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Monitoring endemic plant extinction in Veracruz, Mexico

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We present species extinction information based directly on field work on six endemic vascular plants of Veracruz. Amongst 22 species that have been reported to consist of very few individuals for the State, seven of them are endemic to Veracruz. We looked for six of these species in previously recorded sites to determine if they are totally extinct. We determined the status of the extant species and their actual habitat and populations. The species studied included: *Antirhea aromatica*, *Diospyros riojae*, *Eugenia mozomboensis*, *Impatiens mexicana*, *Hyperbaena jalcomulcensis* and *Zamia inermis*. We located these in fragments of tropical and dry forests. Juvenile plants of the *Zamia* and *Eugenia* were not seen in the field.

Keywords: plant species extinction; Veracruz; Mexico; tropical forest; cloud forest; dry forest.

Introduction

Field based evidence of plant extinctions is scarce. Extinction indices have largely been documented on information found in 'red data books on threatened species', on deforestation rates (Smith *et al*., 1993) and predictive models (Koopowitz, 1992). Almost all examples of species extinction come from temperate areas as well as organisms such as mammals and birds (Heywood and Stuart, 1992).

Regions of the world which have been well studied show relatively high proportions of extinctions while those regions least studied show relatively fewer extinctions (Smith *et al*., 1993). However, it is possible that investigating some of these geographical areas and taxonomic groups, many species described some decades ago and not studied since then may well be extinct (Smith *et al*., 1993).

Species extinction information based directly on field work on endemic vascular plants of Veracruz is presented in this study. The Flora of Veracruz Project has explored extensively the state of Veracruz and a good collection index has been registered (Sosa and Gómez-Pompa, 1994). Deforestation rates and habitat fragmentation assessment have been determined for Veracruz (Equihua *et al*., 1998). The database on the Flora of Veracruz contains information on vascular plant species records held in the principal herbaria of the world (Gómez-Pompa *et al*., 1984). The relatively wide knowledge of the Flora of Veracruz, permits us to investigate the status of the endemic species of the State.

The number of vascular plant species for Veracruz is estimated to be 8200 (Sosa and Gómez-Pompa, 1994). Approximately 200 of these have been reported to be threatened (Anonymous, 1994; Vovides *et al*., 1997). Among these, 22 species have been considered to consist of very few individuals for the State, and seven of these are endemic to Veracruz

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(Sosa, 1998). The endemic Veracruz studied species are: *Antirhea aromatica* Cast.-Campos and Lorence (Rubiaceae); *Diospyros riojae* Gómez-Pompa (Ebenaceae); *Eugenia mozomboensis* P.E. Sánchez (Myrtaceae); *Hyperbaena jalcomulcensis* E. Pérez and Cast.-Campos (Menispermaceae); *Impatiens mexicana* Rydb. (Balsaminaceae); and *Zamia inermis* Vovides, Rees and Vázq.-Torres (Zamiaceae).

The objectives of this study are to determine on the basis of direct field observations, whether the Veracruz endemics are in fact extinct and if still extant, to determine the actual state of their populations.

Methods

Flora of Veracruz databases were consulted to determine previous localities for the six endemic plant species. Sites were visited based on this information. At the sites we walked extensively through each population to estimate its extent. Six 10×10 m quadrats were laid out to verify the average number of individuals per square metre, and the total individuals in the population was estimated. In the case of trees, height and d.b.h. were recorded.

Results and discussion

Studied species

Antirhea aromatica is a tree of the central region of Veracruz in the municipality of Jalcomulco, growing in an area characterized by calcareous hills with evergreen tropical rain-forest (Castillo-Campos and Lorence, 1985). Natural regeneration of this species was the highest among the species studied. The populations had more juveniles than adult plants, and a total of 39 individuals in 600 m^2 were counted (Tables 1 and 2; Fig. 1). This oil-containing species is apparently used as medicinal by the local community, and might merit further study and pharmaceutical screening.

Diospyros riojae is a small tree reported from cloud and evergreen tropical forests. We still consider this species largely as a Veracruz endemic even though a few individuals have been reported from the neighbouring states of Tamaulipas and Hidalgo. *Diospyros riojae* has also been reported from Rancho del Cielo in Tamaulipas (Pacheco, 1981). This species appears to be extinct from its type locality in the Sierra de Chiconquiaco, Veracruz (Williams-Linera *et al.*, 1996). However, it is known from two other localities; the Sierra de Tantima, an isolated inaccessible tepui-like mountain in northern Veracruz with relatively undisturbed cloud forest, and in a forested escarpment surrounded by pasture south of Plan de las Hayas that was monitored during this study where a total of 21 individuals in 600 m^2 were counted. More work is needed to determine the status of this species (Tables 1 and 2; Fig. 1).

