

## Book Reviews

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STEVEN SHAPIN and SIMON SCHAFFER, *Leviathan and the air-pump. Hobbes, Boyle, and the experimental life*. Including a translation of Thomas Hobbes, *Dialogus physicus de natura aeris*, by Simon Schaffer, Princeton University Press, 1985, 8vo, pp. xiv, 440, illus., £43.00.

In his *History of the Royal Society of London*, published in 1667 as an explanation and defence of men who spent their time weighing the air and anatomizing beetles, Thomas Sprat threw out many striking analogies between contemporary politics and the activities he defended. The Society fitted perfectly with the spirit of reconciliation and tolerance supposed to characterize the Restoration: it forbade discussion of politics or religion; it limited dissent to matters about which agreement could be reached; it stuck to matters of fact; it promoted industry, sobriety, good judgment, and balance; it opposed enthusiasts, dogmatists, radicals, and sinners.

Shapin and Schaffer have dilated and developed Sprat's analogies and metaphors with the persistence and prolixity of the Society's cynosure, Robert Boyle. Their argument may be distilled as follows. Boyle wished to set aside a "social space" (the term is theirs) for the cultivation of experimental philosophy; he also wanted to demonstrate to society at large how civic and religious dissent might be managed peacefully and productively; in fact, he wanted both, for, as Shapin and Schaffer claim, "solutions to the problem of knowledge are solutions to the problem of social order" (p. 332). They discern three "technologies" in Boyle's effort to establish his "experimental language" (p. 49), his "disciplined collective social structure" (p. 78), his "space . . . so securely bounded that dispute could occur safely within [it]" (p. 303), his "experimental form of life" (p. 314). The technologies were: the material, that is, experimental apparatus, of which the air-pump was the exemplar; the literary, or wordy descriptions of experiments performed, of the witnesses present and their reliability, and of the machines themselves; and the social, or rules of engagement in philosophical debate, the pre-eminence of the matter of fact, and the down-grading or exclusion of conjectures or theories about the causes and principles of certified phenomena. Withall, the experimental philosopher must be modest, open and flexible: "Till a man is sure he is infallible", Boyle wrote, "it is not fit for him to be unalterable."

These "technologies" drew fire from the plentiful furnace of Thomas Hobbes, whom Shapin and Schaffer use as a detector of the aspects of Boyle's programme offensive to contemporaries who differed from him politically. Hobbes pointed out that the material technology leaked; that the literary technology, at least in respect of the testimony of witnesses, had no force ("no infinite number of grave and learned men" make certainty, "but authority"); and that the social technology misconstrued the nature of knowledge. By making the matter of fact, and not the underlying principle, the main object of investigation, one forfeits the chance at truth and certainty and has no reliable way to exclude serious and dangerous error. Boyle and his precious air-pump would be an ongoing peril as long as experimental philosophers waffled over the nature of the "vacuum". Hobbes knew from principle that a true void space, being immaterial, could not be; others not so guided, like the noisy Cambridge philosopher Henry More, and the demonstrator of witches, Joseph Glanvil, admitted the void, and imagined that Boyle's experiments proved the existence of spaces for angels and spirits to play in.

Hobbes's dogmatism in natural philosophy was of a piece with his concept of the State. In philosophy, the force of reason, working from sure principles in the style of Euclidean geometry, must compel assent; "who is so stupid", he asked, "as both to mistake in geometry, and also to persist in it, when another detects his error to him?" In the State, the King's authority should prevail over all dissent and dissenters in both civil and religious matters. Just here, loose talk about vacuums threatened the peace. For priests would set up as experts on the immaterial, and construct an independent base of power on the strength of their pseudo-knowledge, as they had in the past; and so bring about subversions and rebellions. The method of creating and certifying knowledge, and the problem of establishing social order, forced Boyle and Hobbes to sharply

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different conceptions of the relationship between organized religion and natural philosophy, as well as to conflicting evaluations of the relation between knowledge and fact.

Shapin and Schaffer have directed attention to a capital problem in the historiography of early modern science: the creation of a sustained practice of experimental natural philosophy. It is not a new problem. To go back no further than 1971, Joseph Ben-David then emphasized that the success of what he indiscriminately called "scientists" in obtaining social acceptance for their claims to knowledge and thereby a role in society needed explanation; and he dated the first full-dress staging of the role to Restoration England. Shapin and Schaffer have gone far beyond Ben-David in the detail of their reading of the texts and in the intricacy of their argument. They show that Boyle and his group shouldered a burden of proof when they claimed that the matter of fact should be the basis of their science and their ethics. It was the old question of the hierarchy of knowledge: natural philosophy and its practitioners had a place in the schools, and hence in society; to challenge them—not necessarily to replace them—required mobilization of more than a few bits of contrived experience interpreted as contradictory to traditional ideas.

In this last connection Shapin and Schaffer's representation of Boyle's group as assertive and expansive, as missionaries of the model method for all social transactions, rings false. They write (p. 340): "The experimentalists' task was to show others that their problems could be solved if they came to the experimental philosopher and to the space he occupied in Restoration culture." But, as they also emphasize, it was just these problems—social problems—that the Royal Society excluded from its "space". Their claim that, because Boyle and his followers advocated application of the results of their investigations to the support of religion, "their laboratories acquired a sacred status" (p. 319), should also be put down to over-enthusiasm.

The enthusiasts provide much information of value even to those who may doubt the reach of their analogy between politics and natural philosophy. Their concept of literary and social technologies in the practice of experimental science deserves refinement and extension. Their account of the difficulties Boyle's contemporaries experienced in reproducing his experiments and even in making air-pumps deserves study by all historians of science. Assent to new experimental findings requires their replication, or at least a belief in the practicability of replication; but repetition and confirmation, always problematic to some degree, become suspect where the technology involved is new or exotic, or when only a single machine capable of producing the new effects exists, or when copies of the competent machine can only be made to work by people who had practised on the original. These problems were not peculiar to the seventeenth century: the difficulties of replication, the unique machine, and the need for immediate experience with it to reproduce it, recur in modern particle physics. And finally, among the parts of *Leviathan and the air-pump* of utility apart from interpretation, is Schaffer's translation of Hobbes's response to Boyle, the *Dialogus physicus* of 1661 and 1668, presented in English for the first time.

On the debit side, *Leviathan* has swollen so large that, as is usual with books on British natural philosophy, it has no room for relevant parallels from Europe. That is a pity. The Society's policy against conjecturing about causes, which Hooke wished to raise to the status of a by-law, also informed the practice of the Florentine Accademia del Cimento; and Boyle's second technology, the witnessing of experiments by trustworthy observers, was common procedure in Florence, at Athanasius Kircher's "museum" at the Collegio Romano in Rome, in the various groups that anticipated the Paris Academy of Sciences, and elsewhere. This is not to impugn the reasons Shapin and Schaffer bring to explain the practices of the Royal Society of London, but to suggest that what was peculiar to the British case can only be discovered by comparing it with parallel happenings on the Continent.

Shapin and Schaffer convey their intricate story and lesson clearly apart from a little jargon that does not always translate easily. They conduct us through "social spaces"; "disciplinary spaces"; "physical space"; "abstract space", where "virtual witnesses", i.e. readers of Boyle's books, "could effectively be mobilized" (p. 336); and, of course through space void of air. This spissitude bamboozles even its creators. "For Hobbes", they write, "the rejection of vacuum was the elimination of a space within which dissension could take place" (p. 109).

J. L. Heilbron  
University of California, Berkeley