

BEES IN THE NEW MILLENIUM

Author: DANFORTH, BRYAN N.

Source: BioScience, 52(9) : 848-850

Published By: American Institute of Biological Sciences

URL: [https://doi.org/10.1641/0006-3568\(2002\)052\[0848:BITNM\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2002)052[0848:BITNM]2.0.CO;2)

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

**BEES IN THE NEW
MILLENNIUM**

The Bees of the World. Charles D. Michener. Johns Hopkins University Press, Baltimore, 2000. 913 pp., illus. \$145.00 (ISBN 0801861330 hardcover)

Sixty-five years after publishing his first paper on bees and 56 years after publishing the first higher-level study of the bees of the world (Michener 1944), Charles D. Michener, professor of entomology at the University of Kansas since 1950, has finally finished his PhD thesis. Well, not exactly—he actually completed that in 1942—but *The Bees of the World*, the culmination and synthesis of all that he has learned about bees in his distinguished career, is an updated and greatly expanded version of the research he started as a graduate student at the University of California–Berkeley.

This is an extraordinary book that summarizes the current state of knowledge of bee phylogeny, taxonomy, and classification in a single, authoritative, and scholarly treatment. This is no small task, given that bees comprise 425 genera and more than 16,000 species, which are distributed on every continent except Antarctica. The introductory chapters of the book provide background information on bee biology (including sections on development, reproduction, sociality, floral relationships, nests, and modes of parasitism), anatomy (of adults and larvae), the bee fossil record, bee biogeography, the history of bee classification, and our current understanding of higher-level bee phylogeny. While the introductory chapters provide the background, the major portion of the book focuses on bee taxonomy, classification, and identification to the level of genus and subgenus.

The book is organized taxonomically with each section covering a higher taxon (tribe, subfamily, or family). Table 16-1 provides a summary classification to the level of subgenus, in combination with an estimate of the total number of species within each subgenus and genus. This

table alone covers 8 pages. Each section thereafter (there are 83 such sections) treats the bee families, subfamilies, and tribes and begins with a general overview of the taxon, discussing monophyly (evidence for or against), diagnostic features, general morphology, biogeography, nesting biology, and previous phylogenetic or taxonomic studies. These taxonomic overviews are extremely useful because they condense Michener's broad knowledge of bee taxonomy into a short overview that can be referred to again and again. Following these introductory comments, there are keys to the groups within the higher taxon (to genus and subgenus). These keys are illustrated in part, but people not already familiar with bees and bee morphology will find that they should have read the introductory chapter on anatomy more carefully. The keys are not always easy, especially for the taxonomically most difficult groups (try the keys to the subgenera of *Andrena*, for example), but this is the nature of the taxa in most cases and not the fault of the author. Keys are kept to a reasonable length, in many cases, by providing separate keys for different zoogeographic regions of the world. Following the keys to the genera and subgenera is a taxonomic treatment for each genus and subgenus, with synonymies, taxonomic comments, descriptions of the biogeographic distribution, and in many cases, comments on the nesting biology, host plants visited, and parasites (or hosts in the case of parasitic taxa). These sections are supported by extensive literature citation, and the bibliography, which includes 60 pages of 2500 citations, is extremely thorough. The text and the literature cited section are remarkably free of typographical errors given the size and complexity of the book. What strikes me about the taxonomic treatment is that Michener has chosen, in most cases, to be extremely cautious in preserving the current classification in the absence of published results that would support changes to it. In short, Michener has taken a fairly conservative approach that, in my view, is the correct one for a book of this sort. New results will undoubtedly lead to taxonomic changes, but such changes should only be made when they

are based on well-supported phylogenies.

Though the book focuses less on bee phylogeny than on bee identification and taxonomy, it provides the basis for future phylogenetic studies at a variety of levels. Michener does an excellent job of pointing out what is known (e.g., the monophyly of the long-tongued bees, the monophyly of the Apidae, the monophyly of the corbiculate bees) as well as what is not known (the exact branching pattern of the families, subfamilies, and tribes). In fact, the discussion of what we do not know (or what is not well supported by morphological or molecular data) may prove to be an important aspect of the book to students of bee phylogeny. Consider, for example, what we do not know. First, we do not necessarily have a clear understanding of the phylogenetic relationships among the seven families of bees. Consider his comments on the Stenotritidae (an enigmatic family of Australian bees): In Alexander and Michener's (1995) phylogenetic study, Stenotritidae "fell in such diverse positions in different analyses that there was no basis for considering it closest to any other bee group. My belief, notwithstanding, is that the Stenotritidae are either the basal branch, sister group to all other bees, or a group within or sister to the Colletidae" (p. 123). Indeed, recent molecular results strongly support one of these hypotheses, but I cannot tell you which one (Danforth and Sipes, unpublished). The text is filled with other candid observations on what we do not know: "It seems best to recognize that we know nothing about [the] cladistic relationships" among the four genera of the subfamily Meganomiinae (p. 409). In the discussion of higher-level phylogeny of the Megachilidae, Michener points out that it is unclear whether the Fideliinae or Osmiini are monophyletic groups (p. 417–418), providing two perfectly good PhD thesis topics to some interested graduate students. Within the large family Apidae (formerly considered the families Anthorophoridae and Apidae), there is much we do not know about higher-level phylogenetic relationships (in spite of the excellent study of Roig-Alsina and Michener 1993).

