

SCHAEFER, C. W. (ed.) 1996. *Studies on Hemipteran Phylogeny*. Entomological Society of America (Thomas Say Publications in Entomology); Lanham, MD. iii + 244 p. ISBN 0-938522-54-X. Paperback. \$13.20 ESA members, \$22.00 non-members, from ESA Sales, 9301 Annapolis Rd., Lanham, MD 20706-3115. Add \$2.50 per volume for postage and shipping (\$3.50 to foreign addresses).

This book evolved from a symposium on hemipteran phylogeny at the Eighteenth International Congress of Entomology held in Vancouver in 1988. It is a collection of eleven independent papers that present the ideas of scholars from Canada (K. G. A. Hamilton), Czech Republic (P. Štys), Japan (H. Mori), Poland (J. Koteja), Russia (Y. A. Popov and D. E. Shcherbakov), United Kingdom (R. J. Wootton), and United States (J. R. Aldrich, H. D. Blocker, C. W. Schaefer, M. H. Sweet, and D. B. Thomas, Jr.), who are studying evolutionary relationships and higher systematics in Hemiptera. Cladistics permeate this book, as stated by Schaefer in his introduction, even if cladistic techniques are not explicitly used. Schuh's (1986) article on the Influence of Cladistics on Heteroptera Classification is a good introduction to many of the terms used in this book to those uninitiated in hemipteran cladistics. The glossary in Schuh & Slater's (1995) book is also helpful.

I would consider the Introduction as a true chapter since, aside from a helpful summary and analysis of the following 11 chapters, it presents information not included in them. Specifically, Schaefer discusses recent research papers on analysis of molecular (18S rDNA) data and proposes a classification for Hemiptera based on both these papers and this book. He expects vigorous discussion of both the classification and the names of the Hemiptera suborders that he proposes to substitute for Homoptera and Heteroptera, which are the following: Sternorrhyncha (for Psylloidea, Coccoidea, Aleyrodoidea, and Aphidoidea), Clypeorrhyncha (for Cicadoidea), Archaeorrhyncha (for Fulgoroidea), and Prosorrhyncha (for both Peloridiidae and Heteroptera).

The first two chapters summarize a long-term study of the insect collections in the Paleontological Institute in Moscow. Cladograms, phylograms (including extinct groups), geographic distribution maps, black and white illustrations, and photographs of existing species and of fossils extensively illustrate the text. The following chapter presents a synthesis of ideas on the origin and radiation of the suborder now called Auchenorrhyncha (for Fulgoroidea, Cicadoidea, Cercopoidea, and Cicadel-

loidea), the classification of which is still not agreed upon. The fourth chapter discusses the morphological and structural evolution of coccids based on 130 scale insect characteristics (morphological, genetic, developmental, and other), introduces a coccid phylogenetic tree and includes several drawings of wing venation and sculpture. Hamilton presents in his chapter on fossil Homoptera from Brazil the classification of Hemiptera that Schaefer adopts, although with different names (Psyllomorpha, Cicadomorpha, Fulgoroidea, and Heteropteroidea), based on cladistic data derived both from fossil and recent morphology as well as DNA analysis that demonstrate that the suborders are monophyletic; he recommends adopting the names proposed by Sørensen et al. (1995), which were presented in the introduction of this book.

Stys presents and supports the hypothesis that Enicocephalomorpha (for Enicocephalidae and Aenictopecheidae) is a sister group to the rest of Heteroptera but at the same time encourages exploration into the possibility that Enicocephalomorpha may not be a natural taxon. His paper discusses four character complexes in trying to present the components of a heteropteran ground plan: male genitalia, first abdominal sternite, forewing venation, and abdominal and thoracic scent glands. Sweet surveys the external morphology of the abdomen, excluding the genital segment, in Hemiptera and in other insect orders and discusses how the various forms of the abdomen and its structures serve the insects in their various habitats. Based on abdominal morphology he supports the division of Hemiptera into four instead of two suborders, but not the same as Hamilton and Schaefer support: Sternorrhyncha, Auchenorrhyncha, Coleorrhyncha, and Heteroptera; he also proposes a new heteropteran infraorder, Aradomorpha, to be added to the generally-accepted other seven infraorders (known as suborders by those who consider Heteroptera an order). An extensive reference list (241 entries) makes this an important source of information on hemipteran morphology. Thomas's chapter reports on autosomal polyploidy in Heteroptera; he concludes that polyploidy has not been a major speciation mode in Heteroptera, but that it has probably been significant at the macroevolutionary levels, and presents five dendrograms based on chromosome numbers, one for Heteroptera, the others for some infraorders.

The remaining chapters do not propose or analyze hemipteran phylogenies. Instead, they discuss some characters important for sorting phylogenetic relationships in Hemiptera in the future. For example, Wootton discusses the functional significance of front wing design in Hemiptera, the morphology of which is a compromise between the conflicting needs of flight efficiency and protection, venation variations reflecting differences in flexibility. Wootton cautions that too many conclusions in phylogenetic studies have been drawn from superficial resemblances, which can be due to convergence, a widespread phenomenon in Hemiptera. Numerous illustrations of wings and of a cercopid in flight make this a very interesting paper. Aldrich reviews the sex pheromone systems of eight terrestrial hemipteran families: Margarodidae, Diaspididae, Pseudococcidae, Aphididae, Miridae, Reduviidae, Pentatomidae, and Scutelleridae and illustrates his text extensively with drawings, photographs, chemical formulae, walking tracks, and gas chromatograph tracings of the pheromone components. He also reviews some aspects of acoustical communication in Hemiptera. The 172 references are a good source of information on hemipteran volatile secretions. Mori suggests that phylogenetic reconstructions could be based on embryonic structures instead of on structures only seen in the adult insects. He believes that distribution patterns at the family level of embryonic ventral nerve masses and of the convolution in the posterior part of the midgut are useful characters for analyses of phylogeny in Heteroptera.

This book is primarily for the very specialized entomologist, in part because a glossary is not included and many terms go unexplained. Both a glossary and a subject in-

dex are missing. The addition of the first one would make this book more accessible and the second one would make it more useful to all readers. This book is important for all hemipterists and systematic entomologists because it updates the higher classification of this order, presents new ways to study some characters, has extensive reference lists, and gives new ideas and directions for research in the phylogeny of Hemiptera.

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