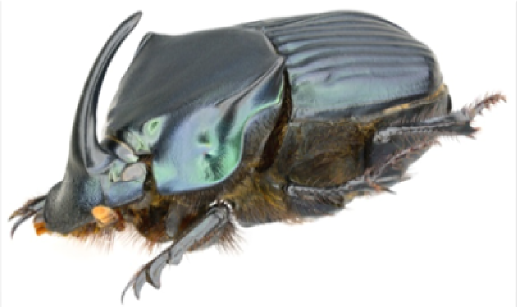
Factors affecting dung beetle, jewel scarab and moth communities in cloud forests of Honduras

Despite their critical importance within ecosystems, many insect groups are extremely understudied in areas of high biodiversity like Cusuco National Park. It can take many years and much effort to establish a sampling framework and identify collected specimens. Therefore we are very fortunate to have a both an accurate species list and reliable long-term data for the dung beetles and jewel scarab beetles, and are nearing this level with the two moth families we study. Nevertheless, there is still a vast amount that is unknown about these groups in Cusuco, and this previous work provides only a basic background from which a wide range of project ideas could be studied. In addition, it is possible to sample both groups consistently using standardised methods and collect species in high abundances, providing statistically rigorous and informative results.

Dung beetles

Despite the initial revulsion this group engenders, the dung beetles are an excellent focal taxon for ecological research in a range of topics, many of which are possible in Cusuco. The population structure at a site is relatively easy to characterise, so it would be possible to explore topics relating habitat structure or other environmental variables to the occurrence of specific species or guilds (groups of species that are similar in habit or function). Past data could be utilised in planning such projects, and also presents interesting species patterns which could be studied further – for example, some species are found throughout the park, whereas others occur within very limited ranges. What differences between the species, or variations in environment, might cause this?



Phanaeus endymion, a Cusuco dung beetle

Dung beetles provide a host of ecosystem functions: the most obvious is waste removal, but as part of this dung beetles also recycle nutrients, condition soil, suppress parasites and disperse seeds – all important functions to conserve. This is not limited to animal waste – many dung beetles feed on other resources, such as rotting fruit, carrion and fungi. Many dung beetles act as transportation hosts for phoretic organisms, and some even act as pollinators. This ecosystem importance underlies their use in conservation planning as indicator species for habitat quality or occurrence of other groups of organisms such as large mammals. Within these broad topics there is scope to examine several useful areas, for example the effectiveness of dung beetles at carrying out specific ecosystem services, and how this might vary over environmental gradients. There may also be scope to examine how well the dung beetles of Cusuco might act as indicators of habitats or other taxa in the park.

Little is known about the ecology of many of the species found in Cusuco, and projects could easily incorporate experimental work to discover many aspects of dung beetle lifestyles relevant to broader ecological study. For example, how different species interact with resources, the variation in distance travelled to resources, and the times of day that different species are active all have relevance to studies into ecosystem functioning by dung beetles. Experiments could incorporate the use of live specimens and the use of specially constructed experimental plots. For example, a previous project placed live beetles within specially-constructed bait preference apparatus to test different species' resource preferences.

The majority of dung beetle sampling is carried out on the network of sampling plots set up through the park, and utilises sets of baited pitfall traps to collect dung beetle specimens. Student research can take advantage of these sample sites, and it may be possible to integrate certain projects with the monitoring work of the invertebrate team, resulting in much greater sampling effort for the project. There is a comprehensive identification guide to the 38 known species of dung beetles found in Cusuco, and students are expected to learn and perform the basic identification of their samples – although there is of course expert assistance on hand in the field.

The following selection of papers covers a number of interesting topics in dung beetle ecology which may help to stimulate project ideas. A more comprehensive reading list will be provided to assist in planning your individual topic.

Nichols, E., Larsen, T., Spector, S., Davis, A. L., Escobar, F., Favila, M., et al. (2007). Global dung beetle response to tropical forest modification and fragmentation: a quantitative literature review and meta-analysis. *Biological Conservation,* **137** (1), 1-19. http://dx.doi.org/10.1016/j.biocon.2007.01.023

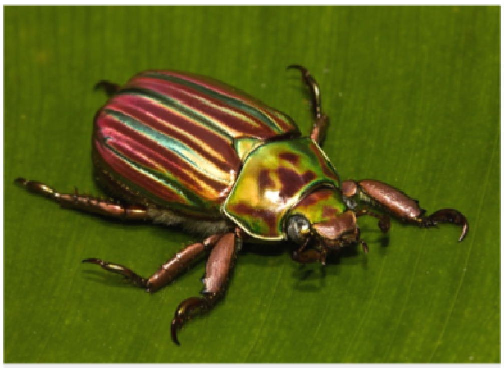
Larsen, T. H., Lopera, A., & Forsyth, A. (2006). Extreme trophic and habitat specialization by Peruvian dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae). *The Coleopterists Bulletin,* **60** (4), 315-324. http://dx.doi.org/10.1649/0010-065X(2006)60[315:ETAHSB]2.0.CO;2

Andresen, E. (2002). Dung beetles in a Central Amazonian rainforest and their ecological role as secondary seed dispersers. *Ecological Entomology,* **27** (3), 257-270. http://dx.doi.org/10.1046/j.1365-2311.2002.00408.x

