Book Reviews

Reticulate Evolution

Evolution in the Microbial World. Proceedings of a symposium, London, April 1974. Published for the Society for General Microbiology by Cambridge University Press, New York, 1974. x, 430 pp., illus. $22.50.

In this symposium the contributors have been given space to develop ideas and pull together information in a way not possible within the confines of research papers, and most of them have availed themselves of this opportunity.

Perhaps the dominant theme that emerges is how different the evolution of microbes is from that of higher organisms. The latter have evolved through a series of branches, most of which come to a dead end but all of which are theoretically traceable to a common ancestor. There is a much more anarchic arrangement among the bacteria and viruses, which blithely exchange genetic information with each other and with their hosts to such an extent that a conventional unraveling of their relationships becomes almost impossible.

This problem of reticulate evolution is considered from a theoretical standpoint by P. H. A. Sneath in the first paper. He shows how different matrices constructed between two characters measured in the same group of organisms may reveal sudden discontinuities brought about by gene exchange in one set that was not paralleled by gene exchange in the other. So far, alas, this approach has not turned up such discontinuities in practice, but this seems to be due to a paucity of information. As more amino acid sequences become available, it may prove to have wide applicability.

The extent of genetic exchange is undoubted. M. H. Richmond and B. Wiedeman document the rapid spread and recombination of plasmids from one bacterial genus to another—in cultures, in human volunteers, and in populations of hospitalized humans who served as unwitting culture flasks for resourceful pathogens. B. S. Hartley, in discussing enzyme families, recounts the story of two serine proteases found in the bacterium *Streptomyces griseus,* one bacterial in character and the other showing a remarkably high amino acid sequence homology with bovine trypsin. Was, as Hartley suggests, this bacterium infected by a cow?

Further down the scale of complexity, J. H. Subak-Sharpe and his colleagues review the remarkable series of homologies between viruses and their hosts turned up by nearest-neighbor DNA analysis. (This technique determines the frequencies of different pairs of bases adjacent to each other on the DNA backbone; such sets of frequencies are often characteristic for a group of organisms.) The smaller the virus, the more closely its DNA resembles that of its host. These authors give some hope that nearest-neighbor analysis can be extended to the next base down the line, with a corresponding increase in sensitivity.

The recent evolution of influenza viruses, reviewed by J. J. Skehel, again provides evidence for the unceasing interchange of genetic information. Recombinants between fowl plague virus and turkey influenza virus were found after an experimental turkey flock was infected by both. The likelihood that similar recombinations are responsible for the sudden appearance of new infective strains of flu virus seems high, particularly in view of the evidence that there are a number of amino acid differences in the hemagglutinins of different pandemic strains. Until complete sequences are available, however, Skehel cautions that these differences may be artifactual, perhaps due to different cleavage points of the hemagglutinin precursor in different strains.

In view of all this information on genetic exchange, perhaps the toughest nut for the evolutionist to crack is where the viruses came from. W. K. Joklik makes a game attempt, setting forth the multifarious properties of viruses and making a convincing case for the independent origin of many of the more than 30 virus groups. At one point, however, he relies on an argument that is essentially the same as one put forth by the antievolutionist Creation Research Society in its criticism of current interpretations of the fossil record. If viruses had a common origin, Joklik points out, then one would expect to see intermediates between the various morphological forms. No such intermediates have been found. The immediate reaction of this reviewer is that such reasoning is suspect!

There is not room here to mention all the other interesting aspects of microbial evolution covered in the symposium. Another major theme is the manipulation of evolutionary forces in the laboratory. H. E. Kubitschek gives an excellent capsule summary of the dynamics of chemostats, devices for the continuous cultivation of microorganisms. He points out that under these artificial conditions a number of selectively neutral or nearly neutral genes can be pulled rapidly to fixation in the population by a single advantageous one. He uses this "periodic selection" argument to discount in advance recent reports of low amounts of enzyme variation in *Escherichia coli* from many parts of the world. If the variants were selectively neutral, one might expect many more to be present, but Kubitschek points out that if neutral genes are rapidly dragged to fixation they might not show up as variants. It seems likely to this reviewer, however, that periodic selection would pull different neutral genes to fixation in different *E. coli* populations, something that has not been found. It appears that the world is not one big chemostat for *E. coli*—at least not yet.

Hartley and P. H. Clarke deal with the evolution of enzymes in the laboratory. Hartley's experiments with the gradual acquisition of the ability of *Klebsiella aerogenes* to utilize xylitol rather than ribitol are of interest because they seem to illustrate a situation of "you can't get there from here." Under normal conditions, the ribitol dehydrogenase of his strains oxidizes xylitol very slowly. The first response of *Klebsiella* fed xylitol in the chemostat is to make more ribitol dehydrogenase, almost certainly through a process of gene duplication. The only way in which a mutant with altered substrate specificity could be produced was with heavy mutagenesis with nitrosoguanidine, presumably enough to make more than one amino acid alteration. It appears that multiple changes are necessary in order to produce an enzyme that (i) has a higher specific activity for xylitol and (ii) has enough activity to allow strains carrying it to outcompete the wild-type strain. These experiments are an illustration of the difficulties in the way of tailoring enzymes to order by harnessing selection. While mutants are easily produced, the small refinements that result in an efficient enzyme are likely to be selected for very slowly, especially if the refinements give a very slight advantage. To give an example calculated from the formulas of Kubitschek: in a chemostat with a total population of 10^{10} cells in which 25 percent of the medium is replaced each hour, it will take a mutant with a 10 percent growth advantage almost 40 days to reach the point where it makes up half the population (the changeover time). A mutant with only a 1 percent advantage, which is in the range often dealt with by population geneticists, will take well over a year.

