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**Frontier Madagascar Environmental Research Series**

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**REPORT 22**

**The Effect of Forest Degradation on the Species  
Richness and Diversity of a Diurnal Lepidoptera  
Community in Northern Madagascar**



**Frontier Madagascar  
2009**



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**Tsarakibany**

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### **Frontier-Madagascar**

Madagascar, the fourth largest islands in the world, is renowned for its high biological and ecological diversity, and is characterised by its high abundance of endemic species. Madagascar is one of the poorest nations in the world and very dependant on the resources the natural environment provides. As a result, conservation and development work is of paramount importance as efforts are made to preserve an environment under pressure from non-sustainable exploitation. Frontier Madagascar is in the process of carrying out baseline survey work in the northern tip of coastal Madagascar, the Antsiranana region, in an effort to provide biological and resource utilisation data for the preparation of sustainable management initiatives for the region.

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## **Abstract**

The effects of habitat degradation on the community composition of day-flying butterflies were studied in anthropogenically-altered habitats in northern Madagascar. Species richness and diversity was compared in four habitat fragments; open scrubland, a banana plantation, secondary forest and an area of relatively undisturbed forest. The lowest diversity was found in the banana plantation. This result is notable because in terms of its physical characteristics the plantation resembled the least disturbed forest fragment more closely than either of the other two habitat patches. The results suggest that future reforestation schemes in northern Madagascar must give careful consideration to species composition if they are to have significant impacts on species recovery and conservation in the future.

**Key words: Butterfly diversity, human disturbance, dry deciduous forest, Madagascar**



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## 1. Introduction

Madagascar has some of the highest biodiversity on the planet (Norscia & Borgognini-Tarli, 2006) and like many islands has a high degree of endemism. Madagascar's endemic species include mammals, reptiles, amphibians, birds and invertebrates (Hawkins & Goodman, 2004). The island's wildlife is severely threatened however, with habitat loss being a major contributing factor. Figures from 1990-1995 (FAO, 1997) indicated that the annual percentage loss of forests in Madagascar had reached 0.9% (Brookes et al., 2002) and this figure has continued to increase (Sommer *et al.*, 2002). Although this rate of habitat loss is not as high as that of many other biodiversity "hotspots" around the world, when you consider the high degree of endemism on the island it makes it one of the most fragile environments in the world. Even in areas where protection exists clearance strategies such as burning, grazing and commercial forestry are rapidly causing encroachment into the remaining forests (Hawkins, 1990). Species composition for all fauna is well known to be negatively effected by clearing, with loss of canopy cover being the major driving factor behind these species losses (Scott *et al.*, 2006). Madagascar has one of the world's highest rates of human population increase (Vallan, 2002) and this makes the rate of habitat destruction unlikely to slow.

Global habitat loss is predicted to greatly impact on invertebrate species (Chinery, 1993). Invertebrate species are frequently used as indicator species to estimate the health of other wildlife communities, and butterflies (Lepidoptera) have been used for this purpose in Madagascar (Kremen, 1992, 1994). Previous research on lepidopteran diversity found that habitat modifications such as the conversion of forests to farmland significantly affected richness and abundance (Bobo *et al.* 2006). Some families of butterflies have been deemed especially useful indicators of ecological disturbance, for example Satyrinae (Kremen, 1994) and Nymphalidae (Bobo *et al.*, 2006).

Butterflies are excellent indicators of environmental status as they are very sensitive to minor changes in micro-habitat, in particular light levels (Kremen, 1992). Light levels increase as canopy cover is lost and communities of butterflies rapidly change and adapt to these alterations. Butterflies can therefore be used to directly assess environmental variables such as loss of canopy cover and therefore forest degradation. On the nearby Comoros Islands it was found that geographically widespread butterfly species increased in abundance with rapid habitat loss. However, those species with more limited ranges became even more restricted in distribution, and some species became endangered (Lewis *et al.*,

1998). Similar changes in abundance and distribution of butterfly species have become increasingly obvious in the Tsarakibany region of northern Madagascar, where research by Frontier began in January 2008.

In order to assess in depth the effect of habitat degradation in this area of Madagascar, a study was carried out to investigate the health of butterfly communities in habitats showing different degrees of environmental degradation.

### **1.1 Aim**

- To assess the impact of human-induced forest degradation on butterfly diversity.

### **1.2 Objectives**

- To survey butterfly communities in the anthropogenically-influenced habitats found in an area of northern Madagascar.
- To carry out habitat and human disturbance transects at each site to investigate levels of disturbance and the effects on butterfly species richness and diversity.

## **2. Methods**

### *2.1 Study Area and Site Selection*

Research was carried out in the northern region of Madagascar near to the small settlement of Tsarakibany (049.10210, 12.46490), approximately 85km south of Antsiranana (Diego Suarez). The area has a large human influence and has no remaining primary forests. The majority of secondary forest fragments have been altered with the introduction of productive species such as mango (*Mangifera indica*), banana (*Musa acuminata*), palm (*Raffia* sp.) and eucalyptus (*Eucalyptus* sp.). There is also evidence that the land is used for zebu grazing, selective logging and charcoaling.

