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HANDBOOK OF ZOOLOGY, VOLUME IV, ARTHROPODA: INSECTA, edited by M. Fisher, Part 35 Lepidoptera, Moths and Butterflies, Volume 1: Evolution, Systematics, and Biogeography, edited by N. Kristensen, 1998, 490 pp, ISBN3-11-015704-7 and Volume 2: Morphology, Physiology and Development, edited by N. Kristensen, 2003, 564 pp, ISBN 3-11-016210-5, de Gruyter, Berlin and New York. List price (Amazon Books): Volume 1, US$299.60; Volume 2, US$347.20.

Few lepidopterists have the comprehensive knowledge or stamina to direct the production of *The Handbook of Zoology – Lepidoptera, Moths and butterflies*. Indeed, the two volumes that resulted from editor Kristensen's deliberate planning are more suitably described as 'encyclopedia' than 'handbook'.In 40 chapters written by outstanding contributors these books cover evolution, systematics, biogeography, comparative morphology and anatomy of early stage and adult Lepidoptera.

Volume 1: *Evolution, Systematics, and Biogeography* contains 21 chapters. The 'Historical Introduction' (Kristensen) enumerates critical landmarks marking the progress of Lepidoptera studies, and functioning as a gateway for further exploration. Chapter 2, 'Phylogeny and Palaeontology' (Kristensen & Skalski), is a lucid overview of superfamily-level relationships based on a deep understanding of the Lepidoptera groundplan, extant and fossil taxa. Figure 2.1 beautifully describes the groundplan, and should be of interest to all entomologists, and Fig. 2.2 gives a phylogeny for extant superfamilies of Lepidoptera. This chapter also lists known fossils by family; a useful reference guide to original studies. A chapter on 'Classification and Keys to Higher Taxa' (Carter & Kristensen) naturally follows. While the key to adults includes 46 superfamilies and does not require illustrations (readers will recognize all characters), the key to larvae is supplied with illustrations of basic larval morphology and leads to 129 categories, including superfamilies, families, and subfamilies. Chapters 4–19 cover higher groups; 'The Non-Glossatan Moths' (Kristensen), 'The Homoneurous Glossata' (Kristensen), 'The Monotrysian Heteroneura' (Davis), 'The Tineoidea and Gracillarioidea' (Davis & Robinson), 'The Yponomeutoidea' (Dugdale, Kristensen, Robinson & Scoble), 'The Galechioidea' (Hodges), 'The Zygaenoidea' (Epstein, Geertsema, Naumann & Tarmann), 'The Cossoid/Sesioid Assemblage' (Edwards, Gentili, Horak, Kristensen & Nielsen), 'The Tortricoidea' (Horak), 'The smaller Microlepidoptera-Grade Superfamilies' (Dugdale, Kristensen, Robinson, Scoble), 'The Pyraloidea' (Munroe & Solis), 'The Axioidea and Calliduloidea' (Minet), 'The Butterflies: Hedyloidea, Hesperioidea, and Papilionoidea' (Ackery, de Jong & Vane-Wright), 'The Drepanoid/Geometroid Assemblage' (Minet & Scoble), 'The Bombycoidea and their relatives' (Lemaire & Minet), and 'The Noctuoidea' (Kitching & Rawlins). All these chapters have a standard format (likely owing to the editor's guidance), are well illustrated, and provide detailed accounts on classification and basic morphology of adults and early stages. No other book on Lepidoptera combines such a breadth of information and extensive citations. Although relationships between groups are discussed, chapters 4–19 do not include phylogenies. I found this a sensible editorial decision. Modern phylogenetic analyses are not homogeneously available for Lepidoptera groups, and discussions of conflicting hypotheses are better placed in the primary literature. Accordingly, chapters 4–19 rest on the solid ground of classical systematics and will remain lasting references for future generations. Chapters 20 and 21, 'Evolution of Larval Food Preferences in Lepidoptera' (Powell, Mitter & Farrell) and 'Biogeography of the Lepidoptera' (Holloway & Nielsen), are excellent reviews and should be required reading for general entomologists, and lepidopterists in particular.

