Francis Bacon, Violence, and the Motion of Liberty: The Aristotelian Background

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> We are very far from knowing enough about Lord Bacon, the first realist in every great sense of that word, to know everything he did, wanted, and experienced in himself.[1]

Friedrich Nietzsche's aphorism underlines the enduring fascination of the "case" of Francis Bacon and its deep role in the foundation of modern thought and science. Much controversy has surrounded Bacon's conception of a new natural philosophy and the exact character, scope, and legitimacy of the human domination of nature he envisaged. Over the years, a number of scholars have argued that Baconian experimentation involved the "torture of nature" (as they interpreted him to say) and hence tended to intervene in nature in disbalanced and dangerous ways, inherently tending

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[1] Friedrich Nietzsche, "Why I Am So Clever," aphorism 4 of *Ecce Homo*, in *On the Genealogy of Morals and Ecce Homo*, trans. Walter Kaufmann (New York: Vintage, 1967), 246.

toward ecological calamity.[2] No mere quibble over language, this controversy concerned the real purport of modern science, especially whether its project of human dominion over nature violated the natural order.

After many exchanges, it now seems generally recognized that Bacon never used the phrase "torture of nature," so that we should not use these words as a touchstone for his meaning.[3] In 2009, one of the leading voices who had long maintained that "the very essence of the experimental method arose out of human torture transferred onto nature" wrote that we "are right to question that last phrase" as having been "rather brashly concluded."[4] Setting such old canards aside now allows us to reassess the significance of what Bacon did say against the background of the natural philosophy he knew, especially his use of Aristotelian philosophy and ancient myth as points of departure for what he called his "new organon," whose very name calls to mind Aristotle's organon.

Even so, Bacon's treatment of the "violence of impediments" has led some to revive the claim that his approach to nature was violative, if not torturous. I will argue that Bacon's term "violence" in this specific context did not have the abusive sense it has in modern usage. In order to recover Bacon's authentic meaning, we need to return to Aristotelian physics, from which Bacon drew this crucial term. This Aristotelian background is essential to understand Bacon's reinterpretation of "violence," his advocacy of its extended use, and his cautions about its limitations. Bacon used the received texts of Aristotle and ancient myths as points of departure for his "new philosophy," which relied on those older sources even as it departed from them.

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[2] See Carolyn Merchant, *The Death of Nature* (San Francisco: Harper & Row, 1980), 164–90; Merchant, "The Scientific Revolution and *The Death of Nature*," *Isis* 97 (2006): 530, 532.

[3] Peter Pesic, "Wrestling with Proteus: Francis Bacon and the 'Torture' of Nature," *Isis* 90 (1999): 81–94; Pesic, *Labyrinth: A Search for the Hidden Meaning of Science* (Cambridge, Mass.: MIT Press, 2000), 21–28; Pesic, "Proteus Rebound: Reconsidering the Torture of Nature," *Isis* 98 (2008): 304–17; Alan Soble, "In Defense of Bacon," in *A House Built on Sand*, ed. Noretta Koertge (Oxford: Oxford University Press, 1998), 195–214; Nieves H. De Madariaga 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 (accessed September 23, 2013); Perez Zagorin, *Francis Bacon* (Princeton: Princeton University Press, 1998), 121–22. See also Brian Vickers, "Francis Bacon, Feminist Historiography, and the Dominion of Nature," *Journal of the History of Ideas* 69 (2008): 117–41; Katharine Park, "Response to Brian Vickers, 'Francis Bacon, Feminist Historiography, and the Dominion of Nature,'" *Journal of the History of Ideas* 69 (2008): 143–46; and Carolyn Merchant, "Secrets of Nature: The Bacon Debates Revisited," *Journal of the History of Ideas* 69 (2008): 147–62.

[4] Carolyn Merchant, "'The Violence of Impediments': Francis Bacon and the Origins of Experimentation," *Isis* 100 (2009): 732–33 n. 3.

The first two sections of this paper review Aristotle's technical use of the term "violence" and the ways authors immediately preceding Bacon continued to refer to its Aristotelian sense. The third section then considers Bacon's use of this term, turning in the fourth section to his matter theory and in the fifth to his mythic retellings. The sixth and final section argues that Bacon understood "violence" as leading to what he called the "motion of liberty." In this context, "violence" leads not to abuse but to the restoration of an original "liberty." Realizing that violence emerges within nature itself, Baconian operators may subtly imitate and co-opt natural violence in order to transform and control nature.

ARISTOTLE'S CONTRAST BETWEEN "NATURAL" AND "VIOLENT"

In the aftermath of the controversies about the "torture of nature," one scholar has argued that, though "some of Bacon's metaphors, terms, and examples are indeed benign and nonviolent . . . as appropriate to his overall goal of mimicking and speeding up nature's processes through art and experiment, but the vast majority of them implied some form of violence toward nature."[5] In contrast to the dispute over "torture," here we are dealing with Bacon's actual language as found in several similar passages, such as this one from *De augmentis scientiarum* (1623):

> 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 own course of development as in the heavens, in the animal and vegetable creation, and in the general array of the universe; or she is driven out of her ordinary course by the perverseness, insolence, and frowardness of matter [*a pravitatibus et insolentiis materiae contumacis*] and violence of impediments [*ab impedimentorum violentia*], as in the case of monsters; or lastly she is put in constraint, molded, and made as it were new by art and the hand of man; as in things artificial.[6]

[5] Ibid., 733 n. 5.

[6] Citations from Bacon will be identified in two standard editions: *The Oxford Francis Bacon*, ed. Graham Rees (Oxford: Clarendon, 1996–), to be abbreviated *OFB*, showing the volume, page, signature, and line numbers of that edition, which remains incomplete as of this writing; and *The Works of Francis Bacon*, ed. James Spedding, Robert Leslie Ellis, and Douglas Denon Heath (London: Longmans, 1857–74; repr., New York: Garrett, 1968), to be abbreviated *SEH*, showing volume and page number, with the Latin original cited in square brackets, here 4.294 [1.496]. For tables collating all the passages

I will argue, however, that Bacon's specific use of the term "violence" (*violentia*) here and elsewhere in his works does not support the claim that he thereby advocated "some form of violence toward nature."[7] In the context of the contemporary natural philosophy Bacon knew, the particular technical meaning of the term "violence" had a notably different meaning from its ordinary connotations as "profanation, infringement, outrage, assault," as did its Latin cognate *violentia*.[8] For completeness's sake: out of Bacon's 104 citations of the terms "violence," "violent," or their Latin cognates, thirty have this ordinary negative connotation, while thirty-one other citations have a more neutral sense of "forcefulness" (such as "a violent sneeze").[9]

Bacon and his contemporaries had been brought up with Aristotle's *Physics*, long a standard text in the *scholae* of Oxford and Cambridge Universities.[10] Its students knew "violence" and "violent motion" as technical terms in Aristotle's argument that

> of things which move in their own right, some derive their motion from themselves, others from something else: and in some cases their motion is natural, in others violent and unnatural [βίᾳ καὶ παρὰ φύσιν]. Thus in things that derive their motion from themselves, e.g. all animals, the motion is natural. . . . And the motion of things that derive their motion from something else is in some cases natural, in others unnatural: e.g. upward motion of earthy things and downward motion of fire are unnatural. . . . When these things are in motion to positions the reverse of those they would properly occupy, their motion is violent [βίᾳ]: when they are in motion to their proper positions—the light thing up and the heavy thing down—their motion is natural.[11]

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in Bacon's work using the term "violence" and its cognates, see Peter Pesic, "Turning the Tables on Bacon: Computer-Assisted Baconian Philology" (unpublished manuscript under review).

