Book Reviews

Effects of the Sun

The New Solar Physics. Papers from an AAAS symposium, Denver, Feb. 1977. JOHN A. EDDY, Ed. Published for the American Association for the Advancement of Science by Westview Press, Boulder, Colo., 1979. xxiv, 214 pp., illus. $17.50. AAAS Selected Symposia Series, 17.

This slim symposium volume presents the current status of research in several areas of solar physics. The book begins with a delightful introductory essay by Eugene Parker on the importance of solar physics to astronomy. This contribution alone is worth the price of the book and should be required reading for all astronomers—solar and nocturnal.

The remaining four review papers, although uneven in style and depth of coverage, will give the serious advanced student a solid overview of the inconstancy of the sun as evidenced by tree rings, solar neutrinos (or rather the lack of them), the solar origin of the solar wind and interplanetary magnetic fields, and solar oscillations of various sorts and frequencies.

The solar oscillation review, by Henry A. Hill, to pick an example, gives a thorough look at a new and exciting subject. Oscillations of the solar diameter with periods longer than five minutes, which have been found by Hill and his co-workers in studying the solar oblateness, represent global effects that promise to give us fundamental data about the interior structure of the sun. Some investigators are skeptical about the reality of these oscillations, and the observational discrepancies that lead to such skepticism are examined in detail by Hill. The five-minute oscillations, for which there is solid observational evidence, are now viewed as global nonradial acoustic waves trapped below the photosphere. Both sets of oscillations allow for the first time a "seismic" probing of the deep solar convective envelope. This is a truly exciting prospect; solar physicists now have a tool that will allow them to probe below the solar surface to determine, for example, the depth of the convection zone and the rotation rates of subsurface layers. The first results are only now beginning to come from this important research, and the possibilities for the future seem enormous.

In another of the reviews John A. Eddy discusses evidence for a changing sun. This evidence—most of it arboreal—supports earlier conclusions about long-term solar activity. These conclusions are based on historical records of sunspots, auroras, and the corona seen at eclipse and on radiocarbon data. The evidence discussed by Eddy confirms the existence of the Maunder minimum, the quiet period in solar activity from about 1645 to 1715, along with other maxima and minima extending back to about 5000 B.C. This valuable information is available from tree rings because of the happy coincidence that the amount of ^{14}C that is produced in the upper atmosphere of the earth and makes its way into organic materials such as tree rings is modulated by the level of solar activity. This happens because the high-energy galactic cosmic rays that produce the ^{14}C in the earth's atmosphere vary in intensity as the solar magnetic fields in interplanetary space vary. Stronger magnetic fields tend to shield the earth from cosmic rays. Thus, with tree rings to fix the date, investigators have stepped back through time to create a yearly index of solar activity. This index is found to correlate remarkably well with climatic variations, which are known fairly well over the last 1000 years. Lower solar activity correlates with colder temperatures on the earth. The mechanism for this relationship remains a mystery, although, as discussed by Eddy, the interplanetary magnetic fields themselves may play an important role. Clearly this is an aspect of solar physics that has implications for the well-being of our civilization.

The subjects covered by the other two reviews in the book are just as new and exciting and have just as much promise for advancing our understanding of the sun and other stars. The volume belongs on the shelf of every astonomer.

ROBERT HOWARD

Hale Observatory,
Pasadena, California 91101

Stellar Deaths

Planetary Nebulae. Observations and Theory. Papers from a symposium, Ithaca, N.Y., June 1977. YERVANT TERZIAN, Ed. Reidel, Boston, 1978. xxii, 376 pp., illus. Cloth, $37; paper, $24. International Astronomical Union Symposium No. 76.

Planetary nebulae are believed to result from the explosive ejection of the outer layers of stars that have exhausted their available nuclear energy sources. For high-mass stars the gravitational collapse that follows the extinction of the energy source leads to a supernova explosion, whereas for stars of one to several solar masses the process is much less violent and results in a planetary nebula, a luminous expanding shell ionized by the hot remnant of the stellar core.

The planetary nebula phenomena last about 10^4 years, and the space density of known planetary nebulae is in approximate agreement with the expected death rate of solar-mass stars. Modern spectroscopic observations have succeeded in producing a consistent picture of the ionization structure, dynamical evolution, energy balance, and crude chemical composition of planetary nebulae. However, many of the details are not understood. The physical process that produces planetaries, the nature and evolution of the stellar remnant, chemical abundances and the role of dust in the dynamics, energy balance, and abundance of heavy elements are all subjects of current research.

International Astronomical Union Symposium No. 76 brought together researchers to discuss outstanding problems concerning planetary nebulae. The published proceedings of the symposium contain the review papers, abstracts of the contributed papers, and the very informative discussions that followed each paper. Among the important advances that have occurred in the past decade have been the discovery of dust in planetary nebulae shells (discussed by Balick and by Mathis), the discovery of the H_2 molecule in the shell (Rank), the technical advance of instrumentation that has led to accurate emission-line intensities (Miller, Gurzadyan, Pottasch, Rank, Terzian), and a substantial advance in the theoretical models of the expanding nebular shells (Harrington, Mathews). Workers are also beginning to construct accurate models of the central star (Hummer, Lutz, Shaviv, Paczyński), an important development if we are to fully understand the planetary nebula phenomenon.

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.

E. JOSEPH WAMPLER
Lick Observatory, University of California, Santa Cruz 95064

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 circumscribed 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 Hepher'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 $3^1/_2$ 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 indeterminant 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-