

between moth hearing and bat sound production. The final chapter on sense organs (12) describes adult compound eyes as well as other organs of vision (larval eyes, ocelli, and dermal photoreceptors). Chapter 13 connects the previous descriptions of sense organs well with the role of exocrine glands that serve as male and female sex pheromone glands for chemical communication in reproductive behavior and as defense glands.

A description of the endocrine system, with reference to the morphology, physiology, and biochemistry of endocrine glands as they relate to molting, metamorphosis, pheromone biosynthesis, diapause, reproduction, and neurosecretion is given in Chapter 15. The structure and function of the gonads and their efferent ducts in males and females is discussed in Chapter 16.

Other topics covered in this book include silk production, karyology and sex determination, and egg structure and development (Chapters 14, 17–19). In Chapter 14, the underlying morphology and physiology of silk production is described. An account of larval and adult labial gland gross morphology, ultrastructure, and production and properties of silk are discussed, not only with respect to the insect but also considering its commercial importance to humans. Morphological aspects of chromosomes, including karyotypic analysis, banding, gene location, and number as well as sex determination are topics covered in Chapter 17. In Chapter 18, the diversity of lepidopteran eggs are described in relation to external, internal, ontogenetic, phylogenetic, and functional aspects. The final chapter (19) is dedicated to the topic of embryology. In addition to covering egg structure and phylogenetic considerations, the authors extensively discuss organogenesis.

Overall, this book is an excellent resource for its readership. It is well written and easy to read, despite the numerous references throughout the text. For students, it provides important supplementary material to the traditional entomological textbooks and works well in a classroom. For the researcher, it complements other handbooks and more specialized texts. Given the fast pace of insect physiology and development research, we look forward to an updated edition.

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Sexual Conflict

Göran Arnqvist and Locke Rowe
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Sex sells. Particularly when, as the rich and famous so adroitly demonstrate, it is punctuated by discord and disenchantment. However, for the better part of the 20th century, sexual interactions between males and females have been viewed through a prism of benign cooperation. It is easy to see why. Males and females are equally related genetically to the offspring formed through the union of their gametes, and so they should have the same vested interest in the well-being of their young. But this rosy picture has gradually given way to a more jaundiced view, one in which the evolutionary interests of the sexes frequently collide. Males and females may disagree with respect to the timing and frequency of copulation, the rate of offspring production, and investment in parental care, among other fundamental reproductive decisions. These evolutionary disagreements are formally known as sexual conflict, and they lead to adaptations in each sex designed to further an individual's own reproductive interests at the expense of their mates. It is these adaptations that are the focus of this lively and engaging book by Göran Arnqvist and Locke Rowe. The book builds on the pioneering work of G. A. Parker, one of the acknowledged architects of the field that became formally established with the publication of his influential landmark paper >25 yr ago (Parker 1979). Only recently, however, has sexual conflict become a hotbed of inquiry, with several journals devoting entire issues to the theoretical development of the field (e.g., *American Naturalist*, 165(5 Suppl S), 2005; *Evolutionary Ecology* 19(2), 2005; and *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences* 361(1466), 2006).

So why should an entomologist buy this book? Well, first, the most convincing evidence of sexual conflict comes from studies of insects, as attested by the empirical studies reviewed in the book and the extensive list of references. Indeed, the exhaustive coverage alone, representing approximately 1,500 references, is worth the price of admission. Second, many of the reproductive adaptations of insects, whether morphological, physiological, or behavioral, can only be properly understood within the context of sexual conflict. Even researchers whose principle preoccupation is dispatching insect pests may find their studies informed by the myriad ways male insects alter the reproductive machinery of females. Finally, the book reminds me of one that I read as a graduate student and which greatly influenced my own career path, Thornhill and Alcock's (1983) *The Evolution of Insect Mating Systems*. Just like that book, *Sexual Conflict* is brimming full of exciting ideas and evocative questions that scarcely have been touched empirically. This book is the kind of book that one hands to a novice graduate student grappling with the problem of identifying a worthwhile dissertation question to pursue.

