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HABITAT, DIVERSITY AND IMMIGRATION IN A TROPICAL ISLAND FAUNA: THE BUTTERFLIES OF LIGNUMVITAE KEY, FLORIDA¹

DENNIS LESTON

Agricultural Research and Education Center, University of Florida,
Homestead, Florida 33031

DAVID SPENCER SMITH

Department of Zoology and Hope Entomological Collections,
Oxford, England

BARBARA LENCZEWSKI

Department of Biological Science, Florida State University,
Tallahassee, Florida 32306

ABSTRACT. An annotated account is presented of the 22 resident and 15 casual butterfly species reported from Lignumvitae Key, a small, protected and relatively unspoiled island in the Florida Keys. The fauna, largely Neotropical, is a segment of that found on the Florida mainland and is analyzed in relation to that area and also to Cuba and Andros. The majority of species occur in open habitats, the forest being impoverished. The overall faunal reduction as compared with the mainland is probably an area effect. Among the species on the Key, *Eunica tatila*, *Hemiargus thomasi* and *Phyciodes frisia* are noted as being in decline elsewhere in South Florida.

Two facets of island faunas are of major interest: their biogeographical affinities and their diversity. Additionally, there is the frequent exhibition of colonization patterns and faunal change (Simberloff, 1978). Since published information on the Florida Lepidoptera covers one hundred years, we have found these insects to be of great value in studying the above related topics. The present work considers the butterfly fauna of Lignumvitae Key. In the chain of small islands situated in Florida Bay known as the Keys, Lignumvitae is the least disturbed by the pressures of man and nature and so is of outstanding biological importance (Wilson & Eisner, 1968). The species compo-

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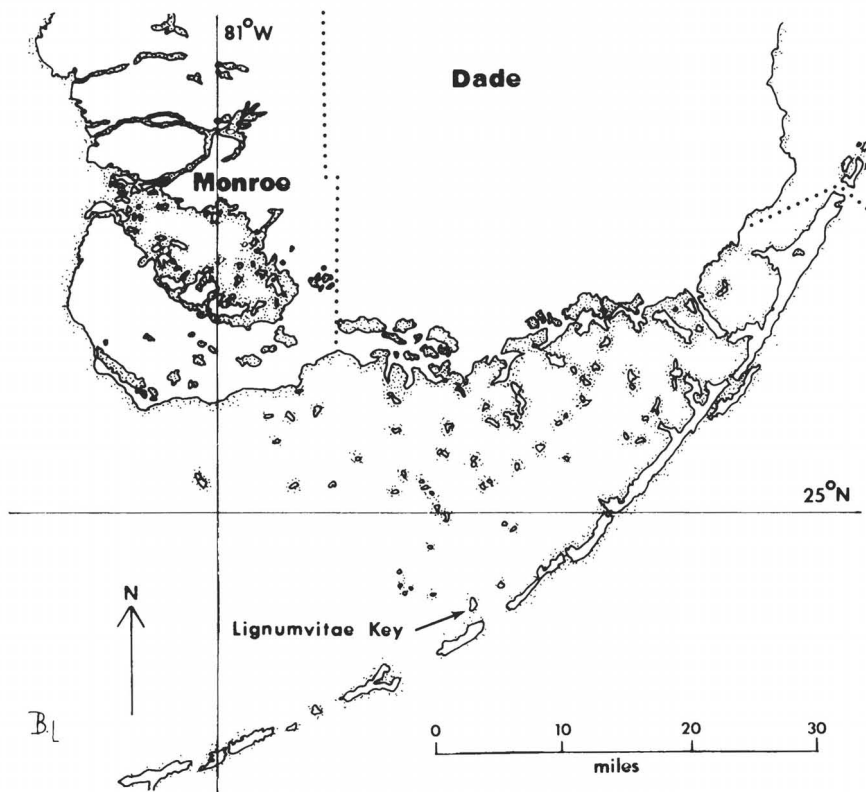


FIG. 1. Map of the southern tip of the Florida peninsula, including the Florida Keys. Lignumvitae Key is indicated (arrow).

sition of this island takes on even greater significance when viewed in the context of a more extensive study of the faunal changes of southern Florida, the Keys and the Bahamas currently in progress (Lenczewski, 1980; Leston et al., in preparation).

Lignumvitae Key covers about 270 acres and is situated about half a mile north of the eastern tip of Lower Matecumbe Key in the middle Keys, Monroe County (Fig. 1). The Florida mainland is approximately 20 miles to the north, the coast of Cuba is 125 miles to the south and the island of Andros in the Bahamas is 140 miles east. The geological composition of the Key is Key Largo limestone, a fossilized coral rock; and Lignumvitae is the highest of the Florida Keys, reaching 16 feet above mean sea level.

There are no meteorological data available for Lignumvitae Key, but, although situated at $24^{\circ}55'$ north and therefore outside the geophysical tropics, its climate in the Köppen system is of tropical rain forest.

