

The book gives a complete overview of the recent progress in this field and would be useful not only to the professional astronomer but to anyone interested in the details of our knowledge concerning the death throes of ordinary stars.

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## Fisheries Biology

### Ecology of Freshwater Fish Production.

SHELBY D. GERKING, Ed. Halsted (Wiley), New York, 1978. xiv, 520 pp., illus. \$47.50.

The modern sciences of ecology and fisheries biology have common roots in theoretical work on population dynamics. Historically both fields relied heavily on the logistic equation of Verhulst to describe single-species population growth and on the mathematical foundations laid by Lotka and Volterra to describe population interactions. In fact the work of Volterra was stimulated by D'Ancona, a young biologist who sought both advice concerning the Adriatic fisheries and the privilege of courting Volterra's daughter (F. M. Scudo, *Theor. Popul. Biol.* 2, 1 [1971]). Despite these common roots, the two fields have largely gone independent ways, so much so that recently a respected fisheries biologist, P. A. Larkin, wrote an article for the purpose of introducing ecologists to fisheries biology (*Annu. Rev. Ecol. Syst.* 8, 57 [1978]). Fisheries biologists have traditionally been concerned, understandably, with production and sustained yield of single-species populations and have paid relatively little attention to how a species interacts with the abiotic environment or with other species. The latter concerns, of course, have been the abiding preoccupation of ecologists.

The present collection of papers on fisheries biology is essentially an updating of a 1967 volume entitled *The Biological Basis of Freshwater Fish Production* that grew out of a symposium held in Reading, England, in 1966. Despite the change in title, the book provides no evidence of an integration of recent ecological theory into the thinking of fisheries biologists. Seven new authors have replaced previous authors, and the repeating authors have generally revised their papers substantially, but very few chapters even cite major ecological figures or works. Although most of the papers provide competent reviews of circum-

scribed aspects of fish biology, the collection as a whole reflects as readily what is lacking in modern fisheries biology.

The 19 papers are presented in four sections: Vital Statistics of Fish Populations; The Fish Population and Its Food Supply; Competition and Social Behaviour Influencing Production; and The Contribution of Fish Production to Human Nutrition and Well-being. The section on vital statistics is concerned largely with the estimation of individual growth, production, and population numbers. Formulations of growth and metabolism are central to a number of papers in the book and are covered in some detail in at least three papers, with considerable redundancy resulting. In addition to these methodological papers, the section contains chapters on fecundity and juvenile mortality. Fish typically are characterized by high fecundity such that more than 99 percent die before reaching maturity. As a consequence, even small percentage changes in mortality can lead to large fluctuations in year-class strength. The early life history stages are critical in this regard but have been little studied. Braum's paper covers some of the ways in which physical factors and food affect survivorship from egg to larval stages. Bagenal presents a thorough review of patterns of fecundity in fish. Only passing mention is made of current life history theory in the latter paper, and some important papers applying such theory to fish are missed. It is clear that much more attention, both empirical and theoretical, must be given to this subject.

The papers in the final section of the book cover topics such as aquaculture and yield assessment and, with the exception of Hephher's paper on experiments in pond culture in Israel, are of noticeably less depth than the others. This leaves the middle two sections of the book to cover the "meat" of ecological relations to production. Ecologists will not find the literature here a rich source of ideas.

Given the wide variety of prey and habitats available in natural communities and the extraordinary flexibility of fish in resource use, prey selection and foraging efficiency would seem to be central to the ecology of fish production. This is not the view reflected in the section on the predator and its food supply. Two papers outline what happens to food after it is in the fish. Windell presents a shopping list of factors affecting digestive rates. Webb, in one of the more thorough and careful chapters, reviews

how energy is partitioned into growth and metabolism. Mann's chapter is largely concerned with the methodology of estimating food consumption in nature. Only 3½ pages explore the relation between availability of food and selection by the fish, though it is admitted that foraging activity is "likely to be a significant item in determining efficiency of utilization of food for growth."

Only Popova, surveying the Soviet literature on the role of piscivorous fish in freshwater communities, indicates the importance of the relation between morphology, body size, and hunting tactics of the predator and the availability of different sizes and species of prey. In most cases current ecological theory that is relevant here is not utilized. Nevertheless, the Soviets, following the visionary work of Ivlev in the 1940's, have paid much more attention to these general problems than have their Western colleagues. One has a sense that there is potential to generalize and build theory here, a feeling not as easily elicited by the efforts to estimate how much food a fish eats in nature or comparisons of production in different systems.

In the section on competition and social behavior, Northcote contrasts the intriguing patterns of spawning and feeding migrations of fish in arctic, temperate, and tropical regions. This is one of the few papers that attempt a general synthesis, and it indicates the potential for important work on these phenomena. Noakes's contribution is largely devoted to spacing systems and schooling. A strong case is made for integrating ecological theory and behavior to understand production processes. The paper unfortunately is one of the shortest in the book and simply is not long enough to do justice to both of these important subjects. Backiel and LeCren present a nice survey of examples of how intraspecific density affects growth rates and mortality in fish. Fish exhibit indeterminate growth, and the many stocking or thinning experiments accomplished with fish provide some of the best examples of density-dependent effects on an ecologically important parameter found in any group of organisms. Possible interspecific effects, however, are mentioned only in passing. In fact, the five pages on interspecific competition in fish, presented almost as an afterthought at the end of Nilsson's paper, are the extent of the book's coverage of this topic. This is rather remarkable when one considers that studies of the role of interspecific competition in structuring animal communities and its interactions with pre-

dation (exploitation) are cornerstones of current theoretical and empirical work in ecology. In his *Annual Review* paper Larkin noted that the world's fisheries provide evidence on a major scale of the effects of removing species from natural communities, "experiments" that for moral or financial reasons no ecologist can perform. Despite the examples of enormous compensatory responses by similar forms or changes in community structure due to exploitation of species, and despite the accessibility of small freshwater systems as sources of relevant data, fisheries biologists have generally ignored the role of interspecific competition.

