lems of dehydration condensation (polymerization) of amino acids and nucleotides. This is the area where the experiments are least satisfactory. The possibility of generating a defined peptide sequence during a random polymerization of amino acids is described as being due to the reactivity inherent in the amino acid side chains. The examples given are less than convincing, yet somehow definite sequences must have been generated in polypeptides or nucleic acids before the replication and protein synthesis apparatus evolved.

The means by which polymers can assemble themselves into larger structures is discussed next. A number of useful models, such as the assembly of viruses from their constituent nucleic acids and proteins, are presented. Another example is the self-assembly of artificial lipid bilayer membranes from the constituent phospholipids.

The final sections deal with the possibility that life is present on other planets in the universe. Twenty years ago this was considered a relatively wild idea. Life on some other planet is now considered quite plausible, and discussion is centered on what fraction of the stars in the universe have planets with life on them and on how to detect radio signals from those planets that have civilizations at a later stage of development than our own.

This book, written for readers interested in a broad and not too detailed view, is a good introduction to the field.

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Backboned Animals

Evolution of the Vertebrates. A History of the Backboned Animals through Time. EDWIN H. COLBERT. Second edition. Wiley, New York, 1969. xviii + 542 pp., illus. $12.95.

The Pattern of Vertebrate Evolution. L. B. HALSTEAD. Freeman, San Francisco, 1968. xii + 210 pp., illus. $7. University Reviews in Biology, vol. 10.

These two texts, both written by paleontologists, are entirely different in their approach to the subject of vertebrate evolution. Colbert's book, a second edition after 14 years, is essentially descriptive, of rather general coverage, and clearly intended for beginning students in the science. Halstead's treatment, on the other hand, is more technical in nature, dealing with a selected range of subjects and presupposing a more extensive background in zoology. Furthermore, Colbert's treatment is in a more authoritative style, with exposition of the principal features largely as accepted principles and relationships, whereas Halstead writes in an admittedly speculative vein, with extensive use of references to the work of others.

Colbert's second edition of *Evolution of the Vertebrates*, treating the animals by groups, follows rather closely the format of the well-known first edition. The characteristics of the animals are discussed in various respects, including their origin, evolution, distribution, and relationships. The text is much like that of the first, with essentially the same illustrations, although here and there paragraphs have been rewritten or headings changed, updating the thought as a result either of newer discoveries or of revised interpretations.

Reorganization and updating of portions dealing with the Amphibia and Reptilia follow naturally from Colbert's own field of investigation during the interval between editions. Within the Mammalia, which relate more closely to my own field of interest, much of the change appears inevitable as a result of more recent study, but in certain instances I find the taxonomic arrangement in the first edition, which follows more closely the concepts of W. D. Matthew and G. G. Simpson, to be preferred. The discussion of primate evolution, about which much has been written in late years, shows rather little change, except for the treatment of primate origin and of the apes in general. I note rather little difference in the discussion of man.

Halstead's *The Pattern of Vertebrate Evolution* treats the subject less by taxonomic groups or kinds of animals than by substance, function, and morphology. He discusses the development of tissues such as skin, cartilage, bone, and dentine, as well as of the skeleton as a whole. As a consequence a rather large part of the text pertains to the origins and early development of vertebrates. Halstead introduces and relies extensively on the thinking and conclusions of other workers, and much of his discussion is speculative and hence debatable, but it does encourage reflection on the part of the reader.

In his treatment of the more advanced categories of vertebrate animals Halstead arranges them by morphological groups, as related to the adaptations or habits, but in comparison with the space devoted to speculation on the origins of vertebrates, such groups as dinosaurs, birds, and mammals (other than man) receive only rather brief attention. The development of the primates is included in the chapter "Man—the weapon maker." Halstead's exposition of the evolution of man is based on the work of recognized authorities, except that I note quotations from Ardrey, who tends to dramatize the controversial. The chapter "The future of man" is much more subjective, with sociological and perhaps political overtones.

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The Study of Surfaces

The Structure and Chemistry of Solid Surfaces. Proceedings of the Fourth International Materials Symposium, Berkeley, Calif., June 1968. GABOR A. SOMORJAI, Ed. Wiley, New York, 1969. Unpaged, illus. $37.50. Inorganic Materials Research Division Series.

This volume chronicles an interesting early stage in the quantitative study of clean solid surfaces. Progress has recently been made possible by the development of a host of sophisticated experimental techniques. Since ultrahigh vacuum systems have become readily available many techniques have become almost commonplace which a few years ago either had not been invented or were used only by a few specialists.

The most striking of these methods, low-energy electron diffraction (LEED), is conceptually simple but quantitatively difficult to interpret. A beam of low-energy electrons ($E \approx 100$ ev) is incident on a single crystal surface. The beam is Bragg scattered and the backscattered part is made visible on a fluorescent screen. Spots are observed, the positions of which are related to the periodicity of the atoms near the surface, since electrons of this low energy penetrate only a few atomic layers. The main difficulty in interpretation is due to the fact that the usual savior of scattering problems, the Born