gation system, the ancestors of Ban Ping, who settled in their present habitat a century ago, were unusually blessed. Their small, communally produced rice surpluses were bartered in local markets for other foods and handicrafts. With the arrival of a railroad in Phayao in 1920, the cultivators of Ban Ping gained access to an insatiable cash rice market. Their response was to clear and claim new land resources—most of which was dependent upon flood water. By 1960, village farmers had tripled the hectarage of their original "great field."

Since 1953, exploitation of the cash market through cultivation of new lands by villagers has been facilitated by access to tractors that can be rented from nearby townsmen. Previously, the unirrigated fields were too difficult to plow, but heavy machinery renders them less labor-intensive than the older, irrigated rice fields. Beneath the apparent prosperity of Ban Ping, many institutional changes rooted in the shifting patterns of rice economics can be discerned. Among these are the increasing importance of purchased over inherited land, increasing reliance upon wage labor over exchange labor, and increasing dependence upon resources (tractors, markets, government officials) beyond community control.

But the people of Ban Ping are a transitional peasantry. Their entry into commerce is incomplete. They conceptually separate their lands into those which produce "eating rice" and those which produce "private rice," and only the private rice is for sale. The two sets of fields are spatially discrete, and separate use patterns pertain to each. The "subsistence" fields are farmed cooperatively by family members and neighbors. The "private" fields are farmed commercially with rented tractors and imported labor from remote locations. However, over recent decades, the private fields have tended to become of increasing concern to the villagers, while obligations to the subsistence fields—such as those for maintenance of the communal irrigation system—are met with increasing resentment.

Obviously, the rice farmer of Ban Ping must make decisions regarding the allocation of scarce resources among his separate fields. It is in delineating the factors that enter into these choices, and the manner in which the rice farmer assesses them, that Moerman has made his major contribution. For he succeeds in convincing us that the peasant cultivator in Ban Ping is not blindly following tradition, but is rationally, with the information-gathering techniques at his disposal, selecting and combining his limited opportunities.

The cumulative impact of shifts in peasant choice operates to produce agricultural change. However, Moerman adds a point in conclusion which, while consistent with an ethnoscientific point of view, finds less favor with this reviewer: "Economic change occurs with the appearance of new standards for making economic decisions and not, as with Ban Ping's tractor, when the outcomes of decisions merely take a modified distribution" (p. 387). This implies that a change in peasant values must precede a change in community structure. But economic change in Ban Ping preserves the adaptive balance between the village, its physical environment, and its social environment of extracommunity relations. Shifts in this adaptive pattern are signaled by modifications in the distributions of decisions made by the village farmers. Community structure may sustain irrevocable change without a prior change in community standards. The tractor may revolutionize agriculture in Ban Ping, and with it the life of the community. The villagers need not *like* the tractor before this can happen.

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Morphogenesis and the Progress of Botany

Essays on Form in Plants. C. W. WARDLAW. Manchester University Press, Manchester, England; Barnes and Noble, New York, 1968. xiv + 399 pp., illus. $8.75.

Throughout a distinguished career devoted to plant morphogenesis, C. W. Wardlaw has frequently taken time out from (perhaps time within would be more apt) his specific investigations to reflect upon the wider significance of recent developments in the biological sciences and to comment upon the present direction of botanical research and the direction which, in his view, it ought to be taking. In his research papers, in his books, and in lectures and essays devoted specifically to these reflections, he has stressed the importance of organization and pattern in organisms as the central question for biologists. At the same time he has urged the unification and integration of diverse fields of botany in an assault upon this problem and warned that unless the attack is channeled along avenues of sound and perceptive scholarship it will inevitably be repulsed by the complexity of organismal phenomena. It is his contention, moreover, that the study of morphogenesis, the development of form, is, by its nature, the logical discipline to draw together the diverse fields of botany, the structural and the functional, the phylogenetic and the genetic, indeed even the systematic, along with biochemistry and biophysics, which are all ultimately concerned with organization but have struggled with it in relative isolation.

This, in a few words, sets forth the theme of *Essays on Form in Plants*, a collection of 30 previously published papers selected by the author to illustrate, as he says, something of the progress in his general experience and thinking which went on as an integral part of his experimental investigations, and accompanied by an introduction and a concluding essay on "Perspectives in morphogenesis" written for this volume. The collection in no sense represents a cross section of the author's scholarly work. The research papers which have been included are several in which a new approach or a new concept is tested for the first time; for example "Phyllotaxis and organogenesis in ferns" [first published in *Nature*, vol. 161, p. 167 (1949)], in which the concept of growth centers and fields as applied to phyllotaxis was explored experimentally. For the most part, however, the essays are reviews, commentaries, and book reviews in which the emphasis is upon synthesis, evaluation, and criticism. Readers will be pleased to find two articles dealing with Turing's diffusion-reaction theory of morphogenesis and will certainly benefit from "Process and record: aspects of botanical science," a little-known article which analyzes the decline of comparative morphology but points to a hopeful future for morphology if investigation of it is pursued along developmental lines as a synthetic approach to evolution.

