Selbyana 16(1): 36–40

THE FATE OF EPIPHYTIC ORCHIDS AFTER FRAGMENTATION OF A MEXICAN CLOUD FOREST

GUADALUPE WILLIAMS-LINERA, VICTORIA SOSA, AND TEODORO PLATAS

Instituto de Ecologia, Apartado Postal 63, Xalapa, Veracruz 91000, Mexico

ABSTRACT. The fate of some orchid species, and the importance of the landscape elements in the conservation of regional biodiversity were determined in cloud forest remnants in central Veracruz, Mexico. Remnant sites included forest fragments, isolated trees in pastures, and forest remnants used as shade for coffee plantations. A total of 61 orchid species were found in the landscape elements. Nine orchid species were recorded on isolated trees in pastures that were not found in any of the forest fragments studied. The terrestrial orchids were observed only in the forest fragments. Special note was made of the presence of orchid species that were collected for the first time in the region as these should be indicative of the status of the epiphytic flora in a fragmented landscape. These orchid species were: *Acineta barkeri, Campylocentrum schiedei, Leochilus carinatus, Lepanthes avis, Lepanthes schiedei* and *Pleurothallis tubata;* all species were observed in forest fragments, except *Lepanthes avis.* Only *A. barkeri* was found on isolated trees in the pasture. *Lepanthes avis, C. schiedei, Leochilus carinatus,* and *P. tubata* were observed on shade trees of the coffee plantations. Results indicate that every remnant of forest, including remnant trees, may contribute to preserve the biological diversity of a region.

RESUMEN. Para determinar el destino de algunas especies de orquídeas y la importancia de los elementos del paisaje en la conservación de la biodiversidad regional se estudiaron remanentes de bosque de neblina en Veracruz, México. Los sitios remanentes incluyeron fragmentos de bosque, árboles aislados en potreros y bosque usado como sombra para cafetales. Un total de 61 especies de orquídeas se encontraron en los elementos del paisaje considerados. Nueve especies que se registraron en árboles aislados no se encontraron en los fragmentos de bosque. Las orquídeas terrestres se observaron sólo en los fragmentos de bosque. Se observó, especialmente, la presencia de orquídeas que fueron colectadas por primera vez en la región ya que pueden indicar el estado de la flora epífita en el paisaje fragmentado actual. Estas especies son: *Acineta barkeri, Campylocentrum schiedei, Leochilus carinatus, Lepanthes avis, Lepanthes schiedei* y *Pleurothallis tubata.* Todas se observaron en los fragmentos de bosque, excepto *Lepanthes avis.* En árboles aislados se observó sólo a *A. barkeri.* En árboles de cafetal se observaron a *Lepanthes avis, C. schiedei, Leochilus carinatus* y *P. tubata.* Los resultados indican que los remanentes de bosque, aún los árboles aislados, pueden contribuir a conservar la diversidad biológica de una región.

INTRODUCTION

The fragmentation of a continuous forest into small remnants isolates local populations of organisms. A landscape perspective is required to understand and predict the effect of different degrees of forest fragmentation on diversity and structure of plant populations with various life-history characteristics. Fragments range in spatial scale from forest patches to individual trees. Conservation value of a fragmented landscape is not directly related to how much original habitat remains. Each landscape element needs to be considered as a repository of biological diversity, and the protection of the biological diversity of a region has to be considered in the broad landscape context (Forman & Godron 1986; Lord & Norton 1990; Saunders *et al.* 1991; Franklin 1993).

Orchids are by far the most diverse family of epiphytic neotropical species, and overwhelmingly the most diverse group of epiphytes (about 70% of their species are epiphytic); therefore estimates of orchid diversity are critical to an evaluation of epiphytic diversity (Gentry & Dodson 1987). In Mexico, epiphytes are characteristic elements of many plant communities ranging from tropical rain forest to arid tropical scrub. Montane (cloud) forest and lowland rain forest are richer in epiphytes than other communities. Epiphytic orchids in Mexico are found in 110 genera and 678 species (Aguirre-Leon 1992). Sixty percent of orchid species are found in the cloud forest, which occupies only 1.5% of the Mexican territory (Soto-Arenas 1992). In Veracruz alone there are 320 species of orchids, 80 of which have been typified from the state and most of which have been collected from the cloud forests near Xalapa, Veracruz (Salazar *et al.* in press).

