “two clear [and acute] eyes” and “truly” in front of the phrase “[truly] of the nature of the sun.” He also changed “for the further disclosing of nature” to “the further disclosing of the secrets of nature.” These changes may refer to James’s interrogations in the 1618 and 1621 cases, as well as his 1597 *Daemonologie*, or, alternatively, they may be meant to emphasize more strongly his continuing interest in investigating witchcraft. They may also represent Bacon’s renewed efforts to regain James’s favor. In any case, I would still maintain that as metaphors they reflect the sexual aspects of the witch trials, including the practice, originally condoned by James VI, of interrogating and identifying witches by sticking needles in their private parts to identify their “insensible” witch marks.³¹

If Bacon did not explicitly state that nature should be put on the rack, however, where did that phrase come from? The rack and its association with Bacon and the torture of nature seem to have been present in cultural exchanges at least by the late seventeenth century. Peter Pesic details the history of the association of Bacon’s ideas with the torture of nature and of putting nature on the rack.³² He points out that its connection to Bacon may first have been put in writing by Gottfried Wilhelm Leibniz. In 1696 Leibniz wrote about “the art of inquiry into nature itself and of putting it on the rack—the art of experiment which Lord Bacon began so ably.” Four years later, Jean Baptiste du Hamel, secretary of the Paris Academy of Sciences, wrote, “We discover the mysteries of nature much more easily when she is tortured [*torqueatur*] by fire or some other aids of art than when she proceeds along her own road.”³³ The Latin verb “*torqueo*” means “to turn, twist, wind,

³⁰ R. H. Robbins, *Encyclopedia of Witchcraft and Demonology* (New York: Crown, 1959), pp. 277–279; Christina Hole, *Witchcraft in England* (New York: Scribner’s, 1947), p. 140; C. L’Estrange Ewen, *Witchcraft in the Star Chamber* (Privately printed, 1938), pp. 13–14, 26–29, 33–34, 56; Ewen, *Witch Hunting and Witch Trials: The Indictments for Witchcraft from the Records of 1373 Assizes Held for the Home Circuit A.D. 1559–1736* (London: Kegan Paul, Trench, Trubner, 1929), chart on p. 106 (the Home Circuit covered Essex, Hertfordshire, Kent, Surry, and Sussex counties); and Rachel A. C. Hasted, *The Pendle Witch-Trial, 1612* (Lancashire: Lancashire County Books, 1993), p. 2.

³¹ Francis Bacon, *The Advancement of Learning* (1605) (*Works*, Vol. 3, p. 331); and Bacon, *De Dignitate et Augmentis Scientiarum* (*Works*, Vol. 4, p. 296).

³² Quotations and citations have been compiled by Peter Pesic in “Wrestling with Proteus” (cit. n. 16), p. 82; and Pesic, “Nature on the Rack” (cit. n. 16), pp. 195 n 29, 197 nn 34, 35. I have added to and elaborated on them in the notes that follow.

³³ Gottfried Wilhelm Leibniz, *Philosophical Papers and Letters*, ed. Leroy E. Loemker (Chicago: Univ. Chicago Press, 1956), Vol. 2, p. 758; and Jean Baptiste du Hamel, *Regiae scientiarum academiae historia*, 2nd ed. (Paris: Delespine, 1701), p. 16: “sic natura arcana longe facilius deprehendimus, cum per ignem aut alia artis adminicula varie torquetur, quam ubi itinere quodam suo progreditur.” Du Hamel is cited and translated in S. Beasley Linnard Penrose, Jr., “The Reputation and Influence of Francis Bacon” (Ph.D. diss., Columbia Univ., 1934), pp. 97–98. Interestingly, Penrose adds (but without a citation): “Bacon said that nature must be tortured upon the rack to make her give up her secrets. The similarity of expression is striking.”

or wrench” and “of torturing on the rack, etc.: to rack, wrench,” as well as “to rack, torture, torment.” Under the word “rack,” the *Oxford English Dictionary* includes “racken ‘torquere, tendere, tormentis, experime.’ See also . . . racken, to vex, torture (Grimm).” There are thus clear associations between the word “torture” and the rack.³⁴ In contrast to Leibniz and Hamel, Johann Wolfgang von Goethe complained that under scientific investigation “nature falls silent on the rack,” and he urged that “phenomena must once and for all be removed from their gloomy empirical-mechanical-dogmatic torture chamber.”³⁵

