Extinction Is Forever

The Status of Threatened and Endangered Plants of the Americas.

The New York Botanical Garden
Extinction Is Forever

Threatened and Endangered Species of Plants in
the Americas and Their Significance in
Ecosystems Today and in the Future

Proceedings of a symposium held at the
New York Botanical Garden, May 11-13, 1976, in commemoration
of the Bicentennial of the United States of America

Edited by
Ghillean T. Prance
The New York Botanical Garden
Bronx, New York 10458, U.S.A.

and
Thomas S. Elias
The Cary Arboretum of
The New York Botanical Garden
Millbrook, New York 12545, U.S.A.
Dedicated to the Memory of
Carlos Muñoz Pizarro 1913 - 1976

Copyright © 1977
The New York Botanical Garden

Published by
The New York Botanical Garden
Bronx, New York 10458, U.S.A.

Library of Congress Catalog Card Number: 77-302
International Standard Book Number: 0-89327-196-9
Printed in the United States of America
Design, Composition and Printing by Maar Printing Service Poughkeepsie, New York, U.S.A.

Publication of this book was made possible by the support of the U. S. Department of Interior through the National Parks Service and the U. S. Fish and Wildlife Service.

Printed on 100% recycled paper.
INTRODUCTION

Mexican territory, which covers approximately two million square kilometers, is largely mountainous and contains many high plateaus. It is geologically, topographically, and climatically very diverse. Fig. 1, for example, gives some idea of the range of climates of just one Mexican state, Veracruz. This, therefore, plus the fact that it lies approximately between 30 and 15 degrees north latitude, placing it at the tropic extremes, enables the country to support a most diversified flora. It is here that three geofloras meet: the holarctic, the autochthonous and the neotropical. The intermingling of these floras during past geological times must have contributed greatly to the present richness of the Mexican flora.

The following is a brief background of the vegetational history of Mexico. Owing to the north-south orientation of the major mountain ranges of the Americas, the southward migration of floras was easily accomplished during the Pleistocene glaciations. We are in agreement with Raven and Axelrod (1975), who state that "Opportunities for the migration of cool-temperate and montane plants and animals between North and South America were never greater than in Pleistocene and Recent Times, and such groups as the gooseberries and currants (Ribes), the locoweed (Astragalus), willows (Salix), and evening primroses (Oenothera), now represented by many species in South America, probably arrived on that continent only during the past million years or so and evolved rapidly under the influence of the expanding and fluctuating climates characteristic of Pleistocene cycles." This would account for the boreal elements at high altitudes in present-day Mexico such as Pinus, Liquidambar, Carpinus, and Acer, to mention a few. These could be said to be the southern biotypes from temperate elements of North America, even though in the past, some of them probably were northern extensions of a tropical montane flora. But no matter what their origin may be, they are now recognized as distinct populations which should be preserved and protected.

According to Raven and Axelrod (1975), plants and animals of temperate North America spread slowly into South America. Typical of these are such genera as Abies,
Alnus, Liquidambar, Fagus, Juglans, and Ulmus, which reached the mountains of southern Mexico 16 million years ago. This accords with Graham (1973) whose findings revealed pollen of ten temperate arborescent genera in the younger Middle Miocene Paraje Solo formation of southern Veracruz. These genera include Alnus, Abies, Celtis, Fagus, Juglans, Liquidambar, Myrica, Populus, and Ulmus.

Fig. 2. Minimum extreme temperatures in the state of Veracruz, measured from 1921 to 1970. (After Gomez-Pompa, 1973).
High altitude areas provide favorable habitats for species typical of more northern latitudes. This gives eastern Mexico an unusual structure in its humid mountain floral communities, which contain a surprising mixture of species with very diverse geographical affinities. Some of these communities are in the transition zone between *tierra caliente* and *tierra templada*, which lies at the altitude between about 1,000 and 1,200 meters. It is in these transition zones where the great geofloras intermingle that there is extreme competition and selection of populations, and it is these very same zones which are fast disappearing. Biotypes with genetic adaptations to tropic extremes are being lost before botanists can get to know them.

Temperature is an important selection factor for floras at this tropic extreme. The average values of temperature are not important factors in understanding species distribution here, but minimum extreme temperatures, even though they may occur only rarely, play a far more important role in the elimination of low-temperature sensitive species from this region. Fig. 2 shows the minimum extreme temperatures in the state of Veracruz, as measured from 1921 to 1970 in stations lower than 300 meters altitude. There is a distinct difference in the north, with minimum extreme temperatures close to 0°C, as compared to the south, with minimum extreme temperatures around 10°C.

