FINAL REPORT of Operation Wallacea El Paraiso forest projects, Honduras 2004

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Introduction and overview

Operation Wallacea (www.opwall.com) is a conservation research organisation specialising in tropical forest and coral reef science and conservation. In summer 2004 and expedition was undertaken to study and help protect the tropical montane rainforest in the Merenden mountains of Honduras.

In order to conduct such research, staff with expertise in a range of scientific areas including biology, geography and social sciences have been contracted to lead scientific projects based in El Paraiso Valley. Paying volunteers are invited to join these projects and to undertake small-scale projects of their own (usually for dissertations for university degrees). This provides the funding for the costs of the scientific work. Most of the fieldwork for the studies was carried out in July and August 2004. The projects are listed in the next section.

This report summarises the research that was conducted at the El Paraiso valley in the north west of Honduras. The El Paraiso valley is a privately owned lowland forest reserve. Some parts were formally cultivated for crops such as cocoa, beans and maize. Don Enrique Morales bought much of the land in the valley in the last decade and since this time the forest has been allowed to regenerate. There are some areas of primary forest in the less accessible, high elevation areas of the reserve, although there is also evidence of abandoned plantations at these sites. The area is a steep sided valley with a river running through the middle. Steep mule tracks run up the left and right hand sides of the valley to the top of the reserve. A small number of steep trails lead from the mule tracks into the forest and join the river at the bottom of the valley.

The purpose of the science program is to provide data on the socio-economic, forest structure, and biodiversity of the El Paraiso valley. Teams of scientist conducted research about the forest structure, small mammals, bats, birds, butterflies and potential for ecotourism at the site. This lowland forest site also acted as a comparative site for the higher altitude Cusuco sites, where Operation Wallacea staff also conducted research at 3 sites within the Cusuco national park protected area and buffer zone. The data from these studies will be used to determine the long-term monitoring programme for the valley and to assess the potential for ecotourism in the valley.

The main aims of the 2004 work are:

1. To start to build an inventory of the flora and fauna of the El Paraiso valley (diversity and abundance).
2. To study the ecology of a range of important organisms, to achieve a better understanding of them and produce scientific dissertations and papers.
3. To investigate the potential for ecotourism in the valley to provide a significant revenue to local communities. One of the future plans for the site is to allow limited access to ecotourists guided by people from the local communities. The objective is for these communities to see the forest and its wildlife as an asset and for this example to be replicated elsewhere in Honduras. The concept of seeing forested areas as a long-term asset for tourism, which is commonplace in countries such as Costa Rica where annual ecotourism revenues top $1 billion, is still virtually unknown in Honduras and the Paraiso valley could become the first such example in the country.

We have found that El Paraiso is biologically very rich, with far greater diversity of all organisms studied than was known from previously existing records. We have recorded new species previously unrecorded in El Paraiso and we have possible species new to Honduras. The 2004 work is only very preliminary in terms of understanding the ecology of the organisms. However, we have found that the El Paraiso valley is very species rich and in addition, is an excellent site to carry out comparative studies on the effects of various faunal groups of differing levels of forest disturbance. Research into the forest structure indicated that the areas of the valley that had been abandoned the longest showed the greatest species diversity. Despite the fact that the primary forest only persists in remnant pockets, El Paraiso contains an abundance of species and was generally more diverse than the comparable sites at higher altitude in the Cusuco national park. In particular we found a plethora of bird species typical of primary forest. Research into bat species found several range expansions and many new records for the El Paraiso valley. Studies of the invertebrates of the valley recorded 93 butterfly species and highlighted the importance of habitat type in influencing the butterfly richness and abundance. Furthermore, surveys of mammal species recorded 10 mammal species that have not previously been recorded in the valley. The social-scientific research suggests that there is potential to develop the area to attract ecotourists. The local people appear willing to get involved with potential tourism and could benefit from the income that tourism would provide.

The scientists and volunteers taking part in the research programme in 2004 have benefited greatly from the experience of conducting research in El Paraiso. Scientifically, it has been both fascinating and valuable. Data confirms that El Paraiso is rich in species abundance and diversity and an area of high conservation value that may be used for conservation and tourism in the future. The research expedition was a greatly beneficial scientific and cultural experience. We expanded our scientific experience and knowledge and learnt a lot about the local area as well as the country of Honduras.

List of the projects undertaken in 2004, with scientists' names

Forest structure and composition

Maarten Blaauw (Trinity College, Dublin, Ireland)
Thomas Cavanagh (University College Worcester, UK)
Cordula Lenkhh (University of Glamorgan, Wales)

Bat diversity and abundance

Prof. John Altringham (Leeds University, UK)
Paula Senior (Leeds University, UK)
Sally Griffiths (Leeds University, UK)
Claire Hopkins (Leeds University, UK)
Dr. Victoria Bennett (Leeds University, UK)

Bird diversity, abundance and ecology

Dr. Robin Brace (Nottingham University, UK)
Dr. Peter Cosgrove (Cairngorms National Park Authority, UK)
Dr. Martin Dallimer (Operation Wallacea, UK)
Robin Cosgrove (Operation Wallacea, UK)
Veronica French (Trinity College, Dublin, Ireland)
Roberto Downing (COHDEFOR, Honduras)

Invertebrate diversity, abundance and ecology

Dr. Francis Gilbert (Nottingham University, UK)
Dr. Graham Rothery (National Museums of Scotland, UK)
Iain Bray (Anglia Polytechnic University, UK)
Jose Nunez-Mino (Imperial College, UK)
Greg Chamberlain (Glamorgan University, UK)

Terrestrial mammal diversity, abundance and ecology

Dr. Ruth Cox (Durham University, UK)
Louise Whittaker (Leeds University, UK)
Leah Findley (Royal Holloway, UK)

Preliminary reports from the individual projects

Forest structure and composition

1. Forest structure investigations in the El Paraiso valley, western Honduras

Maarten Blaauw.

Introduction

The El Paraiso valley contains one of the few remaining examples of lowland forest in Honduras. The forest has been widely used for crop cultivation (mainly cocoa, beans, maize), especially at the lower parts. Higher up, some stands of (near to) primary forest can be found, although also at these elevations there is ample evidence of abandoned plantations (e.g., of coffee).

During the previous decade (starting around 1992), Don Enrique Morales has bought much of the land in the valley. From the time that the lots were bought, existing plantations have been abandoned and the forest is expected to be regenerating in these sites (secondary forest).

Methods

The area is very hilly, with by far the largest part being inaccessible for the type of field work performed in this research project. Moreover, there are only a limited number of trails leading into the forest, some of these trails being considerably difficult to walk on. Therefore, only a limited number of sites could be found that were reasonably accessible and level (slopes not exceeding ca. 35 degrees), and therefore safe to work in. Although the original plan was to use random numbers to select sites, this approach soon proved impossible in the area. We therefore located 15 sites in total (table 1) based on information of a well-informed local guide.

Of the trees, the local names were recorded whenever available (as provided by the guide). To aid in identification, bark and slash characteristics were recorded. Also, leaf samples were taken of the tree species. This should enable identification to at least family level of most species; a visit to the herbarium at the University of Tegucigalpa will be made to find their scientific names.

In areas suitable to work in (not too steep, and not too far from trails), plots of 20 by 20 m were laid out by measuring tape. All corners and the midpoints of the sides were marked with spray paint to enable locating oneself in the plot. All trees with a diameter at breast height (DBH) of more than 10 cm were numbered with permanent tags, their local names were recorded along with bark characteristics, and their heights were estimated using a clinometer from a known distance. The understorey cover (% of moss, litter, shrubs, herbs, stones, bare soil, canopy tree saplings) was estimated for each quarter of the plot. Maps were drawn to show the location and canopy shape of each marked tree.

Preliminary results

Of the 15 sites, 3 were in ‘primary’ forest (higher up in the reserve; although the guide told these sites were primary, they appear be rather secondary when considering the vines and understorey), 2 were in existing plantations, and the rest were in abandoned plantations. Details of the plots including and heights of trees are shown in table 2. We plan to visit Ponderoso, an easily accessible site in the Merendon mountain chain which contains primary forest. Here some additional plots will be made to compare with the mostly secondary forest in El Paraiso.

Preliminary discussion

Most of the selected sites contain evidence of being abandoned plantations; the more level sites would have been easier to exploit for the local farmers and would therefore probably have been preferred over steeper sites. Therefore, our research sites are probably biased to abandoned plantations.

Tom Cavanagh will use the data collected for his thesis and will perform a thorough analysis of the results. A preliminary check of the data does not reveal notable differences of DBH or heights between the different sites, even between ‘primary’ (plots 2, 12, 13) and other sites.

Analysis of the species data (comparison of biodiversity, percentage of planted vs. natural trees, etc.) will be performed. It is clear at first sight that the most abundant tree species in our plots is the cocoa tree.

Pa	Description	Where	Altitude	Slope
1	Abandoned cocoa/banana plantation	Senda 1	329 m	32
2	‘Primary’ forest	Senda 4	640 m	21
3	Secondary forest in plantation abandoned 12 yrs ago	River		21
4	Abandoned plantation?	Heli	240 m	24
5	Abandoned plantation of orange etc., no cocoa	Heli		14
6	Abandoned cocoa plantation	Waterfall		10
7	Regenerating	Senda 3		20
8	Abandoned cocoa plantation	Watefall		10
9	Regenerating	Senda 2		22
10	Bit cocoa	Waterfall	110 m	0
11	Abandoned cocoa plantation	River		30
12	‘Primary’?	Senda 4		30
13	Many boulders, river influence, ‘primary’ as no plantation?	River		0
14	Existing orange plantation	Antolins house		0
15	Existing cocoa plantation	Neighbours house		2

Table 1: summary of the plots

		Diameters at breast height				Heights of trees				Heights of first major leaved branch			
Plot	Number of trees	average	sd	min	max	average	sd	min	max	average	sd	min	max
1	**23**	**54.26**	**19.77**	**13**	**88**	**9.94**	**5.41**	**3.69**	**22.32**	**3.52**	**2.74**	**0.88**	**10.97**
2	**29**	**27.11**	**34.13**	**9**	**191**	**11.51**	**4.39**	**5.36**	**21.68**	**5.11**	**2.24**	**1.23**	**10.29**
3	**14**	**30.57**	**26.71**	**12**	**92**	**12.98**	**5.71**	**8.22**	**25.50**	**4.63**	**3.85**	**1.05**	**10.98**
4	**16**	**30.47**	**22.34**	**9.5**	**70**	**21.59**	**18.74**	**5.73**	**84.22**	**10.83**	**7.21**	**2.22**	**29.14**
5	**25**	**27.50**	**18.70**	**11**	**105**	**20.30**	**10.3**	**4.66**	**39.40**	**7.77**	**5.51**	**0.70**	**22.9**
6	**25**	**24.02**	**9.78**	**10.5**	**46.2**	**12.50**	**5.27**	**5.44**	**27.30**	**5.23**	**4.09**	**0.72**	**13.10**
7	**23**	**23.26**	**21.12**	**9**	**99**	**15.33**	**9.43**	**6.54**	**47.40**	**9.13**	**5.26**	**1.79**	**20.26**
8	**27**	**17.99**	**12.43**	**9.5**	**63.7**	**12.48**	**13.02**	**3.57**	**70.98**	**4.32**	**3.79**	**0.70**	**16.63**
9	**16**	**28.78**	**52.29**	**8**	**223**	**12.58**	**10.22**	**4.20**	**48.03**	**5.95**	**3.68**	**1.09**	**13.93**
10	**28**	**20.25**	**12.32**	**8.5**	**64**	**11.74**	**6.61**	**4.99**	**27.81**	**6.13**	**3.76**	**1.58**	**16.59**
11	**35**	**16.90**	**9.23**	**10**	**43**	**9.90**	**10.40**	**3.38**	**54.00**	**3.19**	**2.52**	**0.72**	**13.50**
12	**37**	**22.42**	**15.16**	**10**	**96**	**18.38**	**19.11**	**5.16**	**99.25**	**9.25**	**5.93**	**3.30**	**27.22**
13	**26**	**24.81**	**13.32**	**10**	**54.1**	**15.32**	**5.46**	**7.87**	**28.17**	**7.94**	**4.24**	**0.70**	**20.33**
14	**7**	**28.71**	**16.86**	**13**	**60**	**24.25**	**12.19**	**10.52**	**44.19**	**7.99**	**4.32**	**2.28**	**14.64**
15	**22**	**22.50**	**14.60**	**10**	**54**	**9.22**	**7.54**	**2.81**	**26.30**	**3.37**	**2.91**	**0.35**	**14.00**

Table 2: summary of DBH, heights and numbers of trees per plot.