[7] See Katharine Park, "Nature in Person: Medieval and Renaissance Allegories and Emblems," in *The Moral Authority of Nature*, ed. Lorraine Daston and Fernando Vidal (Chicago: University of Chicago Press, 2004), 70.

[8] See "violatio, profanatio" in Charles Du Fresne, sieur du Cange, *Glossarium mediæ et infimæ Latinitatis* (Graz: Akademische Druck- und Verlagsanstalt, 1954), 346.

[9] For a complete listing, see Pesic, "Turning the Tables on Bacon," table 3.

[10] For the general background, see James McConica, "Humanism and Aristotle in Tudor Oxford," *English Historical Review* 94 (1979): 291–317.

[11] Aristotle, *Physics*, 254b12–22, 255a2–5; translations from Aristotle follow *The Complete Works of Aristotle*, ed. Jonathan Barnes, 2 vols. (Princeton: Princeton University Press, 1984).

Though it is not clear to what extent Bacon knew the Greek text, for completeness I will refer both to it and to Latin versions.[12] Aristotle's language is strong in every way: his term βία (taken into Latin as *violentia*) literally means first of all bodily strength, then force, an act of violence; in Attic law, this was also the term used to denote rape (βίας δίκη).[13] Yet even though Aristotle's chosen term may thus be taken to refer to rape, so far no one has taken him to task for the "rape of nature" when he describes the motion of a stone thrown upward as "violent," compared to its "natural" motion downward, toward the earth.

Despite the unequivocally abusive sense of the predominant use of βία, *violentia*, or violence, these words have a very different and specialized connotation in this passage and hence in discussions of motion or change phrased in the Aristotelian context, the long-standard account familiar to Bacon and his readers.[14] They, no less than we, could grasp from Aristotle's context the clear sense that, though throwing a stone upward acts against its "natural" motion downward, it does not violate or rape the stone. By glossing "violent motion" in terms of "motion against [the specific] nature" of something, Aristotle signals that his use of this terminology is metaphoric in the root sense of carrying-over (μετα-φέρω, *translatio*), extending or transferring the meaning of a word.[15] "Violence" here signals that force was applied so that the object would move "against nature," but only relatively speaking: downward motion would be "against nature" for fire, but "according to nature" for a stone.

In contrast, Aristotle's word δύναμις denoted strength, power, ability, force in the sense of potentiality or capacity, following the ordinary course of nature, and was usually translated as *vis*.[16] This use of this Latin word occasionally overlapped with the use of *violentia* to denote transgression of

[12] According to Charles B. Schmitt, *Aristotle and the Renaissance* (Cambridge, Mass.: Harvard University Press, 1983), 44–45, most people of this time read Aristotle in Latin translations; see also Zagorin, *Bacon*, 236 n. 15. For the expensive "2 aristotells" John Whitgift bought for Anthony and Francis Bacon in the 1570s, see Phillip Gaskell, "Books Bought by Whitgift's Pupils in the 1570s," *Transactions of the Cambridge Bibliographical Society* 7 (1979): 284–93. For evidence of the awareness of the Greek text in the notebooks of John Day of Oriel College and of John Case, see Charles B. Schmitt, *John Case and Aristotelianism in Renaissance England* (Kingston, Ont.: McGill-Queen's University Press, 1983), 57–58.

[13] According to scholia to Plato, *Republic*, 464e, cited in Henry George Liddell and Robert Scott, eds., *A Greek-English Lexicon* (Oxford: Clarendon, 1968), s. v. βία.

[14] See, for instance, Helen S. Lang, *Aristotle's Physics and Its Medieval Varieties* (Albany: State University of New York Press, 1992), 68–74.

[15] Cf. *Nicomachean Ethics*, 1167a10.

[16] Liddell and Scott, *Greek-English Lexicon*, s. v. δύναμις.

the ordinary limits of nature. Though a full discussion of the interrelated use of all these words would go beyond the scope of this paper, both δύναμις and βία contributed to the development of the concept of force (*vis*) in the new philosophy.[17] Here I will describe how reconsideration of *violentia* altered the very limits of possibility formerly ascribed to nature and its established potential (δύναμις).

THE CONTEMPORARY RECEPTION OF "VIOLENT MOTION"

Aristotle's concept of violent motion was commonplace knowledge among Bacon's immediate predecessors and contemporaries. Bacon read the Neapolitan magus Giambattista Della Porta, whose *Magia naturalis* (1558) uses the term "violence" to describe the first coupling of an ass and a mare to beget a mule, which is "not Natures work, but a kind of theft or adultery devised by man."[18] A letter to Fulke Greville generally attributed to the youthful Bacon (c. 1595–96) refers to "Valerius Physicks," presumably the *Physicae . . . institutio* (1567) by the Dutch humanist Cornelius Valerius, who repeatedly referred to "violent motion" in the ordinary Aristotelian sense as "repugnant to nature."[19] The anti-Aristotelian Bernardino Telesio described the concept of violence as motion "beyond nature [*praeter naturam*]" in his *De rerum natura* (1586), a work Bacon studied closely as he formed his critique of Telesio, whom he also called "first of the moderns."[20]

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[17] For the background, see Max Jammer, *Concepts of Force: A Study in the Foundations of Dynamics* (Mineola, N.Y.: Dover, 1999), 24–52.

[18] Giambattista Della Porta, *Natural Magick* (London, 1658; repr. New York: Basic Books, 1957), 38. For Bacon's relation to Della Porta, see Stephen Gaukroger, *Francis Bacon and the Transformation of Early-Modern Philosophy* (Cambridge: Cambridge University Press, 2001), 27, 33, 195; and Richard Serjeantson, "Natural Knowledge in the *New Atlantis*," in *Francis Bacon's New Atlantis: New Interdisciplinary Essays*, ed. Bronwen Price (Manchester: Manchester University Press, 2002), 88.

