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BUTTERFLIES OF EUROPE, Vol. 2: INTRODUCTION TO LEPIDOPTEROLOGY, by Otakar Kudrna, Editor. 1990. AULA-Verlag GmbH, Postfach 1366, D-6200 Wiesbaden, Germany. 557 pp. + list of contributors, with 4 color plates containing 32 photographs, 93 figures, 25 tables, and 2 diagrams. Hard cover, 16 × 23.5 cm, ISBN 3-89104-033-4; DM 197 ($125 U.S.).

Review by Thomas C. Emmel

The 1945 edition of E. B. Ford's book, *Butterflies* (Collins, London), was the first general book on the biology of butterflies published in the English language. It had been preceded by a comprehensive technical treatise authored by Martin Hering, *Biologie der Schmetterlinge* (Julius Springer, Berlin, 1926), which unfortunately was never translated into English from the original German. Then in 1984, Philip Ackery and Richard Vane-Wright edited an outstanding volume of collected papers, *The Biology of Butterflies* (Academic Press, London), which has recently been reissued (Princeton University Press, Princeton, NJ, 1989) in a paperback version with an updated introduction and additional bibliography. Using a group of authorities invited to a symposium held in England in September 1981, more than thirty excellent contributions were prepared for that volume, covering most of the modern areas of the study of butterflies. Matthew Douglas followed that volume in 1986 with his own book, *The Lives of Butterflies* (Univ. Michigan Press, Ann Arbor), written from a more popular viewpoint. These four books represent those works devoted specifically to a general survey of the biology of butterflies, excluding the rest of the Lepidoptera.

Now in 1990, Otakar Kudrna has provided the scientific community and amateur naturalist with another comprehensive introduction to the biology of butterflies, emphasizing a European perspective. Thirteen European and American authors have contributed chapters of greatly varying length and comprehensiveness to this volume. Most of the literature cited in each chapter is dated earlier than 1986, but several authors have provided literature references up to 1988.

The book opens with a two-page general introduction by the editor which is actually a foreward, describing the intent of the book as a textbook and reference book alike. As the editor points out, the book deals with only some aspects of lepidopterology "and it treats them in an unequal, indeed to some degree unfair, manner." Since the editor blames himself at length here for failing to find a competent ecologist to write a timely chapter on this subject, we need not do so here. Kudrna does promise that ecology will be dealt with comprehensively in the seventh volume of this series. (Volume 1, a bibliography of European literature on butterflies, and Volume 8, a volume on the conservation of butterflies, were previously published in 1985 and 1986, respectively, by the same editor and publisher.) As the editor also points out, all the chapters of this present volume are aimed at advanced students of butterflies, and though highly unequal in coverage, they do indeed direct themselves toward that relatively limited audience. With these omissions and reservations stated, let us proceed to look at the merits of each of the contributed chapters in more detail.

Chapter 2 deals with "Lepidopterology in Europe." Kudrna and Martin Wiemers provide a guide to European lepidopterological institutions, societies, and periodicals. They also treat a selected list of past personalities among the hundreds of well-known European lepidopterists. These treatments are admittedly short and terse, expressing in only several lines the basic biography, but normally also providing a literature reference to a more thorough published treatment of that person's biography. A list of acronyms of major museums relevant to lepidopterology is included for easy reference, and may be useful to those wishing to employ standard abbreviations in their own publications (such as in lists of specimens examined for taxonomic revisions).

Chapter 3 deals with the morphology of early stages of butterflies, and is authored by

Jim P. Brock, of Glascow, Scotland. Brock provides a short but very competent overview of the terminology and structure pertaining to the description of the egg, the larva, and pupa. And the chapter is reasonably well illustrated. The keys to the larvae and pupae of the early stages of the various higher groups of butterflies are excellent. There is also a short section on methods for preserving early stages, and a glossary of terms pertaining to early stages. Most entomologists in North America would be able to obtain the same information in greater detail in their copies of James A. Scott's book, *The Butterflies of North America* (Stanford University Press, Stanford, California, 1986), referring to his excellent introductory section on the same subjects.

Chapter 4 is devoted to a discussion of adult structure and function, by James A. Scott of Colorado. In a series of succinct text sections and detailed figures, Scott covers the body segments, appendages, muscular system, reproductive system, breathing and blood circulation, feeding, digestion and excretion, nervous and sensory systems, and the endocrine system of adult butterflies. He closes his chapter with a glossary of morphological terms pertaining to the adult. One nice feature of this chapter is its emphasis on functional morphology, that is, how each of these structures actually works in the living butterfly. This chapter is excellent, but again a North American reader could obtain the same information in perhaps greater detail from Scott's 1986 book.