The research site is located between Montagne d'Ambre National Park to the North and Ankarana

Special Reserve to the South. This makes the area of great scientific interest as it is potentially an important wildlife corridor, acting as a transitional zone between two already protected areas. The research area is transitional not only in a geographical sense, but also regarding the different climate-influenced ecosystems. Montagne d'Ambre is classified as montane rainforest, whereas Ankarana is a dry deciduous forest famous for its limestone 'tsingy' relief. The region is similar in climate to the rest of Madagascar's western dry deciduous belt. The rainy season begins in November and lasts until March when average daytime temperatures reach 31°C (Jury, 2003). Rainfall during the rainy season averages 14mm per day and the season is also prone to cyclones. The rest of the year is dry with rainfall averaging 1mm per day and average temperatures of 28°C during July (Jury, 2003).

Four study areas with different degrees of human influence were selected. Each study site was approximately 100 m<sup>2</sup> in size. Site 1 (TS1) is open scrubland dominated by grass and scrub vegetation with no arboreal vegetation cover. Site 2 (TS2) is dominated by human-planted banana (*M. acuminata*) and jackfruit tree (*Artocarpus heterophyllus*), neither of which are native to Madagascar. In the centre of the site there is a small stand of natural forest which has been highly degraded by wood harvesting. This site was selected because of its highly modified state. Site 3 (TS3) has also been directly affected by human influence, however the secondary stand of vegetation is dominated by more natural regrowth. The regrowth includes species such as *Latena* sp., a common invasive species found in this region of Madagascar and mango (*M. indica*), another common invasive but productive species. Site 4 (TS4) is a forested area approximately 5km from the village of Tsarakibany and is the least disturbed of the four sites. The area is the most natural forest in the local area but still receives some degree of wood harvesting and also contains some invasive secondary species such as mango and *Latena* sp.

Seven surveys were carried out in each of the four sites. The investigation took place over a period of nine months which allowed data to be collected from both the wet and dry seasons. Surveying during both seasons enabled data to be collected on species which hatch and persist at different times of year (Chinery, 1993).

## 2.2 Butterflies surveys

Sweep netting was carried out within the four study sites (TS1-4). The use of canopy traps was abandoned following an unsuccessful pilot study. Although sweep netting is regularly used in butterfly

surveys it does have some limitations. For example, sweep netting is biased towards slow-flying understorey species. This is because fast, high-flying butterflies, such as many of the fruit-feeding species, are extremely difficult to catch (Molleman *et al.* 2006). To reduce the impact of this limitation on the conclusions made, visual encounters were also included in the results. Captured butterflies were identified using butterfly plates and subsequently released. Any new species found were recorded, pinned and photographed for taxonomic verification. Taxonomy follows that of Lees *et al.* (2003). Timed surveys of one hour were carried out in the pre-defined areas of 100m<sup>2</sup> between 10am and 3pm, the warmest hours of the day. A total of 28 surveys (seven at each study site) were carried out, comprising 176 man hours (table 1).

Site	Surveys	Man hours
TS1	7	51
TS2	7	44
TS3	7	31
TS4	7	50

Table 1. Survey effort at each site

### 2.3 Measuring disturbance

In order to assess the level and distribution of human usage in the three forest sites disturbance transects were carried out in these areas. TS1 does not contain any arboreal vegetation and therefore was not included within this survey. It was assumed that TS1 was originally forested and that anthropogenic disturbance was total at this site. Transects were established through forested areas using randomly selected compass bearings. Because of differences in forest size, transects varied in length, for example, the smallest study site (TS2) had a maximum width of <100m. Along each transect, DBH (diameter at breast height) was used to measure all trees (>5cm circumference) that were growing within the area 5m either side of the transect path. Tree stumps were also recorded and the circumference measured at 30cm from the base. Stumps were classified as human-cut or naturally dead. They were also classified according to the length of time since harvesting in the categories old or recently cut. Every 50m along the transect the following vegetation data was collected; estimated canopy height, percentage canopy cover, percentage shrub layer cover, percentage ground cover. The topography, gradient and aspect of the area were also recorded every 50m. Longitude, latitude and altitudinal measurements were found using GPS and these measurements were taken at the start, finish

and at 50m intervals along the transect.

#### *2.4 Analytical techniques*

The species diversity of each site was calculated using the Shannon Diversity Index. Species richness, abundance and community composition were descriptively analysed and first order jackknife estimations (as suggested by McCune and Grace, 2002) were made. Species richness was analysed using species saturation curves. This allowed sites of varying degrees of degradation to be compared for richness and for sampling efficiency to be assessed.

Jackknife estimates were used as they provide an estimate of true species richness within an area. They do this by estimating the likely number of species not seen during sampling. The estimation makes the assumption that the number of species seen is an underestimation of the actual number present. Jackknife estimates also allow sampling variability to be quantified. Generally, more accurate results can be obtained from Jackknife estimates when focusing on smaller homogeneous areas. In contrast to many species richness estimates, underlying numerical distributions do not affect jackknife estimations (Magurran, 1988).

