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Cover photographs. Front: The three-foot, spine-tipped leaves of *Hohenbergia stellata* can form a rosette occupying up five feet in circumference of precious greenhouse bench space, but few growers would begrudge that room once the brilliant, long-lasting inflorescence emerges. Photograph by Marcel Lecoufle. **Back:** UPPER PHOTO *Billbergia* 'Foster's Striate, a cultivar of *Billbergia pyramidalis*. Derek Butcher discusses this species in text beginning on page 172. Photograph by M. McMahon. LOWER PHOTO: *Billbergia pyramidalis* 'Kyoto'. Photograph by Marcel Lecoufle.

CONTENTS

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Distribution of *Tillandsia recurvata* (Bromeliaceae) on *Cercidium praecox* in a Semiarid Mexican Scrub

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Abstract

In an intertropical semi desert area of central Mexico, the distribution and abundance of *Tillandsia recurvata* L. (Bromeliaceae) growing on *Cercidium praecox* (Ruiz and Pavón) Harms (Leguminosae) were analyzed in order to determine the relationships between height and cover's tree and epiphyte abundance in three sites with different slopes orientation. The spatial distribution of *C. praecox* in the three areas is random but its density on the south slope was much lower. Significant differences for the number of *T. recurvata* tussocks per *C. praecox* individual between sites were registered. In contrast, distribution of tussocks was not uniform: on the north slope, 68% of the tussocks found at a height of 1-2 m and 74.5% on the hilltop in the same height. The correlation between *C. praecox* cover and the number of tussocks was significant only for the north slope ($r=0.62$, $P=0.01$), although a similar association was observed for the hilltop ($r=0.59$, $P=0.07$). This result supports the idea that in the semiarid areas like in Zapotitlán Valley, Puebla, México the orographic conditions results a heterogeneous mosaic of micro environmental conditions that affect the abundance and distribution of *T. recurvata*.

Introduction

In limited water ecosystems, environmental elements such as climate, soil characteristics, and slope orientation have marked effects on the growth and development of plants. Due to incident radiation, slope orientation influences the level of potential atmospheric demand along gradients of increased radiation at the southern orientation to lower radiation at the northern orientation (Oke, 1987). Furthermore, changes in incident solar radiation between slope cause variations in temperature and air humidity, conditions that influence the stomatic conductivity of plants (Dubayah, 1994). This presupposes that the prevailing conditions on south-facing slopes are the most difficult for the establishment and regeneration of plant communities (Ferrer et al., 1995; González-Hidalgo *et al.*, 1996).

Because bromeliads of the subgenus *Tillandsia* exhibit principally atmospheric habits, these plants depend on various decisive factors for the maintenance of their hydric economy: humidity, temperature, and wind (Lange and Medina, 1979). They have developed numerous characteristics, such as a very low stoma/trichome index, CAM-type metabolism, and highly sclerotic leaves, in order to survive in arid environments (Medina, 1974). Other factors that influence the establishment and growth of bromeliads are light, frequent fog, types of support trees, crown size, and competitive interactions (Grubb and Whitmore, 1966; Hietz and Hietz-Seifert, 1995).

In an intertropical semi desert area of central Mexico, the distribution and abundance of *Tillandsia recurvata* L. (Bromeliacea) growing on *Cercidium praecox* (Ruiz and Pavón) Harms (Leguminosae) were analyzed in order to determine the relationships between height and cover's tree and epiphyte abundance in three sites with different slopes orientation.

Methods

The study was conducted in the "Helia Bravo" Botanical Garden located in the Zapotitlán Valley, Puebla, Mexico (18°20' N, 97°28' W). The area is found within the Tehuacán-Cuicatlán Biosphere Reserve, which has a high diversity of flora, 30% of which is endemic (Villaseñor et al., 1990). The climate is dry with summer rains from June to October. Mean annual rainfall is 400 mm and mean annual temperature 21.4° C (García, 1973). The soil is rocky, being derived from sedimentary marine rocks from the Cretaceous Period (Brunet, 1967). The vegetation in the study area is microphyllous scrublands with abundant columnar cacti such as *Neobuxbaumia tetetzo* and *Cephalocereus columna-trajani* (Montaña and Valiente-Banuet, 1998).

C. praecox is a deciduous tree that reaches a height of 4m and maintains photosynthetic parenchyma in branches and trunks (Szarek and Woodhouse, 1978). Its branches can tolerate a varying density of *T. recurvata* (Fig. 1), a small plant with a rudimentary root and shoot system that sustains 5-8 leaves, forming a rosette covered with absorptive trichomes (Benzing, 1980). Adult plants develop multiple ramets that can completely surround small *C. praecox* branches, creating a spherical tussock of up to 12 cm.