There is growing recognition that the survival and maintenance of many epiphyte populations are increasingly threatened (Nadkarni 1992). Some orchid species have been reported as in danger of extinction in almost all tropical countries (including Mexico) due to 1) loss or degradation of epiphyte habitats due to activities

such as removal and fragmentation of forest for permanent conversion to pasture, agricultural fields, plantations or human settlements, and 2) over-collecting of horticulturally valuable species for commercial exploitation (Hagsater 1976; Nadkarni 1992). Due to their specialized habitat requirements epiphytic orchids may be used as indicators of the integrity of fragmented ecological communities.

We studied cloud forest remnants to determine 1) what species of orchids might serve as indicators of original forest conditions, 2) the fate of these species following forest fragmentation, and 3) diversity of orchids in different types of forest remnants.

Study Area

The study region is located in central Veracruz, Mexico, between 19°32'N, 19°25'N and 97°06'W, 96°56'W. Altitude varied between 1250 and 1410 m. Total annual precipitation is between 1500 and 2000 mm, and mean annual temperature is around 18°C. The vegetation is lower montane moist forest (sensu Holdridge et al. 1971) or cloud forest. Until the beginning of this century, the region of Xalapa had large tracts of continuous cloud forest. At present, the intact forest is found only on steep slopes of narrow gorges, where the topography prevents their destruction. The patches are commonly surrounded by coffee plantations, pastures, old fields, and human settlements. *Liquidambar macrophylla, Carpinus caroliniana, Quercus xalapensis, Q. germana, Turpinia insignis, Oreopanax xalapensis,* and some Lauraceae are dominant trees (Williams-Linera 1993).

Methods

Landscape Elements

We studied four remnant forest fragments, ranging from 5 to 15 ha in extent. Slopes were between 40–60%. The total area sampled was about 25 ha. Trunk diameter of big trees was around 0.75 m and canopy height was between 20 and 23 m. Between 70 and 100 host trees were censused in each fragment.

Isolated trees (ca. 70 individuals) within 100 m of a road were examined in one 2.5 km long pasture cleared at least 60 years ago, currently being used. Remnant forest trees were represented mainly by *Liquidambar macrophylla*; a few trees were *Clethra* sp., and *Quercus* spp. Trees were commonly 30 to 50 m apart. Trunk diameters ranged from 0.80 to 1.47 m, and their height was between 19 and 24 m.

We examined approximately 50 host trees in each of two coffee plantations with areas of 12 ha and 10 ha. In these remnants, the understory has been replaced by coffee trees, and the forest canopy is used as shade for the coffee plantation. These forest remnants have introduced trees such as *Citrus* spp., and *Inga* spp.

Orchids

In each study site all orchid species growing on the trees were recorded. Field work was conducted between November, 1991, and October, 1993, visiting each study site every season of the year. Previous to field work, local orchid species were learned from descriptions, collections, photographs, and herbarium specimens. Observations were made from the ground using binoculars. Special note was made of the presence of orchid species originally described from the cloud forests of central Veracruz as these should be indicative of the status of the locally adapted epiphytic flora.

A preliminary list of orchid species that were originally described from central Veracruz was obtained from the data base of the Mexican Orchid Association (AMO, Hagsater & Garcia 1994) and Flora of Veracruz (Sosa & Gomez-Pompa in press). A final list was obtained after reviewing original descriptions. *Acineta barkeri* (Lindley 1843), *Campylocentrum schiedei* (Hemsley *et al.* 1885), *Leochilus carinatus* (Lindley 1842), *Lepanthes avis* (Reichenbach 1849), *Lepanthes schiedei* (Reichenbach 1856), and *Pleurothallis tubata* (Steudel 1854), were collected for the first time in the neighbourhood of Xalapa in primary montane (cloud) forest. Their types are reported as "from Mexico, near Xalapa". All are very poorly represented in the collections of the main Mexican herbaria such as the National Herbarium (MEXU), the Politechnic Herbarium (ENCB), the herbarium of the Mexican Orchid Association (AMO), and the Institute of Ecology herbarium at Xalapa (XAL).