The presence of boreal elements such as *Liquidambar* in the Gulf Coast mountains between 900 and 1,600 meters altitude, is clear evidence of a temperate flora that was probably more widely distributed during the Pleistocene, and that these elements are relics which have found suitable niches at these altitudes (Fig. 3).

**Fig. 3.** Vegetation profile of the volcano of San Martín, Los Tuxtlas, Veracruz (from Gómez-Pompa, 1973).

When attempting to compile an inventory of threatened and endangered species, the biggest stumbling block one encounters is the lack of an inventory of the Flora of Mexico. Partial floras can help, but it is almost impossible to be absolutely certain as to which plants are rare, threatened, or endangered. The existing herbarium specimens are no indication of the plants' status in this respect. Moreover, the existence of a few individuals of a so-called "rare species" in any given locality does not necessarily indicate that the plant is rare, because it may be found to be widely dispersed or much more abundant elsewhere. On the other hand, a very rare species may be locally abundant. Lack of information — coupled with the daily destruction of habitats such as tropical rain forest
and temperate cloud forests — makes the compiling of an inventory of threatened and endangered species an increasingly difficult task. With the disappearance of entire habitats and ecosystems, many species can become extinct before they even are known (Fig. 4). For example, the Misantla region of Veracruz was well-collected during the last century by botanists from Europe and many species were described from classical localities such as Colipa and Pital in that area. Today, however, no rain forest exists there at all. The problem which confronts us today, therefore, is that it is not known what has been lost irretrievably. It is assumed that there were endemics there, but two questions remain: Were they indeed endemics? Or were they products of splitter taxonomy of the last century? We do not know, and type specimens help us very little in this respect.

In the past, strong emphasis was given to species conservation, especially to animals. This awareness largely developed in temperate countries, and as in many other situations, this concern eventually reached the tropics though it has up to now contributed little to the solution of the problem.

We think it is as important to conserve the Mexican genetic pool of species populations at the tropic extreme as it is to conserve rare individual species. Species of wide distribution ranges at more southern latitudes have different biotypes from those of the tropic extremes, and we are greatly concerned because it is this important genetic diversity which is being threatened or lost. The following example illustrates this point: In an experiment to study population differentiation in a tropical rain forest species *Terminalia amazonia*, seed populations were collected from Central America and Mexico. After germination, the young seedlings were transplanted to an introduction station in Mexico. All the Central American seedlings were exterminated by predators, especially ants (Gómez-Pompa et al., 1972). This clearly indicates the existence of physiological races of *T. amazonia* in Mexico which differ from those of Central America.

The importance of genetic diversity should be stressed for both agriculturists and plant breeders. The future for conservation in Mexico, however, appears bright, as more people at the decision-making level become increasingly aware of the existing problems. But the chief stumbling block today is time — do we have enough time? Astonishing as increasing levels of smog began to plague the people of Mexico City. This, coupled with

Fig. 4. Clear felled area in the Río Uxpanapa region.
the smoke produced by the mass burning of vegetation in the southeast of the country which interfered with aircraft landings, alerted officials to the inherent dangers.

Some recent specific governmental action also has triggered concern for Mexico's environment: the creation of the Subsecretaría del Mejoramiento del Ambiente (Undersecretary for the Betterment of the Environment); the Population Law; and the Human Settlements Law. In addition, there is the creation of a National Ecological Programme and the foundation of at least four Institutes or Centers which are related to and concerned with ecology and natural resources. One of these is the Instituto de Investigaciones sobre Recursos Bioticos (INIREB - Institute for Research in Biotic Resources), to which we belong. Legal progress made during the last three years, and its subsequent increasing public awareness, makes us feel optimistic about this problem for the near future.

ENDANGERED ECOSYSTEMS

The most endangered ecosystems in Mexico are lowland tropical forests and mountain cloud forests. In these ecosystems the endemicity at the generic level is very small. In fact, the relative abundance of the endemic element in the woody flora of Mexico, when analysed on the generic level, shows a clear correlation with arid climate. There is a correlation, also, between the relative scarcity of endemic elements and humid climates of Mexico (Rzedowski, 1962). At the species level, the endemism in tropical rain forests of Mexico has not been studied but it is rather high in many groups, especially herbs and shrubs.