[19] Francis Bacon, *The Letters and the Life of Francis Bacon*, ed. James Spedding, 7 vols. (London: Longman, Green, Longman, and Roberts, 1868), 2:22. For its authorship, see Vernon F. Snow, "Francis Bacon's Advice to Fulke Greville on Research Techniques," *Huntington Library Quarterly* 23 (1960): 369–78. Cornelius Valerius defines violent motion as "repugnante natura" in *Physicae, seu de naturae philosophia Institutio* (Antwerp, 1567), 15. See also ibid., 18, 36, 42.

[20] Bernardino Telesio, *De rerum natura iuxta propria principia* (Naples, 1586), 51, which (according to Graham Rees) was the edition Bacon used (*OFB* 6:423); for the 1570 edition, see Bernardino Telesio, *La natura secondo i suoi principi*, trans. Roberto Bondì (Florence: Nuova Italia editrice, 1999), 100–103, 134–41. For Bacon's commentary on Telesio, see his *De principiis atque originibus*, *OFB* 6.224–267; *SEH* 5.476–500 [3.103–18]. On Telesio's appropriation of Aristotelian tenets, see Guido Giglioni, "The First of

Bacon also refers to Tommaso Campanella, whose rejection of the distinction between natural and violent motion in his *Philosophia sensibus demonstrata* (1591) rested on his understanding and use of the Aristotelian concept of *violentia* as a point of departure.[21]

Among Bacon's older contemporaries, John Case (d. 1600) was, according to Charles B. Schmitt, "the archetypal English Aristotelian" and "the most important representative of Aristotelian thought in England, certainly during the reign of Elizabeth, and quite possibly during the entire Renaissance." In Schmitt's view, Case, "as well as anyone, represents a contemporary English Aristotelian treatment of man's participation in nature, which could well serve as a useful backdrop for a fuller understanding of Bacon's position and an evaluation of how precisely it differs from those of Aristotelian contemporaries."[22] Case's most significant work, *Lapis philosophicus* (c. 1599), gave an exposition of natural philosophy following Aristotle's *Physics* that confirms the reading of "violence" given above:

> *Are violent and natural forces found in all kinds of motion and change?* In order to resolve the controversy, the Philosopher said *that is violent which is beyond or against nature* [*præter aut contra naturam*], *whose source of motion is outside of itself*. This posited, he responds that it is given not only in local motions, but also in other kinds of change, that some are called natural, some violent: as he shows by examples: first, he says that in generations certain are destined or natural, when the order constituted by nature is preserved; while others are violent, such as are the generations of frogs and serpents, which are brought forth through some kind of art [*artificio aliquo*]; or the production of roses and fruits out of season, which we see often in England (winter being so fierce).[23]

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the Moderns or the Last of the Ancients? Bernardino Telesio on Nature and Sentience," *Bruniana & Campanelliana* 16 (2010): 69–87; and Michel-Pierre Lerner, "Aristote 'oblieux de lui-même' selon Bernardino Telesio," *Les études philosophiques* 3 (1986): 371–89.

[21] See Tommaso Campanella, *Philosophia sensibus demonstrata*, ed. Luigi De Franco (Naples: Vivarium, 1992), 383, 426, 622; Michel-Pierre Lerner, "Telesio et Campanella: De la nature 'iuxta propria principia' à la nature 'instrumentum Dei,'" *Bruniana & Campanelliana* 13 (2007): 79–97; Germana Ernst, *Tommaso Campanella: The Book and the Body of Nature* (Dordrecht: Springer, 2010), 9, 47. Bacon refers to Campanella in *Historia naturalis et experimentalis*, *OFB* 12.7–8 B2v5; *SEH* 5.131.

[22] Schmitt, *Case*, 6, 221, 192; see also Schmitt, *Aristotle and the Renaissance*, 10–33; and Schmitt, *A Critical Survey and Bibliography of Studies on Renaissance Aristotelianism, 1958–1969* (Padua: Editrice Antenore, 1971), 72–79.

[23] John Case, *Lapis philosophicus* (London, 1612), 614, translation mine with thanks to William Donahue for his help.

Thus, Case considered "violence" as a kind of art that does not abrogate or outrage the natural order. He goes on to distinguish the "common" use of the word violence (*illîc nomen violenti communiter sumi*) from its proper use in Aristotle's philosophy, thus confirming widely shared awareness of these two uses of this word discussed above. Grafting plants and forcing blossoms also fascinated Bacon, underlining Schmitt's claim that Case "foreshadowed some of Francis Bacon's formulations," who (along with Harvey and Newton) "were all heirs in one way or another of the Aristotelian revival in England."[24]

BACON'S USE OF THE ARISTOTELIAN CONCEPT OF "VIOLENCE"

As Graham Rees put it, "for the sake of convenience Bacon retained the Aristotelian term 'violent' to denote projectile motion, but repudiated scholastic explanations."[25] In what follows, we shall try to make more specific the precise ways Bacon used this important Aristotelian term. Bacon's reliance on the prior Aristotelian context appears in forty-four of his citations involving the term "violence" and is often confirmed by his accompanying use of the term "impediments," directly echoing Aristotle's description of "violent motion" as *impeded* from its natural course. Aristotle notes that, though "a thing might be potentially light . . . through some hindrance [ἐμποδιζόμενον] {*impeditum*} it does not occupy an upper position, whereas, if what hinders [ἐμποδίζον] {*impediens*} it is removed, it realizes its activity and continues to rise higher."[26] Aristotle specifies that in this context "violence" arises from and is synonymous with the "hindrance" applied, further clarifying that "violence" here does not mean "violation" but the far milder "hindering."

Bacon also noted that the origin of this "violence" may be *nature itself*, even apart from human action. In Bacon's enumeration of three states of

[24] Schmitt, *Case*, 171, 28, 198; cf. *New Atlantis*, *SEH* 3.158. See also Michèle Le Doeuff, "Man and Nature in the Gardens of Science," in *Francis Bacon's Legacy of Texts*, ed. William A. Sessions (New York: AMS Press, 1990), 119–38.

[25] Graham Rees, "Atomism and 'Subtlety' in Francis Bacon's Philosophy," *Annals of Science* 37 (1980): 564, citing *Cogitationes de natura rerum*, *SEH* 5.433–434 [3.28]. See also Richard Kennington, *On Modern Origins: Essays in Early Modern Philosophy*, ed. Pamela Kraus and Frank Hunt (New York: Lexington Books, 2004), 36, 40, 71.