Disturbance data was used to find the average number of trees (based on the number of DBH measurements >5cm) per 50 m transect. The stem data was also averaged out to allow for comparisons to be made. More transects were carried out in TS3 and TS4 as the total width of TS2 was less than 100m. Differences in the structure of the habitat (density of understorey, canopy height, percentage canopy cover, percentage bare ground and leaf litter) at each forested trapsite (i.e. all except TS1) were compared using ANOVAs.

### **3. Results**

#### *3.1 Structure and Disturbance at Trapsites*

TS4 was found to have the highest tree density. Surprisingly, TS2, an artificial banana plantation, had a relatively high average number of non-banana trees found per transect. It also contained a fairly high number of human-cut stumps (figure 1). The number of newly cut stems was low at all three sites;

however, disturbance appeared to be highest at TS2. This finding is not surprising considering that this site has one of the closest proximities to the village and is regularly visited by local people for fruit harvesting. Evidence of wood harvesting is also frequently observed in the area and large trees are used for making traditional canoes. Traditional canoe making was observed twice during the six-month period.

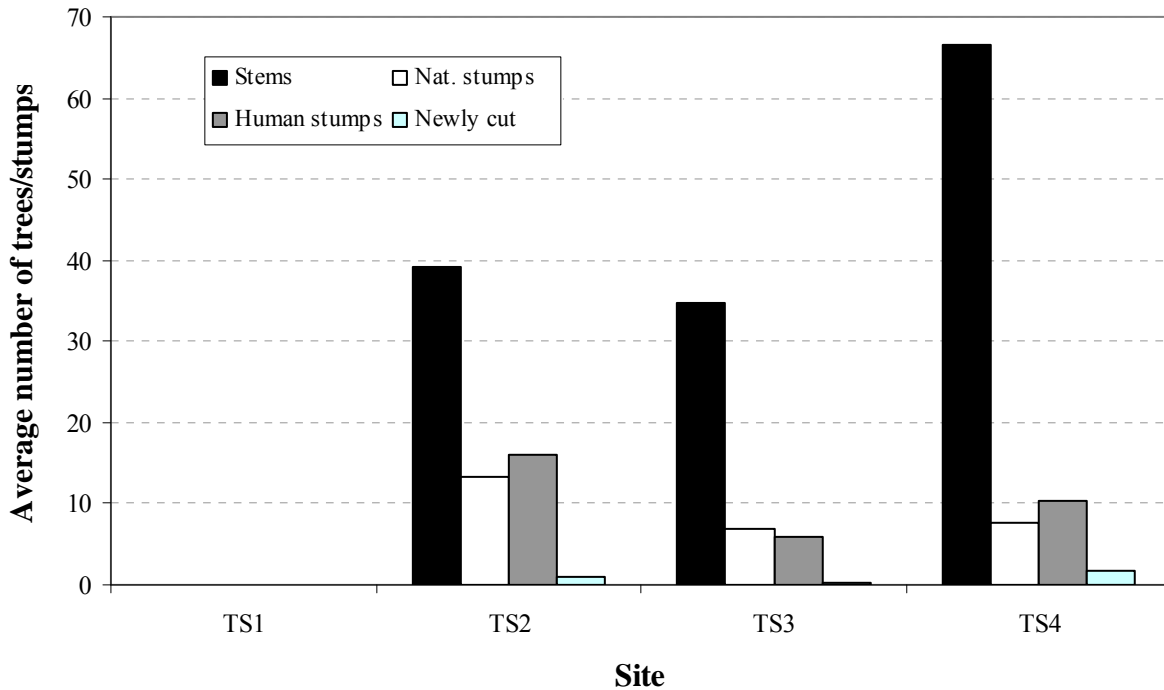


Figure 1. Disturbance data collected from trapsites. No data is available for TS1 as this is an open grassland site.

Of the variables measured to study habitat structure, the three forested sites were found to differ significantly between the density of understorey ( $F_{2,95} = 14.565$ ,  $p = 0.000$ ), canopy height ( $F_{2,95} = 21.133$ ,  $p = 0.000$ ) and amount of bare ground ( $F_{2,95} = 13.418$ ,  $p = 0.000$ ; figure 2).

### 3.2 Butterfly Species Composition and Abundance

A total of 782 individuals representing 63 species were collected across each of the four sites (appendix 1). Fifty-three percent of the species ( $n=34$ ) were endemic to Madagascar, with a further four endemic subspecies (6%). Eight species were observed in every site surveyed, of which three species were from the Nymphalidae family (*Danaus chrysippus aeyptus*, *Biblya anvatarata anvatarata* and *Junonia goudoti*), three from the Lycaenidae family (*Leptotes pirithous*, *Zizeeria knysna* and *Zizula hylax*) and two

species belonging to the Pieridae family (*Eurema floricola floricola* and *Leptosia alcesta sylvicola*). Of the species sampled, eight were found to only occur at the least disturbed site (TS4), with six species being collected only at the open site (TS1).