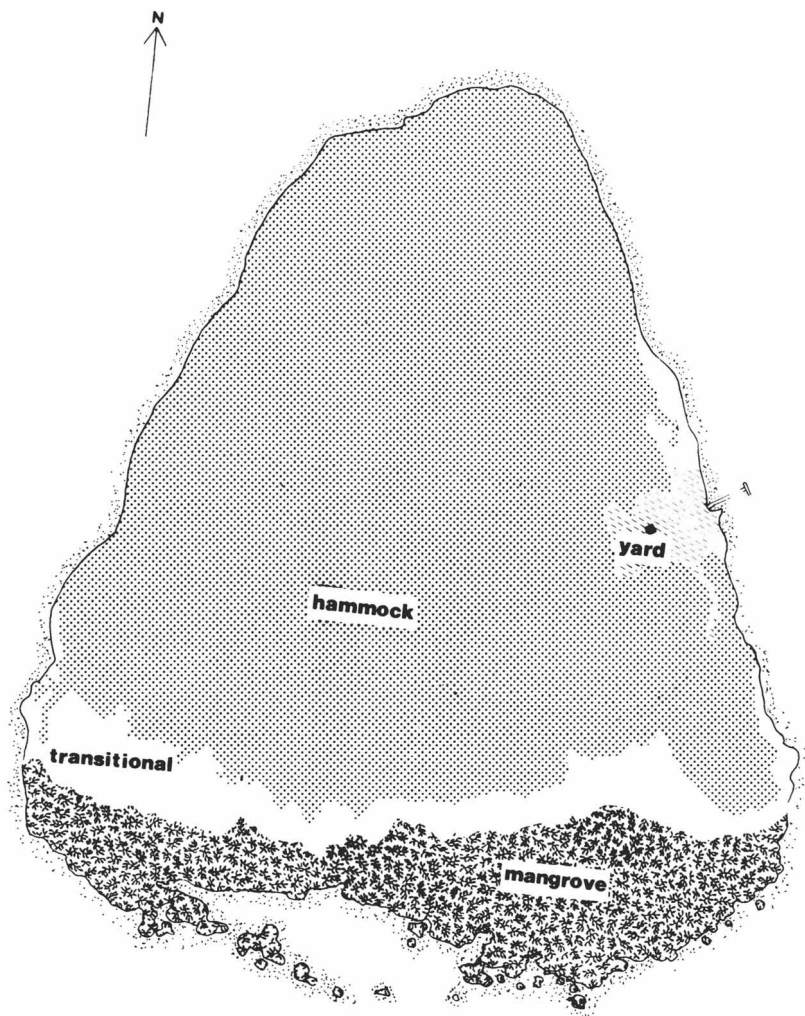


FIG. 2. Map of the vegetation zones of Lignumvitae Key. Note the pier and adjacent yard on the eastern shore. Numerous paths of indeterminate age extend from the yard area through the hammock; these have not been surveyed and are not included here.

There is a dry period extending from November through April, the rest of the year being wet. The absence of adequate figures, especially of mean hours of bright sunshine per day, does not permit greater precision in the defining of seasons (Leston & Gibbs, 1971).

The Key has a long history of human occupation, dating back to pre-Columbian times, but more recent farming has left little mark save for some surviving sisal and a few overgrown coconut palms. The

Matheson house, dating from 1919, is the only substantial building on the Key except for outhouses and a caretaker's dwelling: these all lie within a somewhat barren mown yard with a few ornamental plants and nearby refuse dumps. A short pier extends from the yard. The Key became the property of the State of Florida when it was established as a Botanical Preserve in 1971.

The greater part of the vegetation is forest (Fig. 2), locally known as 'hammock,' comprising about 60 species of trees and larger shrubs, almost entirely of West Indian origin. Popenoe and Avery (1972) suggested that "the Key is covered by one of the finest tropical forests in an essentially virgin condition to be found anywhere in Florida."

METHODS

Butterflies were netted and, except for hesperiids required for identification, were usually released after capture. A voucher collection has been deposited with the Department of Natural Resources on Lignumvitae Key.

One or more of the authors visited the Key, singly or in various combinations and sometimes accompanied by a colleague, on ten mornings between 8 March 1979 and 10 July 1980. A record of person-hours collecting was kept (Fig. 3), and a regular route was followed to maximize the area covered. No particular attention was paid to larvae but any seen were recorded. A few records of adults seen or collected by Ranger Jeanne Parks are included in the checklist and so identified (J.P.).

After completion of our fieldwork, our attention was drawn to two earlier, unpublished studies, the results of which have been incorporated. R. E. Silberglied (pers. comm.) scored butterflies during several visits between 1967 and 1971 and recorded 18 species. The absence of precise dates has limited us to listing only the four species not found in our own collecting. C. V. Covell (pers. comm.) visited the Key on 14 May 1973 and 15 May 1974, and all his records are cited below. One of the present authors (D.S.S.) was a member of Dr. Covell's party on the former visit.

