Forest Ecology and Management, 57 (1993) 161–168
Elsevier Science Publishers B.V., Amsterdam

Survey of *Tillandsia recurvata* L.: preference, abundance and its significance for natural forests

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(Accepted 27 July 1992)

ABSTRACT

Caldiz, D.O., Beltrano, J., Fernández, L.V. and Andia, I., 1993. Survey of *Tillandsia recurvata* L: preference, abundance and its significance for natural forests. *For. Ecol. Manage.*, 57: 161–168.

The ball moss (*Tillandsia recurvata* L.) is an epiphytic weed that causes a deleterious effect upon its host when abundance is high. Because of its increasing abundance a survey was carried out in three different sites of the Province of Buenos Aires, Argentina, covering about 1000 ha and 457 trees from 114 species, belonging to 79 genera and 44 botanical families. A scale of abundance, from 0 (no epiphytes) to 4 (almost the whole host with epiphytes) was used to estimate the *T. recurvata* population. In the Riparian Forest of Punta Lara almost 100% of the surveyed trees have an abundance of 0 and 1; the average for all sites showed 58% of the individuals with an abundance of 1, 10% with an abundance of 2, 8% with 3 and less than 8% with abundance 4. Although there was no significant correlation between the diameter of the hosts and abundance of the epiphyte, 90% of the trees with the greatest abundance had a diameter greater than 0.40 m.

Three host types were defined according to the epiphyte average abundance and preference: Group I, high susceptibility; Group II, moderate susceptibility; Group III, epiphyte avoiders. Species with rough, deep and no exfoliating barks, with horizontally growing branches, and no exudating allelopathic compounds or latex, which favour *T. recurvata* anchorage, are potential members of Group I, while species with smooth, exfoliating and continuous bark, branches growing close to the main trunk, and exudating allelopathic compounds or latex are potential members of Group III or epiphyte avoiders. From this survey eight host species were seen to be heavily laden with *T. recurvata*, regardless of the growth habit of the host (evergreen or deciduous), representing different genera and botanical families. It is important to point out that individuals heavily laden with *T. recurvata* showed signs of decline. As commercial forests and plantings are carried out under conditions that promote rapid growth, natural forests are more susceptible to the invasion of this epiphyte; therefore some measures should be taken to preserve or recover them; for example, the successful chemical control proposed by our research group.

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INTRODUCTION

The ball moss (*Tillandsia recurvata* L.) is an atmospheric epiphyte (Pittendrigh, 1948) which can be found along the American continent, from the southern USA to the middle part of Argentina. The importance of this species has increased in recent years because of its deleterious effects on forest and ornamental trees and bushes (Claver et al., 1983). Benzing (1980) called this effect 'nutritional piracy' and stated that it can be observed only under specific conditions. Other authors considered *T. recurvata* as an epiphytic weed (Petetin and Molinari, 1977; Claver et al., 1983) that competes for light, or produces some growth inhibitor that determines leaf abscission.

It is important to note that this epiphyte has been steadily increasing its range in the USA and this is also evident in Argentina (Claver et al., 1983; Caldiz and Beltrano, 1989). Benzing (1980) suggested that in the USA this is probably the result of drier winters than normal for the past several decades. In this season the seeds are wind-dispersed and with their delicate coma hairs they cling to a suitable surface. Climate analysis for the area under study for the last 50 years did not show the same pattern and no other climatic parameter could be associated with the increasing population. Prolonged anchorage is especially important since, in juveniles, the first root appears several months later (Benzing, 1980). The great seed number per capsule (about 50) and the high germination capacity, at least in controlled conditions (Fernández et al., 1989), may contribute to the invasion of new areas and host species.

The objectives of the present research are to identify the host species for *T. recurvata* and whether this epiphyte shows host preference, according to different host characteristics, in relation to its significance for natural forests.

MATERIALS AND METHODS

Areas of research

The areas researched are situated in the surroundings of La Plata, capital city of the Province of Buenos Aires, located in the middle east part of Argentina, and have an extent of 1000 ha. The field work, which was carried out during 1985–1988, covered three different sites: (a) Riparian Forest of Punta Lara, (b) Pereyra Iraola Park, and (c) parks and squares of La Plata town. These places were chosen because of the diversity of tree species presented and because of several local reports about the presence of epiphytes.