In Chapter 5, entitled "Butterfly phylogeny and fossils," James A. Scott and David M. Wright of the United States first present an interesting summary of methods for the study of phylogeny, including chemical/genetic methods, intuition, phenetics, and phylogenetics, or cladistics. The rest of the chapter employs cladistic methods to deduce the branching sequence in phylogenetic trees of butterflies. A brief discussion of the ancestors of butterflies is followed by detailed specification of characters for each major group of Lepidoptera (superfamilies). A very short discussion on butterfly fossils is then followed by detailed specification of shared derived traits between the major superfamilies of butterflies, families, and subfamilies, even down to tribal level. This very thorough discussion culminates in a single figure for this chapter, showing the phylogeny of butterflies obtained by these two authors using these procedures.

Chapter 6, by J. P. Brock, also deals with the origins and phylogeny of butterflies. Using the characters of eggs, larvae, and pupae, and various adult structures, Brock looks at various evolutionary scenarios as to the phylogeny of butterflies, and finally to families within Rhopalocera. A comparison of these two chapters (5 and 6) will provide many hours of stimulating mental exercise in considering the evidence from various phylogenetic approaches to relationships among the butterfly groups. The worldwide coverage in both chapters will provide innovative ideas and food for thought to the interested lepidopterist.

The genetics of European butterflies is surveyed by Roy Robinson in Chapter 7. This is a very generalized discussion of the principles of inheritance, looking first at Mendelian ratios and then discussing some of the other basic genetic concepts. Almost all of the literature cited stops with Robinson's book in 1971, and few specific examples are offered for each phenomenon discussed. Robinson then goes on to treat the topic of cytogenetics in the rest of the chapter. He has compiled a list of the haploid chromosome numbers of European Rhopalocera, and compares the numerical modes for the European families with the worldwide distribution of chromosome numbers among families surveyed in his 1971 book. Robinson also reviews the traditional hypotheses for variation in chromosome number and then presents an interesting discussion on sex chromosomes, supernumerary chromosomes, and other topics; in all of these areas, the work as described is primarily based on material already in his 1971 book, *Lepidoptera Genetics* (Pergamon Press, Oxford). Finally, Robinson treats the genetics of various European species of butterflies, listing the genetic variations that have been found in each. This section cites both old and new references (post-1971) in considerable detail. In a very real sense, this is a modern-day treatment of the genetics of British and other European species that is similar to what Ford first did in 1945, in his book *Butterflies*. Lepidopterists interested in breeding these species or in trying their hand at genetic work will find this section quite valuable. This chapter closes with a glossary of genetic and evolutionary terms authored jointly by Paul M. Brakefield and Roy Robinson.

Chapter 8 deals with case studies in ecological genetics and is by Paul M. Brakefield,

one of the leading ecological geneticists in England today. Although relatively short, this chapter covers the basic methodology of ecological genetics and then discusses and illustrates work with *Maniola jurtina,* including the heritability of hindwing spotting, the expression of spotting, and types of selection operating on these other spot characters, along with discussion of the extensive field survey data for hindwing spot number in the species. Since Brakefield has been a prolific worker in the field and is incapable of writing a dull paper, this chapter is one of the most interesting in the book and offers much food for thought for those interested in evolutionary phenomena in butterflies. He even treats variation in the *genitalia* from the viewpoint of an ecological geneticist. In the final portion of his chapter, he applies some of the lessons learned from *Maniola jurtina* to *Coenonympha tullia* populations. A model presented by R. L. H. Dennis regarding the selective influences of climate and predation on butterfly variation is discussed with special emphasis. These authors found a close positive association between type of spotting pattern and the duration of bright sunshine in the adult flight period in particular areas. The relationship with sunshine is consistent with geographic changes in increased levels of adult activity, which apparently could shift the balance of selection on wing pattern towards an emphasis on more highly developed spotting, which in turn would function primarily to deflect attacks by predators.

The following chapter is also among the best in the book. Zdravko Lorkovic covers butterfly chromosomes and their application to systematics and phylogeny in Chapter 9. This 65-page chapter provides a brilliant synthesis of our knowledge of chromosomes, spermatogenesis, and oogenesis in butterflies. He shows in great detail how to prepare material for the examination of chromosomes and covers recently introduced methods, including their advantages and disadvantages. He points out that of the 500 or so European species of butterflies and skippers, the karyotypes of approximately 272 species (about 60%) are known. Yet only about 23% of closely related species can be distinguished by their chromosome sets; most species in every family have such constant chromosome numbers that chromosome number is of little utility as a taxonomically differentiating character. Lorkovic then goes on to discuss, in much more detail than Robinson's earlier chapter, the topics of supernumerary chromosomes, variable chromosome numbers, subspecific differences in chromosome numbers, and the behavior of chromosomes in hybrids, where Lorkovic's work has provided distinguished leadership in the field. He illustrates his discussion not only with outstanding text figures, but also with two color plates of 16 figures. The chapter closes with a discussion of the distribution of chromosome numbers among the various families worldwide. This chapter is really an outstanding contribution to the literature on evolution of butterflies and their chromosomes.

