DAVIS EXPEDITION FUND

REPORT ON EXPEDITION / PROJECT

Expedition/Project Title: INVESTIGATING AGROFORESTRY BUTTERFLY BIODIVERSITY IN THE MANU NATIONAL PARK

Travel Dates: 16th JUNE- 13th AUGUST (FIELD WORK BETWEEN 16th JUNE AND 2nd OF AUGUST)

Location: MANU NATIONAL PARK, PERU

Group Members: ELEANOR DRINKWATER AND ROBIN MORRISON

Aims: TO COMPARE BUTTERFLY BIODIVERSITY IN AGROFORESTRY PLOTS TO BUTTERFLY BIODIVERSITY IN TRADITIONAL BANANA PLANTATION, IN THE CULTURAL ZONE OF THE MANU NATIONAL PARK

Outcome (not less than 300 words):-

Peru 2013 Expedition Results

A comparison of local butterfly biodiversity between banana plantation and agroforestry farming sites

Eleanor Drinkwater and Robin Morrison

Introduction

The Manu National Park, Peru, is a hotspot for biodiversity containing over 800 species of bird, 200 species of mammal and at least 77 species of amphibian, as highlighted by UNESCO World Heritage list **(Manú National Park, 2009)**. Whilst protection of tropical habitat in reserves is fundamentally important for maintaining biodiversity **(Bruner *et al*, 2001)**, the reality is that a great deal of land in tropical regions is needed for agriculture. As a result of this, the Manu National Park is divided into zones afforded different levels of protection, one of which is the cultural zone. The cultural zone is 19,395 ha in size and largely covered with tropical rainforest. Within this area private land ownership, farming and logging are permitted **(Shepard *et al* 2010)**. Given the importance of the area several NGOs, including CREES, are working to introduce more sustainable agricultural practices within the cultural zone, one of which is the implementation of agroforestry. Agroforestry aims to combine necessary crop planting with other species of native vegetation, which is thought to have a variety of benefits, including carbon sequestration, improved soil retention, a sustainable income from managed wood as well as greater local biodiversity **(Montagnini and Nair, 2004).**

Roughly 90% of butterfly species are predicted to inhabit tropical regions **(Bonebrake *et al*, 2010)** and the Manu National Park itself is known to contain over 1,300 species of butterfly **(Robbins *et al*, 1996)**. Understanding how different butterfly species use different land types in tropical regions can lead to better conservation strategies for maintaining this exceptional diversity. In addition to a purely conservational interest in this group, butterflies are of crucial importance to rural economies in their provision of ecosystem services such as pollination **(Kremen *et al,* 2007)**. Furthermore, butterflies have been used on numerous occasions as indicators of biodiversity **(Lawton *et al*, 1998)(Kessler *et al*, 2010)(Daily and Ehrlich, 1995)(Fleishman and Murphy, 2009)(Bonebrake *et al*, 2010),** where the diversity of butterfly species found in an area can be used to predict overall biodiversity in the area, allowing rapid assessment of the value an area provides, in terms of the biodiversity of species it supports.

Whilst numerous studies comparing biodiversity between rainforest and agroforestry farmed regions have been undertaken, to our knowledge there has never been a comparison between biodiversity within areas farmed with traditional methods, and those farmed by agroforestry techniques in the Manu National Park. The question of how biodiversity differs between these two systems of farming is important as it allows the direct comparison of agroforestry with the alternatives that would be seen if agroforestry were absent. This enables us to evaluate the benefits of converting farmland into agroforestry plots and investigate how effective this agroforestry method is at supporting the diverse ecosystem present in the area. We investigated the difference in biodiversity of butterfly species in areas farmed using traditional methods and those farmed using agroforestry techniques developed by the CREES foundation, for the production of banana crop, using banana and fish baits, to determine whether the implementation of agroforestry practices was supporting a higher diversity of butterfly species then the traditional plantation methods.

Materials and Method

The work was carried out in the southern part of the cultural zone within the Manu National Park, Peru, in the agricultural areas associated with the local settlement of Salvación (S12° 48.4 - 47.4, H071° 22.8 - 22.2). Four one hectare plots of banana agroforestry, and four one hectare plots of banana plantation without the use of agroforestry techniques, were used. The agroforestry plots had previously been used for agriculture prior to the implementation of agroforestry between 2 and 4 years ago. Sites were sampled over a five week period between 24th June and 28th July 2013. Despite sampling over a five week period, we were only able to include data collected over the first four weeks due to extreme weather conditions during the final week.