Recommendations for further research

-Study the understorey (relevant for, e.g., research into small mammals) of existing plots, for example by random siting of 5*5 m sub-plots within the existing tree plots.

-Study the moss, lichen and epiphyte cover of trees (could give indications of level of disturbance) of existing plots

-There are plans to remove planted trees and replace them with ‘native’ trees; comparing changes through time (forest regeneration) between replanted and unaltered plots could be interesting.

-Generally integrate the different areas of research more, e.g., social science and (abandoned?) plantations; butterflies and host plant species.

-Extend research into higher parts of the reserve (the vegetation there is reported to be different from the lower part and includes pines and tree ferns; access is possible through mule trails)

Limitations

-The number of knowledgeable guides is low in El Paraiso (1 good guide who is also needed for other research projects); for tree species identification such a guide is needed

-Antolin is a very good, hard working, well-natured and knowledgeable guide and he is therefore very valuable for the El Paraiso site. There exists a language barrier however, as many of the researcher did not speak Spanish.

-For the forest research, at times long hikes have to be made into the forest. Trail 5 along the river can be difficult/dangerous to walk on, especially when crossing the river, walking on boulders (these can be very slippery after rain), and at the diversions at the waterfalls higher up in the reserve. At times hard climbing is needed and there are no ropes on the trail.

-In general the area is very hilly and only few trails lead into the forest. This makes it difficult to find sites suitable to work in.

-The catering timing limits the hours that can be spent in the forest, especially when working high up. Lunch can be brought up to the waterfall but that is still a few hours’ hike from remote locations. It would be welcome to have packed lunch provided.

-Because of the catering limitations mentioned above, and because of the hot afternoons, most work was done in the morning. This limited the number of hours that could be spent for field work.

2. An Initial Report on the Forest Structure in Lowland Forest at El Paraiso, Cortes, Honduras

Thomas Cavanagh

Introduction

Natural rainforests in Honduras have been extensively logged and cleared since the early 1950's both by commercial and ad hoc activities. This has left a patchwork of primary forest with secondary succession, mainly in high altitude mountainous areas. Remnants of lowland primary forests are very rare and hardly studied within the North-west of Honduras.

Project Aim

The aim of this project is a preliminary description of lowland forest structures within the private El Paraiso forest reserve. The sample sites are positioned in primary and secondary forests in an area of approximately 300 ha, which is situated along the Rio Piedra close to the village of El Paraiso in the District of Cortes in North-western Honduras.

Forest structure and tree diversity are assessed via replicate 20x20 metre quadrates. The collected data are additionally used for a description of reforestation of abandoned plantations (e.g. cacao, coffee, banana, plantain), as well as abiotic or biotic factors influencing the succession within secondary forest structures.

Method

Sample sites are selected within primary and secondary forest so that a comparison can be made of the two types of woodland. The sample area is only used if deemed safe to work in (see Risk Assessment) such as not too excessively steep slope and not too slippery.

When a safe area is selected a random bearing is taken (between 0 and 360) for direction and a second random number (between 0 and 50) for distance along the bearing in metres to the end point. This 'end point' is the start of the sample plot (top left corner of the 1^{st} quarter). Note: If the end point is in a reasonably homogeneous stand of vegetation this will be the start of the plot. If the vegetation is grossly heterogeneous in structure (i.e. part clearing and part high forest) the end point is shifted to nearest reasonably homogeneous stand)

Due to the dense structure of the forest quadrates can not be created by eye. To overcome this problem a tree is selected and marked by paint, this becomes the top left hand corner of first quarter. From this corner a 20m tape is run out in the straightest line possible and its bearing is taken by a compass. All other 20m tapes are located by compass bearings (90^0 at each turn) until the tapes join. Along each 20m stretch 10m points are marked to aid mapping the forest structure.

When the quadrate is marked out a Global Position System (GPS) reading is attempted along with recording the altitude. Slope of the sample site is measured by a clinometer. Each tree >10cm within the quadrate is numbered with a standard forestry tree tag and recorded on the data sheet with the following information

- Species name (Local)*
- Diameter at breast height, 1.3m (dbh)
- Bark description
- Height of first major living branch **
- Overall height of tree **

* Scientific name will be added at a later date

** Both measured at a distance of 10m, unless stated.

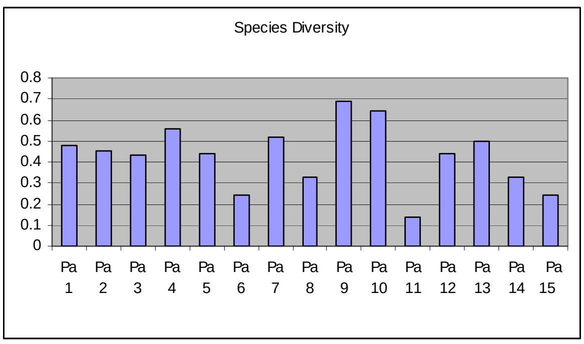
A sample of bark is taken by slashing the stem with a machete to allow the colour of timber to be noted along with smell, exudate and any other characteristics such as structure (e.g., smooth, fissured, stippled) that can help in identification of the tree. To aid with tree identification telescopic loppers are used to collect leaf samples which are then pressed in a leaf press for preservation. By using the 10m and 20m marks along the tapes a map is drawn of the tree location, extent of the tree canopy and the canopy direction. Dead wood is also recorded. Understory and canopy cover is estimated for each quarter on a sheet describing percentage cover (see sample form) A digital camera is used to help in drawing the vertical and horizontal profile of the sample site. A soil sample is taken from the surface removing any leaf litter; these soil samples are to be analysed later by measuring N, P, K and pH.

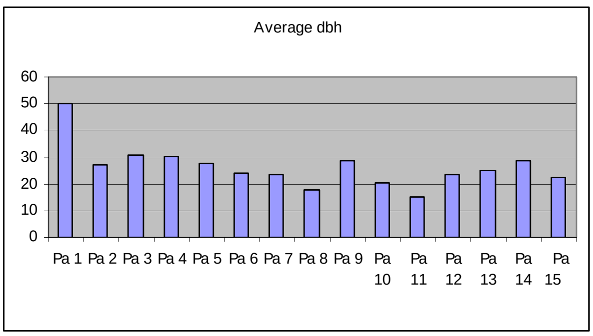
Constraints
Accessibility to sample sites is very difficult due to the very steep slopes and limited number of used paths throughout the valley. Understory is not identified due to time constraints and lack of detailed published material to help with identification.

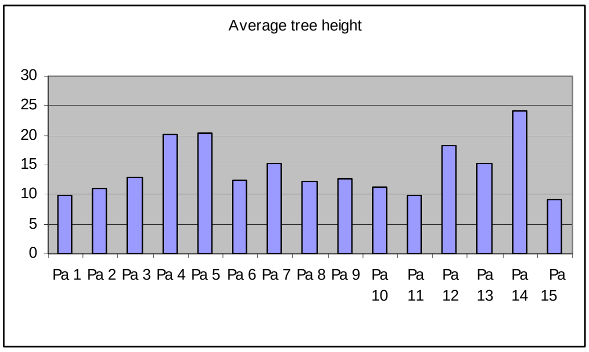
Errors
To limit any 'edge effect' a 4m buffer zone is created around the random sample sites. If the sample site falls within this zone then the start point is moved into the forest away from the edge effect in the most direct route. Measuring tree height can be difficult in a dense stand due to vegetation blocking visual sight of the tree top.

Statistical Tests and Presentation of data
The data collected will be analysed by using the technique Multivariate Analysis. Multivariate analysis will be presented in the form of scattergrams and nearest neighbours cluster analysis (based on Euclidean distance) being presented in a dendrogam. Overall forest profile will be presented by drawings showing both vertical and horizontal forest structure.

Results
Originally the research at El Paraiso was to be based on primary and secondary forest, however it became clear that primary forest is in fact old secondary forest. We plan visit Ponderoso a primary forest site within the same Merendon mountain range at the same altitude so that a comparison can be made. So far 15 samples have been taken within El Paraiso a summary of the data is shown below.







Discussion

Due to the difficult terrain all of our sample sites have been on relatively flat areas with would have been exploited for agriculture at some point, therefore reducing the samples to secondary forest. When samples have been taken of the Ponderoso site a more detailed analysis can be performed on structure changes due to succession. Data at the moment shows low species diversity in the existing plantations and high diversity in the oldest abandoned plantations. Plantations are created by clearing a small area of forest but still leaving the large trees (due to lack of chainsaws) this type of clearance produces a mixed age structure after abandonment which can cause problems than if the sites were just cleared felled.

Bat diversity and abundance

1. Interim Report, Bat Biodiversity Assessment: Cusuco National Park and El Paraiso

Paula Senior, Claire Hopkins & Sally Griffiths, University of Leeds, UK
6 August 2004

Aims 2004:

- To establish a protocol for assessing bat diversity and abundance using a combination of mist netting and echolocation call recording along transects
- To begin the process of assessing diversity and abundance
- To begin compiling a reference library of echolocation calls

This report was written in the middle of the field season, before much of the data had been collated or analysed.

Methods

Two teams of two are operating simultaneously in the field. Each is erecting four mist nets of a total length of 32 m each night between dusk and midnight. Nets are placed across tracks, in clearings or along habitat edges to maximise catches. All bats captured are identified to species and sexed. Morphological data are collected, age and sexual status determined and 3 mm wing biopsies are taken for later microsatellite DNA analysis. Bats are released from the hand and their echolocation calls recorded to a minidisk using a time-expansion bat detector. Sonograms of the calls will be analysed to see how many species/genera have unique calls that enable them to be identified without capture.

We will determine if there is a correlation between abundance measured from capture data and from flying bats recorded on transects. Between 20:30 and 21:30 bats are recorded for 5 min at sequential spot locations 25 m apart along a transect that includes the mist netting site.