All sites showed similar levels of species richness. After seven surveys, sites TS1 to TS4 had yielded 33, 28, 32 and 34 species observations respectively. However, despite similar levels of species richness there was a high degree of species variation between sites. The species richness of endemic species was also similar across sites (TS1-TS3 each contained 19 species, TS4 contained 21). Greater sampling efforts may have produced further species, especially in trappingsites 2 and 3 where the species-accumulation curves show little sign of reaching an asymptote (figure 3).

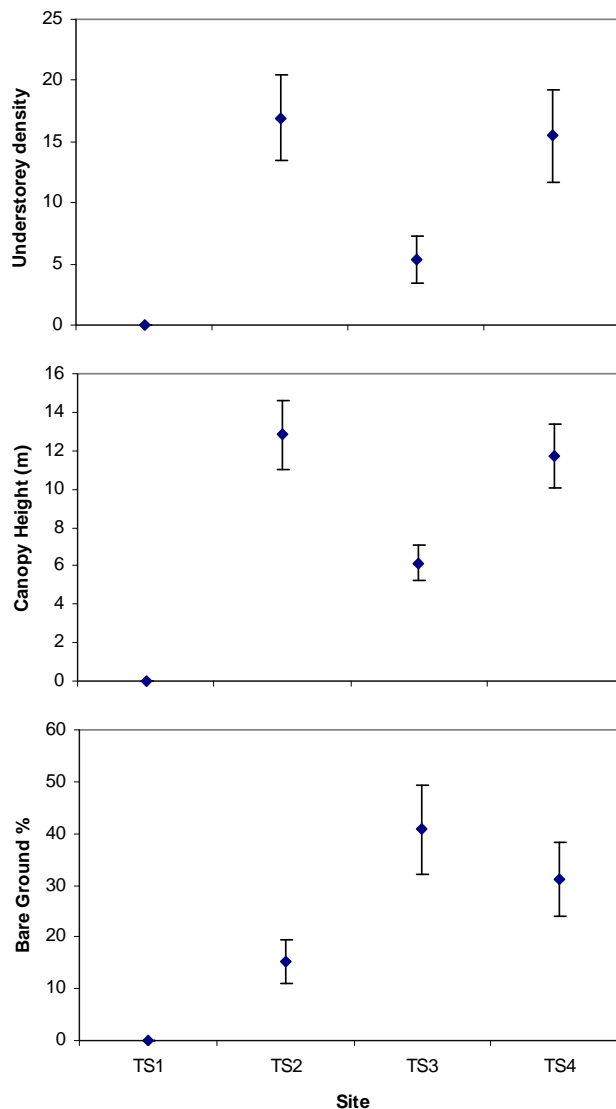


Figure 2. Habitat differences between trapsites.

The jackknife technique estimates that the true species richness for the area as a whole is 86 species, indicating that the original species richness was under-recorded by 27%. We therefore suggest that these results are a reasonably accurate estimate for the species richness of low-flying butterfly species in this area. However, since no canopy trapping was carried out in connection with this study, it should be expected that the true number of species would be somewhat higher.

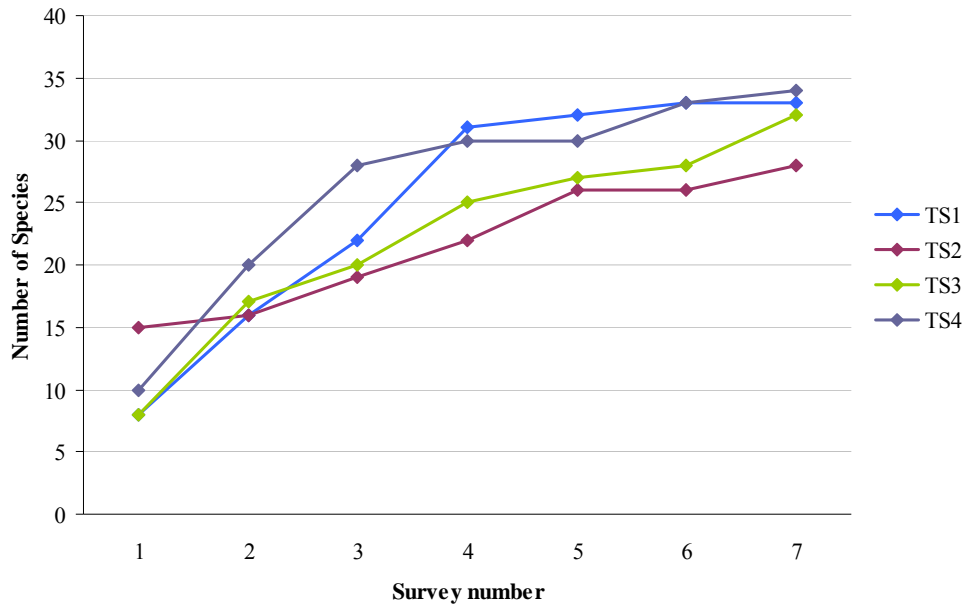


Figure 3. Species saturation curves for each of the four trap sites shown over the seven surveys

