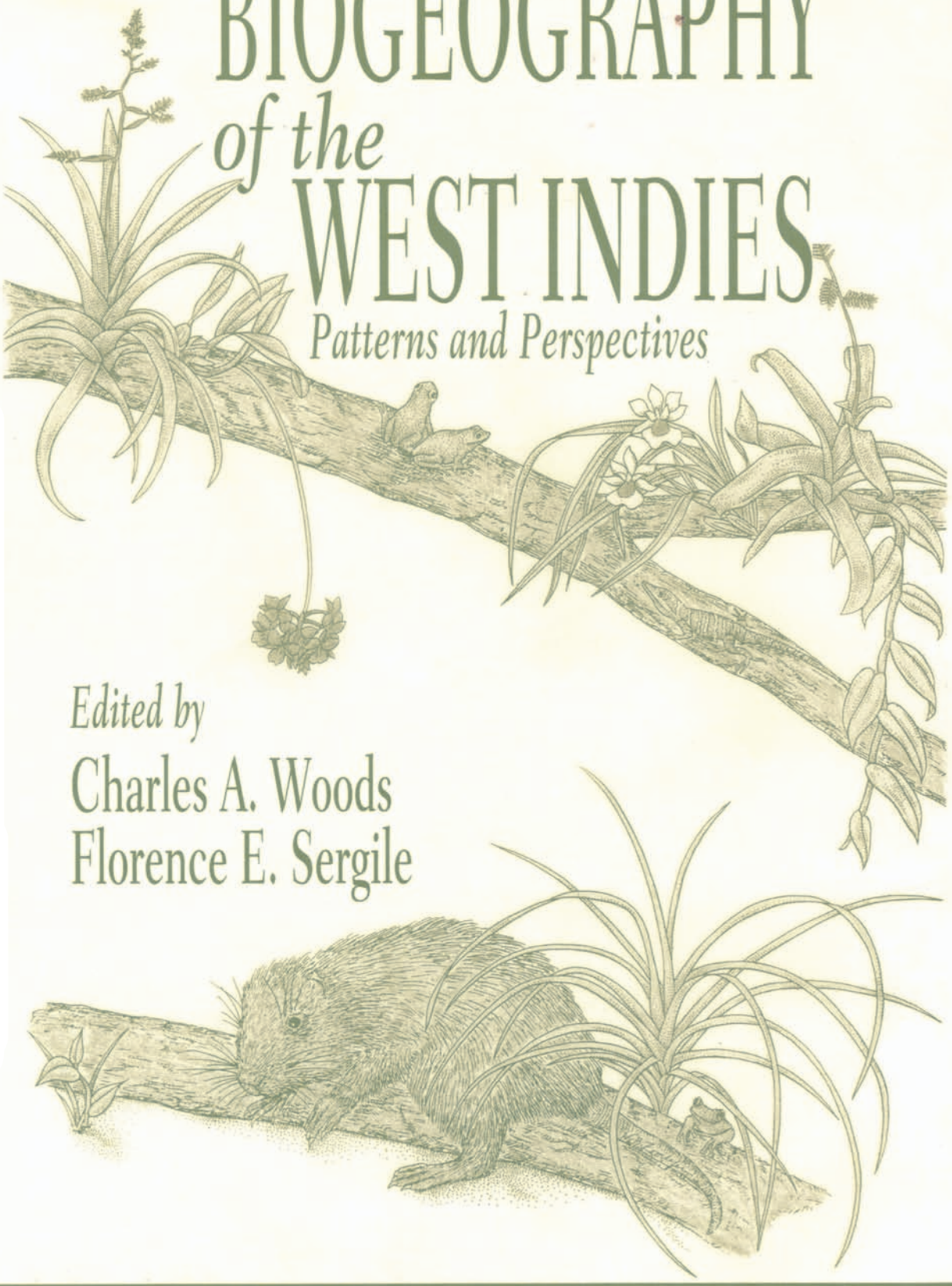
BIOGEOGRAPHY *of the* WEST INDIES

Patterns and Perspectives



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SECOND EDITION

6 Patterns of Endemism and Biogeography of Cuban Insects

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Abstract — The taxonomy and biogeography of insects are poorly known for most islands of the West Indies with the exception of Cuba (8,316 species) and Puerto Rico (5,066 species). It is estimated that if all insects on Cuba could be documented that the total would be close to 10,000 species. Some groups are better known than others, and it is only in these well-known groups that real levels of endemism can be calculated. In some groups endemism is very high, such as stick insects (92.8%), mutillids (90%), Cercopoidea (82%), and Trichoptera (81%). In other groups it is surprisingly low, such as dryinids (0%), agromizids (3.8%), and mosquitoes (5.9%). Large well-known groups tend to have levels of endemism between 40 and 60%, for example, butterflies (39.9%), ants (43.6%), and bees (47.3%). Cockroaches have an endemism level of 63.5%. These data do not provide complete insight into the patterns of dispersal of insects into Cuba or between major mountain ranges or offshore archipelagos. The very different levels of endemism between the various groups of insects suggest that insects colonized Cuba in a variety of ways. Additional studies on the distribution and systematics of Cuban insects are important to help us more accurately understand biogeographical patterns of Cuban insects and how the insect fauna of Cuba relates to other islands in the Greater Antilles.