Traps

Butterfly traps were made of white netting attached to 2 large metal rings to form a cylinder. A plastic tray was suspended from 3 points at the bottom of the trap and a gap of roughly 4 cm was left between the tray and netting through which butterflies could enter, shown in Figure 1. The top of the traps was closed as the netting was tied and suspended by rope from a tree in the plot. Traps were suspended roughly 1m off the ground. Traps were baited with either fermented banana or rotten fish. The banana bait contained only banana. The fish bait contained only fish and water. Two traps of each bait type were used in each plot.

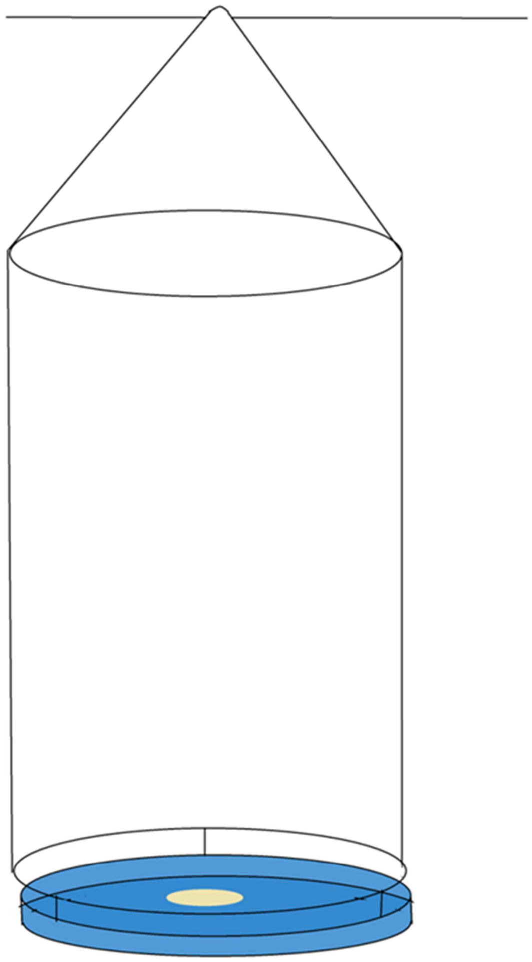


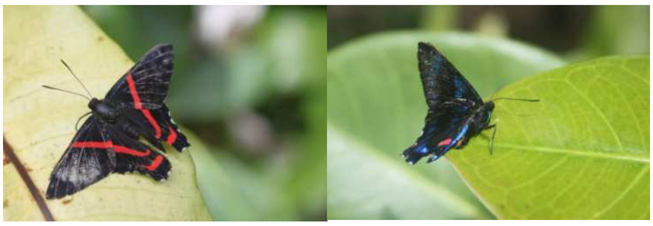
Figure 1: Diagram of hanging butterfly trap

Results

Species Identified

In total, 1065 butterflies were caught from which 113 separate species were identified. Of the 113 different species caught, nine of these had never been previously identified in the proximity of the research centre. These are shown in Table 1.

Table 1: Species of butterfly never previously identified at the research

New butterflies to the reserve	
Rhetus periander	
Adelpha iphiclus	
Adelpha pleasure	
Ancyluris moliboeus (sp unknown)	
Diaethria clymena	

Eunica malvina	
Memphis appias appias	 
Anartia amathea	 
Calycopis partunda	 

Discussion

No significant effect of habitat type on butterfly diversity was seen between agroforestry and plantation plots for either of the methods for estimating species diversity, number of butterflies collected or species richness. This lack of significant difference in diversity goes against our expectation that a greater diversity of species would be supported in the agroforestry habitats. We will consider the possible confounding effects which differences in vegetation and choice of bait type may have had on the results before drawing overall conclusions from the data.

Density of Vegetation as a confounding factor

Despite plots originally being planted as monocultures, a much larger number of additional species grow here as non-intensive farming methods were common. Many of the local farmers work these plots on days off work, but are primarily based in the local town. This style of non-intensive farming occurred in both areas planted by traditional methods and those planted using the agroforestry methods implemented by the CREES foundation. There is little in the way of automation of farming methods in the area, therefore keeping the plots clear of anything except crops would be highly labour intensive. Additionally in some plantations other trees were actively encouraged, especially avocado plants, due to the local knowledge that using shade from taller trees could protect young banana plants from the sun. The result was that even though there was initially a wider range of trees planted in the agroforestry plots, very quickly both plantations and agroforestry plots would become overgrown with a wide range of fast growing native plants from the nearby forest, or pockets of vegetation between fields, and only the immediate surroundings of the banana trees and the paths between them would be maintained.

