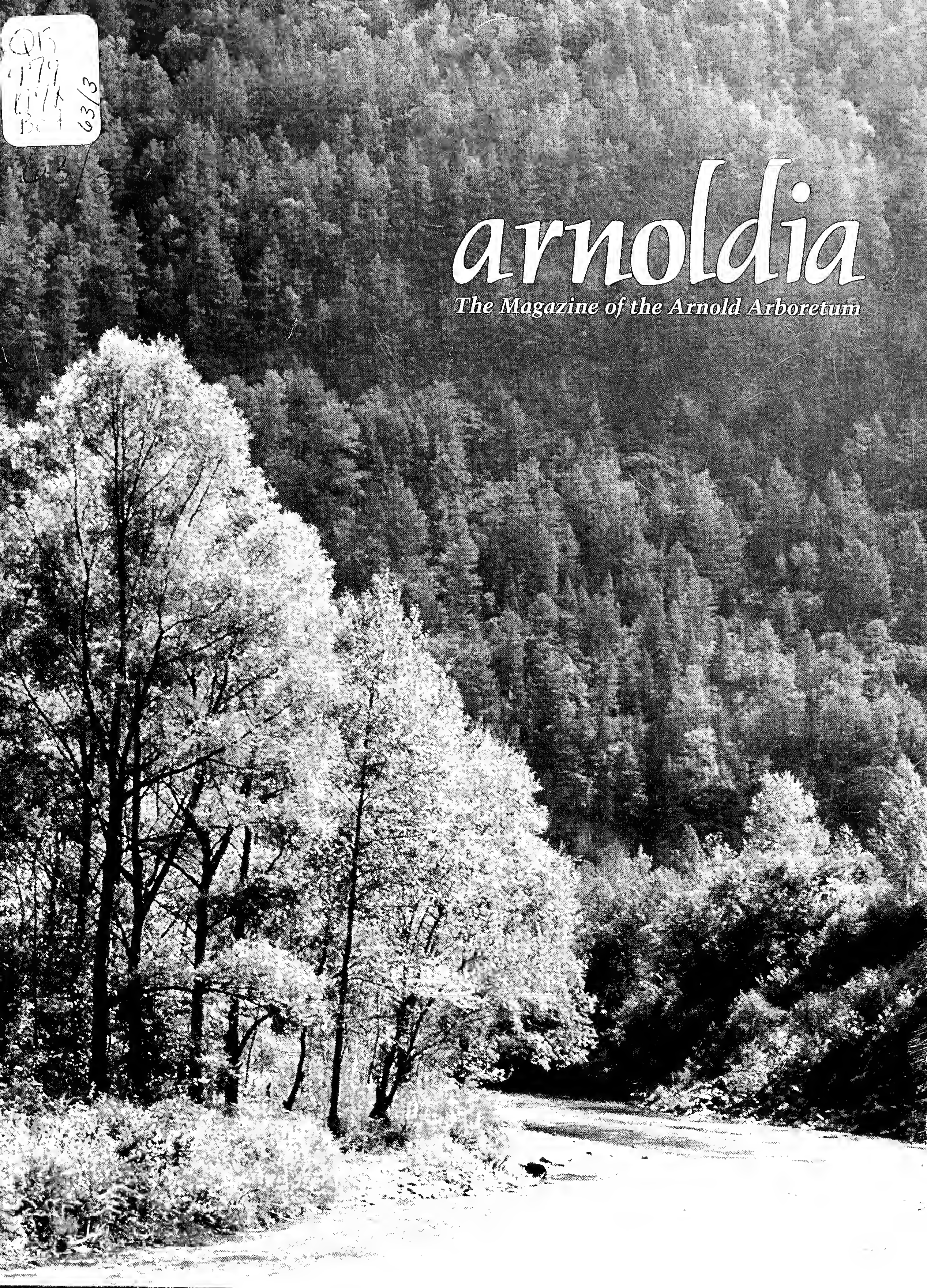

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Page

Front cover: Chosenia arbutifolia growing near the Yalu River on China's border with North Korea, photographed by Peter Del Tredici.

Inside front cover: Betula ermanii clinging to a rock face on Changbai Shan, photographed by Peter Del Tredici.

Inside back cover: In October 1923, while collecting plants for the Arnold Arboretum in Shanxi Province, China, Joseph Hers photographed the roots of this *Thuja orientalis* (now *Platycladus orientalis*, the oriental arborvitae) growing out of a stone wall. The image is one of 4,500 images in the Arnold Arboretum's collection of historical photographs of East Asia.

Back cover: The leaves and fruits of *Dipterocarpus costulatus* photographed by K. M. Wong in Malaysia.

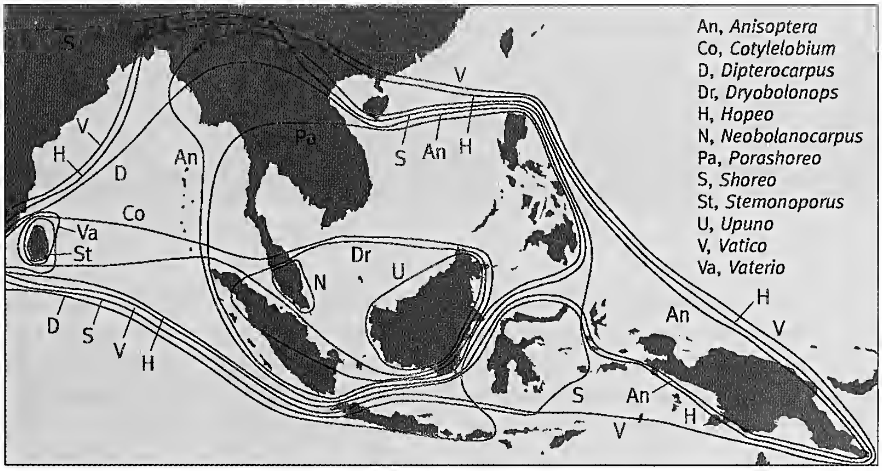
Dipterocarps: Trees That Dominate the Asian Rain Forest

Richard Corlett and Richard Primack

First-time visitors to the rain forests of Indonesia and Malaysia will be amazed to slowly turn around and realize that virtually every giant tree is a member of the dipterocarp family, and yet that they belong to several separate genera and dozens of distinct species. The tree family Dipterocarpaceae (literally "two-winged fruits") plays a dominant role in the ecology and economics of Asian forests in a way that no comparable family plays in other rain forest regions. Dipterocarp trees dominate forests in Borneo, Sumatra, Java, the Malay Peninsula, and the wetter parts of the Philippines, where the majority of the large trees are members of this one family and account for the majority of the biomass. Outside this core everwet area, dipterocarps gradually decline in diversity and abundance. A secondary center of dipterocarp diversity exists in Sri Lanka. In total, there are at least 500 Asian species. Dipterocarp trees also have excellent timber qualities, and they are marketed internationally as luan plywood and as sawn timber under names such as Philippines red mahogany, meranti, keruing, and kapur.

