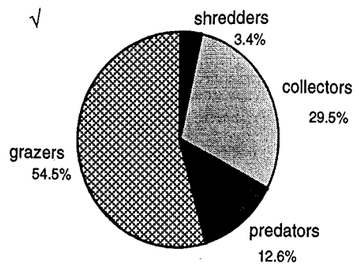

FIG. 1. Functional feeding groups in a first order stream at Monteverde Cloud Forest Preserve, Costa Rica. Cover by riparian vegetation was 75%, and mean weight of leaf litter occurring in the stream bed was 74.28 g.

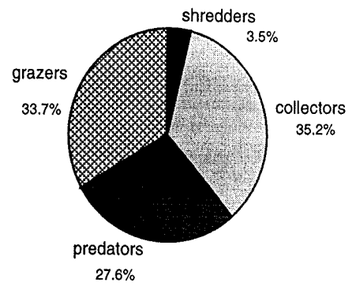

FIG. 2. Functional feeding groups in a second order stream at Monteverde Cloud Forest Preserve, Costa Rica. Cover by riparian vegetation was 50%, and mean weight of leaf litter occurring in the stream bed was 45.69 g.

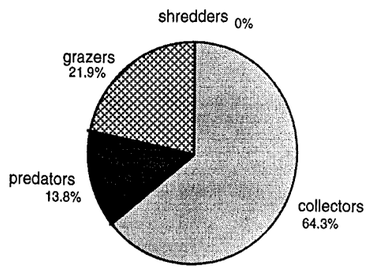

FIG. 3. Functional feeding groups in a third order stream at Monteverde Cloud Forest Preserve, Costa Rica. Cover by riparian vegetation was 75%, and mean weight of leaf litter occurring in the stream bed was 12.65 g.

HOLDING ON FOR DEAR LIFE: THE EFFECTS OF BARK SUBSTRATE ON EPIPHYTE LOAD AND COMPOSITION

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Abstract .We assessed epiphyte loads on trees in Estación Biológica Monteverde, Costa Rica to examine the effects of bark shedding trees versus non-bark shedding trees on vascular epiphyte load and composition. We hypothesized that there would be a larger total epiphyte load on bark shedding trees than non-bark shedding trees We predicted that trees would show either a predominance of bromeliads or of orchids, and that this would be related to bark type and that shedding trees would be more effective than non-shedding trees at dislodging large bromeliads. We found no significant differences in total epiphyte load on shedding versus non-shedding trees. We did find that there were more bromeliads than orchids on non-shedding trees and more orchids than bromeliads on shedding trees. Shedding trees demonstrated a lower number of large bromeliads than small bromeliads, while non-shedding trees showed no significant difference between the number of large and small bromeliads. This study suggested a relationship between epiphyte host tree suitability and bark characteristics.

Key Words: bark-shedding, Bromeliaceae, Orchidaceae

INTRODUCTION

The rich abundance and diversity of both vascular and non-vascular epiphytes in tropical forests creates an "aerial-draped appearance" which is most pronounced in mid-elevation cloud forests (Hartshorn 1983). Two major families of vascular epiphytes, Bromeliaceae (bromeliads) and Orchidaceae (orchids), primarily use their host plants as platforms from which to obtain the necessary amounts of water, nutrients, and sunlight needed to survive. Their presence, however, may be detrimental to the fitness of the host species by diverting critical resources from reproduction to structural reinforcement (Forsyth and Miyata 1984).

Many tropical trees exhibit a variety of bark types that may hinder initial epiphytic growth and enable the host to expel unwanted epiphytes. While trees with smooth bark are able to shed water rapidly and may be more efficient than rough-barked trees at preventing the colonization by algae and lichens, trees which have evolved flaky barks are believed to be more effective at dislodging and expelling established epiphytes (Forsyth and Miyata 1984). From this, we hypothesized that there would be less total epiphytes on trees with shedding bark than trees with non-shedding bark.

Certain host species are better suited for either bromeliads or for orchids (Walter 1983). However, there has been no conclusive evidence as to what factors, including bark type, might be responsible for the occurrence of "bromeliad trees" and "orchid trees." We therefore hypothesized that trees would show a predominance of either bromeliads or orchids, and that this would be related to bark type.

We predicted that bark shedding trees would effectively dislodge large and heavy bromeliads, and would therefore have a proportionately lower number of large bromeliads than small ones. This would suggest that shedding trees have a higher epiphyte turnover rate than non-shedders as evidenced by their ability to dislodge bromeliads before they reach maturity.

METHODS

We conducted this study along the cloud forest trail located north of the Estación Biológica Monteverde (EBMV) in Costa Rica. To obtain a representative sample over this elevational gradient, we sampled along the trail every 20 m from 1560 m to 1740 m. At each elevation, we located study trees systematically by selecting the nearest tree between 15 cm and 35 cm DBH, and of estimated height between 75% and 100% of the canopy height, such that all sides of tree could be visually surveyed with binoculars from the ground.

At each site we sampled an equal number of bark shedding trees and non-bark shedding trees. We defined shedding trees as those which had visible flaking or sloughing of bark both at the base and the top of the tree, and non-shedding trees as those demon-

strating no visible flaking or sloughing of bark. For the five intervals from 1560 m to 1640 m we sampled two each of shedding and non-shedding trees, and for the top five intervals (1660-1740 m) we sampled one of each. Sampling was limited in the higher elevation sites because of a limited number of shedding trees.

For each tree sampled we measured the following: (i) total number of orchids, (ii) number of small (<10 cm estimated diameter), medium (10-50 cm estimated diameter), and large (>50 cm estimated diameter) bromeliads, and (iii) number of other epiphytes (non-orchid and non-bromeliad vascular plants). All epiphytes were counted by visually surveying the entire tree with binoculars.