If it is possible to identify a significant proportion of the bats from their echolocation calls then bat diversity determined using the two methods will also be compared.

We are attempting to study four basic habitat types at three sites (Base Camp, Buenos Aires and El Paraiso): primary forest, secondary forest, plantation and 'other' disturbed sites.

Preliminary results

Table 1. Summary data.

	El Paraiso	Buenos Aires	Base Camp
Nights trapping (nights lost to rain)	15(4)	11(2)	7(5)
Total no. of species caught	21	13	9
Average number of bats/night	15	9	3
Insectivores	Y	Y	Y
Frugivores	Y	Y	Y
Nectarivores	Y	Y	Y
Carnivores	N	Y	N
Vampires	Y	Y	N

Bat diversity is high at all sites, but the number of bats caught has been low, particularly at Base Camp. Representatives of all of the major trophic groups have been caught at all locations, with the exception of vampires at Base Camp. Carnivorous bats are often present at low densities, so it is not too surprising that only one has been caught. Sustained effort and a growing knowledge of the sites should lead to improved capture success, but low numbers, particularly at Base Camp may have to be accepted. This may impact on effective monitoring.

One in three nights have been completely lost to rain and rain has fallen on over 80% of nights, reducing bat activity and therefore capture success.

Table two summarises the capture data by taxonomic group and by site. Records new to Honduras, that represent range expansions or that are new to individual sites are also indicated. The most noteworthy records are *Eptesicus brasiliensis*, previously unrecorded in Honduras (to be confirmed by literature survey on return to the UK) and Phyllostomas hastatus, captured at Buenos Aires (1200m), but previously only recorded up to 600m. There are several range expansions and many new records for the two principle locations.

Frugivores are over represented, relative to insectivorous bats, but it is too early to say whether this result is real or due to capture bias.

Future practical issues

Capture success has been relatively low, but this should improve as knowledge is gained of the sites. A pool of four harp traps to move around the sites, in addition to mist nets, would greatly improve capture success without increasing the time spent extracting bats. A single team of two experienced mist netters, with a helper capable of handling bats would be able to cope with the bats caught and keep volunteers/staff and school parties occupied.

Family	Subfamily	Species	BaseCamp	Buenos Aires	El Paraiso
Emballonuridae					
Noctilionidae					
Mormoopidae		*Pteronotus davyi*		Y3	
		Mormoops megalophylla			Y
Phyllostomidae	Phyllostominae	*Micronycteris microtis*	Y3		
		Lonchorina aurita			Y
		Phyllostomas hastatus		Y2	
	Glossophaginae	*Glossophaga soricina*		Y3	Y
		Glossophaga commissarisi			Y3
		Hylonycteris underwoodi	Y2		
		Anoura Geoffroyi		Y3	
	Carolliinae	*Carollia castanea*			Y3
		Carollia perspicillata			Y
		Carollia brevicauda	Y3		Y3
	Stenodermatinae	*Sturnira lilium*	Y	Y	Y
		Sturnira ludovici	Y2	Y2	
		Artibeus intermedius		Y3	Y3?
		Artibeus jamaicensis		Y3	Y
		Artibeus lituratus			Y3
		Artibeus toltecus	Y2	Y2	
		Artibeus watsoni			Y
		Uroderma bilobartum			Y
		Platyrrhinus helleri			Y
		Vampyrodes caraccioli		Y2*	Y3?
		Chiroderma salvini		Y2	
		Centurio senex	Y3	Y3	
	Desmodontinae	*Desmodus rotundus*		Y3	Y
Natalidae					
Furipteridae					
Thyropteridae					
Vespertilionidae		*Myotis velifer*			Y2
		Myotis nigricans			Y3
		Myotis keaysi	Y3		
		Eptesicus brasiliensis	Y1		
		Eptesicus furinalis			Y3
		Rhogeessa tumida			Y3
Molossidae		*Molossus ater*			Y
		Molossus sinaloae			Y

Table 2. Species data

Y1 – previously recorded in Park

Y2 - previously recorded in the region

Y3 – outside previously known range

2. A comparison of acoustic and capture methods for making inventories of bats in Honduras

Claire Hopkins, University of Leeds, UK.

Supervisors: John Altringham, Richard Field
Dates: 26th June – 8th August 2004
Sites: Cusuco Base Camp, Buenos Aires, El Paraiso
Date for completion: October 2004

Introduction

Bats are one of the major taxonomic groups in Honduras, comprising the most species-rich mammalian taxon at the local community level in the Neotropics (Patterson *et al*. 2001). Around 98 species of the microchiopteran suborder are currently recognised in Honduras (IUCN – www.redlist.org) although knowledge about the distribution and ecology of most of these is generally limited.

Flight and echolocation are two attributes of microchiropteran bats which help to explain the diversity of functional niches filled by bats as they allowed adaptation to pursue previously inaccessible resources (Fenton *et al.* 1995, Aldridge & Rautenbach 1987).

All microchiropteran bats use echolocation – vocalisations produced in the larynx and emitted from the nose or mouth – to orient and in some to detect insect prey, by making comparisons between pulse and echo to acquire information about the presence, location and structure of objects and details about changes in position in relation to the surroundings (Dear *et al* 1993). Signals are typically short ultrasonic pulses (> 20kHZ, between 1-50 ms in duration) which provide high resolution of 3-dimensional objects and prey and allows separation of pulse and echo in time (Fenton *et al* 1995, Bogdanowicz *et al* 1999). Most aerial-feeding bat species call using intense (>110dB SPL) echolocation calls to detect moving targets, although species which forage for other sources of food may be more reliant on other senses to locate food, such as olfactory (Fenton *et al* 1995).

There is great interspecific variety in call characteristics (Fenton *et al* 1995), a property which has frequently been exploited as a means of species identification in the field (Fenton & Bell 1981, Vaughan *et al* 1997, Rydell *et al* 2002). There are two types of echolocation call structure: broad- and narrowband. Broadband calls cover a range of frequencies while narrowband focus more energy into a smaller range of frequencies and duty cycles (the time the signal is "on") also vary. The effective range of echolocation is constrained by the speed of sound in air ($331ms^{-1}$), spreading loss according to the inverse square law, and atmospheric attenuation of high frequency sounds (Laurence & Simmons 1982) which means that bats must use call structures which give the most effective information about the surroundings, and therefore a trade-off between resolution and effective range. The acoustic characteristics of a bat's call has been shown to influence the comparative success at foraging within particular habitats (Neuweiler 1983, Brigham *et al* 1997).

However a degree of intra-and inter-individual variety has been demonstrated by studies of individuals over extended time periods (Obrist 1995). This serves several functions in transmission of information. Unique, flexible calls have the benefit of ensuring self-recognition and reduced ambiguity as well as enabling adjustment to the environment as flexibility allows access to a greater variety of habitats (Obrist 1995). Differences between sex and age also exist (Jones *et al* 1992). Acoustic methods have not previously been found to be a reliable method of making assessments of bat diversity as even with a good call library it can be difficult to distinguish between species (Barclay 1999).

Previous studies of bats in the Neotropics have focused largely on traditional capture methods including mist netting and harp trapping (Kunz & Kurta 1988, Medellin *et al.* 2000, Kalko & Handley 2001). These methods have been found to be inherently biased towards species which forage in the understorey, and have resulted in a high representation of Phylostomine bats (Kalko & Handley 2001). Only one study has previously set out to directly compare acoustic and capture techniques for the inventory of bats (O'Farrell & Gannon, 1999) although acoustic methods are often used to complement capture data (eg. Mills *et al.* 1996). Different species have been found to be unequally susceptible to each detection method and the aim of the current study is to compare acoustic sampling and mist net capture techniques as methods of assessing bat diversity in three locations in Honduras. The objectives are to build up a library of calls from bats captured in mist nets and use this to identify bats detected by a transect acoustic sampling method. Statistical analyses will be used to directly compare the two methods as means of assessing bat diversity.

Methods

An acoustic bat monitoring study was undertaken in three locations in Northern Honduras (Cusuco National Park Base Camp, Buenos Aires and El Paraiso). The area of interest comprises part of the Merendon mountain range and supports a wide range of habitats and distinct vegetation types at altitudes up to 1500m.

Four sites were chosen in the vicinity of each location. Criteria for site selection were that sites should represent a range of different habitats, elevations and levels of disturbance representative of the region. These included forest trails, habitat edges, streams, unnatural vegetation and other areas likely to have concentrated bat activity, although sites were not selected on the basis of known presence or abundance of bats as no pilot studies have been previously carried out in the area. Each site was studied twice and results for the two capture nights were pooled. Pseudoreplication was avoided by always using a different site on consecutive nights, which also avoids the problem of trap evasiveness by knowledgable bats (Altringham 1996). This exceeds the number suggested to obtain reliable estimates of the number of bat species in forest areas and takes into account variation in weather conditions (Mills *et al.* 1996).

Four mist nets (2 x 9m, 2 x 6m) were deployed at each site (e.g. Kunz & Kurta, 1988); the orientation of nets was influenced directly by the physical characteristics of the sampling location and additional disturbance to the local vegetation was kept to a minimum. Mist netting effort was standardized in terms of number of capture hours (between 19.30 and 23.00), frequency of checking (every 5 – 10 minutes) and total net length.

Captured bats were identified to species level using a key (M. B. Fenton, pers. comm.) and field guide (Read 2002), the sex, age and reproductive condition were noted as Jones *et al.*(1992) have demonstrated call differences between different ages and sex. Bats were subjected to wing biopsy as a means of marking captured bats; and biometric analyses including forearm and mass measurements. Analyses were carried out with minimum stress to the bats.

An ever-expanding library of calls was created of captured bats being released from the hand close to the net of capture (O'Farrell *et al.* 1999, Aldridge & Rautenbach 1987), using a Tranquility Bat detector (Stag Electronics) connected to a Sony Minidisk recorder held 2 – 3m from the bat. The library was developed to provide standard call information of known species against which to compare transect recorded calls. Although such calls are not typical due to the novelty of the situation and a degree of distress by the bats, call parameters are assumed to be sufficiently specific to allow identification of individuals detected using the transect method, at least down to the genus level.

A method involving a 250m linear transect was employed to sample bat activity around each site. Calls were recorded using a Tranquility bat detector on 400ms time expansion mode. The detector was placed at a 45º angle to the ground in such a position as to maximize the likelihood of detecting high-quality calls (O'Farrell *et al.* 1999) for at least five minutes at each 25m point along the transect, selected as the largest practical distance at which to avoid sampling overlapping foraging grounds. Recording ceased during periods of rain to minimize risk of microphone damage. Using such a method allows bat activity to be sampled regardless of the purpose of the flight (foraging or commuting between foraging sites or roosting grounds). Transects typically followed the forest trails or natural vegetation breaks as these have been shown to be used by aerially feeding forest dwelling bats (reviewed in Wunder & Carey 1996). Transects incorporated parts of the trail before, around and beyond the netted area in order to sample a comparable area, and acoustic sampling was carried out simultaneously with capture. Transects were timed to coincide with 2 hours after sunset (according to GPS) to take the maximum activity of foraging bats and the photoperiod into account (Aldridge & Rautenbach 1987) and making the assumption that there is little temporal partitioning of foraging time in different bat species (Fenton 1982).

