cranes with foster sandhill cranes are of great interest both to conservationists and to behavioral scientists.

The breeding of endangered species in captivity and the associated problems of the genetics of small populations and of reintroducing captive-raised birds into the wild receive considerable attention, and the papers on the maintenance of genetic diversity associated with such situations are of special significance. Last, there is a group of papers on integrated approaches to the management of endangered birds.

The book is printed on paper of moderately good quality and has 31 photographic illustrations. It should obviously be part of the library of any biologist concerned with the conservation and management of endangered bird species.

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Ecology Since Colonial Times

History of American Ecology. With an introduction by Frank N. Egerton. Arno, New York, 1977. Unpaged; illus. $25. History of Ecology.

Why has so little work been done on the history of ecology? The history of most other areas of modern biology, such as molecular and population genetics, physiology, and developmental biology, has been extensively explored, and studies of Darwin are in full flood. Yet the rise of ecology, a science whose roots lie intermingled with those of evolutionary theory, has been generally ignored by historians of biology. The present collection of papers assembled by one of the few historians of ecology, Frank Egerton, is testament to this. Of the nine papers seven (all previously published) were written by working ecologists between 1958 and 1976 and reflect the heterogeneous viewpoints of individuals embedded within the matrix of the history.

The first two long pieces in the book simply recount facts about ecological endeavors from colonial times to the present. Egerton describes the transformation of 18th- and 19th-century natural history into four self-conscious disciplines, limnology, oceanography, plant ecology, and animal ecology; and he identifies the important role that the practical needs of medicine, agriculture, and wildlife and resource management played in structuring ecology up to 1900. Robert McIntosh continues the narrative into the 20th century by detailing the introduction of theoretical concepts and the establishment of a strong tradition of mathematical analysis through the construction of ecological models.

Animal ecology is represented by only a single paper recounting the interplay of economic and scientific trends in fisheries research; and a narrow, though important, aspect of the history of limnology is described in an account of the growth of freshwater studies in Wisconsin. The latter essay makes clear the incredible productivity and significance of the lifelong collaboration between E. A. Birge and Chancey Juday in laying the empirical foundations of midwestern lake studies.

There follow no fewer than four papers on the development of community concepts in plant ecology over the last century and one institutional history, an accounting of the Ecological Society of America, its geographical origins and numerical growth. Only one of these papers attempts a broad analysis, this a study of the American grassland research community using sociological and bibliographical data to test current philosophical notions concerning the way science is done. I was left with a curiously dry taste after all the graphs had been read and felt that the creativity and influence of midwestern plant ecology had been lost from view in the push for quantitative currency. In two of the papers, both dating from the '50's, two plant ecologists argue their own alternative interpretations of plant associations. McIntosh returns with an assessment of H. A. Gleason, Gleason's "individualistic" concept of species distribution, and the long-delayed influence of his ideas on the understanding of plant communities. Perhaps the most important theme to emerge from the several treatments of plant ecology is the overwhelming influence of one man, Frederick Clements, and the dominance of his concept of the plant community as a developing organism.

Overall, this book is not a "history of American ecology" but a collection of primary essays that provides a bibliographical beginning and suggests some possibilities for future work. The problem with the history of ecology seems to be that many of the critical questions have yet to be asked. Darwin was, above all, a remarkable ecological observer; why was the evolutionary side of ecology lost until the second half of this century? Why did ecology first emerge from a somewhat Lamarckian conception of the ontogeny of plant communities, and how did animal population ecology find its way into this view? Why did most early American ecologists grow up and work in the Midwest, and how much is the nature of creativity in ecology influenced by a worker's origins or choice of organisms and habitat? When and how did theoretical ecology eventually establish its legitimacy in the face of a strong tradition of empirical and field work, and what was the role of the greatest living ecologist, G. Evelyn Hutchinson, in bringing a British (Cambridge) philosophical tradition to bear on both community and population ecology? What is the relation between the history of the academic abstractions seen in modern ecology and the immense environmental impact humans have long had on their surroundings? The study of the history of ecology has barely begun, and the present volume represents an important step. The field for fruitful analysis is wide open, and I hope historians will not leave it for ecologists to till alone.

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Processes in the Magnetosphere

Geomagnetic Diagnosis of the Magnetosphere. A. NISHIDA. Springer-Verlag, New York, 1978. viii, 256 pp., illus. $38.80. Physics and Chemistry in Space, vol. 9.

The field of magnetospheric physics is still developing rapidly as new and crucial observations are made and interpreted. The discoveries of such major phenomena as the plasma mantle and regions of field-aligned electric fields a few thousand kilometers above the ionosphere have had an enormous impact on the field, yet were made less than half a decade ago. Thus the subject is difficult to deal with in a book, because theories and analyses of data may be obsolete by the time the book is published. Given these constraints, Nishida's book, which deals with the geomagnetician's view of the magnetosphere, will prove to be a valuable addition to the libraries of both graduate students and professional space scientists. The treatment of the various aspects of geomagnetic perturbations is both comprehensive and modern, and each section of the book contains just enough material to give the reader a good overview and provides the necessary references for those who want more than an overview.

If there is any weakness in the book, it is the author's tendency to pass over the controversies that have swirled (and

continue to swirl) around certain topics. For example, the nature of DP 2 fluctuations is still a matter of some controversy, centering around whether the causative current system is merely a variant of one of the previously known current systems (for example, DS) or is something unique and different. A second example concerns substorms, which Nishida discusses in the framework of the neutral line hypothesis. There is, in fact, a strong school of opinion that contends that substorms do not involve the formation of near-earth neutral points in the region of the neutral sheet. In both of these cases, Nishida neglects to mention the opposite points of view, leaving the impression that there is no disagreement about the points of view expressed in the book. Despite this, I feel that the book is one of the most comprehensive, up-to-date works dealing with magnetospheric physics that is available.