The real problem of Mexican rain forests — and possibly of all rain forests — is their inability to regenerate under intensive use. Rain forests regenerate themselves through a process of secondary forest succession. Secondary species which are fast-growing, sun-loving, and produce seeds which have long dormancy and viability, take advantage of clearings produced by natural processes such as storms, floods, and by fires caused by lightning. However, there are always seedlings of young primary tree species on the forest floor. Under disturbed conditions these seedlings will continue to grow at an increased rate while many secondary species start growth from dormant seeds in the soil. After several years the primary trees have overtopped the secondary ones and the major step in regeneration is thus accomplished. Primary rain forest trees have large heavy seeds with short viability and natural dispersal by animals, water, and gravity. Regeneration of these species can occur only if sufficient rain forest is left undisturbed in the immediate vicinity, such as in primitive shifting cultivation systems where only minute areas are cleared and where the genetic pool of the primary trees is retained to give a supply of propagules to the disturbed areas when abandoned.

This serious problem has been discussed and emphasized in the past also. For example:

Professor E.J.H. Corner reported in his Malaysian study just after the Second World War: "There is urgent need for the preservation of the tropical forest, particularly lowland in large nature reserves in all tropical countries. The number of botanic gardens in the tropics should be increased and should develop better relations, particularly in the loan or exchange of staff" (Corner, 1946).

Professor J. Heslop-Harrison: "There are real hazards in eliminating biological diversity. Our scientific understanding of the rain forest plants now vanishing is no more than superficial; our knowledge of the economic potential of the species under threat fragmentary; and our acquaintance with their chemistry and pharmacology trivial. The high successes of modern agriculture have been bought at a cost by reducing the genetic basis on which production rests. The expansion of areas under cultivation ousts the wild races and primitive relatives of marginal lands. So the gene pool available for future breeding is drained away" (Heslop-Harrison, 1975).

"It is of imperative importance to retain pieces of the original rain forest as the only way to reconstruct future forest. With the present rate of destruction of the tropical rain forests there is great danger of mass extinction of thousands of species due to the simple fact that primary tree species from tropical rain forests are incapable of recolonizing large areas opened to intensive and extensive agriculture. Thousands of
species could disappear before any aspect of their biology has been studied. This would mean the loss of millions of years of evolution. There is incomplete scientific evidence to prove this assertion, but if we wait for a generation to provide abundant evidence there will not be any rain forests left to prove it” (Gómez-Pompa et al, 1972).

(Figs. 5, 6).

Fig. 5. Selective felled forest in the Balankan-Tenosique region of Tabasco.

CONSERVATION

Conservation frequently is regarded as a sentimental middle-class luxury of western
society which the poorer countries cannot afford. However, it should be pointed out here that conservation also forms the very essence of the great ancient ethical and religious systems of the East. But conservation must never be practised for conservation’s sake alone, without including Man as an integral part of the ecosystem to be conserved. For example, it is totally wrong to earmark an area as a “Nature Reserve: Keep Out,” and then have it policed, while multitudes of starving peasants in the vicinity are looking for a suitable spot where they can plant next season’s crop, the latter being traditional and never varying from one or two species. This “colonialist” approach to conservation is doomed to failure, for it fails to reach the very heart of the problem and can lead only to future deep-rooted antagonism for generations to come — if the system ever manages to survive that long in spite of itself!

Conservation of natural resources has been approached in many ways and has played an increasingly important role in industrial civilization. According to Dansereau (1957) conservation, historically, can be divided into four distinct phases:

1) Legislative phase:
   Protection given to wild plants and animals decreed by law and focussed almost entirely on rare species.

2) Biological phase:
   As detailed inventories of flora and fauna were made, a more scientific approach was initiated; freedom of certain areas from disturbance so that individual plants and animals could be studied; protection of large populations of trees and birds.

3) Ecological phase:
   With the disappearance of many species and a rising consciousness of the interrelatedness of living things, it was claimed that no efficient protection of individual species was possible if the habitat as a whole were not free from direct or indirect disturbance.

4) Sociological phase:
   The harnessing of the world’s resources is being viewed in a new light and a joint attack made on the question as a whole. Conflicting forces are increasing human populations and decreasing resources. It has been said that land and available resources are an
arithmetical progression, whereas human population increases in a geometrical progression.

In a bulletin it publishes based on regular worldwide reports, the International Union for the Conservation of Nature states that individual species of plants and animals and — even more important — biotypes and endemics, can receive no effective protection unless their habitat itself is spared from destruction or interference, and that ecosystems are the really vital units with which our economy deals.