No significant differences were observed in the numbers of butterflies caught per man hour at each site (Kruskal Wallis:  $H = 3.03$ ,  $df = 3$ ,  $p = 0.387$ ; figure 4)

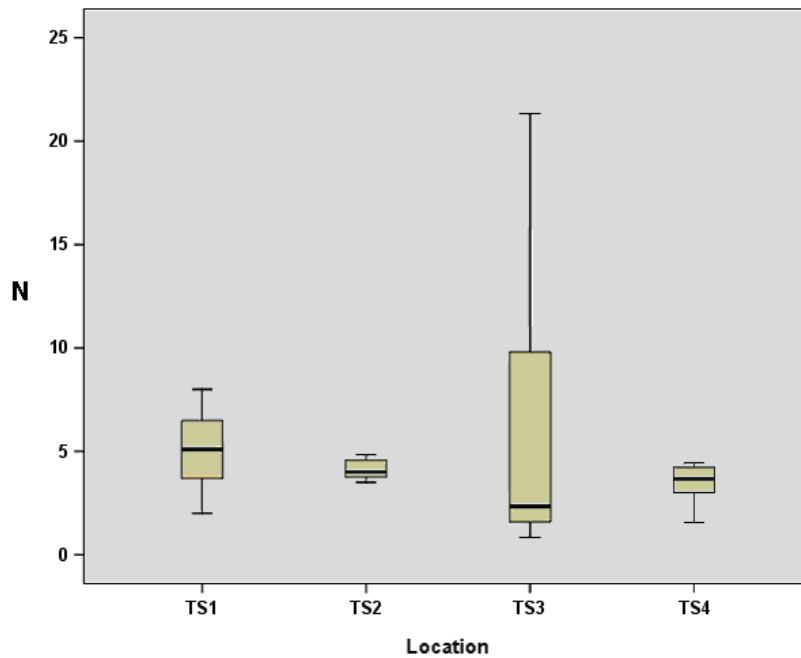


Figure 4. Number of individuals caught per man hour (N) at each trappingsite.

Whilst the numbers of individuals did not differ significantly between sites, the diversity (calculated using the Shannon index) did, with Trappingsite 2 showing considerably lower levels of diversity than the other sites (figure 5).

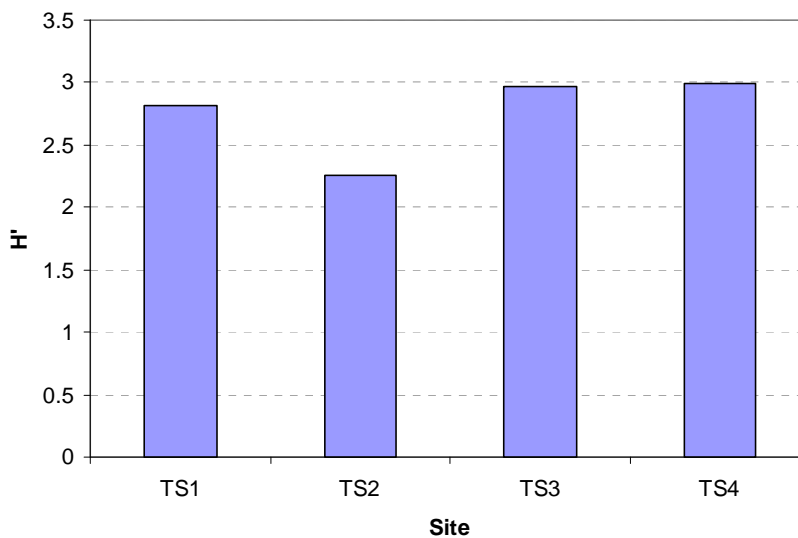


Figure 5. Diversity of butterflies (H') at each site, calculated using the Shannon-Weiner Diversity Index

A greater number of unique species (those found at just one site) were observed at trappingsites 3 and 4

(nine and eight respectively) compared to the six and three species observed at trapsites 1 and 2. Whilst this is a non-significant difference ( $\chi^2 = 3.23$ ,  $df = 3$ ,  $p = 0.36$ ), it is notable that trapsite 2, artificially planted with non-forest trees, contained only a fraction of the number of unique species observed at the other sites.

All families were represented at each site. The HesperIIDae, however, showed much greater species richness at sites TS3 and TS4 (figure 6).

