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A Twelve Month Study of Insect Abundance and Composition at Various Localities on Aldabra Atoll

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A twelve month study of insect abundance and composition at various localities on Aldabra Atoll

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Insect populations were sampled at regular intervals, by using Heath light traps, throughout a 12 month period at various localities about Aldabra Atoll. Abundance and fluctuations in numbers throughout the year of the predominant orders, families and species of insects are given for localities on West, South and Middle Islands, and Ile Michel. Differences between the composition, diversity and density of insect populations at selected localities are discussed in relation to ecological factors such as vegetation, rainfall and the presence or absence of higher animals, in particular giant tortoises, *Geochelone gigantea*, and/or colonial breeding birds.

1. Introduction

The majority of earlier publications concerning Aldabran insects were based on collections made by Abbott in 1892, Voeltzkow in 1895, Dupont in 1906 and 1910, Thomasset in 1907 and Fryer in 1908–9. The collections by Fryer were made during the Percy Sladen Trust Expeditions to the Western Indian Ocean and, incorporated with the collections of Dr Hugh Scott from the Seychelles, form the basis of a series of comprehensive papers covering a wide range of insect taxa (see Scott 1933). For detailed accounts of these earlier studies and a bibliography of pertinent literature see Stoddart (1967*a*, *b*, 1971). Stoddart & Wright (1967) briefly reviewed the status of Aldabran insect faunas in the light of current knowledge, and Cogan, Hutson & Shaffer (1971) discussed the Aldabran insect faunas in general terms based on their own collecting during a Royal Society Expedition to Aldabra in 1967–8 and on the findings of previous investigations.

More recently, intensive studies on selected taxa of Aldabran insects have been made by Blackman & Pinhey (1967) on Odonata, by Viette (1958), Berio (1962), Herbulot (1962), Diakonoff (1969) and Legrand (1965, 1971) on Lepidoptera, by Webb (1975) on Fulgoroidea (Hemiptera-Homoptera), and by Wiebes (1975) on Chalcidoidea (Hymenoptera). Apart from a study by Woodell (1977) on a number of insect pollinators on Aldabra, and a preliminary account of insect abundance on West Island by myself (Frith 1975, 1979) no other ecological data are available on Aldabran insects. Data presented here provide information concerning composition, diversity and density of insect populations about the atoll which are considered in view of ecological factors such as vegetation and the presence or absence of higher animals, in particular giant tortoises, *Geochelone gigantea*, and colonial breeding birds. Furthermore, abundance and seasonal fluctuations of insect taxa predominant at various localities about the atoll are discussed.

Families listed in the tables are arranged according to the systematic lists in the book *The insects of Australia* (C.S.I.R.O. 1970) and species within each family are listed alphabetically.

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2. Trap localities, vegetation and trapping periods

Heath light traps were placed at the following localities (listed from west to east) about Aldabra:

Research Station, West Island. Trap 1; about 70 m inland from the west coast and behind the research station; on champignon in *Pemphis* thicket (see appendix 1†). Monthly samples (2–8 nights a sample) were taken from September 1971 to August 1972. Trap 2; about 60 m inland from the west coast and just north of the research station; on champignon in diverse mixed scrub (see appendix 1). Monthly samples (2–10 nights a sample) were taken from September 1971 to August 1972.

Anse Mais, South Island. About 150 m inland from the west coast; in coastal palm grove surrounded by diverse mixed scrub (see appendix 1). Monthly samples (2–4 nights a sample) were taken from September 1971 to August 1972.

Gionnet, Middle Island. About 10 m inland from the north coast; on champignon in poor mixed scrub (see appendix 1). Monthly samples (1–2 nights a sample) were taken from September 1971 to August 1972.

Middle Camp, East Channel, Middle Island. About 10 m inland from East Channel; on champignon in poor mixed scrub (see appendix 1). Samples were taken about every 6 weeks (1–3 nights a sample) from November 1971 to August 1972.

Ile Michel. About 10 m inland of the east coast: in palm grove surrounded by mixed scrub and mangrove (see appendix 1). Samples were taken about every 6 weeks (1 night a sample) from November 1971 to August 1972.