What can be done to get land-hungry peasants and laymen to accept this? Basic awareness of the problem is of prime importance. This can be accomplished by a concerted educational program, and by publicity through the mass media such as radio, T.V., and newspapers. The problem must be communicated to official decision-makers as well as to the general public. The encouragement of conservation-oriented competitions and quizzes in schools also is an effective method of communicating the problem to young people in whose hands the future of countless species ultimately rests. A good example of the type of program which should be encouraged is the recent competition put forward by INREB for primary schools of the state of Veracruz. Children were asked to submit pressed specimens, drawings and information on any useful wild plant of Veracruz. The contest has met with great enthusiasm and success and winners will receive a conducted tour of the state and a visit to the Institute's laboratories in Xalapa (Figs. 7, 8).

Fig. 7. Useful wild plant of Veracruz competition for primary schools. *Sabal mexicana* used for making mats, chairs, roofing and bedding, prepared by Hector Díaz Hernández, age 14.

Following are four general guidelines for a suggested National Conservation Program:

1. Technical, practical and scientific explanations must be clearly stated so that everyone will understand what is needed. Radio and T.V. documentaries can be of great help in this connection.
2. Conservation should be included in a list of sound land use practices.
3. More research biologists are urgently needed to work in the most endangered zones, such as in the Mexican lowlands and in the cloud forests of the Sierras. At present, most of the experts spend much of their time in Mexico City, rather than out in the field.
4. The possibilities of increased tourism, hunting, fishing, and other recreational activities in areas of exceptional beauty can bring untold wealth to small peasant
communities as well as a better income from more efficient farming.

Fig. 8. Useful wild plant of Veracruz competition. Agave plant, ixtle, used for making household items, prepared by Serafin Vallejo Galan, age 12.

It should be pointed out that today’s destruction of natural areas in the tropics is a symptom of a much greater problem: population growth and deficient food supply. To permanently solve the problem of conservation, it is first necessary to solve the major problems of population and food. This is by no means a defeatist attitude on our part, rather it emphasizes the need to go to the very roots of the problem. Protected National Parks are not the permanent solution. The political and socio-economic aspects of under-development first have to be solved, before a definite and permanent solution for the tropics is arrived at. One possible answer to this problem in Mexico, at least, are the biosphere reserves.

BIOSPHERE RESERVES

The Man and the Biosphere (MAB) programme of UNESCO is doing much to promote international cooperation in the fields of conservation and development. Through this programme Mexico approved the general idea and adapted it to suit the country, with the result that two biosphere reserves already have been established in la Michilia and Mapimi in the state of Durango. These are desert areas, but a similar system of reserves is being planned for the Selva Lacandona of Chiapas.

The fundamental part of the programme is designed to promote a multiple agreement between scientists, landowners, the general public, and the federal and state governments. With this agreement, an association is formed with the consensus of all and signed by all parties. The obligation of the participants to the pact is to follow the agreements and to help to enforce them.

The object of biosphere reserves of Mexico is to conserve for the present and future use of man, the diversity and integrity of all biotic communities within natural ecosystems; to serve as gene-pool banks in order to safeguard the genetic diversity of animal and plant species; to provide areas for basic ecological research within the biosphere reserves as well as in adjacent areas; and to provide the means for efficient management of the reserves by teaching at different levels and training of local personnel. In addition,
residents must be taught the principle of "renewable resources" in general, and how they can improve their present land use practices. For example: The Michilia reserve covers an area of 35,000 hectares and is divided into the four following zones:

(a) Nucleus or integral reserve zone
(b) Buffer zone
(c) Applied reserve zone
(d) Influence zone

Nucleus zone:
This is an area of total conservation in its truest sense, to which only research scientists have access. This zone not only serves as a germ plasm bank but also as a means of comparison of what has been done in the buffer and research zones, i.e., faunistic and floristic changes due to anthropogenic or natural causes. Valuable autecological information can be obtained from this zone, which has had practically no human disturbance.

Buffer zone:
This is a relatively large area completely enclosing the nucleus zone from easy access. It serves the important function of protecting the nucleus zone from either geochemical or microclimatic man-induced changes. The zone offers potential recreational amenities, implementation of educational programs, tourist activity, and other means, all designed to promote increased appreciation of the ecosystems.

