Effects of anthropogenic forest disturbances on Jamaican epiphytes

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Introduction

Habitat fragmentation has been shown to affect a wide variety of forest organisms. The clearing of patches of previously contiguous forest results in changes in environmental variables, such as light, temperature, and humidity, in adjacent forest patches. The effects of these newly created edges can be positive for some types of plants, such as lianas and pioneer tree species (Laurance et al 2006, Ries et al 2004 and cited references), or negative for those species of plants that require undisturbed habitat.

In Jamaica, bauxite mining in the Cockpit Country results in the removal of existing vegetation from the bottomlands, thus creating edge habitats in forest on adjacent hillsides. One of the goals of this study is to quantify these edge effects by examining communities of epiphytes in hillside forests.

Epiphytes were chosen for this study because of their sensitivity to environmental changes. Having no direct access to soil reserves of water and nutrients places epiphytic species in chronic danger of water and nutrient shortage (Benzing 2000 a and b). Anything that increases temperature and/or lowers humidity in the extant forest can have lasting effects on populations of epiphytes. The epiphytes of the Cockpit Country also deserve special conservation attention, due to the large number of endemic epiphytic orchids (Gloudon and Tobisch 1995).

Materials and Methods

We sampled epiphyte abundance and diversity along transects in forest reserves in Mt. Diablo, Linton Park Mountain, and Lichfield-Matheson Run areas of the Cockpit Country. The terrain consisted of rugged karst limestone hills and mountains. The transects began at the bottom of hills and ran up to the tops of the hills. We recognized several types of bottomland disturbances: bauxite pits, forestry plantations, and pastures. In Mount Diablo and Linton Park Mountain, since the trees were relatively small in diameter and the canopy was low, we sampled plots that were 5 x 5m every 25m. In these areas, epiphytes were counted from the ground. In Lichfield-Matheson Run, the trees were larger and the canopy higher, necessitating climbing using single-rope techniques. In this case, every 25 m along each transect, the nearest tree permitting canopy access was sampled, and the diameter at breast height (DBH) of these trees was recorded. These transects will be referred to here as "relatively undisturbed." Epiphytes were identified to genus, and rarely species, if the material was fertile or the species was known. Some ferns were placed into morphospecies if they were not identifiable. Sampling occurred from March 26 to April 7, and from June 17 to June 29, 2007.

Results

We sampled 18 transects, nine originating in bauxite pits, four originating in bottomland forestry plantations, two originating in relatively undisturbed bottomland and three originating in pasture. We found a total of approximately six bromeliad taxa, 18 orchid taxa, and 12 fern taxa and morphospecies (Table 1). We also discovered leafless ghost orchids, but since they were sterile, we could not determine if they were *Campylocentrum* sp. or *Dendrophylax* sp.

Plots on transects originating in bauxite pits had an average of 5.96 epiphytic species. Plots along transects that originated in pasture had an average of 3.71 species. Those from forest adjacent to forestry plantations averaged 6.38 species per plot. Finally, those plots along transects beginning at relatively undisturbed bottomland contained an average of 8.4 species. There was a significant positive relationship between distance from disturbance and number of species for forests adjacent to bauxite pits ($p=0.001$, $r^2=0.425$, slope=0.071, Figure 1) and for forests adjacent to plantations ($p=0.001$, $r^2=0.376$, slope =0.046, Figure 2). The correlations between distance from disturbance and number of species were not significant for the other disturbance types.

Plots on transects originating in bauxite pits had an average of 32.86 epiphytic individuals. Plots along transects that originated in pasture had an average of 11.5 individuals. Those from forest adjacent to forestry plantations averaged 33.38 individuals per plot. Finally, those plots along transects beginning in relatively undisturbed bottomland contained an average of 49.50 individuals. There were significant positive relationships between distance from disturbance and number of epiphytic individuals for bauxite pits ($p=0.011$, $r^2=0.128$, slope=0.531, Figure 3) and for plantations ($p=0.023$, $r^2=0.140$, slope =0.363, Figure 4). As with the numbers of species, the correlations between distance from disturbance and number of epiphytic individuals were not significant for the other disturbance types.