Takamaka (old camp), South Island. About 30 m south of the old camp; on platin in diverse mixed scrub (see appendix 1). Samples were taken about every 6 weeks (1 or 2 nights a sample) from December 1971 to August 1972.

Cinq Cases (lagoon side), South Island. At extreme landward end of tidal mangrove creek on champignon. Samples were taken about every 6 weeks (1 night a sample) from December 1971 to August 1972.

The number of catch samples is small for some localities owing to their relatively poor accessibility, particularly for those samples taken at the extreme east end of the atoll. Results from these localities are presented, however, as they provide important evidence of particularly interesting and undescribed situations of taxonomic diversity of insect populations with respect to the apparent presence or absence of ecological factors such as vegetation and/or higher animal communities.

3. Results

Details of mean nightly catch of insect taxa predominant in Heath light trap catches are given for all localities in tables 1–8. Relative proportions of each predominant insect order, expressed as a precentage of the total catch, is included in these tables. It should be noted that insects rarely caught in Heath light traps are referred to by the subheading 'others' in these tables and, apart from West Island catches (for species details see Frith 1975, 1979), remain unsorted. Figures for monthly rainfall on West Island during the present study period are given in table 1.

† Appendix 1 and tables 1–8 appear on the microfiche included with this publication; see note at end of this paper for details.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

(*a*) *Composition of catches about the atoll*

Insect catches were similar in general composition at all coastal localities (West Island, Anse Mais, Gionnet and Middle Camp) being dominated by Lepidoptera and to a lesser extent by Hemiptera, Coleoptera, Diptera and Hymenoptera (tables 1–5). It is noteworthy that Lepidoptera represented a much higher proportion of the catch at Middle Camp than at any other coastal trap locality (table 5). At lagoon localities (Ile Michel, Takamaka and Cinq Cases), Coleoptera and Diptera were as well represented in the catches as Lepidoptera (tables 6–8). In addition, insect orders Odonata, Isoptera, Dictyoptera, Embioptera, Orthoptera and Neuroptera were present in catches at some localities about the atoll (tables 1–8) but owing to their relative sparsity in samples they are not discussed further as only insect taxa predominant in catches will be examined here. The numbers of those predominant insect taxa caught in Heath light traps at all localities are summarized in tables 1–8 and these data represent the quantitative results of this study.

(*b*) *Variations in diversity and density of catches about the atoll*

Most insects caught in the two Heath light traps on West Island were identified to species (Frith 1975, 1979). Of the 261 identified species in West Island catches, 201 (77 %) occurred in trap 1 catches (*Pemphis* thicket) and 251 (96 %) in trap 2 catches (mixed scrub); 193 (74 %) were common in both catches. Results thus indicated a greater diversity of insects in the mixed scrub habitat, as is to be expected in view of the greater floral diversity found there than in *Pemphis* thicket (see §4). An analysis of these West Island catches showed, however, that species diversity of the predominant orders differed considerably in the two habitats (tables 1 and 2). In total 107 lepidopteran, 31 hemipteran, 44 coleopteran, 48 dipteran and 18 hymenopteran species occurred in West Island catches. Of these species totals, 75 and 106 species of Lepidoptera, 27 and 28 species of Hemiptera, 36 and 42 species of Coleoptera, 37 and 47 species of Diptera, and 17 and 16 species of Hymenoptera occurred in trap 1 and 2 catches respectively. Thus species diversity of Lepidoptera and, to a lesser extent, Coleoptera and Diptera was greater in mixed scrub than in *Pemphis* thicket. As catches for localities other than West Island are only sorted to predominant insect taxa no data indicative of relative diversity are, as yet, available for them. At a preliminary examination of material from these localities, however, it would appear that species diversity was relatively lower in the mangrove habitat at Cinq Cases than in other habitats from which samples were taken (see §4).

As shown in tables 1 and 2, the average number of species in families of the predominant orders Lepidoptera, Hemiptera, Coleoptera and Diptera was relatively low (8.9, 2.4, 2.4 and 2.4 respectively), but that the average number of families in each of these orders was relatively high.

