Community composition and behaviour of butterflies at a permanent water point in Kirindy Forest, Madagascar

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Abstract

Community composition and behaviour of 21 butterfly species in five families was recorded at the permanent water point in Kirindy Forest, Madagascar. Papilionidae was the most common family observed, whilst Hesperiidae was the least common. Species richness and abundance were found to be significantly correlated and peak at between 10.00 and 11.00 am. There was a significant difference amongst species behaviours, though no correlation was found amongst behaviours. Feeding in groups was observed in a number of species, though it was highest in *Graphium sp.* Feeding in groups for this species may be related to both resource availability and predation avoidance strategies.

INTRODUCTION

Butterflies are a very diverse group, yet they remain poorly studied. The total number of butterfly species in Madagascar is estimated at about 341 (Lees *et al.*, 2007). Our knowledge of the island's butterflies however is far from comprehensive, as over a quarter of this fauna comprises large endemic radiations of satyrine nymphalids, which have not yet been revised. In fact, species level endemism across Malagasy butterflies is currently estimated to be 70.3% and is expected to increase to 74% once all morphospecies are described. Over 21% of species are likely to qualify as at least "vulnerable" on the IUCN red species list based on restricted range and/or restricted extent of occurrance criteria, as well as rapidly declining or fragmented habitat.

There are many gaps in our knowledge of Malagasy butterfly ecology and behaviour. Baseline data on species habitat preference and activity patterns remain largely unknown. This project aimed to investigate community composition and behaviour of butterflies at the permanent water point in Kirindy dry deciduous forest in the Menabe region, Western Madagascar.

The permanent water point and surrounding vegetation of Kirindy forest represent an important habitat for many vertebrate and invertebrate taxa, especially during the dry season, when resources are generally scarce. Butterflies are one of the taxa that can be found at the permanent water point.

They use a variety of microhabitats including wet sandy substrates, wet leaf litter, as well as herbaceous and woody plants.

The main objectives of our study were to:

i) Describe the community composition of butterflies at the permanent water point in Kirindy forest,

ii) Compare butterfly abundance and species richness patterns at different times of day;

iii) Describe differences in individual species' behaviour and;

iv) Make observations on and investigate possible hypotheses explaining the "grouping" behaviour in *Graphium sp*.

METHODS

Study site

Kirindy dry deciduous forest is located 60 km North East of Morondava (20º 03´S, 44º 39´ E) in the Menabe region, Western Madagascar. It covers an area of 12,000 ha and is managed by the Centre de Formation Professionelle Forestiere (CFPF). The annual temperature and precipitation for the forest are 24ºC and 799mm respectively. The permanent water point in Kirindy Forest is located in the Kirindy dry river bed, east of the CFPF camp.

The project was carried out between 15 and 21 November 2007. Observations were made from two separate locations at the permanent water point between 7.00am to 5.00pm.

Community composition

The number of individuals present per species was recorded every hour during a five minute observation period. Changes in species richness and abundance during the course of the day were tested for with a Kruskall-Wallis test. Average species richness and abundance values per hour of day were then compared with a Spearman correlation.

Individual species' behaviour

Twenty ten-minute observation periods were recorded per species. Within each ten-minute observation period one of the following behaviours was scored every minute: (1) flying (individually or in a group), (2) not flying/fluttering (individually or in a group), (3) not flying/not fluttering (individually or in a group). Individuals were said to "flutter" when they opened and closed their wings repeatedly while feeding. When not flying the type of habitat used was noted (1. sand, 2. herbaceous plant, 3. woody plant, etc.). Scores were then converted into proportions.

Relationships between different behaviours were investigated by correlating the average behaviour proportions per species (Spearman correlation). Differences in species behaviours were explored in a Kruskall-Wallis test.

Group feeding observations and experiment:

The most commonly used "feeding patch" by *Graphium sp.* was covered 6 times to observe whether following disturbance, the group would settle together on a single patch or split and feed on multiple patches.