From the data from transects through undisturbed forest, there was a significant correlation between DBH and number of epiphytic species ($p=0.006$, $r^2=0.625$, slope=0.075, Figure 5) as well as between DBH and number of epiphytic individuals ($p=0.015$, $r^2=0.545$, slope=0.702, Figure 6).

All of the forests sampled showed varying evidence of human impact. This included stumps of felled trees, small trunk diameters indicating removal of larger stems, and the presence of nonnative, human-dispersed species such as *Persea americana*, *Citrus* spp., *Mangifera indica*, and particularly *Musa* X *paradisiaca*. Additionally, in Mount Diablo, we encountered a pile of lumber along the roadside, indicating the (probably illegal) removal of trees from the forest.

Discussion

Both number of epiphytic species and number of epiphytic individuals showed significant positive relationships with distance from disturbance for bauxite pits as well as forestry plantations, while the pasture and undisturbed forest did not. For the relatively undisturbed forest, this means that there is no trend in number of epiphytic species or individuals with an increase in elevation along the hill slope. From this information, we infer that the trend seen in forests adjacent to bauxite mines and forestry plantations is the result of the disturbances. Plots along transects in forest adjacent to the pasture had less than half the number of species and slightly more than one fifth of the number of individuals as sampling units along the transects through undisturbed forest (also without a significant correlation). The "pasture forest" contained trees that were small enough for us to revert to the 5x5m plot sampling protocol, and the ease of access of this forest suggests that it experiences a fair amount of disturbance from local farmers collecting yam sticks for their farms. Given that larger trees support more epiphytes, this constant hypothesized removal of trees could result in the paucity of epiphytes found at

Linton Park Mountain. In essence, at Linton Park Mountain, we discovered no edge effects because the remaining forest consists entirely of edge. It is likely that the edge effects found at Mount Diablo are caused, at least in part, by the removal of trees for lumber.

One of the main limitations of this study is the lack of pre-disturbance data. Thus we cannon definitely say that species present in some areas but not others were extirpated due to disturbance where they are not found. This highlights the need for two things: exhaustive and robust pre-disturbance quantification of plant communities by entities wishing to modify existing forest and long-term demographic studies on epiphytes in order to ascertain the viability of their populations, particularly in disturbed habitats. The presence of apparently robust mature individuals, particularly orchids, does not guarantee the survival of the population. Mature specimens may persist in environments where reproduction and/or seed germination are impossible. If this is the case, these populations are effectively moribund.

Conclusions

The epiphytes of the Cockpit Country suffer from edge effects. One of the main effects of disturbance appears to be that it eases access into the forest, which permits illegal logging and removal of other forest products. This prevents the development of epiphytic communities. The primary goal of efforts to conserve the epiphytes of Jamaica must be the protection of large contiguous forest remnants by halting activities, such as bauxite mining, that fragment the forest and provide ready forest access to those conducting illegal lumber harvesting.

Literature Cited

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Table 1. Taxon lists for Mount Diablo, Lichfield-Matheson Run, and Linton Park Mountain. Identifiable fern taxa, but not fern morphospecies, are listed.

