Entomophiles, Rejoice!

Evolution of the Insects. David Grimaldi and Michael Engel. Cambridge University Press, New York, 2005. 755 pp., illus. $80.00 (ISBN 9780521821490 cloth).

The field of entomology and the study of insects in general are fortunate to have a history of notable authors who have produced numerous excellent and readable books on a wide range of topics. However, there is room for many more, because (not surprisingly) the book-to-taxon ratio for invertebrates in general, and insects in particular, is extremely low compared with that for animals of larger size and those more closely related to us. This disparity is nowhere clearer than in texts on fossil organisms. In *Evolution of the Insects,* David Grimaldi and Michael Engel take on the demanding task of producing a high-quality work that covers the breadth of insect systematics, including a much-needed treatment of insect fossils, thus filling an important need in modern biological reference works.

I have often heard it said with a dismissive wave of the hand that the insect fossil record is too incomplete to be of much use. To be sure, it has some extremely inconvenient lacunae, right where we think the unknown forms would be that could provide the character data needed to answer important questions about the origins of insect wings and powered flight, or about the relationships among the main branches of the pterygote (winged) insect lineages. Relative to the vast species diversity of insects presumed in the past, we definitely could wish for more fossils. However, what Grimaldi and Engel make abundantly clear in their book is that throughout insects there is a significant and important array of fossils, which provide data that many, and probably most, biologists have not incorporated in their understanding of insect diversity and evolution. The taxonomic distribution and quality of fossil insect specimens are more than sufficient to greatly enhance our understanding of insect evolution and expand the known diversity and importance of insects in terms of the evolution of biodiversity on Earth. Once the information from insect fossils becomes a normal part of our discussion of insects in class lectures, in the same way that dinosaurs are a usual part of any discussion on vertebrate evolution, we will wonder how we ever did without it. Grimaldi and Engel have made a saltatory move for the field toward this state by writing a book that smoothly integrates fossil with extant insects. They also clear up or avoid some of the rampant speculation and questionable fossil interpretations posited by some individuals who have worked on fossil insects in the past. Grimaldi and Engel maintain a critical and sober view of the data throughout.

This reference work is filled with a great deal of accurate and important summary data about insects and their evolution. Grimaldi and Engel are careful and clear about the sources of their information and the limits of the interpretation of existing data. There are also many important insights of a more synthetic nature scattered through the book. One example is found in the section on the evolution of insect sociality. The fossil record shows that the highly sophisticated eusocial insects (insects with a form of social behavior beyond what we humans have, which includes anatomically different castes, reproduction only by certain castes, and overlapping generations) were present by the Cretaceous, 140 million to 115 million years ago, but made up probably only 1 percent of the fossil specimens from the period. The significant dominance of eusocial groups like termites and ants that we see now is not found in the fossil record until the

Eocene, some 90 million years later. The implication is that the highly sophisticated social system of present-day insect species was not enough in itself to result in the success we see in these groups. Without the fossil evidence, we could easily and erroneously assume social complexity was the single causal factor.

One of the great benefits of the way that this book is written is that it follows a path like that of a good class in insect systematics. First it leads the reader through sections on basic and broad concepts that underlie scientists' understanding of insect evolution. Grimaldi and Engel briefly lay out their ideas on important issues such as homology, species, and phylogeny reconstruction. These areas of systematics remain steeped in debate, so the authors' particular take on such topics will not please everyone, but this is not the intent of the book.

For those of us less familiar with fossils, the book provides a good primer on fossil formation and different types of insect fossils. Fossils and fossilization of insects are extremely well treated, with a particularly fascinating overview of amber inclusions. One cannot help but be captivated by the remarkable quality of amber preservation, which makes it possible to view mitochondria in some fossils and recalls controversy over the amplification of ancient DNA.

The bulk of the book begins with a systematic treatment of arthropods that are near relatives of insects, and then details each of the major insect groups. The incorporation of fossils in the book is its most innovative aspect, but there is a very competent treatment of every insect order, providing a salient and mercifully brief historical overview of the taxonomic work in each group, tabular lists of significant characters in the included taxa, and overviews of both fossil and extant taxa. Clearly drawn phylogenetic trees are provided for all major groups. The trees that include fossil taxa, however, are by necessity composite compromise diagrams derived from several disparate sources, rather than actual cladograms based on an inclusive analysis of all data and taxa. But the authors are clear about the source of the trees, so the reader has

reasonable warning of their limitations. Current DNA evidence is discussed, and important morphological data are presented in many easily comprehensible figures.

Although the text is clearly geared to a relatively sophisticated readership, it is the most accessible treatment of fossil insects available. The organization of information follows historical and phylogenetic lines and so maximizes connectivity and information content. The book is beautifully illustrated with close to 1000 photographs and figures (most in full color), including adult, immature, fossil, and extant insects. Attention to detail and quality in the figures sets this work apart from other entomology texts. The book is up to date in its information and will be an invaluable resource for anyone teaching a course in insect systematics. I have already used it as background reading for class preparation.

This is a rich work and an excellent contribution to the study and teaching of insect and arthropod science. Anyone with an interest in insects—and just about any organismal biologist—will want to have access to this fine reference, either through an institutional library or on the bookshelf at home. Grimaldi and Engel have breathed life into old cuticle (or at least the traces of old cuticle) and have reinforced the idea that a broad and integrative view of any group is essential for understanding its evolution, and indeed for a full understanding of life on Earth.

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SEXUAL CONFLICT: A NEW PARADIGM?

Sexual Conflict. Göran Arnqvist and Locke Rowe. Princeton University Press, Princeton, NJ, 2005. 360 pp., illus. $39.50 (ISBN 0691122180 paper).

I'm watching a breeding colony of southern elephant seals on a remote island in the Falklands. The harem master is an impressive behemoth, and as he makes his way through his courtiers to clash with rival males, some of his females and their pups are inevitably crushed. This does not seem to bother the master, since his main raison d'être is to sire the pups that will be born a year later. Females, which have only about a fifth of his mass, are powerless to fight him off to save themselves and the pups. A short distance away, southern giant petrels breed on the same beach. Giant petrels pair for life, and they raise their single offspring by sharing the incubation, brooding, and feeding of their young for a staggering 6 months.

So why and how did nature produce some species in which males and females have severe conflicts over reproduction, such as elephant seals, whereas in others, such as giant petrels, cooperation prevails? In *Sexual Conflict,* Göran Arnqvist and Locke Rowe offer some illumination, and in so doing they make a major contribution to the field of sexual selection. This is a wonderful book, packed with exciting natural history, distilled interpretation of recent experimental studies, and straightforward explanations of complicated mathematical models. If you want to learn how male bedbugs rape females (and fellow males), examine the tactics of penis fencing in marine flatworms, or discover the tricks a promiscuous penduline tit uses to cheat its mate, this is the source to turn to. These and other intricate examples illustrate that nature produces many bizarre examples of sexual conflict in which the interests of males and females are strikingly divergent.