where economic new deposits of metals might be discovered utilizes the vast amount of information recovered during the extraction of known ore deposits. The author is fully aware that this is so and has systematically documented the characteristics and debates concerning genesis of the many important rock associations that have yielded ore deposits throughout the world.

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Plant Processes

Photosynthesis, Photorespiration, and Plant Productivity. ISRAEL ZELITCH. Academic Press, New York, 1971. xiv, 348 pp., illus. $15.

Photosynthesis and Photorespiration. A conference, Canberra, Australia, Nov. 1970. M. D. HATCH, C. B. OSMOND, and R. O. SLATYER, Eds. Wiley-Interscience, New York, 1971. x, 566 pp., illus. $19.

These books deal with a subject of great current interest to plant scientists. The discovery of C_4 plants (those in which the early products of carbon dioxide fixation are four carbon dicarboxylic or amino acids instead of phosphoglyceric acid) and the realization that this biochemical difference was associated with altered habitat, anatomy, and physiology have provided a meeting ground for various botanical disciplines. Differences between C_4 and C_3 plants are of more than academic interest; the field productivity of C_4 plants is generally considerably greater than that of the classical C_3 plant. The reader may be interested to learn that crabgrass is a C_4 plant.

Surprisingly, the lesser productivity of C_3 plants is thought to be due to their respiring away, during illumination, a considerable portion of newly fixed carbon. This phenomenon, called photorespiration, is a major subject of both books, but the reader will look in vain for a rationale.

The book by Zelitch brings together most aspects of plant productivity. A section on chloroplast biochemistry, genetics, and photochemistry is followed by sections on photorespiration and productivity in single leaves and in stands. The book is a fine introduction to these subjects and will doubtless be valuable to students and research workers, for it combines topics which are related but are usually treated separately. Photorespiration and the C_4 pathway occupy a large portion of the text, which is of course not surprising, this being one of the author's research interests. The physical and morphological parameters of leaves which affect productivity are discussed, along with the nature of the stand. Metabolism of carbon compounds involved in carbon dioxide fixation and in respiration is given good coverage. The book covers a larger subject matter than do most books of its size, and therefore some areas are treated very briefly. In certain cases this is all to the good. For example, Zelitch seems to believe the triplet state is an obligatory intermediate in the photochemistry of photosynthesis; certainly nothing profitable could be achieved by a lengthy discussion of that matter. The book suffers from the author's adoption of the role of advocate rather than judge. Particularly on the somewhat controversial subject of photorespiration, evidence contrary to his viewpoint is often ignored or treated very lightly. In short, the book is a good introduction to several subjects but does not reflect the disparate opinion that actually exists about them.

Photosynthesis and Respiration is the proceedings of a conference. It is, in the main, devoted to C_4 plants and includes sections on adaptation, evolution, carbon dioxide assimilation, chloroplast structure, photorespiration, and the role of microbodies. It is an excellent publication, extremely easy to read for books of its type. Each section is prefaced by review papers and ends with assessments. Some excellent micrographs aid in understanding the complexities of C_4 plants. The book starts with fine reviews by Downton and Björkman which point out the anatomical and physiological differences between C_4 and C_3 plants. Björkman suggests that the C_4 pathway represents an adaptation to conditions of high temperatures and light intensity combined with limited water supply. Plants having this pathway photosynthesize more rapidly than do C_3 plants under atmospheric partial pressures of carbon dioxide and oxygen. C_3 plants can approach the C_4 rate if the partial pressure of CO_2 is increased or that of oxygen lowered, presumably because of suppression of photorespiration. The roles of glycolic acid and microbodies in photorespiration are discussed by several contributors. The section on carbon dioxide fixation is bracketed by Hatch, who introduces, and Slack, who assesses. The consensus is that C_4 plants fix carbon dioxide into dicarboxylic acids in the mesophyll cells and that these acids are transported into the bundle sheath cells, where they are decarboxylated and the liberated carbon dioxide is refixed via the Calvin cycle. As I read this volume shades of Warburg appeared to my mind; it seemed as if the late master were running things by some kind of remote control. The volume ends with a final assessment in doggerel.

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Nonmammals

Physiology and Biochemistry of the Domestic Fowl. D. J. BELL and B. M. FREEMAN, Eds. Academic Press, New York, 1971. In three volumes. Vol. 1, xxii pp. + pp. 1–602, illus., + index. $29.50. Vol. 2, xxii pp. + pp. 603–1152, illus., + index. $29.50. Vol. 3, xiv pp. + pp. 1153–1488, illus., + index. $23.50.

This set of volumes is unique because it is the first reference work on the anatomy, physiology, and biochemistry of the domestic fowl. There has long been a need for the authoritative coverage provided here. Those who as students or as seasoned investigators venture forth into avian physiology have, up to now, faced the time-consuming and frustrating task of locating pertinent articles hidden within a mountain of mammal-oriented literature.

The 53 contributors dedicated themselves to the task of assembling through 1970 these difficult-to-find publications, but they have done much more. They evaluate the publications of others in the light of their own extensive first-hand experience and supplement their own competency by drawing generously from the unpublished data and ideas of colleagues. Such cooperation was possible because almost all were based on the "tight little island," 35 in England, 14 in Scotland, and 2 in Northern Ireland; one contributor was located in New York City.