Insect density was in general greater at the east end than at west end of the atoll localities, but this may have been due, to some extent, to the smaller number of samples taken from the former localities. It is noteworthy that results showed, however, a markedly higher density of insects in the mangrove habitat at Cinq Cases and a markedly lower density of insects in *Pemphis* thicket on West Island (tables 1 and 8). In palm grove habitats at Anse Mais and Ile Michel the insect densities were similar to each other (tables 3 and 6), and of the mixed scrub habitats insect density was greater at Takamaka than at West Island, Gionnet or Middle Camp (tables

2, 4, 5 and 7). Relative densities of insect taxa predominant in traps are summarized in tables 1–8 for all localities and these are discussed below (see §4).

(*c*) *Seasonal fluctuations in insect numbers*

At all localities, insects were most abundant during the wetter months from November 1971 to April 1972, particularly during December–January and March–April. Monthly fluctuations in insect numbers on West Island followed very closely the monthly patterns of relative rainfall (tables 1 and 2). Insects on West Island were particularly abundant during December and March when there was a sudden marked increase in precipitation (tables 1 and 2). Catch size decreased, however, during January and April despite the fact that rainfall remained relatively high. Monthly fluctuations of insect numbers on West Island do not correspond with those from Anse Mais or Gionnet (tables 3 and 4). At Anse Mais the marked increase in catch size was during November and March and to a lesser extent during June and August, and at Gionnet during January and April, these results probably reflecting local variations in rainfall about the atoll (see §4). Unfortunately rainfall data were not available for localities other than West Island during the present survey. It is noteworthy that the two smaller peaks of higher rainfall in June and August on West Island did not apparently affect catch size during those months (tables 1 and 2). While figures of insect abundance for the east end of the atoll are not available for all months, results do show that there was a marked increase in relative abundance during December–January (tables 5–8).

Various aspects of seasonal fluctuations of numbers of predominant insect taxa at all collecting localities are comprehensively summarized in tables 1–8. It is noteworthy that as Lepidoptera, particularly Tortricidae, Tineidae and Pyralidae (Phycitinae), were extremely abundant in monthly catches at all localities, relative peaks of the total monthly insect abundance therefore reflect relative abundance of these predominant taxa. Furthermore monthly fluctuations in numbers of Coleoptera and Diptera at lagoon localities, in addition to the above mentioned Lepidoptera, greatly affected the total monthly catch size at those localities.

4. Discussion

Most insects caught in the light traps were phytophagous and, therefore, differences found in the taxonomic composition of insect populations at localities about the atoll probably reflect, first and foremost, floral differences in these areas. Insufficient life-history knowledge of the vast majority of the Aldabran phytophagous insect taxa does not however, permit, any significant understanding of variations in their distribution and/or relative abundance indicated by the results of the present study (tables 1–8). It is nevertheless hoped that variations such as the greater abundance of the moths *Rhodogastria aldabrensis* and *Eilema aldabrensis* (Lepidoptera, Arctiidae), and the bug *Lethaeus stellatus* (Hemiptera, Lygaeidae) on West Island; of the bug *Chaetormenis madagascariensis* (Hemiptera, Flatidae) at Anse Mais; of the beetle *Ananca aldabrana* (Coleoptera, Oedemeridae) at Ile Michel and Anse Mais; and the notable absence of the weevil *Cratopus viridisparsus* (Coleoptera, Curculionidae) in the mangrove habitat at Cinq Cases, found during the present survey will provide suitable subjects for more intensive studies.

A comparison between insect populations of *Pemphis* thicket and mixed scrub habitats on West Island (see §3*b*) clearly indicated that the florally less diverse *Pemphis* thicket supported fewer insect species. A preliminary analysis of insect populations in the mangrove habitat at

Cinq Cases, the other uniform habitat investigated during the present study, indicated that species diversity there was also lower than that of florally more diverse habitats. It is noteworthy in this respect that both *Pemphis* and mangrove habitats have been found to support far less insectivorous bird feeding activity than any of the other habitats on Aldabra (C. B. Frith 1979, this volume).