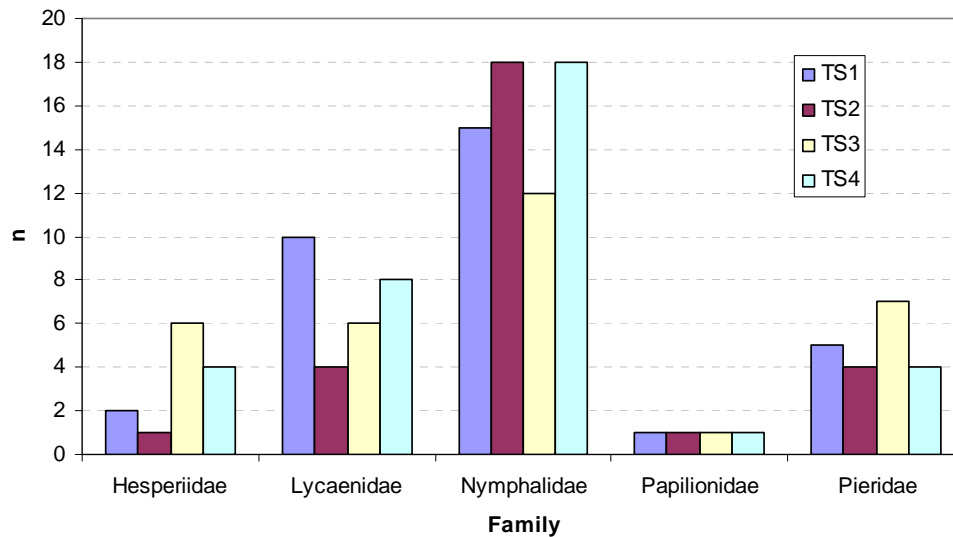


Figure 6. Species richness (n) at each trapsite displayed by family.

#### 4. Discussion

We measured the species abundance and diversity of day-flying Lepidoptera in four habitat fragments which differed in the amount of anthropogenic disturbance. The sites ranged from total deforestation (assumed at TS1, but see Kull (2000) and Klein (2002) for discussions of the natural occurrence of grassland in Madagascar) to mildly degraded forest (TS4). Of the forested sites, TS2 showed the most anthropogenic disturbance, principally through the introduction of fruit trees and a heavy harvesting burden. However, it still had canopy cover and understorey similar to the least disturbed site, TS4. TS3, on the other hand, had few introduced trees, but suffered greater harvesting pressure than TS4 proportionate to the tree density. Consequently TS3 was characterised by a more open canopy, less understorey and more bare ground.

The number of species found at each site did not show a high degree of variation, with each site providing between 28 and 34 species. However, species composition varied to a significant degree between sites - a finding common in other studies (e.g. Willott *et al.*, 2000). Hesperiid species differed strongly in their distribution. Highly modified habitats (TS1 & TS2) held just three species between them, whilst the sites with more natural forest contained a total of seven species (TS3: n = 6; TS4: n = 4). Since butterflies are often considered to be useful indicator species of habitat degradation (e.g. Pearman & Weber 2007; but see Lawton *et al.* 1998), we would suggest that, for Madagascan forests, it may be most useful to pay particular attention to the species assemblage of HesperIIDae. Other families should not be discounted, however; the Nymphalidae have previously been mentioned as good indicators of habitat disturbance in African ecosystems (Bobo *et al.* 2006)

The response of the butterfly communities to habitat degradation has been investigated during a number of previous studies. Hill *et al.* (1995) found that selectively logged areas of Indonesia showed a decline in biodiversity within freshly logged areas, whilst unlogged areas continued to support high levels of community complexity. Butterfly species in Costa Rica were shown to decrease in diversity as forest patch sizes declined (Daily, 1995). Most recently, it has been suggested that large-scale logging frequently causes a shift in the dominance of butterfly guilds as the vegetation itself changes (Clearly *et al.* 2005). In this situation, species typically occupying open areas are able to enter into logged areas, therefore causing an apparent increase in species diversity in affected areas. It has also been found that as light-dependent species are added to unlogged areas, and opportunistic (generalist) species are added to the edges of remaining forest patches, the assemblages of butterfly species present change in accordance (Spizter *et al.*, 1993).

Our results introduce a different element into this reasoning, that of natural and introduced plant species. The lowest diversity, and the lowest number of unique species (species found at just one trapsite), occurred at TS2, even though this site was physically similar to TS4 in floral structure. However, this site contained many more plants which had been introduced, instead of having a more natural community as was found in TS4. TS1, conversely, was a totally degraded area, but still represented grassland areas of the type naturally found in Madagascar. It is highly possible that once this habitat was exposed, grassland species were able to colonise, whilst the habitat at TS2 doesn't provide more specialist butterflies with conditions within which they can prosper. It might be expected

that, were this the case, endemic species would be conspicuously absent from ‘unnatural’ habitats. This was not the case. Trapsites 1 to 3 all contained 19 endemic species while TS4 contained 21.

Only three species were unique to TS2, whereas the other sites contained six (TS1), nine (TS3) and eight (TS4) unique species. This could indicate that a greater majority of species found in TS2 were generalists, possessing a wide geographic range, making them of lesser conservation value compared to those species with limited ranges (Spitzer *et al* 1997).