Applied research zone:
From the point of view of economical benefits, this zone is of major importance. It is here that experiments are carried out which have long or short-term applications. The search for plant species with possible medicinal or forage use, both direct or indirect, is carried out. One of the most important factors that this zone has to offer is to channel the resolution of specific problems confronting common-land users, the general public, small landowners, and peasants, as well as the improvement of their cattle, agricultural, fructicultural, and silvicultural methods. Research into new products for local industries will give the inhabitants an alternative source of income besides the fringe benefits obtained from tourism. It is hoped that this activity also will further understanding between scientists, peasants, small landowners, and government authorities, and also will encourage amicable relations among these groups. This is of fundamental importance to the actual protection and future conservation of the nucleus and buffer zones.

Influence zone:
Technically, this zone remains a part of the reserve until such time as research results have a permanent application in the ecosystems of the buffer and research zones, but the results can and should be extended to all ecosystems with similar characteristics in the area.

As land use techniques improve and with the introduction of new products for local industries, it is hoped that there will be less need for peasants to migrate into new areas or to the big cities when traditional agricultural methods fail. With these areas the needs of all participants will be fulfilled and the protection of the area is effected by the people living there. No guards, therefore, will be needed.

PRESENT WORK ON ENDANGERED SPECIES

Owing to the above-mentioned difficulties concerning the production of a reliable list of threatened and endangered species, Instituto de Investigaciones sobre Recursos Bióticos (INIREB) has a program in collaboration with the IUCN to produce a preliminary list of endangered and threatened plant species of Mexico which offers as objective a view of the problem as possible. The main method used for achieving this is to submit a questionnaire to botanists and specialists, asking them for such information as species, locality, state, altitude, reasons, etc., for their belief that a plant species is threatened or endangered.
This, coupled with the consultation of the meagre available literature, is beginning to form a slowly-growing list of endangered plants. Interviews with amateur and commercial collectors also can be helpful, but one must be wary because these people are often those most responsible for the rapid depletion of many ornamental species such as cacti.

Tighter legislation should be enacted in order to control the activities of commercial exporters. It has been brought to our attention that a large number of Mexican cacti are exported from Mexico, for example, under the pretext of utilization for biochemical research. Cacti also are exploited ostensibly for construction of botanical gardens, but

Fig. 9. Dioon spinulosum Dyer with female cone. One of the plants on the Mexican endangered species list seen here growing in a garden in Acatlán, Oaxaca.
we believe they are to be resold for other uses. Mexican plants collected in the wild are exported, though such license was originally granted to cover nursery-grown stock only.

Publicity in horticultural journals should reduce demand by fostering an enlightened attitude amongst private collectors and enthusiasts. This is by no means aimed at persecuting the private collector. In fact, properly-documented private collections can be of infinite value to conservation. The desire to raise difficult plants from seeds and to propagate such plants must be fostered amongst enthusiasts. It requires far more skill on the gardener’s part to raise a difficult plant from seed or cutting than to pay large sums of money for an imported specimen, which often does poorly and soon dies, due to the sudden change of environmental conditions. Flower show judges should be alert to this difficulty and should award winning points accordingly.

We wish to collect from endangered habitats samples of endangered plants for cultivation and propagation in future botanic gardens and it is hoped that in the near future, rare and endangered plants can be reintroduced into suitable habitats that have been assigned to reserves or national parks in much the same way that reindeer were reintroduced into the Highlands of Scotland, after having been extinct there for many generations.

Here are some examples of threatened or endangered plant species from our growing list:

<table>
<thead>
<tr>
<th>Species</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astrophytum myriostigma Lem.</td>
<td>Coahuila</td>
</tr>
<tr>
<td>Agave victoria-reginae Moore</td>
<td>Nuevo León</td>
</tr>
<tr>
<td>Ceratozamia miquelianiana Wendl.</td>
<td>Veracruz</td>
</tr>
<tr>
<td>Dipoon edule Lindl.</td>
<td>Oaxaca</td>
</tr>
<tr>
<td>D. spinulosum Dyer</td>
<td>Veracruz</td>
</tr>
<tr>
<td>Diospyros riajae Gómez-Pompa</td>
<td>Veracruz</td>
</tr>
<tr>
<td>Hydrangea nebulicola Nevl. &amp; Gómez-Pompa</td>
<td>Coahuila</td>
</tr>
<tr>
<td>Leuchtenbergia principes Hooker</td>
<td>Veracruz</td>
</tr>
<tr>
<td>Zamia furfuracea L.</td>
<td></td>
</tr>
</tbody>
</table>

We hope that some day soon, Man in his potential infinite wisdom will want to repair the damage done to all ecosystems, especially the tropical rain forest. We hope also that there will be enough germ plasm left to enable the reconstruction of these ecosystems as living museums for future generations of mankind.

LITERATURE CITED