This volume is a valuable addition to the literature of the biological sciences. Wardlaw's sense of, and knowledge of, the historical adds interest and authority to his predictions and recommendations for the future development of plant science. For those who appreciate the

philosophical approach to science, it will not be necessary to commend this book. For those who do not, or think that they do not, it will certainly be profitable to give an articulate proponent of this point of view a sympathetic hearing. For all, it will be an illuminating self-revelation of one scholar's intellectual progress.

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Microbiologist

Scientific Contributions of Selman A. Waksman. Selected Articles Published in Honor of His 80th Birthday, 22 July 1968. H. BOYD WOODRUFF, Ed. Rutgers University Press, New Brunswick, N.J., 1968. xxii + 392 pp., illus. $15.

The scientific career of Selman A. Waksman, Nobel Laureate in Physiology or Medicine in 1952, is a classic version of the American dream of the poor boy who makes good by fulfilling the Calvinistic ethic of hard work. His story is made even more American because he came to this country as a young lad to escape the hazards and difficulties for Jews of life in Czarist Russia. His 80th birthday festschrift, edited by one of the closest of his former students, is devoted principally to the reprinting of selected articles on the many subjects in microbiology on which Waksman and his students worked: soil microbiology, in which he became the principal American authority; microbial enzymology and physiology, which he helped launch as sciences; sulfur bacteria; marine microbiology; taxonomy; and last, antibiotics, where his studies on isolation and characterization culminated in the discovery of streptomycin and the Nobel award.

The book is well illustrated both with plates from the representative published works and with photographs of Waksman, his colleagues, and his students. Particularly enjoyable reading is the tribute by Boyd Woodruff, summarizing Waksman's career and describing with sensitivity the warm personal qualities which have made him such an inspiring mentor to his students.

This volume should be of value in department libraries for the benefit of the current generation of graduate students in microbiology.

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Neural Function and Evolution

Primitive Nervous Systems. THOMAS L. LENTZ. Yale University Press, New Haven, Conn., 1968. xii + 148 pp., illus. $7.50.

It is now 50 years since the publication of G. H. Parker's *The Elementary Nervous System.* In that influential book Parker developed a coherent account of the evolutionary origin of nervous systems, based on his own experimental observations with lower invertebrates and the neurohistology available at that time. In the years since Parker's book appeared a number of workers, especially those who have concerned themselves with lower invertebrates, have proposed modifications of his ideas. The most recent of these is Lentz.

Lentz's account is a short book, shorter than its pagination indicates since nearly half of its pages (68 out of 148) are occupied by figures and facing pages, indices, and an extensive bibliography. The introductory chapter reviews theories on the origin of nervous systems. This is followed by a description of the behavioral physiology and neuronal organization of sponges, hydra, and flatworms. The emphasis here is on results from electron microscopy and histochemistry, areas in which Lentz has made valuable contributions. The structure and ultrastructure of the animals considered are illustrated with drawings of exceptional clarity. The final chapter is a speculative treatment of the origin of nerve cells. Lentz suggests that the primitive nerve cell was a secretory cell which released biologically active material in response to stimuli. It is proposed that the product of such cells modulated the activity of otherwise independent effectors. Neurons as they are found today resulted from specialization of receptive, conductile, and secretory processes in these cells. Unfortunately the arguments presented for this view are not very compelling, principally because of limitations in the kinds of animals Lentz has chosen to consider. Sponges, hydra, and flatworms are rather poor material on which to base a theory on the functional evolution of nervous systems since so little is known about neural function in each. There is considerable doubt as to whether sponges have nerve cells at all. Nothing in their behavior suggests the kind of neural coordination characteristic of higher animals. Hydras clearly do have nerve cells, but because of the probable occurrence of both nervous and nonnervous conducting mechanisms the role of the nervous system in determining their behavior is uncertain. In fact, with hydras the evidence is better for the participation of the nervous system in growth and regeneration than it is for its involvement in any particular behavioral act. Among cnidarians the structure and function of the nervous system are better known in anemones and scyphomedusae than in hydras, but these organisms are barely mentioned by Lentz. Although flatworms are now widely used in learning research they are not very encouraging material for electrophysiological methods and have been scarcely touched by modern techniques. Finally, the total neglect of ctenophores, strategically placed in terms of complexity between the cnidarians and the flatworms, is a serious omission.

This book will serve as a source of information on neurochemistry and ultrastructure in some lower invertebrates, but because of these limitations it will probably have little impact on contemporary thought about the early evolution of nervous systems.

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The Concept of the Atom

Atoms and Elements. A Study of Theories of Matter in England in the Nineteenth Century. DAVID M. KNIGHT. Hutchinson, London, 1967, 30s; Hillary House, New York, 1969, $4.50. vi + 168 pp., illus. The History of Scientific Ideas.

A critical history of atomism is one of the most important tasks of the history of science, whatever one's philosophical point of view may be. Together with Lasswitz's great work, Kargon's study of 17th-century atomism, and Thackray's investigations of 18th-century theory of matter (in preparation), David Knight's book completes the chain up to 1870. It is thus a work of first importance.

Atoms and Elements reviews briefly the traditions ruling in 1800: corpuscularean Newtonianism, chemical Newtonianism (theory of affinities), and Boscovichean theory of matter. The author considers Boscovich an anti-Newtonian, and an early field physicist, whose influence on both Davy and Faraday is beyond doubt. The Eulerian theory of matter, and Euler's most important disciple in England, Thomas Young, whose work initiated the far-reaching