To ensure that our results were not confounded by how overgrown a plot had become, with non-significant differences in species diversity being a reflection of equal density in vegetation within the two plot types, vegetation density was measured. Agroforestry plots were found to have a significantly higher density of vegetation, as would be expected by their planting methods, showing that although both plots were overgrown, this had not occurred to such a degree as to obscure the differences between plot types entirely. Furthermore, regression of species diversity with vegetation density was non-significant, showing that there was no obvious relationship between how overgrown a plot had become, and the diversity of butterfly species found there. Vegetation density is therefore unlikely to have been confounding our results for species diversity and we can disregard the higher than expected density of vegetation in plantation plots as a reason for the non-significant difference in species diversity between plot types.

However we did find that the number of butterflies caught in traps correlated strongly with the density of vegetation in the surrounding area, with the highest number of butterflies being caught in areas of low vegetation density. So although species diversity was unaffected, the actual number of species present was.

Bait Type as a confounding factor

Plantation plots were planted with a higher density of banana trees than agroforestry plots, where a more diverse range of trees were present. We used both fish and banana bait types in this experiment to determine whether the use of banana as a bait type was affecting the species diversity of butterfly collected, since we were sampling plots with differing abundance of banana trees. We found no significant interaction between diversity of species collected using the different bait types and the plot type they were in, showing that a higher than expected species diversity in plantation plots was not purely due to a greater diversity of butterflies that fed on banana. This allowed us to disregard the choice of bait type as a confounding factor in our study. Overall fish bait led to a higher diversity of butterflies being caught but a larger number and higher species richness were caught using banana bait.

Non-significant difference in diversity between plot types

Since neither of these factors are able to explain our result, we consider two further explanations to be viable, and these we will explore further. Firstly that diversity in Plantation plots is higher than expected as the local non-intensive farming methods employed in the area lead to a high diversity of plant species within plantation plots; and secondly that diversity in agroforestry plots is lower than expected as agroforestry plot planting does not encourage greater butterfly biodiversity in the area. It is also possible that both of these explanations are true to some extent.

The first of these explanations, that the particular type of farming methods used in this region provide habitats that support a wider than expected diversity of butterfly species is encouraging as it predicts that areas of low intensity farming can provide pockets of biodiversity. The finding by **Bhagwat *et al* (2008)**, that less intensively managed agroforestry plots tend to support a higher species richness, can potentially also be applied to the context of non-intensive plantation management, supporting the idea that non-intensive management in a plantation context may also lead to higher biodiversity. Since agroforestry plots are expected to exhibit higher levels of biodiversity than plantation plots, it could be suggested that if both were managed non-intensively, the agroforestry plots would continue to show higher biodiversity than the plantation plot. Therefore the overgrown nature of the plots alone would still not explain the lack of a difference between the plots, unless the intensity of farming played a larger part in determining the diversity of butterflies supported, than the original planting method used. Although greater vegetation density was recorded in agroforestry plots than plantation plots, likely due to the agroforestry planting method used, it is possible that the overgrown nature of both plot types provided equivalent ecological niches to support butterfly populations leading to equivalent diversity of species being present.

The second explanation, that agroforestry plots are not supporting any increase in butterfly diversity over regular plantation farming methods is somewhat less encouraging. However agroforestry techniques can provide many benefits in addition to supporting butterfly diversity such as carbon sequestration and the support of diversity in other taxonomic groups **(Montagnini and Nair, 2004)(Bhagwat *et al*, 2008),** and so even with this second explanation there are still a great number of other benefits to using agroforestry farming practices. Our data does not enable us to distinguish between these two possibilities, and for this, understanding of butterfly diversity in a greater variety of land uses would be necessary.

Can we extrapolate these findings to apply to biodiversity in general?

Butterflies have been used as an indicator from which predictions can be made of the overall biodiversity level of a region to varying success, and their effectiveness as indicators is greatly debated **(Lawton *et al*, 1998)(Kessler *et al*, 2010)(Daily and Ehrlich, 1995)(Fleishman and Murphy, 2009)(Bonebrake *et al*, 2010)**. This is primarily thought to be due to vast differences in the ecological requirements of different species, and to a greater extent, different taxonomic groups. For this reason the use of any single taxonomic group as such an indicator has been brought into question, and maximising the number of taxonomic groups used to best estimate overall biodiversity levels has been advised **(Lawton *et al*, 1998)(Kessler *et al*, 2010)**. However, this is rarely possible due to the great cost and time involved in such a project and butterflies are advised as a useful group for rapid evaluations of biodiversity. Given the time restraints of our project, butterflies were a good choice of taxonomic group however we are hesitant to apply these findings broadly as we cannot be sure that they are indicative of biodiversity more generally. It does however indicate that further investigation into whether agroforestry techniques do support a greater diversity, to that of normal agricultural techniques, in a variety of taxonomic groups, is necessary to determine the extent of benefits that agroforestry provide.

