theoretical overview is not a convincing exposition of the importance of research in this area. Perhaps the most important and interesting aspect of the body schema concept is that by which it is seen as the internalized organization of the mobile body which underlies the ability to coordinate movements in simple and complex skills. This aspect is barely hinted at in this volume.

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Plant Products

The Biochemistry of Alkaloids. TREVOR ROBINSON. Springer-Verlag, New York, 1968. x + 152 pp., illus. $9.75. Molecular Biology, Biochemistry, and Biophysics, vol. 3.

The presence of alkaloids in plants commands attention. Their startling effects on man and animals are something we have lived with throughout history, and at times must have turned history's course significantly. Yet within the plants which make them the alkaloids seem to produce no outstanding effects. We have had ample time to make their acquaintance, for it was at the beginning of the last century that alkaloids were isolated and shown to be the quintessences of such drugs as opium and cinchona. Since then the search for other alkaloids from plants has been prosecuted with great diligence and in recent years has been accompanied by an equally diligent and more sophisticated investigation of the chemical structure of alkaloids. But the question still remains whether these interesting dynamic substances have any particular role to play in the economy of the plant producing them. Robinson's book is concerned mainly with this question; as he points out, there are a number of other books which deal quite thoroughly with the occurrence, isolation, structure, and characteristics of alkaloids. This book deals mainly with how alkaloids are built up in the plant (biosynthesis) and whether they are utilized or degraded by further metabolic processes. Obviously this sort of information is necessary before the question of function in the plant can be settled. Biosynthesis is an aspect of the alkaloids that has been particularly studied during the last few decades, and the bulk of the book is devoted to this topic. In fact, apart from anything else, this book is an excellent, comprehensive yet compact discussion of this subject. It also includes as much biochemical information as is available. The general theories of alkaloid biosynthesis are discussed, and this discussion is followed by detailed consideration of alkaloids grouped according to their basic chemical structure (pyridines and pyrrolidines, tropanes, isoquinolines, morphinans, indoles, terpenoids, and so on). Two interesting chapters on the metabolism of alkaloids by bacteria and animals and on the biochemical pharmacology of alkaloids balance out the coverage.

The survey clearly shows that knowledge of biochemical aspects such as the enzymology of biosynthetic processes is still rudimentary; similarly, we are a long way from having a satisfactory explanation of function. The most obvious guess, that alkaloids impart survival value by protecting the plant from overgrazing by animals, meets with the answer that many alkaloid-containing plants are eaten by animals. In fact (p. 49), certain aphids are so anxious to get at the alkaloids of the broom plant that they will crowd round and suck the parts richest in alkaloids, and I myself have seen a flock of goats in the Sudan vigorously devouring the very poisonous leaves of *Datura metel* and *Argemone mexicana.*

More precise information, however, suggests possible roles in individual plants. For example, relationships have been found between certain alkaloids and pyridine nucleotides (p. 29) and between tomatine and growth hormones in the tomato plant (p. 5), and studies of the conversion of alkaloids such as nicotine (p. 34) and morphine (p. 69) to other compounds in the plants producing them suggest a metabolic role for these substances, as do the rapid changes in the alkaloidal patterns of *Catharanthus roseus* and *Conium maculatum* (p. 5).

In the light of the shift in emphasis in the study of secondary products in plants, I think this book is timely, and the incorporation of the all too scanty information on the biochemical aspects justifies its title.

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Biogenesis

Chemical Evolution. Molecular Evolution towards the Origin of Living Systems on the Earth and Elsewhere. MELVIN CALVIN. Oxford University Press, New York, 1969. x + 278 pp. + plates. Cloth, $9; paper, $4.50.

It is generally believed that life began on the earth sometime between 4.5 and 3.5 billion years ago. The first step in this process was the synthesis of simple organic compounds from the constituents of the reducing atmosphere. This was followed by the polymerization of these simple compounds, and finally by the organization of the polymers into a self-replicating structure. This sequence of events is sometimes called chemical evolution, although it is not evolution in the Darwinian sense, inasmuch as reproduction, mutation, and selection are not involved before the first living organism arises. There has been considerable experimental investigation in this area in the last 20 years, and the author of this book has made substantial contributions to the field. This book summarizes his view of the subject.

The first section of the book deals with the fossil record. There is a brief discussion of Post-Cambrian fossils and a detailed discussion of the Pre-Cambrian microfossils that have been found by Barghoorn and Schopf in cherts from the Bitter Springs, Gunflint, and the Fig Tree formations. An excellent addition to the book is five color plates showing samples of these Pre-Cambrian rocks; all these rocks would look about the same in black-and-white photographs. The next section, amounting to almost a third of the book, is an extended discussion of hydrocarbons and fatty acids found in present-day organisms and in rocks. Although this is an interesting subject, it does not tell us much about how life began. This section might well have been extended and made into a separate book.

The primitive reducing atmosphere and the sources of energy available for organic compound synthesis are taken up next, and the experiments synthesizing organic compounds under primitive earth conditions are then reviewed. From the standpoint of a worker in the field this section is too short, but for the average reader it is a good summary.

The story continues with the prob-

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