tronics. Although an information theory of quantum mechanical channels is *not* presented, the theoretical foundation for such a theory may well be contained in Takahasi's stimulating paper.

As indicated by the above discussion, this volume contains a wide variety of material, some of which was interesting and stimulating, and some of which fell far short of expectations. I expect that most readers will have similar mixed feelings.

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History of Science

Michael Faraday. A biography. L. Pearce Williams. Basic Books, New York, 1965. 547 pp. Illus. $12.50.

It is indeed unfortunate that this extremely readable and comprehensive biography, obviously the product of painstaking scholarship, should have its many virtues seriously jeopardized by the basic point of view from which it was written.

The following items suggest the positive accomplishments and characteristics of the biography. First, Williams has attempted to consider essentially the whole scope of Faraday's investigations and to place them within their scientific context. Second, he has selected creatively from a diversity of primary sources including published and unpublished notes, notebooks, letters, diaries, and journals, as well as *Faraday's Diary* and the published papers of Faraday and other investigators. Third, the biography makes liberal and effective use of long citations from the primary sources. Fourth, Williams has been able, frequently, to succinctly and clearly present a complex situation in either Faraday's personal life or his experimental work by developing a skillfully chosen representative aspect of the situation. In short, Williams has written some very good history in these instances. Fifth, he has forcefully conveyed Faraday's profound commitment to the idea of the "convertibility of forces."

In tracing Faraday's theoretical achievements, Williams has attempted a grandiose synthesis. Thus, he insists on a single, hidden basis for essentially all of Faraday's theory construction during his most productive 25-year period. Williams states (pp. 77–78) that "Although he did not publicly announce his commitment to the [Boscovich] theory of point atoms until 1844, Faraday worked within this framework from his earliest productive years." Subsequently Faraday's acceptance of Boscovich's theory is dated at 1823 (probably), his commitment to it at 1826, and the early indications of his break with it at about 1848. In presenting the theoretical component of a number of Faraday's contemporaneous investigations, Williams implies, without convincing demonstration, that to make a given investigation intelligible it is *necessary* to accept Faraday's commitment to Boscovich's theory. Each of these presentations follows an exceedingly simple pattern. By conjecture Williams depicts Faraday as (i) basing his reasoning, more or less directly, on Boscovich's "point atomism," (ii) developing a clear set of concepts which, then, (iii) suggest an experimental confirmation.

Williams's rich and provocative consideration of the discovery of electromagnetic induction exemplifies several of the above comments. In his view (p. 161), Faraday used Ampère's ideas as a touchstone in such manner that "his concepts became clearer and clearer until he was led by them to the discovery of electromagnetic induction." By plausible reasoning which is grounded, ultimately, in Boscovich's "point atomism" and which, admittedly, "contains a good deal more conjecture than is desirable" (p. 169), Williams represents Faraday as *expecting* those two transient pulses, the detection of which constitutes his discovery. However, the relevant published literature suggests that the transciency surprised Faraday and that he subsequently invented his undetected "electro-tonic state" as a steady interpulse "response" thus eliminating the transiency. The other instances of Williams's contention of Faraday's adherence to Boscovich's "point atoms" are similarly not indispensable.

It thus remains useful to consider Faraday as having been openly committed to general qualitative ideas, such as the "convertibility of forces," and further to study the clarification of his concepts as occurring *with* his experimental results and not necessarily as a prior condition for them.

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Theology and Social Progress: A Cargo Cult

Road Belong Cargo. A study of the Cargo Movement in the southern Madang District, New Guinea. Peter Lawrence. Humanities Press, New York, 1964. xviii + 291 pp. Illus. $6.50.

The cargo cults that have swept the area of Melanesia for the past several generations have been, since World War II, of increasing interest to scholars and public administrators. They are perhaps the most gaudy of all the varieties of revitalization movements that spring up, characteristically, among peoples who have lost faith in their own old traditions. Such intensively emotional movements as these, in the remaining colonial areas of the world, in the independent but underdeveloped countries, and among the underprivileged in advanced countries, are of considerable importance to all concerned with policy and the application of policy in foreign and domestic affairs, for they are the milieu in which intergroup relations must be carried on.

The cargo cults and related movements of Melanesia have been the subject of several excellent recent studies, some of them already reviewed in the pages of *Science*: Margaret Mead's *New Lives For Old* and Theodore Schwartz's *Paliau Movement*, which are intensive studies of a single movement; P. M. Worsley's survey, *The Trumpet Shall Sound*; and several others. Peter Lawrence's book *Road Belong Cargo* is a welcome addition to this library, for it combines intensive field study of the cults of a region with careful attention to historical process. Lawrence spent about three years in the field in the Madang area of the Trust Territory of New Guinea, studying not just a single tribal group but a region. The historical and regional survey aspects of the study are important, for, now that there are numerous examples of individual movements in particular tribes, it is important to proceed to an understanding of how the endemic cargo idea spreads and evolves in a whole area, with movements flaring

up now and then in particular localities. Lawrence is able to outline the five major stages in the evolution of the cargo belief in this region and to relate the theological features of each stage to indigenous pagan and to imported Christian doctrines. In his view, this structure of cargo belief is now a principal inhibitor of modernization among native peoples in New Guinea.