In order to test whether group size had any effect on potential predator avoidance behaviour in *Graphium sp.*, groups of varying size were approached and minimum distance before group flight was recorded. The influence of group size on minimum approach distance was tested for in a regression.

RESULTS

Community composition:

A total of 2986 butterfly observations were made. The community sampled included 21 species and five families (Nymphalidae, 9; Pieridae, 6; Papilionidae, 4; Hesperiidae, 1 and Lycaenidae, 1). The overall relative abundance for each family was as follows: Papilionidae: 81.7%, Nymphalidae: 6.8%, Lycaenidae: 6.4%, Pieridae: 3.1% and Hesperiidae: 0.9%. One species of Papilionidae alone, *Graphium sp*., accounted for 76.9% of the 2986 observations made (Table 1).

Table 1: Total observations per species made at Kirindi pond over a period of 7 days

FAMILY	SPECIES	ABUNDANCE
Papilionidae	*Papilio* 1 (black/blue)	29
Papilionidae	*Graphium evombar*	2297
Papilionidae	*Papilio* 3 (yellow/black)	113
Papilionidae	*Papilio* 2 (yellow, red on outer wings)	3
Nymphalidae	Charaxinae 1 (distinctive green line on anterior wings)	2
Nymphalidae	*Danaus chrysippus*	44
Nymphalidae	*Junonia rhadama*	10
Nymphalidae	*Junonia hierta*	34

Nymphalidae	Nymphalidae 1 (orange/black patterns)	5
Nymphalidae	*Acrea* sp. (light orange/black spots on posterior wings)	77
Nymphalidae	*Phalantha* sp. (orange/black spots)	34
Nymphalidae	*Strabena* sp. (Setirida, orange/black eyes)	1
Nymphalidae	*Hypnartia* sp. (Orange/brown,yellow bands on anterior wings)	19
Pieridae	Pieridae 1 (light green)	35
Pieridae	*Zolotis* sp. (white/orange tip on anterior wings)	19
Pieridae	Pieridae 2 (large white/yellow)	5
Pieridae	*Anaphses aurota* (white/black markings)	8
Pieridae	Pieridae 3 (small white/yellow)	5
Pieridae	*Eurema* sp. (small yellow)	26
Hesperiidae	Hesperiidae 1 (brown)	28
Lycaenidae	Lycaenidae 1 (small grey/spotted)	192

Both species richness and abundance for 21 species of butterflies were found to vary significantly at different times during the day (Kruskal-Wallis, H=21.36, P=0.019, H=27.77, P<0.01 respectively).

Moreover, average species richness and abundance per hour were significantly correlated (Spearman's rank correlation, P<0.01) and were highest in the morning between 10.00 and 11.00 am (Fig. 1).