This book, as was its predecessor, will be a useful reference for investigators concerned with fish. Fish offer many unique opportunities for the study (especially experimental) of ecological processes, and a large literature already exists on the natural history of fish that those of a more theoretical persuasion could mine. For my own part, I hope that this book is not so much a harbinger of the future as a record of the foundations from which a more ecological treatment of the structure of fish communities can emerge. Such a change would prove most profitable in the long run, not only for those interested in basic ecological theory but for those charged with the intelligent management of the world's fisheries as well.

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## Migration

**The Evolutionary Ecology of Animal Migration.** R. R. BAKER. Holmes and Meier, New York, 1978. xxii, 1012 pp., illus. \$85.

Migrants include animals as different as the fragile aphids and zooplankton and the massive tuna and blue whale. With migration patterns as varied as the sizes and locomotory capacities of the organisms displaying them, it is hardly surprising that, as Baker indicates in his preface, a diversity of viewpoints and terminologies have arisen among zoologists regarding the phenomenon of migration. Not for almost half a century has anyone attempted a perspective on the entire subject without taxonomic restriction. Such a perspective is what Baker has attempted here.

What we get is a book that runs on for some 922 double-columned pages of text in which it appears that no effort has been spared to increase the length in every way possible. Long explanations of trivial and often anecdotal examples and unnecessarily detailed elementary natural history are found throughout. The illustrations are accompanied by legends that often run to several columns of circuitous explanation. The logic of many of the illustrations escaped me. Some, such as the various photographs of pinnipeds and gorillas, were evidently included simply because of their elegance. There is also (so help me) a photograph of a moving van in the section on human migration. The failure to apply a strict standard of relevance and succinctness has no doubt substantially contributed to the price of the book.

This tome is divided into three parts. The first is an extensive discussion of the definition of migration, with an array of subdefinitions of its various components. Some of these do not follow standard usage, and indeed they include behaviors, such as exploration of a habitat beyond a local familiar area, that most zoologists would regard as having little to do with migration. But since the various definitions and redefinitions are used throughout the book it behooves the reader to learn them at the start. This is a considerable burden and is perhaps too much to ask, especially of students looking for a survey of the field. I found Baker's primary definition of migration as "the act of moving from one spatial unit to another" too broad, especially since it includes what he calls "accidental" migration (migration "due to a failure in the normal station-keeping mechanism of an animal"), on which natural selection is unlikely to act. Some definitions in this section I did find useful, such as the concept of the direction ratio as the percentage of individuals moving in each of the four main sectors of the compass.

Part 2 of the book is Baker's attempt at the development of a migration model. This effort turns out to be a fairly conventional one based on optimality theory, apparently arrived at independently of various other theoreticians using similar concepts. The optimal adaptation model is applied to an array of examples throughout the remainder of the book. The problem is that no unitary theory is likely to hold for all migrants unless it is so general that it becomes essentially unfalsifiable. This is the basis of Lewontin's recent critiques of optimality theory and the uncritical adaptationist view of evolution; these critiques are particular-

ly apt here. A further weakness of Baker's model is its failure to relate migration in any significant way to other aspects of the life histories of the animals concerned. Nor does Baker seem to understand the nature of constraints imposed by genetic and environmental variances and covariances. Where he does venture into life histories, he confuses issues, as is indicated by his obvious misunderstanding of Fisherian reproductive value. He seems not to realize that the use of reproductive value in island biogeography represented a special case of a more general theory; its relation to migration does not represent an "extrapolation" from island-migration to mainland-migration strategies, as he states. Baker further fails to distinguish between within- and among-species variation in fecundity with respect to colonization. Finally, he misrepresents what other authors, including this one, have said with respect to both reproductive value and life history traits.

The final section of the book, running to over 800 pages, is a survey of migration in various groups presented in the context of the optimality model. What is surprising is that although the book bears a 1978 publication date the literature citations virtually cease with 1972. There are some exceptions, but not many, and these seem to be work by friends or associates of the author's. The survey is thus woefully out of date, since the subsequent years have seen a great deal of activity in the study of migration patterns and their life history correlates. A listing of absent investigators would read like a who's who in current migration biology. There are also some odd omissions in the pre-1972 literature cited. David Lack's major papers on radar tracking of birds are cited, but those on the evolution and ecology of migration are not. None of C. J. Krebs's papers on *Microtus* appear, nor is there any reference to Boris Uvarov in the section on insects. Other examples abound. There are some strong sections, such as the one on bats, which suffers less than most from the lack of recent references, and the more dated but still useful one on pinnipeds, where Baker has managed to pull together data from a number of disparate sources into a comprehensive review and summary of the migration patterns of many species. Herpetofauna, however, are barely mentioned. The sections on human movements I found out of place, weak, and unconvincing, especially the thesis that human migrations are adaptations in the evolutionary sense.