(a) Riparian Forest of Punta Lara (PL). This is a biological reserve on the bank of La Plata River (s.l. 34°47′, w.l. 58°1′). The reserve occupies a reduced area of natural forest with several indigenous tree species.

(b) Pereyra Iraola Park (PIP). The park extends to the north of La Plata town and comprises about 13 000 ha. It was established with numerous exotic species brought from Europe, representative of several botanical families.

(c) Parks and squares of La Plata (PLP). La Plata is characterized by its architectural design, with numerous parks and squares every six blocks in any direction and trees along each street, with many different indigenous and exotic species.

Experimental procedure

An arbitrary scale of abundance for the epiphyte has been used because of the difficulties in counting the exact number of individual plants that are present on each host: 0, lack of epiphytes; 1, only a few epiphytes per host; 2, 25–50% of the host with epiphytes; 3, 50–75% of the host with epiphytes; 4, almost the whole host with epiphytes.

The hosts (>5 m height) were classified into three groups, according to their breast height diameter (BHD): <0.2 m; 0.2–0.4 m; >0.4 m. The data were analysed by analysis of variance and averages compared by the LSD test at the 0.05 level (Statgraphics Program). Based on this analysis the preference for different species, genera and botanical families was studied. In this respect, a few characteristics of the host that may be important for anchorage of the epiphyte were observed; for example, texture, stability and thickness of the bark, growth habit of the branches and if the host was evergreen or deciduous.

RESULTS AND DISCUSSION

Four hundred and fifty-seven trees, belonging to 114 species from 79 genera and 44 botanical families, were surveyed. The complete data are available on request; meanwhile the most notable cases are presented and discussed.

In PL 45% of the trees surveyed have an abundance of 0 and 55% an abundance of 1, and belong to ten different species (Fig. 1(A)). This indicates either that the invasion is rather recent (Cabrera and Dawson, 1944), that the conditions of the location are not suitable for *T. recurvata* invasion, or that host characteristics are not favourable for successful colonization by this epiphyte. Based on the species present this last possibility may be the most important.

Ninety percent of the trees surveyed in PIP and PLP bore epiphytes. In PIP 40% of the trees had an abundance of 1, 22% abundance 2, 12% abundance 3, and 15% an abundance of 4. For PLP a high percentage (78%) had an abundance of 1 with less than 10% of individuals in each of the other three categories (Figs. 1(B) and 1(C)).

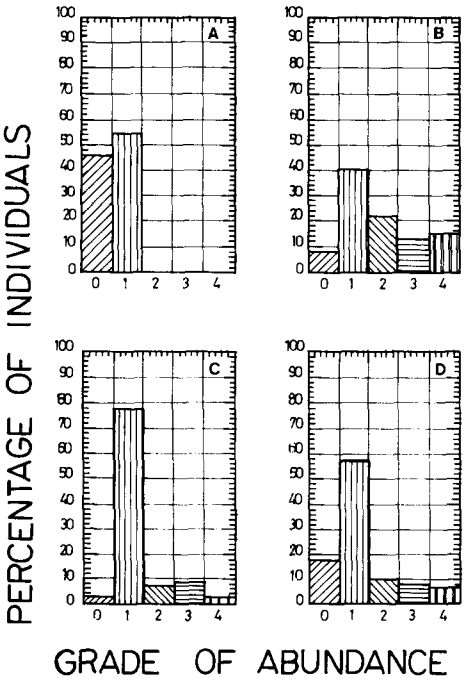

Fig. 1. Percentage of host trees in the different sites according to abundance of epiphytes (see text for explanation). (A) Riparian Forest of Punta Lara; (B) Pereyra Iraola Park; (C) parks and squares of La Plata town; (D) total for all sites.