Generally the rates of endemism observed were low for the area. National rates are estimated to be 74% (Lees *et al* 2003), whilst only 63% of the species observed were endemic. The relatively low levels of endemism are likely to be caused by the disturbed nature of the study site. The results found here may concur with other previous studies (e.g. Hamer *et al.*, 1997) which state that those species with the largest geographic ranges, occurring in the highest density are confined primarily to secondary forests or disturbed areas while those with more limited geographic ranges tend to be restricted to the more natural forests.

First-order jackknife estimations suggested an underestimation of species diversity by approximately 27%. Future studies should replicate the surveys in similar forest fragments so that independent estimates of species diversity can be produced for each habitat type and compared. There is one considerable bias within this study that needs to be addressed in any future investigations: only low-flying species were sampled. While this should have given a good estimate of the number of species at TS1, where there was no canopy, it is likely that a significant proportion of the canopy-dwelling species existing at TS2-4 were not sampled (see Dumbrell and Hill, 2005). Some families, for example the Nymphalidae (see Hamer *et al.*, 2003), may have been particularly poorly sampled. Data collection in more dense forests was also physically more difficult than in open areas. Canopy traps proved to be ineffective for trapping butterflies in these habitats, it is not understood why. Traps were baited, as is normal in butterfly surveys (e.g. Hamer *et al.*, 2003; Dumbrell and Hill, 2005), with rotting banana, but failed to catch any butterflies. This could represent the fact that there simply are no canopy-dwelling butterfly species in the Tsarakibany region of Madagascar, but this seems unlikely. Other sampling methods may need to be trialled (e.g. butterfly walks, see Willott *et al.* 2000)

Transect walks and improved canopy trap methods could have improved sampling efficiency. The use

of mapping software could also have been useful to the investigation; allowing the comparison of species distributions and highlighting potential wildlife corridors in the area. Wildlife corridors are extremely important as they help to maintain connections between suitable habitats allowing the movement of species; butterflies and potentially invertebrates and larger animals (Daily, 1995). One useful avenue for further research is to investigate the importance of agroforestry systems which contain some remnants of natural forest. It has been suggested by Bobo *et al.* (2006) that systems such as these would help to maintain species richness within an area.

## 5. Conclusions

The use of indicator species to monitor habitat change is a contentious issue (Lawton *et al.* 1998). Butterflies are one of the taxa, due to their high visibility and relative ease of identification, that are often used as indicator species. However, this study highlights the fact that a broad guild approach is not particularly useful since all habitat types contained similar numbers of species and individuals. It is better to identify specific specialist groups (such as the Hesperidae appear to be in this study) and use them as more specific indicators.

This study also indicates that the naturalness of a habitat might be more important to the biodiversity of a site than forest cover per se. The grassland site (TS1), which is assumed to be totally degraded forest, contained a higher diversity of species compared to the highly forested, but unnatural site at TS2. The grassland site is likely to mimic habitats which have long been established in Madagascar, whilst plantations of non-native species (whether this is on a national or regional scale) offer fewer opportunities for native species to persist. Ensuring that agroforestry systems contain some remnants of natural forest, or are planted with natural forest species, should help to sustain the species richness in the area. These findings suggest that community reforestation programs, such as are recommended for the Tsarakibany area (Frontier-Madagascar in prep), must pay significant attention to the species composition of newly replanted forests. There could be a tendency to plant productive, 'useful' trees such as mango and banana, but if these species are not native, then their effectiveness at providing habitat for the recovery of local species might be lower than would be hoped.

Whilst species richness and diversity was relatively similar between the most degraded (TS1) and the

least degraded (TS4) sites, it is likely that the more forested sites were significantly under-recorded as the canopy was not surveyed during this survey. A more inclusive survey technique should be used in these areas to gain a more representative sample of the entire butterfly community in the different habitat types.

The main focus of Frontier-Madagascar's work in Tsarakinbany is to assess the region between the National Parks of Montagne d'Ambre and Ankarana as a potential transition zone and habitat corridor. Our findings do little to suggest that this area is of high conservation importance. The level of endemism was low and the forest fragments generally quite degraded. High resource use pressure from local communities means that remaining fragments continue to be degraded, and erosion of the topsoil means that restoration activities would be difficult. However, it is still possible that forest fragments are acting as stepping stones to allow gene flow of mobile species, such as butterflies, to be maintained between areas of subpopulations.

Future lepidopteran work in the area should focus firstly on the diversity of canopy-related species. It may be important to trial different bait types to attract species. Once the full species assemblage is known then conclusions can be drawn with greater confidence. It would also be interesting to compare species present in forest fragments that have different levels of native and non-native species. The results of this study seem to suggest that the butterflies of Madagascar, as a community, are particularly vulnerable to the modification of forests to include species such as mango (*Mangifera indica*), banana (*Musa acuminata*), palm (*Raffia* sp.) and eucalyptus (*Eucalyptus* sp.).

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Appendix 1. Species recorded during study. E = endemic species, Es = endemic subspecies, n = total number of individuals captured.