The notable differences in the composition of catches of Coleoptera and Diptera at coastal and lagoon localities were apparently related to factors other than vegetation in many cases. Unique to the eastern end of the atoll, particularly the areas of Takamaka and Cinq Cases, are a number of temporary and permanent fresh and brackish water pools. These provide significant ecological niches to insects unavailable elsewhere on the atoll. It was not surprising, therefore, that collections from trap localities at Takamaka and Cinq Cases contained a larger number of aquatic and/or semi-aquatic insects, in particular members of families Dytiscidae and Hydrophilidae (Coleoptera) and Tipulidae, Culicidae and Ceratopogonidae (Diptera), than was found in collections taken elsewhere about the atoll. Moreover, the greater abundance of Culicidae and Ceratopogonidae (mosquitoes and biting midges) in the mangrove habitat at Cinq Cases than in mixed scrub at Takamaka was probably due to the fact that the saline conditions of mangrove waters provide more favourable breeding grounds for many species of these families (Macnae 1968). It is noteworthy that Cogan *et al.* (1971) pointed out that the wide range of aquatic habitats on Aldabra, from truly marine to freshwater, in relatively close proximity to Madagascar 'must be responsible for the very rich aquatic insect fauna in comparison with other island groups' within the western Indian Ocean. Doubtless future intensive studies of the aquatic insects of these eastern areas will show that a number of insect taxa are found there and nowhere else on the atoll.

The very large populations (about 150000) of the endemic giant tortoise, *Geochelone gigantea*, on South Island, in particular about Takamaka and Cinq Cases (Coe, Bourn & Swingland 1979, this volume), constitute a most significant factor of the terrestrial ecology of the Aldabran fauna. It is not surprising, therefore, that the presence or absence of these animals was found to apparently affect insect populations and their densities about the atoll markedly. While this finding was to be expected, results of the present study provide the first evidence of a relation between the giant tortoise and insect populations on Aldabra and suggest important and rewarding future lines of investigation. In addition to the tortoises themseves providing a food source for blood-sucking insects, their decaying corpses provide a temporary rich feeding and breeding ground for many insect groups that presumably could not exist on Aldabra without the presence of these larger terrestrial vertebrates. In addition, tortoise dung provides a widespread and continuously abundant and available food source and breeding ground for many insect species. Thus the presence of the large numbers of giant tortoises about trap localities at Takamaka and, in particular, at Cinq Cases probably accounts for the abundance of such insects as some Hydrophilidae and Staphylinidae (Coleoptera), and Tipulidae and Tethinidae (Diptera) which are known to feed on or associate with dung and decaying animal matter as well as members of the families Culicidae and Ceratopogonidae (Diptera) that feed on blood. The relative sparsity of these particular insect groups at localities investigated elsewhere about the atoll, where tortoises are few or absent, supports this conclusion. These findings are noteworthy in that Cogan *et al.* (1971) considered the number of insects associated with animal waste products on Aldabra to be very low, and while the results of this present preliminary survey support their findings, they also indicate that the few species concerned are apparently

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

very abundant, especially in mangroves. It would be of particular interest to establish to what degree, or dependence, certain insects have adapted to the utilization of tortoise dung on Aldabra. Moreover, the presence of large seabird colonies (*Fregata* spp. and *Sula* spp.) (Diamond 1971, 1975) would not only provide an additional food source for such insects as the blood-sucking mosquitoes and biting midges, but the bird's nests might also provide suitable microhabitats for insects such as staphylinid beetles (Britton 1970) and thus contribute to the larger numbers of these insect taxa found in mangroves at Cinq Cases than in mixed scrub at Takamaka. It is also noteworthy that the humid conditions of the mangrove forest environment and the associated slow-decaying plant detritus (providing an important food source) probably accounts for the larger numbers of certain insect species found in this habitat.