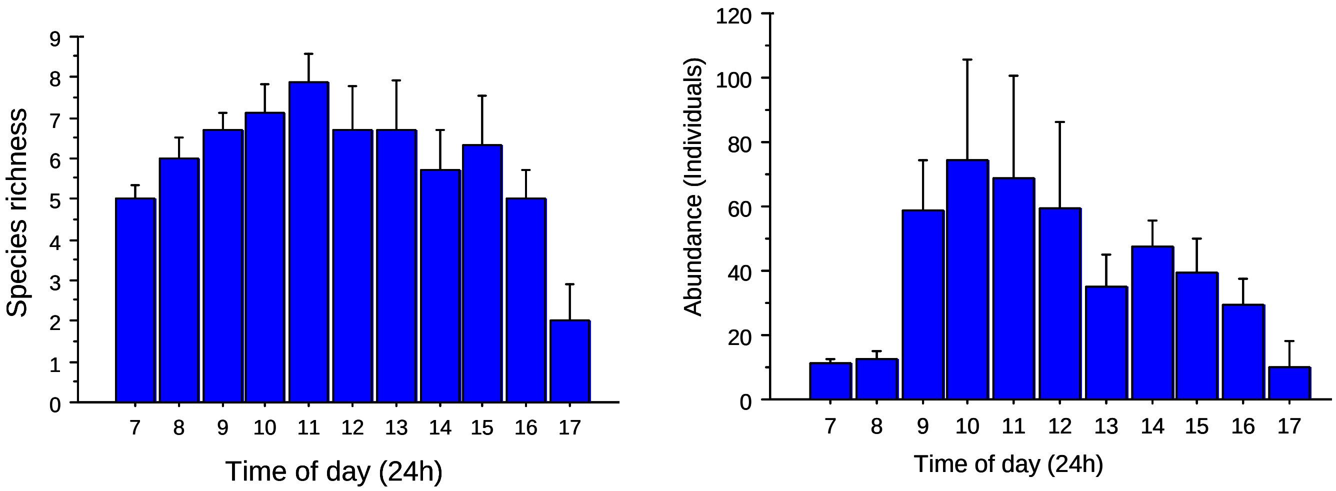

Fig. 1 Species richness and abundance of 21 species of butterflies between 7.00 am and 5.00 pm

Individual species' behaviour:

Species differed significantly in the proportion of time spent in groups (Kruskal-Wallis, H=98.20, P<0.001, Table 2), fluttering (Kruskal-Wallis, H=91.35, P<0.001, Fig. 2a) and flying (Kruskal-Wallis, H=40.47, P<0.001, Fig. 2b).

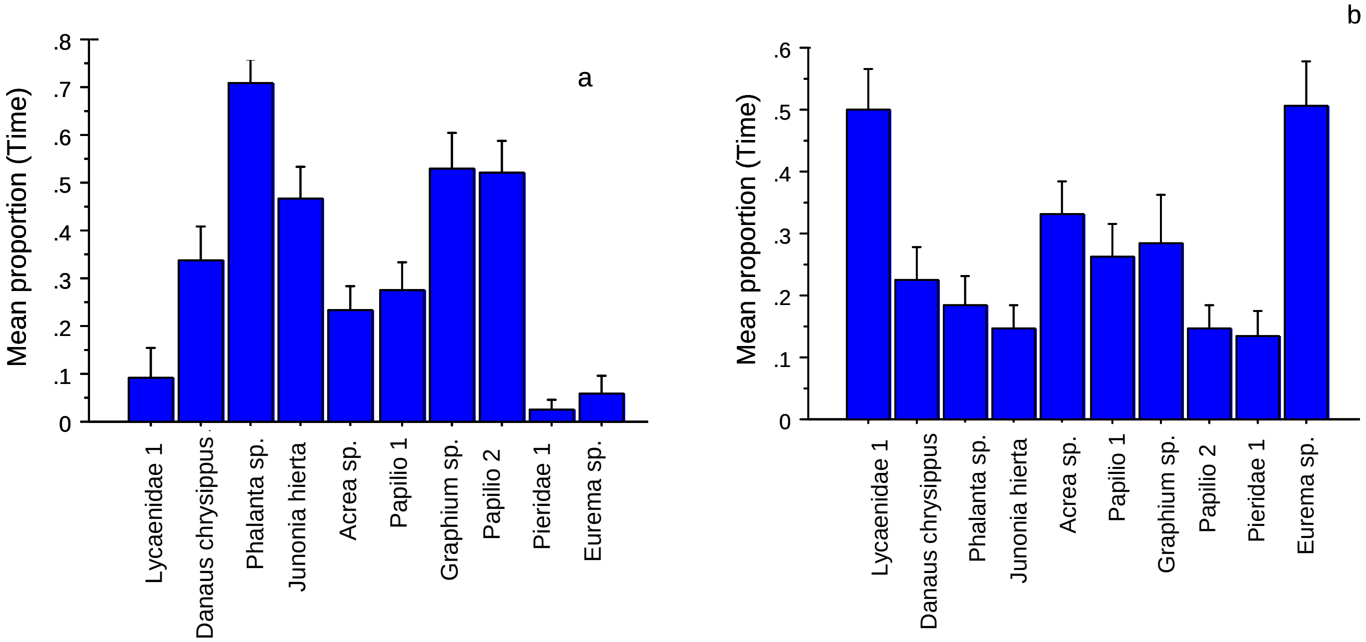

Fig. 2a, b Mean proportion of time spent fluttering (a) and flying (b) by different species.