Recorded calls (defined as individual, discrete pulses of sound; O'Farrell *et al.* 1999) were processed using Batsound Pro software on a desktop PC and parameters including frequency range (max and min), frequency of maximum energy (kHz), duration (time in ms) and shape were identified where possible with reference to the call library and other reference literature; although variation at a number of levels, fragmentary calls and background noise made correct identification down to species level difficult at times (Barclay, 1999).

Preliminary Results

Capture data

Some capture sites were shown to be more successful than others in terms of numbers and diversity of bats caught, possibly as a result of site-specific characteristics, weather and moonlight variables or net orientations. Repetitions at each site and pooling of data is believed to take account for much of this variation.

There was a significant paucity of bat activity noted in Cusuco sites in comparison with Buenos Aires and El Paraiso sites, which could be alluded to differences in altitude as well as in forest structure and suitability of food resources. In future it may be more successful to replicate with more traps than to extend trapping to more nights, as spatial variation appears to be greater than temporal variation under the weather conditions experienced.

Acoustic data

The echolocation call library was successful in that over half of all captured bats that were recorded leaving the hand emitted identifiable calls. This was the first known such library of calls to be carried out in the area and can be used to support future acoustic surveys in the area.

The transect method for acoustic sampling proved more successful and effective in some sites than others, depending on technical factors as well as site-specific factors. Bats were typically under-represented using this method in comparison with actual activity, although preliminary analyses suggest that numbers of bat passes were comparable with numbers caught in nets. Many species recorded using this method could not be identified even when compared with the library, which suggests that this method is making different assemblages of bats susceptible to detection than that recorded in nets. It should be noted that the transect method concentrates on a small time period in comparison to the netting and that much of the recorded activity is likely to be from the same individuals foraging or commuting over the detector multiple times. This suggests that this method could not be used as an exact measure of bat abundance, except for measuring relative activity.

It is assumed that there is a large overlap between species captured by each method, especially given that in this study they were both based in the understorey. Future studies may involve sampling at different elevations in the canopy.

In conclusion this study has shown that although each method for making inventories of bats in the forest in Honduras is biased, when used in conjunction with each other it is possible that in the future more representative inventories could be made of bats in the Neotropics.

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3. The Effect of Anthropogenic Forest Disturbance on the Diversity and Abundance of Bats in Northwest Honduras

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Aims

- Determine impact on diversity of bats of increased conversion to plantations in and around Cusuco National Park.
- Determine whether Neotropical bat diversity changes in a predictable way with increased anthropogenic disturbance.

Objectives

- Does anthropogenic forest disturbance in the form of plantation formation reduce the diversity and abundance of bats when compared with natural forest openings?
- Are there endangered/ rare/ endemic bat species found on the edges of natural forest openings but not on the edges of plantations? What are the conservation implications of such a finding?
- Does the impact of plantations as opposed to natural forest openings differ between three different altitudes?
- Does the impact of plantations as opposed to natural forest openings differ between primary versus secondary forest?

Methods

Bat diversity in the tropical rainforests of Honduras is high with 98 species reported. Human activity has converted much of the original forest surface to plantations, with dispersed clusters of forest fragments in the lowlands and a small fraction is still preserved as extensive forest mainly at elevations greater than 1200 metres above sea level.

Study Habitats

The study was conducted at 2 locations in Northeast Honduras. The first of these contained continuous, pristine primary rainforest within the 23,440 ha forest of the Cusuco National Park. The original forest at 300 meters below the continuous forest has been gradually converted to plantations by the inhabitants of the village of Buenos Aires. This area consists of remnant rainforest and interdigitated stands of coffee shaded by rainforest trees, and of citrus and banana groves as well as patches of pineapple, avocado and papaya trees. The second location is at El Paraiso, at an elevation of below 500 meters above sea level. A small core of primary forest is surrounded by an area of regrowth edged by active coffee and cacao plantations and banana groves. At each of the two locations, we sampled sites on the edges of primary forest, secondary forest, plantations and sites of high anthropogenic disturbance such as ornamental gardens.

When sampling each of the four habitat types, openings (such as man-made paths) were used to allow space for the mist nets, and were used consistently so that predominantly edge species were sampled throughout.

At each site, between one and four mist nets were used (two at 6 meters long, one 9 meters long and one 12 meters long; all 3 meters high). Nets were operated from 19.00 to 24.00 hours, or shorter periods depending on weather. The nets were checked every 15 minutes. Each extracted bat was identified to species, sexed, weighed (to the nearest 0.5g), measured (forearm length), classified as adult or juvenile, assessed for reproductive status and biopsied (for later microsatellite DNA analysis). On release a 'Tranquility' and mini-disc recorder were used to record echolocation calls to build up a library of calls. Bat species found at each site are shown in table 1, page 14. Since we only sampled ground-level habitats and because species of bats may be caught unequally by mist nets, we are aware that the reported data may represent a biased portrait of the bat community present in the area. Such a bias, however, will be present throughout the sites and locations, so that results will nonetheless be comparable. Taxonomic nomenclature for bats followed Reid. Each bat was assigned to one of six general foraging guilds according to information reported by Bonaccorso (1979) and Nowak (1994). These guilds were insectivore, frugivore-insectivore, necatrivore-insectivore-frugivore, sanguinivore and carnivore-insectivore.

Y1 Present, previously recorded in park; Y2 Present, inside known range; Y3 Present, outside known range

Bird diversity, abundance and ecology

1. The importance of Cusuco National Park for birds, and the avifauna of El Paraiso

Robin Brace, Peter Cosgrove, Robin Cosgrove, Martin Dallimer, Roberto Downing, Veronica French & Kimberley Fadden.
27 June – 20 August, 2004

Rationale:
Honduras has a rich Neotropical avifauna comprising over 700 species. A good proportion of this fauna (both residents and migrants) can be found in west Honduras, where Cusuco Park is located, and thus undoubtedly the park is rich in both Caribbean Slope and highland species. But the park checklist of Brough (1992) (covering a wide range of altitudes and including 11 Nearctic migrants) lists only 107 species, and thus is clearly species deficient. Obviously, obtaining a complete picture of the park's undoubtedly rich avifaunal diversity is crucial in underpinning conservation initiatives. To this end, the principal aim of the ornithology team was to record birds – through visual observations and trapping (mist-netting) – from several sites within the Merendon mountains that span collectively a range of altitudes (as does the Brough list [*loc. cit.*]). The sites were the Cusuco park core, the park buffer zone and the El Paraiso valley.

This report summarises the survey (that included mist-netting) of the birds conducted in the El Paraiso valley. This property comprises largely secondary forest, but pockets of primary forest are patchily distributed throughout the rugged terrain.

Our principal objective was to produce reasonably comprehensive species lists for all sites visited; this has been achieved.

Methods:
Extensive visual observations and mist-netting were undertaken in the Base Camp (c. 1500 m) area (particular along the Danto and Quetzal trails [see below]) and at Buenos Aires (c. 1100 m), and to lesser extents at Guanales (c. 1200 m) and El Paraiso (to c. 650 m).

Results:

Research conducted in El Paraiso between June and August, together with observations made by Roberto Downing earlier in the year, has resulted in the production of a list spanning 122 species; 15 species were trapped (including Green Kingfisher). The avifaunal composition is that typical of a lowland forest location, though the presence of many adjacent pastures has clearly facilitated incursion by a number of species typical of open/mosaic habitats (e.g. Blue-black and Yellow-faced grassquits). Intriguingly, the song of an antbird heard (three individuals) would appear to be that of Streak-crowned Antvireo, a range-restricted species known from Honduras at present only east of the Sula Valley (a biogeographical divide). Clearly, confirmation (or not) of the presence of this antvireo is an important future goal.

Including El Paraiso, the ornithological team recorded a total of 206 species across the set areas visited (67 species trapped). Birding in the coastal strip yielded an inventory of 78 species, and a global expedition species count of 238.

Obviously extension of observations further into autumn, and into winter would result in augmentation of species complements, due to the arrival of Nearctic migrants. In this context, a number of New World warblers have been detected arriving during the August period to join the small number of resident warblers; such species include Black-and-white Warbler, American Redstart and Louisiana Waterthrush.

Discussion:

- Our work at El Paraiso has not unexpectedly revealed a lowland forest avifauna that contrasts starkly with that of Cusuco Park.
- Despite the fact that primary forest persists only as remnant pockets, the El Paraiso property contains a plethora of species typical of primary forest: e.g. Slaty-tailed Trogon, Blue-crowned Motmot, Keel-billed Toucan, Tawny-winged Woodcreeper (attends army ant swarms), and White-collared and Red-capped Manakins.

Reference:

Brough, K. (1992*) Lista de las Aves Parque Nacional Cusuco*.

Robin C. Brace, 20/08/’04

Invertebrate diversity, abundance and ecology

1. Butterfly Team End of Season Report 2004 Part A

José Nuñez Miño

Introduction

Insects are both major contributors to overall biodiversity and are an important part of many ecosystem functions (McGeogh, 1998), yet in the tropics they remain a vastly understudied group (Godfray *et al.*, 1999). Butterflies in particular have evolved a vast range of ecological strategies but their greatest taxonomic diversity is to be found in the tropics (Ehrlich, 1984; DeVries, 2001). It has been noted that some Neotropical butterfly subzones (areas where rare/endemic species are found, species phenotypes mix or abrupt changes in species composition occur) are often the same areas where other unique animal and plant species are present (DeVries, 1987). Butterflies undergo a high degree of speciation and can be suitable indicators of potential biogeographical areas worthy of increased protection in the Neotropics (Brown, 1991; Thomas, 1991; Daily & Ehrlich, 1995).

Honduras ratified the Convention on Biological Diversity (CBD) in 1995, in its National Strategy and Plan of Action (produced to meet part of the requirements of the CBD) it acknowledges that "Of the invertebrate groups, insects are the most numerous and the least studied. At this time, 2500 species of insect have been recorded although estimates for Honduras put the total number at between 30000 and 50000 species." (SERNA, 2001).

Although the FAO (2003) defines all of Honduras Forests as "Tropical" this does not reflect its wide range of forest types, classified by Holdridge (1967) as **Central American Montane Forest**. Honduras is a highly mountainous country with 75% of its land having a gradient greater than 20˚ (CEP, 1996). The National Park "Parque Nacional El Cusuco" (PANACU) contains a wide variety of high altitude habitats including Cloud Forest. The total butterfly diversity contained within the park and its buffer zone remains unknown.

Aims of the project

- To study the species richness and abundance of butterflies in a variety of different habitats at two sites (El Paraiso valley and Buenos Aires).
- Compare the diversity and abundance of fruit feeding butterflies in secondary forest with that of forest edges.
- Assess the suitability of Butterfly assemblages as indicators of habitat change.

Site details

The following work was carried at two sites within the Merendon mountain range:

I. Buenos Aires (BA). PANACU consists of an area of 23440 ha of forest within the Merendon Mountain range in North-western Honduras. The core zone of the park (15° 29.8'˜ 15° 32.1' N, 88° 13.0'˜ 88° 16.3' W), making up 7690 ha, is all above 1800m of altitude and receives the highest level of protection. Surrounding this core zone is a buffer zone of 15750ha where 45000 people live in approximately 50 villages and other small settlements (Pérez Regalado, 2001). The village of Buenos Aires lies to the South West of PANACU on the road leading to the park entrance.