Mount Diablo	**Lichfield-Matheson Run**	**Linton Park Mountain**
Aechmea sp.	*Aechmea* sp.	*Aechmea* sp.
Anthurium sp.	*Anthurium* sp.	*Anthurium* sp.
Begonia sp.	*Bulbophyllum* sp.	*Bulbophyllum* sp.
Brassia sp.	*Campylocentrum* or *Dendrophylax*	*Campylocentrum micranthum*
Brassavola sp.	*Campylocentrum micranthum*	*Campyloneurum* sp.
Bulbophyllum sp.	*Campyloneurum* sp.	*Clusia rosea*
Campylocentrum or *Dendrophylax*	*Columnea* sp.	*Epidendrum* sp.
Campylocentrum micranthum	*Encyclia* sp.	*Guzmania monostachia*
Campyloneurum sp.	*Epidendrum rigidum*	*Hohenbergia* sp.
Catopsis berteroniana	*Ficus* sp.	*Maxillaria* sp.
Catopsis nitida	*Guzmania monostachia*	*Microgramma* sp.
Clusia rosea	*Hohenbergia* sp.	*Oncidium* sp.
Cochleanthes sp.	*Isochilus* sp.	*Peperomia* sp.
Columnea sp.	*Lepanthes* sp.	*Philodendron* sp.
Encyclia sp.	*Microgramma* sp.	*Phlebodium* sp.
Epidendrum sp.	*Oncidium* sp.	*Syngonium* sp.
Guzmania lingulata	*Oreopanax* sp.	*Tillandsia* spp.
Guzmania monostachia	*Peperomia* sp.	*Tolumnea* sp.
Hohenbergia sp.	*Philodendron* sp.	
Lepanthes sp.	*Phlebodium* sp.	
Lycaste sp.	*Pleurothallis* sp.	
Microgramma sp.	*Prosthechea fragrans*	
Nephrolepis sp.	*Psilotum nudum*	
Oncidium sp.	*Rhipsalis baccifera*	
Peperomia sp.	*Schomburgkia lyonsii*	
Philodendron sp.	*Selenicereus* sp.	
Phlebodium sp.	*Syngonium* sp.	
Pleurothallis sp.	*Tillandsia* spp.	
Pleurothallis sertularioides	*Tillandsia bulbosa*	
Polystachia sp.	*Tillandsia setacea*	
Rhipsalis baccifera		
Syngonium sp.		
Tillandsia spp.		
Tillandsia bulbosa		
Tillandsia setacea		
Vriesea sp.		

Figure 1: Number of epiphytic species as a function of distance from bauxite pits.

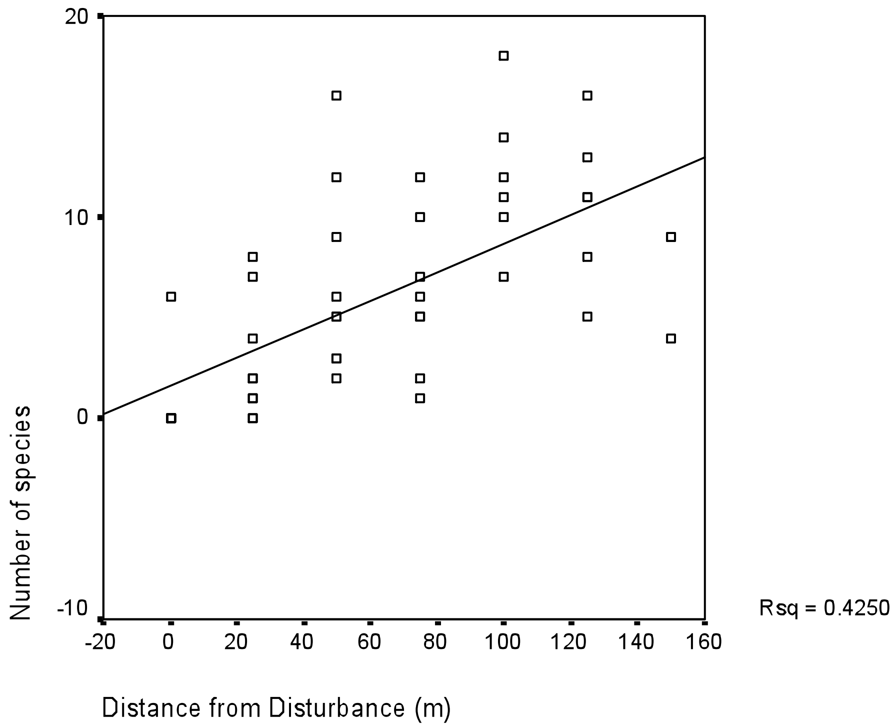

Figure 2. Number of epiphytic species as a function of distance from forestry plantations.

