Newtonian Traditions

Mechanism and Materialism. British Natural Philosophy in an Age of Reason. ROBERT E. SCHOFIELD. Princeton University Press, Princeton, N.J., 1970. viii, 366 pp. $9.50.

Schofield has taken for the subject of his book the conceptual development of two opposing views of matter and its action, both deriving ultimately from Newton, and both contending vigorously for the allegiance of British natural philosophers in the 18th century. In the course of his study he has added considerably to our understanding of what it was like to be a "Newtonian" in this complex period and has presented his readers with several provocative theses which should provide the basis for considerable further discussion.

The author distinguishes between two Newtonian traditions: the mechanist and the materialist. The former, ultimately deriving from the mechanical philosophy of the 17th century, maintained that the explanation of natural phenomena was to be sought in the atoms or corpuscles of primary matter (in their sizes, shapes, combinations, and motions) and in the attractive and repulsive forces which determine those motions. The latter (materialist), ultimately deriving in the author's view "from Aristotelean substantial qualities," held, to the contrary, that though such ultimate explanations might in fact exist, the pursuit of them was for the time being futile. Instead, they sought their explanations of physical phenomena in the presence or absence of a material substance which itself carried the necessary properties; the material causes are furthermore generally regarded as imponderable, highly tenuous fluids as in caloric or the famous electrical fluid of Franklin. The dynamic corpuscularians or mechanists claimed direct Newtonian lineage from the *Principia*. The materialists pretended Newtonian legitimacy from Newton's ether speculations in the later editions of his *Opticks*, speculations which as it was reported at the time "surprised [Newton's] physical and theological disciples."

The earlier mechanist tradition is represented in the 18th century by speculative corpuscularians like the Keills, John Freind, and John Rowning, men inspired by the success and model of the *Principia*. However, according to I. B. Cohen and to Schofield in support, Newton's *Opticks* initiated a period of experimentation governed by Newton's own suggestions and speculations. The tension between the aspirations of mechanism—to find the forces among ultimate particles—and the plethora of irreducible experimental data as in electricity provides a major substratum for the transition to materialism.

But the scientific failure of the mechanist program was not the only element in the conceptual change which was to dominate the last half of the century. Schofield suggests that in the crucial period, 1735–1745, several other important changes occurred: alongside a general turn toward incipient Romanticism, a generational shift cut away the hegemony of the mechanists. During the presidency of Martin Folkes (1741–52) the Royal Society "came increasingly to be dominated by dilettantes." More pertinently, the old Newtonians trained at the English universities had by 1744 died, and were increasingly replaced on the scientific scene by those who had been educated in Holland, Scotland, or dissenting academies or were self-taught. This new generation produced a new Newtonianism, characterized by a turn from an emphasis upon "exact" science (after the *Principia*) to one upon "experimental" science (after the *Opticks*). The sentiment for the new Newtonianism supported a revival of the reputation of Bacon; it reflected the influence of Continental (especially Dutch) science; it found its theoretical basis in Newton's own ether hypotheses. "Once the aether, as a special material cause, is adopted," Schofield concludes, "its materiality can be merged with that of other causative substances as these emerge from other sources" (p. 114). The search for other material substrata was on.

The materialist explanations were, according to the author, dominant throughout the second half of the 18th century. Nevertheless, an important group, including Cavendish, Herschel, Priestley, and Hutton, were dissatisfied: "Content with neither the substitution of taxonomy for analysis nor the quantification of quality by conservation of substance, these men returned to the mechanist aspirations of earlier generations" (p. 235). Indeed, Priestley's famous disagreement with Lavoisier was not basically a dispute over phlogiston but rather one between materialism and mechanism. As a chemist "Lavoisier abandoned physical reductionism for the jig-saw puzzle problems of permutation and combination of substances. To Priestley the solution of such problems was comparatively unimportant" (p. 273).

Without question, Schofield has challenged his readers with a consistent and well-buttressed set of views. One may, however, have less confidence than he in the degree of tenacity with which Black and even Lavoisier held a materialist creed, and one may wish for additional analysis, for example, of the importance of changes of state to the calorists. That many of the materialists may have held such a view as an unhappy expedient, as a temporary policy rather than a creed, is borne out by Schofield's own description of materialism as proto-positivistic.

One is struck by the truly strong strain of agnosticism, bolstered by references to Newton's methods, discoverable among many of the materialists; they appear to have taken what they understood to be Newtonian methods of philosophizing (as laid out in the *Rules of Reasoning* and the 31st query) rather more seriously than the need for immediate recourse to corpuscular, dynamic explanations. As with Newton, the search for certitude took precedence. The materialists, faced with a contradiction between Newton's admonitions against groundless hypotheses and the methods required for corpuscularianism, perhaps took a path of little resistance, believing, however, that the future might well resolve that contradiction.

Mechanism and Materialism is a book to be read not only by historians, but by scientists desiring a sound and stimulating entrée into the inner character of 18th-century natural philosophy.

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Studying Muscle

First and Last Experiments in Muscle Mechanics. A. V. HILL. Cambridge University Press, New York, 1970. xvi, 144 pp., illus. $9.50.

A. V. Hill has maintained a boyish enthusiasm for research for over 60 years; he has studied the heat changes and mechanical events in sartorius muscles of the frog in ways that no one else was able to emulate for years, and on top of a steady output of classical