Results

Orchid Species in the Landscape Elements

A total of 61 orchid species were found in the three landscape elements studied. Eight terrestrial orchid species and eight epiphytic species were observed growing only in the forest fragments (Table 1).

All six of the focal species originally described from Xalapa cloud forests were observed in forest fragments, except *Lepanthes avis.* Only *Acineta barkeri* was found on isolated trees in the pasture. *Lepanthes avis, Campylocentrum schiedei, Leochilus carinatus,* and *Pleurothallis*

TABLE 1. Orchid species recorded in forest fragments, isolated trees in pastures, and coffee plantations under forest remnants in the cloud forest region of central Veracruz, Mexico. * indicates orchids that were originally described from this region.

	Forest	Trees	Coffee shade
Epiphytic orchids			
Acineta barkeri (Batem.) Lindl.*	X	X	
Amparoa beloglossa (Rchb. f.) Schltr.		X	
Arpophyllum alpinum Lindl.	X	X	
Brassia verrucosa Lindl.	X	X	X
Campylocentrum schiedei (Rchb. f.) Benth. ex Hemsl.*	X		X
Chysis laevis Lindl.	X		X
Coelia macrostachya Lindl.	X	X	
Comparettia falcata Poepp. & Endl.	X		X
Dichaea glauca (Sw.) Lindl.	X	X	
Dichaea muricatoides Hamer & Garay			X
Dichaea neglecta Schltr.	X	X	X
Dichaea sp.	X		
Elleanthus cynarocephalus (Rchb. f.) Rchb. f.	X	X	
Encyclia candollei (Lindl.) Schltr.	X		X
Encyclia ochracea (Lindl.) Dressler	X	X	X
Encyclia polybulbon (Sw.) Dressler	X	X	X
Encyclia varicosa (Lindl.) Schltr.		X	
Encyclia vitellina (Lindl.) Dressler	X	X	
Epidendrum laucheanum Rolfe ex Bonhof		X	
Epidendrum longipetalum A. Rich. & Gal.		X	
Epidendrum melistagum Hagsater		X	X
Epidendrum parkinsonianum Hook.	X	X	X
Epidendrum polyanthum Lindl.	X		
Epidendrum repens Cogn.	X	X	
Epidendrum veroscriptum Hagsater	X		
Epidendrum sp.		X	
Gongora galeata (Lindl.) Rchb. f.	X		X
Isochilus major Cham. & Schlecht.	X	X	X
Isochilus aff. *unilaterale* Robins.	X	X	X
Jacquiniella leucomelana (Rchb. f.) Schltr.	X	X	X
Jacquiniella teretifolia (Sw.) Britt. & Wilson	X	X	X
Laelia anceps Lindl.			X
Leochilus carinatus (Knowl. & Westc.) Lindl.*	X		X
Leochilus oncidioides Knowl. & Westc.	X		X
Lepanthes avis Rchb. f.*			X
Lepanthes schiedei Rchb. f.*	X		
Lycaste aromatica (Graham.) Lindl.	X	X	
Lycaste deppei (Lodd.) Lindl.		X	
Maxillaria aff. *cucullata* Lindl.	X		
Maxillaria densa Lindl.	X	X	X
Maxillaria meleagris Lindl.	X	X	
Maxillaria variabilis Batem ex Lindl.	X	X	X
Mormodes maculata var. *unicolor* (Hook.) L. O. Wms.		X	
Nidema boothii (Lindl.) Schltr.	X	X	X
Oncidium incurvum Baker ex Lindl.	X	X	
Oncidium sp.	X		
Pleurothallis platystylis Schltr.	X	X	
Pleurothallis tubata (Lodd.) Steud.*	X		X
Pleurothallis tuerkheimii Schltr.	X	X	
Rhynchostele cordatum (Lindl.) Albinger		X	
Scaphyglottis livida (Lindl.) Schltr.	X	X	X
Stanhopea oculata (Lodd.) Lindl.	X		
Stelis aff. *rubens* Schltr.	X	X	
Xylobium foveatum (Lindl.) Nicholson	X		
Terrestrial orchids			
Calanthe calanthoides (Rich. & Gal.) Hamer & Garay	X		
Cranichis sp.			