Eugenia mozomboensis is a shrub from the Actopan region, in tropical deciduous forests (Sánchez-Vindas, 1990), though low in individual numbers, each individual covers a great area (over a 100 m^2 in some cases) by stoloniferous spreading. We believe that this is an alternative strategy to sexual reproduction since no regeneration from seed was noted. A total of six individuals in 600 m^2 was counted (Tables 1 and 2; Fig. 1). This species has potential as an ornamental tropical shrub.

Hyperbaena jalcomulcensis is a deciduous tree of central Veracruz in a range of vegetation types from deciduous to tall evergreen rain-forests on karst topography of the

Table 1. Species, habit, year of description, and habitat

Species studied	Habit	First described	Habitat
Antirhea aromatica	Tree	1985	Evergreen tropical forest
Diospyros riojae	Tree	1964	Cloud forest
Eugenia mozomboensis	Shrub	1986	Deciduous tropical forest
Hyperbaena jalcomulcensis	Tree	1988	Evergreen tropical forest
Impatiens mexicana	Herb	1910	Cloud forest
Zamia inermis	Cycad	1983	Deciduous tropical forest

Table 2. Number of individuals observed directly in the actual habitat

Species	Sites	No. per 600 m^2
Antirhea aromatica	Jalcomulco	39
Diospyros riojae	Alto Lucero	21
Eugenia mozomboensis	Mozomboa	6
Hyperbaena jalcomulcensis	Jalcomulco	26
Impatiens mexicana	Las Minas	2
Zamia inermis	Mozomboa	72

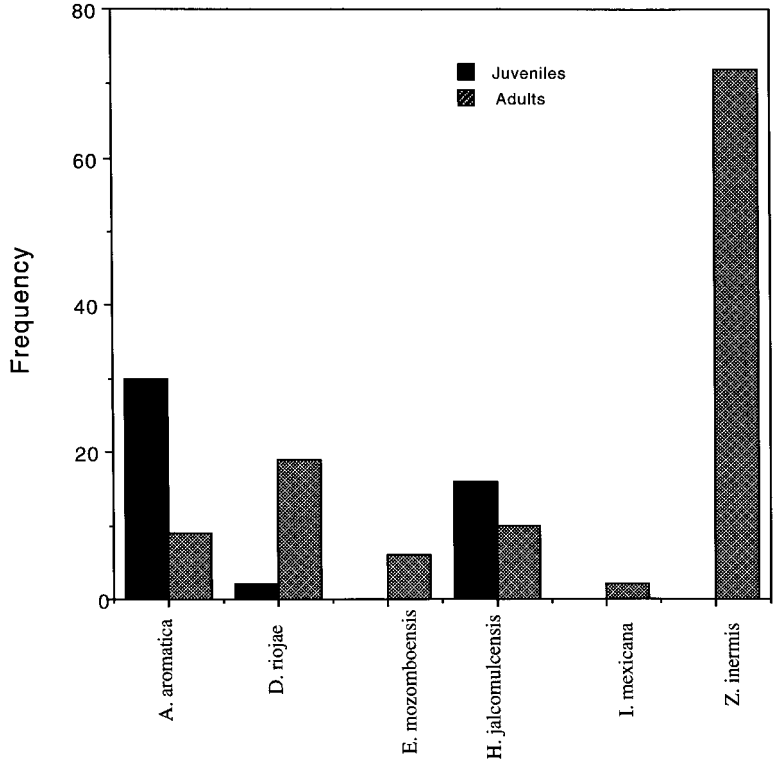

Figure 1. Number of individuals directly found in the field of the studied species in 600 m^2.

Jalcomulco region (Pérez-Cueto, 1995). Twenty-six individuals were counted in 600 m^2 (Tables 1 and 2; Fig. 1).

Impatiens mexicana is a small succulent herb from the mountains of Orizaba, Cofre de Perote and Xalapa (Barringer, 1991). During this study it was found at only one locality near the Cofre de Perote region in disturbed cloud-forest in a moist canyon grazed by goats. Only two individuals of this species were found in 600 m^2 with no sign of regeneration (Tables 1 and 2; Fig. 1). In the case of this species grazing by goats is affecting the plants.

Zamia inermis is a cycad endemic to small mountain range in central Veracruz, in deciduous tropical forests. Exact locality is not disclosed since this cycad species is subject to illegal collecting (Vovides, 1983).

Status of populations

Antirhea, *Hyperbaena*, and *Diospyros* show reasonable regeneration from seed (Fig. 1). In spite of the lack of a detailed population study of these three species, we can say that the populations are regenerating, and if the habitat is not further disturbed there are good probabilities of their long term survival.

For *Eugenia*, *Impatiens* and *Zamia* no regeneration from seed was observed (Fig. 1).