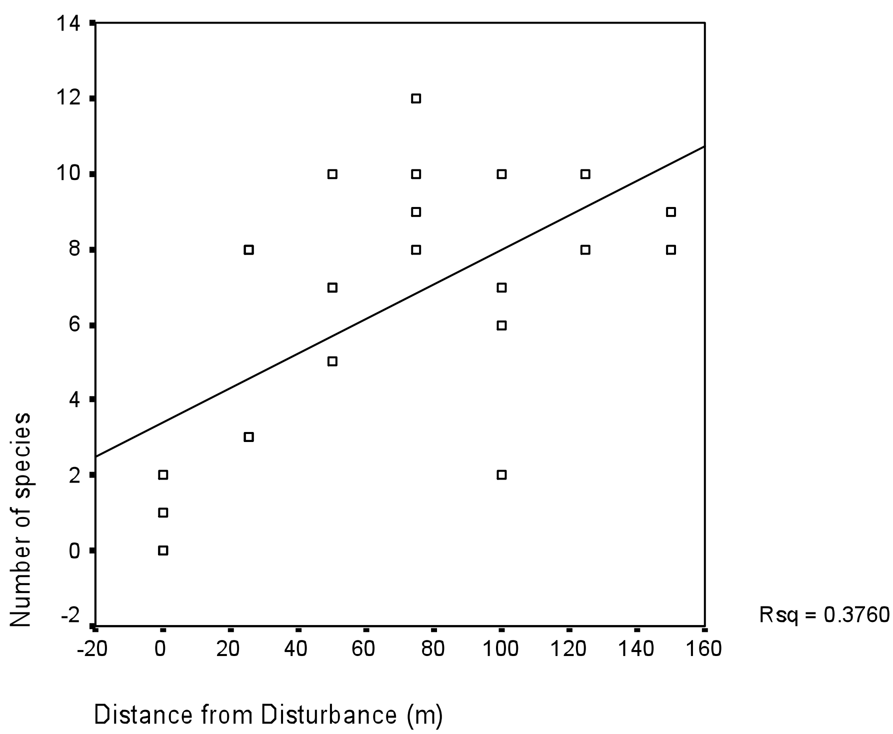

Figure 3. Number of epiphytic individuals as a function of distance from bauxite pits.

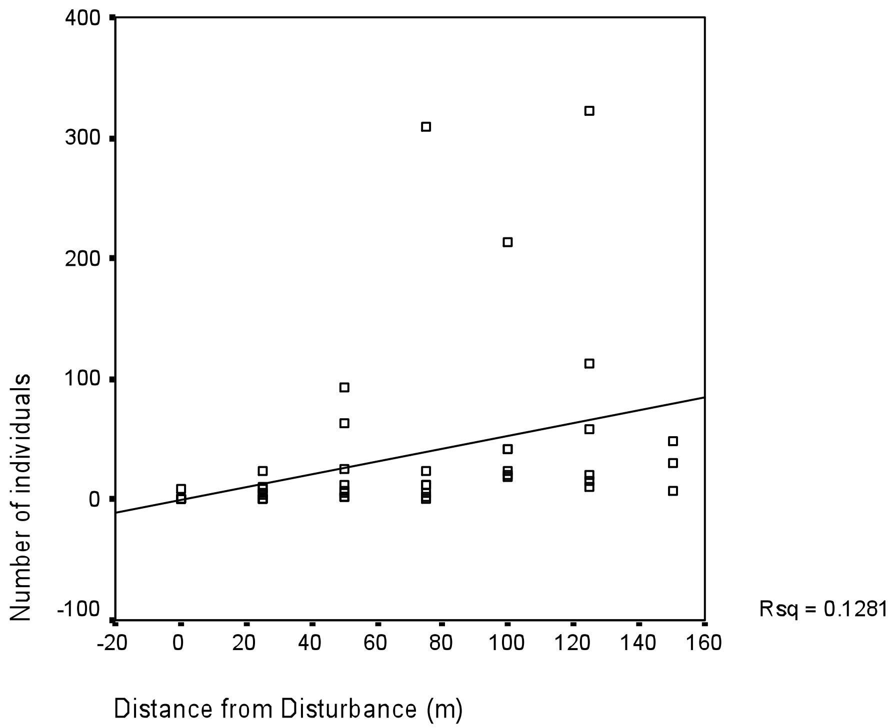

Figure 4. Number of epiphytic individuals as a function of distance from forestry plantations.