For comparison, data are included for mainland Dade and Monroe Counties and the rest of the Florida Keys, based upon the findings of Leston et al. (in preparation), for Cuba (Bates, 1935; Riley, 1975) and for Andros, Bahamas (Clench, 1977).

RESULTS

Terminology

We use **migrate** in its basic meaning: to pass from one place to another. This excludes "flitting," the short-range movement associ-

ated with the search for food. A **regular migrant** is a species whose movements show a consistent seasonal pattern, as opposed to **casual migrants** (=transients).

Checklist of Species

Satyridae

1. *Euptychia areolata* Smith

Present before 1972 (R.E.S.). Clearly a rare casual on Lignumvitae Key, the species occurs around freshwater marshes and grassland habitats on the mainland and the larger Keys. It is absent from Cuba and Andros.

Danaidae

2. *Danaus plexippus* Linnaeus

Hammock edge and yard (30.III.79) also 28.X.76 (J.P.). An uncommon but regular non-breeding seasonal migrant. Probably absent between May and early October. Occurs in mainland Dade and Monroe Counties, throughout the Keys, in Cuba and, sporadically, in Andros. The scarcity of *Asclepias* species host plants on the Key perhaps limits the opportunity for breeding, which may take place on the adjacent mainland in the dry period.

3. *Danaus gilippus* Cramer

Northwest shore, 17.V.79—when disturbed, the butterflies flew back out over Florida Bay; transition zone, 8.VI.79, numerous; yard and east shore, 10.VII.80, three or four only. Probably a non-breeding seasonal migrant, surprisingly absent August through April. Occurs in mainland Dade and Monroe Counties, throughout the Keys, in Cuba and in Andros, where it was first noted in 1977. When compared with *plexippus* this is scarcely to be considered a migratory species, but there is some evidence for movement (Harris, 1972). Brower (1962) showed that *gilippus* and *plexippus* can compete for larval food, and the apparent non-overlap of the two on Lignumvitae Key may reflect this. *Asclepias* is scarce on the Key; however, other Asclepiadaceae such as *Cynanchum scoparium* and *Sarcotremma clausa* are indigenous and may perhaps be utilized.

Heliconiidae

4. *Heliconius charitonius* Linnaeus

Hammock, 8.III., 16.III., 30.III., 20.IV., 17.V., 8.VI., 18.VII., 13.XI.1979, 18.I., 10.VII.1980. Also 15.V.74 (C.V.C.). Visits the yard in search of flowers, as on 30.III.79 at flowers of *Carissa macrocarpa* and on 18.VII.79 far more frequent at the yard edge than in the hammock. In all, the butterflies were present in the yard on five of ten visits. New broods occur at least in March and June, and observations on a 'dormitory' of this species in Miami (T. Smith & D. S. Smith, unpublished) suggest that at least five generations may be completed in a year.

A resident, the zebra is found in the nearby mainland counties, throughout the Keys, and as different subspecies in Cuba and Andros. The larval foodplants are *Passiflora* species (Passifloraceae), one or two of which occur on the Key.

5. *Dryas iulia* Fabricius

Yard, 8.III., 16.III., 30.III., 20.IV., 17.V., 8.VI., 18.VII. 1979, 18.I., 10.VII.1980. Also 15.V.1974 (C.V.C.). On 16.III.1979, individuals were at the northwest shore on flowers of *Suriana maritima*; on 30.III.79 some were feeding upon flowers of *Carissa macrocarpa* in the yard. A new brood was present in June.

A resident, the Lignumvitae Key subspecies is the same as on the adjacent mainland and throughout the Keys. Other subspecies occur on Cuba and Andros (Clench, 1975). The larvae feed upon *Passiflora* species.

6. *Agraulis vanillae* Linnaeus

Yard, 8.III., 16.III., 30.III., 20.IV., 17.V., 8.VI., 18.VII., 13.IX.1979; 18.I., 10.VII.1980; also 28.X.1976 (J.P.). Only found in the yard, where it visits flowers including *Carissa macrocarpa* and *Nerium oleander*. Most abundant in May through July, with new broods occurring at least in early May and late July.

A resident, the larval foodplants being *Passiflora* species. This insect is found in mainland Dade and Monroe Counties and throughout the Keys, a distinct subspecies occurring in Cuba and Andros.

Nymphalidae

7. *Marpesia petreus* Cramer

Hammock, 10.VII.1980, also sight records 11.VI.1979, 3.VII.1980 (J.P.). The single sighting in 1979 suggested a casual immigrant, but the numbers seen within the hammock in 1980, when up to four were visible at a time, indicate that this is a resident. The butterflies were commonly seen around *Ficus aurea* (Moraceae), a native fig and known larval foodplant.

