Reproductive Behavior

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rhythm of seed germination (N. Garwood). In addition, much of the strength of the remaining chapters is derived from the burgeoning botanical expertise of workers on the island, a tribute largely to the excellent recent flora by T. Croat and the patient tutelage of R. Foster.

Reports on long-term studies of animal populations constitute another major contribution. Nearly all of these clearly show the effects of good and bad years on the key demographic processes of recruitment and mortality. The most significant of these studies, on howler monkeys, goes back nearly 50 years to the work of Carpenter. The account of changes in age structure, birth rate, and age-specific mortality during periods of rapid increase and subsequent stability provides important insights into the processes regulating this population and surely constitutes the best demographic study to date of a rain forest mammal (K. Milton).

I have intentionally concentrated on strengths in this review because in so massive a tome anyone can find defects to suit his or her taste. There are gaps in the picture, such as the lack of any data on vertebrate predation or on the growth rates of trees. Certain figures are ambiguous or incomprehensible owing to lack of adequate captions or other deficiencies. In general, though, the editors can be praised for having done their job thoroughly. Altogether, this is an outstandingly fresh and significant work, with enough interest and scope to serve as a textbook. Most remarkably for a collection of papers, it contains a prodigious volume of new data. In the field of tropical ecology it is clearly a landmark and can be expected to stimulate comparative studies for many years to come.

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Mate Choice. PATRICK BATESON, Ed. Cambridge University Press, New York, 1983. xvi, 462 pp., illus. $59.50; paper, $19.95. Based on a conference, Cambridge, England, July 1981.

Charles Darwin brought to the attention of biologists mate choice, and particularly female choice of males, as a key element in understanding sexual pairing in animals. He and Wallace disagreed over the importance of female choice, and with the publication of *Mate Choice* it is apparent that this issue is not yet resolved. Ten of the 21 papers in this book focus on female choice in species in which males make no material contributions to females or their young. The ultimate basis for female choice in such mating systems has become one of the most controversial issues in evolutionary biology, and its emphasis in this book is timely and appropriate.

Females within polygynous populations often tend to show distinct preferences for a few males. It is commonly suggested that favored males are good sires. Current debate has centered on what evolutionary processes have shaped female mate choice. Authors in this book consider this and many other hypotheses.

Bradbury and Gibson present an insightful review of hypotheses concerned with the evolution of lek mating systems in birds and mammals. Leks deserve special attention because females are able to make mating decisions uninterrupted by male control and uninfluenced by material contributions made by males. Bradbury and Gibson evaluate factors affecting lek placement and favor the "hot spot" hypothesis over many other models including Bradbury's earlier home-range model. The causes of male aggregation and the basis for female choice are also considered. Bradbury and Gibson challenge the commonly held view that males preferred by females often hold central positions on leks and that females can use male position to judge the quality of prospective sires.

A much-needed description of recent models of runaway sexual selection is presented by Arnold. He endorses the runaway process as critical in explaining the extreme development of male display characters commonly seen in polygynous species. Arnold's valuable characterization is flawed by his suggestions that other good-genes models predict group-wide optimization of fitness and that males evolve maladaptive display characters. Recent sexual selection models are based on intersexual conflicts of interest that predict no such optimization. Display characters may lower male survival rates, but they evolve because they enhance individual male fitness. There is good reason to suspect that the runaway process may be important in sexual selection. However, the absence of any strong empirical support and the still primitive development of sexual selection theory suggest that Arnold's enthusiasm for the runaway process may not be justified.

O'Donald has been the most active modeler of the runaway process. His review of his earlier modeling efforts, a candid admission of a fundamental misunderstanding of the operation of runaway, and discussion of possible problems of polygenic models of sexual selection call attention to this paper.

Two wide-ranging reviews of mate choice are provided by Halliday and Partridge. Halliday embraces LeCroy's suggestion that females on leks don't really choose males. Bright plumes, common among polygynous birds, are said to evolve exclusively for male-male display. No convincing evidence is provided that supports this view, and Halliday fails to explain its major weakness: if female choice isn't the basis for lek formation, why do males group in leks and females find it necessary to attend these leks? Partridge reviews the rare male effect, effects of inbreeding and outbreeding, and the effect of polygynous mating on the loss of heritable genetic variation. She draws on a large body of literature in discussing each of these problems, but in most cases her conclusions are limited by the lack of appropriate data.

Parker suggests that much male display is associated with simple advertisement and that males better able to advertise will attract more mates. Thus, many male display characteristics commonly considered products of active female choice may be products of male advertisement. The economy of this approach makes it attractive because it circumvents many of the problems that arise when female choice operates. Such a model is useful for explaining long-distance female attraction to males but cannot explain female discrimination in favor of particular males once the female has moved within a male aggregation.

Arak is able to draw on a large number of studies of mate selection in anurans. He emphasizes the high cost of interspecific mismating and implies that frogs are especially susceptible to such errors. This may be due to the explosive breeding common in many species. The relatively sophisticated type of choice observed in species with long breeding seasons, such as bullfrogs, suggests that intraspecific discrimination may be important in some anurans.

Rowley's detailed review of re-mating in long-lived birds and Coulson and Thomas's summary of their work on kittiwake mating behavior deserve special attention.

The papers in this collection vary greatly in quality. Too frequently sentences appear that are uninterpretable, few new ideas are presented, and many topics that could have been covered are

omitted. Nonetheless, there is no volume that provides a better collection of ideas on mate choice. If you are interested in mate choice you must read this book.