No significant correlations were observed amongst behaviours recorded (Fluttering vs Grouping Z=1.07, P=0.28; Flying vs Fluttering Z=0.81, P=0.41; Grouping vs Flying, Z=1.40, P=0.16).

The three members of the Papilionidae and one of the Pieridae species were observed to feed in groups more than 50% of the time. *Graphium sp.* however was observed in groups on average 97% of the time and with a relatively low standard error (Table 2).

Table 2: Averages and standard deviations of % time spent in a group for ten butterfly species

FAMILY	SPECIES	GROUPING % (Average±Std.Error)
Papilionidae	*Papilio* 1	41±40
Papilionidae	*Graphium* sp.	97±10
Papilionidae	*Papilio* 3	67±33
Nymphalidae	*Danaus chrysippus*	6±12

Nymphalidae	*Acrea* sp.	3±7
Nymphalidae	*Junonia hierta*	15±25
Nymphalidae	*Phalanta* sp.	32±36
Pieridae	Pieridae 1	52±41
Pieridae	*Eurema* sp.	15±25
Lycaenidae	Lycaenidae 1	3±6

Microhabitat use

The four members of the Papilionidae family were all observed on moist sandy substrates at about 5-20 cm from the water edge. Species in both Nymphalidae and Pieridae families used a variety of habitats including woody plant species (*Acrea sp.*), herbaceous plant species (*Danaus chrysippus, Junonia hierta, Eurema sp., Zolotis sp, Nymphalidae 1*), moist sandy substrates (*Phalantha sp., Pieridae 1, Nymphalidae 1*). The only species in the Lycaenidae family was observed almost exclusively flying from one small herbaceous plant to another, taking nectar from flowers or moisture from leaves and stems, though it was occasionally observed on moist sandy substrates as well. The only species observed in the Hesperiidae family was found exclusively on wet decomposing leaf litter at the edge of the water.

Grouping observations and experiment

When groups of *Graphium sp.* were disturbed from their feeding patch, they resettled in one group on another patch (four out of six trials), never occupied multiple patches and sometimes disappeared altogether (two of six trials). In three out of six cases the group which resettled following disturbance was smaller, while in one out of six cases it increased.

Larger groups were observed to “swarm” at further distances than smaller ones ($F=32.27$, $R^2=0.59$, $P<0.001$, Fig. 3). Time of day had no effect on minimum approach distance ($F=0.03$, $R^2=0.002$, $P=0.84$).

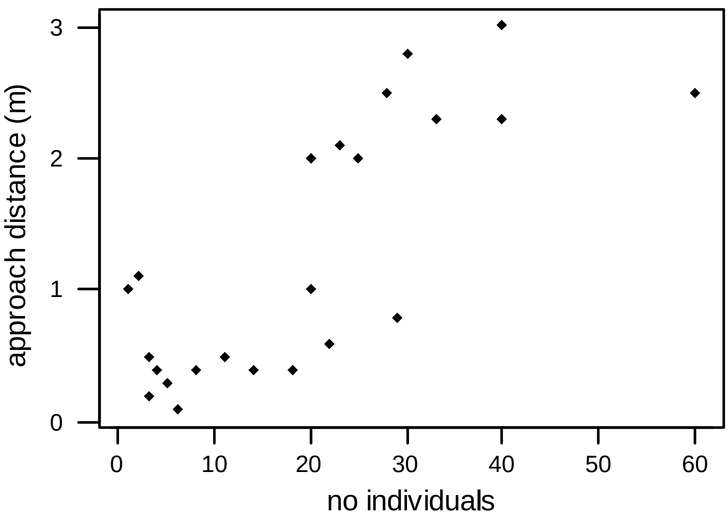

Fig. 3 The relationship between number of *Graphium sp.* in a group and minimum approach distance (m).