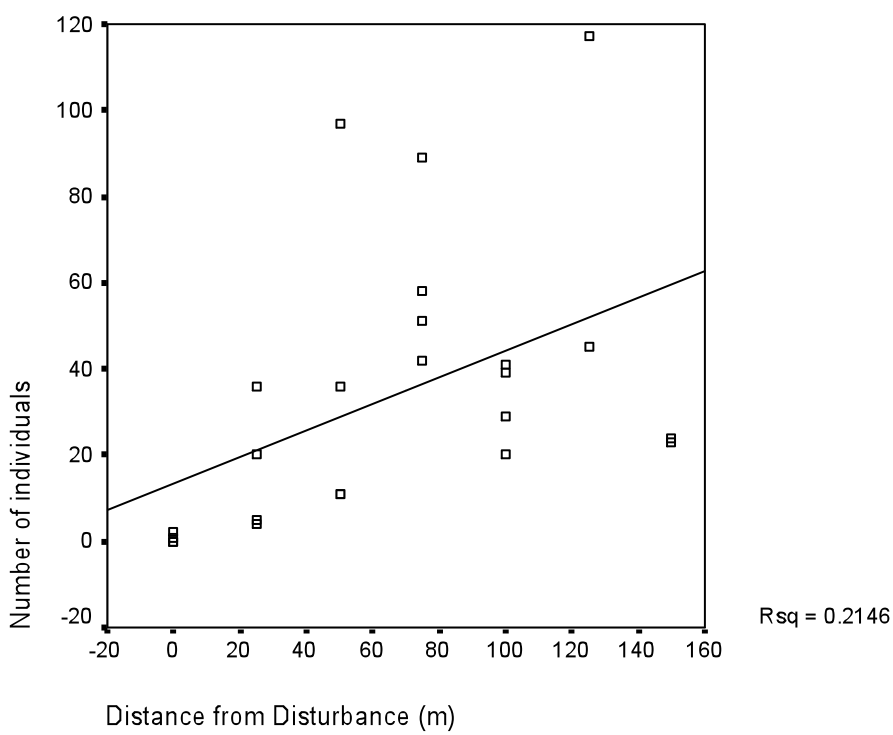

Figure 5. Number of epiphytic species as a function of host tree diameter at breast height (DBH)

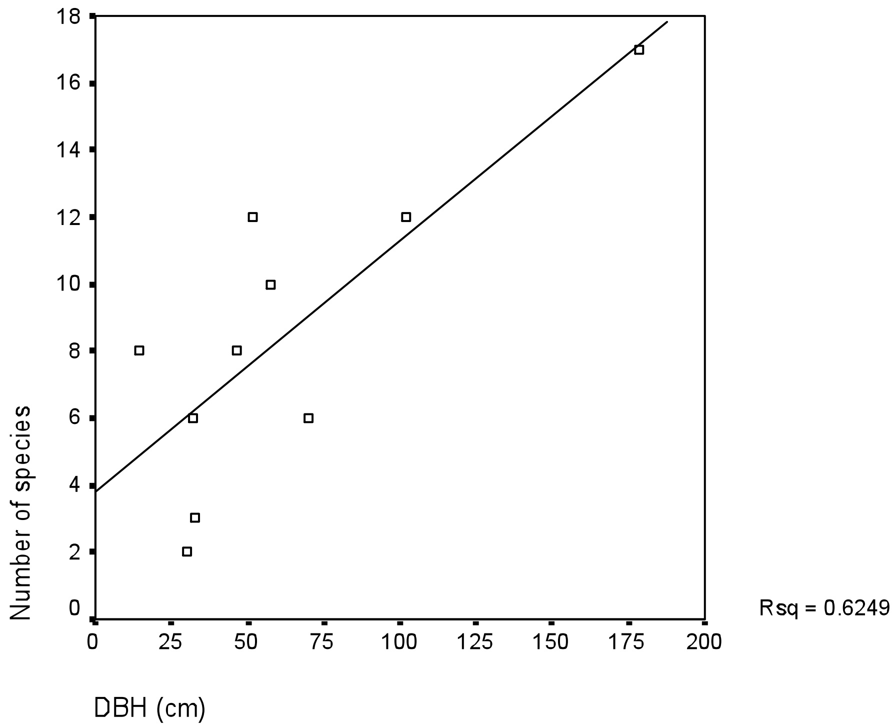

Figure 6. Number of epiphytic individuals as a function of host tree diameter at breast height (DBH)