TABLE 1. Continued.

	Forest	Trees	Coffee shade
Goodyera aff. *striata* Rchb. f.	X		
Habenaria sp.	X		
Malaxis sp.	X		
Pelexia funckiana (A. Rich. & Gal.) Schltr.	X		
Presscottia stachyodes (Sw.) Lindl.	X		
Psilochilus macrophyllus (Lindl.) Ames.	X		

tubata were observed on shade trees of the coffee plantations (TABLE 1).

In the forest fragments as a whole we found 51 orchid species, compared to 35 on isolated trees in the pasture, and 25 species observed growing on shade trees in the two coffee plantations. Unexpectedly the isolated trees in the single pasture supported more orchid species than the richest single forest fragment (28 spp.). Nine species recorded on isolated trees in the pasture were not found in any of the forest fragments studied. These are *Amparoa beloglossa, Encyclia varicosa, Epidendrum laucheanum, E. longipetalum, Epidendrum* sp.; *Rhynchostele cordatum, Lycaste deppei,* and *Mormodes maculata* var. *unicolor; Epidendrum melistagum* was found both on an isolated tree and on shade trees of a coffee plantation. Two species were observed only in remnant forests used as shade for coffee: *Dichaea muricatoides* and *Laelia anceps.*

DISCUSSION

The modern distribution of the six species selected a priori as indicative of the original cloud forest conditions in central Veracruz can give us some insight into the impact of current land use on epiphyte populations, and into the conservation value of various types of forest remnants. All six species still exist in the area, but no single type of remnant contains all. Five were found in forest fragments (and one, *Lepanthes schiedei,* only there); four in coffee shade trees (and one, *Lepanthes avis,* only there); and one (*Acineta barkeri*) was found in isolated trees as well as forest fragments, but not in coffee shade trees.

Although the use of 'indicator species' to monitor or assess environmental conditions has been critisized (see Noss 1990), these six orchids grew originally in a distinctive, epiphytic, habitat, so their presence or absence in the present landscape may indicate something of the status of the regional biodiversity.

Species originally collected from several forests worldwide, are no longer found in the region. For instance, in the monsoon tropical forest of the Kerala region, Western Ghats, India, comparative floristic accounts reveal that a large number of orchids are not found where they were recorded earlier. The orchid-rich areas are now more or less barren and devoid of orchids, due presumably to reckless and rapid destruction of the orchid habitats. In this region some orchids are considered extinct and no collection record is available other than the type collection (Kumar & Sasidharan 1986).

In comparison, the cloud forests of central Veracruz are fortunate. If a remnant is any patch of native vegetation around which most or all of the original vegetation has been removed (Saunders *et al.* 1991), then, the smallest forest remnant is an isolated forest tree in a pasture. In our study of such trees, the "living dead" may sustain communities of several species, including species characteristic of the original forest. Thus, isolated forest trees should be considered and preserved as an important landscape element, as well as forest fragments, or modified forest remnants.

Our results indicate that in the case of orchid populations, conservation measures should be planned in terms of the entire landscape. Each landscape element has permitted the survival of orchids outside the original forest. Studies and methods to protect viable populations of orchids in different landscape elements need to be developed.

In central Veracruz every remnant of forest, including remnant trees, may contribute to preserve the biological diversity of the region. Species-based efforts for conservation should not be abandoned, but a landscape approach has to be implemented to monitor the biodiversity of this region and to preserve forest fragments and other landscape elements.