In total, 58% of the individuals surveyed had an abundance of 1, 10% an abundance of 2, 8% of 3 and less than 8% with an abundance of 4 (Fig. 1(D)). Although there was no significant correlation between the BHD and the abundance of the epiphyte, 90% of the host trees with abundance 4 had a diameter >0.4 m. Richard (1939) and Brown (1986) also stated that epiphytes occur chiefly on the largest individuals of each tree species. Moreover, Yeaton and Gladstone (1982) suggested that tree size appears to represent the time available for colonization by the epiphyte, rather than a measure of habitat diversity.

Based on the scale of epiphyte abundance and on the statistical analysis of the data, three major host groups were identified in relationship to *T. recurvata* preference: I, high susceptibility; II, moderate susceptibility; III, epiphyte-avoiders. Hence, we will discuss some particular cases based on the epiphyte preference for different species, which in consequence determines the preference for genera and botanical families. These cases serve as good general examples of the epiphyte preference as summarized in Figs. 2(a)–2(c).

Species conforming to Group I are characterized by a rough, deep, permanent and non-uniform bark. They have branches growing horizontally, and

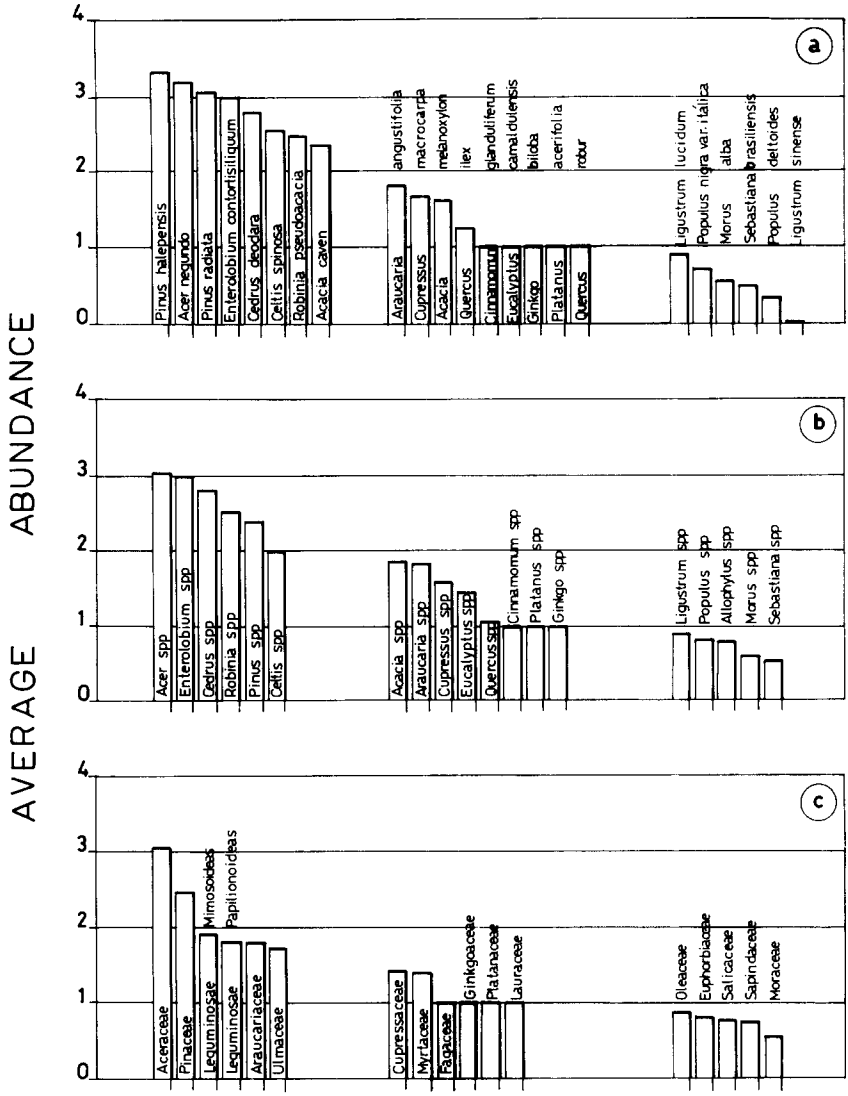

Fig. 2. Average abundance for (a) species, (b) genera and (c) botanical families of some notable cases. Complete data available on request.

an ample canopy; examples are *Cedrus deodara, Pinus radiata* and *Celtis spinosa*. This last species also has tortuous and curved branches. These traits favour *T. recurvata* colonization. This preference is also reflected in the genera, with the exception of *Acacia* ssp.; *Acacia caven* has a great branch density, presence of nodes and stipule, while *Acacia melanoxylon* does not possess such characteristics and belongs in consequence to Group II (Figs. 2(a) and 2(b)).