We calculated total epiphyte load by adding together the total number of orchids, bromeliads, and other epiphytes per tree. Trees were then classified as either bromeliad-dominated (>50% of total epiphytes bromeliads), orchid-dominated (>50% of total epiphytes orchids). Only those trees shown to be dominated by either bromeliads or orchids were used in the contingency table analysis (25 of 30 trees sampled).

We calculated percent large and small bromeliads per tree by dividing the number of large or small bromeliads by the total number of bromeliads.

RESULTS

We found the mean total epiphyte load in shedding trees was 13.1 + 2.5 epiphytes, while that of non-shedding trees was 16.6 + 4.3 epiphytes. This difference was not statistically significant (paired t-test, t=0.703, df=28, P=0.488).

The type of epiphyte that was dominant on a tree depended on bark type (Table 1). More specifically, bromeliad-dominated trees were mainly non-shedding trees while orchid-dominated trees had shedding bark (X2=10.8, df=25, P=0.001).

Table 1: Number of trees categorized by dominant epiphyte

	Bromeliad	Orchid
Bark Shredding	4	10
Non-Bark Shredding	10	1

We found a higher mean number of orchids on shedding trees than non-shedding trees (paired t-test: t=2.48, df=9, P=0.035; Fig. 1). There were fewer bromeliads on shedding trees than non-shedding trees (Fig. 1), although the difference was not statistically significant (paired t-test: t=1.57, df=9, P=0.15).

There was a lower mean percent large bromeliads (6.87 + 2.91) than small bromeliads (36.25 + 8.20) on shedding trees (paired t-test: t=2.89, df=9, P=0.018; Fig. 2). For non-shedding trees, however, there was no significant difference between mean percent of large bromeliads (9.04 + 3.67) versus small bromeliads (20.2 + 7.69; paired t-test: t=1.02, df=11, P=0.33; Fig. 2).

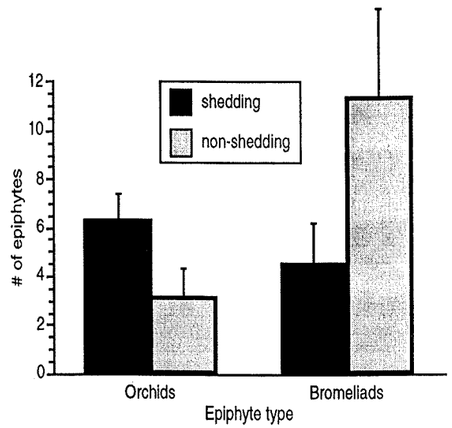

FIG. 1. Number of orchids and bromeliads on bark shedding and non-bark shedding trees. N=10 for each tree type.

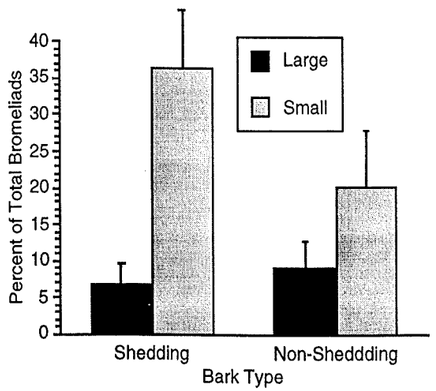

FIG. 2. Difference in percent small bromeliads versus percent large bromeliads on bark shedding and non-bark shedding trees. N=10 for each tree type.

DISCUSSION

Contrary to our predictions, epiphyte load was not significantly larger on shedding trees than non-shedding trees. It may be that non-shedding trees employ a tactic other than bark shedding, such as chemical defenses against epiphyte establishment, to lessen epiphyte load (Forsyth 1984).

However, we found a greater number of orchids than bromeliads on trees that shed their bark and a greater number of bromeliads on non-shedding trees. This supports our hypothesis that trees with epiphytes would be dominated by either bromeliads or orchids , and that this phenomenon may be a function of bark substrate. Walter (1983) suggests that orchids do not grow well on trees that have smooth bark and slough off great sheets of trunk bark. However, the shedding trees we observed had generally rougher bark than the non-shedding trees, possibly providing a suitable substrate for orchids. The non-shedding trees were smoother and probably poorer orchid hosts. Further studies could be done differentiating between smooth flaking bark trees and rough shedding bark trees with regard to epiphyte growth.

That bromeliads grow in greater numbers on non-shedding bark trees suggests that they may be dislodged by trees with shedding bark. The bromeliads grow faster than the orchids and probably weigh more, therefore they may have a greater chance of falling off due to shedding bark. Orchids, on the other hand, did grow well on shedding bark trees suggesting that, since they grow more slowly and weigh less, they are not dislodged as easily from the shedding bark trees. Orchids also seem to have a more spreading root system, which possibly provides them with a better grip on the smoother bark trees.

We found that there were proportionally fewer large bromeliads than small bromeliads on shedding trees, but no significant difference in proportion of bromeliad size classes on non-shedding trees. This supports our hypothesis that shedding trees might dislodge bromeliads before they can mature to larger size. These results could also point to a higher recruitment rate of small bromeliads on shedding trees, but were based on a single static sample, so rates cannot be determined. However, a future long-term study could potentially measure bromeliad turnover rate to determine if the rate is higher on shedding bark trees.

In conclusion, our studies support the idea that there indeed exist "bromeliad trees" and "orchid trees" and that these differences may be attributable to tree trunk bark shedding and texture. It is not certain whether trees have developed these bark characteristics in to avoid certain types of epiphytes, or if epiphytes grow differentially or colonize in response to bark type. Perhaps this relationship has allowed bromeliads and orchids to specialize on certain tree bark types.

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