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BOOK REVIEWS

THE LEPIDOPTERA OF BERMUDA: THEIR FOOD PLANTS, BIOGEOGRAPHY, AND MEANS OF DISPERSAL, by D. C. Ferguson, D. J. Hilburn, and B. Wright. 1991. Memoirs of The Entomological Society of Canada, No. 158. Soft cover, 16.5 × 25.5 cm, 105 pp., 1 color frontispiece, 204 black and white figures. ISSN 0071-075X. Available from The Entomological Society of Canada, 393 Winston Avenue, Ottawa, Ontario, K2A 1Y8, Canada. Price in Canada: $15 (Canadian) non-members, $12 members of ESC. Price in U.S.A.: $13.50 (U.S.) non-members, $10.75 members of ESC. (All prices postpaid.)

The authors of this monograph and A. B. Ewen, current Editor of the Memoirs, are to be congratulated on a most professional production. The basic content is a systematic treatment of the 183 species of Lepidoptera recorded from Bermuda, arranged in the sequence of the *Check List of the Lepidoptera of American North of Mexico* (Hodges et al. 1983, E. W. Classey Ltd., Faringdon, England, and the Wedge Entomol. Found., Washington, D.C.), with some modifications where more recent published taxonomic changes have been accepted. Following a brief introduction are concise descriptions of the natural history and physiography of Bermuda and historical notes on the early collectors and students of the Lepidoptera of Bermuda. A separate section evaluates dubious historical records and explains why certain species are excluded from the check list that follows, in which each species is identified as endemic, migratory but presently established, irregular visitor, accidentally introduced, or of uncertain status. An interesting and thought-provoking essay by Ferguson on migration of Lepidoptera, with special reference to the history and establishment of the fauna of Bermuda, is included as an appendix. It is accompanied by a table that lists Lepidoptera known to migrate regularly in eastern North America, with notes to indicate which of these species also reach Bermuda. All but the common butterflies and the larger, showier moths are well illustrated by 201 black and white photographs grouped near the end of the volume and followed by an index of scientific names. Errors and synonyms discovered in earlier accounts are clearly identified. The volume is not expensive and should accompany any entomologist visiting Bermuda. It can also be of assistance in identifying quite a number of the more common noctuids and pyralids found in the eastern United States.

This monograph is the most thorough and comprehensive treatment of the fauna of these islands. It is also the first review of the Lepidoptera of Bermuda since L. Ogilvie provided a check list of over 100 names in his "Insects of Bermuda" in 1928. I hasten to say that Mem. Entomol. Soc. Canada No. 158 not only will be the standard reference work on Bermudian Lepidoptera for many years to come, but also far exceeds in content the minimum requirements for a reliable, regional systematic review. As mentioned above, the authors have included fascinating historical information concerning not only the contributions made by the early collectors, but also the legacy of problems left by some early workers, e.g., the Reverend H. B. Tristram, who attached names to Bermudian Lepidoptera based only on experience with butterflies and moths of England. (This would not have mattered much had not several later authors perpetuated these erroneous records by taking them at face value.) Also included is much useful botanical, geological, and biogeographical information on Bermuda.

This volume is of considerable interest to me. I visited Bermuda first in 1976 and again in 1982 on other business, but between fruitless searches in rough seas for the humpback whales reported off Bermuda by Roger Payne and Scott McVay in the early 1970's, I managed to do some limited collecting for Lepidoptera in Sandys and Warwick parishes. The results of the first night convinced me that there was an awful lot of *Spodoptera* spp. in this manicured paradise!

After a few more days, however, I became impressed by the number of species recorded, if not by their exotic qualities or rarity. This point is stressed by Ferguson et al.: Bermuda has a supersaturated lepidopterous fauna, the result of frequent pulses of migrants from the southeastern seaboard of North America and the eastern Caribbean. Ferguson comments that years ago he saw the potential of Bermuda as an insular field laboratory to test hypotheses on dispersal and migration of Lepidoptera. There is no evidence to suggest

that the islands of Bermuda received any of their resident fauna and flora by previous links to the mainland, so, mercifully, a digression concerning the protracted conflict between dispersalist and vicariance biogeographers can be avoided in this case.

The small cluster of islands called Bermuda sits on the crest of a marine volcano uplift of probable Oligocene age, and there has been some land in the present area for perhaps up to one million years. No doubt, founder effect has played a continual role in the establishment of species of plants and animals throughout the Pleistocene and Recent history of Bermuda, with periodic evolution of endemism. There have been rather irregular, cyclic changes in altitude and exposed surface area during the Pleistocene, sometimes increasing the exposed land and reef area to between 600–700 km^2, at other times reducing it to perhaps less than 10 km^2. The present surface area is about 54 km^2. Each sea level change was almost certainly accompanied by significant alteration in mean annual air temperature and rainfall. Such oscillations frequently are inimical to flora and fauna alike. Nevertheless, some groups manage to survive such visicitudes, and a few species may even prosper during unstable periods. The long-term result, however, has been periodic extinction of endemic elements, particularly those with specialized food plants and habitat requirements or restricted ranges. The current faunal association of Lepidoptera (one hesitates to call it a "community") on Bermuda, then, is comprised mostly of immigrants, many of relatively recent origin. Historical data indicate that some species of the genus *Spodoptera*, for example, of which I wrote so slightingly earlier, were not known to entomologists working on Bermuda 20–80 years ago. Occasional transients, which are recorded in each observational season, comprise a category of species that has yet to demonstrate a capacity to breed successfully on Bermuda for an extended period.