Spector, S. (2006). Scarabaeine dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae): an invertebrate focal taxon for biodiversity research and conservation. *The Coleopterists Bulletin,* **60** (sp5), 71-83. http://dx.doi.org/10.1649/0010-065X(2006)60[71:SDBCSS]2.0.CO;2

Lewis, O. T. (2009). Biodiversity change and ecosystem function in tropical forests. *Basic and Applied Ecology,* **10** (2), 97-102. http://dx.doi.org/10.1016/j.baae.2008.08.010

Jewel scarab beetles



Chrysina quetzalcoatli, a Cusuco jewel scarab

The seven species of jewel scarab known to Cusuco are easily identifiable, and we have a basic understanding of their broad distribution throughout the park. However very little is known of their community structure, or how this varies over environmental gradients, and these may be areas a project could cover. Worldwide, jewel scarabs are an extremely understudied group because they are usually restricted to remote neotropical habitats such as Cusuco, so beyond basic feeding habits and lifecycles, there is ample opportunity for study into their ecology. For example, jewel scarabs are usually observed at night time, but are not infrequently found during the day – at what times are they most active? As with the dung beetles, a study into dispersal distance may yield interesting results relevant to work on jewel scarab population structure.

While jewel scarabs are not as important for ecosystem functioning as the dung beetles, they are extremely attractive and therefore highly valued by insect collectors. This is not necessarily negative - collecting and selling jewel scarabs could provide an income for local people that is dependent on the preservation of intact forest. However, accurately assessing the population size is crucial for creating a sustainable exploitation plan, and would be a good topic for a student project. It would also be informative to study how the population of jewel scarabs varies with different habitats and the effects of disturbance and varying land use.

Projects looking at aspects of jewel scarab ecology would likely use capture-mark-recapture analysis to estimate population size and other parameters, collecting specimens using light traps. Standard light trapping is also carried out on the fixed network of sampling plots throughout the park, and students may have the opportunity to utilise the entirety of the invertebrate team's sampling effort to aid in their data collection. Again, it would also be possible to integrate experimental studies into projects, or set up special or alternative plots.

The following papers give an idea of the possible avenues of study that could be pursued with the Cusuco jewel scarabs – however, they are concentrated on different focal taxa, as very little relevant research has been done on jewel scarabs. Again, further papers will be suggested when planning your chosen topic.

Tikkamäki, T., & Komonen, A. (2011). Estimating population characteristics of two saproxylic beetles: a mark-recapture approach. *Journal of Insect Conservation,* **15** (3), 401-408. http://dx.doi.org/10.1007/s10841-010-9313-3

Sutherland, W. J. (2001). Sustainable exploitation: a review of principles and methods. *Wildlife Biology,* **7** (3), 131-140. http://www.wildlifebiology.com/Downloads/Article/329/en/oldpath.pdf

Kremen, C., Colwell, R. K., Erwin, T. L., Murphy, D. D., Noss, R. F., & Sanjayan, M. A. (1993). Terrestrial Arthropod Assemblages: Their Use in Conservation Planning. *Conservation Biology,* **7** (4), 796-808. 10.1046/j.1523-1739.1993.740796.x

Moths

As pollinators of a number of flowering plant species, moths are often important ecosystem function providers in tropical forest environments. Like the dung beetles, this may also mean that moth population structure is consistently correlated with certain aspects of the habitat, and so they may act as an indicator group for forest quality. In Cusuco we have a large number of known species of hawkmoths (Sphingidae) and giant silk moths (Saturniidae), which are relatively easy to identify, especially the former. As with the jewel scarabs, we have a basic understanding of the distribution of these two families throughout the park. However, little work has been done on any other families, and so a project could look at how different families of moths are distributed.

As with the other two groups, there would also be opportunities to study associations between different species or species groups and environmental characteristics, or to examine how disturbance affects the moth community. Surveying for moths uses the same light-trapping methodology as for jewel scarab beetles.

New, T. R. (2004). Moths (Insecta: Lepidoptera) and conservation: background and perspective. *Journal of Insect Conservation,* **8** (2), 79-94. http://www.springerlink.com/content/k3606813187072q0/

Summerville, K. S., Ritter, L. M., & Crist, T. O. (2004). Forest moth taxa as indicators of lepidopteran richness and habitat disturbance: a preliminary assessment. *Biological Conservation,* **116** (1), 9-18. http://dx.doi.org/10.1016/S0006-3207(03)00168-X

Hawes, J., Motta, C. D., Overal, W. L., Barlow, J., Gardner, T. A., & Peres, C. A. (2009). Diversity and composition of Amazonian moths in primary, secondary and plantation forests. *Journal of Tropical Ecology,* **25**, 281-300. http://dx.doi.org/10.1017/S0266467409006038

Ignatov, I. I., Janovec, J. P., Centeno, P., Tobler, M. W., Grados, J., Lamas, G., et al. (2011). Patterns of Richness, Composition, and Distribution of Sphingid Moths Along an Elevational Gradient in the Andes-Amazon Region of Southeastern Peru. *Annals of the Entomological Society of America,* **104** (1), 68-76. http://dx.doi.org/10.1603/AN09083

Thomas J. Creedy, August 2011