Book Reviews

Evolution: What Is Required of a Theory?

Mathematical Challenges to the Neo-Darwinian Interpretation of Evolution. A symposium, Philadelphia, April 1966. PAUL S. MOORHEAD and MARTIN M. KAPLAN, Eds. Wistar Institute Press, Philadelphia, 1967. xii + 140 pp., illus. Paper, $5. Wistar Institute Symposium Monograph No. 5.

The idea of this symposium is supposed to have originated from a discussion at two picnics in Switzerland, when four mathematicians, Schützenberger, Ulam, Weisskopf, and Eden, had a discussion with the biologists Kaplan and Koprowski on mathematical doubts concerning the Darwinian theory of evolution. After heated debates it was proposed "that a symposium be arranged to consider the points of dispute more systematically, and with a more powerful array of biologists who could function adequately in the universe of discourse inhabited by the mathematicians." During the course of the symposium further heat was generated.

It is not easy to summarize the case made by the mathematicians, which involves both the challenge that computer simulation of evolution shows evolutionary theory to be inadequate and a complaint that the biologist has not provided sufficient information for efficient computer simulation. Eden was particularly concerned with the element of randomness which is claimed to provide the mutational variation upon which evolution depends. "No currently existing formal language," he contends, "can tolerate random changes in the symbol sequences which express its sentences. Meaning is almost invariably destroyed. Any changes must be syntactically lawful ones." He therefore conjectures that "what one might call 'genetic grammaticality' has a deterministic explanation and does not owe its stability to selection pressure acting on random variation." He points out that attempts to provide for computer learning by random variation have been unsuccessful, and that an adequate theory of adaptive evolution would supply a computer programmer with a correct set of ground rules. Schützenberger takes a more extreme position. Arguing that all genetic information should consist of a rather limited set of words in an alphabet of 20-odd letters—in which evolution is typographical change—he finds a need for algorithms "in which the very concept of syntactic correctness has been incorporated." He compares this "syntactic topology" with the "phenotypic topology" of organisms as physical objects in space-time, and a major part of his challenge to neo-Darwinian theory is "the present lack of a conceivable mechanism which would insure within an interesting range the faintest amount of matching between the two . . . topologies." ". . . an entirely new set of rules is needed to obtain the sort of correspondence which is assumed to hold between neighbouring phenotypes. . . ."

A major part of the biologists' answer to this challenge was in the claim that the neo-Darwinian theory used in computer models, based on the Haldane-Fisher-Wright interpretation of 1920–1930, misses out those forces which lead to continuing evolution, such as continued environmental change, the heterogeneous environment, epigenetic organization of phenotypes, and the progressive elaboration of the types of mutation possible. Waddington presented the main elements of a theory of phenotypes involving canalized processes of development (with switching mechanisms), the heritability of developmental responses to environmental stimuli, and a principle of "Archetypes," inbuilt characteristics of an evolving group which determine the directions in which evolutionary change is especially easy. Realistic models would need to build in these elements.

Many of the papers by biologists in this volume are peripheral to the theme stated by the mathematicians, providing an accompaniment of sophisticated evolutionary theory rather than a counterpoint to the mathematical challenge.

Most biologists are satisfied with a theory that can be tested and that proves predictive. It is a different challenge to a theory that it should have an effective working model, for failure may imply either imperfection in the theory or imperfection in the model. It is doubtful whether this symposium has done much to influence the theory of evolution; it may have done much to improve future models.

It must have been tremendous fun to attend this symposium, but the full record of argument and interruption is very irritating to at least one reader. An interchange between speakers which runs X "No," Y "No, no," X "O.K. let's waste time," Y "We understand the question," Z "The answer is no" surely needs no record in the literature of science. The short pre- and post-conference papers included in the volume are excellent succinct expressions of points of view, but much of the main text reads like a word-for-word record of a heckled political meeting. This may be a useful way to discuss problems in science; it is not the way to publish them.

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Climate and Life

Ground Level Climatology. A symposium presented at the Berkeley meeting of the AAAS, Dec. 1965. ROBERT H. SHAW, Ed. AAAS, Washington, D.C., 1967. xii + 395 pp., illus. $12.50; to members, $10.50.

A visiting Soviet agricultural climatologist who had a brief look at this symposium while I was driving him to the train seemed quite taken with it. So was I, at first glance. It was hopeful to see a book devoted to processes at and near the long-neglected surface of the earth. But as I looked for a framework that might unify this field and for studies that might demonstrate its capabilities to students and fellow scientists, disappointment grew. I looked for work like that of Brooks, Neiburger, and Leighly in California, Lettau, Tanner, Sargent, or Trewartha in Wisconsin, Hare in Canada, Landsberg in Washington, or America's greatest agricultural climatologist, the late Warren Thornthwaite, or his students, or for the ex-