II. El Paraiso (EP). This second site is situated North East of PANACU and is a privately owner reserve within the Merendon Mountain range that has also received a high degree of protection for the last 25 years.

<u>Methods</u>

The study was conducted over a six week period from July 4th to August 20th. The week prior to the start of sampling was used in order to standardise the methods between the two teams working on the project, in particular the pace/rate of transect walks and identification procedures. All identifications were carried out using DeVries (1987, 1997) (*The Butterflies of Costa Rica and their Natural History*. Vol. I & II).

Two different methods of data collection were used, one sampled the fruit feeding butterflies and the other sampled the general butterfly population. The techniques are namely fruit bated Van Someren traps and "Pollard walk" transecting technique respectively.

Bait Traps

Van Someren traps (see Figure 1) were used to sample the fruit-feeding butterfly populations of the forest interior (secondary forest/ex-plantation) and forest edges (scrub/pasture). All traps were produced locally by the Alvarenge family in Buenos Aires.

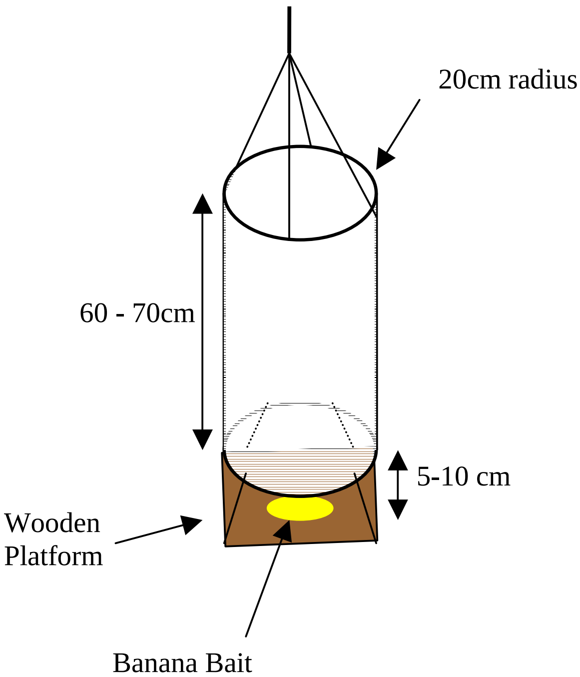

Figure 1. Van Someren Trap

Sampling sites were selected at random in each of 4 forest sites at BA and 5 sites at PA. Each site was fitted with twenty traps: ten on the forest edge and ten traps in the forest interior. Each set of 10 traps was placed in 5 sampling points, two traps set at each point: one at Under Storey (within 1m of ground) and one at a level of at least 5m off the ground. Each sampling point was at least 5m from the nearest neighbour.

The traps were baited with fermented banana. This was prepared by cutting up ripe bananas (*Musa sp.*) into a bucket and allowing them to stand for 48 hours. The traps were sampled over a four-day period with extra bait added from the original batch. Daily checks consisted in identifying and recording every butterfly caught before releasing them. If the butterfly could not be identified in the field it was killed (pinch to the thorax) and placed in a glassine envelope for later identification.

Transect Walks

Transects were walked daily based a modified Pollard (1977) technique. All butterflies entering an imaginary box 5m wide either side and in front of the observer were identified and counted while walking at a slow steady pace for ten minutes (500m). All butterflies observed were identified on the wing where possible. If the butterfly was an unknown or confirmation was required, then the stopwatch was stopped while the butterfly was caught using a sweep net (Sparrow et al.1994). On occasions where it was not possible to record the butterfly species, a note was made of its distinguishing features to attempt later identification. The time of day, weather, aspect and a description of the vegetation (Presence/Absence of upper canopy, approximate % canopy cover & approximate Lower Canopy Height) were all recorded for later analysis. Transects were started at random points (distance generated through random number generation), when a habitat or weather change occurred this was noted along with the distance/time into the transect.

Transect walks were carried out in four habitats at both sites. In Paraiso the habitats were: Secondary forest, Scrubland (early successional regeneration), x- palm tree plantation and Grassland. At El Paraiso the four categories were: Secondary coffee, Scrubland, Coffee plantations and grassland. All habitats were transected a minimum of 7km between the hours of 8.30am and 4 pm. A minimum of 7Km worth of transects was carried out in each of the four habitat types.

<u>Results</u>

Index 1 shows the total species list for Buenos Aires and El Paraiso. Of the total 135 species, 26% are present in both sites while the others were found in only one or the other.

Index 2 shows the bar charts for abundance of fruit feeding guild butterflies in secondary forest and forest edge. A G-test was carried out in order to establish whether variations between lower and upper canopy counts were associated in any way with whether the counts were in Secondary forest or forest edge. The G value for both sites was below the critical value of 7.81 (P=0.05) suggesting there is no significant difference. Chi- squared test does show a highly significant difference in the abundance of butterflies as a whole between secondary forest and edge sites. This is also apparent from the graphs in Index 2.

Many species recorded in Forest traps were never recorded in edge traps or during transect walk sampling. Namely *Prepona* sp., *Catonephele* sp. and *Archeoprepona* sp. (both potentially flagship species) while others such as *Caligo uranus*, *Memphis* sp. & *Adelpha* sp. were only occasionally seen during transect walks.

Transect walks appear to show the lowest overall abundance and diversity in Secondary forest with the highest in Scrubland areas. Statistical test have yet to be done to confirm this observation. Similarly to the fruit baited trap data some of the species recorded during transect were only rarely recorded outside the forest environment, namely members of the Ithomiinae. Members of the Satyrinae, particularly species belonging to the *Cissia* genus were the most commonly encountered (widespread) butterflies in both types of sampling and in all habitats.

Discussion

Although many of the disturbed habitats sampled (i.e. forest edge and Scrubland) have the highest abundance and diversity, some less abundant species appear to be restricted to the forest habitat. The data collected therefore suggests that the assertion that butterflies hold great potential as indicator species may well hold true in PANACU. Further statistical analysis on the quantitative and qualitative data collected should confirm this hypothesis.

Additionally this work constitutes the first known survey of the butterfly diversity and abundance of the PANACU buffer zone. The baseline data collected during the course of this project may forma a useful basis from which future work may be carried forward.

Many of the species encountered have unknown biology and Ecology which means that a full understanding of how they are good indicator species remains to be resolved.

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INDEX 1. Butterfly species list for Buenos Aires & El Paraiso.

Family/sub family/species	**Buenos Aires**	**Paraiso**	**Total**
Papiliondae			
Eurytides branchus	**1**		**1**
Eurytides phaon	**1**		**1**
Papilio androgeus	**1**		**1**
Papilio astyalus	**1**		**1**
Papilio cresphontes	**1**		**1**
Papilio iphidamas iphidamas	**1**		**1**
Papilio polyxenes (asterius?)	**1**		**1**
Papilio sp (Voucher 114 BA)	**1**		**1**
Papilio thoas nealces	**1**	**1**	**1**
Parides arcas mylotes		**1**	**1**
Parides iphidamas iphidamas	**1**		**1**
Parides lycimenes		**1**	**1**
Riodinidae			
Ancyluris inca inca	**1**	**1**	**1**
Calephelis sp	**1**	**1**	**1**
Charis sp		**1**	**1**
Emesis lucinda		**1**	**1**
Exoplisia cadmeis	**1**	**1**	**1**
Juditha molpe		**1**	**1**
Mesosemia gaudiolum	**1**	**1**	**1**
Mesosemia lamachus		**1**	**1**
Thisbe Lycorias		**1**	**1**
Pieridae			
Anteos clorinde	**1**		**1**
Aphrissa statira		**1**	**1**

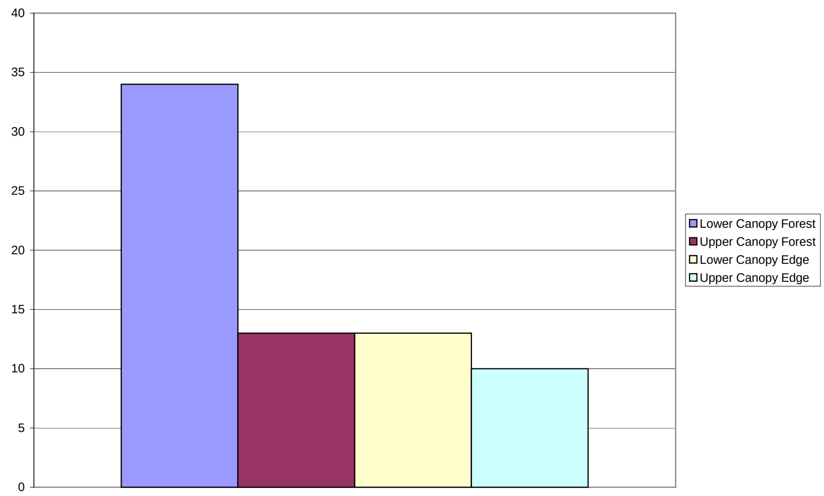
Ascia monuste	1		1
Enantia sp.	1		1
Eurema albula		1	1
Eurema daira	1		1
Eurema nise	1	1	1
Eurema proterpia	1		1
Leptophobia aripa	1		1
Lieinix nemesis	1		1
Phoebis argante	1	1	1
Phoebis sennae		1	1
Dismorphinae			
Dismorphia lua	1		1
Dismorphia amphiona praxinoe	1		1
Ithomiinae			
Aeria eurimedia		1	1
Dircenna sp.	1	1	1
Godyris zavaleta sorites	1	1	1
Greta sp.	1		1
Hypoleria sp.	1	1	1
Hypothyris sp.	1		1
Ithomia sp.	1		1
Mechanitis lysimnia doryssus	1	1	1
Mechanitis polymnia isthmia	1		1
Melinaea sp.	1	1	1
Napeogenes sp.	1		1
Oleria paula	1	1	1
Pteronymia sp.	1		1
Satyrinae			
Catargynnis sp.			1
Cissia gigas	1	1	1
Cissia gomezi	1		1
Cissia hermes	1	1	1
Cissia hesione	1	1	1
Cissia libye		1	1
Cissia metaleuca	1		1
Cissia renata	1	1	1
Cissia redstripe	1	1	1
Cissia usitata	1	1	1
Dioriste sp.	1		1
Euptychia westwoodi	1		1
Pierella luna luna		1	1
Taygetis sp		1	1
Taygetis andromeda	1		1
Taygetis virgilia rufomarginata		1	1