Later philosophers also associated the torture of nature with Francis Bacon. In 1878 Thomas Fowler wrote that Bacon “insisted, both by example and precept, on the importance of experiment as well as observation. Nature like a witness, when put to the torture, would reveal her secrets.”³⁶ In 1953 Ernst Cassirer noted that Bacon’s approach to science was to treat nature as if it were a witness on the rack. Cassirer wrote:

The very style of Bacon’s writing evinces everywhere this spirit. Bacon sits as a judge over reality, questioning it as one examines the accused. Not infrequently he says that one must resort to force to obtain the answer desired, that nature must be “put to the rack.” His procedure is not simply observational but strictly inquisitorial. The witnesses are heard and brought face to face; the negative instances confront the affirmative ones, just as the witnesses for the defence confront those for the prosecution. After all the available bits of evidence have been gathered together and evaluated, then it is a matter of obtaining the confession which finally decides the issue. But such a confession is not obtainable without resorting to coercive measures. [As Bacon states,] “For like as a man’s disposition is never well known or proved till he be crossed . . . so nature exhibits herself more clearly under the trials and vexations of art than when left to herself.”³⁷

And in 1975, writing in *The Great Instauration: Science, Medicine, and Reform, 1626–1660*, the historian Charles Webster concurred: “By ‘interrogation’ applied with extreme

³⁴ For the Latin “torquere” see Sir William Smith, *A Smaller Latin–English Dictionary*, rev. J. R. Lockwood (New York: Barnes & Noble, 1960), p. 759; for “torqueo” see *Cassell’s New Latin Dictionary*, rev. D. P. Simpson (New York: Funk & Wagnalls, 1959), pp. 607–608. For the definition of “rack” see *Oxford English Dictionary*, compact ed., 2 vols. (Oxford: Oxford Univ. Press, 1971), Vol. 2, p. 2401.

³⁵ J. W. v. Goethe, *Maximen und Reflexionen: Nach den Handschriften des Goethe- und Schiller-Archivs herausgegeben von Max Hecker* (Weimar: Goethe-Gesellschaft, 1907), maxim 115, p. 21: “Die Natur verstummt auf der Folter; ihre treue Antwort auf redliche Frage ist: Ja! ja! Nein! nein! Alles Übrige ist vom Übel.” Goethe, *Sämtliche Werke: Jubiläums-Ausgabe*, ed. Eduard von der Hellen, 40 vols. (Stuttgart/Berlin: Cotta, 1902–1912), Vol. 39, maxim 430, p. 64: “Die Phänomene müssen ein für allemal aus der düstern empirisch-mechanisch-dogmatischen Marterkammer vor die Jurn des gemeinen Menschen-verstandes gebracht werden.” For the English see Goethe, *Maxims and Reflections*, trans. Elisabeth Stopp, ed. Peter Hutchinson (London: Penguin, 1998), maxim 115, p. 14: “Nature grows dumb when subjected to torture; the true answer to honest questioning is yes! yes! no! no! All else is idle and basically evil”; and maxim 430, p. 55: “Phenomena must once and for all be removed from their gloomy empirical-mechanical-dogmatic torture chamber and submitted to the jury of plain common sense.” See also Erich Heller, *The Disinherited Mind: Essays in Modern German Literature and Thought* (Cambridge: Bowes & Bowes, 1952), p. 18: “Goethe regards it as his own scientific mission to ‘liberate the phenomena once and for all from the gloom of the empirico-mechanico-dogmatic torture chamber’”; this is taken from Goethe, *Sämtliche Werke: Jubiläums-Ausgabe*, ed. von der Hellen, Vol. 34, p. 64.

³⁶ Thomas Fowler, *Bacon’s Novum Organum* (Oxford: Clarendon, 1878), p. 124; in the second edition (1889) see p. 127, as noted in Martha [Ornstein] Bronfenbrenner, *The Role of Scientific Societies in the Seventeenth Century* (New York: Arno, 1975), p. 40. In his 1990 film *Mindwalk* (directed by Bernt Amadeus Capra), Fritjof Capra used the torture chamber to illustrate the torture of nature under mechanistic science.