A few species of dipterocarp trees are found in the African tropics and Madagascar, though not in rain forests, and in the highlands of South America, giving testament to the family's origin and spread on the ancient southern supercontinent of Gondwana. The dipterocarps appear to have reached Southeast Asia from Africa via the Indian plate and did not arrive until the middle Eocene (45 million years ago), when a moist corridor between India and Southeast Asia resulted in a major influx of plants with Gondwanan affinities. Despite this relatively late arrival, the dipterocarps underwent a massive evolutionary radiation in Southeast Asia.

Enumerations of research plots in Southeast Asian forests show a conspicuous proliferation



FROM T. C. WHITMORE, 1984

The ranges of dipterocarp genera illustrate that the center of distribution of this tree family lies in Indonesia's Sundaland region. Sri Lanka, just off the southern coast of Africa, is a secondary center. Each line encloses the distribution of all species in one genus.

of tree species within the individual genera *Shorea, Hopea, Dipterocarpus,* and *Vatica.* In any one forest in the Malay Peninsula, Sumatra, or Borneo, it would be common to find 25 or more species of *Shorea,* and six or more species of the other three genera. Imagine going into a small patch of forest in North America and finding 40 species of oaks and chestnuts. More recently, in

Giant dipterocarp trees, such as this one in Borneo, dominate the forests of Southeast Asia. Photo by Richard Primack geological terms, a few dipterocarp species have managed to disperse from island to island across the narrowing water gap to New Guinea, where they dominate in scattered patches.

This proliferation of closely related tree species is found in a few other Southeast Asian groups as well, such as *Syzygium,* in the myrtle family, and *Diospyros,* in the ebony family. The proliferation of distinctive but closely related tree species growing together in one place is a special feature of the Asian rain forests, not as common in rain forests elsewhere. Scientists are still debating the arguments to explain this local abundance of closely related tree species. One example of this phenomenon in the temperate zone is the numerous species of morphologically distinct oaks (family Fagaceae) found growing together in the dry forests of southeastern United States.

TIM LAMAN

Looking up at the cauliflower-like branching pattern of dipterocarp trees, Borneo.

Why should the dipterocarps in particular be so dominant in Asian rain forests? There is no obvious single answer, but certain common features hint at the reasons behind their success. Dipterocarps tend to have smooth, straight trunks rising to great heights without side branches or forks until the canopy is reached. The base of the tree is often buttressed. These growth characteristics emphasize the strength and stability of individual dipterocarp trees. Because of these growth characteristics and the abundant year-round rainfall, the dipterocarp trees often reach heights of 50 meters (150 feet) or more, which is higher than rain forests elsewhere. Also, trees do not typically fall over or get blown over as is seen in many Neotropical trees. Rather, dipterocarps often die standing, gradually losing their branches until only the trunk remains. As a result, the dipterocarp forest tends to be darker and more stable than forests in Africa (where the trees are shorter and are killed by periodic drought) and the Amazon (where trees may have a greater tendency to fall over and create large canopy gaps soon occupied by sun-loving trees and vines). Once dipterocarp trees reach the canopy and emerge from it, they produce a characteristic crown that is shaped like a cauliflower, with clusters of leafy branches evenly spaced around a dome. A tendency toward lower wind speeds in Southeast Asian rain forests than in the other regions may favor this growth habit.

Another possible key to the dipterocarps' success in Asian rain forests and the long lives of individual trees is the presence in all plant parts of an oily, aromatic resin that presumably aids the plant in defense against attack by bacteria, fungi, and animals. This resin often accumulates where the bark is bruised and is encountered as hard, crusty, glass-like pieces on the trunk or on the ground. This resin, called *dammar,* is collected by the local people and used in varnishes or as boat caulking. The value of this resin is illustrated by the kapur tree, also known as the Bornean camphor tree *(Dryobalanops aromatica).* Historically, this species has been one of the main commercial sources of camphor, an essential oil of importance for its use in medicine and as a preservative. The crushed leaves have a distinctive camphor or kerosene-like smell.

Dipterocarps also contain bitter-tasting tannins as a further deterrent to attack. Although nondipterocarp trees also have chemical defenses in their foliage, dipterocarp leaves do seem peculiarly inedible, at least to vertebrates. This is illustrated by the colugo, a leaf-eating, gliding mammal that lives in dipterocarp forests and forages widely in the tree canopy for new leaves but does not eat dipterocarp leaves. The orangutan and proboscis monkey, which also eat young leaves, again do not eat dipterocarp leaves.

The flowers of dipterocarps vary in size, some being small and others being relatively large and showy with five white, yellow, or pink petals and often with numerous stamens. The flowers are also often scented and are adapted for pollination by a variety of insects—thrips, beetles, bees, or moths—depending on the species. Following flowering, a fruit is produced consisting of a single-seeded nut with a membranous winglike calyx that looks like a badminton shuttlecock. The ratio of the fruit weight to the total wing area—known as the wing loading—is much higher in dipterocarps than in most other winged fruits, so they spin to the ground within a few meters of the parent tree. At least this is what usually happens. Certain dipterocarp species have crossed major water barriers to reach New Guinea and the Philippines, which suggests that they sometimes travel long distances. The key to their success must lie in occasional windstorms plucking the winged fruits off the tall trees and transporting them across rivers and seas.

A further reason for the success of the dipterocarps in the everwet areas of Southeast Asia may be the way most of the dipterocarp species over a wide region flower and fruit simultaneously only once every two to seven years. In an entire forest only a few dipterocarp trees will flower in an ordinary year, but during a so-called "mast" year almost every large tree reproduces.

