

problems in animal and plant breeding, pollution biology, and evolution. What they have done, more than anything, is to show what *might* be known if this line of investigation were pursued with diligence and perception. To this end a strong argument, critically developed and forcefully presented, could well catch the imagination of present-day biologists. I am afraid this treatment will fall short of that mark. Not all of the authors' arguments are sound, not all of their observations are sufficiently critical, and they try to do too much for too many areas. The supercilious or hypercritical reader will almost certainly abandon reading and dismiss the book before its message becomes clear to him. This is regrettable, because the book's major theme has merit, and the authors are attempting to share with the reader a vision that contemporary biology should profit from. I hope that most readers will bear with the authors' lapses and stick with the exposition until they glean the substance that is there.

The first chapter begins with an introduction to the concept of heterosis. It is treated in the traditional manner, which is to say, with all the opacity of midparent values, inbreeding depression, and so on. This is discouraging. The authors, being in a position to lead, have chosen to follow. They might have formulated a strong and concrete definition of heterosis founded directly on considerations from molecular mechanics. Instead they repeat the customary formula and lament its vagueness, but they leave the concept no better than they found it, still vague, still contradictory, still unsatisfactory. They do, however, depart from tradition in a most important fashion. They place appropriate emphasis on negative heterosis. This is where heterozygotes, through deleterious interallelic and interlocus interactions, are less fit in some environments than the homozygotes. It is through balancing positive against negative heterosis that Manwell and Baker achieve their most useful insights and open up new areas of explanation.

From the first chapter through chapter 8, the subjects dealt with are population genetics (from the standpoint of the protein devotee), the molecular biology of proteins, and patterns of protein polymorphisms. The treatment of the last topic, stretching over 146 pages, is a patiently tedious summary of the literature, with good but far from complete coverage to around 1968. References to data from plants are more scanty than their relative contribution

to the literature of this subject would justify. In chapters 9 and 10, considering allosteric effects and relationships among protein subunits, the foundation is laid for development of the primary theme, which takes up the last two chapters of the book. This theme can be presented succinctly, and I paraphrase it here mainly from the preface (p. xvii). Protein polymorphisms originate through mutation and gene duplication. They may persist with heterozygote advantage resulting from complementation between subunits of functional proteins. Alternately, heterozygote disadvantage may result from miscomplementation, in which case diverse mechanisms may come into play to reduce or eliminate the consequences of deleterious subunit interactions. Race and species formation are among the most interesting, and perhaps the most significant, of the means by which populations adjust to negative heterosis.

Different readers will find fault with different passages in this book and, page by page, I sympathize with them. Much of the text seems to have been written hastily or from hastily prepared and not always accurate notes, and some of the interpretations are not always carefully thought out. For example, there is a question of the interpretation that is to be given when data show an excess or deficiency of heterozygotes for a marker locus. To what extent can departures from random expectation be assigned to the metabolic or physiologic consequences of the one marker locus? To what extent might these more realistically be assigned to the net effect from a set of linked loci? Need the effect, the excess or deficit of heterozygotes, be assigned to the marker locus at all? For the case Manwell and Baker wish to make, these are clearly important questions. Equally clearly, their treatment of them is haphazard and contradictory. On pages 11–25 they ostensibly consider complications of exactly this sort. On page 16 they point out that the individual, not the locus, is the unit of selection. On page 17, in a discussion of segregational genetic load, they remark that "adaptive value had been referred to each locus and not to the individual as it should have been." Then in chapter 8, apparently sensing no contradiction, they use population data from single marker loci as evidence in support of their case for the reality of heterotic interactions. They cannot have it both ways. They berate population biologists for too directly assigning adaptive values to

marker loci. Then they do the same thing themselves, for that is exactly what they do when they interpret an excess or deficit of heterozygotes at one marker locus in terms just of the interactions of the products of that locus.

Fortunately for the book's major thesis, interpretations of population data, while important, are not the most central issue. Models of protein interactions are. So also is the exposition of the ways in which protein interactions may contribute to phenomena ordinarily studied and *explained* only at the organismic level. It is here that novel interpretations are presented and it is here that the reader, casual or professional, can have his horizons broadened and his insights sharpened. For example, the possibilities that may exist for in vitro investigation of the adaptive properties of protein variants seem very promising. We may realistically anticipate learning more about whether alleles are adaptively neutral, or of how or when they exhibit advantage, by test tube studies than we may soon learn otherwise. Considering the refractoriness of the problem at the population level, and the extended public debate on the issue, this potential, even if not fully real or never fully realized, is welcome. It is for such insights primarily that I recommend this book to the reader, but always with the cautions implicit in my earlier remarks. We are yet too ignorant, both of population phenomena and of molecular interactions, for one treatment to authoritatively encompass both. This treatment does not, but if the reader realizes and discounts for that he cannot be led too far astray, and what he gains will be worth the effort.

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Control of Temperature

Comparative Physiology of Thermoregulation. Vol. 1, Invertebrates and Nonmammalian Vertebrates. G. CAUSEY WHITTOW. Academic Press, New York, 1970. x, 334 pp., illus. \$17.50.