³⁷ Ernst Cassirer, *The Platonic Renaissance in England*, trans. James P. Pettegrove (Austin: Univ. Texas Press, 1953), pp. 47–48; he is citing Bacon, *De Dignitate et Augmentis Scientiarum* (*Works*, Vol. 4, p. 298). For Cassirer’s use of the phrase “nature must be ‘put to the rack’” see also Pesic, “Wrestling with Proteus” (cit. n. 16), p. 82 n 4.

determination and cunning, nature would be ‘tortured’ into revealing her secrets; she would then submit to voluntary ‘subjugation.’”³⁸

Was Bacon’s method of interrogating nature to put it on the rack? These philosophers certainly interpreted him that way. To them, the rack exemplified the constraint of nature in a closed, controlled system, responding to questions posed by an inquisitor before witnesses—the very core of experimentation itself. Through metaphor and imagery, Bacon struggled to define experimentation as a new way of learning nature’s truths.

A related controversy arises over Bacon’s use of the terms “hound,” “vex,” and the “vexation” of nature. Again, Soble objects to harsh readings of Bacon’s usage. “Even though Bacon’s use of ‘vex’ is occasionally strong,” he writes, “‘vex’ does not always or usually carry a pernicious connotation but is meant, innocuously, along the lines of his ‘hound’ and my ‘pester.’” In the passage from *De Dignitate et Augmentis Scientiarum* (Table 1, col. 2), Bacon writes: “For you have but to follow and as it were hound nature in her wanderings, and you will be able when you like to lead and drive her afterward to the same place again.” The *Oxford English Dictionary* gives the following definition of the word “hound”: “to pursue, chase, or track like a hound, or, as if with hound; esp. to pursue harassingly, to drive as in the chase”; it quotes the phrase from Bacon’s 1605 *Advancement of Learning* that I cited earlier (Table 1, col. 1) as the first example. Other definitions of “hound” are equally violent: “to set (a hound, etc.) at a quarry; to incite or urge on to attack or chase anything” and “to incite or set (a person) at or on another; to incite or urge on.” Such meanings are reminiscent of the English foxhunt (outlawed by the British Parliament in 2005 for its excessive cruelty to the hounded and tortured foxes). Nature for Bacon, as Soble himself puts it, must be “out-foxed.” But, contrary to Soble’s desire to read Bacon’s rhetoric innocuously, merely “pestering” nature would not produce the results Bacon desired of his new method—extracting the secrets of nature.³⁹

Bacon also used the term “vex” to refer to the interrogation of nature under constraint: “The vexations of art are certainly as the bonds and handcuffs of Proteus, which betray the ultimate struggles and efforts of matter.” Art in this context meant *techne* or the technologies used to “vex” nature. The term “vex,” meaning “to shake, agitate, disturb,” likewise carried connotations of violence, including to “harass aggressively,” to “physically distress,” to “twist,” “press,” and “strain,” and to “subject to violence.”⁴⁰ All these meanings convey force in ways that range from irritation to inflicting physical pain through intentional violence. All precisely describe much of the early experimentation done on animals and human beings, as I discuss in Part III.

“Vex” and “torture” were closely associated in Bacon’s cultural milieu. The French historian Pierre Hadot, in *Le voile d’Isis: Essai sur l’histoire de l’idée de Nature*, quotes a recent French translation of the *Novum Organum* that renders the English phrase “the

³⁸ Charles Webster, *The Great Instauration: Science, Medicine, and Reform, 1626–1660* (London: Duckworth, 1975), p. 338. See also Pestic, “Wrestling with Proteus,” p. 82 n 4.

³⁹ Soble, “In Defense of Bacon” (cit. n. 16), p. 205; Bacon, *De Dignitate et Augmentis Scientiarum* (*Works*, Vol. 4, p. 296); and *Oxford English Dictionary*, compact ed. (cit. n. 34), Vol. 1, p. 1338.