[26] Aristotle, *Physics*, 255b20–22, showing in curly brackets the standard Latin translation by Jacob of Venice. See Aegidius Forcellini, *Lexicon totius latinitatis*, 4 vols. (Padua, 1771), 2:566, s. v. *impedio* (or *inpedio)*.

nature, the first is "free" and completely "natural," in the Aristotelian sense, while the second "is driven out of her ordinary course by the perverseness, insolence, and frowardness of matter and violence of impediments, as in the case of monsters," and the third is under "constraint, molded, and made as it were new by art and the hand of man." In fact, the "violence of impediments" is not due to human action, for only in the *third* state is human activity present; in the second state, man is absent, yet nature and the "perverseness of matter" *impedes itself*.[27] Here Bacon drew out a hidden implication of Aristotle's reasoning: the "impediments" that hinder the realization of natural potentialities can come from other purely natural processes through happenstance, which Aristotle calls τύχη ("chance").[28] Further, Bacon located the "violence of impediments" in this second state, independent of human agency, rather than using this terminology to describe human molding through art, implying that "violence" is to be identified first of all with these mutually hindering aspects of nature itself. Here again Bacon clearly began with Aristotle's terms and categories, which he then extended and reinterpreted in terms of his new sense of the importance of human art as reaching to the status and consequentiality of a state of nature itself.[29]

Where Aristotle privileged the "natural" over the "violent," Bacon considered the "violent" far more useful in finding new knowledge, now understood as the ability to control nature. Here, Bacon followed Aristotle's own lead in posing the possibility of motions "against nature" as an important alternative that needed to be included in physics. Aristotelian commentators had much earlier begun to reconsider the nature of "violent" motion in terms of impetus and other concepts that became important for the new philosophy.[30] As careful students of Aristotle, they realized that this whole topic had not been sufficiently developed by their ancient master. In his own way, Bacon also acknowledged the significance of Aristotle's distinction even as he valorized action "against nature" in a new way. For

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[27] Cf. Merchant, "Violence of Impediments," 745–46.

[28] See Aristotle, *Physics*, bk. 2, chap. 4.

[29] Cf. Lorraine Daston and Katharine Park, *Wonders and the Order of Nature, 1150–1750* (New York: Zone Books, 1998), 292.

[30] For instance, see Christia Mercer, "The Vitality and Importance of Early Modern Aristotelianism," in *The Rise of Modern Philosophy: The Tension Between the New and Traditional Philosophies from Machiavelli to Leibniz*, ed. Tom Sorrell (Oxford: Clarendon, 1993), 33–67; Ian Maclean, "Foucault's Renaissance Episteme Reassessed: An Aristotelian Counterblast," *Journal of the History of Ideas* 59 (1998): 149–66; and Craig Martin, "With Aristotelians Like These, Who Needs Anti-Aristotelians? Corpuscular Chemistry in Niccolò Cabeo's Meteorology," *Early Science and Medicine* 11 (2006): 135–61.

instance, Bacon critiqued Aristotelians, who, "even when they want to point to anything to do with the causes of motion, and to draw distinctions between them, they very lazily introduce the distinction between natural and violent motion, which is a stock notion if there ever was one, since all violent motion is in reality natural, but with an external efficient setting nature working in a way different from the one it was working in before."[31] Yet even Bacon's statement of his alternative view relies on Aristotelian concepts and terminology, here the "efficient," the *causa efficiens* Aristotle identifies as one of the four causes.[32]

Indeed, Bacon's use of the word "art" as a specific description of "the violence of impediments" takes up Aristotle's chosen term to describe the general alternative to nature. Thus, insofar as "violence" acts "against nature" through a shaping agency external to the body in question, Aristotle implies that "art" and "violence" may be coextensive terms. In the passage cited above, Bacon describes nature "put in constraint, molded, and made as it were new by art and the hand of man [*ab arte et opera humana*]; as in things artificial [*ut in artificialibus*]." Bacon's use of these terms often refers to and is dependent on Aristotelian terminology, thereby clarifying that the artisan can only equivocally be said to employ "violence" when applying artifice whose origin lies outside the object by itself.[33] To succeed, art must apply its powers exquisitely, imitating or extending, rather than violating, nature. Case, like other Aristotelians before him, argued that man "can contribute in a significant way to the fulfillment of nature by becoming an active participant," which Schmitt judges "will culminate in Bacon's thoughts on the same subject a few years later."[34] As Paolo Rossi and Sophie Weeks, among others, have argued, Bacon's ambitions go beyond the Aristotelian notion that art can only perfect or complete what nature allows.[35] Assessing his more radical vision requires close attention to the exact character of the "violence" he proposes to achieve it.

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[31] *Novum organum*, *OFB* 11.104–107 I1r34–2; *SEH* 4.67–68 [1.177].

[32] *Physics*, 194b30–32, 195a4–26.

[33] *Physics*, 192b9–23; Daston and Park, *Wonders*, 220–31, 290–301; and Peter Dear, "The Meanings of Experience," in *The Cambridge History of Science*, vol. 3, *Early Modern Science*, ed. Katharine Park and Lorraine Daston (Cambridge: Cambridge University Press, 2006), 106–31. See also Graham Rees, "Matter Theory: A Unifying Factor in Bacon's Natural Philosophy?" *Ambix* 24 (1977): 110–25; and William Newman, *Promethean Ambitions: Alchemy and the Quest to Perfect Nature* (Chicago: University of Chicago Press, 2005), 34–114, 238–89.

[34] Schmitt, *Case*, 193–205; cf. Aristotle, *Physics*, 199a15–17.

[35] See Sophie Weeks, "Francis Bacon and the Art-Nature Distinction," *Ambix* 54 (2007): 117–45; Paolo Rossi, *Francis Bacon: From Magic to Science,* trans. Sacha Rabinovich (London: Routledge & Kegan Paul, 1968), 26–27; Paolo Rossi, *Philosophy, Technology,*

MATTER THEORY AND THE USE OF VIOLENCE

Bacon's comments above on "the perverseness, insolence, and frowardness of matter [*materiæ*]" still depend on their Aristotelian context, in which *materia* (the standard translation for Aristotle's term ὕλη) denotes not bare matter but "building material," which is not infinitely plastic and hence resistant to being shaped by art or used "against nature."[36] Aristotle notes that "mistakes occur even in the operations of art" and "mistakes are clearly possible in the operations of nature also" (199a33–199b1), not least because of the recalcitrance of *materia* to external or internal shaping: lumber has knots and imperfections as inherent aspects of its materiality. He also notes that natural processes only operate "if nothing impedes [ἂν μή τι ἐμποδίοῃ]" (199b26), acknowledging that *materia* itself is subject to "impediments" from within various parts of the natural order itself, as well as from art.