M. petreus occurs in mainland Dade and Monroe Counties and throughout the Keys but is absent from Andros and Cuba.

8. *Eunica tatila* Herrich-Schaeffer

Hammock, 8.III., 16.III., 30.III., 20.IV., 17.V., 8.VI., 18.VII., 13.IX.1979, 18.I., 10.VII.1980, also 27.X.1976 (J. P.) and 14.V.1973, 15.V.1974—"more common than in 1973" (C.V.C.). This butterfly never leaves the hammock nor, apparently, does it fly above the canopy. It was abundant in March but scarce in May and June, with a new brood in July (1979, 1980) producing a smaller population than the February brood. Numbers are relatively low through the Fall.

The larval foodplants, all of which are trees, probably include *Gymnanthes lucida* (Euphorbiaceae). Currently, this butterfly occurs in the Upper Keys between Elliot Key and north Key Largo, and there are recent reports from Upper Matecumbe and Plantation Keys. However, the Lignumvitae Key population is undoubtedly the largest concentration. Although a single fresh specimen was found in a Miami garden in 1979 (D.S.S.), no populations have been found by us in a search of the larger surviving Dade and Monroe mainland hammocks, and the last Everglades National Park example dates from 1973 (Lenczewski, 1980). *E. tatila* is present in Cuba but probably absent from Andros—see discussion by Clench (1977).

9. *Junonia evarete* Cramer

Yard, 16.III., 30.III., 20.IV., 18.VII.1979; also in transition zone, 20.IV., 18.VII., 13.XI.1979 and in the hammock, 30.III.1979. A resident, but absent or scarce in May through July. The larval foodplants include *Lippia nodiflora* and *Stachytarpheta jamaicensis* (Verbenaceae).

This butterfly occurs on Andros and, perhaps, as a separate subspecies in Cuba (cf. Riley, 1975). It is widespread in the Keys but confined to coastal areas on the Florida mainland: migrations complicate the distribution pattern.

10. *Anartia jatrophae* Johansson

Seaward edge of the yard, 10.VII.1980. Three specimens were seen within five minutes, but absence of this distinctive species from previous samplings or inspections and absence of the larval foodplant, *Bacopa monnieri* (Scrophulariaceae) indicate that this is a non-established casual immigrant. It occurs in mainland Dade and Monroe Counties, the Keys, Cuba and Andros.

11. *Siproeta stelenes* Linnaeus

Yard, 30.III.1979, one, at flowers of *Carissa macrocarpa*; also one seen 18.VI.1979 (J.P.). A non-established casual immigrant known from Cuba and, for the past 15 or so

years, established in the Keys and mainland south Florida but apparently absent from Andros. The larval foodplants are *Blechnum* species and perhaps other Acanthaceae.

12. *Phyciodes frisia* Poey

Yard, 8.III., 16.III., 30.III., 20.IV., 18.VII., 13.XI.1979, 18.I., 10.VII.1980; also hammock, 30.III.1979. Also 14.V.1973 (C.V.C.). Numbers were high in March, reduced in April and again up (the result of a new brood) in June. Through the rest of the year, the biology of the Cuban crescent was unclear. Adults visited flowers of *Carissa* in the yard in late March and flowers of *Pluchea purpurescens* in the transition zone in July 1980. A resident, the larval foodplants include *Dicliptera assurgens* (Acanthaceae), which is common on the Key. The species is found in Andros, Cuba and throughout the Keys but on the mainland of Florida is now confined to the Flamingo area in the Everglades National Park (Lenczewski, 1980).

13. *Phyciodes phaon* Edwards

Yard, 30.III., 20.IV., 19.VII., 13.XI.1979, 18.I., 10.VII.1980. Absent in May and June and scarce in July, this butterfly was most frequent in November and January. It is a breeding resident, the larval foodplant being *Lippia nodiflora* (Verbenaceae). Unlike *frisia* this species never strays from the yard.

Phyciodes phaon is widespread in southern Florida and the Keys, rare in Cuba and absent from Andros.

Lycaenidae

14. *Strymon melinus* Hübner

Yard, 8.III., 16.III., 30.III., 17.V., 8.VI.1979. This species is a breeding resident with two, perhaps three, broods per year. It is highly polyphagous and its larval foodplant has not been detected on the Key, but this plant is undoubtedly one of the common yard forbs. The butterfly is common in the Keys and on the mainland, absent from Andros and Cuba.

15. *Strymon columella* Fabricius

Transition zone, 13.XI.1979, 10.VII.1980. On the latter date the butterfly was visiting flowers of *Pluchea purpurescens*. Also 14.V.1973 (C.V.C.). The larval foodplant is probably one of the Malvaceae, of which several occur as yard forbs on the Key. The species occurs on the mainland and through the Keys, also in Andros and Cuba, but there is some uncertainty concerning the identity of the involved subspecies (Clench, 1963). On Lignumvitae Key, the paucity of records suggests that *columella* is a casual immigrant, though the presence of potential foodplants indicates that breeding populations may be sporadically established.

16. *Strymon martialis* Herrich-Schaeffer

Yard, 30.III. and 13.XI.1979. Probably a casual migrant, although the foodplant *Trema micrantha* (Ulmaceae) is said to occur on the Key. Widespread, but never abundant in mainland Dade and Monroe Counties and in the Keys; it is also present in Cuba and Andros.