⁴⁰ The meanings of “vex” included “(1) to trouble, affect, or harass (a person, etc.) by aggression, encroachment, or other interference with peace and quiet. (2) of diseases, etc.: to afflict or distress physically, to afflict with pain or suffering. . . . (6) to disturb by causing physical movement, commotion, or alteration; to agitate, toss about, work, belabour, or tear up; b. to disturb by handling; to twist; c. to press, strain, or urge.” Similarly “vexation” was “(1) the act of troubling or harassing by agitation or interference; (2) the action of troubling, disturbing, or irritating by physical means; . . . (5) the action of subjecting to violence or force.” *Oxford English Dictionary*, compact ed., Vol. 2, p. 3621.

vexations of art” in French as “la torture des arts [mécaniques]”—that is, “the torture of the [mechanical] arts.” A possible French translation of the English word “vex” is in fact “tormenter.”⁴¹

Soble suggests that Bacon’s association of the vexations of art with Proteus do not pertain to nature as female because Proteus was a “guy.” Yet Bacon himself compares Proteus to nature in the female gender, as was common in the period (translations notwithstanding): “For like as a man’s disposition is never well known or proved till he be crossed, nor Proteus ever changed shapes till he was straitened and held fast, so nature exhibits herself more clearly under the trials and vexations of art than when left to herself.” The verb “straiten” in the seventeenth century meant “to tighten a knot, cord, or bonds—an act that would hold a body fast as on the rollers and levers of the rack.” As John C. Briggs, in his discussion of Bacon’s use of the Proteus myth, states: “Still the lesson that Bacon draws from the myth turns upon the wise man’s power to chain Proteus to the rack so as to force matter ‘to extremities, as if with the purpose of reducing it to nothing.’”⁴²

For Bacon, the myth of Proteus was a stand-in for the interrogation of nature under constraint. Proteus was a Greek sea god (the prophetic “old man of the sea”), the son of Neptune and herder of Poseidon’s seals. He had the gifts both of prophecy and of changing his shape at will. He would not share his knowledge of the future and changed his shape to avoid doing so unless held fast. He would reveal the future only to someone who could capture and constrain him. Capturing and constraining was the very method used to extract confessions and secrets from witches. Bacon’s use of the terms “straiten,” “held fast,” and “vexed” all indicate violence toward nature; and, I would still argue, casting nature in the female gender (both then and now) legitimates the treatment of nature in ethically questionable ways (that Proteus is a “guy” notwithstanding).⁴³

⁴¹ Francis Bacon, “Paraseve ad Historiam Naturalem et Experimentalem” or “Preparative Towards a Natural and Experimental History” (1620) (*Works*, Vol. 4, p. 257); and Pierre Hadot, *Le voile d’Isis: Essai sur l’histoire de l’idée de Nature* (Paris: Gallimard, 2004), p. 133: “De même, en effet, que, dans la vie publique, le naturel d’un individu et la disposition cachée de son esprit et de ses passions se découvrent, lorsqu’il est plongé dans le trouble, mieux qu’à un autre moment, de même les secrets (*occulta*) de la nature se découvrent mieux sous la torture des arts [mécaniques] que dans son cours naturel.” Hadot is citing Bacon, *Novum Organum*, ed. and trans. Michel Malherbe and Jean-Marie Pousseur (Paris: Presses Univ. France, 1986), p. 165. For the French translation of “vex” see E. Clifton and J. McLaughlin, *A New Dictionary of the French and English Languages*, new rev. ed. (New York: McKay, 1904), p. 630.

⁴² Soble, “In Defense of Bacon” (cit. n. 16), p. 205; and Bacon, *De Dignitate et Augmentis Scientiarum* (*Works*, Vol. 4, p. 298). In the 1605 English edition of *The Advancement of Learning* (*Works*, Vol. 3, p. 333) the passage reads: “For like as a man’s disposition is never well known till he be crossed, nor Proteus ever changed shapes till he was straitened and held fast; so the passages and variations of nature cannot appear so fully in the liberty of nature, as in the trials and vexations of art.” The 1623 Latin edition, *De Dignitate et Augmentis Scientiarum* (*Works*, Vol. 1, p. 500) reads: “Quemadmodum enim ingenium alicujus haud bene noris aut probaris, nisi eum irritaveris; neque Proteus se in varias rerum facies vertere solitus est, nisi manicis arcte comprehensus; similiter etiam natura arte irritata et vexata se clarius prodit, quam cum sibi libera permittitur.” *Oxford English Dictionary*, compact ed. (cit. n. 34), Vol. 2, p. 3080 (“straiten”); and John C. Briggs, *Francis Bacon and the Rhetoric of Nature* (Cambridge, Mass.: Harvard Univ. Press, 1989), p. 35.