ACKNOWLEDGMENTS

We are very grateful to Bob Lawton and Steve Ingram for helpful suggestions and constructive criticism that improved the manuscript. We thank Michael Keyes and Eric Hagsater for comments

on an earlier version, and Sergio Avendaño for help in the field. This study was supported in part by a grant from CONACyT (Ref:0063-N9106).

Literature Cited

Aguirre-Leon E. 1992. "Vascular epiphytes of Mexico: a preliminary inventory." *Selbyana* 13: 72–76.

Forman R. T. T. and M. Godron. 1976. *Landscape Ecology.* John Wiley & Sons. New York. 619 pp.

Franklin J. F. 1993. "Preserving biodiversity: species, ecosystems, or landscapes." *Ecol. Appl.* 3: 202–205.

Gentry A. H. and C. H. Dodson. 1987. "Diversity and biogeography of neotropical vascular epiphytes." *Ann. Missouri Bot. Gard.* 74: 205–233.

Hagsater E. 1976. "Orchids and conservation in Mexico." *Orchid Rev.* 84: 39–42.

Hagsater E. and J. García. 1994. "AMO-DATA. (Electronic data base of the Asoc. Mex. Orq. Herbarium)." Mexico City, Mexico.

Hemsley W. B., F. Godman and J. Salvin. 1885. "*Campylocentrum schiedei.*" *Biol. Centr. Amer., Bot.* 3: 292.

Holdridge L. R., W. C. Grenke, W. H. Hatheway, T. Liang, and J. A. Tosi. 1971. *Forest environments in tropical life zones: a pilot study.* Pergamon Press, Oxford. 747 pp.

Kumar M. and N. Sasidharan. 1986. "Orchids of Kerala and their conservation." Pp. 363–376. *in* S. P. Vij, ed., *Biology, conservation, and culture of orchids.* Afiliated East-West Press Provate Limited. New Delhi.

Lindley J. 1842. "*Leochilus carinatus.*" *Bot. Reg.* 28: Misc. 23.

Lindley J. 1843. "*Acineta barkeri.*" *Bot. Reg.* 29: Misc. p. 68.

Lord J. M. and D. A. Norton. 1990. "Scale and the spatial concept of fragmentation." *Conserv. Biol.* 4: 197–202.

Nadkarni N. M. 1992. "The conservation of epiphytes and their habitats: summary of a discussion at the international Symposium on the Biology and Conservation of Epiphytes." *Selbyana* 13: 140–142.

Noss R. F. 1990. "Indicators for monitoring biodiversity: a hierarchical approach." *Conserv. Biol.* 4: 355–364.

Reichenbach H. G. 1849. "*Lepanthes schiedei.*" *Linnaea* 22: 820.

Reichenbach H. G. 1856. "*Lepanthes avis.*" *Xenia Orchidacearum.* Vol. I p. 144, vol. II pp. 5–7.

Salazar G., V. Sosa and M. A. Soto-Arenas. "Orchidaceae I. Flora de Veracruz." Vol. 82. Instituto de Ecologia-University of California, Riverside. Xalapa, Veracruz, Mexico. *In press.*

Saunders D. A., R. J. Hobbs, and C. R. Margules. 1991. "Biological consequences of ecosystem fragmentation: a review." *Conserv. Biol.* 5: 18–32.

Sosa V. and A. Gómez-Pompa. "Lista florística. Flora de Veracruz." Vol. 83. Instituto de Ecologia-University of California, Riverside. Xalapa, Veracruz, Mexico. *In press.*

Soto-Arenas M. 1992. "The distribution of Mexican orchids and its implications in conservation." Symposium abstract. *Selbyana* 13: 165.

Steudel E. G. 1854. "*Pleurothallis tubata.*" *Nom. ed.* 2 (2): 356.

Williams-Linera G. 1993. "Vegetación de bordes de un bosque nublado en el Parque Ecológico Clavijero, Xalapa, Veracruz, México." *Rev. Biol. Trop.* 41: 107–117.