# BOOK REVIEWS

## Offsetting Advantages

**Sexual Selection**. MALTE ANDERSSON. Princeton University Press, Princeton, NJ, 1994. xx, 599 pp., illus. $65 or £52.50; paper, $24.95 or £19.95. Monographs in Behavior and Ecology.

That the sexes can differ quite spectacularly is apparent to all but the least attentive observers. But it is the manner in which they differ that attracted Darwin's attention. Most sexually dimorphic traits are more elaborate in males and are implicated in the mating process, either by providing males an advantage in combat for females or by making them more attractive to the coy sex. Possessing such traits has its costs—increased mortality.

The evolution of sexual dimorphisms seemed to be at odds with Darwin's theory of natural selection, which emphasized adaptations for survival. The resolution, Darwin suggested, is sexual selection: "Sexual selection depends on the success of certain individuals over others of the same sex, in relation to the propagation of the species; whilst natural selection depends on the success of both sexes, at all ages, in relation to the general conditions of life." Thus traits that are maladaptive for survival can evolve if this cost of mortality is offset by an advantage in mating success. It seems simple, but this theory was not greeted with much favor even by staunch Darwinians such as Alfred Wallace. The main problem rested with one of the mechanisms of sexual selection that Darwin proposed: female choice. Two criticisms were immediate—there was little evidence that females actually choose mates, let alone attend to the details of dimorphic traits when doing so, and there was no logically coherent explanation why females would evolve such preferences, especially in cases in which they gain no immediate benefit from choosing among mates, the well-known paradox of the lek. These criticisms persisted, contributing to a 100-year dormancy of the theory. In the last two decades, however, assessment of sexual selection has grown to be one of the most active areas of study in behavioral ecology and evolution. It is also one of the most integrative endeavors in biology, with studies coming from disciplines as diverse as population genetics, phylogenetics, ethology, population biology, behavioral ecology, physiology, and computational neurobiology. Now, for the first time since Darwin introduced the idea of sexual selection, Malte Andersson has provided a comprehensive review and evaluation of the theory.

Andersson's review of sexual selection is an impressive accomplishment. His introduction to the theory is clear and concise; especially welcome is his lucid presentation of the somewhat complicated population-genetic models for the evolution of female preferences. Andersson takes two approaches in reviewing empirical studies of sexual selection. First, he discusses at length some case studies. The advantage here is that the reader is provided with a sample of the various research programs in sexual selection and the biological richness of the phenomena they address. Then Andersson provides an exhaustive review of the field; in one table he provides more than 200 references to studies documenting sexual selection on specific male traits—so much for the lack of evidence for female mate choice. There are over 2000 references in the book, many of them published in the last ten years. One might criticize the treatment for not being sufficiently synthetic, and it is true that no new theory or major insights emerge. But Andersson critically evaluates both the theory and the data, and his criticisms are neither perfunctory nor cynical but are well reasoned and constructive.

Although much of the book is devoted to the question of how and why females choose mates, Andersson addresses many other issues in sexual selection. He discusses the relationship of sexual selection to parental roles, including sex-role reversal, the spectacular array of weapons that have evolved for sexual combat, how sexual selection might contribute to the process of speciation, and how it is constrained by sensory systems. The book ends with an especially engaging chapter on sexual selection in plants, which might result in an increased interest in pollination biology. This aspect of the book should not be overlooked by those anxious for the most recent update on the paradox of the lek, for Andersson has shown the richness of a field that has long been dominated by this central controversy.

When a female's choice of mate increases her reproductive success, as when she obtains resources from the male, there is little controversy as to why such a preference evolved. Why should a female discriminate among mates, however, if her choice has no effect on the number of offspring produced, and how can a preference evolve if it does not generate an advantage in reproductive success? This is the controversy, and this is where much of the book focuses. Andersson's review suggests no single solution for why females evolve preferences.

One major hypothesis for the evolution of preference is arbitrary choice, an early favorite of population geneticists, in which females evolve preferences for traits that are not necessarily optimal for survival through Fisher's process of runaway sexual selection. An alternative hypothesis that garnered more support among field biologists, good genes, suggests that females evolve preferences for males of better genetic quality because this increases the survival of their offspring. Genetic models in the 1970s and '80s showed that runaway sexual selection could work, but models of choice for good genes tended not to support the intuition of the naturalists who posited that hypothesis. Runaway sexual selection enjoyed primacy during these times, despite the lack of any strong empirical support for the exclusive action of a runaway process in nature. In the late 1980s a series of mathematical models showed that there were some conditions under which selection based on good genes could operate, and these models have been supplemented by several empirical studies showing the strongest support to date for good-genes selection. This was an astonishing shift of emphasis, and the naturalists' intuition seemed to have won the day. Recently, however, there have been a number of studies applying techniques from neurophysiology, neural net theory, and phylogenetics that show that females have hidden preferences and males evolve traits to exploit these preferences. These hidden preferences are not arbitrary in a strict sense but reflect constraints on sensory systems as well as the past history of selection on sensory systems both in and out of the context of mate choice.