We believe that the regeneration problem in *Zamia* is pollination related. Field observations with cycads, such as *Z. integrifolia* (Norstog *et al*., 1992) have demonstrated that low to nil regeneration is likely to be related to pollination. Periodic burning of their habitats has reduced the number of beetle pollinators in the case *Z. integrifolia* (Norstog *et al*., 1992). Pollinators were not found in *Z. inermis* habitats even though coning was found to be frequent, no regeneration was recorded amongst these cycads. It appears that deforestation, burning and illegal collecting are the main factors that have reduced populations of this species (Gilbert, 1984; Vovides, 1989; Vovides and Iglesias, 1994), thus reducing brood and shelter sites of the specific insect pollinators (Norstog and Fawcett, 1989). *Zamia inermis* is of ornamental importance. A similar situation is seen with the endemic cycad *Microcycas calocoma* (Miq.) A.DC. in relatively intact habitats of Cuba, which shows very low to nil natural regeneration though coning can be frequent, but no pollinators present (Vovides *et al*., 1997).

Habitat fragmentation

Our field observations indicated that the species are isolated in fragmented patches of forest that have survived due to the inaccessible sites and topography. They will probably go extinct because of population size and poor regeneration in some cases.

These habitats are highly fragmented but nevertheless important for the survival of these endemics. Since these fragments are not protected by any nature reserve system their situation therefore becomes even more critical since agricultural expansion is a constant threat.

Fragmentation of habitats poses problems in species survival and in designing conservation strategies. Edge effects in fragmented forests need to be understood more (Murcia, 1995). Fragmentation threatens the persistence of some species independently of the species loss predicted by the species–area relationship. Herbivory or predation of particular species may increase in a fragmented landscape due to light incidence that causes leaf flushes (Murcia, 1995) or successional processes may be impeded by fragmentation and lead to a different sort of climax community (Simberloff, 1992). One more

problem is that habitat fragmentation leaves rare species stranded in scattered areas, each containing relatively few species as indicated by Curnutt *et al*. (1994). Scattered areas obviously present more difficulties.

The six endemic species located are found in steep mountains surrounded by pasture lands or corn or mango plantations. Efforts to preserve these species must focus at the landscape level (Ghazoul, 1996). Franklin (1993) has pointed out that designing an appropriate system of habitat reserves is one landscape level concern. Understanding and appropriately manipulating the landscape matrix is at least equal in importance to reserve use.

It can be seen from this study that these Veracruz endemics are not extinct, which appears contrary to what theoretical models might predict if global deforestation rates are considered. For example, cloud forest area in Veracruz is reduced to 24% of the original surface or deciduous tropical forest occupies only 19% (Equihua *et al*., 1998). However, the species studied were still found in these forests. This supports Turner and Corlett's (1996) contention that 'a substantial number of forest species can persist for decades in fragmented forest'.

Though this study may be considered empirical, we contend that it is important for the localization of suspected extinct, rare, threatened and endangered species. This sets the stage for more detailed population and pollinator interaction studies in the future as well as propagating the species in botanic gardens. Furthermore, these forest fragments should be of conservation priority since many of them lie near or within one of the five primary Pleistocene refugia of Mexico thus harboring rare biotypes (Vovides and Gómez-Pompa, 1977; Toledo, 1982). These inaccessible and difficult-to-work-in habitats must be more thoroughly explored botanically and proposed as micro-reserves or sanctuaries. Being relatively small fragmented forests their conservation need not be costly and can fall within the possibilities of local communities, land owners and plantation managers, especially if useful species are contained therein (Turner and Corlett, 1996).

Conservation strategies

The number of individuals of the species studied populations will have also to be considered for designing conservation strategies. The likelihood of survival of a species depends on both population size and time (Shaffer, 1987). Lande and Barrowcloth (1987) concluded that every conservation effort should be made to preserve evolutionarily important amounts of quantitative genetic variation by maintaining effective population sizes of at least several hundred individuals. Four of the endemic species located have several hundreds of individuals, and three of the species appear to be producing seed. Saving these species from extinction might be possible through the action taken by botanic gardens as suggested by Heywood (1991) by: collecting and bulking up of seed samples, preservation of seed under desiccation and refrigeration, research into the reproductive biology and the production of germination protocols for the species and research into their cultural requirements for further reintroduction.

Conclusions

We feel it should be mentioned that most theoretical papers on the endangered species problems do not always consider canyons and other inaccessible microhabitats where the species might be found. We therefore emphasize that exploratory work in these localities should be carried out and the following conservation strategies are proposed: (i) collection

of germplasm for *ex-situ* conservation and propagation in botanic gardens, and other gene banks; (ii) proposition of sanctuaries; and (iii) detailed demographic and plant–animal relationship studies as well as the dynamics of the vegetation fragments.

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