was reported in 1974 to have "touched up" his experimental mice. Except for a "superb" account (p. 41) that eventually appeared in the *Journal of the American Medical Association*, Goodfield contends that the reporters who covered the story, especially those who did so for the mass-circulation media, "forgot the basic ethics of reporting and the professional standards of their jobs." They made an undeserving hero out of the accused researcher, who claimed that he was being pilloried by the establishment. They failed to dig out all the relevant facts and interview all the principals, relying instead on hand-outs, random remarks, and gossip. "To an extent," she claims, "this was true even of the reporters on *Science*" (p. 40). Although Goodfield does not provide enough evidence for the reader to make up his or her own mind about this case, the general tenor of the critique rings true. All too often, in cases like this, the first stories to appear reflect the views of the aggrieved party, who usually takes the initiative in contacting the press; correctives turn up only later, if at all.

The other case cited is that of the book purporting to describe the "cloning" of a human being, which Goodfield aptly refers to as "Rorvik's Baby," after the author who conceived it. As she points out, the publisher of the book chose to issue it as truth rather than fiction although the author refused to provide any supporting evidence, even under a guarantee of confidentiality. With rare exceptions, the story was treated as though it were scientifically credible by many journalists, who "did not bring investigative resources to bear on the book, the claim, or the author soon enough" (p. 55). The trouble is not merely than an occasional hoax of this sort attracts more attention than it deserves, but that it is "just one of a whole host of marginally scientific productions, purporting to be factual, but which glide smoothly over the evidence or appeal to emotion or irrationality rather than dealing with solid, proven work and what it promises—or threatens" (p. 65).

To balance the account, Goodfield cites two cases in which media coverage was exemplary. One was the campaign mounted by the "Insight" team of the *Sunday Times* of London to expose the failure of the distributors of Thalidomide to test the drug's safety before rushing it to market and to put public pressure on the company to offer more adequate compensation to the victims. The second positive example is the coverage of the Asilomar conference on recombinant DNA research, which resulted in several prizes for the journalists involved and showed what can be accomplished when scientists and journalists cooperate. This is a particularly effective example because the scientists involved were at first anxious to limit coverage so as to avoid "a media circus." When they were persuaded (mainly by Howard Lewis of the National Academy of Sciences staff) to arrange broader coverage that would allow them to explain the issues adequately, the outcome was a happy one.

The Asilomar example points the moral Goodfield draws. Journalistic ethics, she suggests, "must apply with special force to the reporting of science and science issues" (p. 91). Scientists are advised to cooperate with journalists, to behave "as they did at Asilomar: forthcoming, open, honest, and articulate" (p. 92). For both groups, the fundamental point is that "the very notion of being a professional implies an acceptance of moral responsibility for the consequences of one's work which affect both the other members of the profession and society at large" (p. 63).

This emphasis on the need for professional responsibility is certainly warranted, but it would be unfortunate if it were to divert attention from the most vexing obstacle to improved public understanding of science. This is, of course, the worsening state of scientific literacy. At a time when hard choices must be made by individuals and whole societies in deciding how to make use of the products of the laboratory and which lines of inquiry to support, mass ignorance and indifference are an acute problem. Goodfield recognizes it but prefers to concentrate both her fire and her recommendations on the professionals who shape public understanding through the media. The trouble is that their best efforts will be in vain if most of those they aim to address are ill prepared to become informed. Media coverage of science has improved immensely in recent years. Some of it is as distinguished in its own terms as the scientific achievements reported upon. But unless the audience for this effort can be greatly enlarged, the hoary popular perception of scientists as modern sorcerers speaking in tongues will vitiate the force of further reforms.

One can quarrel with Goodfield's apparent unwillingness to put at least equal blame on the failure of ordinary citizens to shoulder their democratic responsibilities by making more of an effort to educate themselves to understand important scientific issues. One can also quibble with other points she makes. It is debatable, for example, whether the American media, with their muckraking tradition and structural decentralization, are less prone to advocacy than their British counterparts, hemmed in as they are both by tighter legal restraints and by subtle ties to the social establishment. Although this book is not a comprehensive account of the subject, or one with which readers are likely to agree entirely, it is just what it claims to be: a reflective essay on science and the media—and one that is lively, provocative, and very readable.