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The Plasma State

Physics of Ion-Ion and Electron-Ion Collisions. F. BROUILLARD and J. W. MCGOWAN, Eds. Plenum, New York, 1983. xii, 538 pp., illus. $69.50. NATO Advanced Study Institutes Series B, vol. 83. From an institute, Baddeck, Nova Scotia, Canada, Sept. 1981.

The study of matter in the ionized and plasma state encompasses a wealth of interesting problems associated with the various subfields of physics. It exhibits its closest connection with atomic and molecular physics, and the present book establishes that connection quite firmly by illustrating how atomic and molecular physics provides the key to understanding the structure and underlying collisional energy pathways of the plasma state.

The book serves as another excellent reminder of the significant advances that have been made in the past 25 years in the field of atomic and molecular physics and of the contribution the field has made to the study of astrophysics, controlled thermonuclear fusion, and lasers. It provides a clear review of the ionized state in astrophysics and in thermonuclear fusion, together with detailed discussions of the appropriate theoretical quantum mechanics and laboratory experiments for the rates and cross sections of certain specific collisional mechanisms.

Not only does the formation of a plasma in the laboratory represent a complex sequence of atomic and molecular energy-change processes, the plasma state, which may last anywhere from a few microseconds in some high-energy plasmas to a few hours (as in a low-density glow discharge), is controlled by a dynamic balance of various recombination-dissociation processes.

The recombination of electrons and of ions to form neutralized species, or other ion-pair systems, determines the ionization structure of plasmas. The analysis of the recombination spectrum associated with the removal of the excess energy of recombination by the emission of radiation is a powerful diagnostic probe of the physical environment in which the emitting species resides. The formation of ion pairs H^+ and H^- by dissociative recombination between electrons and hydrogen molecular ions has attracted considerable attention from the thermonuclear fusion community, which is interested in producing high-current H^- ion sources for neutral beam injectors.

Dalgarno sets the astrophysical scene in a particularly interesting, lucid, and engaging chapter on the roles of electron-ion and ion-ion collisions in astrophysics. The physical conditions here range from the cold, weakly ionized molecular clouds associated with gaseous nebulas (for which the sources of ionization are energetic cosmic rays) to the hot, highly ionized solar and stellar corona (for which the sources of ionization are thermal electrons heated by shocks driven by supernova explosions in the disk of the galaxy, supplemented by absorption of x-ray and ultraviolet photons associated with the recombination spectrum) and comets and planetary atmospheres (which are ionized by solar ultraviolet radiation). The chemical energy-change pathways appropriate to the various physical conditions are concisely described by Dalgarno.

Post then provides a comprehensive account of the role of atomic collisions in magnetic and inertial controlled fusion research. He discusses the hot central plasma, where fusion reactions occur; the plasma edge, where the plasma interacts with the external environment; methods for the production of the hot plasma; and techniques for the diagnosis of the physical properties of the plasma. Both Dalgarno and Post furnish fairly exhaustive lists of references.

The subsequent ten chapters deal with the theoretical and experimental methods required to yield detailed cross-section information on specific collisional mechanisms, such as electron impact excitation and ionization of atoms and ions, electron-ion and ion-ion recombination, and ion-atom charge transfer collisions.

Although quantum mechanical scattering theory is in principle a well-documented subject, extensive theoretical development is still required for implementation of the various working models associated with the various collisional mechanisms. Also, the recent advent of intersecting beam ion traps and laser excitation techniques has provided much more sensitive and wide-ranging approaches to recombination experiments than were previously available.

The present vigor of the field is well characterized by the theoretical developments and new experimental techniques discussed in this book. Although the list of processes discussed is fairly complete, a few chapters, particularly those dealing with high-energy collisions, are quite routine and could have been replaced by chapters dealing with current research on the theory, say, of ion-molecule state-to-state collisions and reactions at thermal energies and of ion-ion recombination in dense plasmas. The inclusion of such work would have been more appropriate to the chemistry of the interstellar medium and would have provided greater balance to the book.

My enjoyment in reading the book was somewhat marred by the well-above-average number of typographical errors. All in all, however, the book is thoughtful and stimulating. It would prove invaluable not only to active researchers in the appropriate fields but also to those interested in reviewing the great contribution that atomic and molecular physics has made to astrophysics and to fusion programs.

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The Planet Venus

Venus. D. M. HUNTEN, L. COLIN, T. M. DONAHUE, and V. I. MOROZ, Eds. University of Arizona Press, Tucson, 1983. viii, 1143 pp., illus. $49.95. Space Science Series.

Venus is closer to the sun than Earth is, yet it absorbs less sunlight than Earth. In spite of this, its surface temperature is maintained at a baking 730 K because of effective blanketing by a thick atmosphere that blocks the loss of thermal radiation to space. The atmosphere contains an opaque cloud deck whose major constituent is sulfuric acid. Photochemical production of the acid at high levels is balanced by destruction in the lower atmosphere, or perhaps even by a cycle that involves the planetary surface and geological processes. The solid body of the planet rotates very slowly (period 243 days) in a retrograde direction, but the atmosphere at the level of the cloud deck rotates at the robust rate of about once every four days. Although very similar to Earth in mass and size, Venus possesses only a trace of the volatile compound most abundant on Earth, water. It shows no evidence yet discernible of the kind of tectonic activity that dominates terrestrial surface geophysics.

Altogether, Venus is an interesting planet and provides a humbling example of the diverse consequences of the laws