As mentioned by Piers (1968) for the genus *Eucalyptus* and by Del Moral and Muller (1970) for *Eucalyptus camaldulensis* which seemed to be avoided by the epiphytic flora, the same occurred in the present survey. This is mainly because of their exfoliating bark and the allelophatic effects of some species such as *Eucalyptus camaldulensis* and *Eucalyptus globulus*. A similar case of epiphyte preference is that of *Platanus acerifolia*, with its exfoliating bark. *Cinnamomum glanduliferum*, another species belonging to Group II, is mentioned by Benzing (1980) as being avoided by epiphytes because of its dense evergreen crown, smooth bark and content of ethereal oils. Another example with a smooth bark was *Ginkgo biloba*, also belonging to Group II.

Other species which have been mentioned in the literature as being allelophatic, showed a low presence of the epiphyte in the survey: *Quercus robur, Quercus palustris* (Frei and Dodson, 1972), *Ailanthus altissima* (Mergen, 1959), and *Juglans nigra* (Davis, 1928). Nevertheless, within Group II, two species — *Araucaria angustifolia* and *Cupressus macrocarpa* — showed a higher average abundance, 1.81 and 1.67 respectively, probably because of their horizontally growing branches and their dense and non-exfoliating barks.

With regard to Group III, 83% of individuals of *Populus* ssp. had abundances ranging from 0 to 1. One example is *Populus nigra* var. *itálica*, which, in spite of having a rough bark, has branches growing very close to the main trunk, and it is difficult for the epiphyte to colonize trees with this architecture. Moreover, *Populus alba* has a rather smooth bark, which is another negative characteristic for epiphyte anchorage. Another example of rough bark and low presence of epiphytes is *Morus alba*, with 88% of individuals having an abundance of 0 and 1. This species exudes latex, and epiphytes seem to dislike this kind of tree (Piers, 1968).

As suggested by Benzing (1980), bromeliads seem to be less choosy in their selection of host, even less than many epiphyte ferns and orchids. In the present survey, eight species of host trees were heavily laden with *T. recurvata*, regardless of the growth habit of the host (evergreen or deciduous). Genera and botanical family preference were in accordance with those species surveyed in this work. It became evident that there are some characteristics of the support which are relevant for the successful anchorage of the epiphyte: for example, rough, deep, and no exfoliating barks, branches which grow horizontally, no allelophatic and no exudating latex supports. It is also important to point out that individuals heavily laden with *T. recurvata* showed signs of decline, although the mechanism responsible for this is not clear (Benzing, 1980; Claver et al., 1983).

Drier winters, which improve seed dispersion, a greater number of seeds per plant, a high germination capacity during the first 4 months after the opening of the capsules — at least in controlled conditions (Fernández et al., 1989) — and hosts with the characteristics mentioned above favour the colonization of new areas and obviously of new hosts. As commercial forests and

plantings are carried out under conditions that promote rapid growth as a result of genotype selection, fertilization, disease control, etc. and which differ a lot from those situations found in natural forests, it is concluded that the presence of *T. recurvata* under certain environmental conditions is particularly dangerous for natural formations, mainly because of the time available for colonization and the wide offer of different supports. This fact is being confirmed by numerous reports from differents parts of the country. Therefore, some measures should be taken to reverse this situation in the short term as, for example, the successful application of selective herbicides carried out by Caldiz and Beltrano (1989) and Bártoli et al. (1992).

ACKNOWLEDGEMENTS

To Noemí Pérez, R. Andreau, C. Della Croce, F. Gnecco and A. Tambussi for skilful technical assistance during the work. The authors wish especially to thank Dr. J.C.G. Banks (Department of Forestry, the Australian National University, Canberra) for his valuable comments which contributed greatly to improving the present paper.

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