On the north and south slopes and top of the hill located within the "Helia Bravo Botanical Garden", on 1995 a transect was established during the dry season that measured 10 m x 100 m divided into 10 m x 10 m blocks. On each, the number of *C. praecox* individuals was registered along with crown diameter, height, and distance between plants. For all trees, the number of bromeliad tussocks was recorded on different height (0-1 m, 1-2 m, 2-3 m, and 3-4 m strata). Using the Clark-Evans method, a spatial distribution pattern was determined for *C. praecox* on each of the sampling sites. Kruskall-Wallis analysis was employed to compare the height and cover of *C. praecox* individuals and the number of tussocks registered on the sampling sites. Furthermore, Pearson correlation analysis was used to relate the number of *T. recurvata* tussocks to *C. praecox* cover and height on each site (Zar, 1996).

Results and Discussion

The spatial distribution of *C. praecox* in the three areas is random (R=1.59, P>0.05 north slope; R=1.26, P>0.05 hilltop; R= 1.64, P>0.05 south slope). This result indicates that microenvironmental differences between sites do not affect the spatial distribution of the plants. They do, however, seem to influence density, as the number of *C. praecox* individuals on the south slope was much lower (50 ind.ha^{-1}) than that registered on the north slope and hilltop, 170 ind.ha^{-1} and 140 ind.ha^{-1}, respectively. Significant differences were not registered for the height of *C. praecox* individuals between sites (H=3.14, P=0.28). As for the number of *T. recurvata* tussocks per *C. praecox* individual, significant differences were registered between the south slope and the other two sites, but not between the north slope and hilltop (U=90, P>0.05). The average number of *T. recurvata* tussocks per *C. praecox* individual for the south slope was 0.4, while the north slope and hilltop registered much higher, with an average of 23.5 tussocks per *C. praecox* individual. In contrast, distribution of tussocks on *C. praecox* individuals was not uniform: on the north slope, average tree height was 3.26 m ±0.9, with 68% of the tussocks found at a height of 1-2 m. On the hilltop, 74.5% of the tussocks were recorded for the same section; the height of *C. praecox* individuals was 2.77 m ± 0.34. Significant differences in the cover of *C. praecox* individuals were registered between the three sampling sites (H=7.32, P<0.05). On the north slope, estimated cover was the highest, at 328.8 m2 ha^{-1} as compared to the hilltop and south slope at 172.1 m2 ha-1 and 73.2 m2 ha^{-1}, respectively. The correlation between *C. praecox* cover and the number of tussocks was significant only for the north slope (r=0.62, P=0.01), although a similar association was observed for the hilltop (r=0.59, P=0.07).

Although this study did not include measurement of air humidity, temperature, and radiation on the sites, it was evident that differences in slope orientation caused marked differences in the three variables. It is well known that these microenvironmental factors affect the establishment and development of *C. praecox*, and differences in the abundance and cover of *C. praecox* individuals between the three sites was noteworthy. The abundance of the epiphyte *T. recurvata* is, in turn, affected.

Due to orography, environmental variations in the Zapotitlán Valley occur on a limited scale (Zavala-Hurtado, 1982), permitting the identification of conditions favorable to bromeliad presence. Thus a greater abundance of *T. recurvata* tussocks was recorded on the north slope, with an observable gradient in the number of *T. recurvata* tussocks from the N-S orientation, a fact that is significantly associated with a decrease in *C. praecox* cover.

In this same study area, Montaña et al. (1997) demonstrated the negative effect of *T. recurvata* on the dynamics of *C. praecox* shoots, an interaction considered to be structural parasitism. Although the proximate cause was not investigated, the authors considered a possible explanation to be that photosynthesis on the green tissue of *C. praecox* branches is inhibited because they are hidden by bromeliads. The intensity of the structural parasitism that *T. recurvata* causes in *C. praecox* due to possible photosynthetic inhibition would, then, depend on the density of bromeliad on the tree. The study demonstrates that there is a positive association between bromeliad density and *C. praecox* cover, which reaches its highest value on north slopes where microenvironments conditions permit better plant development. This relationship seems to indicate that structural parasitism occurs with greater intensity on larger trees, which would explain why the negative effect of bromeliads on *C. praecox* budding does not influence the size of individuals.

Figure 23. *Tillandsia recurvata* tussocks on *Cercidium praecox* in the semiarid scrub in Zapotitlán de Salinas, Puebla, México.

Orographic characteristics such as altitude and slope orientation affect a set of variables that are frequently correlated, such as radiation, temperature, and humidity. These variables combine to influence community structure. Thus the semiarid valley of Zapotitlán, Puebla, presents a quite heterogeneous mosaic of microenvironmental conditions that affect the abundance and distribution of *T. recurvata*.

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