Only 15,000 years after the last glacial stadial and 6,000 years after the "warm" period, Bermuda has but a handful of endemic Lepidoptera. Ferguson et al. conclude that these endemic Lepidoptera—11 species and 2 subspecies—are those that survived the last drastic reduction of land area, somewhat over 100,000 years ago. Each time such cyclic events occur, there is presumably a dramatic reduction in diversity. During the relatively long intervening periods of stability, however, biodiversity of any group should attain some kind of equilibrium related to the limited surface area and food plant resources available. During such stability plateaux the chances of new immigrant Lepidoptera establishing themselves as permanent residents presumably might be much reduced. Success is perhaps at a maximum shortly after the occurrence of climatic events unfavorable to the endemic populations. However, this does not imply that the number of species on Bermuda at any given time in the past necessarily would have been lower than today; there would still have been annual influxes of transients from the southeastern seaboard of North America, and from the eastern Caribbean, except in times when there were major changes in the flow of the Gulf Stream and North Atlantic Drift and their associated air masses. However, these immigrant waves may have consisted of quite different species of Lepidoptera than those that have established themselves in relatively recent years.

In his essay on migration, Ferguson argues that even in the case of the cutworm pest species and their allies, most of the lepidopterous fauna of Bermuda was not introduced by man, but became established after over-water dispersal from southeastern North America, and the northeastern Caribbean islands. The greater numbers of cutworms and other noctuids taken in traps today, as compared to the numbers recorded by early collectors on Bermuda, are attributed to these migrants being less abundant in the past. Ferguson concludes that the great agricultural modification of southeastern North America during the last century, with the substitution of arable land for forests, provided and sustained conditions for a huge increase in population sizes of such species that thrive not only on crops but also on the large tracts of weedy fallow land that accompany forest clearing and agriculture.

Similarly, massive disturbances inflicted on the New Zealand flora and fauna by humans have facilitated the establishment of more migrant Lepidoptera, especially from Australia, in the last 50 years or so than in the entire period when E. Meyrick (1887, *Trans. Proc. N.Z. Inst.* 19:3–40), A. Philpott (1928, *Trans. Proc. N.Z. Inst.* 58:359–370), G. V. Hudson (1928, *The butterflies and moths of New Zealand*, Ferguson and Osborn Ltd., Wellington,

N.Z.), and others were recording and describing the Lepidoptera of the archipelago. Data collected by K. J. Fox (1975, *N.Z. Entomol.* 6:66–69) at traps set up at Cape Egmont on the west coast of the North Island for example, suggest that in most years the jet streams carry migrants to New Zealand in far greater abundance than was believed in earlier years. Although historically this probably has been a continual process, establishment may have been more difficult during relatively long periods of ecological stability prior to the arrival of humans within the last one thousand years. The original flora of New Zealand had such a large proportion of endemic groups that suitable foodplants for most Australian insect species were simply absent. Even when light seed was windblown or carried by birds, the germinating plants would still be prone to competitive exclusion by established floral communities.

At this point, it is worth pausing to see what Ferguson et al. have to say about the ecology of Bermuda, if in fact one can glorify Bermuda with that term. In many ways present-day Bermuda resembles the huge, disturbed, urban fringe areas of North America, where remnants of the native vegetation are inextricably mixed with introductions from other North American life zones and from every part of the world. Programs to conserve or enhance biodiversity of native insects in stressed, degraded, and often polluted environments face the same basic problems whether the habitat is an oceanic island or a continental region.

The majority of the plant species that comprised the Bermudian flora when the islands were discovered still survive today. These include 17 endemic species, which range in size from Bermuda Moss (*Trichostomum bermudanum*) to Bermuda cedar (*Juniperus bermudiana*). The ecological communities, however, are gone beyond reclamation. They have been lost to agricultural clearing, periodic burning, early demand for building timber and firewood, and, in the case of the relict native cedar groves, the depredations of an introduced scale insect which brought the tree to the brink of extinction. Ferguson et al. note that the surviving endemic plants face intense competition for resources from introduced weed species of a wide taxonomic range. Similarly, the insect fauna is now dominated by pest species of various kinds that develop large populations periodically, particularly on island crops and introduced horticultural species which now abound in gardens, hotel grounds, and golf courses. The authors also believe that a geometrid moth *Semiothisa ochrifascia*, which fed only on Bermuda Cedar, is now extinct, since the last confirmed capture was in 1928.

In many respects the ecological problems of Bermuda resemble, only too well, those of many other oceanic islands in the tropics and subtropics—such as Fiji, Tonga, Samoa, Easter Island, St. Kitts, the Caymans, Guam, Hawaii—the list is depressingly long. In 1973, F. A. Fosberg (pp. 209–215, *in* Nature Conservation in the Pacific, A. B. Costin and R. H. Groves (eds.) Austral. Nat. Univ. Press, Canberra) published a special plea for a world program to try to save the unique florae and faunae of oceanic islands. There has been some progress since then, in Madagascar, Aldabra and Jamaica, for example, but the total effort is still pitifully limited. Bermuda is particularly vulnerable because of its small size, accessible topography, attractive climate, and proximity to major population centers of eastern North America.

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REARING WILD SILKMOTHS, by Ronald N. Baxter (with a foreword by Brian O. C. Gardiner). 1992. Chudleigh Publishing, 45 Chudleigh Crescent, Seven Kings, Ilford, Essex IG3 9AT, England. x + 72 pp., 2 black & white pls., 8 text figs., 28 color photos by the author. Soft cover, 14.75 × 21 cm, ISBN-0-9519219-0-8, £7.95, plus £2.20 for airmail. (U.S.A. buyers can send $20.00 in cash to receive one copy by airmail.)