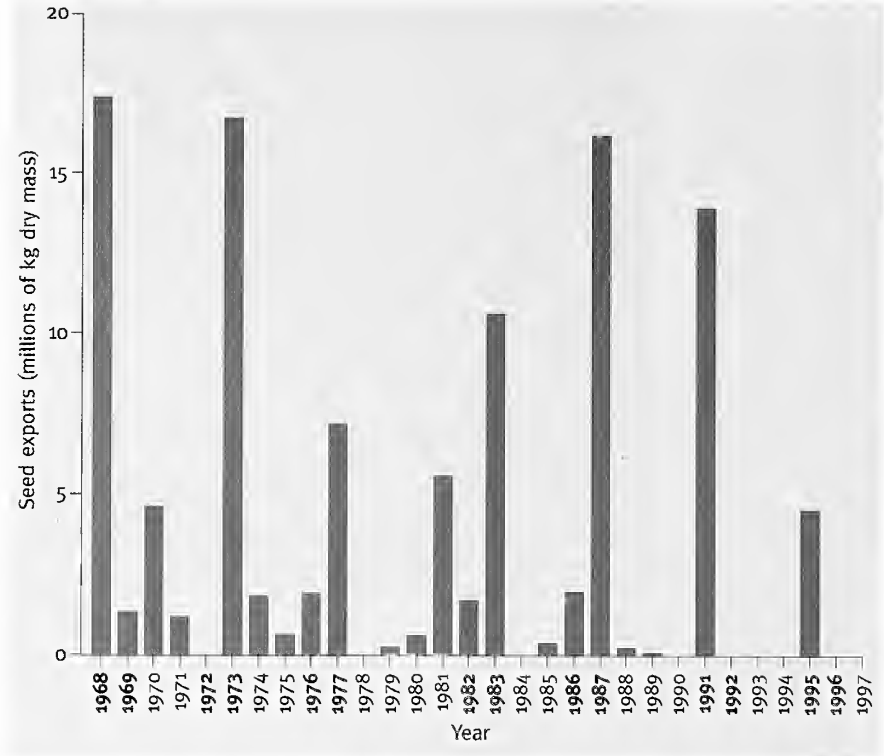
Individual plant species have mast years in all rain forests, but only in Southeast Asia do the mast years of so many species coincide over such a large area. The trigger for the initiation of flower development may be a brief episode of low nighttime temperature caused by strong radiative cooling under cloudless conditions during a drought two months before flowering. However, these meteorological conditions do not always trigger mass flowering, showing that other factors are also important, presumably

Flowers of a dipterocarp species, Hopea ponga, *from India.*

including the amount of resources the trees have accumulated since the last event.

Two main advantages to this type of masting behavior have been suggested. First, in the Asian everwet climate, with no distinct wet and dry seasons, plants need some cue to trigger the onset of reproduction. In this way, all the individuals of a species can flower at the same time, and cross-pollination among trees of the same species can occur. The multiyear seasonality of the El Niño cycle provides the distinct set of conditions needed to coordinate reproduction, and it is used by almost every species of dipterocarp in these forests.

Second, and perhaps more important, mass fruiting at long intervals may prevent the build-up of the populations of insects, birds, and mammals that would destroy the large and highly nutritious, oil-rich fruits. Synchronization of fruiting by many dipterocarp species across large areas is necessary for this to work, otherwise nomadic seedeaters, such as wild pigs, could simply move to wherever the trees were fruiting and destroy the whole crop. Thus, it is only in the mast years that any seeds survive long enough to germinate and grow into seedlings. And during these flowering years, dipterocarp trees make a full commitment to reproduction. Dipterocarps invest so much energy in reproduction during flowering years that they



*Dipterocarp trees mass-flower once every two to seven years with little or no flowering during the intervening years. This is illustrated by the export figures for illipe nuts (*Shorea *spp., section Pachycarpae), oil-rich seeds of a common group of dipterocarp species, from West Kalimantan, Indonesian Borneo, from 1968 to 1997. Years with El Niño–Southern Oscillation (ENSO) events are shown in bold; strong flowering years are associated with ENSO events. From L. M. Curran & M. Leighton, 2000.*

stop growing; in practice, they often have several years of growing without reproducing, followed by a heavy flowering year with no growth.

Producing successful crops of seedlings only every two to seven years could be a major disadvantage in responding to the short-term recruitment opportunities that occur following the death of adult trees. Therefore, another important element in the success of dipterocarps is the ability of seedlings of some species to survive for many years under the dense, shady canopy of established trees. The resources provided by a large seed are an obvious advantage here. This effectively creates a "seedling bank" that can respond to opportunities created by an opening in the canopy overhead. In forests in Borneo, the seedlings of some dipterocarp species last for more than fifteen years on the forest floor after a single fruiting event. The variation among dipterocarp species in how well the seedlings can survive in deep shade and in how rapidly they can increase their growth rate in response to an increase in light levels allows the family as a whole to take advantage of a wide range of conditions.

Dipterocarp seedlings may also have an increased chance of survival as a result of a special form of the mutualistic relationship between roots and the fungi called mycorrhizae (literally, "fungus roots"), in which the plant receives mineral nutrients and water from the fungus in exchange for carbohydrates. Almost all plants form mycorrhizae, but unlike most other rain forest trees, dipterocarps are ectomycorrhizal—that is, the fungus forms a sheath over the outside of the roots. Ectomycorrhizal trees and their seedlings are linked by a network of fungal hyphae that transfer nutrients from decaying organic matter to the plants. As soon as it germinates, a dipterocarp seedling may be able to plug into the existing network and may obtain resources from its nearby parent, although this has not yet been convincingly demonstrated. Whether this suggested ectomycorrhizal advantage exists or not, it is very striking that the same fungal association occurs in the oak family, which often dominates Southeast Asian montane forests, and in legume trees in the subfamily Caesalpinioideae, which form extensive stands dominated by single species in parts of Africa and South America. Ectomycorrhizal associations are also the norm in low-diversity, temperate-zone forests. It is striking too that many of these ectomycorrhizal tree species follow a pattern of heavy fruiting at multiyear intervals—mast fruiting—that is similar to that shown by the Southeast Asian dipterocarps.

Many of these elements of the dipterocarp strategy for rain forest success seem to fit

TIM LAMAN

An assortment of dipterocarp fruits, Borneo. Species vary widely in the size and shape of the wings.

together. Wind-dispersed fruits are only practical in the rain forest for very tall trees that emerge from the forest canopy: there is too little air movement inside the forest. Large seeds produce seedlings that can establish and survive in deep shade. What is food for a seedling is also food for a beetle, rat, pheasant, or a pig, but mast fruiting at long time intervals can satiate these seed predators so that many seeds escape consumption to grow into seedlings.

