

hypotheses in the foreseeable future.

Obviously, the main empirical patterns which Cohen finds are only as good as the data on which they are based. Cohen himself is transparently honest about most of the weaknesses in his data, in the second part of chapter seven. There is no need to repeat them here. He also has some extremely perceptive remarks to make about data collection, and if the book does no more than encourage field biologists to collect new data on food webs that are specifically designed for and directed towards testing Cohen's hypotheses, it will have done a great service.

The main weakness in the data, however, is side-stepped by Cohen. In place of "species" he is often forced to use "kinds of organisms", and these may be very broad categories—for example, "spiders" feeding on "collembola" in Figure 1. Without wishing to nit-pick, there are actually rather a large number of species of collembola, and even more sorts of spiders even in the one Canadian willow forest to which this particular web refers, and they are not

usually trivial components of terrestrial ecosystems. Thus, properly constructed, this and I would guess most of the other food webs might look totally different. I do not know whether they would still be interval graphs, or how many of the other generalisations would still apply. This is decidedly not to say that Cohen should never have done the analysis in the first place. If ecologists always wait for perfect data nothing very interesting is going to get done. Nor will people ever suspect that there are theoretical problems worth solving with better data. But in this particular case we must definitely beware of the data, embrace the vision (Cohen claims that he got the idea in a dream), and take the book as a grand hypothesis. More than anything else, I hope that Cohen's contribution will stimulate others to look more seriously at the design of foodwebs.

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Utilising phosphate resources

Phosphorus in the Environment: Its Chemistry and Biochemistry. Ciba Foundation Symposium chaired by R. J. P. Williams. Pp. 320. (Elsevier: Amsterdam, 1978.) \$31.75; Dfl.72.60.

THIS symposium report contains 16 papers given by a diverse group of experts on the utilisation of the world's phosphate resources. The coverage is very wide; and chemical, biological, technical, ecological and economic factors are all discussed. Almost everything gets a mention: methods of birth control, water closets, marsh gas, nerve gas, toothpaste, detergents and even such mundane items as the current price of phosphate rock.

Although the pure chemistry content is somewhat limited, the book abounds with statistics, predictions and speculations about the future of mankind and how it will be linked to the availability of phosphorus. Reserves, consumption and the eventual fate of the element as utilised by man are critically discussed at some length.

Not unnaturally, there are differences of viewpoint and some contradictions in the data supplied by different authors. The symposium, nevertheless, makes a serious, valuable and timely contribution to its subject. Individual papers are of a high standard and the discussions are particularly informative.

An obvious message emerging from the symposium is that fertilisers will always constitute the most important

use for the element, and if a rapidly expanding world population is to be fed, the conservation of phosphate supplies is already a matter requiring serious attention.

Phosphates are not in themselves harmful to life, and pollution problems arising from their use are local, often controllable, and are probably somewhat overrated.

With perhaps as much as three-quarters of the world's phosphate reserves lying in Arab countries, these reserves will undoubtedly, in the long

term, prove to be their most valuable asset. Unlike oil, which can be replaced by alternative energy sources, phosphorus is irreplaceable in life systems.

It is pointed out that the complete natural cycle of phosphorus, unlike those of other major life elements, probably extends over many millions of years. This may be associated with a natural depletion of dry-land deposits and a temporary build-up of phosphate on the ocean floor. It is argued by some that the sudden and rapid exploitation of phosphorus compounds during the past 100 years, and the continued increase in their rate of consumption, will in a century or so lead to exhaustion of dry-land phosphate rock supplies.

It would therefore seem prudent not to worry unduly about detergents, but rather to concentrate on improving the present low efficiency of uptake of phosphorus from soils. This might be done, either by modification of existing fertilisers and soil systems, or by genetic engineering of suitable new plant species.

The eventual exhaustion of dry-land deposits, if this is to be believed, may one day necessitate direct sea-bed phosphate mining. Alternatively it may be possible to obtain food from suitable sea plants which could utilise phosphate directly from the ocean.

This is not a book for a newcomer, but it should appeal to all those with some previous knowledge of the subject who have wide interests in phosphorus science.

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Microbial growth in extreme conditions

Microbial Life in Extreme Environments. Edited by D. J. Kushner. Pp. 465. (Academic: London and New York, 1978.) \$40.50; £19.60.

THIS book needed to be written in view of the increasing significance of microbial growth in extreme conditions. The extreme environmental conditions chosen are principally physical ones: extremes of temperature, pressure, pH value, water and salt activities and radiation. Heavy metal toxicities are also included. This selection may be considered rather arbitrary, as it excludes the class of extreme environments caused by deficiencies of nutrients—for example, the trace elements, although excess of these elements is dealt with under toxicities.

A great interest of extreme environments is that the description of their effects may throw light on the effects of the normal or non-extreme environ-

mental conditions. The special adaptations revealed may suggest possible new technological applications of the microbes. However, the main motivation of these studies has been to explain microbial ecology.

Many of the articles tend to be catalogues of facts which are useful for reference but not compelling reading. Also there is much turgid description of effects due partly to a lack of use of the quantitative parameters of growth such as specific growth rate and lag period.

The state of knowledge in the field seems to be in an early descriptive phase. The development of general explanatory principles will require much more study in depth of the problems from a whole organism viewpoint as well as molecular study. The reader will find in this work the growing points of the subject as well as a valuable reference source.

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