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Binary Systems

Double Stars. WULFF D. HEINTZ. Reidel, Boston, 1978. x, 176 pp., illus. Cloth, $29; paper, $14. Geophysics and Astrophysics Monographs, vol. 15.

Dynamics of Close Binary Systems. ZDENĚK KOPAL. Reidel, Boston, 1978. xiv, 514 pp., illus. $65. Astrophysics and Space Science Library, vol. 68.

Wulff Heintz begins the preface to his book, "Double and multiple stars are the rule in the stellar population, and single stars the minority, as the abundance of binary systems in the space surrounding the sun shows beyond doubt." This fact, slow in dawning on the astronomical community, is still not widely appreciated—its implications for nucleosynthesis, galactic evolution, and population synthesis remain largely unexplored. And yet the opening of new regions of the electromagnetic spectrum to astronomical inquiry and investigations of peculiar stars have inundated us with exotic objects of known or suspected duplicity in such a profusion of guises as to confuse newcomer and authority alike. The pace of exploration has so outstripped the assimilation of its results that any discussion that purports to bring order to the subject deserves attention.

Zdeněk Kopal, author of numerous astronomical texts, is a veteran of nearly half a century's labor on problems connected in one way or another with the interaction of two stars in a binary system. As early as 1934, when it was decidedly unfashionable to do so, he ventured a discussion of the evolution of binaries. Our understanding of these objects has undergone several metamorphoses since then, and to Kopal goes credit for a number of important contributions to the subject, most notably the popularization of the Roche potential in describing the geometry of binary systems. His book *Close Binary Systems* (Chapman and Hall, 1959), now out of print, was a landmark in the development of the subject and remains widely cited.

Kopal's avowed purpose in writing this new monograph is "to provide a comprehensive account of our present knowledge of the theory of dynamical phenomena exhibited by close binary systems; and on the basis of such phenomena as have been attested by available observations to outline probable evolutionary trends of such systems in the course of time." The sense attached here to the word "dynamical" is purely a mechanical one: figures of equilibrium, dynamical tides, generalized rotation, orbital dynamics, the Roche model, and the secular and dynamical stability of self-gravitating configurations of arbitrary structure, in the order of their appearance (chapters 2 through 7). The treatment does not extend to hydrodynamical or magnetohydrodynamical phenomena, such as the physics of mass loss or mass accretion.

The greater part of this book thus deals with subjects that have been the focus of much of Kopal's own research, and of that of his students at the University of Manchester, in the two decades since the publication of *Close Binary Systems*. Much of the presentation parallels that of the earlier volume (and of Kopal's *Figures of Equilibrium of Celestial Bodies*, University of Wisconsin Press, 1960), as developed and elaborated by Kopal and co-workers in a long series of articles in the journal *Astrophysics and Space Science*, which Kopal edits. Indeed, portions of the text are repeated practically verbatim from these sources, but they are welded together in nearly seamless fashion. Omitted from the present volume, but promised in a future work, are the observational aspects of the subject—light and radial velocity variations—that were dealt with in *Close Binary Systems*.

Dynamics of Close Binary Systems is unmistakably out of the same mold as Kopal's earlier works and shares their strengths and weaknesses. The presentation is extremely formal but eminently readable. The mathematical development of each subject is given fully. If so expansive a treatment occasionally borders on tediousness, it is nevertheless an enormous help to the novice in coming to grips with a mathematically complex subject. The author rarely ventures far beyond his own published studies of dynamical processes, but he continues the laudable practice of *Close Binary Systems* in providing extensive bibliographical notes at the end of each chapter.

Ultimately, however, the severely classical approach Kopal adopts is likely to prove more satisfying to the mathematician than to the astrophysicist. The attempt to divorce mechanical aspects of a problem from their underlying physical processes and astrophysical context frequently leaves a wide gulf between the mathematical framework developed and its application. (A notable exception is the discussion of apsidal motion.) Thus, for example, convection scarcely rears its ugly head during the discussion of dynamical tides (it never has been amenable to rigorous treatment), although where it occurs it utterly dominates all other sources of dissipation. The reader is likely to find the classic series of papers on this subject by J.-P. Zahn of far greater utility in astrophysical applications, though Zahn's work receives only the scantiest of recognition here. It is the stress on what are mathematically well-defined problems that flavors the six central chapters of Kopal's book.

The final chapter deserves special comment. Addressing the broad question of the origin and evolution of close binary systems, it promises fulfillment of the second half of the author's stated goal. In fact, it is as much a personal statement of philosophy as an overview of the subject. The author aims many barbs at the way in which one or another problem has been handled theoretically (see, for example, the amazing broadside leveled at studies of eruptive binaries on p. 472). These criticisms are well taken, and we should applaud the author all the more for them did he not himself indulge in the ad hoc concoction of "scenarios" he so vehemently condemns. Thus we encounter speculations concerning chemically homogeneous evolution among progenitors of Algol-type binaries or the birth of cataclysmic binaries in the fission of the rapidly rotating cores of red giants that are easily excluded on observational grounds. The chapter is extremely uneven: it contains a well-argued account of the classification of binary systems by degree of detachment, for instance, but also a disturbing number of factual misrepresentations (for ex-