INTRODUCTION

Because of its geological history and geographical location as an island, Cuba has few mammal species and few vertebrates. The highest level of species abundance (and diversity) on Cuba and its associated archipelagos is represented by invertebrates (Table 1), mainly insects. While the status of insects is poorly known in most areas of the Antilles, there is an important trend toward inventorying biodiversity to better understand their natural history and the biological potential of each habitat and biogeographical region. This is important because of the rapid loss of habitats in the region, and because some species will be lost before they are ever discovered. It may not be possible ever to know the true biodiversity of insects in Cuba. The number of insects in Cuba has been estimated from as high as 25,000 species (Berovides, 1988), downward to 17,000 (Aguayo, 1951; Alvarez Conde, 1958) and 12,000 to 15,000 species (Ferrás et al., 1995). However, they have been accurately quantified only twice. Vales et al. (1992) documented 6,384 species, although this study only evaluated 10 insect orders, and is therefore not a complete record. In the study "Proyecto Pais" (Vales et al., 1998) insects were treated in more detail resulting in a figure of 7,831 species in 29 orders. However, in our opinion, even this higher figure is not a complete picture of the total number of insects on the island.

DISCUSSION

This chapter provides an estimate of the number of Cuban insect species obtained from publications that list or catalog taxa. These listings have been further updated by adding new records, new species, personal communication from various specialists, and data from specimens in collections but not yet in the public record (i.e., published). We present these results as a way of integrating scattered information and laying the foundation for future studies.

The total world number of species (Table 2) in our survey was obtained from Strefferud (1952), Borror and White (1970), and Hogue (1993). Based on the data available to us there are 8,316 insect

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TABLE 1
Quantitative Biodiversity of the Main Taxa of Cuban Terrestrial Invertebrates, Excluding Insects

Taxa	Number of Genera	Number of Species
Mollusca (land snails)	159	1,419
Annelida (earthworms)	14	21
Arachnida (spiders, scorpions, mites, ticks, harvest-bugs, and others)	614	1,350
Decapoda (land crabs)	17	33
Isopoda (sowbugs)	37	68
Chilopoda (centipedes)	17	43
Diplopoda (millipedes)	36	90
Pauropoda (pauropods)	2	2
Symphyla (symphylans)	2	3
Trematoda (flatworms)	100	160
Nematoda (roundworms)	208	525

TABLE 2
Number of Families, Genera, and Species of Cuban Insects, and World Number of Species According to the Order

Insect Order	Families	Genera	Species	World Species
Protura	1	1	1	500
Diplura	3	7	19	800
Collembola	13	63	110	6,000
Thysanura	3	8	10	750
Ephemeroptera	6	15	37	2,139
Odonata	7	41	80	4,950
Orthoptera	4	72	122	14,500
Dictyoptera (Blattaria)	4	33	81	4,000
Mantodea	1	4	4	1,500
Phasmatodea	2	8	14	2,500
Dermaptera	5	11	19	1,100
Isoptera	3	14	31	2,100
Embiidina	3	4	4	150
Psocoptera	16	19	28	1,100
Zoraptera	1	1	1	22
Mallophaga	4	19	39	2,675
Anoplura	2	5	5	250
Heteroptera	36	323	603	23,000
Thysanoptera	4	26	61	4,500
Neuroptera	9	28	74	4,670
Megaloptera	1	1	1	250
Trichoptera	12	26	90	7,000
Diptera	64	410	984	87,000
Lepidoptera	65	762	1,539	112,000
Siphonaptera	2	5	6	1,100
Coleoptera	91	964	2,615	300,000
Strepsiptera	4	6	7	300
Hymenoptera	49	474	1,069	105,000

