

Symbioses

Lichenology. Progress and Problems. Proceedings of a symposium, Bristol, England, April 1974. D. H. BROWN, D. L. HAWKSWORTH, and R. H. BAILEY, Eds. Published for the Systematics Association and the British Lichen Society by Academic Press, New York, 1976. xii, 554 pp., illus. + plates. \$48.25. Systematics Association Special Volume No. 8.

Lichens have long been the models of symbiosis. They are one of the most successful of the different types of symbiotic associations, but they have also been one of the most difficult to work with experimentally. New techniques of investigation and increased field studies have advanced our knowledge of them greatly. This book describes the progress that has been made and strongly projects the present vitality of the field.

The book consists of 20 chapters ranging from research papers to review articles. There are 10 chapters on different aspects of lichen ecology, most emphasizing British lichens, and chapters on ultrastructure, developmental morphology, and algal taxonomy.

The chapters on lichen physiology are informative but often overly conjectural. Farrar presents a novel picture of the lichen as a miniature ecosystem and introduces the concept of "physiological buffering" to explain how lichens withstand extreme environmental stresses.

Hawksworth gives an excellent treatment of the controversial subject of lichen chemotaxonomy and presents a sensible, broad-based taxonomic scheme that takes into account both chemical and morphological traits.

The most provocative chapter is that by James and Henssen on the significance of cephalodia. The authors challenge the assumption on which every scheme of lichen classification is based, namely that every lichen has a different fungal member. They present morphological evidence that in some lichen families one fungal symbiont can form two different, independent lichens. Which lichen is formed depends on whether the fungus associates with a green or with a blue-green alga. The claims of the authors notwithstanding, their evidence is not conclusive. The authors have not witnessed the beginnings of some of their morphotypes and thus cannot exclude the possibility that what they consider to have been free-living algae when captured by one lichen fungus contained fragments of another lichen fungus. Moreover, in other lichens there is evidence that different species of algae may be present in lichens that cannot be distinguished morphologically.

A theme of the book is that more effort should be devoted to experimental work in the laboratory in order to test the many hypotheses developed from field and morphological studies.

It was the editors' intent that this book should reflect the current style of lichen research and reveal insufficiently explored areas and specific problems that remain to be solved. The book serves these purposes well.

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Biological Assimilation of N₂

Symbiotic Nitrogen Fixation in Plants. Papers from a meeting, Edinburgh, Sept. 1973. P. S. NUTMAN, Ed. Cambridge University Press, New York, 1976. xxviii, 584 pp., illus. \$55. International Biological Programme 7.

The recent rapid rise in the price of fertilizers, associated with the rise in the price of petroleum, has brought the need for available soil nitrogen for food production into sharp focus once again. This need has existed in developing regions for more than the past few years, and the increase in the price of fertilizers has merely highlighted the fact that synthetic nitrogen fertilizers are not used—whether because of cost or because of unavailability—by much of the earth's population.

Symbiotic nitrogen fixation has long been known as a means of introducing protein into the human food supply or into the feed of animals. This process was increasingly exploited for the first four decades of the 20th century, and its exploitation was accompanied by interest in it on the part of microbiologists, soil and crop scientists, plant physiologists, and biochemists. Eventually, however, the availability of fertilizers in large amounts and at low cost in North America, Western Europe, and Japan and the lack of suitable biochemical, physiological, and ecological techniques resulted in a decline in both exploitation of and scientific interest in the legume-*Rhizobium* symbiosis. Fortunately, the increasing concern with fertilizer cost and the energy input for fertilizer nitrogen production has been accompanied by other events that have helped lead biological scientists to return to nitrogen fixation: the introduction of the acetylene-reduction technique, the development of genetic and ecological procedures for study of the root-nodule bacteria, and

possibly even the development of some sense of social responsibility on the part of a segment of the biological community. Simultaneously, it has become more widely recognized that nitrogen fixation by effectively nodulated legumes is a practical and immediately usable means to help provide adequate nutrition for many people in the tropics.

One of the striking outcomes of the International Biological Program has been the fostering of research on nitrogen fixation. By the initiation or promotion of cooperative research activities and conferences, the coordination of culture collections, the publication of a manual of methods, and the development of professional linkages in this field, the IBP has catalyzed a burgeoning effort on nitrogen-assimilation processes. This volume is a collection of papers, most of which were presented at an IBP meeting in 1973. Unfortunately, much of the information in the book is now dated or will be less useful to professional workers in the field than if it had been made available sooner.

The 40 papers fall naturally into five groups: genetic aspects, legume inoculant technology, field experiments on nitrogen fixation, environmental factors affecting the legume-bacterial symbiosis, and nitrogen-fixing symbioses in non-legumes. The papers range from the exciting to the pedestrian, the original to the routine, the esoteric to the practical. The picture that emerges, however, is of a field advancing on many fronts. Unfortunately, the ecology of *Rhizobium* and of legumes, the taxonomy of the micro-symbionts, and the biochemistry of the symbiosis are all but ignored. Many of the information gaps having to do with the biochemistry are now being closed, but the ecological and the taxonomic aspects have yet to be subjects of extensive inquiry. Of far greater importance, however, is the paucity of papers from scientists in the developing countries, or even from scientists elsewhere who are concerned with problems of the developing nations. It is there that the human need for symbiotic nitrogen fixation is greatest. It is to be hoped that the impetus provided by books like this one, the IBP, and the current research in the temperate zone will stimulate work in the tropics so that the need for nitrogen in a form usable by humans and livestock can be met and the misery of human populations that continue to suffer from malnutrition can be overcome.

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