Conclusion

Overall, the study has demonstrated a lack of significant difference in butterfly biodiversity between CREES agroforestry plots and traditional plantation methods within the same area. This may be due to agroforestry plots not providing a significantly beneficial habitat for butterflies, or non-intensive farming techniques providing habitats that are equally beneficial to agroforestry plantations and thus supporting a greater diversity of butterflies than previously expected. For a complete picture of the extent to which agroforestry affects butterfly biodiversity additional studies need to be carried out. A study comparing butterfly biodiversity in agroforestry plantations with areas of primary and secondary forest types, as well as areas of high intensity farming would give a broader view of the different levels of biodiversity found in areas of different land use, ideally this study would be carried out over a period which would allow species saturation to be reached. Additionally further research into the efficacy of butterflies as a marker of overall biodiversity in this area would allow appropriate extrapolation of findings into other taxa.

References

Bhagwat SA, Willis KJ, Birks HJB, Whittaker RJ. (2008) Agroforestry: a refuge for tropical biodiversity?, Trends in Ecology & Evolution, Vol. 23, pp. 261-267.

Bonebrake TC, Ponisio LC, Boggs CL, Ehrlich PR (2010), More than just indicators: A review of tropical butterfly ecology and conservation, Biological Conservation Vol. 143 pp.1831-1841.

Bruner AG, Gullison RE, Rice RE, da Fonseca GAB (2001) Effectiveness of parks in protecting tropical biodiversity, Science Vol. 291 pp. 125-128.

Daily GC, Ehrlich PR (1995), Preservation of biodiversity in small rainforest patches: rapid evaluations using butterfly trapping, Biodiversity and conservation Vol. 4 pp.35-55.

Fleishman E, Murphy DD (2009), A Realistic Assessment of the Indicator Potential of Butterflies and Other Charismatic Taxonomic Groups, Conservation Biology Vol. 23 pp.1109-1116.

Kessler M, Abrahamczyk S, Bos M, Buchor D, Dwi Putra D, Gradstein SR, Höhn P, Kluge J, Orend F, Pitopang R, Saleh S, Schulze CH, Sporn SG, Steffan-Dewenter I, Tjitrosoedirdjo SS, Tscharntke T (2011), Cost-effectiveness of plant and animal biodiversity indicators in tropical forest and agroforest habitats, Journal of Applied Ecology Vol. 48 pp.330-339.

Kremen C, Williams NM, Aizen MA, Gemmill-Herren B, LeBuhn G, Minckley R, Packer L, Potts SG, Roulston T, Steffan-Dewenter I, Vázquez DP, Winfree R, Adams L, Crone EE, Greenleaf SS, Keitt TH, Klein A-M, Regetz J and Ricketts TH. (2007), Pollination and other ecosystem services produced by mobile organisms: a conceptual framework for the effects of land-use change. Ecology Letters, Vol.10 pp. 299–314.

Lawton JH, Bignell DE, Bolton B, Bloemers GF, Eggleton P, Hammond PM, Hodda M, Holt RD, Larsen TB, Mawdsley NA, Stork NE, Srivastava DS, Watt AD (1998), Biodiversity inventories, indicator taxa and effects of habitat modification in tropical forest, Nature Vol. 391 pp.72-76.

Manú National Park, 2009. Available from: http://whc.unesco.org/en/list/402. [30 October 2013].

Montagnini F, Nair PKR (2004)Carbon sequestration: An underexploited environmental benefit of agroforestry systems, Agroforestry Systems Vol. 61: pp.2 81–295.

Robbin RK, Lamas G, Mielke OHH, Harvey DJ, Casagrande MM, (1996). Taxanomic Composition and Ecological Structure of the Species-Rich Butterfly Community at Pakitza, Parque Nacional del Manu, Peru. Pp.217-252, in Manu: The biodiversity of Southeastern Peru (D. E. Wilson and A. Sandoval, eds.). Smithsonian Institution Press, Washington DC.

Shepard HJ, Rummenhoeller K , Ohl-Schacherer J and Yu DW (2010)Trouble in Paradise: Indigenous Populations, Anthropological Policies, and Biodiversity

Conservation in Manu National Park, Peru Journal of Sustainable Forestry Vol.292-4 pp. 252-301.