

ductive strategies of male and female nonhuman primates is more accurate and exhaustive than any that has previously been attempted. If her bibliography has any shortcoming, it lies in its failure to deal with research on birds and nonprimate mammals. This omission causes her treatment of theoretical issues to be rather myopic in that it fails to give credit to the many scientists whose hypotheses laid the groundwork for later research on monkeys and apes. In its treatment of primate behavior, however, Hrdy's book has no peers, and it provides the layperson with a fascinating account of the selective pressures that have shaped the behavior of males and females.

Unfortunately, in the course of these explanations Hrdy occasionally lapses into a loose style that detracts from the book's scientific quality. For example, the sentence "Females can be dominant, subordinate, equal, or not interested" confuses levels of causation. Indeed, in Hrdy's book very few attempts are made to inform the uninitiated reader that a given pattern of behavior can be explained in both proximate and ultimate terms. Similarly, though Hrdy implies that ecological factors are the primary determinants of female sociality, she also states that kin groups provide females with essential allies against male dominance. Because little distinction is made between the selective factors that give rise to a given pattern of behavior and those that help to maintain it, it is never clear whether Hrdy believes that alliances against males are a cause or a consequence of female sociality. Throughout the book, also, females of different primate species are variously described as "wretched," "privileged," "ruthlessly exploited," or sexually "insatiable." Such adjectives are clearly meant to enliven what might otherwise become a rather dry scientific treatise, but they detract from the otherwise commendable review of female reproductive behavior by seeming to imply that one sex is somehow better or worse than the other.

Hrdy has marshalled considerable empirical evidence that competition and manipulation are as much a part of women's evolutionary past as they are of men's. But how much does our evolutionary past influence us today? Does it severely constrain the extent to which our present-day behavior can be altered, or does it merely serve as a backdrop to contemporary behavior, of academic interest but not directly relevant? The degree to which there may be genetic predispositions, inherited from our ancestors, to behave in certain ways is never

directly addressed. Hrdy makes no attempt to evaluate the relative contributions of genes and the environment to our behavior, and in this sense her hesitant conclusions belie the bold stance taken in earlier chapters.

Clearly, the evolutionary origins of female behavior are far from well understood. Despite its limitations, Hrdy's book redresses some serious imbalances and inaccuracies. It makes an interesting and provocative read and should serve as a stimulating alternative to many existing popular accounts of the evolution of human behavior.

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Neutron Stars

Pulsars. Papers from a symposium, Bonn, Germany, Aug. 1980. W. SIEBER and R. WIELEBINSKI, Eds. Reidel, Boston, 1981 (distributor, Kluwer Boston, Hingham, Mass.). xvi, 476 pp., illus. Cloth, \$60.50; paper, \$28.95. International Astronomical Union Symposium No. 95.

The discovery of pulsars in 1967 by J. Bell-Burnell and A. Hewish ranks as one of the central events in what has been a "golden age" in astronomy. Although the initial excitement and activity have ebbed, advances continue, and a retrospective on the accomplishments of the past 13 years is long overdue.

This volume contains contributions from most of the experts and more than fills the bill. Sixty-five papers, including nearly 30 reviews of uniformly high quality, discuss the most up-to-date theories of pulsar magnetospheres and the pulsar emission process and describe the vast store of observational data that has been accumulated on everything from marching subpulses to timing glitches. As a whole, the book provides an indispensable synopsis of research on pulsars for the experienced investigator. Although it is written at an advanced level, the book can be a source of fascinating observations and entertaining ideas for the casual reader with a strong background in physics and astronomy.

Despite the dogged efforts of both observers and theorists, a confident explanation of the way in which pulsars are born and die still eludes us. In a paper about the relation between supernovas and the formation of pulsars, Chevalier details the present unsatisfactory state of supernova calculations. Ruderman, in a lively paper on pulsar evolution, dis-

cusses the possibility that pulsars turn off because their rate of spin decreases, and Manchester, in a review of radio timing observations, considers the possibility that pulsed emission ceases because the magnetic field decays.

More embarrassing, we lack a fundamental understanding of the central feature of pulsars: the emission of intense and coherent radio pulses. Ideas about how the pulses are produced are reviewed nicely in papers by Arons, Melrose, and Ferguson and in the paper by Ruderman. Papers by Cordes, Smith, and Bucccheri detail the considerable constraints on these ideas imposed by radio, optical, and x-ray observations.

Singular as the pulsar phenomenon is, the knowledge gained from pulsars has had an important impact on a wide range of topics in modern astrophysics. The very existence of pulsars, and therefore neutron stars, has provided a critical impetus to studies of the forces between nucleons and the properties of matter at extremely high density. Canuto and Bowers concisely describe the results of these studies. The behavior of PSR 1913 + 16, the famous pulsar in a binary, has provided new and stringent tests of the general theory of relativity, as is documented by Taylor. Pulsar emission provides the motivation not only for investigations of the emission mechanism itself but for studies of pulsar magnetospheres; Mestel describes the incomplete state of our knowledge of these structures.

Magnetic neutron stars appear as the principals in a second important phenomenon: pulsing x-ray sources. Study of these sources has yielded complementary information on magnetospheric structure and on radiation processes in superstrong magnetic fields. Papers by F. Lamb, Zheleznyakov, and Ventura discuss aspects of these topics. When neutron stars occur (either as pulsars or as pulsing x-ray sources) in binary star systems, their pulsing provides a precise clock that can be used to determine both the masses and the separation of the two stars. Kelley and Rappaport show how this technique has been used to determine the masses of six neutron stars, and Taylor reports the information that has been obtained in the cases of the three known pulsars in binaries. The latter systems pose a riddle for stellar evolution, since the short-period (eight-hour) binary has a highly elliptical orbit whereas the two wide binaries, with periods of one day and three years, have highly circular orbits. One expects just the opposite, because the explosion creating the pulsar produces a more elliptical

orbit if the binary is wide, and in a wide binary tidal effects are less effective in circularizing the orbit. Possible ways out of this difficulty are suggested by Blandford and DeCampli and by van den Heuvel, who also discusses the multifarious ways nature may make pulsars.

Thanks are due to the authors, the editors, and the scientific organizing committee of IAU Symposium No. 95, who have laid before us a feast of facts, ideas, and speculations on a subject that continues to delight and amaze.

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