such as faint stars could mimic a black hole. In fact, often there is no isotropy at all; fast rotation found for some nuclear star clusters may indicate that they are disk-like. Moreover, such disks could even be strongly bar-like, and if such a bar is seen end-on the observer will measure star velocities near the pericenters of very elongated orbits so that the velocities turn out to be much larger than the circular velocities at the same radius. Ignoring this effect would lead to an overestimation of the mass. It may be that the large mass-to-luminosity ratios found for some nuclear star clusters that have been interpreted in the literature as evidence for central supermassive black holes are—at least a part of them—due to this effect.

Even if a large mass-to-luminosity ratio is real, the presence of a black hole is still not the only explanation. An alternative explanation could be the presence of a cluster of dark stars, either of massive stellar remnants or of low-mass stars. Distinguishing between these alternatives could be an experimental task for the Hubble Space Telescope. New observational data coupled with detailed modeling of nuclear star clusters would lead to more reliable conclusions as to whether or not the nearby galaxies contain central black holes.

It would be very instructive to find out whether our own galaxy harbors a central black hole. The center of the Galaxy (being about 100 times closer to us than our nearest neighbor, the Andromeda galaxy) provides evidence for a black hole with a mass not exceeding a few million solar masses. Again, this evidence from stellar dynamics is suggestive but not fully convincing, and some other approaches indicate that the upper limit could be smaller by a factor of $10^2$ to $10^4$.

The above-mentioned problems of stellar system dynamics related to the presence of central black holes provide intellectual stimulus for a substantial fraction of the volume. But in the remainder readers can find no less fun associated with more traditional topics of stellar dynamics, mostly dealing with the specific conditions of dense environments. Some of these issues are: stellar systems with negative temperatures, various aspects of dynamical evolution of dense stellar systems, solving the collisional Boltzmann equation in general relativity, globular clusters in a pre- and post-collapse state, stellar collisions in dense stellar systems, binary stars and their influence upon the evolution of dense systems, and gravothermal processes in $N$-body systems.

As with many volumes based on workshop talks, this book suffers from the brevity of some papers, but gains in both the variety of topics covered and approaches taken. Most of the volume should be very helpful to research scientists and graduate students, who will find in it a lot of subjects for novel investigation, both theoretical and observational. For instance, there are many unresolved issues pertaining to the topic of late evolution of globular clusters and especially of galactic nuclei. Although vigorous development of the field may make unavoidable some aging of its content, this book will retain for a long time the charm of an initial period of work in the fascinating boundary domain between astrophysics and stellar dynamics.

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## Complexities of Ecology

**The Ecology of Bird Communities.** JOHN A. WIENS. Cambridge University Press, New York, 1990. In two volumes. Vol. 1, Foundations and Patterns. xiv, 539 pp., illus. $80. Vol. 2, Processes and Variations. xii, 316 pp., illus. $65.50. Cambridge Studies in Ecology.

In 1969, when John Wiens published his first major work on avian communities in *Ornithological Monographs*, community ecology was a growing discipline whose practitioners were full of optimism. The work of Robert MacArthur and his colleagues had established in the minds of many ecologists that the ecology of communities of plants and animals could be understood by appealing to a small number of general principles deduced from mathematical models of biological populations. MacArthur's favorite study organisms were birds, and his doctoral dissertation on wood warblers, published in 1958, had become a model study. By 1975, a consensus had developed among community ecologists regarding the interpretation of patterns in biological communities. Thomas Schoener's review of resource partitioning published in *Science* the year before stated the major conclusion of this consensus: that the differences in use of food and habitat by organisms of different species within a community were the result of competition between species for limited resources. The relative abundances of species in a community could be understood, and in some cases predicted, from the application of this simple idea.

It has been nearly three decades since MacArthur published his first paper, and the field of community ecology has witnessed a virtual explosion of research. In *The Ecology of Bird Communities*, Wiens reviews the substantial body of this research that deals with birds. The size of his review is a good indication of how popular the field of avian community ecology has become. One of the major themes underlying this monumental effort is the necessity of examining exciting ideas in the cold, hard light of data. Wiens argues that many of the ideas generated during the years when MacArthur had such a great influence over the development of community ecology, though logically sound, have not fared well when examined by rigorous field studies. To make this point, he spends two chapters in volume 1 discussing general principles underlying the collection, analysis, and interpretation of ecological data. He then examines many of the patterns that were used as validation of the ideas generated during the MacArthur period and suggests time and again that these ideas were either not supported by the results of field studies or not adequately tested. These empirical problems led community ecology into a decade of intense controversy.

At the center of the controversy documented by Wiens were two related ideas. The first was that competition is the major process determining the properties of species in a community. The second was the question of whether communities can be regarded as deterministic systems, as MacArthur had envisioned them, or whether they are "random" associations of organisms independently undergoing their life histories. These two ideas, and many corollaries of them, are discussed in volume 1 as Wiens reviews patterns documented by avian ecologists. Wiens concludes that to test these ideas rigorously, long-term, intensive studies of bird populations are necessary. Results obtained from studies such as those done by Peter Grant and his colleagues on the finches of the Galapagos Islands indicate that, although nature is more complex than the simple models of MacArthur allowed, there is at least some support for competition and deterministic processes as causes of observed patterns. The majority of the studies that Wiens reviews, however, are the results of one to at most three years of fieldwork, usually during the breeding season. Wiens maintains a healthy kepticism about the ability of such studies to rigorously test causal hypotheses because many of the processes that give rise to observed patterns are resolved on time scales much longer than two or three years.

In volume 2 Wiens deals with the difficult problem of explaining the patterns in bird communities that ecologists have documented. Interspecies competition is given considerable attention. After a careful review of definitions, Wiens examines the kinds of evidence that have been used to test hypotheses regarding competition. He concludes, "A good deal of the evidence that has been offered in support of the view that

competition plays a major role in producing community patterns does not go much beyond demonstrating an agreement between observed and expected patterns. If these patterns can be produced by no process other than competition, such inferences are justified, but this is rarely the case." Wiens discusses in detail in a later chapter additional processes that can generate the patterns used as evidence in support of the importance of competition.

The bulk of volume 2 contains a synthetic discussion of spatial and temporal aspects of community variation. Wiens concludes that many processes contribute to such variation. From the outcome of individual life histories to the patterns of speciation and extinction over geological time, processes operating at multiple scales contribute to the exceeding complexity of local communities. This richness of structure makes simple, single-factor models of cause and effect very difficult to apply to bird communities. Throughout both volumes, Wiens presents diagrams of alternative processes that might result in observed patterns. He suggests that careful consideration of all alternative explanations is critical in the design, analysis, and interpretation of bird community studies.

Despite the complexity of the ecological systems that birds live in, patterns in assemblages of birds still exist. Species are different ecologically, and they often occur in nonrandom combinations. MacArthur's explanations for these patterns may have been too simple, but his approach to asking questions about communities revolutionized the field. The questions MacArthur asked injected a sense of excitement into community ecology. Because of this, MacArthur became the heart of the field. But if MacArthur was the heart, Wiens has been the conscience. History may remember MacArthur for his ability to ask interesting questions, but it is the less glamorous, methodical approach to looking for the answers advocated by Wiens that makes science work. The legacy of MacArthur was not in the answers he provided but in the questions he asked and how he asked them. Wiens simply suggests that the answers are far more interesting than we originally suspected.

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