Even in the rain forest, however, there are exceptions to some of these generalizations, including dipterocarp trees too small to emerge from the canopy and species that flower every year. Their strategies for survival must be different and require further research. Moreover, in areas outside of the everwet zone, such as in Thailand and the Western Ghats, a hilly region of southwestern India, dipterocarps flower and fruit on annual cycles in response to seasonal weather changes. In the rain forest at Sinharaja, in southwest Sri Lanka, which has a brief annual dry period, some dipterocarps have annual cycles while other show synchronized masting at multiyear intervals.

Over the last few decades, many scientists have speculated about how one family of trees could be so dominant in the forests of Southeast Asia. Careful comparisons are now needed among rain forest regions to determine if dipterocarp trees really are different in their growth habitats, masting behavior, and seed biology from rain forest trees in other plant families. Of special interest would be comparative studies of the animal communities: do dipterocarp forests really have lower densities of insects and other animals due to the absence of flowers, fruits, and seeds during the long periods between masting years? Our ability to answer these questions is being facilitated by the network of rain forest plots being established by the Center for Tropical Forest Science, a joint project of the Smithsonian Institution and the Arnold Arboretum. Perhaps in the years to come we will be able to understand the amazing dominance of the dipterocarp family.

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Richard Corlett, a professor at the University of Hong Kong, is investigating the role of seed dispersal in rain forest recovery after deforestation. Richard Primack, a professor at Boston University, is currently conducting research on the effects of climate change on plants and birds. Both authors have worked and traveled in Asian forests and are the co-authors of a recent book on rain forests, cited above, from which this essay is adapted.

Chosenia: An Amazing Tree of Northeast Asia

Irina Kadis

Many travelers to Northeast Siberia return with fond memories of the young chosenia groves they have seen. These riverside communities harbor many showy flowering herbs that stand out brightly against the otherwise monotonous background of the Siberian taiga. Even more striking are the groves of mature chosenias with trees of a colossal size that is unusual not only for Yakutia, the coldest place on the continent of Eurasia, but even for lushly productive regions like Manchuria. The chosenia groves miraculously emerge on lifeless river pebbles in just ten to twelve years. The entire transformation from tiny seedlings to majestic 60-foot trees on fertile soil normally takes only sixty to seventy years. By then, the total organic mass of the grove may equal the amount accumulated by any other taiga forest in one hundred fifty to two hundred years.

Chosenia arbutifolia (Pall.) A. Skv., one of the fastest-growing trees of Northeast Asia, is closely related to the willows. Indeed, it has often been mistaken for a large willow even by experienced botanists. However, a close look at its catkins and flowers reveals clear differences from willows. The nectaries, or glands—structures

ALEXEY ZINOVIEV

Chosenia seeds typically germinate on fresh pebble deposits such as these along a tributary of the Kamchatka River.

A fruiting branch of chosenia.

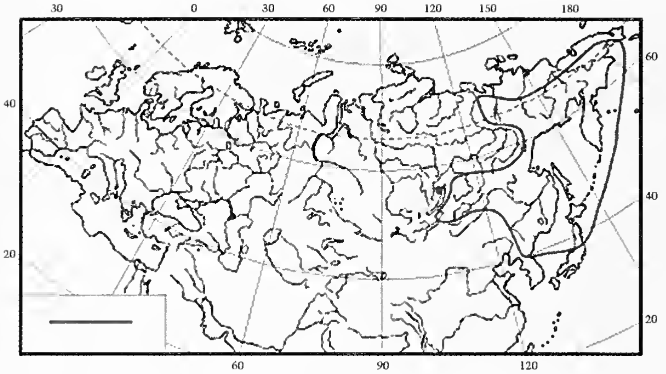
that are found in any willow flower—are missing. The stamens, pistils, and bracts look different from those found in the flowers of both the willow and poplar: the male flower of chosenia has five stamens hiding under the bract, partially fused with it in the lower filaments; and the female flower has two styles, each with a two-lobed stigma. Like poplars, chosenia is wind pollinated, whereas all willows are insect pollinated. These peculiarities alone were enough for botanists to place chosenia in its own, monotypic (single-species) genus. But the list of this tree's interesting traits isn't yet exhausted. Chosenia also surprises us with a distinctive root system featuring a taproot—possessed by none of the willows—along with unique anchoring structures. And whereas the wood of willows has the so-called heterogeneous rays, chosenia's wood has the more phylogenetically advanced homogeneous rays.

Chosenia's leaves are also quite special. Like the xeromorphic (water-saving) leaves of the primitive Turanga poplars and willows of the section Longifoliae, they are somewhat fleshy and covered with a bluish bloom, especially on young plants. This bloom also covers the tender, young twigs, which gives chosenias their peculiar appearance. The twigs remain without bark for a few years, contributing to the tree's photosynthesis. Later, they develop brownish bark that darkens with age. The bark on the trunks of old trees exfoliates much like that of shagbark hickory *(Carya ovata)* but unlike that of any willow. (Granted, the bark of *Salix triandra* also exfoliates but in a different pattern.)

Being strictly confined to a certain type of habitat—sandy-pebbly deposits on the banks of mountain rivers—chosenia, like many other riverine plants, always finds itself in a rather uniform environment of river valleys where climatic and soil differences between zones are alleviated. Because of this confinement, chosenia has been able to claim a huge geographic area ranging from the broadleaf forests of Honshu to the harsh tundras of the Anadyr River watershed in Siberia and extending along rivers beyond the Arctic Circle, where no other tree of such magnitude can grow. This vast range—comparable to the entire area of the United States west of the Mississippi River—comprises a major part of Siberian Russia east of Lake Baikal and the Lena River, the Russian Far East, including Sakhalin Island and the Kamchatka Peninsula, northeastern China, northeastern North Korea, and Hokkaido and Honshu Islands of the Japanese archipelago.

The multipurpose tree: From sandals to telegraph poles

The peoples of Northeast Asia have long known, loved, and exploited chosenia for all kinds of industries, from sandal-, clog-, and rope-making to dwelling- and bridge-building. Chosenias have been used for making dugout boats with a displacement capacity of up to one ton; this fact alone gives a sense of the impressive dimensions these trees can attain. Among northern reindeer breeders, chosenia is particularly valued as forage. In the wintertime, the reindeer dig diligently under the snow for fallen chosenia leaves, which contain unusually high amounts of calcium and thus serve as a winter food supplement.



The geographic distribution of Chosenia arbutifolia. *Redrawn from Norin 1958, Makryi & Bardunov 1977.*

The most ambitious commercial venture in which chosenia played a role was a bold attempt in the 1860s by the Western Union Telegraph Company to build a telegraph line connecting North America with Europe via the Bering Strait and Siberia. When a competing company succeeded in dragging a telegraph cable across the Atlantic, however, Western Union gave up the entire project, and after several years of hard work the indefatigable leader of the Siberian expedition, George Kennan (a distant relative of the later diplomat and historian of the same name), had to abandon thousands of telegraph poles that had been prepared along the proposed telegraph line with great difficulty. Many of those poles were made from the trunks of chosenia, which Kennan apparently considered to be a kind of large willow or poplar. In the farthest northeast portion of his route, along the lower Anadyr River, it was probably the only suitable tree he could find. By the time the construction was canceled, this remarkable man had bravely surveyed the wildest and most remote regions of Northeast Siberia, notorious for their extremely harsh climate and only sparsely inhabited by nomadic tribes.

A new name for an old friend

Little wonder that Kennan mistook chosenias for willows. Russian settlers of the Kamchatka Peninsula, where chosenia grows abundantly, have always called the tree *vetla* (a tree willow). *Topol* (poplar), its other Russian name, is used in Northeast Siberia, whereas real poplars are called "aspens" there. The Yakuts call it *tiryakh,* which is also their name for a poplar *(Populus suaveolens)* that often grows in mixed groves with chosenia; for willows they have a different word, *talakh.* Chosenia's colloquial names also include *seiakhta* and *sikhta,* in Nanayan and Udegeyan respectively—the languages of some of the ethnic groups in the Far East. *Leo-mo* and *zhuantianliu* (the willow that pierces the sky) are Chinese names, and *kesho-yanagi* (the beautiful willow) and *karafuto-kuroyanagi* (Sakhalin black willow) are the names used in Japan. The confusion about this tree's identity lasted well beyond the time of the telegraph project. By the beginning of the twentieth century chosenia had been observed by many botanists. However, some mistakenly took it for a willow species familiar to them, others described it as a previously unknown willow, and no one realized that the proliferating names all referred to a single species.

The Japanese botanist Takenoshin Nakai was first to recognize chosenia's uniqueness. At the time of his first encounters with the tree, in Korea from 1911 to 1918, he too had taken it for a willow he already knew. He gradually came to the conclusion that he was dealing with something unlike all willows, and in 1920 he proudly introduced the tree to the scientific world as a new genus of the willow family (Salicaceae), *Chosenia.* The discovery of a new genus in such a well-known family produced a sensation in the field of botany. Educated Russians started to call the tree *koreyanka,* a Russian translation of the name *Chosenia,* which literally means "an inhabitant of Korea." (This name didn't take, however, and was gradually supplanted internationally by *chosenia.*) Nakai did not identify his finding with all the scientific names previously given to the tree, and it took nearly forty years to completely clear away the confusion and to choose the correct species epithet according to the rules of priority.

Chosenia begins life: The first three hurdles

Let's now take a closer look at the tiny chosenia seedlings and the intricate path they must follow to survive and develop into majestic trees. At the very beginning of its life, this remarkable plant depends completely on the water flow and sediment accumulation that occurs in

E. H. Wilson photographed this freestanding chosenia in Korea, August 1917. He recorded its height at fifty feet and girth of trunk at nine feet.

river floodplains. The Far East is famous for its spectacular floods—severe, abrupt, and overwhelming, sometimes even catastrophic. They occur in summer rather than in spring, usually two or three times during the season. As the snow melts on the hills and mountains, it adds to the drenching rains brought by the summer monsoon, turning each river into a powerful stream that soon leaves its bed and fills the entire floodplain. Near the bottom of the riverbed the water is filled with great numbers of drifting pebbles that originate in the river's upper reaches: the noise produced as the river drags them along sometimes becomes so loud that a person talking at the streamside can't hear his own voice. Each flood forms fresh pebble deposits along the riverbanks and may cause the river to change its direction.

During late July to early August—often immediately following a summer flood—chosenia trees disseminate their abundant, minute seeds, each weighing no more than 0.25 mg and bearing a crown of white hair. The seeds cover the entire surface of the water, crowd the riverbanks, and accumulate along the water's edge. It is mostly on newly deposited pebbles that the seeds succeed in taking root. They germinate right away, and multitudes of seedlings appear on bare, moist pebbles at the very edge of the flowing water, where the most favorable conditions for germination are found. Along the banks of meandering rivers, seedlings of different generations

OLEG KORSUN (HTTP://WWW.NATURE.CHITA.RU)

The exfoliating bark of an old chosenia.

sometimes appear as distinct stripes: the older the plants, the farther away from the water they are located.

The young chosenia seedling is tiny: only one centimeter tall. The root, however, extends down between the pebbles as much as three to four centimeters (just over an inch to one and one-half inch). Most of these little plants do not survive the next flood, but those that hang on for at least a month become so firmly anchored between the pebbles that you cannot pull or even dig them out without breaking the root.

During the second year, the primary shoot dies back, and another shoot, larger than the first, starts growing. By the end of the second growing season, this new shoot becomes prostrate, with just the very tip extending above the pebbles. Finally it too dies off to be replaced during the third summer by three or four virgate (long and flexible) shoots that avoid damage from severe floods by lying flat on the pebbles, giving the entire plant the look of a prostrate rosette.

A tree that provides for itself

Juvenile chosenia leaves are even more succulent than adult leaves—fleshy and juicy and covered with pruinose bloom as if they were leaves of some desert species. There is nothing strange about this resemblance, since during the periods of drought between floods the bare pebbles around the young plants may become as hot as 50 degrees C (120 degrees F).

It is only during its third and fourth years that chosenia gradually abandons the prostrate habit and starts to grow as an upright shrub. By this time, the young chosenia already finds itself a few feet away from the flowing water's edge. Of course, this happens because of the river's meandering rather than any movement of the plant.

Yet another important process contributes to "moving" the young chosenia plants away from the running water. Their long, vigorous shoots, especially the lower ones, are damaged during floods and die, but they don't fall off. Instead, they form a thick, brushlike network that functions very much like whalebone, efficiently catching alluvial material and forming large sediment deposits around the tree. This nourishing soil layer may grow as much as a foot or more during a single flood. Generally speaking, the older the plant, the higher its position is and the greater its distance from the edge of the open water where it began life. If you dig into the soil in an old chosenia grove, you will find it to be layered like a cake, with each layer representing a single flood, its lower parts consisting of coarse material and the upper ones of fine particles.

