are referring to. Darwin had priority in the discovery and in the writing down of both natural selection and the principle of divergence. Brackman fails to disprove that long received view of the events. Wallace had priority in composing a paper that was ready for publication. But Darwin also had an important claim with respect to composition. By June 1858 he had completed ten and a half chapters of his book, that is, over 250,000 words of well-articulated argument supported by a masterly array of facts. Darwin had virtually completed the plan that Wallace was just contemplating.

Brackman successfully shows that Darwin's friends acted to protect his interests by arranging simultaneous publication. He also shows that Darwin was sufficiently self-interested to encourage joint publication and produce both an extract of his 1844 Essay to prove the longevity of his claim to natural selection and the 1857 abstract prepared for Gray to prove the priority of his claim to the principle of divergence. But Darwin's claims were valid and the mere fact that his friends acted to defend them is not a conspiracy. Hooker and Lyell, however, did go one step further. Brackman is right when he says that they manipulated the order of submission (without Darwin's knowledge) by putting Darwin's pieces before Wallace's paper. By placing the documents in the chronological order of their composition they favored Darwin's priority over Wallace's. No doubt they colored the judgment of history. Did this act constitute a conspiracy? No, just a delicate arrangement.

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Issues of Communication

Reflections on Science and the Media. JUNE GOODFIELD. American Association for the Advancement of Science, Washington, D.C., 1981. xii, 114 pp. Paper, $9. AAAS Publication No. 81-5.

"As seen through the medium of the popular press the scientist is apt to appear as an enemy of society inventing infernal machines, or as a curious half-crazy creature talking a jargon of his own and absorbed in the pursuit of futilities." So wrote E. E. Slosson, the first director of Science Service, a nonprofit corporation endowed in 1921 by the publishing magnate E. W. Scripps in order to provide American newspapers with accurate reports on science.

If this caricature persists, it is not because the coverage of science in the mass media remains as uniformly poor and haphazard as it undoubtedly was when Slosson surveyed the scene. Today, as William D. Carey observes in the foreword to this thoughtful essay on the subject, science and the media "depend on each other." Scientists have an interest in communicating the results of their work, if only to assure continuation of the public patronage that has become the sine qua non of large-scale research. Some scientists and technologists also play major roles in discussions of public policy. For the media, science has become a regular source of important news—or, more exactly, of what the gatekeepers of public information consider newsworthy. (Their criteria are certain to include dramatic and controversial applications of science, but not necessarily a discovery that merely alters the fundamental understanding of nature.)

This mutual dependence has brought about important changes in the coverage of science. More space is devoted to it by the print media, more time by the broadcast media. A new profession of "science writers" and "science correspondents" has acquired a perch on both branches. Popular magazines have sprung up alongside the more established and more technical journals. Television programs and series have been produced to explore the process of discovery and to investigate issues and problems connected with new technologies.

Overwhelming as the flood of information often appears, anyone with sufficient interest and preparation can keep abreast of major developments by judiciously monitoring the best of the newspapers, periodicals, and broadcasts. But what about "ordinary citizens" with only a casual interest and a limited educational background, who are less discriminating as to sources and are therefore dependent on whatever they happen to "read in the newspaper" or "see on TV"? It is June Goodfield's contention that the information about science that tends to reach this largest and most politically weighty segment of the population is too often flawed, oversimplified, imbalanced, and misleading.

As a prolific historian of science, whose other most recent book (*An Imagined World: A Story of Scientific Discovery*) is based on years of first-hand observation of scientists at work, Goodfield is equally troubled by the tendency of the media to report research findings out of context. Without some understanding of "the patterns, the limits, the nature of discovery, the balance of certainty and uncertainty," the methodology and "spirit of science," (p. 88), she points out, the data alone cannot be properly evaluated.

In seeking to explain the reasons for such shortcomings in the communication of scientific findings, Goodfield calls attention to the contrasts in mind-sets and constraints between scientists and journalists. Scientists are trained to be cautious, to publish findings only after peer review. They do not expect the most vexing quandaries to be cleared up quickly; they know that every discovery is apt to raise as many new questions as it answers old ones. They express themselves in technical languages. Some are so acutely aware of the limits of their expertise that they are reluctant to speculate about the remote implications of their work. Others inflate their expertise and take advantage of the gullibility of susceptible reporters. Human frailty makes them happy when their accomplishments are publicized but indignant when investigative efforts cast their behavior or that of their institutions in an unfavorable light.

For their part, journalists are constantly on the scent of scoops and exposés and just as constantly confronted by imminent deadlines. They cannot always take the time to investigate a development in science thoroughly or to present it with all the qualifications that may be necessary. In order to obtain information quickly, and to make it seem credible, they are tempted to rely on those Rae Goodell has called the "visible scientists," whose names are well known but who may not be the most expert sources. Even when they take pains to tell a scientific story properly, their work is at the mercy of editors who may be more concerned with the span of attention of the average reader or viewer and who may "slug" the story with a sensational headline that "sells newspapers" or raises ratings. In the wake of Vietnam and Watergate, journalists have tended to become especially skeptical, even adversarial, toward all authority. Some who view science as the last of the sacred cows to be left unmolested take particular delight in finding conflict, suppression, scandal, and petty foibles in the ranks of "pure" science.

As evidence of the shoddy treatment of scientific subjects, Goodfield cites two cases in particular. One concerns the allegation of the falsification of research data by an investigator at the Memorial Sloan-Kettering Institute who 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,