Nymphalinae			
Adelpha celerio	**1**	**1**	**1**
Adelpha iphiclus		**1**	**1**
Adelpha leuceria	**1**		**1**
Anartia fatima	**1**	**1**	**1**
Anartia jatrophae		**1**	**1**
Callicore peralta	**1**		**1**
Catonephele mexicana	**1**	**1**	**1**
Catonephele numilia esite	**1**	**1**	**1**
Diaethria anna	**1**		**1**
Diaethria astala	**1**		**1**
Dynamine thalassina		**1**	**1**
Ectima sp.		**1**	**1**
Epiphile adrasta	**1**		**1**
Hamadryas februa ferentina		**1**	**1**
Hamadryas feronia farinulenta	**1**	**1**	**1**
Hamadryas fornax fornacalia	**1**		**1**
Hamadryas guatemalena guatemalena		**1**	**1**
Hamadryas ipthime ipthime		**1**	**1**
Hamadryas laodamia saurites		**1**	**1**
Historis acheronta	**1**	**1**	**1**
Hypanartia godmani	**1**		**1**
Hypanartia lethe	**1**		**1**
Junonia evarete		**1**	**1**
Marpesia marcella			**1**
Mestra amymone	**1**	**1**	**1**
Nessaea aglaura aglaura	**1**	**1**	**1**
Nica flavilla canthara		**1**	**1**
Siproeta stelenes		**1**	**1**
Siproeta epaphus epaphus	**1**		**1**
Symrna blomfildia	**1**		**1**
Tigridia sp.		**1**	**1**
Thessalia theona		**1**	**1**
Vanessa virginiensis	**1**		**1**
Heliconiinae			
Aeria eurimedea		**1**	**1**
Agraulis vanillae		**1**	**1**
Dione june	**1**	**1**	**1**
Dione meneta poeyii	**1**		**1**
Dryas iulia	**1**	**1**	**1**
Eueides isabella	**1**	**1**	**1**
Heliconius charatonius		**1**	**1**
Heliconius clysominus	**1**		**1**
Heliconius cydno	**1**	**1**	**1**
Heliconius erato petiverana	**1**	**1**	**1**
Heliconius hecale zuleika	**1**		**1**

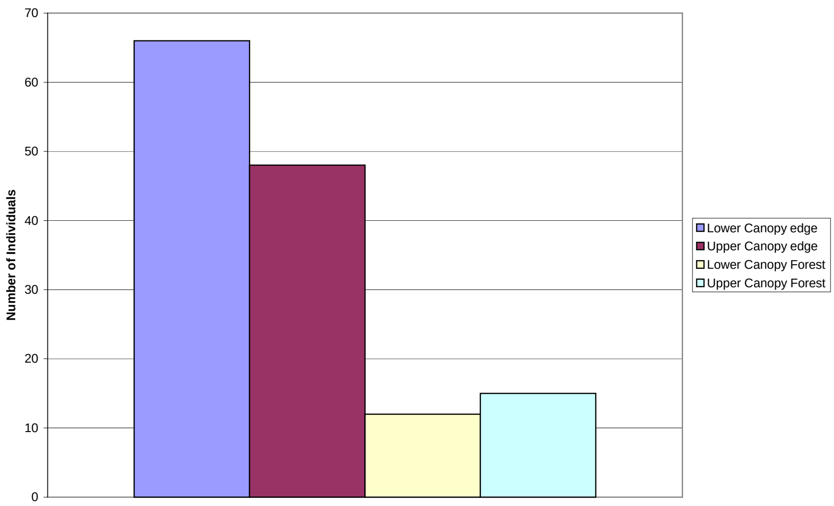
Lycorea cleobaea atergatis	**1**		**1**
Tithorea tarricina pinthias	**1**		**1**
Morphinae			
Morpho peleides limpida		**1**	**1**
Morpho amathonte		**1**	**1**
Morpho polyphemus catarina	**1**		**1**
Danaine			
Danaus plexippus	**1**	**1**	**1**
Danaus gilippus thersippus		**1**	**1**
Melitaeninae			
Anthanassa ardys		**1**	**1**
Chlosyne lacinia	**1**	**1**	**1**
Chlosyne janais		**1**	**1**
Eresia clara		**1**	**1**
Brassolinae			
Caligo uranus	**1**	**1**	**1**
Caligo memnom memnon		**1**	**1**
Caligo eurilochus sulanus		**1**	**1**
Osiphanes cassina chiriquensis		**1**	**1**
Charaxinae			
Archeoprepona demophon centralis		**1**	**1**
Archeoprepona demophoon gulina		**1**	**1**
Archeoprepona meander amphimachus			**1**
Consul fabius cecrops		**1**	**1**
Memphis eurypyle		**1**	**1**
Memphis glycerium	**1**		**1**
Opsiphanes cassina chiriquensis		**1**	**1**
Prepona sp		**1**	**1**
Lycaenidae			
Thecla aetolius		**1**	**1**
Thecla damo		**1**	**1**
Total	**83**	**84**	**133**

INDEX 2 – Butterfly abundance in fruit bated trap

Buenos Aires - Butterfly abundance



El Paraiso - Butterfly abundance



2. Butterfly Team End of Season Report 2004

Iain Bray and Melanie Beard

A Study of the Species Richness, Composition and Abundance of Butterflies in Different Habitats in the El Paraiso Valley

Aim:

- To study the species richness and abundance of fruit feeding and nectar feeding butterflies in four different habitats in the El Paraiso valley.

Objectives:

- To determine whether habitat type has an effect on butterfly richness and abundance.
- To identify the environmental variables that are influencing butterfly distribution.
- To determine whether butterfly species can be used as ecological indicators within the different habitats for use in a long term monitoring scheme.

Introduction:

Habitat quality and vegetation structure are to known to affect the richness and abundance of butterfly communities. El Paraiso Valley is primarily a moist tropical lowland forest, which has been affected substantially by land-use changes. The site is composed of a patchwork of habitats, which are suitable for studying such differences in habitat use.

Methods:

Four different habitats were chosen for investigation; secondary forest, ex-plantation, scrub and pasture. Three replicate sampling sites were established in each of the four habitats and two different methods of data collection were used to sample the nectar feeding and fruit feeding butterfly populations. The two methods complement and eliminate the bias of each (Caldas and Robins 2003), while also providing a comparison of the reliability of each method for future monitoring programs.

The study was conducted over a six week period from July 4th to September 20th.

Transect Walks

Transects were walked daily based a modified Pollard (1977) technique. All butterflies entering an imaginary box 5m wide either side and in front of the observer were identified and counted while walking at a slow steady pace for ten minutes (500m). All butterflies observed were identified on the wing, or if the butterfly was an unknown or to confirm its type the recording time was stopped while the butterfly was caught using a sweep net (Sparrow et al.1994). On occasions where it was not possible to record the butterfly species, a note was made of its distinguishing features to attempt later identification. The time of day, weather, aspect and a description of the vegetation were all recorded for later analysis.

Bait Traps

Van Someren traps were used to sample the fruit-feeding butterfly populations of the forest interior (secondary forest/ex-plantation) and forest edges (scrub/pasture). Each site was fitted with twenty traps: ten on the forest edge and ten traps in the forest interior. These were divided between the under storey and upper canopy to maximise the sampling effort. The traps were baited with fermented banana and the sample period lasted over a four-day period with the traps emptied and re-baited each day. All butterflies caught were identified and recorded. If the butterfly could not be identified in the field it was placed in a glassine envelope for later identification.

Initial Results:
A total of ninety-three species were recorded at the site. Initial observations suggest that habitat type may influence butterfly richness and abundance (figure 1). The habitats surveyed provide a succession of habitat re-growth, with changes in vegetation structure and diversity as the habitat matures. The butterfly distribution observed appears to be correlated with these changes.

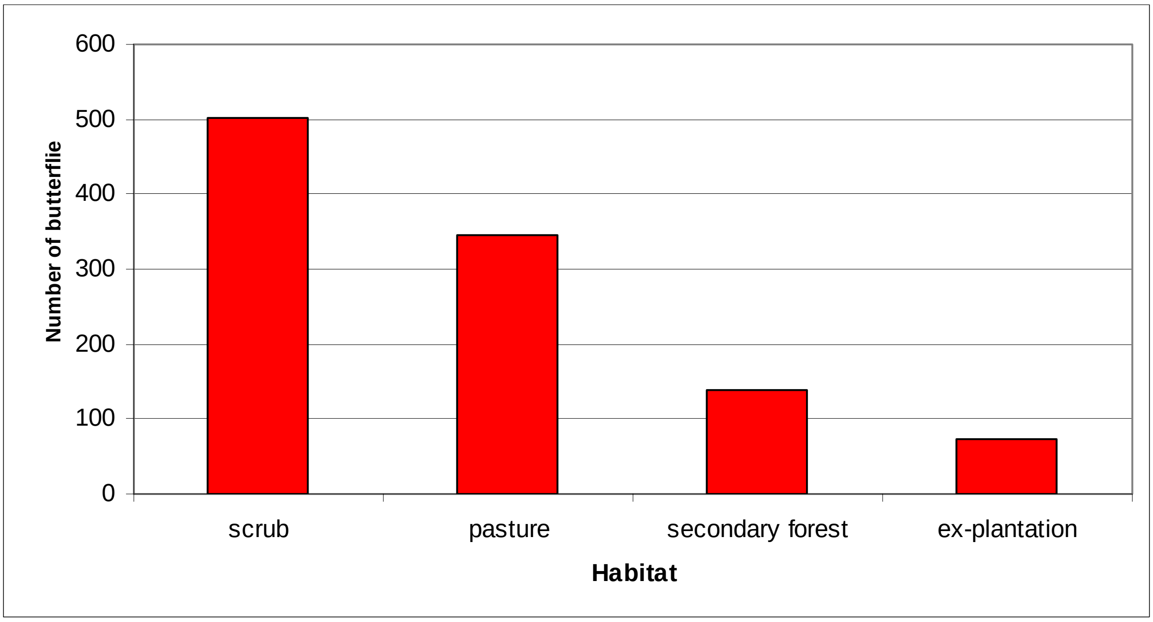


Figure 1: The number of butterfly species observed in four habitats.

Scrub was the habitat with the highest abundance of butterflies. The secondary forest and ex-plantation had the lowest butterfly abundance. A comparison of the butterfly species found in the different habitats showed that some species were restricted to a certain habitat, while others were found across them all. This can be demonstrated by the genus *Cissia* which were commonly found in all habitats, whilst a number of butterflies, including the *Caligo* species, were only found in the secondary forest. This suggests that some species have the potential to make good indicator species for future monitoring programs.

The forest edge traps recorded higher butterfly species richness and abundance than the traps placed in the forest interior (figure 2). This may provide evidence for the 'edge effect' where changes in biotic and abiotic conditions can result in differences in species composition depending on the physiological tolerances of the butterfly (Murcia 1995).

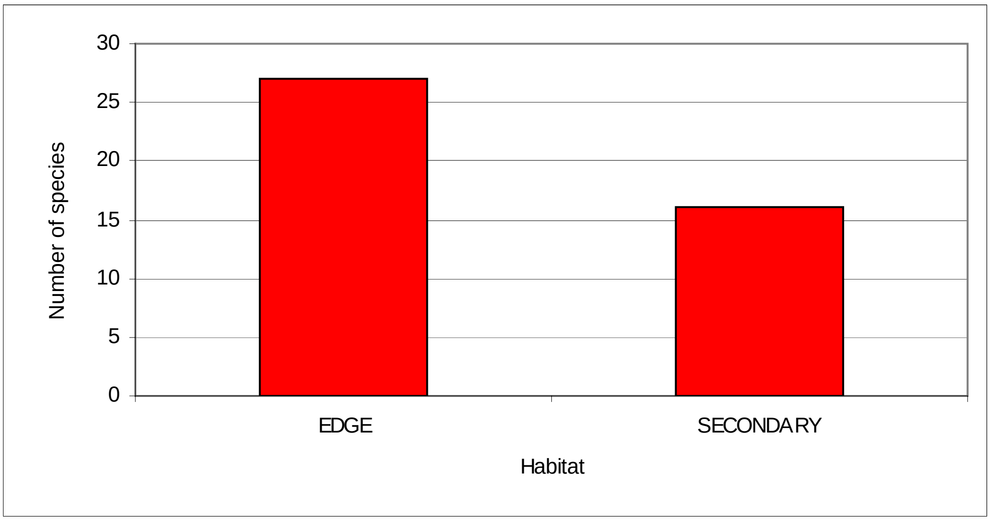


Figure 2: The number of butterfly species recorded in edge and secondary habitats.