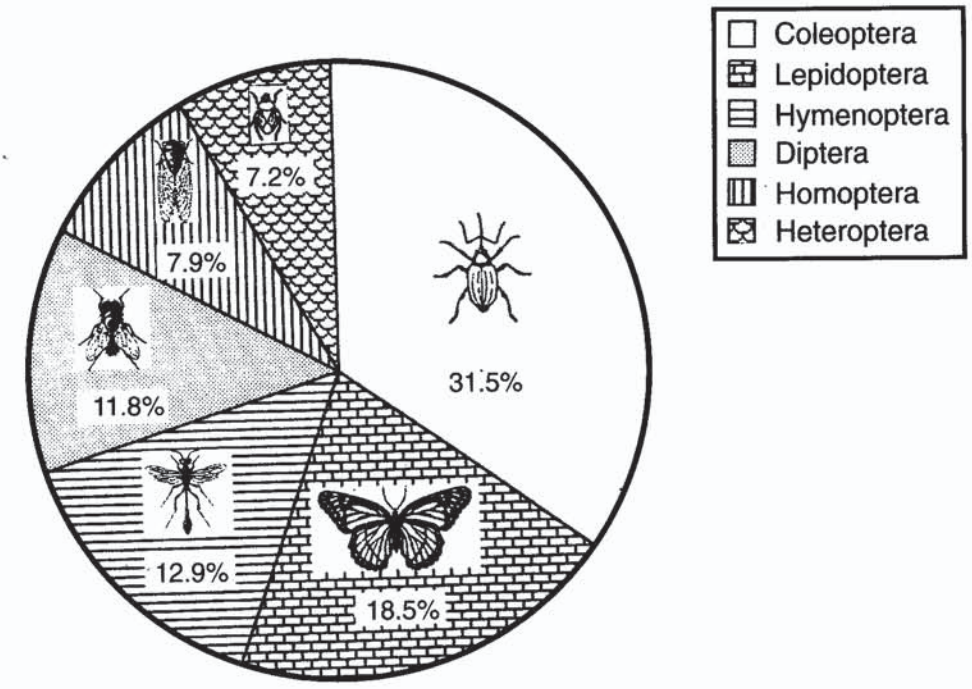

FIGURE 1 Percentages of the main Cuban insect orders.

species in Cuba belonging to 29 orders (Table 2). The largest number of species were represented by beetles, butterflies, Hymenoptera, and flies (Table 2; Aguayo, 1951; and Figure 1). We believe that the estimates for the number of Cuban insects proposed by other authors (see above) are too high. In our opinion, the maximum number of species on Cuba should be around 10,000.

It is important to continue to collect insects in Cuba, and elsewhere in the West Indies, before comprehensive biogeographical comparisons will be possible. Increased financial and logistical support will be necessary to put these expeditions in the field to collect insects and to be able to curate and fully document the level of insect biodiversity in Cuba. The latter phase would require the participation of many specialists in various insect groups who are not always available because of a lack of training in the taxonomy of certain poorly known groups or because of other commitments. Many areas of Cuba are very remote and rugged, which make such faunal surveys major undertakings.

The methodology of collecting insects is another major consideration. Collecting has been carried out in the past mainly by traditional methods such as insect nets. Only recently have modern insect traps such as the Malaise trap, pan traps (yellow plates), and nocturnal black-light traps been utilized. Most insect surveys have been carried out in daylight hours while we now know that night collecting offers a completely different scenario. Most new taxa are mainly small-size insects that can be found even in places disturbed by humans. The best places in Cuba for identifying new insects is deep into rugged mountain ranges, on offshore keys and islands, and in wetlands such as the Zapata Swamp.

The taxonomy and distribution of Cuban insects is well known in comparison with other regions of the West Indies and South America. Nevertheless, problems arise in Cuba when trying to apply this knowledge to ecological and ethological studies or when incorporating the data into management plans focused on the conservation of ecosystems and fauna. These difficulties arise from a lack of good reference collections and taxonomic specialists, as well as scattered literature, difficult access to old publications, the deposition of holotypes in foreign institutions, and a lack of practical articles allowing for species identification through keys or field guides.

There have been several attempts to explain how invertebrates dispersed to the Antilles (Darlington, 1938; Liebherr, 1988a, 1988b) and to present explanations for distribution patterns of invertebrates within the West Indies (Darlington, 1937; Fontenla, 1992, 1994; Fontenla and Cruz, 1992). The depth of systematic knowledge varies depending on the taxonomic group and some groups are very poorly known. Zoogeographic analyses cannot be undertaken in many groups until a more complete systematic review has been completed. The taxonomic groups that have been best studied are butterflies (Lepidoptera) (Scott, 1972; Brown, 1978; Fontenla and de la Cruz, 1986, 1992; Miller and Miller, 1989; Fontenla, 1992); beetles (Coleoptera) (Darlington, 1943, 1971; Matthews, 1966; Liebherr, 1988b; Browne and Peck, 1996); dragonflies and damselflies (Odonata) (Paulson, 1982); ants (Wilson, 1988; Fontenla, 1994); bees (Hymenoptera) (Michener, 1979; Eickwort, 1988), and to a lesser extent, mayflies (Ephemeroptera) (Edmunds, 1982), caddisflies (Trichoptera), bugs (Heteroptera), and flies (Diptera) (Liebherr, 1988b).

