Book Review

Hawkmoths of Australia, Identification, Biology and Distribution. Monographs on Australian Lepidoptera. Volume 13. By Maxwell S. Moulds, James P. Tuttle, and David A. Lane. CSIRO Publishing. Clayton South, Victoria, Australia. 2020. 414 pp. (including 83 color plates, small folio). ISBN: 9781486302819 (Hard cover). $162.00 and up. Available from the publisher and many retail outlets including Pemberley Books (United Kingdom), Goecke Evers (Germany), ABEBooks.com and Amazon.com online retailers.[1]

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I rarely see a book about Lepidoptera of such high quality and completeness at such a reasonable price. I am excited about this book and anybody excited about biology will appreciate the authors' efforts. This book is a model to be followed.

The first examination reveals a book of quality construction. The pages are Smythe sewn and hard bound with a rounded back allowing the book to easily lie flat when open. The grain of the glossy paper runs from top to bottom allowing the paper to bend easily rather than fighting the user. Laminated paper covers the boards, a type of binding called casewrap, a durable binding found in many popular books including books on cookery and children's books. The book has colorful covers and the spine clearly identifies the book. I praise the authors for the Chapter "Collection and preservation" describing the methods for collecting, killing, storing, labeling, preparing specimens for molecular work, and making dissections. Having these handy details in one location is especially useful.

Another Chapter "Rearing hawkmoths" is thorough and the information should be applicable to all herbivorous species of lepidoptera. The Chapter "Biology" provides details that might normally be overlooked such as "Hawkmoths as pests," and "Hawkmoths as human food and medicine." The chapter "Classification and nomenclature" might seem elementary to the experienced entomologist or lepidopterist, however the authors wisely anticipated this book may find its way onto the shelves of persons wanting a more in-depth treatment of this information.

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The book begins with the usual chapters: Preface, Acknowledgments, Organization and Structure, and Historical Review. Following these chapters, the book gets intensely interesting.

The next 13 pages provide detailed information about the structure and form of the adult moth, the larva, the pupa, and the egg. Each of these life stages and morphological details, including male and female genital structures, are illustrated with high quality drawings and photographs. I am amazed to find so much information transferable to all lepidoptera included in this book. These few pages alone are a complete reference to lepidoptera. As far as I am concerned, I would happily pay money for these pages alone.

The next three pages discuss collection and preservation of specimens – extremely valuable information. The next two pages discuss rearing hawkmoths. Following are 10 pages discussing the biology of the moths. If you are still counting pages you will find the first 31 pages of the book are a complete text on lepidoptera and many other animals. The information is detailed, informative, well-illustrated, well researched, and concise.

After these introductory pages, comes the meat of the book, the hawkmoths (Lepidoptera: Sphingidae), 32 genera, 121 and species including 17 nominate and 7 other subspecies, of the Australian hawkmoths. This is a modified revision of the Australian hawkmoths as the text includes a list of all proposed taxonomic changes. One new genus, and no new species are described. There is a systematic checklist of Australian hawkmoths with genus/species/subspecies combined; the descriptive text of species accounts does not follow the order of the systematic checklist. Then there is a key to last instar larvae illustrated with detailed drawings. Following the key to larvae a key to pupae is illustrated with detailed drawings including magnified drawings of morphological structures to clearly distinguish similar species.

The descriptive text is complete by providing: synonymies; distributions and habitats; adult diagnoses; descriptions of immature stages; biologies (including larval food plant associations further summarized in an appendix), eggs, larvae, pupation details, parasitoids (also summarized in an appendix), predators, and adults. The descriptive text for each species includes references to the plates and figures in the text. Distributions are illustrated with maps. As expected, the distributions of most species are clustered on the coasts where there is most human habitation. The thoroughness of the coverage in this book is illustrated by maps that show continental-wide and inland distribution, such as *Agrius convolvuli, Agrius godarti,* and *Hopliocnema brachycera*. The descriptive text is inclusive, liberally illustrated with photographs and drawings to help separate similarly appearing adults and larvae. The text shows the incredible research expended to gather the information provided in the book.

Information about parasitoids and parasitoid associations is unusual for a book of this type, and it demonstrates the extent of the research in rearing conducted by the authors and shows thoroughness on their part to obtain

authoritative identifications of the parasitoids (The authorities are listed.), share this information with illustrations, and descriptive text for each species.