To be sure, Bacon's view of the "perverseness, insolence, and frowardness of matter" may have regarded those inherent qualities differently from Aristotle's judgment that "in natural products the sequence is invariable," absent "impediments." Here, Bacon may have been looking more toward Plato's account in the *Timaeus* of the demiurge, "finding the visible universe in a state not of rest but of inharmonious and disorderly motion, reduced it to order from disorder."[37] Plato's dim view of mere matter may have helped Bacon form his early objections to Aristotle, which dated back to his university days (c. 1577), during which Petrus Ramus's attacks on Aristotle were subjects of fierce debate.[38] Bacon's language seems to reflect and

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and the Arts in the Early Modern Era (New York: Harper & Row, 1970), 137–45; Antonio Pérez-Ramos, *Francis Bacon's Idea of Science and the Maker's Knowledge Tradition* (Oxford: Clarendon, 1988), 68–105, 135–66, 175–76, n. 14; Pérez-Ramos, "Bacon's Forms and the Maker's Knowledge Tradition," in *The Cambridge Companion to Bacon,* ed. Markku Peltonen (Cambridge: Cambridge University Press, 1996), 113–16; Margaret Llasera, "Art, Artifice and the Artificial in the Works of Francis Bacon (1)," *Bulletin de la société d'études Anglo-Americaines des XVIIe et XVIIIe siècles* 22 (1986): 7–18; Peter Dear, *Discipline and Experience: The Mathematical Way in the Scientific Revolution* (Chicago: University of Chicago Press, 1995), 155–56; Rees, *OFB* 6:384, 13:xlviii; Zagorin, *Bacon*, 223; and Lorraine Daston, "The Factual Sensibility," *Isis* 79 (1988): 464. Cf. Newman, *Promethean Ambitions*, 256–71; Newman, "Alchemical and Baconian Views on the Art/Nature Division," in *Reading the Book of Nature: The Other Side of the Scientific Revolution*, ed. Allen G. Debus and Michael T. Walton (Kirksville, Mo.: Sixteenth Century Journal Publishers, 1998), 81–90.

[36] Forcellini, *Lexicon*, s. v. *materia*.

[37] *Timaeus*, 30a.

[38] See William Rawley, "Life of the Right Honourable Francis Bacon," *SEH* 1.4; and Craig Walton, "Ramus and Bacon on Method," *Journal of the History of Philosophy* 9 (1971): 289–302.

redirect Plato's critique of unformed, unquiet, "importunately fluctuating [*importuno fluctuans*]" matter; the invective tone of Plato's *importunus* as meaning "pertinacious and obstinant" (*cum pertinacia et obstinatione*) leads directly to Bacon's "perverseness, insolence, and frowardness of matter" (*pravitatibus et insolentiis materiæ contumacis*), vividly rendered in Gilbert Watts's 1640 translation as "*the pravities and insolences of contumacious Matter.*"[39] For his part, Case's matter theory also included Platonic elements that intensify the importance (and hence the subtlety) of "impediments" that could restrain the fluctuations of mere matter.[40]

Going past Plato, Bacon also emphasized the intrinsic *activity* of matter, which therefore affects how violence might affect it and on which he grounded his critique of Telesio:[41]

> Let us assume what Telesio grants, that the sum of matter remains forever constant, and is not increased or diminished. This property, by which matter preserves and sustains itself, he dismisses as passive, and as belonging to the category of quantity rather than to form and action, as if there were no need to impute it to heat and cold, which are set down as the sources of active forms and virtues only; for matter is not simply empty and deprived, but deprived of all active virtue. Now these claims rest on a formidable mental blunder, and a truly amazing one at that, were it not that conventional wisdom, and common and inveterate opinion take the wonder away from it. For we come across practically no error which is like that of not regarding this virtue implanted in matter as an active virtue, a virtue by which matter saves itself from destruction, such that not the smallest portion of matter can be either overthrown by the whole mass of the world, or destroyed by the power and fury of all agents, or in any way annihilated and reduced to order, but it both occupies some space, and keeps up resistance with impenetrable

[39] Du Cange, *Glossarium*, 340, s. v. *importunus*. See John C. Briggs, *Francis Bacon and the Rhetoric of Nature* (Cambridge, Mass.: Harvard University Press, 1989), 41–131; and Merchant, "Violence of Impediments," 747, n. 40. Latter quotation from Francis Bacon, *Of the Advancement and Proficience of Learning; or, The Partitions of Sciences*, trans. Gilbert Watts (Oxford, 1640), 79.

[40] For Case's view of Plato, see Schmitt, *Case*, 167; for his view of matter, see *Lapis philosophicus*, 55–58, 66–68, 74, 80, 100, 106, arguing that "privation is necessary to excite matter to acquire new forms."

[41] Graham Rees, "Francis Bacon's Semi-Paracelsian Cosmology," *Ambix* 22 (1975): 81–101; Rees, "Francis Bacon's Semi-Paracelsian Cosmology and the *Great Instauration*," *Ambix* 22 (1975): 161–73; Rees, "Matter Theory"; Rees, "Atomism and 'Subtlety'"; Rees, introductions to *OFB*, vols. 6, 13.

> dimensions, and has a go itself at something in its turn, and does not give itself up; this then is no passive virtue but on the contrary by far the most powerful of all, completely unconquerable, and as it were nothing but fate and necessity . . . his [Telesio's] mistake seems to lie in this, that he acknowledges a certain and definite mass of matter, but is blind to the virtue by which it maintains its quantity, and (sunk in the bottomless pit of Peripatetic darkness) ranks it as an accessory when it is the most important thing of all, shaking one body, moving another, solid and adamantine in itself, and that from which decrees of possible and impossible spring with inviolable authority.[42]

This "completely unconquerable" active power ultimately protects matter against attempts to accentuate violence into annihilative torture: "Thus, for self-preservation bodies are defended by nature by the four motions just mentioned, as by defensive weapons with which to guard themselves against annihilation, a vacuum, torment [*tortura*], and separation."[43] "Violent" intervention can effectively bind and harness only through knowledge of those powers. Not only might indiscriminate violence botch the intended trial, but (as Bacon ominously notes) "Force maketh *Nature* more violent in the Returne": those who attempt to alter nature must beware the reaction they may provoke.[44]

Bacon's manuscript *De vijs mortis* (c. 1611–1620?), his earliest writing on the problem of prolongation of life, gives a vivid, dramatic description of the complex reactions of the *spiritus* to the "gross body" that both protects and confines it. This spirit

> naturally delights in moving about, agitating and turning about, but much more, when enclosed within a tangible or gross body, does it work restlessly, continually make trials and gets prompted to drive that gross body away, and thrown back by that it rebounds and repeats such assaults endlessly. But in the meantime it rends, savages and undermines that gross body by this kind of onslaught. . . . This very spirit conspires and hurries no less to unite and conjoin itself with bodies akin to it if a similar spirit come in close or if the mass or region of kindred and connatural bodies (such as air is in particular in relation to vegetables, and all

[42] *De principiis atque originibus, OFB* 6.259–261; *SEH* 5.495–496 [3.114–115].
[43] *Abecedarium nouum naturae*, *OFB* 13.192 29v28–30.
[44] *Essays*, *OFB* 15.119 2G2r5–6; *SEH* 6.469, 571.