While the Coleoptera and Diptera were well represented in catches at Ile Michel, an analysis of them showed that in composition they differed somewhat from Takamaka and Cinq Cases catches. Diptera were represented predominantly by mosquitoes which is surprising in view of the sparsity of tortoises (only one or two during the study period) and dense seabird populations at this locality. It is possible, however, that the large population of feeding and roosting bat colonies in the coconut palms at Ile Michel (observed during the present study) supported this large mosquito population. Coleoptera at Ile Michel consisted mainly of terrestrial rather than aquatic species, as is to be expected in view of the sparsity of non-marine aquatic habitats at this locality. It is noteworthy that the beetle *Ananca aldabrana* (Coleoptera, Oedemeridae) was abundant at this locality (see above).

Seasonal fluctuations in the relative monthly abundance of insects on West Island was greatly affected by rainfall (Frith 1975; C. B. Frith 1976). Insect numbers suddenly increased with periods of sudden higher rainfall, as is typical of insect populations in tropical areas of marked seasonal precipitation. This is worthy of particular note with regard to the insect fauna of Aldabra, however, as fluctuations in relative insect numbers varied considerably about the atoll, which is suggestive of rainfall variations from one locality to another. That rainfall does in fact vary in distribution and relative monthly production about the atoll has been established during the last few years, and apparently these variations are inconsistent in character (i.e. from year to year) (R. J. Hnatiuk, personal communication). C. B. Frith (1976, 1977) has shown that certain endemic, and predominantly insectivorous, birds on West Island begin breeding with the marked increase in insect abundance at the onset of the rainy season. It seems possible, therefore, that as monthly variations in insect abundance are governed by relative rainfall, these insect fluctuations might in turn be responsible for small variations in breeding seasons within the year about the atoll in the more insectivorous bird species. This is, however, speculative and requires further studies involving the simultaneous observations of bird and insect populations at various localities about the atoll.

5. Conclusions

(1) The vast majority of insects on Aldabra are phytophagous feeders and thus the distribution, diversity and/or density of the taxa concerned presumably relates closely to the presence or absence of food plant species.

(2) A number of extremely important environmental or ecological factors to insect populations are restricted in their distribution on Aldabra Atoll. It is not possible to account for the presence, absence and/or relative abundance of certain insect populations without due

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

consideration to factors such as (*a*) the presence of mangroves along the lagoon shore of Aldabra, which provide a major vegetation type unavailable elsewhere about the atoll; (*b*) fresh and brackish water pools at the east end of the atoll, predominantly at Takamaka and Cinq Cases, which provide significant ecological niches unavailable elsewhere; (*c*) the giant tortoises which apparently provide a vast and important biomass which is utilized by insects in various ways, and (*d*) additional populations of larger vertebrates, notably colonial seabird breeding populations, and bat roosts and feeding aggregations, provide important foods and microhabitats restricted in their geographical availability on Aldabra.

(3) Relative abundance of insect populations on West Island was controlled by rainfall. Peaks of relative monthly abundance, however, differed about the atoll and these differences therefore almost certainly reflect differences in local rainfall.

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Microfiche

The relevant frames of the microfiche included with this publication contain the following material referred to in the text of this paper.

Appendix 1. A list of plant species (arranged alphabetically) surrounding Heath light traps at localities on Aldabra Atoll

Table 1. Mean catch per night of predominant insect taxa caught in a Heath light trap (1) on West Island Aldabra Atoll

Table 2. Mean catch per night of predominant insect taxa caught in a Heath light trap (2) on West Island Aldabra Atoll

Table 3. Mean catch per night of predominant insect taxa caught ina Heath light trap at Anse Mais, South Island, Aldabra Atoll

Table 4. Mean catch per night of predominant insect taxa caught in a Heath light trap at Gionnet, Middle Island, Aldabra Atoll

Table 5. Mean catch per night of predominant insect taxa caught in a Heath light trap at Middle Camp, Middle Island, Aldabra Atoll

Table 6. Mean catch per night of predominant insect taxa caught in a Heath light trap at Ile Michel, Aldabra Atoll

Table 7. Mean catch per night of predominant insect taxa caught in a Heath light trap at Takamaka, South Island, Aldabra Atoll

Table 8. Mean catch per night of predominant insect taxa caught in a Heath light trap at Cinq Cases, South Island, Aldabra Atoll

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES