Pines

A Mexican Gift to the World

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Mexico is recognized as one of the five countries with the highest biological diversity in the world. Of all the known species on our planet around 10 percent can be found in Mexico. This is partially the result of a very complex geological history, together with a broad climate gradient, which have created many different environmental conditions. Also, its geographical position as a land bridge connecting North and South America has contributed to its diversity.

The world's coniferous forests are characterized by the presence of tall woody trees, among these are such familiar trees as *Tsuga* (hemlock), *Abies* (fir), *Picea* (spruce), *Juniperus* (juniper, red cedar), *Sequoiadendron* (Sierra redwood) from the Northern Hemisphere and *Araucaria and Podocarpus* from the Southern Hemisphere. Most of these produce their ovules in a compound conelet (*strobili* is the technical name for conifer "flowers"). Maturation of the seeds occurs in cones which constitute the "fruits."

Mexico is predominantly highland, with more than half of its territory over 1,000 meters high. This mountain landscape is mainly covered by forest. The National Institute for Forestry, Agricultural and Animal Husbandry Research (INIFAP) estimates that there are about 30 million hectares of forest or wooded land in Mexico, of which 21 million are coniferous forest, with pine as the dominant species.

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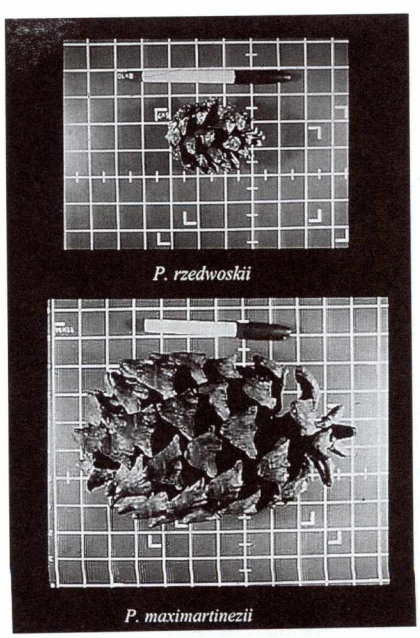

Above: Pinus rzedwoskii.
Below: Pinus maximartinezii.

What Is a Pine?

Common names sometimes cause confusion. To many people "pines" include not only the genus *Pinus*, but *Abies* (fir), *Picea* (spruce) and *Pseudotsuga* (pseudohemlock) as well. These genera are included in the family *Pinaceae*, one of the 8 conifer families. Pines are distinguished from other conifers by their needle-like leaves, born singly or more commonly in fascicles of two to six on short shoots, with a sheath of bud scales at the base when young. They have woody cone scales with specialized apical regions. Many cones of different pine species are used for decoration at Christmas time. The genus *Pinus* is the largest in the family *Pinaceae* and is more diverse that any other conifer.

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Pines are native only to the Northern Hemisphere, with the exception of a single species, *Pinus merkusii*, found below the equator in Sumatra. Pine species are distributed throughout the boreal region, but species diversity is low. On the other hand, in the tropical mountains, the range of species distribution is low while species diversity is greater. Also species diversity of pines is higher in North America than in Eurasia. For example *Pinus sylvestris*, the Scott pine, is very widely distributed, covering enormous forest inland areas of Europe and Asia, whereas the mountains and coastal ranges of northwestern Mexico and California boast almost 25 different species.

Photos by Volkhard Seits

Immature cone of *Pinus nelsonii* with a long penduncle.

Lively debate continues about the exact number of species in the genus. Some botanists have recognized around 90 species while others have totaled 120. This is partially due to the fact that widespread taxa often show geographical variation that may or may not be worthy of infraspecific rank. Mexico is a center of pine diversity. From 43 to 51 species (depending on the author) and many infraspecific taxa are found in Mexico. This accounts for almost half of the total number of pine species in the world.

CLASSIFICATION

Pines are an old group of plants: their ancestors lived at the same time as the dinosaurs, more than 100 million years ago. It is widely accepted that there are two natural groups within the genus *Pinus*; they are often called "hard" and "soft" pines. This distinction corresponds to subgenus *Pinus* and subgenus *Strobus* respectively. Both of these subgenera are present in Mexican forests. Maximino Martínez, a Mexican botanist, published a very detailed monograph of the pines in Mexico 50 years ago. At that time, he recognized 39 species and several subspecies and varieties.

Within the two main groups, pines are classified into subgroups named sections and subsections. Accepted classifications of the genus include 17 subsections, nine of which include Mexican pines. New revisions of this group of trees have led botanists and taxonomists to consider the creation of new subsections for some of the Mexican species. This is a result of the very peculiar or

intermediate morphology that they present. A Mexican species with its own subsections is *P. rzedowskii.* This pine, which grows in a few places in Michoacán state, exhibits many features of soft pines but also some characteristics of the cone and seeds found in hard pines, making it somewhat intermediate between the two major groups. Their study provides us with incomparable information about pine evolution.

PINE DIVERSITY

The origin of species remains one of the most important questions in evolutionary biology. We know that biological diversity is generated by the differentiation of populations and their further consolidation by speciation. One of the factors associated with these processes is environmental conditions that promote fragmentation of populations and concomitant divergence.

In Mexico there are two important north-south mountain ranges, the Sierra Madre Occidental in the West and the Sierra Madre Oriental in the East. The Eje Neovolcánico Transversal joins these western and eastern ranges with a chain of volcanic mountains reaching altitudes of 3,000 to 4,000 meters, along the states of Michoacán, Mexico, Morelos and Puebla. To the southwest, the Sierra Madre del Sur continues along the Pacific coast as a narrow range of mountains that jut almost straight up from the sea. The Sierra Madre Oriental, after joining with the Eje Neovolcánico Transversal in Puebla, continues southeastward and merges with the Sierra Madre del Sur around the Valley of Oaxaca. At this point the mountain ranges extend eastward to the Isthmus of Tehuantepec. East of the isthmus the mountains rise again to more than 2,000 meters and divide into two principal ranges, the Sierra Madre de Chiapas and the Mesa de Chiapas.

The elevation of these mountains was a monumental change that had equally important effects on the pine populations over a vast area. Many species disappeared entirely while others were reduced to relict populations. Furthermore, fragmented populations were probably the origin of new species. The mountain ranges in Mexico have risen in different geo logical periods. The oldest is the Sierra Madre Occidental, dating from about 85 million years ago, while others are more recent. This exerted a profound influence on the region's vegetation. The two main north-south ranges undoubtedly contributed as routes for the spread of pines. Two centers of pine diversity and evolution are associated with the topology of the country: the Eje Neovolcánico Transversal, with extensions along the Sierra Madre Occidental and the Sierra Madre del Sur. The other center is northeastern Mexico. Here we find 14 to 18 taxa in most states. The species of the first area are almost all Mexican taxa non-existant in any other part of the world. In addition, this region constitutes the main area for three species complexes that have very high levels of morphological and genetic variation: *P. devoniana, P. montezumae and P. pseudostrobus.*

Virtually all the environments in which pines grow throughout the world exist in Mexico. The country's extraordinarily varied topography and climate range from wet, lowland tropical rain forests and montane tropical cloud forest, to hot shrub land and deserts and snow-capped mountains, often in close proximity to each other. Due to the great elevation of some of the mountains and their latitude, climatic zonation is pronounced within short distances, and isolated populations and taxa are commonplace. The northeastern center of pine diversity apparently corresponds to pine species that had adapted to warmer, dryer conditions, and this had led to the spread of taxa and colonization of environments where few other trees can survive. The isolation accounts for another important characteristic of Mexican pines: local endemism, with species like *P. culminicola, P. nelsonii, P. rzedowskii and P. pinceana,* presenting very narrow and localized distribution.

Pine forests are significant because of their ability to produce food (such as pinyons) and oxygen; they also provide shelter for birds, mammals and insects. Various epiphytes, especially lichen and mosses, grow in their bark and branches. Also a very intricate net of mycorrizal fungi grow associated with the pine roots. Pine forests play a very important role in maintaining an efficient ecological cycle of nutrients. A correct strategy for maintaining the forest will prevent soil erosion, a common consequence of indiscriminate clear cutting on mountain slopes.

ECONOMIC IMPORTANCE

The great value of pine trees in paper and lumber production and for ship building and other commercial purpos-

es has markedly reduced the extent of natural stands in areas readily accessible to transportation. Mexico still has some of these areas, which represent a reservoir of genetic pine resources for the world.

