HM203 The effect of altitude, tree height, rainfall and other variables on leaf structure

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A number of studies have suggested that leaf size, the frequency of compound leaves and the frequency of drip-tips decreases with altitude while the thickness increases (e.g. Grubb 1977, Dolph & Dilcher 1980, Turner 1994, Schneider *et al*. 2003, Poorter & Rozendaal 2008). But it's hard to lay hands on good quantitative data to show this. Moreover, the underlying ecological reasons for the changes are not understood. Generally leaves tend to be smaller in drier, hotter, and nutrient-poor habitats but also at higher altitudes where it is colder, windier and often wetter (Li *et al*. 2008) but which factor is most important in Cloud Forest?

It is also known that soil, local topography and successional stage (i.e stage of development of the forest after clearing or in a gap caused by a tree falling) affect leaf size but it's not clear what role these factors played in the published studies. The forests of Cusuco National Park are ideal for collecting good quantitative data – the trees are always there!

It is likely that lower temperatures and changes in rainfall are responsible for the changes in leaves, so leaves can be looked at along an altitudinal gradient on the east and west facing slopes which have different rainfall patterns. Weather data is available from different stations and a GIS model allows prediction of weather parameters for anywhere in the park.

Average leaf size (and presumably other leaf properties) is known to vary in a predictable way along large-scale environmental gradients regardless of species (Poorter & Rozendaal 2008). So, providing a large enough sample is taken, the emphasis can be on frequencies across all tree species with no need to worry about which species are sampled.

Questions that can be investigated in Cusuco National Park include the following:

- How do leaf characteristics change with altitude and what are the underlying ecological reasons?
- How do leaf properties within a tree vary from the sun leaves at the top to the shade leaves at the bottom, including size, thickness, mass per unit area and stomatal density (e.g. Panditharathna *et al*. 2008)?
- How do leaf characteristics vary in openings in the canopy/clearings; do new open areas have species with small leaves (drier and hotter) changing to species with larger leaves as the canopy closes? Does the same pattern occur at low and high altitudes?
- Is there a difference in leaf characteristics between monocot and dicot plants, and do these link to the degree of herbivory, i.e. the proportion of leaf area missing (Grubb *et al*. 2008)?
- A common North American tree, Sweet Gum (*Liquidambar styraciflua*), is remarkably widespread in Cusuco national Park. It is deciduous, has lobed leaves, no drip-tip and yet seems to compete well with the hard-leaved evergreen species

typical of rainforest. Since this is a very different tree, does it also fit the pattern of smaller, thicker leaves with altitude?

Fairly simple data can be collected to answer many of the questions raised above. Leaves are readily collected using extendable pruners (which can sample leaves up to 12 m above ground). Canopy access teams can also sometimes be used to collect samples vertically through tall trees. Once leaves are collected, it is easy to measure leaf length, maximum width and area (using photographs and a simple programme such as ImageJ). Leaf thickness is also measurable to 0.01 mm using digital callipers. The presence or absence of a drip tip (easiest done using a silhouette of what's a long enough point to be counted as a drip tip) and the drop tip length as a proportion of leaf length can also be measured. At Base Camp there are also drying facilities so that dry mass per unit area can be assessed.

In this way it is possible to collect large quantities of quantitative data to address a wide range of, as yet, unanswered ecological questions about how trees in Cloud Forest function.

Suggested Reading

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