In the West Indies, geographical isolation, wide variety of soils, and differences in altitude and climate all have combined to account for high levels of endemism in land organisms. The analysis of endemism is difficult in insects because no single publication or source integrates the systematic knowledge and geographical distributions of all species. Some taxa and groups have been better studied than others, however, and it is possible to estimate endemism in the following groups: cockroaches (63.5%) (Gutiérrez, 1995); mosquitoes (5.9%) (González and Rodríguez, 1977); sirphids (30.6%) (Garcés and Rodríguez, 1998); agromizids (3.8%) (Garcés, 1998); Odonata (62%) (C. Naranjo, personal communication); stick insects (92.8%) (Moxey, 1972); Trichoptera (81.1%) (Botosaneau, 1979; 1980); Dermaptera (15.8%) (Brindle, 1971); meloids (42.8%) (Genaro, 1996); tiger beetles (40%) (P. Valdés, personal communication); bruquids (22.2%) (Alvarez and Kingsolver, 1997); Psocoptera (52.5%); Hymenoptera, dryinids (0%), scoliids (20%); tiphiids (62.5%); ants (43.6%) (Fontenla, 1997); mutillids (90%); bees (47.3%); Cicadoidea (70%); Membracidae (63%); Cercopoidea (82%); Kinnaridae (75%) (Ramos, 1988); mirids (17%) (Hernández and Stonedahl, 1997); ligaeids (27%) (Slater, 1988); butterflies (39.9%) (Smith et al., 1994).

The present status of systematic knowledge allows only for an estimate of overall endemism. In many taxa is very high, while in others it is lower, and it may be zero. On average, endemism ranges between 40 and 60%.

Insect groups have different dispersion patterns; even within an order there are families with different degrees of vagileness. Fauna has been shaped by the arrival of species from several parts of the world at different geological times, and following their arrival in Cuba these species adapted and evolved under insularity conditions. This flow of insects to and from the West Indies continues. The Antilles are composed of many islands and keys dissected by open water. Air currents, especially powerful forces such as hurricanes, have played an important role in the dispersion of insects. Introductions, both accidental and intentional, have also played a role in the dispersal of insects. The dragonfly *Crocothemis servilia* (Libellulidae) from Asia was accidentally introduced in Florida, where it is common, and arrived recently to Cuba (Flint, 1996). The African beetle *Onthophagus gazella* (Scarabaeidae) was introduced on purpose in the United States and is now common in the north coast of Cuba (R. B. Woodruff, personal communication). Examples of dispersal events in the opposite direction include several species of butterflies that have become established in Florida from the West Indies within the last hundred years (Scott, 1972). These examples demonstrate that faunal exchange in the West Indies is a dynamic process. We believe that many more examples will appear if in-depth studies are carried out in Cuba and the West Indies in general. The senior author (J.A.G.) is finding many species of Aculeata (Hymenoptera) in Hispaniola that were previously thought to be exclusive to Cuba.

The knowledge of insect taxonomy and systematics varies from island to island in the West Indies and has been integrated for only two islands, Puerto Rico and Cuba. In Puerto Rico, the smaller island, 5,066 species were recently quantified (Maldonado, 1996). In Jamaica, there is not a reliable count of all species, although Farr (1984) provides numbers for several groups. The most critical example of a poorly known fauna is that of Hispaniola. A little smaller than Cuba, this

island has both more diverse habitats and the least well-known insect fauna. What is known indicates that Hispaniolan insects have a high level of endemism, and are most similar to the insect fauna of eastern Cuba.

CONCLUSIONS

The insect fauna of Cuba has been well enough documented to project that about 10,000 species occur on the island. The levels of endemism vary remarkably between the various insect groups, ranging from over 90% (mutillids and stick insects) to as low as zero (dryinids). The reasons for this high level of variability are poorly understood, and await data from more complete studies of the life history and ecology of Cuban insects. Such studies should be given a high priority. The average level of endemism is close to 50%, with endemism levels for most well-known groups in the 40 to 60% range. While the insects of Cuba are relatively well known, as are the insects of Puerto Rico, insects are poorly documented and little studied in other areas of the West Indies, with major lacunae in Hispaniola and Jamaica. Based on the preliminary data available to us, it appears that the closest relatives of insects from eastern Cuba are found in Hispaniola.

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