Mexican pines as a forest resource are of great significance and importance to the economy of the country. There are two main types of pine products. The primary, or direct, products are wood, resins and seed, while secondary, or indirect, products are charcoal, turpentine, pitch, tar, etc.

Pinus nelsonii at Peña Nevada, Nuevo León.

The timber of many species is used for industrial and commercial purposes as well as for the local population. It is also one of the best sources of pulp for craft paper and cardboard. Its importance lies in the fact that the xylem of most hard pine species produces long fibers, giving extra strength to the final product. Among the pines currently being heavily exploited are *P. patula, P. oocarpa, P. pseudostrobus and P. herrerae*. Tree branches are also locally collected for fuel, although the resin often causes a great deal of smoke. Pine resin exploitation is the basis for the turpentine industry, which is a major job provider in several states, particularly Oaxaca, Chiapas, Jalisco, Nuevo León, Durango and Michoacán. The pinyon pines are also an important source of local revenue in northern Mexico, producing edible nuts that may be eaten or used as decoration. When the pinyons are ripe, whole communities move to forest areas to harvest them. Actually, one the most recently described species, *P. maximartinezii*, was discovered by the great botanist, Jerzy Rzedowski. In a local market in Zacatecas, he noticed that the seeds on sale were much larger than the well-known seeds of the *P. cembroides*, the Mexican pinyon pine.

Timber exploitation is increasing at an amazing rate, and in many areas it is indiscriminate. Pines subject to it suffer from genetic erosion, decreasing their ability to change and adapt to different conditions and in some cases even to sustain viable populations. Obviously this has a very negative influence on reforestation efforts.

ECOLOGICAL DIVERSITY AND POTENTIAL USES

Despite their economic and ecological importance, the ecological diversity of pines is amazing. Variation among species in morphology and life history is rich. There appears to be a striking recurrence of ecologically similar sets of species in different geographic areas. For example, one group of pines is distinguished by characteristics increasing the likelihood of mature trees surviving fire: most are tall, with thick bark, long needles, and thick twigs. In addition, they tend to have large, heavily armed cones (with stout, sharp spines), large seeds with long wings, and be slow in initiation of seed production. Some Mexican species in this group are *Pinus duranguensis, P. montezumae, P. engelmanni and P. hartwegii.*

Another ecological group of pines includes species with higher shade tolerance than others: thin twigs, unarmed cone scales, mesic sites, fast growth, tall habit, short needle retention and precocious reproduction. This group is represented by the Mexican soft pine *P. ayacahuite* and its close relatives, *P. strobiformis* and *P. chiapensis.*

Pines considered stress-tolerant comprise another ecological group. They are short trees or shrubs, with long leaf persistence; they produce large seeds that generally lack wings. Their bark is very thin and they grow slowly. They grow mainly in dry or cold sites, or both. Many of the pines that comprise this group are known as pinyon pines; their seeds are spread by birds.

Cone serotiny (late opening) is the main characteristic shared by another

ecological group of pines whose cones require very high temperatures to open and release their seeds. Populations of the species in this group tend to survive as seeds when they go through infrequent though catastrophic fires. Some of the species in this group with different levels of serotiny are *P. eiophylla, P. patula, P. attenuta* (knobcone pine) and *P. contorta* (lodgepole pine); the latter two also grow in the western United States.

The characterization of these groups gives us an idea of the potential uses of different species. Pine conservation strategies may lead us, for example, to select resistant trees for different purposes. Trees well adapted to dry conditions may be selected for planting in dry areas. Also, if a new blight develops, trees resistant to it may be chosen to regenerate affected regions. In this sense, Mexican pine forests are an important source of natural resources. Unfortunately, *P. patula* is the only Mexican species widely planted with a high demand for its seed. Other Mexican species are not known commercially outside the country.

Finally, endangered and beautiful pines like *P. nelsonii* and *P. rzedowskii*, with an exceptional morphology, are excellent candidates for use as ornamental species, and we should also foster their survival. Pines, like corn and chocolate, are another gift from Mexico to the world that should be appreciated and wisely used. VM

FURTHER READING

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