DISCUSSION

The diverse butterfly community observed at the pond included 21 species in five families. Nymphalidae was the most diverse family, accounting for 9 species. One Papilionidae species, *Graphium sp*. dominated the community accounting for 76.9% of total butterfly abundance. This species, as well as other members of the Papilionidae was found to feed exclusively on moist sandy substrates and wet leaf litter within 5-20 cm of the water edge. The high abundance in *Graphium sp.* may be due to the rarity of this habitat within Kirindy Forest. Hesperiidae, the least common family observed, accounted for only 0.9% of total abundance. This result could be due partly to the fact that only one species was recorded in this family and partly to its ecology, as Hesperiidae were sighted almost exclusively early in the mornings or late in the afternoons (before 9.00 am and after 3.00 pm). This observation is consistent with other studies, as members of this family are known to be active mainly during dawn and dusk.

Despite *Graphium sp.* accounting for a disproportionate amount of total abundance, species richness and abundance were significantly correlated and were found to peak between 10.00 and 11.00 am. The temperature at this time of day might offer optimal foraging and flying conditions for many species. Insect eating bird species, such as drongos, kingfishers and flycatchers were observed at the permanent water point consistently throughout the day. The peak in species richness and abundance is therefore not likely to be related to anti-predator behaviour.

Species varied significantly in the amount of time they spent flying/not flying, fluttering/not fluttering and individually or in groups. No significant relationship was found amongst behaviours. In other words, species which fluttered more often were not more likely to spend more time flying or feeding in groups. It is therefore difficult to provide any hypotheses about the evolutionary significance of these behaviours. Due to small numbers of species per family, the influence of relatedness on behaviour was not evaluated. For instance, compared to other families, Papilionidae species were often observed feeding in groups, though while *Graphium sp.* was almost exclusively found in groups (97±10% of the time), the other two (*Papilio 1*, *Papilio 3*) were also observed feeding alone (41±40%, 67±33% of the time, Table 2).

Graphium sp. was often observed feeding on the largest patch of moist sand available at the water edge. It is possible that this patch offered the most optimal feeding conditions and that *Graphium* sp. therefore congregated exclusively because of spatial resource distribution. When groups of *Graphium* sp. were disturbed from this feeding patch, they were found to either shift to and resettle in another smaller available patch or to disappear altogether. They were never observed to split the initial group and spread across a number of smaller available patches. We therefore doubt that resource availability is the only factor which drives *Graphium* sp. to feed in large groups.

Feeding in groups may offer an advantage for predator avoidance. This species was often observed to "swarm" whenever birds or other animals approached the area where they were feeding. On approaching feeding groups of *Graphium* sp., larger groups were observed to "swarm" at greater distances than less numerous ones. This suggests that larger groups may be able to respond sooner than smaller groups to potential predator attacks.

SUGGESTIONS FOR FURTHER STUDY

Regular observations at the permanent water point in Kirindy Forest could provide some insight on how butterfly community composition might change throughout the year and particularly in the wet season. Comparisons with other habitat types could reveal important information on species' behavioural and ecological plasticity. The hypothesis that grouping is a consequence of resource availability and/or predator avoidance behaviour requires further experimental work both on *Graphium* sp. and others found to feed in large groups.

ACKNOWLEDGEMENTS

We would like to thank Kate Lessells for her invaluable help with statistics, Rosie Trevelyan for useful comments and constructive criticism, Jeremy for catching one of our specimens, CFPF for hosting us, our course colleagues for support and TBA for giving us the opportunity to come to Kirindy in the first place.

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