The group under the planning of the editors has produced a well-integrated and coordinated sequence of topics: digestive system, presented anatomically, physiologically, and biochemically; the same sequence for respiratory systems; chapters on energy, gaseous, carbohydrate, lipoid, acetate, and protein metabolism; and then chapters on the roles of the vitamins and trace

elements in metabolism. The next sequence, the endocrines, is handled well, structurally and functionally, in 160 pages. The last chapter in volume 1 reviews the prostaglandins in nonavian and avian species. Volume 2 begins with the integument, goes on to the skeletal system, and then presents a number of chapters on each of the interrelated systems, muscular, vascular, and nervous, terminating with chapters on bile formation and body temperature, including regulation. The third volume is devoted entirely to the structural and hormonal aspects of male and female reproductive systems.

Almost without exception each author has pointed out wherein the information for the chicken and other birds differs from that known and generally accepted for mammals. By this approach they have performed a signal service to students in general and relieve the neophyte in avian physiology of the necessity of seeking answers for the bird in texts and reference books based on mammals.

Sometimes scholarly publications of this magnitude are read through once and largely ignored in the years thereafter. This reviewer found that the chapters are written with the attention-holding qualities of a popular publication, that the information presented opens up whole new fields for research, and that the suggestions and critical approach make this work the kind of reference publication that will be used repeatedly, if close at hand. The volumes will be a special boon to students just entering the arena of avian anatomy and physiology and will provide material for many stimulating seminars.

Only two of the 62 chapters seem to fall somewhat short of the average high standard. Much of the chapter on the digestive tract is anatomically accurate, but the divisions of the intestine as given by the author follow mammalian rather than avian terminology as found in the ornithological literature. Also, the pancreas of the chicken differs in several important respects from those of mammals. Later chapters take up some of these differences and give them proper emphasis. The chapter introducing the vascular system has borrowed some terminology from mammalian anatomy, such as "innominate artery" for "brachiocephalic artery." Blood returning from the lungs is said to enter the left atrium rather than the left auricle.

Such minor errors are offset by the masterly handling of other topics—for example, the treatment of the respiratory system by all the authors involved is outstanding. The excretory system of birds has two kinds of tubules. The renal portal system probably plays a role in uric acid formation in the kidney, the process thereby differing from uric acid formation in the livers of mammals. The insulin content of the chicken pancreas is low, approximately one-tenth as much as in mammals. On the other hand, the glucagon content of the fowl pancreas is 10 times that of mammals. A hormone may be present in the cloacal bursa that acts upon the adrenal to maintain ascorbic acid concentration. These and many more provocative ideas, new hypotheses, and reevaluations of previously accepted facts continue through all the chapters.

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Neural Mechanisms

Neuron Structure of the Brain. G. I. POLIAKOV. Translated from the Russian. Harvard University Press, Cambridge, Mass., 1972. vi, 122 pp., illus. $5.

The English rendition of this monograph has been made possible by a special U.S. program for scientific translations. The author is a neuromorphologist who has worked extensively with the Golgi method, and his studies have included significant observations on the establishment of neuronal contacts during embryonic life. But the reader should not expect to find in this book any detailed discussion of either the anatomical or physiological aspects of synaptology. There is no attempt to correlate the Golgi picture with that obtained by the electron microscope or with degeneration studies. And since there is no index, it should also be mentioned that there is no inclusion of such timely topics as dendro-dendritic and axon-axonal connections, vesicles, axonal flow, cholinergic and aminergic systems, the glia, tight junctions, miniature and graded potentials, or lateral inhibition.

Rather, the author's purpose is to present his concepts of how progressively more complicated neural circuits make their appearance during the course of vertebrate evolution. The usual cybernetic models, he contends, are oversimplified and "represent more of the cybernetic aspect than an exact knowledge of the brain."

Claiming a somewhat novel approach, Poliakov identifies three main functions of the nervous system which he refers to as (i) "regulatory function," (ii) "control," and (iii) "direction." These are respectively subserved by (i) a "coordinating mechanism," (ii) an "analyzing-coordinating mechanism," and (iii) the "systems of analyzers." The coordinating mechanism regulates local defensive and adaptive reflexes involved in posture, locomotion, assimilation of food, and so forth. Poliakov points out that the principle of "action-counteraction" was first established by N. E. Vvedenskii and later formulated by Charles Sherrington as reciprocal innervation. The analyzing-coordinating mechanism subserves more complicated reflexes such as those involved in orientation. Finally, there are the analyzer systems, including cortical and subcortical mechanisms, that account for all psychological functions and dominate all reflex coordinations.

The first 70 pages would seem to be a sketchy and sparsely documented account leading up to detailed consideration of Poliakov's major interest in the fine structure of the analyzers and their interactions. One finds, however, that although the "grid" drawings showing interconnections become more complicated, the supporting evidence remains flimsy. (Two short legends provide the only explanation of one model, illustrating how impulses, given 10^{200} possible routes, might take a direct course to a given locus.)

Were it not for the references in the footnotes, some as recent as 1964, one would infer from the language and diagrams that the book was written in the early 1950's, when cybernetic modeling relied heavily on Lorente de No's neuroanatomical schemes of self-exciting chains of neurons and Forbes's physiological evidence of the reverberating circuits. Two more examples will serve to reflect the style of Poliakov's analysis. In discussing cortical connections, he states, "The main function of tangential contacts of axonal ramifications of lateral dendritic outgrowths is apparently the establishment of indirect tangential effects of some neurons on others." After a cursory presentation of one set of diagrams he concludes, "The above-described structure of interconnections in the highest