The two methods of data collection used to sample the fruit feeding and nectar feeding butterflies recorded different results. A large proportion of fruit-feeding butterflies caught in the traps, for example *Catonephele* and *Archaeoprepona* were not viewed on the forest transects.

Recommendations for Future Study:

Overall the research carried out by the butterfly team was successful. Findings from the 2004 season may be considered as the basis for future (and more detailed) work investigating the ecological factors affecting the butterfly populations in the area. The following points may wish to be taken into consideration when planning such work:

- The diversity of habitats at El Paraiso makes the site ideal for comparative studies. However, this may also act as a pitfall as the variety and complexity of habitats may render replicate sites hard to find. It is strongly recommended that sufficient sample sites are established before commencing survey work within the forest. Information on the composition of the forest may be available through the findings of the Forest Structure Team 2004.
- The Van Someren traps did not yield as much data as expected and at times were almost entirely ineffective. It is recommended that future studies should aim to use 40 traps (as opposed to 20) and minimise the number of comparative sites used in order to increase the usefulness of the data collected.
- Transects in 2004 were mostly carried out along established trails in the forest. The quality of the data gathered may be improved by establishing set transects along purpose cut routes through the vegetation. This may be arranged through the warden of the reserve (Antolin).

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3. *Copestylum* hoverflies in Cusuco

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*order of names does not reflect seniority in authorship of this report

Introduction

The hoverflies (Syrphidae) are a family of true flies (Diptera), with about 5500 described species. It is one of the largest and most diverse of all fly (or indeed insect) families: all adults feed from flowers on nectar and pollen, but the larvae have incredibly diverse shapes and feeding modes – predators, phytophages, saprophages, and even ectoparasitoids – and live in a phenomenal range of habitats. This tremendous diversification makes the family exceptionally useful for studying many kinds of questions in evolutionary biology.

The largest genus of hoverflies is undoubtedly the New-World *Copestylum*, with about 325 described species, but probably more than 1000 in reality, nearly all Neotropical. There are only a handful of such megadiverse genera in the animal kingdom: what has caused this astonishing diversity? Understanding the answer to this question is an evolutionary problem with important implications.

In *Copestylum* the major generator of bursts of speciation appears to be the invasion of novel larval breeding sites, and then range expansion followed by geographical isolation and speciation. For example, there seems to be a unique set of species with hook-bearing larvae in every valley of the Central American highlands, breeding in decaying bromeliads.

Cusuco National Park is a conservation priority, and documenting the diversity of *Copestylum* in relation to other cloud-forest sites in Meso-America is an important goal in itself. Experience has shown that searching for breeding sites and larvae records one-third more species than by capturing adults, and the priceless additional knowledge of the larval ecology and morphology: such information is not available for the vast majority of insect species apart from the butterflies and moths. This part of the project therefore involves searching for the larvae of *Copestylum* species in their known breeding sites (e.g. bromeliad tanks, decaying bases of tree-fern fronds, *Heliconia* bracts and leaf sheaths, etc.), as well as trying to discover new breeding sites.

The main aim of the project was to assess whether we can develop indicators for disturbance using censuses of hoverfly larvae. The results will also show the degree of endemicity present in *Copestylum* in Cusuco National Park. A wider aim is to contribute to the phylogeny and evolutionary biology of the genus which, when complete, may well solve the conundrum of megadiverse genera.

Methods

Copestylum has a number of larval morphotypes associated with various different breeding sites (Table 1), and a new morphotype was discovered during the course of this work. Morphotypes were recorded from as many breeding habitats as we could find in the sites we sampled. Only rearing will allow determination of the material collected, and thus the true significance of the data will only then become apparent. Larvae typically take between 1-6 months to transform into adults. Only when the species identities have been established will we be able to place the results within the wider context of the evolutionary biology of the genus as a whole.

We spent four weeks with Operation Wallacea in Honduras: two in Base Camp in the Cusuco National Park, and two in El Paraiso. The intention was to spend a week in each of the four sites (Base Camp, Guanales, Buenos Aires, and El Paraiso). The plan was to sample along a gradient of disturbance in each of these four sites: however, on arrival and it was clear that these gradients did not exist in each site, and some changes were necessary. We therefore decided to sample Base Camp intensively, and a gradient of disturbance at El Paraiso.

We used two methods. The first is semi-quantitative, and involves moving slowly through the site, searching for possible breeding sites and recording what is found. The second is quantitative: it involves selecting plots of 15 x 10 m adjoining the trails (10 m of the side of the trail, and 15 m into the forest), and counting and searching every known breeding habitat within that area. The main breeding habitats were bromeliad tanks, tree-ferns, *Heliconia* plants, sap-runs and tree-holes: a new breeding habitat was discovered during the course of the work: decaying lianas.

Results

A total of * larval morphotypes was discovered during sampling, which is **** for Central American sites (Rotheray et al., unpublished data). There was an abundance of a new species of *Copestylum* in the bromeliad tanks, with less common representatives of at least one other, together with some predatory larvae (probably of a known species). Decaying bromeliads produced some of the hook-bearing clade in which we are particularly interested: emergence of the adults will show whether these are yet another new species. In addition we discovered a completely new morphological type in the outer leaves of the ground bromeliads of the elfin forest. There were more new species in tree-ferns and *Heliconia* leaf sheaths.

A female of a beautiful and large new *Copestylum* species was seen ovipositing in the deep forest where a liana had been cut and was decaying; a female of another species was seen the next day doing the same thing, and we found larvae deep in the softening tissue. This represents a completely new breeding site for *Copestylum*.

4. An initial assessment of Hydrachnidia of the El Paraiso Valley

G.H. Chamberlain,
August 23RD 2004

1.0 Introduction

Water mites are classified in the Class Arachnida, Subclass Acari, Superorder Actinotrichida, and Order Prostigmata. They are formed from the two groups of Prostigmata aquatic Acari, the Family Halacaridae of the suborder Eupodina and the phalanx Hydrachnidia, suborder Parasitingona (Cook, 1986).

Mites rank high in species richness with over 40,000 named species of Acari, which rises to anywhere between half to one million species when estimates of unnamed species are included. Mites are ubiquitous in aquatic, terrestrial, arboreal and parasitic habitats, but being among the smallest arthropods are often overlooked. However mites are not passive inhabitants of ecosystems and are strong interactors, which are important indicators of disturbance in aquatic habitats and are major components of biodiversity.

The Hydrachnidia are morphologically diverse and are found throughout the world's freshwater habitats including seepage waters, springs, cave pools, rice paddies, tree holes, lakes, streams and rivers. They are top carnivores as they are distasteful to fish and other predators and pierce their prey through the use of chelicerae, sucking the contents and disgarding the remaining skin (Evans, 1992).

Part of the larval stage of their life cycle is parasitic on adult insects of aquatic benthic macro-invertebrates including members of the taxa *Trichoptera, Ephemeroptera, Plecoptera, Coleoptera, Odonata, Hemiptera* and *Diptera* (Parasad and Cook, 1972; Wainstein, 1980; Smith, 1988). Few Studies have observed the behaviour of water mites or have recorded their distributions; the life cycles and diet of most neotropical species remains unknown, while the parasitic larval stages of most species have yet to be described and their hosts identified.

2.0 Survey objectives

1. Provide baseline data on the overall diversity and abundance of Hydrachnidia within the El Paraiso valley and Cusuco National Park.
2. Identify and classify new species.
3. Investigate the diversity and abundances of Hydrachnidia in association with land use.

3.0 Study areas

The El Paraiso valley formed one discrete sampling area of an investigation into the Hydrachnidia of Northern Honduras in addition to two separate sampling areas within the Parque Nacional El Cusuco. Surveys were carried out over the period July 10th 2004 to August 5th 2004. For full list of sites sampled see Table 1.

3.1 El Paraiso

The El Paraiso valley is primarily a wet, lowland rainforest which has been significantly affected by land use changes. The upper sections of the forest (altitude 500m) are less accessible and remain small examples of fragmented, primary forest. The middle sections (altitude 100m) are representative of disused plantations of cocoa and mosaics of fruit plantations. Most plantations have been abandoned for 15-20 years and secondary forest has developed. The lower sections (altitude 20m) reveal extensive vegetation removal, primarily for cattle grazing and orange plantations. The lower sections are bisected by main highway, which is currently being upgraded to provide the main transport link between Honduras and Guatemala. The removal of river substrate for use as aggregate, for road building has dramatically affected the river morphology and aquatic macro-invertebrate community assemblages and negated the sampling of sites below road. In 2003, initial surveys concentrating on small mammals and herpetological fauna were carried out by Operation Wallacea, although no aquatic invertebrates were studied.

Plate 1. Deforestation of moist, lowland rainforest for grazing within the El Paraiso valley

Plate 2. Sampling above road bridge on the Rio Cuyamel

4.0 Methods

The freshwater ecosystem provides a diverse range of habitats and consequently methods for collection vary according to habitat type. Hydrachnidia are generally associated with the bottom substrate, shoreline gravel, interstitial environments and aquatic macrophytes.

4.1 Lotic and lentic habitats

1. A fine meshed dip net (1mm) was placed in a suitable section along a riffle or pool habitat of river.
2. Standing upstream, the substrate was dislodged and collected in net.
3. The sample was sieved through large sieves of 3.0mm and 0.3 mm mesh.
4. The material contained in the fine mesh was transferred to white trays and active mites were removed by eye using bulb pipette.
5. Adult and nymphal water mites were preserved in Koenike's solution; a mixture of acetic acid: glycerol: water (1:5:4).
6. Each sample was labelled recording:

a. Date
b. River and country
c. Sample reference
d. Brief site and habitat description
e. Global Position System Garmin GPS II
f. Altitude
g. Collector

7. At each site the following environmental parameters were recorded:

a.	PH		Hanna model HI 98127
b.	Dissolved oxygen		(mg/l) Jenway meter model 9071
c.	Conductivity		(Ms) Jenway meter model 4071
d.	Mean air temperature	(0C)	
e.	Mean water temperature	(0C)	
f.	Mean channel width	(m)	
g.	Mean channel depth		(m)
h.	Stream order		(1,2,3,4,5)
i.	Substrate size Wentworth scale	(%)	

Additional information recorded included

j. Diagram of site with sampling points
k. Habitats sampled
l. Notable aquatic macro-invertebrates
m. Photographs

8. For microscopical examination the adults were first soaked in Lundblad's solution (111.5 g phenol, 125 g chloral hydrate, 12.5 ml water) to remove lipids and then washed in Koenike's solution.

9. Samples were dissected (under x40 microscope) and displayed in a double coverslip within glycerine mounts (10 g sheet gelatine, 54ml water, 0.5 g phenol) and sealed with glyceel.