ALEXEY ZINOVJEV

A chosenia seedling growing on pebbles in the Maritime Province, Russian Far East.

The champion of the neighborhood

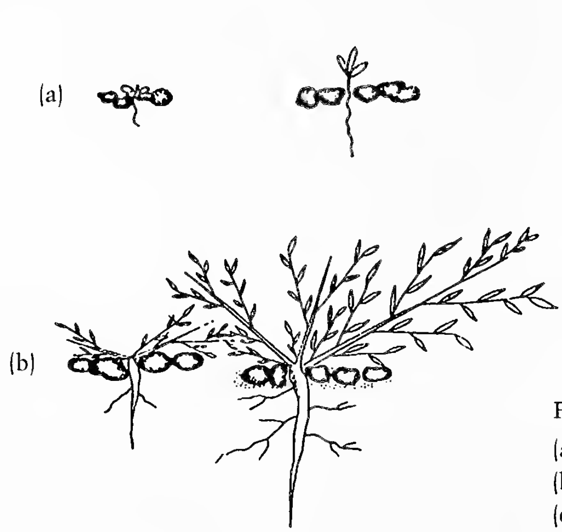
Every year the chosenia saplings lose a large share of their branches. Young branches are brittle and break off easily, which is not unusual in the Salicaceae. During the summer floods, many branches are scratched by moving pebbles, but even more of them—up to half of all the branches—do not survive the harsh winters. Anything that protrudes from the snow dies back, if it is not consumed by moose or reindeer. This huge dieback doesn't hinder the sapling's growth, however. During its early years, this amazing tree performs rather like a semishrub, producing one generation of branches after another. Every year the new growth becomes more and more vigorous, and the growth rate accelerates accordingly. By the age of five, a young chosenia may be adding up to a full meter to its height in a single season. About this time, the sapling "realizes" that it is destined to develop into a majestic tree and produces a leader with a crown of powerful virgate shoots around it, all densely covered with thin and slender pruinose leaves. At this point the plant's habit is intermediate between those of a tree and a shrub.

PETER DEL TREDICI

Chosenia arbutifolia *in the wild at Changbai Shan, China.*

A few years later, when the crowns of the young chosenias merge, the trees start to thin out and develop into a grove typically consisting of some thirty to one hundred trees. The grove still endures floods, but since the trees are now farther from the river, the water flows much more slowly and deposits fine particles rather than heavy pebbles. By the age of eight to ten, trees normally reach 7 to 8 meters (22 to 26 feet) in height, their stems 10 to 15 centimeters (4 to 6 inches) in diameter. The leader starts to dominate; the only trace remaining of virgate branches is the dense brush at the bottoms of the stems. These remnants continue to serve as alluvium traps during floods.

A grove of young chosenias with its open canopy and fertile alluvial soil produces a showy plant community that is brightened by abundant grasses, flowering legumes, and other herbs—plants not specific to chosenia groves but also occurring in willow, poplar, and other riverine woods. Some of them have a much wider distribution than chosenia and can be found even outside the river valleys. In northern Yakutia, for



From Mazurenko & Moskalyuk 1989:
(a) Chosenia seedlings
(b) Chosenia plants at the rosette stage
(c) A sapling of chosenia developing a leader

example, the legumes found in chosenia groves (species of *Astragalus, Oxytropis,* and *Hedysarum*) are also widely distributed in sparse larch forests and mountain tundras.

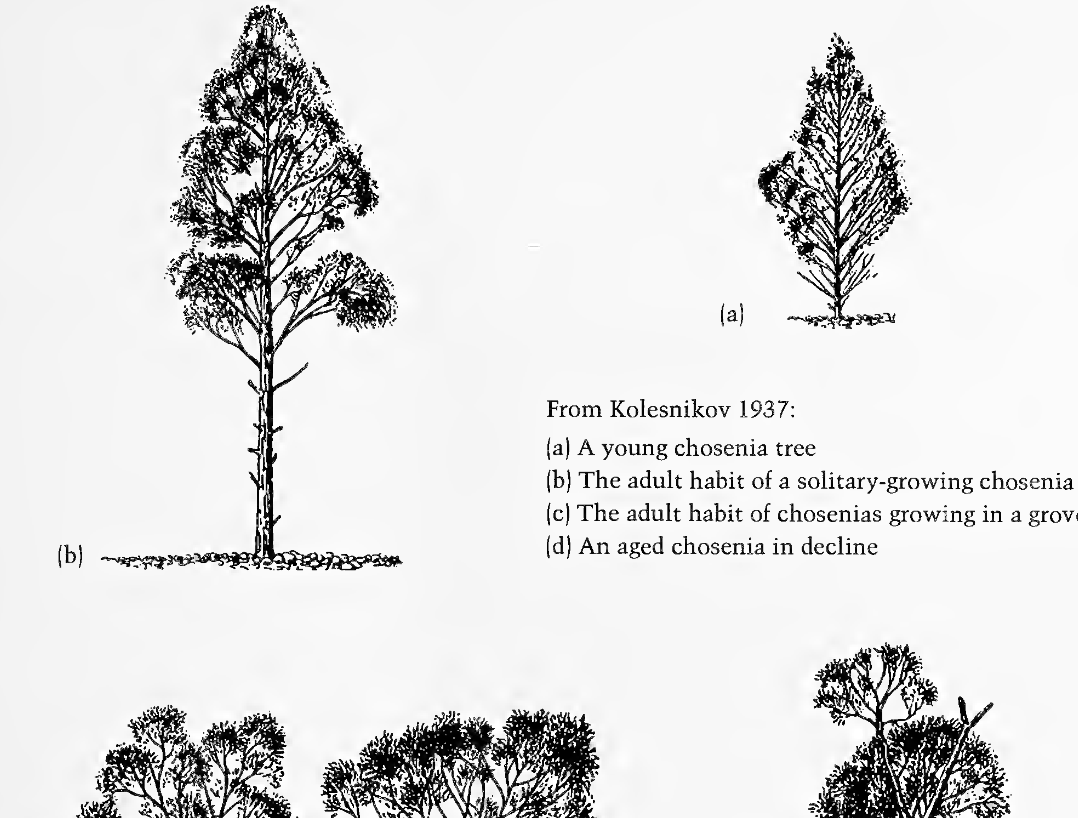
Chosenia's period of intensive growth lasts until the trees are about thirty years old. By then most attain heights of 25 to 30 meters (80 to 100 feet) and trunk diameters of almost half a meter. Records exist of chosenias as tall as 40 meters (130 feet) and as thick as 1.5 meter (5 feet). The root system of an adult tree consists of a central taproot that extends as far as 3 meters to reach the underground water table; its entire surface bears scars left by moving pebbles. Many thread-like roots grow downward from all sides of this "carrot." In addition, at a depth of 30 to 40 centimeters (12 to 16 inches), the taproots of adult trees develop three to five horizontal appendages, each shaped like and serving as an anchor. This system stabilizes the tree in its very unstable environment: adult chosenias remain standing even in strong winds and through the majority of severe floods.