Another outstanding chapter follows Lorkovic's. In Chapter 10, Hansjurg Geiger treats the subject of enzyme electrophoretic methods and their impact on studies of the systematics and evolutionary biology of butterflies. Geiger, like Lorkovic with chromosomes, presents some 40 pages of outstanding step-by-step discussion of the utility of enzyme electrophoretic methods in such studies. He includes detailed step-by-step interpretations of the genetics of zymograms (staining of enzyme bands on a gel) and explains how to calculate allelic frequencies from such data. Even more usefully, he discusses in a step-by-step manner the various ways of calculating genetic identity and distance based on enzyme electrophoretic data. This allows even a novice in the field to understand how to quantify the degree of genetic correspondence between populations or taxa, using several different methods. This chapter provides an excellent entry into the literature and methodology of enzyme electrophoresis, and its utility in systematics.

Chapter 11 is by Sydney R. Bowden of West Sussex, Great Britain, and deals with the experimental breeding of butterflies. Beginning with a treatment of the usefulness of experimental cross-breeding in determining taxonomic relationships, he proceeds to discuss in short sections such elementary topics as larval housekeeping, size of cages needed, the recording of data, and how to work out breeding scenarios. Although this short introduction to the problem of experimental breeding of butterflies is interesting, a great many additional topics ought to be covered in a thorough treatment of the subject.

In Chapter 12, the parasitoids of European butterflies are surveyed by Martin R. Chaw, of the Royal Museum of Scotland's Natural History Department. Chaw provides a useful

summary of the topics of population ecology (such as estimating percentage of parasitism), host associations and general parasitoid biology, before describing techniques for collecting, rearing, and handling adult parasitoids. He then provides an outline of the principal groups and families of parasitoids attacking European butterflies. The short paragraph for each family includes one or several literature references to monographs on the European or world genera and species. The chapter concludes with a short glossary.

The penultimate chapter in the book deals with the behavior of butterflies and is authored by Timothy G. Shreeve of Great Britain. With only one figure (basking postures adopted by individuals engaged in temperature regulation), Shreeve nevertheless provides a carefully written summary of thermoregulation, mate location, mate recognition, egg laying behavior, and feeding behavior as "the five major components" of adult butterfly behavior. In each section, Shreeve treats a few examples and cites a fair number of references on European and American species. The chapter concludes with a brief discussion (of several pages) on methods that can be used in behavioral research on each of these five components of adult butterfly behavior.

The final chapter (14), also by Timothy G. Shreeve, deals with the movements of butterflies—migration, dispersal, and within-habitat movements. The treatment begins by defining the various types of movement, and then examines variation in movement, range, sex, timing, and so forth. Local movements are treated at length, and factors underlying dispersal are discussed over several pages, with a modest number of references cited. The topic of directionality in dispersal and migration is treated with a single figure (showing peak flight directions of *Pieris rapae* recorded in western Europe during late summer 1987, though the data are said to be from Baker 1969!). The final pages of this chapter describe methods of measuring dispersal and migration, but the information provided is so sparse as to merely tantalize the reader, who must refer to the original papers for very significant details, such as specific marking methods or the utility of each procedure.

Each of the chapters in this book concludes with a more or less detailed list of references, not necessarily restricted to the European fauna and European studies. There is no central bibliography. There is, however, a terminal index to the scientific names of Lepidoptera mentioned in the text, and a general index to topics.

It is clear that this *Introduction to Lepidopterology* is not really a comprehensive introduction to the biology of butterflies, but instead represents a group of papers on selected topics that are developed with highly uneven thoroughness by their respective authors. As such, this volume cannot equal in coverage the outstanding *Biology of Butterflies* volume edited by Ackery and Vane-Wright (1984, 1989). Nor is it as highly readable as Matthews' *The Lives of Butterflies* (1986). However, the outstanding nature of several of these chapters makes this new work an important reference for those interested in cytogenetics, ecological genetics, or the genetics of European butterflies, especially for researchers employing techniques of enzyme electrophoresis in studies of the systematics and evolutionary biology of butterflies. Taxonomists may find the chapter on European museums and other institutions to be of interest as well. The high price of this book insures that it will be sold mostly to institutional libraries, where it could serve as a useful reference for the above purposes. A well-illustrated introduction to the biology of butterflies, with detailed modern treatment of all areas in this rapidly advancing field of study, is still in the future.

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