This informative symposium is disappointing primarily in not having more on the manipulation of the microbial genotype by the remarkably precise bacterial restriction enzymes and other tools of the molecular biologist. These allow one virtually to stitch and sew a chromosome to order. In view of the recent concern on the part of many molecular biologists about the consequences of such manipulations, such a discussion would have been timely and suitable.

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Natural History of Islands

Island Biology. SHERWIN CARLQUIST. Illustrated by Sherwin Carlquist and Michael J. Cole. Columbia University Press, New York, 1974. xii, 660 pp. $25.

Remote islands fascinate us, whether we are romanticists or scientists or some combination of the two. Indeed, the peculiarities of terrestrial island life pose many puzzling problems for the biogeographer, the ecologist, the systematist, and the evolutionist. In particular, biological conditions on remote oceanic archipelagoes like Hawaii deviate sharply from most of those on the continents.

A founding propagule must somehow make its way across vast ocean distances; accordingly, chance strongly affects both arrival and establishment. The latter process, furthermore, requires genetic integration of the newcomer into a unique and often discordant ecosystem. Response to this new situation may take the form of an extraordinary multiplication of species and the evolution of adaptations that are new for the group. *Island Biology* deals with all these topics in a great variety of plants and animals on islands around the world.

Sherwin Carlquist is the author of two other books on the upland biology of islands, *Island Life* and *Hawaii: A Natural History* (Natural History Press, 1965 and 1970). Accordingly, some burden rests on the reviewer to relate the present book to these others. All three books center on the same phenomena. The first two are successful popularizations, with little documentation in the text. In *Hawaii*, the author produced a lavishly illustrated guide to the islands he knows best. The general principles advanced in *Island Life* are skillfully invested with Hawaiian examples.

The newest book is the most ambitious; it attempts to be a technical treatise of encyclopedic breadth. There is no accompanying major change from the other books in concept or content. Again, the author deals with plants, animals, anatomy, systematics, ecology, genetics, geography, and adaptations. Beyond all this, most of the islands of the world are at least mentioned, and he deals with islandlike areas on the Australian, African, and South American continents as well. The result this time around leaves something to be desired. The earlier books succeeded because of the need for communication of these scattered facts and concepts to a large audience, but the breadth of the material is so great that the author's attempts to deal with it in documented technical detail are only partly successful.

The book tries to do many difficult things. For example, 24 "principles" of island biology are announced in the first chapter. This is a bold attempt at integration of widely dispersed and somewhat disparate knowledge. The statements are challenging, provocative and in many cases speculative. Discussion of each principle is brief, however, and one is left with the feeling of unsatisfactory coverage of both the origins of the ideas and their present status.

Considerable attention is given to the important topic of long-distance dispersal of organisms. Here the author comes closest to a satisfactory treatment in depth. These chapters are elaborations of a series of five previously published technical papers. The author guides us through this material with a sure hand, but I was annoyed by some detailed repetitions of material. For example, eight of the photographs in *Island Biology* were also used both in *Hawaii* and in a technical article in the *Bulletin* of the Torrey Botanical Club, 1967. Indeed, the chapters tend to be almost separate articles, and repetition plagues the reader in other ways. Each chapter has its own reference list and many references are repeated within the book. *Island Life*, for example, is cited in 13 out of 15 of these lists.

The bulk of the book is given over to a description of "adaptive radiation" in various insular biotas. In these chapters, the author simply describes adaptive differences between related species within islands or island groups. He emphasizes his favorite material, the higher plants. Much of this discussion is little more than clever guesswork, the fascinating game that all observant naturalists play. Carlquist is very good at this game, but the reader longs for hard evidence among the hypotheses. The author is surely aware of this and indeed points out how little is known about insular biotas beyond the floristic and faunistic level. Perhaps it will be an important function of this book to stimulate interest in obtaining the evidence that is so badly needed.

Neither modern ecological theory nor genetical patterns of evolution are given much place in this book. The author frequently refers to the classical work of MacArthur and Wilson, but the discussions do not go very far. He falls into the old trap of wondering if something is due to drift or to selection. Of course it is the interaction of these processes that is important. He declares that "weedy immigrants would be expected to have the advantage of high mutability." There are no data which suggest that such variations in mutability occur. Vague phrases are often used, such as "evolutionarily upgrade" and "genetic momentum."

In his preface, the author suggests that he does not have to apologize for presenting materials that could be called "natural history." I heartily agree. While the book falls short of being a definitive treatise, large amounts of widely dispersed and valuable materials are compiled in it and future litera-