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A Branch of Mathematics

A History of the Calculus of Variations from the 17th through the 19th Century. HERMAN H. GOLDSTINE. Springer-Verlag, New York, 1980. xviii, 412 pp., illus. $48. Studies in the History of Mathematics and Physical Sciences, 5.

The calculus of variations is a branch of mathematics with a long history. Roughly formulated, its concern is with maxima and minima of certain functionals, quantities that depend on functions. The history is closely linked to the development of analysis. The author observes that in a survey of the history of the subject he could have gone back to the study of isoperimetrical problems by the mathematicians of antiquity, but because their means of solving the problems were geometrical and he has in view the history of results obtained by the methods of analysis he starts the story in the century in which the calculus was created, with Fermat, Leibniz, Newton, and the Bernoullis.

The invention of differential and integral calculus was from the beginning related to variational problems in their simplest form. Questions pertaining to maxima and minima of functions were studied, but more general problems soon came to be considered: quantities that depend on curves had to be taken into account. (At the end of the 19th century the name "functional" was introduced for them; Volterra used the name "fonction de lignes.") The general type of the problems in this branch is to determine a function y_0 of a variable x such that the integral

$$I = \int_a^b F(y_x, y; x)dx,\ y_x = \frac{dy}{dx}$$

in which F is a given real function, takes a (relative) minimum (or maximum) for this function in a given set of functions y,

adequately defined. There are more complicated problems: problems in higher-dimensional situations, problems concerning the existence of such functions satisfying supplementary conditions, variable end-point problems, and so on.

The author describes the history of these problems up to the 20th century, including many technical details. Problems of mechanics and physics provided the original impetus for studying variational problems. In the 17th century—and for many years afterward—there was a kind of unity between mathematics and the physical sciences. There were, for example, the problem of the passage of a light ray from one optical medium to another (the problem of the least possible time), already studied by Fermat; the famous brachystochrone problem (the problem of finding the curve joining two points in a vertical plane along which a body will descend frictionlessly in the least possible time, studied by Leibniz and the Bernoullis); and the problem of least action. There were also classical mathematical problems such as geodesics on a surface (Euler) and the problem of finding a surface of least area among all those bounded by a given curve (Lagrange; the problem of Plateau). The influence of physical sciences remained for a long time. The author deals with the theory of Hamilton and Jacobi (19th century) in analytical mechanics. Variational principles are important into modern times (dynamics). He considers the way in which through the work of Euler, Lagrange, Legendre, and others the more special theory developed into a general theory in connection with differential equations. First and second variations of functionals that present themselves in this theory are discussed. Weierstrass, especially, did important work in giving the theory an exact basis. There are questions of necessary and sufficient conditions and questions of what is to be understood by the neighborhood of a curve. Coming toward the end of the 19th century the author mentions the work of Hilbert. Note that some of the 23 problems that Hilbert proposed at the International Congress of 1900 at Paris concern variational calculus. The author proceeds to the work of Carathéodory, Bliss, Bolza, and Kneser, hinting at the calculus of variations in the large developed by Morse (1934).

This book gives a good picture of an important branch of mathematics, to which many great mathematicians of history contributed. I add some remarks.

Hilbert's work in this domain is related to Dirichlet's problem in potential theory and the well-known failure of the so-called principle of Dirichlet to solve that problem. This principle is a variational problem. The author mentions it briefly. More attention to it in the context of the remarks on Hilbert's work would have been interesting because this work marks the beginning of the so-called "direct method" for variational problems, a method that avoids the classical way of introducing auxiliary parameters that reduced the problem to questions on functions of one variable. Mentioning it would have been the more interesting because it provides an opportunity to show the relation of the variational calculus to functional analysis. Although the latter is mainly a development of the 20th century, there were studies in this direction at the end of the 19th century. Note the work on integral equations—historically related to the calculus of variations—and the introduction of the concept of a "functional" (Volterra). I add a supplementary bibliography on these points.

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