Family	Species	Range	n	TS1	TS2	TS3	TS4
Hesperiidae	<i>Borbo borbonica borbonica</i>		1			*	
Hesperiidae	<i>Borbo gemella</i>		13	*			
Hesperiidae	<i>Borbo ratek</i>	E	3			*	
Hesperiidae	<i>Coeliades forestan arbogastes</i>		2			*	
Hesperiidae	<i>Coeliades rama</i>	E	4			*	*
Hesperiidae	<i>Coeliades ramanatek ramanatek</i>	E	5	*		*	
Hesperiidae	<i>Fulda imorina</i>	E	1				*
Hesperiidae	<i>Tagiades insularis insularis</i>	E	4		*	*	*
Lycaenidae	<i>Anthene princeps smithii</i>		3	*			*
Lycaenidae	<i>Azanus sitalces</i>	E	3	*			*
Lycaenidae	<i>Azanus soalalicus</i>	E	14	*			
Lycaenidae	<i>Chilades trochylus</i>		9	*	*		
Lycaenidae	<i>Eicochrysops sanguigutta</i>	E	12	*	*		*
Lycaenidae	<i>Euchrysops malathana</i>		58	*			
Lycaenidae	<i>Hemiolaus cobaltina</i>	E	15			*	*
Lycaenidae	<i>Lampides boeticus</i>		1			*	
Lycaenidae	<i>Leptotes pirithous</i>		14	*	*	*	*
Lycaenidae	<i>Leptotes rabefaner</i>	E	5	*		*	*
Lycaenidae	<i>Zizeeria knysna</i>		35	*	*	*	*
Lycaenidae	<i>Zizula hylax</i>		95	*	*	*	*
Nymphalidae	<i>Acraea calida</i>	E	2	*			
Nymphalidae	<i>Acraea dammii</i>	E	7	*	*		
Nymphalidae	<i>Acraea encedon encedon</i>		39	*	*		*
Nymphalidae	<i>Acraea eponina</i>		13	*			*
Nymphalidae	<i>Acraea masamba</i>	E	2	*	*		
Nymphalidae	<i>Acraea ranavalona</i>	E	7		*	*	
Nymphalidae	<i>Acraea zitja</i>	E	29	*	*	*	
Nymphalidae	<i>Aterica rabena</i>	E	9		*	*	*
Nymphalidae	<i>Byblia anvataara anvataara</i>		19	*	*	*	*
Nymphalidae	<i>Cyrestis camillus elegans</i>		8		*		*
Nymphalidae	<i>Danaus chrysippus aegyptus</i>		56	*	*	*	*
Nymphalidae	<i>Eurytela narinda</i>	E	3				*
Nymphalidae	<i>Heteropsis ankaratra</i>	E	2		*		
Nymphalidae	<i>Heteropsis ankoma</i>	E	7				*

Nymphalidae	<i>Heteropsis narcissus fraterna</i>	E	2	*		*
Nymphalidae	<i>Heteropsis strigula</i>	E	2		*	*
Nymphalidae	<i>Heteropsis vola</i>	E	2	*	*	
Nymphalidae	<i>Hypolimnas misippus</i>		2	*		*
Nymphalidae	<i>Junonia goudotii</i>	E	33	*	*	*
Nymphalidae	<i>Junonia oenone epiclelia</i>		13	*		*
Nymphalidae	<i>Junonia orithya madagascariensis</i>		1			*
Nymphalidae	<i>Junonia rhadama</i>	E	16	*	*	*
Nymphalidae	<i>Limenitis sp</i>		1			*
Nymphalidae	<i>Melanitis leda helena</i>		1		*	
Nymphalidae	<i>Neptidopsis fulgurata fulgurata</i>	Es	2		*	*
Nymphalidae	<i>Neptis kikedeli</i>	E	7		*	*
Nymphalidae	<i>Neptis saclava saclava</i>	Es	1			*
Nymphalidae	<i>Pardopsis punctatissima</i>		12			*
Nymphalidae	<i>Phalanta madagascariensis</i>	E	1			*
Nymphalidae	<i>Phalanta phalantha</i>		8	*		*
Papilionidae	<i>Graphium cyrnus</i>	E	1			*
Papilionidae	<i>Papilio demodocus demodocus</i>		1	*		
Papilionidae	<i>Papilio epiphorbas</i>	E	5			*
Papilionidae	<i>Papilio grosesmithi</i>	E	1		*	
Pieridae	<i>Belenois antsianaka</i>	E	1			*
Pieridae	<i>Catopsilia florella</i>		44	*		*
Pieridae	<i>Catopsilia thauruma</i>	E	6	*		
Pieridae	<i>Colotis evanthe</i>	E	6	*	*	*
Pieridae	<i>Colotis lucas</i>	E	1			*
Pieridae	<i>Eurema brigitta brigitta</i>		8			*
Pieridae	<i>Eurema floricola floricola</i>	Es	45	*	*	*
Pieridae	<i>Leptosia alcesta sylvicola</i>	Es	55	*	*	*
Pieridae	<i>Mylothris phileris</i>	E	5		*	*