> the more if the air has been warmed by the Sun's rays or something else) do the same. On the other hand, the urge to escape is curbed in three ways: by the bounds of the thing, by putting freedom off, and by involvement in something else. For the spirit will not put up with being very finely broken up or divided because of the desire to go out, but evidently recoils from such self-division as well as from subtilization and confined spaces.[45]

As Rees puts it, "the spirit, like a demented prisoner, hurls itself against the walls of its tangible prison and rebounds from them, and slowly but surely breaks them down."[46]

Another passage in this work makes the violence of this imprisonment explicit, describing the reaction of the spirit to the complex influence of its ambient material surroundings, which sometimes "excite and arouse" the spirit "to invite and, as it were, evoke escape" and sometimes "appease and calm it." "Indeed, they [ambient things] themselves even dissolve, coagulate, spread out or bring together the spirit by their own action; they tear apart, interfuse themselves and stamp or impress their nature—and not just by a kind of violence [*violentiâ quâdam*] but rather by consent [*consensu*]."[47] Bacon's description shows how violence operates within an emergent consensus between spirit and the forces that attempt to confine it. His later writings on the problems of life and death confront the implications that any attempt to go beyond nature (and hence use "violent means") requires the exquisite calibration of those means in order to preserve spirit and cooperate with its intrinsic powers. Bacon stressed the dynamic effect of imprisonment more than any predetermined character of any elements, for even "fire is not violent or furious but where it is checked or pent."[48]

BACON'S MYTHIC TREATMENT OF VIOLENCE

Bacon's reinterpretations of "the wisdom of the ancients" (*De sapientia veterum*, 1609) consider the possibilities and dangers of violence in mythological contexts familiar to his contemporaries.[49] He chose potent divinities

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[45] *De vijs mortis*, *OFB* 6.322–325 18r5–18v2 (omitting editorial marks).
[46] *OFB* 6.lxii.
[47] *De vijs mortis*, *OFB* 6.286–287 7r7–12.
[48] *Sylva sylvarum*, *SEH* 2.353; for Bacon's view of nature as "a theater of conflicts," see Guido Giglioni, "Mastering the Appetites of Matter: Francis Bacon's *Sylva Sylvarum*," in *The Body as Object and Instrument of Knowledge: Embodied Empiricism in Early Modern Science*, ed. Charles T. Wolfe and Ofer Gal (Dordrecht: Springer, 2010), 154.
[49] See Bacon, *De sapientia veterum*, *SEH* 6.687–764 [6.605–686]; and Rossi, *Bacon*, 73–134.

to personify the salient natural forces, such as Proteus (''Matter—the most ancient of things, next to God'') and Pan (''the universal frame of things, or Nature'').[50] Bacon's choice of their masculinity reflects his sense of their powers, hence the dangers they may pose and the courage required to confront them.[51]

Bacon's reinscription of the story of Pan personifies the inherent activity of Nature and Love as engaged in a cosmic battle of contrary wills, which sometimes results in monstrous or unusual phenomena:

> With regard to the audacity of Pan in challenging Cupid to fight, it refers to this,—that matter is not without a certain inclination and appetite to dissolve the world and fall back into the ancient chaos; but that the overswaying concord of things (which is represented by Cupid or Love) restrains its will and effort [*malitia et impetus*] in that direction and reduces it to order. And therefore it is well for man and for the world that in that contest Pan was foiled. The same thing is alluded to in that other circumstance of the catching of Typhon in a net: because however it be that vast and strange swellings (for that is the meaning of Typhon) take place occasionally in nature,—whether of the sea, or the clouds, or the earth, or any other body—nevertheless all such exuberances and irregularities [*exuperantias atque insolentias*]are by the nature of things caught and confined in an inextricable net, and bound down as with a chain of adamant.[52]

Bacon's dramatic language depicts the inherent violence that is part of the concourse of nature itself, prior to any human intervention and caused by the essential activity of matter. As Rees observes, ''Cupid was therefore not some abstract stuff but a *person*, i.e. individualized.''[53]

Bacon's description of Proteus in fetters extended their Aristotelian

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[50] Contra Merchant, ''Violence of Impediments,'' 748, identifying ''Proteus as the bound hero, exemplar of the heroic (male) scientist.''

[51] Contra Merchant, ''Violence of Impediments,'' 739: ''Nature for Francis Bacon and nearly everyone else in the Renaissance and Scientific Revolution was female.'' See Park, ''Nature in Person,'' 69; and Catharine Gimelli Martin, ''The Feminine Birth of the Mind: Regendering the Empirical Subject in Bacon and His Followers,'' in *Francis Bacon and the Refiguring of Early Modern Thought: Essays to Commemorate* The Advancement of Learning *(1605–2005)*, ed. Julie Robin Solomon and Catharine Gimelli Martin (Aldershot: Ashgate, 2005), 70.

[52] *De sapientia veterum*, *SEH* 6.712–713 [639]. See also *De augmentis scientiarum*, *SEH* 4.325–326 [1.528–529].

[53] *OFB* 6.420.

sense as "impediments" to a new and daring project: not allowed his usual liberty, the god should be artificially constrained to answer the seeker's questions.[54] These fetters illustrate "the violence of impediments" acting *contra naturam* in its usual free state, which Bacon depicted as pastoral to the point of laziness, Proteus dozing with his flock.[55] As Weeks notes, "to shift nature from this otiose condition, the Baconian operator recapitulates the original binding of matter," leading to a new science of magic.[56] She emphasizes that this goes far past "completing" or "perfecting" nature, in the Aristotelian sense, to the accomplishment of everything possible, past all expectations and prior experience.

Yet not everything *is* possible; however far the operator may vex the fettered god, Bacon emphasized the intrinsic "term" or limit expressed by the way Proteus eventually cycles back to his original form, which must be carefully observed. Proteus is not a genie who will simply grant any wish desired by the Servant of Nature holding him fast; instead, the operator must learn from his experiment what the limits of the possible really are and how far they may be extended. After all, the ultimate goal of Bacon's new philosophy was to reveal laws of nature he called "forms," whose very name indicates defined limits, not unbridled possibility. In the end, "no violence and, if it comes to that, no age or stretch of time can reduce any amount or the smallest portion of matter to nothing, but it stays something and occupies some space and (no matter what kind of necessity is imposed upon it) either frees itself by changing its form or its place or (if it is not given this chance) it stays as it is; and things never get to the point of being nothing or nowhere."[57] Bacon's mythic retellings keep these ultimate limits before us, even while encouraging us to go much further than we had ever dreamed possible.