Questions include what is the placement of the Xylocopinae (the carpenter and allodapine bees); where do the parasitic tribes Isepeolini, Osirini, and Protepeolini belong (within the Nomadinae or not); and is the subfamily Apinae monophyletic (p. 570)? This list goes on. New discoveries will undoubtedly come about in the next few years, both because of active work in the area of the bee fossil record (e.g., Engel 2001) as well as in the field of bee molecular systematics (e.g., Cameron and Mardulyn 2001, Danforth 2002). With new data sets provided by the slowly evolving single copy nuclear genes, we are at a stage where we can expect in the next 5 to 10 years to have a well-resolved (and well-supported) phylogeny of the bees, at least at the level of the tribes, subfamilies, and families. And molecular data can also provide us a glimpse of species-level phylogenetic relationships within some of the taxonomically most difficult groups (e.g., Sipes and Wolf 2001). Michener has laid the foundation for these studies and has already stimulated much active research in bee phylogeny through the publication of *Bees of the World*.

In conclusion, by condensing into one book all the keys and taxonomic information, Michener has made it possible for anyone, anywhere in the world, to key out bees to genus and subgenus and then to track down the primary literature on that group for species-level identification (if such a taxonomic study exists). This book is obviously of great use to bee biologists, but it will also be an invaluable resource to botanists interested in bee–plant interactions, pollination biologists, and conservation biologists. The book, as noted by Jerome G. Rozen Jr. on the back cover, will become the "bible" for bee biologists of any sort. Indeed, as a result of this book and one previously published on the North and Central American bees (Michener et al. 1994), the "Bee Course" (<http://research.amnh.org/invertzoo/beecourse>) was developed by Jerome G. Rozen Jr. and Ronald J. McGinley. This course is a 10-day, intensive class in bee identification and biology (offered annually at the American Museum of Natural History's Southwestern Research Station, Portal,

Arizona). The highlight of the course is, of course, going into the field with Charles Michener and collecting bees. On the class field trips, Dr. Michener invariably collects some interesting species of bee that no one else has managed to pick up. It is then clear to us all why Dr. Michener has had such an outstanding career in bee biology: He just loves to collect (and study) bees.

References cited

- Alexander BA, Michener CD. 1995. Phylogenetic studies of the families of short-tongued bees (Hymenoptera: Apoidea). *University of Kansas Science Bulletin* 55: 377–424.
- Cameron SA, Mardulyn P. 2001. Multiple molecular data sets suggest independent origins of highly eusocial behavior in bees (Hymenoptera: Apinae). *Systematic Biology* 50: 1–18.
- Danforth BN. 2002. Evolution of sociality in a primitively eusocial lineage of bees. *Proceedings of the National Academy of Sciences* 99: 286–290.
- Engel MS. 2001. A monograph on the Baltic amber bees and evolution of the Apoidea (Hymenoptera). *Bulletin of the American Museum of Natural History* 259: 1–192.
- Michener CD. 1944. Comparative external morphology, phylogeny, and a classification of the bees. *Bulletin of the American Museum of Natural History* 82: 151–326.
- Michener CD, McGinley RJ, Danforth BN. 1994. *The Bee Genera of North and Central America* (Hymenoptera: Apoidea). Washington (DC): Smithsonian Institution Press.
- Roig-Alsina A, Michener CD. 1993. Studies of the phylogeny and classification of long-tongued bees (Hymenoptera: Apoidea). *University of Kansas Science Bulletin* 55: 123–173.
- Sipes SD, Wolf PG. 2001. Phylogenetic relationships within *Diadasia*, a group of specialist bees. *Molecular Phylogenetics and Evolution* 19: 144–156.

BRYAN N. DANFORTH
Associate Professor
Department of Entomology
Comstock Hall
Cornell University
Ithaca, NY 14853-0901