17. *Brephidium pseudofea* Morrison

Transition zone, 16.III., 30.III., 20.IV., 17.VI., 8.VI., 18.VII., 13.XI.1979, 18.I., 10.VII.1980; also on shore of the yard throughout. Other records: 14.V.1973, 15.V.1974 (C.V.C.). The butterfly was abundant in June and July, common at other times. It is a resident breeding species, the larvae feeding on *Salicornia* species (Chenopodiaceae). Adults seldom move more than a few yards from the larval foodplant, and those noted at flowers of *Pluchea purpurescens* (10.VII.1980) were no exception.

Brephidium pseudofea is present in saltmarshes along the coast of Dade and Monroe Counties and in the Keys, but is absent from Cuba and Andros.

18. *Leptotes cassius* Cramer

Yard, 8.III., 16.III., 30.III., 18.VII., 13.XI., 1979, 18.I., 10.VII.1980; also in transition zone 13.XI.1979, and 14.V.1973 (C.V.C.). This butterfly is seemingly absent April through June. It is a resident species, the larvae feeding on flowers of a range of herbs, all papilionaceous. It is common in mainland Dade and Monroe Counties, throughout the Keys, on Andros and in Cuba.

19. *Hemiargus thomasi* Clench

Yard, 8.III.1979; transition zone and yard, 16.III.1979; hammock, transition zone and yard, common 30.III.1979 and in the same areas 20.IV. and 17.V.1979; transition zone and yard, 8.VI. and 18.VII.1979; transition zone, 13.XI.1979; yard, 18.I.1980; hammock and transition zone, 10.VII.1980.

A resident species, the larvae feed upon the green seeds within the inflated calyx of *Cardiospermum halicacabum* (Sapindaceae); this is the same foodplant previously noted by us on Key Largo (Lenczewski, 1980). On Lignumvitae Key, *thomasi* is essentially a species of the hammock canopy and the transition zone edge of the hammock, at times flying further afield in search of flowers.

The Miami blue is now probably extinct in mainland Dade and Monroe Counties, but it occurs throughout the Keys from Key Biscayne and Elliot Key southwards and on Andros but is apparently absent from Cuba (but see discussion in Riley, 1975).

20. *Hemiargus ceraunus* Fabricius

Yard, 30.III., 13.XI.1979. The paucity of records suggest that this is a casual immigrant, but as the larval foodplants include a range of weedy Caesalpiniaceae and Papilionaceae (*Abrus*, *Cassia*, *Crotalaria* and *Phaseolus* species), establishment is possible. The species is common on the mainland and occurs throughout the Keys, also on Andros and Cuba (but compare the views of Riley, 1975 and Clench, 1977 as to the identity of this species and *H. hanno* Stoll).

Papilionidae

21. *Papilio cresphontes* Cramer

Yard, 16.III., 30.III.1979, some at flowers of *Carissa macrocarpa*; hammock, 17.V., 8.VI.1979; yard and hammock, 13.XI.1979. Also 22.X.1976 (J.P.); 14.V.1973, 15.V.1974 (C.V.C.). Larvae have been found on *Zanthoxylum fagara* and *Amyris elemifera* (Rutaceae). The captures suggest that there are three broods of this resident. The species occurs throughout the Florida mainland and in the Keys but is absent from Andros and rare in Cuba.

Pieridae

22. *Phoebis sennae* Linnaeus

Transition zone and yard, 8.III., 30.III., 8.VI.1979; yard only, 16.III.1979. A regular migrant, perhaps temporarily established. The larval foodplants are usually weedy herbaceous Papilionaceae or Caesalpiniaceae. The butterfly is common in mainland Dade and Monroe Counties and throughout the Keys, in Cuba and Andros.

23. *Phoebis agarithe* Boisduval

Yard, 8.III.1979; transition zone and yard, 16.III. and 30.III.1979, some at flowers of *Carissa macrocarpa*; 20.IV., 17.V., 8.VI., 13.XI.1979, 18.I., 10.VII.1980. Also 14.V.1973, 15.V.1974 (C.V.C.). Numbers remain fairly constant throughout the year except for a dip in July. It is a resident butterfly, the larvae feeding upon *Pithecellobium* (Mimosaceae), of which two species occur on Lignumvitae Key. Common in mainland south Florida and the Keys, the insect is present also in Cuba and Andros.

24. *Aphrissa statira* Cramer

Present before 1972 (R.E.S.) and regarded by us as a rare casual, the 'migrant sulfur' (Riley, 1975) is recorded from the Keys, the Florida mainland and Cuba but not from

Andros. It is very restricted in southern Florida but certainly breeds locally, its numbers possibly augmented by immigration. We follow Riley's generic placement.

