and the role of density-dependent processes, by C. B. Huffaker and P. S. Messenger. Then Doutt and DeBach discuss some much debated questions dealing with biological control—on population equilibria; the effects of attacks by more than one parasite in individual hosts, and on parasites by hyperparasites; the relative value of parasites and predators; the sequence theory; the island theory; the influence of different types of environment on the chances of success, and so on. They have skilfully fitted into 24 pages the essential facts and views, and their own conclusions, apparently without serious omissions. In Section 3, Doutt and K. S. Hagen deal with the biology of natural enemies (100 pages), and E. I. Schlinger and Doutt discuss systematics in relation to biological control, beginning with theory and concluding with keys to families of entomophagous insects.

The fourth section of 144 pages is in effect a detailed practical handbook by six of the authors on the methods of collection, maintenance, release and recovery of entomophagous insects, illustrated with photographs of insectaries and equipment.

In the fifth section, of 83 pages, five authors describe methods of enhancing the effectiveness of parasites and predators by such measures as the introduction of supplementary hosts or food and the modification of the environment, and discuss the integration of chemical and biological control. In Section 6 (113 pages), E. A. Steinhaus deals with microbial diseases of insects, Y. Tanada with their epizootiology, and M. E. Martignoni and I. M. Hall with their mass production and use in control. In Section 7, of 40 pages, Huffaker outlines the fundamentals of the biological control of weeds, and J. K. Holloway describes the success in various countries of measures to control 13 major weeds by the introduction of insects. In a concluding section of similar length, DeBach lists over 200 cases of biological control (of insect pests) rated as completely, substantially or as partly successful, and discusses present trends and future possibilities.

There is a bibliography of more than 2,500 titles, extending to mid-1961, and an index to species. The book is compact and well produced; the numerous illustrations are on the whole effective, although a few of the half-tone pictures are too small and some of the line drawings are poorly reproduced.

Hitherto the standard work in English has been H. L. Sweetman's *The Principles of Biological Control* (revised 1958). The plans of the two books are somewhat similar, but Sweetman's is much shorter (and may still be preferred as a text for students). *Biological Control of Insects and Weeds* is more comprehensive, more authoritative and more up to date, and presents the subject more adequately in its theoretical setting. It will no doubt be the definitive work for many years to come.

M. E. SOLOMON

SCIENTIFIC AND PHILOSOPHICAL UNCERTAINTY

Scientific Uncertainty, and Information

By Prof. Leon Brillouin. Pp. xiv + 164. (New York: Academic Press, Inc.; London: Academic Press, Inc. (London), Ltd., 1964.) 52*s*.

OUR knowledge of the world is inevitably imprecise and uncertain. In his latest book, Prof. Brillouin stresses, illustrates, and draws rather far-reaching consequences from this fact. His stress on the importance and inevitableness of imprecision is very welcome. Experimental error has too often been discounted as a tiresome but trivial excrescence on the neat deductive structure of science. This has led, on one hand, to needless alarm at the appearance of theories incorporating imprecision and, on the other, to misguided attacks on the notion that scientific explanation is deductive. The second part of the book, "Uncertainty in Classical Mechanics", should help to dispel the former complaint. There is a valuable discussion and extension of Poincaré's theorem. Several examples are given of instability, and especially of discontinuities of prediction arising from infinitesimal changes in initial conditions. In all this the author gives due credit to Poincaré; he might have acknowledged his debt to Duhem's *The Aim and Structure of Physical Theory*, which also discusses the "mathematics of approximation" in some detail.

The first part, "Information and Uncertainty in Science", which strays into philosophy, is not nearly so good. Here Duhem not merely forestalls (by nearly fifty years) but also far excels. It is a great pity that eminent scientists will not inform themselves about philosophy before pronouncing on it (and, of course, vice versa). The author's scientific insights are offset by a philosophical confusion which greatly diminishes the value of what might have been a major work in the philosophy of science. To start with, positivism is confused with solipsism: "A narrow positivism intended to limit each individual to the knowledge of his own sensations: other human beings around him appeared to him only as ghosts" (p. 47). This is just part of the more serious confusion about the existence of an external world: "The scientist should never confuse the actual outside world with his *self-invented physical world model*" (p. 51) . . . "The modern scientist must absolutely renounce the idea of a real objective world" (p. 52). Must the 'modern scientist' become a 'narrow positivist'? If there is no 'actual outside' (='real objective'?) world, how does the scientist's confusion arise? On p. 50, Planck is represented as saying: "This world is not directly accessible to us". Three lines below, this is referred to with the remark: "what is the use of speaking of an inaccessible world?"—which is scarcely a faithful reproduction.

A corollary of the author's confusion about reality is his equivocal attitude to fact and theory. In the introduction, the assertion: "We select experimental results that appear to us as logically connected together, and we ignore many facts that do not fit into our 'logic' ", is immediately followed by the scarcely compatible assertion: ". . . a *theory* may be discarded, while *facts* remain . . . and the connexions (between the facts) will be maintained in a different theory". In what sense do facts 'remain' if we are free (to an extent) to ignore those which the new theory does not explain? This is a serious problem, but oscillating between contradictory answers is no way to deal with it. This uncertainty pervades the whole book: warnings of the temporary, relative, corrigible nature of theories are interspersed with passages in which consequences of quantum and information theories are presented as facts about the world.

One particular consequence is made a great deal too much of, namely the "interaction between observer and the observed element" (p. 52). In the first place, the author seems to suppose that pointing out that "the *interaction is finite*" refutes what "was currently assumed, that this interaction could be made very small and negligible" (p. 52). In the second place, he confuses this with the impossibility of making precise predictions. But it does not follow that because an observer interacts with what he observes he cannot know the effect of his observation and hence compute both what the future will be and what it would have been if he had not made the observation. Given some present-day theory, it may follow; but I take the author to be making a quite general point.

Of the other topics dealt with, there is space only to record further confusion about causality, determinism and the arrow of time, and an appalling looseness in applying the concepts of information and probability.

D. H. MELLOR