⁴³ Briggs, *Francis Bacon and the Rhetoric of Nature*, pp. 32–38. Such descriptions are particularly relevant to biotechnology today. The name “Proteus” comes from the Greek word “*protos*” (also the root of “protein”), meaning “mutable,” “changeable,” “versatile,” and “capable of assuming many forms.” The biotechnology company Proteus describes itself as a modern-day Proteus: “Proteus discovers and develops biomolecules of primary importance and turns them to any form that meets the needs of the near future. It is the leading provider of wireless applications and carrier connectivity. . . . Some of the popular programming brands that have been extended to a mobile audience through Proteus’s services include HBO’s ‘The Sopranos’ and ‘Sex and the City’ and ABC’s ‘The View: His & Her Body Test’”: “Proteus,” <http://proteus.com/hom.jsp>.

III

Bacon's words and work influenced the growth of scientific societies and experimentation in the early modern period (even if he himself did not anticipate their development). Although condemned by individuals such as John Locke, Samuel Butler, John Wesley, and Leibniz, experiments done on animals during the seventeenth and eighteenth centuries and continuing even to the present can indeed be described as torture. Such experimentation was legitimated by the mechanical philosophy of nature that viewed animals as automata. Both René Descartes and Thomas Hobbes conceptualized the bodies of humans and other animals as machines. Descartes denied thought to animals, although he admitted that they have life and sensation. In his *Meditations on the First Philosophy* (1641) he wrote, "If the body of man be considered as a kind of machine, so made up and composed of bones, nerves, muscles, veins, blood, and skin, that although there were in it no mind, it would still exhibit the same motions which it at present manifests involuntarily." In his introduction to *Leviathan* ten years later (1651) Hobbes stated, "For what is the heart, but a spring; and the nerves, but so many strings; and the joints, but so many wheels, giving motion to the whole body, such as was intended by the artificer." If animals or even human bodies were thought of as machines, experimentation could be done with impunity.⁴⁴

In England, the Cambridge Platonist Thomas More objected to Descartes's idea of animal automata, writing in 1648: "I recognize in you not only subtle keenness, but also, as it were, the sharp and cruel blade which in one blow, so to speak, dared to despoil of life and sense practically the whole race of animals, metamorphosing them into marble statues and machines." In his response Descartes continued to deny a soul to animals, writing,

I speak of cogitation, not of life or sense; for to no animal do I deny life, inasmuch as that I attribute solely to the heat of the heart; not do I deny sense in so far as it depends upon the bodily organism. And thus my opinion is not so much cruel to wild beasts as favourable to men, whom it absolves . . . of any suspicion of crime, however often they may eat or kill animals.

Although objections to the concept of the "beast-machine" were voiced in England, the idea nevertheless lent credence to the notion of animal experimentation.⁴⁵

In his *History of the Royal Society* (1667), Thomas Sprat reported on experiments done on animals under constraint, experiments that could be considered torture. "Experiments of keeping creatures many hours alive, by blowing into the lungs with bellows, after that all the thorax, and abdomen were open'd and cut away, and all the Intriails save heart, and lungs remov'd: of reviving chickens, after they have been strangled, by blowing into their lungs: to try how long a man can live, by expiring, and inspiring again the same air."

⁴⁴ Scott, *History of Torture throughout the Ages* (cit. n. 25), p. 138; René Descartes, "Animals Are Machines," in *Environmental Ethics: Divergence and Convergence*, ed. S. J. Armstrong and R. G. Botzler (New York: McGraw-Hill, 1993), pp. 281–285, esp. p. 285; Descartes, "The Meditations," in *Meditations and Selections from the Principles of Philosophy* (La Salle, Ill.: Open Court, 1952), p. 98; and Thomas Hobbes, *Leviathan*, in *English Works*, ed. William Molesworth, 11 vols., rpt. ed. (Aalen, Germany: Scientia, 1966), Vol. 3, p. ix.