25. *Eurema lisa* Boisduval and Leconte

Yard, 13.XI.1979, 10.VII.1980. Only one specimen was found in November; the insect was apparently absent in January and yet numerous in July 1980. We consider this species to have been a casual originally, but now established. The larval foodplants comprise a range of Papilionaceae and Caesalpiniaceae. Common throughout southern Florida and found through the Keys, the butterfly occurs also in Cuba and Andros, but there is some confusion concerning the range of the various subspecies.

26. *Eurema daira* Godart

Yard, 16.III., 30.III., 20.IV., 17.V., 18.VII., 13.XI.1979, 18.I., 10.VII.1980, also 28.X.1976 (J.P.). The species was most common in each July. A resident and never found away from the weed-riddled grass areas of the yard, the larvae feed on a range of low herbaceous Papilionaceae. *E. daira* is common throughout mainland Florida, the Keys, Cuba and Andros. Elsewhere (Smith et al., 1982), we have re-examined the problem of seasonal and sexual variation in this butterfly, and have included Lignumvitae Key material in the analysis. As in Dade County populations surveyed, *palmira*-like individuals occur on Lignumvitae Key.

27. *Nathalis iole* Boisduval

Before 1972 (R.E.S.); 15.V.1974 (C.V.C.). This species was sought for in our visits without result. We regard it, therefore, as a casual species on Lignumvitae Key, perhaps becoming temporarily established. It is widespread and often abundant on the mainland and in other Keys, Cuba and Andros.

28. *Ascia monuste* Linnaeus

Yard and transition zone, 8.III., 16.III., 30.III., 20.IV., 17.V., 8.VI., 18.VII., 13.XI.1979, 18.I., 10.VII.1980, including individuals visiting flowers of *Pluchea purpurascens*. The grey form was present in the June sample. The species is apparently most numerous in January through March. While a resident, the numbers may well be enhanced by regular immigration. Larval foodplants include a range of herbaceous Capparidaceae and Cruciferae. The species is common in south Florida, the Florida Keys, Cuba and Andros.

29. *Appias drusilla* Cramer

Hammock, 20.IV., 17.V., 18.VII., 13.XI.1979, 10.VII.1980; also at the hammock-yard edge, 17.V. and 18.VII.1979. Also 15.V.1974 (C.V.C.). The butterflies were noticeably absent in January and March, most numerous in June and July, with a new brood present in June. A resident, the larval foodplants include *Drypetes* (Euphorbiaceae) and *Capparis* (Capparidaceae) species. This pierid is present in the hammocks of mainland Dade and Monroe Counties and in suitable habitats throughout the Keys, in Cuba and, rarely, in Andros.

Hesperiidae

30. *Panoquina panoquinoides* Skinner

Shore edge of yard, 18.VII., 13.XI.1979, at flowers of *Conocarpus erecta*; 18.I.1980. Resident, but numbers always low and confined to the narrow coastal edge of the yard. The larval foodplant is *Sporobolus virginicus* (Graminae). In addition to buttonwood, the adults utilize the flowers of *Sesuvium portulacastrum*. The species is found in similar habitats on the mainland, throughout the Keys, on Andros but not currently occurring in Cuba, according to Riley (1975).

31. *Asbolis capucinus* Lucas

Yard, 8.III., 30.III., 20.IV., 17.V., 18.VII.1979. A resident, the larvae feed upon the introduced *Cocos nucifera* (Palmae). Originally Cuban, *capucinus* has been estab-

lished on the Florida mainland and through the Keys since about 1950. It is not recorded to date from Andros.

32. *Erynnis zarucco* Lucas

Before 1972 (R.E.S.). This skipper is widespread in the lower Keys and present on the mainland and in Cuba, but not Andros. Clearly a casual on Lignumvitae: foodplants include a few Papilionaceae.

33. *Urbanus proteus* Linnaeus

Yard and hammock, 16.III.1979; yard and transition zone, 13.XI.1979, 18.I.1980, also 7.XI. and 12.XI.1976 (J.P.). A regular immigrant, temporarily established and breeding in the dry period, November through April. The larval foodplants include a wide range of herbaceous Papilionaceae. This species is common in mainland Dade and Monroe Counties, throughout the Keys, and is represented by a distinct subspecies in Cuba and Andros.

34. *Urbanus dorantes* Stoll

15.V.1974 (C.V.C.). Another casual species, recorded only once from Lignumvitae, this skipper occurs in Cuba and Andros and, in the past decade or so, has become a common butterfly on the Florida mainland and in the larger Keys. It is markedly seasonal, and its foodplants include many weedy Papilionaceae.

35. *Polygonus leo* Gmelin

Yard, 16.III., 30.III.1979, at flowers of *Gliricidia* and *Carissa*; 20.IV., 17.V.1979, 18.I., 10.VII.1980; in hammock, 30.III., 20.IV., 13.XI.1979, 18.I.1980; also in transition zone, 13.XI.1979. Also taken 15.V.1974 (C.V.C.). This hesperiid, a resident, is most common November through March. The larvae feed upon *Piscidia piscipula* (Papilionaceae). The distribution includes mainland Dade and Monroe Counties, the Keys, Cuba, but apparently not Andros.