To that end, the Baconian operator must use violent means judiciously, for not all initiatives to restrain the ordinary course of nature can succeed. As he confirmed the specific association of "violence" with its Aristotelian context, he placed that term, as usually understood, under advisement:

> For the scholastic philosophy holds that it is enough to distinguish between natural and violent motion, and to proclaim that heavy

[54] See Briggs, *Francis Bacon*, 32–38; Pesic, "Wrestling with Proteus"; and William E. Burns, "'A Proverb of Versatile Mutability': Proteus and Natural Knowledge in Early Modern Britain," *Sixteenth Century Journal* 32 (2001): 969–80.
[55] *De sapientia veterum*, *SEH* 6.725 [6.651].
[56] Weeks, "Bacon and the Art-Nature Distinction," 117, 127.
[57] *Novum organum*, *OFB* 11.384– 385 2O1v5–12; *SEH* 4.214–15.

> bodies are carried downward by natural motion and light bodies upward. But such speculations are of little use to philosophy. For these words, *nature*, *art*, and *violence*, are a kind of trivial shorthand [*compendia verborum sunt, & nugæ*]; and people ought not only to refer this motion to nature, but also to look for the particular and proper affection and appetite of the natural body in this motion itself. For there are many other natural motions arising from quite different passions of things. Thus the matter is to be dealt with according to its differences. Moreover, those very motions which they call violent may be said to be more according to nature than this one that they call natural, if a thing be more according to nature which is stronger, or indeed if it be more according to the arrangement of the universe. . . . For place has no power, and body is not acted upon save by body, and all the haste of a body which seems to be aimed at positioning itself somewhere, is longing and labour for configuration relative to another body, and not relative to a mere location or position.[58]

Rather than dwelling on this "trivial shorthand," Bacon considered it "far more necessary (for a great deal turns on it) to persuade men that violent motion (which I call *Mechanical* . . .) is nothing other than motion of liberty, i.e. from compression to relaxation."[59] Because of the inherent activity of matter, "there seems to be a certain love of liberty which will hardly suffer itself to be constrained or diverted [*qui se constringi aut trahi ægre patiatur*]."[60]

Even so, Bacon continued to worry about the dangers and limitations of "violent" means. In several contexts, he rejected the "violence of the *primum mobile*" and "a destructive nature or violent imprinting of any new nature" through heat.[61] Bacon observed critically that "the alchemists over-fired the work," overstepping "a temperate and even heat" needed so

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[58] *De principiis atque originibus*, *OFB* 6.266–7 M10r8–11r33; *SEH* 5.499–500 [3.118].
[59] See also *Novum organum*, *OFB* 11.104–107 I1r34–2; *SEH* 4.67–68 [1.177]; *Novum organum*, *OFB* 11.332–33 2H4v12–2I1r14; *SEH* 4.187 [1.301]; and the editor's note in *OFB* 11.575. Giglioni, "Mastering the Appetites of Matter," 155–56, holds that "motion of liberty is fundamental in Bacon's physics." For an excellent analysis of the "mechanical," see also Sophie Weeks, "The Role of Mechanics in Francis Bacon's *Great Instauration*," in *Philosophies of Technology: Francis Bacon and His Contemporaries*, ed. Claus Zittel et al. (Leiden: Brill, 2008), 133–96.
[60] *Abecedarium nouum naturae*, *OFB* 13.192–193 29r12–13.
[61] See, for instance, *Thema cœli*, *OFB* 6.180–3 G11r37–G11r8; *SEH* 5.552 [3.774]; and *Novum organum*, *OFB* 11.258–259 2A3r28–30; *SEH* 4.148 [1.260].

that "no part of the spirit be emitted, but detained: for if there be emission of the spirit, the body of the metal will be hard and churlish."[62] In his account of "Ericthonius; or Imposture," Art (personified by Vulcan as fire) "when it endeavours by much vexing of bodies to force Nature to its will and conquer and subdue her . . . rarely attains the particular end it aims at. . . . Such things may often be observed among chemical productions, and among mechanical subtleties and novelties."[63]

While acknowledging that "compressions and suchlike violent motions certainly make a great contribution to local motion and other things of that kind, as in machines and missiles, and also in the ruination of an organic body and those of its virtues which wholly depend on motion," Bacon nevertheless judged that violent motions "do not do much for the nobler transformations and alterations of similar bodies, for these bodies do not obtain any new stable and steady consistency from them, but a transient one which is always struggling to restore itself and break free," so that "it would be very beneficial if we could impose a fixed and stable nature on bodies by violent means." The very power of violent motion is limited by the transience of its effects, though this too might conceivably be remedied by further research, for "man is master of violent motions more than of the rest."[64] To that end, Bacon's account of "Proserpina, or Spirit" takes further advantage of the activity of matter, for "most certain it is that there are two ways of confining and restraining spirit in solid and earthy matter; one by constipation and obstruction, which is simple imprisonment and violence [*violentia*]; the other by administering some suitable aliment, which is spontaneous and free."[65]

The ramifications of Bacon's views permeated his political philosophy and rhetorical views. For instance, his essay "Of Great Place" refers to Aristotelian concepts of place and violent motion to argue that, "as in Nature, Things move violently to their Place, and calmely in their Place: So Vertue in Ambition is violent, in Authoritie settled and calme."[66] Yet this "violent motion" Bacon considered "honourable," for "all Rising to *Great*

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[62] *Sylva sylvarum*, *SEH* 2.449–50. See Stanton J. Linden, "Francis Bacon and Alchemy: The Reformation of Vulcan," *Journal of the History of Ideas* 35 (1974): 558–59; and Briggs, *Bacon*, 142–50.

[63] *De sapientia veterum*, *SEH* 6.736 [661]. I thank Sophie Weeks for drawing my attention to Peter Shaw's editorial note in *The Philosophical Works of Francis Bacon* (London, 1733), 1:565: "'Tis a fundamental Position with the author, that *Nature*, like the Ladies, can only be won by Submission." Cf. Merchant, "Violence of Impediments," 746–47, n. 39.

[64] *Novum organum*, *OFB* 11.422–25 2S1r32–33, 2S2r25–27; *SEH* 4.235–37 [1.352–53].

[65] *De sapientia veterum*, *SEH* 6.760 [681–82].

[66] *Essayes*, *OFB* 15.36 1K2v100–103; *SEH* 6.115.