⁴⁵ Leonora D. Cohen, "Descartes and Henry More on the Beast-Machine: A Translation of Their Correspondence Pertaining to Animal Automatism," *Annals of Science*, 1936, 1:48–61, on pp. 50, 53. Objections to the concept of animals as machines were voiced by Thomas Willis, John Locke, John Keill, John Ray, David Hartley, and David Hume. See also Albert G. A. Balz, "Cartesian Doctrine and the Animal Soul: An Incident in the Formation of the Modern Philosophical Tradition," in *Studies in the History of Ideas*, ed. Columbia Department of Philosophy (New York: Columbia Univ. Press, 1935), Vol. 3, pp. 117–177.

Sprat describes the fatal effects of keeping animals in rarified air and of investigations into the amount of air necessary for a breathing animal to survive. Experiments were made on living animals kept in a bell jar with candles to see which would expire first. Vipers, frogs, fish, and insects were subjected both to the removal of air and to increased air pressure.⁴⁶

Experimentation moved from animals to humans. In 1656 Christopher Wren injected a liquid infusion into a dog's veins, with other members of the Royal Society, including Robert Boyle and John Wilkins, as witnesses. Animals were "purg'd, vomited, intoxicated, kill'd, or reviv'd, according to the quality of the liquor injected." A dog was injected with opium, then whipped and beaten to keep it alive. Other dogs and drugs were tested. The experiments soon led to blood transfusions, first on animals and then on humans. Wren used a quill to inject the blood of one animal into another, and Richard Lower described his animal-to-animal transfusions in 1665 and 1666. In 1667 the blood of a sheep was injected into the veins of a spaniel. In France, Jean Baptiste Denis transferred blood between two dogs and experimented with introducing calves' blood into dogs. He then injected lamb's blood into a young woman and, later, blood from a sheep's artery into a human "lunatic," who at first improved but died following a subsequent transfusion. After charges of poisoning were brought by the man's wife, human transfusions were prohibited.⁴⁷

The historian of science Thomas Kuhn noted that Bacon's method of interrogating nature through constraint influenced seventeenth-century experimenters:

The attitude towards the role and status of experiment is only the first of the novelties which distinguish the new experimental movement from the old. A second is the major emphasis given to experiments which Bacon himself described as "twisting the lion's tail." These were the experiments which constrained nature, exhibiting it under conditions which it could never have attained without the forceful intervention of man. The men who placed grain, fish, mice, and various chemicals *seriatim* in the artificial vacuum of a barometer or an air pump exhibit just this aspect of the new tradition.⁴⁸

Objections to animal torture appeared during the Enlightenment. William Hogarth painted *The Four Stages of Cruelty* in 1751. The series depicted the life and death of the criminal Tom Nero in London. The first stage, the St. Giles Charity Schoolyard, shows acts of cruelty against animals. Nero as a young boy is torturing a dog with an arrow, while other boys are constraining, binding, cutting, goring, hanging, and shooting dogs, cats, and chickens. In the second stage, animal cruelty spreads to the streets and the larger city of London. Nero, now a young man, is beating a horse, while sheep, horses, donkeys, cattle, and humans are tied, beaten, rolled over, and gored. In the third stage, Nero has murdered the woman who carries his child. Finally, Nero himself is publicly dissected in

⁴⁶ Thomas Sprat, *History of the Royal Society* (1667), ed. Jackson I. Cope and Harold Whitmore Jones (St. Louis: Washington Univ. Press, 1958), pp. 218–219, on p. 218.

⁴⁷ Dorothy Stimson, *Scientists and Amateurs: A History of the Royal Society* (New York: Greenwood, 1968), pp. 84–86; Sprat, *History of the Royal Society*, p. 317; and Richard Lower, *Tractatus de corde* (1665). See also Lower [attributed], "The Method Observed in Transfusing the Blood out of One Animal into Another," *Philosophical Transactions of the Royal Society of London*, Dec. 1666, and Lower, "Extrait du Journal d'Angleterre, contenant la manière de faire passer le sang d'un animal dans un autre," *Journal des Sçavans*, 31 Jan. 1667, as cited and discussed in Harcourt Brown, *Science and the Human Comedy: Natural Philosophy in French Literature from Rabelais to Maupertuis* (Toronto: Univ. Toronto Press, 1979), pp. 107–125.