36. *Epargyreus zestos* Geyer

Hammock, 10.VII.1980, a single worn individual; also 15.V.1974 (C.V.C.). A casual immigrant, now probably extinct on mainland Florida but unpredictably present through the island chain from Key Largo to Key West; found on Andros but absent from Cuba. The larval foodplants are probably legumes (Riley, 1975).

37. *Phocides pigmalion* Cramer

Yard, 8.III., 16.III.1979, at flowers of *Gliricidia*. 30.III.1979 numerous, some at flowers of *Carissa*, 20.IV., 18.VII. (new brood), 13.XI.1979, 18.I., 10.VII.1980; also in transition zone, 20.IV.1979 and 28.X.1976 (J.P.). A resident, the larvae feed on the leaves of *Rhizophora mangle* (Rhizophoraceae). This skipper is widespread in the belt of red mangrove of Dade and Monroe Counties, in the Florida Keys and, as distinct subspecies in Andros and Cuba.

DISCUSSION AND ANALYSIS

The butterfly species found on Lignumvitae Key may be divided according to their status as follows:

Immigrant, casual, non-breeding	11
Immigrant, regular, breeding	1
Immigrant, regular, non-breeding	3
Immigrant, total	15
Resident, breeding, total	22
Species total	<u>37</u>

The species, immigrant and resident, also segregated by habitat:

		Immigrant	Resident	Total
Forest:	hammock	1	6	7
	mangrove	0	1	1
	total			<u>8</u>
Open:	yard/scrub	9	13	22
	shore/saltmarsh	0	2	2
	total			<u>24</u>
Total (all habitats)				<u>32</u>

Species noted by previous observers (*E. areolata*, *A. statira*, *N. iole*, *E. zarucco* and *U. dorantes*) for which locality data is not available are not included in the above analysis. Although not statistically significant, it is noteworthy that all but one of the hammock species are resident. There is a marked preponderance of species of open habitats, though these comprise less than 20% of the Key's area; the 50% probability test indicates a significant departure from a random distribution hypothesis— $0.05 > P > 0.01$. Based on mainland observations of habitat preference, none of the five species mentioned above is a forest dweller, suggesting that the significance of non-random distribution based on our survey is underestimated.

The Lignumvitae Key species, resident or immigrant, occur in neighboring areas in the following numbers:

	Lignumvitae	Florida Keys	Mainland So. Florida	Cuba	Andros
Numbers	37	37	34	30	25
Percent	100	100	91.9	81.1	67.6

The butterfly fauna of Lignumvitae Key contains no unique species, all being found elsewhere in the Florida Keys, but beyond this island chain, there is a reduction with distance of species held in common. The difference from the nearby Florida mainland (Dade and Monroe Counties) is the result solely of the recent extinctions in the Miami/Homestead area: *E. tatila*, *H. thomasi* and *E. zestos* have been lost within the past ten to twenty years (Lenczewski, 1980; Leston et al., in prep.). *Phyciodes frisia* too, once widespread in Dade and Monroe Counties, is now confined to the area around Flamingo, Everglades National Park and is another species of diminishing range.

It is assumed that Lignumvitae Key depends for its faunal diversity upon the pool of species provided by the adjacent Florida mainland and the chain of islands of which it is a part. Leston et al. (in prep.) give a checklist of the present day butterflies of Dade and Monroe Counties, which forms the basis of the following comparison; the higher groupings, for convenience follow Klots (1951). Where a species on the mainland comprises both breeding residents and migrants (e.g. *Danaus plexippus* and *Ascia monuste*) it is scored in the former category.

Family	Dade and Monroe Counties			Lignumvitae Key		
	Resident	Migrant	Total	Resident	Migrant	Total
Satyridae	2	0	2	0	1	1
Danaidae	3	1	4	0	2	2
Heliconiidae	3	0	3	3	0	3
Nymphalidae	12	13	25	5	2	7
Libytheidae	0	1	1	0	0	0
Riodinidae	1	0	1	0	0	0
Lycaenidae	16	0	16	4	3	7
Papilionidae	6	6	12	1	0	1
Pieridae	13	7	20	5	3	8
Hesperiidae	36	7	43	4	4	8
Totals	92	35	127	22	15	37

Spearman's rank correlation test shows there is a significant positive correlation between families of the mainland plus Keys fauna, on the one hand, and that of Lignumvitae on the other: $\Sigma d^2 + t = 20.5$, $n = 10$, $P < 0.01$. The assumption made above is therefore confirmed.

The proportion of migratory to resident species is higher in the Lignumvitae list than in the species pool:

	Resident	Migratory	Total
Dade and Monroe	92 (72.4%)	35 (27.6%)	127
Lignumvitae Key	22 (59.5%)	15 (40.4%)	37
L.K. fauna as percent of pool	23.9%	49.9%	29.1%

Overall, the butterflies of Lignumvitae Key represent a little over a quarter (29.1%) of the species pool in Dade and Monroe Counties.