The lower branches of a young adult tree reach upward at a 60- to 70-degree angle, whereas the upper branches are more nearly vertical. This branch arrangement, typical for a tree growing in open space, makes the shape of the crown pyramidal. When the trees grow in dense groups, their crowns are umbrella-shaped. During the winter the trees drop the tender top portions of their branches. This enables them to conserve water during extreme Siberian winters. The deadwood brush at the lower trunks persists for a long time, but as the trees "move" farther away from the riverbed to the center of the floodplain, it gradually loses its importance; by then the trees are situated as high as 1.5 meters above the water level and are flooded only once or twice a year. It is dark and damp underneath the canopy of a mature chosenia grove. Only shade-loving grasses and herbs survive here.

The majestic trees are not long-lived: they start to decline at the age of seventy to eighty. First the top dies back. Then pieces of the trunk start to break off, beginning at the top and working down. Ugly outgrowths caused by bacterial attacks replace the brush at the bottom of the trunk. On average, if a thirty-year-old grove contains some 30 to 50 trees, then by the age of one hundred there normally remain only three to five venerable patriarchs that stand as far as 150 to 200 meters away from the river and almost never experience floods. Poplar and larch trees tend to take over and succeed the chosenia groves.

Cultivated chosenia: A very different story

Chosenia's life cycle in nature suggests that it belongs to a certain type of plant called *explerents, R-strategists,* or *opportunists* in accordance with



From Kolesnikov 1937:
(a) A young chosenia tree
(b) The adult habit of a solitary-growing chosenia
(c) The adult habit of chosenias growing in a grove
(d) An aged chosenia in decline

PETER DEL TREDICI

A chosenia beginning to decline, Changbai Shan, China.

their biological strategy. Opportunists yield favorable places to other, more competitive species and thus avoid competition. Ruderal weeds as well as species of the early successional stages belong to this group. However, avoiding competition requires a trade-off: opportunists must face rather difficult growing conditions, unsuitable for the majority of species. In order to survive on the bare pebbles, chosenia has developed its peculiar traits: a root system that features a strong taproot along with anchoring structures; a prostrate habit at a tender age followed by semishrub-like behavior for a few years; succulent, water-saving foliage; the ability to collect and preserve nutritious material for itself by means of a brushlike network of dead and broken lower branches.

Yet another distinctive character of the chosenia is its plasticity—its ability to suppress many of these adaptations when they are not needed. To grow a chosenia you needn't provide bare pebbles, Siberian winter temperatures, or harsh floods. With adequate moisture, light, and good drainage, it will do well in an average garden. When it is not forced to meet the challenges of life in the wild, it demonstrates its unique abilities in a very subtle manner. In cultivation it starts life as a "normal" tree seedling: though the seedlings easily become distorted, they never develop a truly prostrate habit and tend to produce a few weak roots rather than one taproot. Their juvenile leaves don't look much different from the leaves of adult trees. The young tree does retain a tendency to cast off branches even in cultivation, with new generations of more and more vigorous branches being produced yearly. However, this tendency never reaches the point where the plant acts like a semishrub. It usually develops a leader and starts to grow into a tree earlier in cultivation than in the wild. Indeed, the most challenging part of growing a chosenia in the garden is the propagation itself. Unlike most willows, chosenias are difficult to grow from cuttings, and because the seeds lose viability very quickly, there is little hope for successful propagation when the seed source is remote.

Sources

Little is known about this interesting plant in the West since most publications about chosenia are in Russian, Chinese, Japanese, and Korean. This narrative is based on the Russian literature and incorporates data on chosenia published in a few articles written over a period of more than half a century.

The earliest of the articles was written in 1937 by Boris P. Kolesnikov, then a PhD student who was to become a prominent botanist and a famous researcher in the forests of the Far East. Only during his later years did he leave the Far East for the Urals, where he developed the Forest Science Laboratory at the Institute of Biology in Sverdlovsk (Ekaterinburg). Kolesnikov represented Russian forest science at many international forums.

Vera A. Sheludyakova, who wrote about chosenia growing in Yakutia as early as the time of World War II, founded the main herbarium depository in the Republic of Yakutia, for which she collected thousands of specimens during her daring field trips across the territory of this wild, remote region.

Alexey K. Skvortsov, whose eighty-fifth birthday was celebrated in February 2005, is a world-class specialist on the amentiferous plants (i.e., plants that produce catkins) and is also renowned for his floristic studies. It was Skvortsov who found the correct species epithet for chosenia in 1957. Skvortsov has worked for many years at the Main Botanic Garden in Moscow.

Boris N. Norin (1924–2001) is another prominent Russian botanist. He is credited with original approaches to the study of the vegetation structure in the tundra and forest belt. Boris Nikolayevich worked at the Botanical Institute of the Russian Academy of Sciences in St. Petersburg.

A few articles produced by the younger generation of investigators have played an important role in the contemporary understanding of the species' biology, life cycle, phytosociology, and distribution details. The majority of articles were published in *Botanicheskiy zhurnal,* the chief organ for botanical science in Russia.

I gratefully acknowledge the article by M. T. Mazurenko and T. A. Moskalyuk (1992) that has largely made the spine of this story. Maya T. Mazurenko (born 1935), PhD in biology, works at Tver University. Tatyana A. Moskalyuk (born 1947), PhD, works at the Montane Forest Station of the Far East Branch, Russian Academy of Sciences.