Place, is by a winding Staire," moving against the ordinary course of nature. Even in horsemanship, Bacon re-evaluated the significance of "violent" means, judging that "the spur does not violate the virtue it consistently attends and stimulates," as John Briggs puts it.[67]

Compared to the crudity (and limitations) of mere violence, Bacon preferred persuasion and even guile, for "you may deceive nature sooner than force her."[68] His advocacy of deception echoes his guarded policy of cunning and secrecy in statecraft: in both politics and natural philosophy, he recommended "a good shrewde Proverbe of the Spaniard; *Tell a lye, and find a Troth*. As if there were no way of Discovery, but by *Simulation*."[69] Indeed, the philosophic virtuosi of Bacon's *New Atlantis* excel in using simulations in their "houses of deceits of the senses," even though they "do hate all impostures and lies."[70] Elsewhere, Bacon explored the role of "impediments" in the formation of those operators whose guile and subtlety enable them to question nature and decode her enigmas, such as Oedipus, "a man of wisdom and penetration, but lame from wounds in his feet [*pedibus læsis et perforatis*]," literally "im-peded" yet thereby impelled to rely on deeper faculties to answer the Sphinx's riddle concerning how humans walk at different stages of life.[71]

VIOLENCE AND LIBERTY

Thus, Bacon shaped his new insights through reconsideration of Aristotle's terms, taking them in a new direction by valorizing the powers of art more highly than nature left purely to itself.[72] As Rossi puts it, "Bacon's objections to Aristotelianism and the main themes of his own philosophy are identical."[73] With that in mind, Bacon's scathing remarks about Aristotle in such unpublished earlier works as his *Redargutio philosophiarum* (c. 1608) need to be weighed against his later comments about Aristotle's "high merits."[74] Bacon's insights emerged in close dialogue with Aristotle,

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[67] See Briggs, *Bacon*, 111.
[68] *De augmentis scientiarum*, *SEH* 4.324 [1.527].
[69] *Essayes*, *OFB* 15.22 E3v99–101; *SEH* 6.389.
[70] *New Atlantis*, *SEH* 3.164; see also Briggs, *Bacon*, 37–38.
[71] *De sapientia veterum*, *SEH* 6.755 [6.678]. See Briggs, *Bacon*, 13–14, 34, 174, 214; Pesic, *Labyrinth*, 31–37; and Pesic, "Desire, Science, and Polity: Francis Bacon's Account of Eros," *Interpretation* 26 (1999): 333–52.
[72] See Katharine Park and Lorraine Daston, "Introduction: The Age of the New," in Park and Daston, eds., *Early Modern Science*, 8; and Martin, "With Aristotelians Like These," 135.
[73] Rossi, *Bacon*, 61.
[74] Cf. R. E. Larsen, "The Aristotelianism of Bacon's *Novum Organum*," *Journal of the History of Ideas* 23 (1962): 435–50; and Thomas Kuhn, *The Essential Tension* (Chicago:

who gave the crucial point of departure from which Bacon then directed natural philosophy toward his new priorities.

Though it would exceed the scope of this paper to discuss in detail all 104 passages in which Bacon used the terms "violent" or "violence," I will close with an emblematic passage in his *Sylva sylvarum* (1624):

> 9. Take a glass, and put water into it, and wet your finger; and draw it round about the lip of the glass, pressing it somewhat hard; and after you have drawn it some few times about, it will make the water frisk and sprinkle up in fine dew. This instance doth excellently demonstrate the force of compression in a solid body. For whensoever a solid body (as wood, stone, metal, &c.) is pressed, there is an inward tumult in the parts thereof, seeking to deliver themselves from the compression. And this is the cause of all violent motion. Wherein it is strange in the highest degree, that this motion hath never been observed nor inquired; it being of all motions the most common, and the chief root of all mechanical operations.[75]

Bacon immediately thereafter makes explicit that

> this motion upon pressure is excellently also demonstrated in sounds; as when one chimeth upon a bell, it soundeth; but as soon as he layeth his hand upon it, the sound ceaseth. And so the sound of a virginal string, as soon as the quill of the jack falleth from it, stoppeth. For these sounds are produced by the subtile percussion of the minute parts of the bell or string upon the air; all one, as the water is caused to leap by the subtile percussion of the mute parts of the glass upon the water, whereof we spake a little before in the ninth experiment.[76]

During his studies at Cambridge, Bacon probably read the description of Pythagoras's testing of musical glasses in Boethius's *De institutione musicae*, a standard text in the quadrivium still used in the English universities. Boethius specifies that Pythagoras "struck these glasses—set in order according to various weights—with a rod of copper or iron" (figure 1).[77]

University of Chicago Press, 1977), 30–35. See also Pérez-Ramos, *Bacon's Idea of Science*, 115–20.

[75] *Sylva sylvarum*, *SEH* 2.342.

[76] *Sylva sylvarum*, *SEH* 2.343.

[77] Boethius, *Fundamentals of Music*, ed. Claude V. Palisca, trans. Calvin M. Bower (New Haven: Yale University Press, 1989), 18.

FIGURE 1. Illustration of Pythagorean experiments on bells and glasses, from Franchinus Gaffurius, *Theoria musicae* (1492).

In contrast, Bacon adduced a new kind of musical activity, giving the earliest known description of a moistened finger rubbing the glass's rim to excite its ringing, which he finds similar to the chiming of a bell or the plucking of a string. Bacon considered the moving finger to cause compression, "the cause of all violent motion," which he judged "of all motions the most common," more common than "natural" motion. As "the chief root of all mechanical operations," he underlined the power inherent in the release of such compression and hence its practical importance. Explicitly echoing his earlier description of "violent motion (which I call *Mechanical*)" as the "motion of liberty, i.e. from compression to relaxation," he noted that for the glass "this motion upon pressure, and the reciprocal thereof, which is motion upon tensure, we use to call (by one common name) *motion of liberty*; which is, when any body, being forced to a preternatural extent or dimension, delivereth and restoreth itself to the natural."[78] To instantiate the significance of violent motion, whose neglect he finds "strange in the highest degree," Bacon lets us see (and hear) the glass regaining its liberty.

Thus, Bacon built on Aristotle's concept of violent motion as he revalorized its relation to its endpoint: the "subtile percussion of the glass upon the water" causes a "frisking and sprinkling" that educes a new sound as the body resumes its unperturbed state. By exciting an "inward tumult" in the glass, the moving finger subtly imitates, co-opts, and controls the violence that lies intrinsic within nature itself. Bacon reshaped Aristotle's "violent motion" into a nexus of violence and liberty that could transform nature itself.

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[78] *Sylva sylvarum*, *SEH* 2.342–43.