areas as spherical atmospheres and chromospheres. Steenbock contributes an important comment on the role of departures from local thermodynamic equilibrium in the iron ionization equilibrium in late type stars. Catchpole and Feast survey the distribution of peculiar stars in different astrophysical environments. In a review of the chemical composition of the barium stars, Lambert points to the need for a careful and thorough search for spectral peculiarities among main sequence stars that may be precursors to the peculiar red giants. McClure summarizes recent observations of the frequency of binary stars among the different types of peculiar red giants. He concludes that stars with excesses of heavy elements are probably all binaries, while peculiar red giants with normal abundances of heavy elements show a normal frequency of binary stars. This result has important consequences for theories of the origins of peculiar red giants, the subject of the final review by Wood. He discusses the dredge-up of carbon produced by the triple-α process in stars undergoing double shell burning. Stellar evolution models lead to a qualitative sequence of M-S-C stars, but the quantitative agreement is still not good. Wood suggests that the early carbon stars (R stars) may instead result from the helium-core flash, which may also play a role in the formation of barium stars and CH stars.

This comprehensive review of red giant stars with excesses of heavy metals succeeds in conveying not only the wealth of observational data now available on the characteristics of cool stars but also the extraordinary progress of the last 65 years in understanding the complex process of stellar evolution. Yet we are still only speculating on the origins of many of the peculiar red giants, particularly the barium stars. The book serves as an important milestone on the way to a more complete understanding of the evolution of stars.

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Amphibians

Biology of Amphibians. WILLIAM E. DUELLMAN and LINDA TRUEB. Illustrated by Linda Trueb. McGraw-Hill, New York, 1986. xx, 670 pp., illus. $40.

The class Amphibia consists of three orders, two of which, the Anura (frogs) and the Caudata (salamanders), are familiar to many and the third of which, Gymnophiona, containing the fossorial and rather bizarre caecilians, remains relatively little known even to those who study their biology. Studies of amphibians have made essential contributions to our understanding of a number of biological subjects, especially development, ecological competition, functional morphology, molecular evolution, sensory physiology and neuroethology, and social behavior. Although these studies encompass a diversity of scientific interests, researchers must take into account the fact that the animal is an integrated whole. For those of us working with amphibians the quickest, most reliable source of information about the biology of our study organisms has since 1931 been G. Kingsley Noble's monumental *The Biology of the Amphibia*, reprinted by Dover in 1954. I am not urging by any means that researchers retire their copies of Noble; I predict, however, that Duellman and Trueb's *Biology of Amphibians* will soon become the key reference for details of amphibian biology.

Duellman and Trueb truly review the biology of amphibians, covering most conceivable topics from cytogenetics and development to biogeography and phylogeny. They do this in 19 chapters in four sections: Life History, Ecology, Morphology, and Evolution. The outstanding feature of this work is its extensive and up-to-date (as of about 1983) documentation. The book lists more than 2500 references in 12 languages, and more than a third of these appeared between 1980 and 1983. Duellman and Trueb have, moreover, collated large quantities of data (or added to such collections by others). These collections, especially those in the section on life history, are sure to provide a catalyst for inquisitive minds. Although at times the authors' own presentation becomes a mere litany of facts, for the most part there is an attempt to summarize and synthesize. Of course, in a work of this breadth a thorough consideration of all aspects of amphibian biology is not possible. For example, about 15 pages are devoted to the amphibian ear, a subject to which E. Wever recently (1985) devoted a 500-page book. However, the authors usually provide accurate and concise summaries, along with key references, especially to review articles. Another welcome feature of this book is the abundant, clear, and well-labeled illustrations. Most that have been taken from the primary literature have been redrawn, and some are works of art. The illustrations especially add to the chapters on morphology, which I found the most comprehensive and rewarding. The index is thorough and easy to use—not a trivial point for a book of this nature.

There are some mistakes and misconceptions. For example, attenuation of sound pressure level with distance does not follow the inverse square law (it changes linearly), and the authors seem to imply that low-frequency sounds (<1000 Hz) reach the papilla amphibiorum of the inner ear only through the opercularis system, whereas data presented by Lombard and Straughan in the paper cited for this conclusion clearly show that perturbation of the tympanic-columella system influences thresholds of low-frequency hearing and Wever, in a paper also cited, questions the mechanism implicating the opercularis in low-frequency hearing. There is occasionally uncritical acceptance of studies in the literature; but it is not clear how any two authors could be expected to assess accurately all studies contributing to a work of this breadth. Even though the book is fairly current, the reader should be aware that there have been significant new developments since it went to press, for example with respect to energetic costs of reproductive behavior.

There is no recent textbook on amphibian biology that is worthy of comparison with Duellman and Trueb's. This work also compares favorably with analogous books on other vertebrate taxa, such as Vaughan's *Mammalogy*, Welty's *The Life of Birds*, Pettingill's *Ornithology*, and Bond's *Biology of Fishes*. If only there were a counterpart of this quality for reptile biology.

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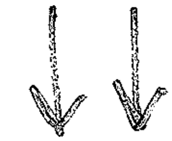

Measuring Selection

The Statistics of Natural Selection on Animal Populations. BRYAN F. J. MANLY. Chapman and Hall (Methuen), New York, 1985. xvi, 484 pp., illus. $55. Population and Community Biology.