⁴⁸ Thomas S. Kuhn, "Mathematical vs. Experimental Traditions in the Development of Physical Science," *Journal of Interdisciplinary History*, 1976, 7:1–31, on p. 12.

a surgeon's hall. The series was meant to raise consciousness against inhumane methods of treatment, and it ultimately led to the outlawing of vivisection and the formation of the Society against Cruelty to Animals.⁴⁹

Objections to experiments on animals in the bell jar were also mounted. Beginning in 1748, James Ferguson constructed scientific instruments and demonstrated them in lectures around England, writing them up in his 1761 *Lectures on Select Subjects*. Although his lectures included "Experiments with the Air Pump," he warned that

if a fowl, a cat, rat, mouse or bird be put under the receiver, and the air be exhausted, the animal is at first oppressed as with a great weight, then grows convulsed, and at last expires in all the agonies of the most bitter and cruel death. But as this experiment is too shocking to every spectator who has the least degree of humanity, we substitute a machine called the "lung-glass" in place [of] the animal; which by a bladder within it, shows how the lungs of animals are contracted into a small compass when the air is taken out of them.⁵⁰

Perhaps inspired by Ferguson's lectures, but not heeding his admonitions, Joseph Wright of Derby painted *An Experiment on a Bird in the Air Pump* in 1768.⁵¹ In Wright's painting, a pet cockatoo has been removed from a cage (shown in the upper right corner) and placed in a bell jar from which the air is evacuated. The experimenter's hand is placed near the stopcock, and he holds the power to halt the evacuation and return air to the jar to revive the bird. A old man stares at a human skull, contemplating death. A young girl covers her eyes to avoid viewing the impending horror, while a second girl stares anxiously upward and a woman, unable to watch, gazes at the face of another man who views the experiment directly. As Yaakov Garb has pointed out, the men and women have different responses. The women are stereotypically emotional, looking in horror at the bell jar, hiding their eyes, or looking at the men, thereby experiencing the results vicariously. The men, on the other hand, control the outcome via the stopcock, stare directly at the experiment with open curiosity, or contemplate the larger philosophical meaning of death. The men "witness" a scientific truth, the women "experience" a dying bird. The painter has forced social norms about male and female scientific responses to nature onto the audience. The experiment reflects the goals of Francis Bacon's method. A question is asked of nature, a controlled experiment is devised, and the results are witnessed and evaluated for their truth content. Whether a particular experiment reflects the torture of nature (or the mere "pestering" of nature) must be left to the individual to decide.⁵²

As I did in *The Death of Nature* in 1980, I would still argue today that Bacon's efforts to define the experimental method were buttressed by his rhetoric and that the very essence of the experimental method arose out of techniques of human torture transferred onto nature. Such techniques are fundamental to the human domination of nature. Bacon's concept of experiment, along with a mechanistic view of animals as automata, legitimated experiments on living animals—experiments that could be, and later were, considered torture.

⁴⁹ William Hogarth, *The Four Stages of Cruelty* (1751), <http://www.graphicwitness.org/coe/cruel.htm>.

⁵⁰ James Ferguson, *Lectures on Select Subjects* (1761), cited in <http://www.mezzo-mondo.com/arts/mm/wright/wright.html>.

⁵¹ Joseph Wright of Derby, *An Experiment on a Bird in the Air Pump* (1768), <http://www.nationalgallery.org.uk/cgi-bin/WebObjects.dll/CollectionPublisher.woa/wa/largeImage?workNumber=NG725>.

⁵² Stephen Daniels, *Joseph Wright* (Princeton, N.J.: Princeton Univ. Press, 1999), p. 40; and Yaakov Garb, personal communication.

Through his use of metaphor, rhetoric, and myth, Francis Bacon developed the idea of the constrained, controlled experiment. Obviously Bacon cannot be held individually responsible for the positive or negative implications or applications of his ideas. He drew on tendencies existing in his culture, and his ideas were augmented by those who followed his direction. Had Bacon lived today he might or might not have supported genetic engineering, factory farming, and biotechnology—rather than stuffing a chicken with snow to see if putrefaction could be halted—as methods of interrogating nature. The development of the scientific method itself was nevertheless strongly influenced by Bacon's rhetoric and his vision of the interrogation and control of nature.