Volume 2: *Morphology, Physiology, and Development* includes 19 chapters that cover all life stages. Here the chapters are slightly less homogeneous in format and coverage, and some are more thorough than others. Chapters 1 and 2 open the volume with detailed information about the 'Integument' (Chauvin & Kristensen) and 'Hairs and scales' (Kristensen & Simonsen). There one may learn, for example, that the relationship between scale size and wing length is not linear, and that several structures of the integument are still poorly understood. Chapter 3, 'Coloration: Patterns and Morphogenesis' (Nijhout) is a brief summary of classical and recent topics and covers both butterfly and moth color patterns. Chapters 4 and 5, 'Skeleton and muscles: adults' (Kristensen) and 'Skeleton and muscles: immatures' (Hasenfuss & Kristensen) make up one-fourth of volume 2, and these two chapters are not for the novice. They are a useful source of comparative information best appreciated by those who have wrestled with these topics for some years. Comprehensive descriptions of adult and larval muscles are provided together for the first time, and

furthermore, they attempt to standardize the terminology for many skeletal structures—something that is particularly timely for genitalic morphology. Chapters 6–9 and 16 concern the 'Digestive and excretory systems' (Barbehenn & Kristensen), 'Respiratory system' (Wasserthal), 'Circulation and thermoregulation' (Wasserthal), and 'Nervous system' (Yack & Homberg) and 'Reproductive organs' (Kristensen). These chapters remind me of R. Chapman's original work *The insects: structure and function.* Although focused on Lepidoptera, these chapters are widely relevant to entomologists and provide up to date, detailed information and useful illustrations for early stages and adults. The chapters covering 'Sensilla and proprioceptors' (Hallberg, Hansson & Löfstedt), 'Auditory and sound producing organs' (Minet & Surlykke), and 'Eyes and vision' (Warrant, Kelber & Kristensen) provide a wealth of comparative detail that characterizes the two volumes of the *Handbook.* At risk of stating the obvious, it is extremely useful to be able to cross consult chapters. For example, Minet & Surlykke note that the forewing base tympanal organs are always innervated by a branch of the nerve IINIc (p 289), which is illustrated by Yack & Homberg (p 234). Chapters 13–16 explore 'Exocrine Glands: Chemical communication and chemical defense' (Hallberg & Poppy), 'Labial glands, silk and saliva' (Akai, Hakim & Kristensen), 'Endocrine glands and hormones' (Sridhara, Bhaskaran & Dahm), and 'Reproductive organs' (Kristensen). These reviews encompass processes from the cellular to ecological levels, and point to huge gaps in our knowledge of certain glands. Finally, chapters 17–19 include 'Karyology and sex determination' (De Prins & Saitoh), 'Eggs' (Fehrenbach), and 'Embryology' (Kobayashi, Tanaka & Ando). These three chapters are framed in a broad, order-level comparative context and present valuable baseline information.

Perhaps the most important contribution of the *Handbook* is the scope of comparative information conveyed in the two companion volumes. Readers can browse the chapters like the stacks in a library. This encourages scholarship by providing easy access to topics of direct or potential relevance to our research on Lepidoptera. The *Handbook* serves as a reminder that a holistic approach to research, including familiarity with embryology, host plants, wings, systematics, genitalia, sensilla, et cetera, will lead to a more sound interpretation of our data, whatever they are, and ultimately a deeper understanding of our study organisms. More than ever, academic biologists in the US face a demand for increased productivity through extramurally funded research. Although productivity is positive in principle, sacrificing quality for quantity, or depth for pace are not. The *Handbook* was done in the fine European tradition of bringing international contributors together with comprehensive excellence as the main goal. Some chapters combine many lifetimes of comparative research (e.g., 'Skeleton and muscles'), and their production required dedicated work that can only be accomplished through scholarly maturity in the best sense of the word. Inasmuch as the mission of the Lepidopterists' Society is to further our understanding of moths and butterflies in all aspects of their natural history and evolution, I feel that the *Handbook* is a giant step towards this goal. These two volumes will certainly stimulate us to dig deeper, look further, think laterally, and read more broadly. The cost of these books is prohibitive to students, but not beyond the reach of professionals. In closing I would like to say, Professors: share the *Handbook of Zoology – Lepidoptera, Moths and butterflies* with your students — they will not find such a wealth of information on the web.

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