The authors begin by distinguishing between intralocus and interlocus sexual conflict in Chapter 1. Intralocus conflicts occur when different alleles at the same locus confer differential benefits to males and females: For example, a particular allele that promotes increased mating success in males may, when present at that same locus in females, compromise female reproductive success. Such conflicts may prevent males and females from achieving their reproductive optima and their outcome is difficult to predict; consequently, they have been poorly studied. Interlocus conflicts occur when the optimal outcome of any reproductive interaction differs between the sexes and are mediated by alleles at different loci. Such conflicts have been more widely studied and lead to sexually antagonistic coevolution between the sexes, promoting the kinds of adaptations that are the primary focus of the book. Chapter 2 continues on in a theoretical vein in which the authors attempt to integrate sexual conflict within the framework of sexual selection. A central problem addressed here is that sexual characters in males that might arise to circumvent reproductive interests of females also could evolve via more conventional models of female mate choice: as indicators of direct material benefits or "good genes," or through Fisherian runaway selection. A critical insight here is that sexually antagonistic evolution is distinguished by the "sign" of the direct selection acting on a female preference, which in this case, is negative.

Chapters 3–5 focus on the adaptations themselves. Chapter 3 considers sexual conflicts that arise before mating, which generally revolve around the timing and frequency of mating. Precopulatory conflicts favor adaptations in males that impose copulations on unwilling females or overcome their resistance to matings (e.g., clasp devices in males such as the dorsal clamp of male scorpionflies and the gin-trap organ of male sagebrush crickets) and counter-adaptations in females to thwart coercive matings (defensive spines of female water striders; "playing dead" in female robber flies). A major class of secondary sexual ornaments in males favored in this context is those that exploit preexisting sensory biases of females. My personal favorite is a photo of a female balloon fly haplessly trying to feed on a willow-seed fluff presented to her as a nuptial food "gift" by the male. One of the controversies yet to be resolved is whether the female resistance to mating that seems pervasive across animal mating systems has evolved because of the direct costs of mating (i.e., via sexual conflict) or as a form of mate screening by females to identify genetically superior sires (i.e., via indirect benefits).

Chapter 4 concerns sexual conflicts that arise after mating has occurred. Here, the conflicts revolve mainly around the female's behavior after mating, particularly her propensity for remating with other males and her subsequent reproductive effort. Polyandry favors the evolution of traits in males that prevent females from remating and which ramp up females' reproductive effort in the short term. Such adaptations often involve conspicuous behavioral tactics such as male mate guarding, but they also can be

more covert, as when males incorporate substances in their ejaculates that turn off female sexual receptivity and promote increased egg production. Counter-adaptations in females include biochemical mechanisms that result in the rapid digestion of sperm and other ejaculatory products. These physiological processes have been most extensively characterized in *Drosophila*, but those who think such conflicts are restricted to insects should read the authors' fascinating account of the hostile reception accorded to human ejaculates upon their introduction into the female reproductive tract. Chapter 5 continues the discussion of postcopulatory conflict but focuses exclusively on the conflict between the sexes over investment in parental care. Generally, in biparental species, it would be to the benefit of each individual in a breeding pair if the other parent made most or all of the investment in rearing the young. There are few serviceable insect examples in this regard, but one illustrative case concerns female burying beetles that attack their mates whenever the males attempt to attract additional females to a carcass through continued pheromone emission.

Chapter 6 is a grab bag of issues related to sexual conflict not covered in the earlier chapters. The authors first consider genomic imprinting as an example of sexual conflict at the molecular genetic level. This is an extension of the conflict over parental care except that here the conflict is over the degree of maternal provisioning of the embryo. Other topics include sexual conflict over offspring sex ratios, sexual conflicts in hermaphrodites and plants, and the role of sexual conflict in promoting rapid speciation. Chapter 7 is a short chapter addressing various conceptual issues and problems of terminology. A specific issue addressed here is whether one sex or the other can be said to have "won" a sexual conflict. The short answer is no. Only specific alleles can accurately be said to prevail over alternative alleles. Chapter 8 comprises one-and-a-half pages of concluding remarks.

Sexual Conflict is destined to become a citation classic. At less than \$40, the book is a steal and deserves to be on the shelf of every entomologist, student, and professional alike. Buy it.

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