The first 72 excellent color plates use photographs to illustrate complete life histories, one or two species per plate. For most species, all life stages are included; ova; several larval instars; ultimate instar with different color morphs; macro photographs of larval heads or thoraxes; of pupae in dorsal, ventral, and lateral views and different color morphs when appropriate; and adults as seen in nature. A few photographs show the demise of a dead animal. These photographs include fungi, wasps (Hymenoptera), flies (Diptera), birds, spiders, and beetles (Coleoptera). Larval hosts are included in the photographs of the larvae or with separate photographs.

The ten color plates of adult pinned specimens are of the highest quality. The three species added after the book was completed are not illustrated in color. There is one page of color photographs of habitats. One of the nicest features is the clear illustrations of the male genitalia. Vesicae are not everted.

There are nearly a thousand literature references indicating the extent to which the authors researched the subject material. The thoroughness of researching the taxonomic history is evident in the treatment of the genus *Agrius*. I am already using the references for research other than hawkmoths of Australia. The index includes both plants and animals, both at genus and species level. This latter feature is especially helpful because generic assignments change and without the double entries, a reader in the future might not be able to locate the desired taxon.

The discussion of sounds produced by adult hawkmoths seems misplaced within the discussion of predators, and it seems to overlook the research by Connor (2009) that sound production in lepidopterans is used in courtship in addition to interfering with echolocation reception in bats. Courtship behavior probably predates interference with bats in the evolutionary scheme of things.

Paradoxically, for a book of this totality and revisionary qualities, there is no abstract nor key to adults, except one short key to a tough genus in the descriptive text. There are no illustrations of female genitalia. Everted vesicae might show additional characters to separate similar species. A checklist separating each genus followed by each species and each subspecies is easier to read. The keys to the larvae and pupae do not follow a systematic order; although I understand the utility of providing a key based on easily seen visual characters. The checklist is a combination of systematic and alphabetical presentation, while the presentation of species accounts, ignoring subfamilies, is alphabetical by genus and species. The description *Chelacnema* does not follow technical telegraphic writing that I expect to find in a description, rather the description is in prose. The text introduces the subject of DNA barcodes and appears to make no use of the tool.

I quibbled with the words, "enemies" and “attacks", when dealing with biological entities interacting with the survival of lepidopteran taxa. To me, the words enemy and attack imply intent and are constructs of human thought and

behavior. The interactions between hawkmoths and the entities listed by the authors might include negative, neutral, or positive impacts, however, in my opinion, the terms presented form a biased point of view, and in this book the bias appears to favor hawkmoths. The section "Hawkmoths as pests" mentions interactions of hawkmoths with human activities, however, not impacts of hawkmoths in the natural world, such as hawkmoth larvae consuming nutrition outside contact with human activities. Most lepidopteran larvae, including hawkmoths, eat plant material, often with significant impacts; more than garden and agricultural plants can be affected. The use of the word attack in association with a fungus appears to misunderstand the random dispersal of fungal spores and the adventive nature of the subsequent utilization of a suitable substrate. Ants defend territory and/or locate sources of nourishment. The nematodes, parasites, parasitoids, other arthropods, and all other predators eating hawkmoth eggs, larvae, pupae, and adults are doing what all eukaryotes, including humans, do: they exploit sources of nourishment, i.e. food, for survival. I feel scientists should be observers and report findings without prejudice.

My few contrary comments notwithstanding, this is an extremely valuable contribution to the biological and entomological literature. The abundant data are well researched and lucidly presented in a book of high quality. The enthusiastic investment of time and energy expended by the authors to prepare and write this monumental volume is evident, and I highly recommend it for any student of biology, entomology, and lepidoptera. The authors should be justifiably proud.

After this review was completed, I heard from Jim Tuttle, the second author, and learned that the book had won the Whitley Award from the Royal Zoological Society of New South Wales (Australia) as the outstanding zoological book of 2020 - a high honor, and in my estimation, richly deserved! As an entomologist, I say "Insects rule."

Literature Cited

Conner, W. E. 2009. *Tiger Moths and Woolly Bears*. Oxford University Press. Oxford, England, UK. 303 pp.