As Andersson clearly documents, the conventional wisdom on the resolution of the lek paradox has shifted from Fisher's theory of runaway sexual selection to good-genes selection, and, more recently, there is some emphasis on pleiotropic effects of the sensory system. As the author asks, "Is this because reality is becoming more accurately portrayed, or is there a new myth in the making?" A related question is What is the interaction of theory and data in this field? Is there cross-fertilization, does one or the other define the pressing problems, or do most theoreticians and empiricists work within their respective universes uncon-

strained by the others' work? The most important insight to emerge from this part of the book is that there is unlikely to be a unitary, exclusive explanation for preference evolution. The possibility of a variety of forces acting sequentially or in concert promises to make this rather difficult problem even more intractable.

In reviewing all these issues Andersson has accomplished an amazing, almost herculean, task. There is no question that this book will take its place among the classics in its field.

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## Vignettes: Pleasures of Chemistry

Vigorous evolution of gas, quick coloration to brown, and the formation of precipitates; there, hidden, was the treasure of possibility in the bubbles of foam on the surface, which were observed in the reaction vessel in a corner of our small laboratory! For organic chemists, facing such an unpredictable phenomenon is not uncommon. In flasks, that which can never be predicted by thought or discussion with co-workers often happens.

—*Teruaki Mukaiyama*, in *Challenges in Synthetic Organic Chemistry* (Clarendon Press)

No other profession is endowed with such a rich landscape, draws inspiration from so many fields of science, exercises the hand and mind in so many different ways, offers such opportunities to employ creative instincts, and mixes ideas, theory, and experiment on a daily basis. Hurrah for the science of organic chemistry, and for the joy it brings those who play the research game.

—*Donald J. Cram*, in the preface to *Container Molecules and Their Guests*, coauthored with Jane M. Cram (Royal Society of Chemistry and CRC Press)

## Condensed Matter

**Die Kunst of Phonons.** TADEUSZ PASZKIEWICZ and KRZYSZTOF RAPCEWICZ, Eds. Plenum, New York, 1994. xii, 432 pp., illus. $110. From a school, Kudowa Zdrój, Poland, Feb. 1993.

Phonon physics, the science of the properties of solids and liquids arising from collective atomic vibrations, is perhaps the oldest branch of condensed matter physics. In 1893, four years before the discovery of the electron by J. J. Thomson, F. Richarz, in an effort to establish a theoretical basis for the observed constancy of the specific heat of a crystal at elevated temperatures (the law of Dulong and Petit), was led to characterize a crystal as an assembly of atoms each of which executes a simple harmonic motion about its mean position. The same model of a crystalline solid was subsequently used by Einstein in attempting to explain the optical properties of diamond, and in this way he was led to his well-known theory of lattice specific heats. One hundred years later, in a testimonial to the vigor the field continues to display, the Winter School of Theoretical Physics held annually in Poland was dedicated to the physics of phonons. The book under review contains the proceedings of this school.

The 36 presentations at the school were divided into seven fairly broad categories—Phonons: General; Phonon Focusing; Nonequilibrium Phonons; Interaction of Bulk Phonons with Low Dimensional Gases of Carriers; Phonon Mediated Detectors of Elementary Particles; Molecular Crystals; and Electron Systems. These were selected with the desire to provide a review of the progress made in phonon physics since a winter school on the same topic was held in 1987. In this reviewer's opinion this goal was well met. However, the book as a whole displays the strengths and weaknesses of most such proceedings. Among the strengths is the breadth of the subject matter and an up-to-date quality reflecting the fact that the authors are all working actively in the fields of their contributions. Among the weaknesses is a certain loss of completeness and coherency. In addition, though the origin of the presentation suggests that they should possess some didactic qualities, not many of them in fact do: a large number instead read like brief research articles. One notable exception to this is A. G. Every's discussion of thermal phonon imaging, the study of the highly anisotropic ballistic, or near-ballistic, phonon flux patterns in crystals that are due primarily to phonon focusing, that is, to the concentration of the energy flux of phonons in special directions in anisotropic crystals. It summarizes in a clear and readable fashion the history of the subject, its theoretical underpinnings, including the contribution of catastrophe theory to the interpretation of the images predicted and observed, experimental methods for studying phonon imaging and their results, and applications of phonon imaging. The figures displaying theoretical and experimental results for phonon images in this and several other contributions on the subject are sufficiently attractive that they go a long way toward justifying the fractured German of the book's title. Another notable survey is that of A. Thellung on momentum and quasimomentum in the physics of condensed matter. The definitions of momentum and quasimomentum, the conservation law each satisfies, for an isolated system or for one interacting with an external electromagnetic field, and new physical effects in which the conservation of quasimomentum plays the central role are expounded in a thoroughly didactic paper that is a pleasure to read. The same qualities are found in the two lengthy papers, by H. Kraus and by R. Gaitskell, in which the possibilities of applying phonon physics to the construction of cryogenic detectors of elementary particles are described.

Someone interested in learning about this new field, which is still in an early stage of development, could hardly do better than read the papers mentioned above. However, even the shorter contributions give snapshots of various activities that confirm the breadth and continuing liveliness of the field of phonon physics. I would rate the volume as a better than average example of its genre, which will reward workers in the field with new insights and new results.

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## Other Books of Interest

**Historical Perspectives in Plant Science.** KENNETH J. FREY, Ed. Iowa State University Press, Ames, 1995. x, 205 pp., illus. $44.95.

In a series of lectures presented at Iowa State University in 1991 eight scholars identified as "makers of plant science history" expounded their views of the course of