

Insects. Their Spermatozoa and Phylogeny. B.G.M. Jamieson, R. Dallai, and B.A. Afzelius. 1999. Science Publishers, Inc., Enfield, NH, U.S.A. 555 pp. US \$144.00. Hardbound. ISBN 1-57808-040-1.

The goal of this book is to critically review all research on the ultrastructure of insect spermatozoa and to relate the data to existing phylogenetic hypotheses. It draws heavily on Jamieson (1987), but contains considerable new information and is mostly re-written. The first three chapters provide background on spermatozoan biology and insect phylogeny, which place following chapters into context. Chapter 3 is essentially a review of the works of Kristensen (1981, 1991, 1995, 1997) and Whiting *et al.* (1997) on hexapod phylogeny. From the title of the book, I was hoping for a more thorough review of insect phylogeny. Nonetheless, this chapter sets the stage for comparative work later in the book.

The main body of the book, chapters 4-19, is descriptive and summarises what is known about sperm in all major hexapod taxa. Chapter organization is essentially phylogenetic, with each chapter treating one higher taxon. I found it somewhat unusual that the authors chose to follow traditional (and in many instances, refuted) taxonomies such as Apterygota in some cases, and recent concepts such as Halteria (Diptera and Strepsiptera) in others. This gives the chapter organization a somewhat haphazard appearance.

The content of these chapters includes some relevant background information, brief diagnoses, habitus drawings, and descriptions. The diagnoses and habitus drawings are an appealing addition. The habitus drawings by Yanni Martin and Geoff Thompson are generally of high quality and in most cases are reproduced well; however, there are some glaring exceptions such as the drawings of Archaeognatha (pg. 83), Thysanura (pg. 88), Ephemeroptera (pg. 108), and Embioptera (pg. 198). My impression is that these substandard drawings were rushed, and have been degraded further during publication (pixilated). Spermatozoal structures are illustrated by numerous line drawings and SEM's, most of which are clear and effective. Despite pixilation in some of the micrograph reproductions their utility is not lost. The information is descriptive, and thus rather dry to read, but is useful and thoroughly reviewed. Unfortunately, there has been no attempt to provide a comparative summary. Tables comparing sperm structures across the groups would have been difficult to produce but would have greatly increased the book's utility. Not only would chapter data be summarised in a format which allows quick reference and easy comparison, but also data would be readily available for assimilation into phylogenetic studies.

I do have a couple of nagging general concerns about the book. I would like to have seen authorities on all of the species and generic names. This makes it all the easier to track the information presented in the text as taxonomic changes are made. A more serious failing is the inconsistent way in which new species

and genera are referenced with respect to higher taxa. First mention of species and genera are always accompanied by reference to their order, but only rarely to their family. This may not appear to be a problem since chapters are arranged phylogenetically (it's easy enough to look something up in the relevant chapter); however, it is a serious problem with taxa referred to in chapters 1-3 and 20. The result is that the user cannot find all references to a taxon of interest by using the index. For example, page 25 refers to *Bactrocera cucurbitae* (Diptera, Tephritidae), but the figure on page 18 refers to *Ceratitis capitata* (Diptera). Someone attempting to track all tephritid references will find the page 25 reference to *Bactrocera* in the index under Tephritidae, but *Ceratitis* can only be found under *Ceratitis*. Anyone working on large taxa will find it a huge task to check for all references to their group in this book.

As I read through the book, I eagerly awaited chapter 20 where a summary of the congruence of sperm ultrastructure with existing phylogenies is presented. The chapter is useful and presents hypothesised groundplan states for spermatozoan characters in many higher taxa. These states are calculated primarily by mapping characters onto the phylogeny hypothesised by Kristensen (1981). I couldn't help but feel somewhat let down in the end though. There are lots of autapomorphies for higher clades, but as acknowledged by the authors, disappointingly few synapomorphies link the major groups. There are no novel relationships of taxa proposed, and many higher relationships have little or no spermatozoan evidence which either support or refute existing hypotheses. For example, the Halteria (Strepsiptera+Diptera) are "weakly supported" only by the loss of accessory bodies. No evidence supporting Strepsiptera+Coleoptera exists. This lack of evidence is not a fault of the authors, but just another example of how few good synapomorphies are available that shed light on the evolution of some of these higher taxa. Some taxa which have a long history and extensive synapomorphic support are well supported by additional spermatozoan characters. For example, the Amphiesmenoptera (Lepidoptera + Trichoptera) has four supporting spermatozoan synapomorphies.

One of the problems with the data presented throughout chapter 20 is apparent in Fig. 20.1 (page 448). In this figure, characters for lower hexapod taxa are mapped onto the Kristensen (1981) phylogeny and two alternative phylogenies from Jamieson (1987). The problem is that the authors do not show all homoplasies. For example, character 7 is shown as a synapomorphy for different lineages in each of the three phylogenies shown, with no indication of homoplasy on any tree. This is potentially misleading and not very informative without going back and wading through all of the descriptions in preceding chapters. As there is no indication of the number of steps on each tree either, the reader is left with no impression of which hypothesis is most parsimonious with respect to the sperm data.

Again, as with earlier chapters, one of my major complaints is that the data are not summarised. The authors state that "parsimony analysis must still await accumulation of more extensive data". This may be true, but if the present data were combined with other data sets such as Whiting *et al.* (1997) it would be very useful. If the data were summarised (i.e. presented in a matrix), it would clarify which areas needed more work AND would facilitate the use of the data by other authors who are compiling total evidence hypotheses of hexapod phylogeny. As it stands, the data are there, but not instantly available for use. Considerable time and expertise in spermatozoan morphology will be necessary to mine useful data from the text.

Reference arrangement is, quite frankly, annoying. Organization of references under a single author is chaotic with no apparent order. This is a particular problem for authors like Baccetti who takes up 3.5 pages of references. Good luck finding the citation that you are looking for. Not surprisingly, with this chaos the authors have managed to repeat at least one reference; Kristensen (1981) is given twice.

A final criticism involves the binding of the book. Mine arrived with the spine broken and with some pages loose. I hope this was the result of extremely rough handling by Australia Post, but I have my doubts. A book that retails for US \$144.00 should not fall apart before use. A little gold leaf on the cover might be appropriate for that cost too.

Cynicism aside, this is an excellent volume overall. People working on hexapod spermatozoa will find this to be an invaluable resource. There is still a great deal to be learned about hexapod spermatozoa and this book indicates some of the glaring holes that need to be filled with respect to sperm structure. For example, in the Diptera, no study has been made on the sperm of lower cyclorrhaphan flies and several schizophoran superfamilies. Denser taxon sampling will also help to further elucidate ground plan states for large taxa like the Coleoptera. For those of us more interested in hexapod phylogeny than sperm morphology, the book is of great interest, but only moderate utility. Summary tables of spermatozoan characters, and preferably a large character matrix of taxa and characters would have increased the value of the book exponentially. Uncertainties about character polarisation presented by the authors will be best resolved by plugging the data into a larger dataset (such as that of Whiting *et al.* (1997)). This book is an excellent stimulus for such future work and illustrates the gaps where more data are needed. I recommend it.

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