Lawrence in conclusion to this carefully documented study has some remarks (pp. 271–73) of relevance not only to the Australian administration of New Guinea, which he directly addresses, but also to Americans involved in the difficult business of combating heresy and introducing social reform in other countries:

> . . . it is useless to pour in 'aid' from air-conditioned offices without going outside to discover and take into account the people's own ideology and their likely reactions to what is being offered them . . . we must acknowledge and respect cargo ideology as a carefully integrated intellectual system which, as has been shown by its persistence over eighty years, is extremely durable.

But Lawrence at last concludes that it is necessary to "attack" the cargo ideology, albeit in a sophisticated way, by introducing "radical change in the economic field." Yet such change is the goal itself; cargo belief is instrumental, either negatively or positively, toward this end. Might it not be wiser, even if more trying, to work with it, to nurture it, to feed it, and to let more highly developed institutions grow from the cargo belief? A manifest aim of the cargo rituals is, in fact, precisely the achievement of "radical change in the economic field," and if the cargo movement does not depend on Western support, it will find that support in other parts of the world. The mere fact that the theology is bizarre does not mean that it cannot support a sophisticated technology and effective social institutions. Japanese political theology has sometimes appeared to be unreasonable, in Western eyes, but it did not inconvenience an extremely successful industrialization process; and today even some Western economists might take issue with Calvinist theology as being a trifle bizarre, yet by encouraging enterprise it contributed to the industrialization of Europe and America.

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Domesticated Plants and Evolution

Essays on Crop Plant Evolution. Sir Joseph Hutchinson, Ed. Cambridge University Press, New York, 1965. viii + 204 pp. Illus. $9.50.

Crop plant evolution is one of the most complex and rewarding fields of study. For many years de Candolle's *Origin of Cultivated Plants* was the only important publication in the field. The reports of Vavilov and his associates in the 1930's, on the kinds of cultivated plants and their wild relatives in many parts of the world, stimulated studies, and much work has since appeared in scattered publications. These essays, based on a series of lectures, summarize the recent research on origins and evolution of some important crop plants.

In the first chapter H. Godwin explains how pollen analysis provides evidence for prehistoric changes caused by man in the natural vegetation. Such evidence indicates that agriculture reached northwestern Europe about 3000 B.C., some 4000 years after it was practiced in Iraq and Iran.

Summaries of the archeological, cytological, genetical, and taxonomic evidence on the evolution of maize, wheat, barley, oats, rye, sorghum, potatoes, and forage crops condense essential data and studies on their evolution. Although the patterns of evolution differ, some striking similarities are revealed. Man's care and transport of cultivated plants and the continuing contact between crop plants and their wild relatives are shown to be important in the development of most of our domesticates.

Most food crops have been cultivated for centuries, but, with few exceptions, the deliberate cultivation of forage grasses and legumes has developed in comparatively recent historic times. J. C. Cooper has assembled data to show how these plants evolved under human selection, and he suggests how breeding might continue.

In the concluding chapter Hutchinson, the editor, points out that the rate of change in domesticated plants is greater than in any other group of plants. The vast resources of wild and cultivated plant materials we now have are material for changes "as great and significant for human welfare as those that have occurred in the past. Our limitations are the limitations of our scientific insight and imagination, rather than of the biological material with which we work."

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University Reviews in Biology Series: Biochemistry

The Metabolism of Insects. Darcy Gilmour. Freeman, San Francisco, Calif., 1965. xii + 195 pp. Illus. Paper, $2.50.

Just as the tiniest insect contains within itself, in perfect proportion, all of its essential organ systems, so this small and convenient book has packed within it, in well-balanced fashion, all the facts and hypotheses essential to present-day understanding of insect metabolism.

The book opens with a thorough discussion of energy metabolism, the first chapter being devoted to mechanisms of energy production, and the second, to those of energy utilization. These first two chapters set the tone of the entire work, which, while emphasizing the fundamental principle of biochemical unity, points out the fascinating biochemical diversity found among the insects. Thus, the wing muscles of insects that are capable of exceptionally rapid, vigorous flight are provided with giant mitochondria having a particularly efficient system for energy production. There follow chapters on carbohydrate and lipid metabolism; the metabolism of insecticides; the metabolism of amino acids; of purines, nucleic acids, pterins, and pyrroles; and of proteins; the final chapter is an up-to-date discussion of the control of metabolism. The chapter on lipid metabolism includes a most interesting section on hydrocarbons with special functions: the pheromones, those remarkable odors of communication, and the various defensive and aggressive secretions. The chapter on insecticides and their mode of action is of considerable general significance.