The butterfly fauna of the Key has 31 species whose affinities are Neotropical, with only 6 (*S. melinus*, *P. cresphontes*, *E. areolata*, *E. lisa*, *N. iole*, *E. zarucco*) with Nearctic affinities.

The relationship of collecting hours to the cumulative number of species noted is shown in Fig. 3. It suggests that additional species, probably non-resident, remain to be recorded for Lignumvitae Key.

DISCUSSION

The butterflies of Lignumvitae Key are overwhelmingly of Neotropical origin, but the absence of Cuban or Bahamian species not found on the Florida mainland suggests that the island has probably been colonized, not directly from Cuba and/or the Bahamas, but from the neighboring Florida Keys and peninsular Dade and Monroe Counties. This is scarcely surprising in view of the relative distance involved and applies whether we consider resident or immigrant species separately or in combination.

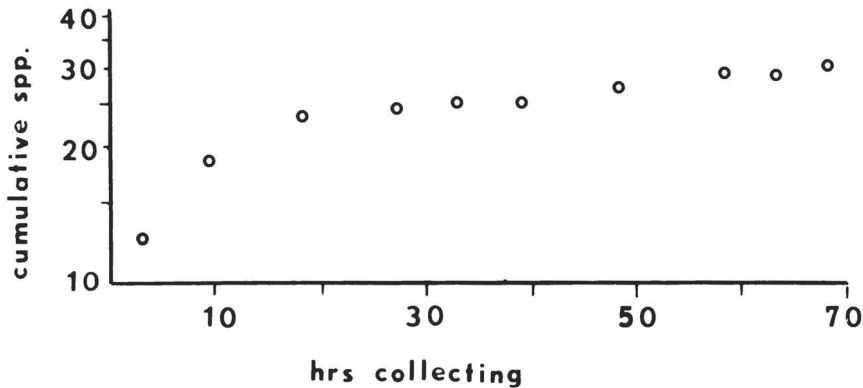


FIG. 3. Illustrating the relationship between person/hours collecting and cumulative number of species recorded (logarithmic).

We meet a phenomenon on the Key of species occurring as transients (casual immigrants) which, in the much larger area of the south Florida mainland and even on some of the larger Keys, are breeding residents: examples include *Danaus gilippus*, *Anartia jatrophae* and *Siproeta stelenes*. MacArthur and Wilson (1967) hypothesized that this might happen, though with little factual data in support. However, whether the absence of species common elsewhere in the vicinity or whether some species are transient instead of permanent can be construed as the result of direct area effect is not at first evident from our data. Simberloff (1978) avers: "... area affects species number independently of habitat diversity." The absence from Lignumvitae Key of such important components of the nearby land areas as pinelands, oak hammocks, Everglades prairies, freshwater marshes and agricultural plots, each of which supports a characteristic butterfly fauna, may directly limit species diversity, though the addition of only one or two of these biotypes can be envisioned in an area as small as 270 acres.

If we ignore exact species composition and work at a higher taxonomic level, as expressed by the list of families and their relative numbers of included species, the significant positive correlation noted indicates that the Lignumvitae Key butterfly fauna may be viewed as a reduced but undistorted simulacrum of the pool community. In other words, direct area effects rather than habitat simplification, may suffice to explain the differences between the faunas of the pool and of the Key.

Both from a study of succession (Southwood et al., 1979) and from a direct comparison of the phytophagous insect fauna of tropical forest

with that of non-forest (Leston, 1980), the wooded climactic areas of Lignumvitae Key would be expected to support more species than the open places. In fact, the reverse is the case: we find the forest of this Key, like the hammocks of mainland south Florida, to carry an impoverished butterfly fauna.

The introduction of *Papilio aristodemus ponceanus* (Schaus' swallowtail) to the Key has been contemplated (Covell, 1976). The principal hostplant of this species *Amyris elemifera* (torchwood) is present on this Key, though sparsely, but the butterfly has not been reliably reported from Lignumvitae or, since May 1945, from nearby Lower Matecumbe Key (Henderson, 1946). *P. a. ponceanus* is established in a threatened area on north Key Largo and is under effective protection on Elliot Key and other islands in the Biscayne National Monument. Covell (1976) has stressed the fluctuation in abundance of this species from year to year: we cannot predict its long-term future in the area, but should a further protected habitat be needed to aid its conservation, Lignumvitae Key remains the obvious choice. In addition, it should be noted that Lignumvitae Key possesses one of the best surviving U.S. colonies of *Eunica tatila*, a species that declines as destruction of hardwood forest progresses. Other species well established on the Key, but with diminishing range elsewhere in the area and notably on the south Florida mainland, include *Phyciodes frisia* and *Hemiargus thomasi*.

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We are sad to record that Dr. Dennis Leston, who initiated the survey described in this report, died in October 1981. An appreciation of his work has been provided by T. R. E. Southwood, 1982. *Antenna* 6:173-174.

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