Field biologists these days are succeeding at the difficult task of measuring selection in natural populations. Much of the current effort is directed at large organisms (for example, deer, birds, lizards, dragonflies, flowering plants). Such organisms can be individually marked, observed, and recaptured in the field so that statistical relations between phenotypic traits and reproductive success can be determined. The focus is on traits with direct relevance to ecological interactions and evolutionary history (for example, body size, feeding structures, running ability). The challenge is to adapt censusing techniques, developed to answer simpler demographic questions, to the task of estimating selection and addressing unanswered questions in evolutionary biology.

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Are sexually selected traits held in equilibrium by opposing natural selection? Are populations perched on adaptive peaks? Is spatial uniformity in selection responsible for the geographic monotony of some species? Selection pressures must be measured to answer these questions, and so Bryan Manly's book will find an attentive audience.

The aim of the book is to summarize statistical methods for analyzing selection. Coverage of topics is broad, ranging from the analysis of ongoing phenotypic selection to estimation of linkage disequilibrium and detection of evolutionary trends. Several chapters treat viability selection acting on discrete polymorphisms and on continuous traits (fertility and sexual selection are barely mentioned). Analysis of clinal variation is discussed as well as tests for parallel clines in two or more species and tests for character displacement. Other chapters treat the analysis of genotypic data, for example, tests for neutrality and selection at two loci.

The book can be recommended on several grounds. The chapters are organized by type of data so that it is often easy to find relevant sections. Numerous examples are used to illustrate statistical approaches and tests. In several contexts Manly illustrates the powerful technique of fitting progressively more complicated models to data. He employs the Rothamsted Experimental Station's general linear modeling program (GLIM), using maximum likelihood ratios to compare fits from successive models, but other statistical packages (such as SAS) could be put to the same use. Manly also illustrates the useful concept of selection surfaces, which permits visualization of multivariate selection, and shows how the surfaces can be computed. Manly pioneered the use of such surfaces; they deserve much wider use.

Manly's book is a compilation rather than a synthesis of the literature. The separate sections stand on their own, but connections between topics are not stressed. For example, the concept of selection opportunity is introduced on three separate occasions, with three different symbols (I_O, I_R, I) used for the same quantity. More important, in the case of continuous traits, no connection is made between statistical measures of selection and the selection coefficients used in equations for evolutionary change. Such a mapping exists, so there is no need for the statistically minded field biologist and the theoretician to speak different languages. Despite such missed opportunities, the book is a fund of useful approaches and examples that will be invaluable to any student of natural selection.

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Invertebrate Neural Systems

Model Neural Networks and Behavior. ALLEN I. SELVERSTON, Ed. Plenum, New York, 1985. xxiv, 458 pp., illus. $69.50.

If we are to believe higher neurobiological authority, there are on the order of 10^{12} neurons in our brains, and from this incredible number are carved the neural networks that generate our behavior. Given this daunting quantity, it is little wonder that some neurobiologists have taken to the study of invertebrate animals, with numerically simpler nervous systems, in search of insights into the cellular bases of neural function. This volume surveys the simple ("model") neural networks approach to neurobiology. A major advantage of working with invertebrate neural systems is that it is possible to study neural structure and function by means of unique and identified single neurons. In every chapter of this book it will be seen that this advantage has translated into remarkable advances in our understanding of neural function.

This is a big book, with 28 chapters by 60 authors, including many of the leaders in their fields. The title of the book is misleading; only a third of the chapters deal with neural networks and behavior, and even then the subject is limited to such (albeit important) aspects as locomotion and learning. Omitted are more comparative studies of ethologically oriented behaviors such as navigation and biocommunication. The use of invertebrate neural systems has made a ringing impact on neurochemistry, membrane biophysics, neurogenetics, and especially neural development, and these topics are nicely surveyed here.

The book has something for everyone. This reviewer enjoyed the network analysis of the snail brain by Benjamin, Elliott, and Ferguson because it proceeds from the biophysical properties of neurons right on to feeding behavior of the animal. An essay on central pattern generators in *Tritonia* by Getting and Dekin and one on lobsters by Miller and Selverston are provocative. Historically, rhythmic behaviors have been favorites for the model systems approach. Current studies indicate that the idea that there are simple, fixed circuits hierarchically organized to generate central rhythms is due for revision. The reality seems to be that networks of anatomically connected neurons can be subdivided into different pattern-generating circuits, depending on such factors as the behavioral and neurohormonal context of the animal. Four chapters on insect and molluscan development, by Hildebrand, Bastiani *et al.*, Weisblat and Kristan, and Kater, will bring the reader up to date on developmental neurobiology, especially with respect to studies of axonal growth and regeneration. *Drosophila* has been a model system for geneticists for half a century, and it now promises to illuminate the neurobiological landscape as well, although a chapter on the genetic dissection of potassium channels by Jan and Jan and one on the specificity of neural connectivity by Wyman *et al.* only introduce the reader to the riches of *Drosophila* neurogenetics. The mollusk *Aplysia californica*, like *Drosophila*, has become so celebrated in neurobiology as to nearly transcend its taxonomic status as a "mere" invertebrate. We see in a paper by Abrams that learning in *Aplysia* has become Pavlovian and in one by Scheller and Schaefer that the egg-laying behavior of *Aplysia* can now be examined at the level of gene expression. These brief sketches can only hint at the other treats that await the reader.

The pioneers of invertebrate neurobiology correctly foresaw behavior as being the primary target for the model system approach. Clearly invertebrates are going to be even more important for our understanding of the genetic and developmental controls that operate in the formation of nervous systems. The reader of this nice collection of research essays will learn how the analysis of invertebrate neural systems has provided key insights into major neurobiological problems.

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