Here is the first of three volumes which the editor has planned to survey the ways in which organisms regulate their internal temperature. Subsequent volumes will deal with mammalian regulation and general principles of heat exchange and temperature regu-

lation. This volume assembles by quasi-systematic group accounts of the responses of aquatic invertebrates (Vernberg and Vernberg), terrestrial invertebrates (Cloudsley-Thompson), fish (Fry and Hochachka), amphibians (Brattstrom), reptiles (Templeton), and birds (Dawson and Hudson). The contributors have avoided a review format and have generally written authoritative statements reflecting the status of understanding of the temperature responses of nonmammalian organisms. Their procedure is a familiar one. The authors cast descriptions of the responsiveness of organisms to temperature, sometimes teleologically, into an ecological or energetic-cost context. In this setting we are shown the variety of adaptation to temperature and the remarkable suitability of an organism to its environment. This volume will serve, as the editor hoped, as a useful comprehensive reference.

In a broader perspective, I find a disconnectedness general in the field of thermoregulation that is uncharacteristic of surveys of other animal functions. There seems to be no unifying theme—no consistent basis for comparison of the thermal responses of organisms. The unanswered central question is, How do organisms, from motile microorganisms to mammals, recognize predetermined temperature levels? The thermal selectivity of *Paramecium* and the functioning of the mammalian thermostat depend upon this ability. Yet we seem no closer to understanding the mechanism underlying thermal responsiveness than Herter or Crozier and many others of a generation or two ago. Meanwhile, the present authors have managed thoughtful essays on their subjects without consensus on first principles.

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Plant Compounds

Chemistry of the Alkaloids. S. W. PELLETIER, Ed. Van Nostrand Reinhold, New York, 1970. xxii, 796 pp., illus. \$24.95.

I brought to this book my usual skepticism about multiauthored textbooks but came away from it convinced that most of the usual defects in such productions had been avoided. The dividing line between text and reference is not a sharp one, but I would

classify this book as an advanced text in that it is selective rather than encyclopedic and balanced rather than indiscriminately inclusive. In level and length it falls between the treatise of Manske and Holmes and the shorter text of Swan.

Aside from two chapters on, respectively, biosynthesis and taxonomy of alkaloids, this is a book of organic chemistry dealing in separate chapters with the different structural classes of alkaloids, their characterization and synthesis. Two aspects that are neglected are procedures for the separation and the analysis of alkaloids. Although specific alkaloids are chosen, there is usually excellent attention paid to the generality of synthetic and degradative methods. One learns not merely that such and such a reaction has been applied to a particular compound but also that it is useful for certain structural types and fails with some that appear similar. The structural formulas are well placed with regard to the text and used unstintingly. In a marked improvement over Manske and Holmes, compounds are identified by Arabic rather than Roman numerals, and the correct structure of an alkaloid is given at its first mention rather than after presentation of all the data and arguments used in establishing it. The reading is enlivened by brief historical remarks about some of the best-known alkaloids.

If the text is well planned and executed, the greatest praise is reserved for the indexes, which I must describe enthusiastically as the finest I have seen in any comparable book. In addition to author and subject indexes that are as thorough as one could ask, there is also a unique "Reaction and Reagent Index" which masterfully gathers together scattered information; so that, for instance, one can look up "Hofmann degradation" or "sodium borohydride reduction" and find a list of applications of these methods with their relevant page numbers.

In most chapters there are references to some literature as late as 1969, although one chapter lists nothing later than 1964. Any errors I found were trivial. It is too bad that the editor was unable to reconcile opposing views about which way up the morphine structure should be drawn, but that discrepancy only makes evident his attention to integration of approach that otherwise welds the book together. Libraries must have Manske and Holmes available for consultation; be-

ginning students of alkaloids will probably be happier with Swan's book; but serious workers in the field of alkaloids will want Pelletier's book on their desks.

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Shellfish Phylum

Living and Fossil Brachiopods. M. J. S. RUDWICK. Hutchinson University Library, London, 1970, and Humanities Press, New York, 1971. 200 pp., illus. Cloth, \$6; paper, \$2.50. Biological Sciences.

Each of the shellfish phyla has its unique mode of life, attachment, and feeding, reflected by and dependent on the morphology of the shell. The ways in which morphology functions are a natural part of neontological studies of bivalves, gastropods, and echinoderms, but are more difficult to grasp for extinct or relict phyla such as the Brachiopoda, in which many structures have no modern analogues. There is no way of witnessing how such structures work. As a consequence, the reason for the structures tends to get overlooked by paleontologists eager to find the age or evolutionary meaning of fossil species.

Martin Rudwick has filled this gap in knowledge by making a special study of functional morphology in fossil and living brachiopods. His series of unique and excellent papers is crowned and summarized in this text, which relates the biology and evolution of brachiopods to their functional morphology. It is an exquisite work, concise and clearly written, logical, and coherent. Text figures are numerous, and adequate. Perhaps the most impressive aspect is the way the author deals with the entire phylum, smoothly changing the focus of attention from Ordovician to Permian to Recent genera to knit the brachiopods into a closely related unity.

Naturally there are a few mistakes—the Strophalosiaceans did not all lose their teeth after the earliest Devonian (p. 54), for example. Some might cavil at the simplified treatment which discusses only one viewpoint, especially over debatable questions of function, but those with better ideas are free to write their own texts. In fact they would be well advised to do so, for it is difficult to agree with Rudwick's interpretation of Lyttoniaceans, for example.