10. Identification of samples was carried out using literature which principally consists of taxonomic papers based mainly on adult morphology.

Plate 6. Removal of Hyrachnidia from sample taken from the Rio Omoa, El Paraiso.

5.0 Results and Discussion

Initial analysis of samples has revealed a range of Hydrachnidia species within all of the river systems sampled. Analysis of species abundance and identification of new species will be carried out at the Tropical Research Unit Glamorgan University November 2004 – December 2005.

Results will be presented in future paper to be complete by December 2005, with working title "New species of neo tropical water mites from Honduras"

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Terrestrial mammal diversity, abundance and ecology

1.An assessment of the mammalian fauna in the El Paraiso valley, Honduras 2004.

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Introduction
The El Paraiso valley is a privately owned lowland forest reserve. Some parts were formally cultivated for crops such as cocoa, beans and maize; in the last decade the forest has been allowed to regenerate. There are some areas of primary forest in the less accessible, high elevation areas of the reserve, although there is also evidence of abandoned plantations at these sites. The valley is steep sided with mule tracks running up the left and right hand sides to the top of the reserve. A number of trails lead from the mule tracks into the forest and join the river at the bottom of the valley.

The objectives were to describe the mammalian fauna of the El Paraiso valley with a view to contributing information towards their longer term monitoring and management. In addition two project students conducted research to compare the abundance and diversity of mammals species in two different types of habitat – regenerating forest and plantation.

Methods
Research was conducted between 5th of July and 21st August 2004 in El Paraiso. Two methods were employed to sample the mammalian fauna present in the valley: baited live traps and opportunistic surveys.

Baited Live traps
100 small mammal traps (31x17x14cm) and two large mammal traps (66x23x23cm) were available. The top of each trap was covered with plastic for waterproofing. In weeks 2 to 4 a pilot study was conducted to assess mammal species present. In weeks 2 and 3 traps were placed randomly in appropriate sites, in week 4 traps were positioned along a transect with two traps placed every 10m. In addition two large traps were placed in appropriate positions in the valley and were baited with banana or raw chicken when available. From weeks 5 to 8 dissertation projects were conducted to compare the mammal abundance and diversity in two different habitats – plantation and regenerating forest. At each site a total of 49 traps were arranged in a regular grid measuring $42m^2$ with traps placed 7m apart in 7 lines. Trapping grids were set at a total of 4 regenerating sites and 4 plantation sites (trapping was conducted in 2 grids at the same time). Traps were lined with leaves and plants from the surrounding area. Traps were opened and baited with a mixture of granola and dog biscuits in the evening between 4pm and 6pm. They were checked and closed the following morning between 5am and 7am. Traps were set for 5 nights in the same place before being moved to a new location.

When an animal was caught in a trap it was identified following Reid (1997), the sex and reproductive status recorded and the following measurements taken: weight, head-body length, tail length, left ear width, left foreleg length, left hind foot length. In addition each animal was given a unique mark by clipping a small patch of outer hair from one part of the back, exposing the different colour hair underneath. If the animal was recaught we could identify it from this unique hair clip.

Opportunistic surveys
Opportunistic surveys were conducted when possible. Small groups of people walked quietly along forest trails, noting any mammal species observed both during the day and after dark.

Results
A total of 13 small mammal species were captured or observed in El Paraiso throughout the study (table 1). During the comparison of regenerating forest and plantation a total of 10 species were caught, 9 in regenerating and 7 in plantation. Statistical analyses will be conducted to compare the species diversity and abundance at the plantation and regenerating sites.

Table 1: Species list for El Paraiso, June – August 2004

Common name	Scientific name	Pilot study	Regenerating site	Plantation site
Mexican deer mouse	Peromyscus mexicanus	x	x	x
Forest spiny pocket mouse	Heteromys desmarestianus	x	x	x
Salvin's spiny pocket mouse	Liomys salvini	x	x	x
Alfaro's rice rat	Oryzomys alfaroi		x	x
Cana rice rat	Oryzomys alfari	x		
Roof rat	Rattus rattus	x	x	
Rusty rice rat	Oryzomys rostratus		x	x
Big eared climbing rat	Ototylomys phyllotis		x	x
Unidentified grey mouse		x	x	
Common opossum	Didelphis marsupialis	x		x
Gray four-eyed opossum	Philander opossum	o	x	
Deppe's squirrel	Sciurus deppei	o		
Variegated squirrel	Sciurus variegatoides	o		

x: trapped; o: observed

Discussion
A total of 13 small mammal species were recorded in the El Paraiso valley in the summer of 2004. A survey in 2003 by Freer recorded only 3 species - the Forest spiny pocket mouse, Big-eared climbing rat and the Mexican deer mouse. All of these species were also recorded in 2004. In addition Freer observed the Nine-banded Armadillo and vocalisations and spoors of an Ocelot. This study therefore adds another 10 species to the species list of the El Paraiso valley.

There were two more species recorded at the regenerating sites than in the plantation sites. Species that were recorded in the regenerating sites that did not occur in the plantations were the Roof rat, Gray four-eyed opossum and the unidentified grey mouse. The Common opossum was only recorded at plantation sites. The unidentified grey mouse was similar to, but smaller than a Mexican deer mouse. However it did not accurately match any species description in Reid (1997). The same species was recorded during studies at other sites in the Cusuco national park. Samples and pictures will be used to attempt to identify the species.

Initial assessment of results indicate that trapping success was higher at regenerating sites than at plantations and in addition that more animals (not including recaptures) were caught at the regenerating sites than the plantation sites. Further analyses will assess in more detail the mammal species at the different sites.

This work constitutes the first long term assessment of mammalian fauna in the El Paraiso valley, following from the brief assessment conducted by Freer in 2003. The data collected during the course of this project may form a useful basis from which future work may be continued.

Suggestions for future research

Diversity and density of mammal species in the El Paraiso valley related to different land use or agricultural practices.

Research conducted this year assessed mammal diversity and density in regenerating and plantation sites. Future research could build on this to compare mammal diversity and density in *i.* areas of forest which have been regenerating for different lengths of time and *ii.* different types of plantation (e.g. banana, maize, cocoa).

Small mammal species interactions

Long term trapping might concentrate on the interaction of certain species. Species such as Mexican deer mice and Spiny pocket mice are abundant and were both found in regenerating sites and plantation. Studies about the habitat use of these species and interaction between the species could be conducted.

A study of the common and gray four-eyed opossum.

During research in 2004 the Common Opossum was recorded in plantation sites while the Gray four-eyed opossum was only recorded in the regenerating sites. Potential studies include investigating habitat use (through radio tracking) and possible niche partitioning.

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2. A comparison of diversity and abundance of small mammals communities between plantation and regenerating sites within El Paraiso, Honduras.

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Introduction

Most forests have been altered by humans at some time, meaning primary forest is unlikely to be encountered. Natural events also alter forest structure greatly e.g. Hurricanes. At present it is difficult to locate and survey true primary forest, therefore human impact is an increasing factor in small mammal community composition due to the impact upon vegetation. The biodiversity of small mammals can be determined by relative abundance and herb species richness whereby site and vegetation with the most herb species harbour the highest relative abundance of small mammals. The effects upon habitat structure and vegetative characteristics, caused by human impact, are largely irreversible or indeed long-lasting there after. Disturbance increases the amount of other plant species which may lead to other small mammals inhabiting a disturbed area because former dominant species are unable to adapt so others flourish.

Small mammals are extremely sensitive to disturbance therefore my investigation looks at small mammal abundance and diversity during and after human disturbance.

Objectives

-To assess whether different land uses affect diversity and abundance of small mammal communities.

-To determine which habitat variables are selected for by the different small mammal species discovered.

Methods

In order to conduct an intensive study of the small mammal population at each of the eight selected grid locations, 49 trapping stations were used at 7m intervals within a 42mx42m grid. Within each grid the trapping stations were placed on the ground in one place and were left closed during the day and open at night, for five days and nights. This gave a total of five nights of trapping per grid. The grids were to allow a detailed comparison of the small mammal communities within different habitat types.

The traps used were live traps, consisting of a tunnel with a door at one end and a sensitive platform at the other. As the mammal walks on this, a spring is released which triggers the door to close. The catch rate using this trap was high and is quantitative in comparison to other trapping methods.

The traps were checked daily between 5.00 and 6.00am. During this period any captures were collected, processed and released with the trap repositioned in it’s original position. New bait was added at 4.00pm and all traps were set to a constant degree of tripping sensitivity. All the traps were covered with a sheet of plastic to protect them from rain. The bait consisted of granola cereal and dog biscuits.

Captured mammals were shaken gently out of the trap into a transparent plastic bag. This minimized handling and allowed for identification, examination for markings etc. If the individual had not been encountered before, it was removed from the bag for closer examination and for measurements to be taken. Each new capture was marked by clipping its fur in a pattern (from A-H) so that the under hair was exposed and would then be subsequently recognized if recaptured. The weight (in grams), length of head and body and tail (in centimeters), left ear, left arm and hind foot, sex (male or female), reproductive status (testes present, nipple halos etc),

mark given or mark present (if recaptures) and trap number and date were then recorded for the individual.
The habitat for each grid was then assessed. All habitats used were designed to be representative of a certain level of disturbance or regeneration. The following measurements were made for each grid area within four 5mx5m plots picked at random.
-Plant species richness (top five species at ground layer, understory and canopy were identified).
-Percentage of deadwood cover (also have bare ground cover, and dead everything cover).
-Percentage cover of ground layer.
-Percentage cover of understory layer.
-Percentage cover of canopy layer.
-Number of trees with a circumference of less than 5cm at breast height.
Number and measurements of trees with a circumference greater than 5cm at breast height.

Analysis and future analysis.
A total of ten species were recorded using our eight grids. Six of our ten species were found at our regenerating sites whilst nine of the ten species were found at our plantation sites.
Capture rates were higher at our regenerating sites and out recaptures were also higher at the regenerating sites. This therefore indicates a higher abundance of small mammals in regenerating areas possibly due to increased habitat cover and diversity.
Further analysis is required to determine small mammal densities between each site using mark-release population densities. Shannon-Weiner diversity index will be used to compare the types and numbers of species in each site.
Closer analysis will be made between the sites within and between species at the sites as well as the morphology e.g. head body etc. Trap success will also be used to compare between plantation and regenerating sites due to more vegetation cover thus more protection from predators.
Principle component analysis will be used to compare our habitat quadrats between the sites used.
From initial comparisons between regenerating and plantation it is clear that some species display habitat preferences. Salvin's spiny pocket mice were found mainly within our plantation sites (only once at a regenerating site) whilst Mexican deer mice were found at regenerating sites. It might be beneficial to see if habitat preferences exist at age classes or even sex. The previous occupant might also indicate what species and sex is next collected as most small mammals are odour oriented (which might lead to increased trap success).
If repeated, a few aspects of the original design maybe altered. One particular problem encountered was ant infestations meaning our bait was often missing and the trap being useless. Experimenting with different types of large bait might increase trap success as the mice rarely ate the dog biscuits provided (although hindered ant populations).
Experimenting over a longer length of time might give a more precise indication of diversity and abundance as five nights might be too short for trap-shy species. Moon shine effected our data and some of our trapping coincided with a full moon, therefore trapping one grid over more time will also make this less of a factor.