The book does not deal with other interesting aspects of the subject, such as comparisons of ectotherms and endotherms and hormonal thermoregulation. However, it is nearly impossible to cover all facets of temperature regulation in a book of this size. The author's intention was to concentrate on thermal reception and related thermoregulatory mechanisms, and the book gives excellent and thorough coverage of them.

The references are selected carefully and provide an overview of the contemporary issues of temperature regulation.

The book is a useful introduction to temperature regulation as well as an evaluation of current work on the subject.

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Females as Strategists

The Woman That Never Evolved. SARAH BLAFFER HRDY. Harvard University Press, Cambridge, Mass., 1981. xiv, 256 pp., illus. $17.50.

Popular books dealing with the evolution of human sexual behavior have tended to fall into one of two distinct categories. First there have been those by authors who have reified the "man the hunter" stereotype, arguing that the development of hunting has had profound influence on human evolution. Under this scenario, males are both the cooperative and the competitive sex, on the one hand cooperating with each other in the demanding pursuit of game, on the other hand competing with one another for mates. Male bonding (as exemplified today in Löwenbräu commercials) is viewed as having ancient evolutionary antecedents, and females are portrayed as mere baby-producing machines, whose reproductive functions demand neither cooperation nor competition with others of their sex. To the extent that intelligence and speech have evolved as the result of selective pressures placed on early man to hunt, these uniquely human attributes are, by implication at least, virtually sex-linked.

This view of human evolution, long championed by anthropologists and other social scientists, has recently been challenged by authors arguing that food gathering, a traditionally female task, was easily as important as hunting to the evolution of human behavior. Though food gathering is thought to have exerted strong selective pressures on intelligence and technological skills, proponents of this view are not agreed about the importance of competition and cooperation in the evolution of female behavior. The reproductive success of females is assumed to be less dependent than that of males on competition for mates, and as a result it is often argued that there has been little selection for competition or aggression in women. Some accounts argue that female subordination to males is a relatively recent event and stress women's alleged equality with or even domination over men in ancient times. As for cooperation, female bonding is often advocated by feminists, but there seems to be no firm consensus about the evolutionary role of female cooperative behavior. Indeed, in some accounts the ability of human and nonhuman primate females to form strong social bonds is denied entirely.

Despite their differing opinions, most books promoting these two views have shared one overriding characteristic: a level of ignorance of research on the behavioral ecology of birds and mammals that almost takes a conscious effort to achieve. To the limited extent that such works refer to research on nonhuman primates, they tend to draw selectively and inaccurately from the literature, and their references are often as much as 20 years out of date. Unfortunately, however, such insouciant hypotheses dominate popular accounts of the origins of human sexual differences.

Given this sorry state of affairs, *The Woman That Never Evolved* is a competent alternative. According to Hrdy, the woman that never evolved—the woman who cooperates with others and possesses none of the nefarious competitive traits of the opposite sex—is a myth invented by social scientists, and her intention is to set the record straight. In marked contrast to authors of previous popularizations, she has extensive knowledge of nonhuman primate behavior to bring to bear on the subject. Hrdy regards the behavior of present-day monkeys and apes as providing a model for the evolution of human female behavior. She further argues that the reproductive strategies of female nonhuman primates demand an almost Machiavellian ability to balance cooperation and competition in the manipulation of others for access to scarce resources and mates.

When male and female birds or mammals mate, the initial contribution of each sex to the fertilized egg is unequal, since, relative to the sperm, the larger egg is energetically more costly to produce. In mammals this initial inequality extends beyond gestation into lactation. The fundamental imbalance in parental investment is thought to have profound influences on the mating strategies of each sex. Evolutionary biologists have argued that the reproductive success of females is limited largely by the energy they can invest in the fertilized egg, whereas the reproductive success of males is limited primarily by the number of females they can fertilize. Because the upper limit on a female's reproductive output is set by nutritional requirements, the distribution of food should have an important effect on female behavior. Whether or not females forage singly or in kin groups should be determined by whether food is evenly or patchily distributed, rich or poor in quality. The distribution of males, on the other hand, is more a function of the distribution of females. The ability of males to monopolize more than one mate will be determined by whether or not it is in the females' interest to form groups.

Because it is advantageous for males to mate with as many females as possible, behavioral ecologists argue that monogamy should evolve only when females space themselves in such a way that each male simply cannot control access to more than one mate, or when male parental care is essential for the offspring's survival. Most species of birds are monogamous, probably because both parents are needed to feed the clutch. In mammals, however, males have largely been freed from direct parental care, since lactation places the burden of feeding the young squarely on the female. Perhaps as a result, most mammalian species are polygynous.

Sexual dimorphism is usually greater in polygynous than in monogamous species. Because a male can potentially monopolize many mates, competition among males for females is often intense, favoring the evolution of large body size, big teeth, and so on. A by-product of such intense sexual selection is that males become larger and stronger than females and are able to dominate females in social interactions. It is with this aspect of our primate heritage that Hrdy's book is concerned.

The Woman That Never Evolved is a schizophrenic book, calling for a schizophrenic review. At times I was annoyed by Hrdy's almost excessive efforts to show that females can be as competitive, manipulative, and sexually active as males. Then I remembered the rubbish that has preceded her book and wondered whether some hyperbole might not be justified. Hrdy's review of the repro-

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, discusses 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