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Irina Kadis, a curatorial assistant at the Dana Greenhouses, has been working at the Arnold Arboretum since 1994. She is a graduate of St. Petersburg University with a major in plant ecology. A student of the willow family, she translated into English a major Russian monograph on Eurasian willows, which was published in 1999.

Capturing and Cultivating Chosenia

Peter Del Tredici

Changbai Shan, counterclockwise from above: A distant view of the surrounding countryside from the summit; the lake in Baitou Shan's crater; the lake's outlet.

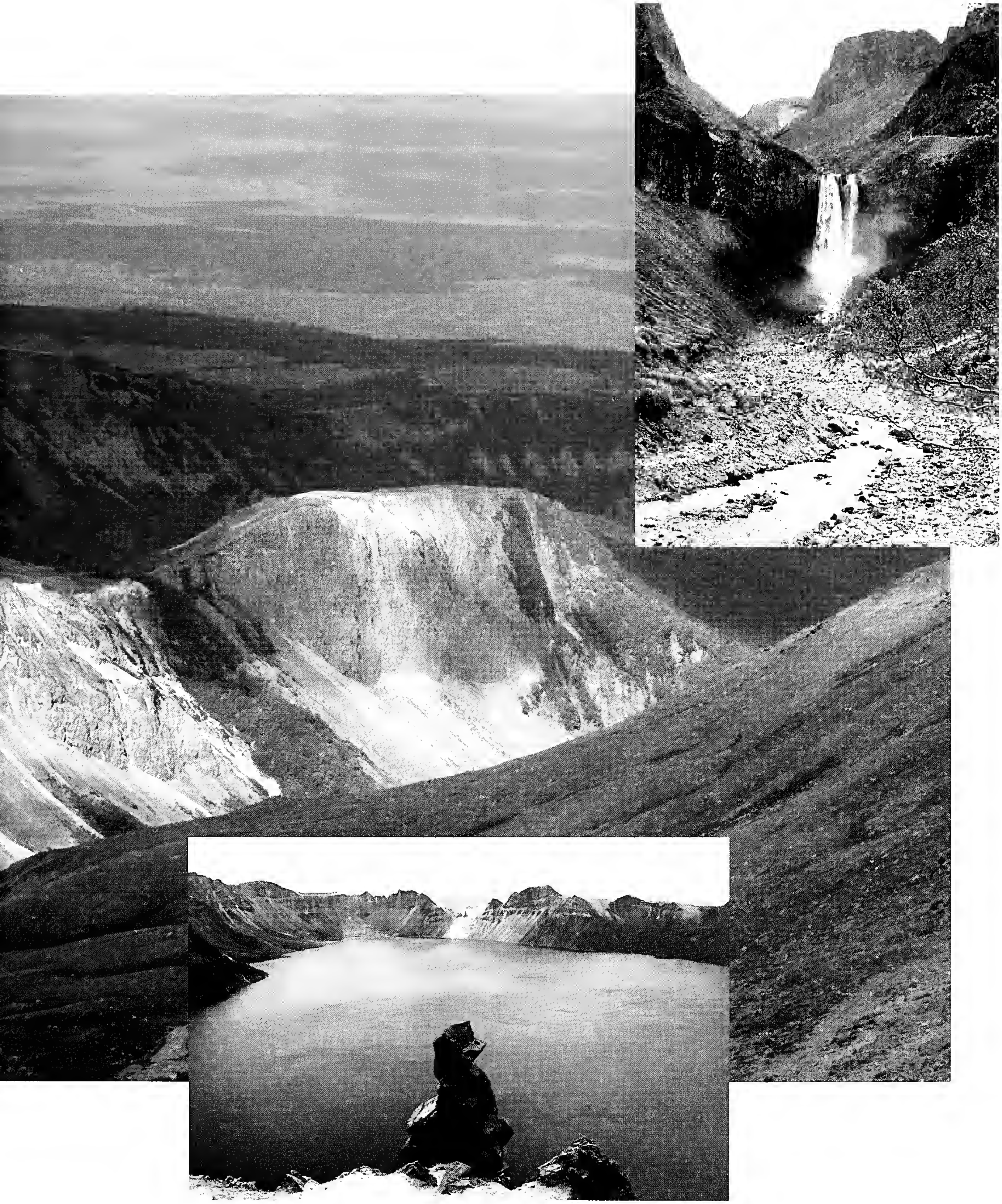
In the fall of 1997 I visited Changbai Shan in northeast China with colleagues from four other botanical gardens, all members of the North American-Chinese Plant Exploration Consortium (NACPEC), as well as botanists from the Shenyang Institute of Applied Ecology and the Nanjing Botanical Garden.* We were there to collect a wide variety of woody plants but were open to anything we came across that was producing mature seed.

Changbai Shan is interesting for a number of reasons. From the geological perspective, the mountain is an active volcano that has erupted four times since the fifteenth century, in 1413, 1597, 1668, and, most recently, in 1702. Botanically speaking, the mountain is famous for the diversity of its vegetation and the size of its forest trees, which have never been heavily logged. Recognizing this, the Chinese established the Changbai Mountain Reserve in 1960 and, in 1979, expanded it to cover 190,000 hectares (475,000 acres) when it became part of UNESCO's "Man and the Biosphere" program.

The mountain is located in the southern portion of Jilin Province and stretches along the border between China and North Korea. *Changbai* translates literally as "eternally white mountain" and refers not to its snow-capped summit but to the layer of light-colored pumice that shrouded it after its most recent eruption. Today, this layer of pumice is covered by vegetation.

The entire Changbai Shan range covers an area of about 8,000 square kilometers (742 square miles) with altitudes that vary between 500 and 2,691 meters (1,640 and 8,825 feet). The highest

* Paul Meyer, Morris Arboretum of the University of Pennsylvania; Kris Bachtell, Morton Arboretum; Jeff Lynch, Longwood Gardens; Charles Tubesing, Holden Arboretum; Wang Xianli, Cao Wei, Zhao Shuqing, and Zhong Linsheng, Shenyang Institute of Applied Ecology; Sheng Ning, Nanjing Botanical Garden; and Sun Long Xing, Changbai Xian Forestry Department.



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Changbai Shan, counterclockwise from above: A distant view of the surrounding countryside from the summit; the lake in Baitou Shan's crater; the lake's outlet.

peak, Baitou Shan, is a volcano rising from a lava plateau. Inside the crater is a large lake, Tian Chi—the "Heavenly Lake"—between 200 and 350 meters (655 and 1,150 feet) deep. The border between China and North Korea runs straight through the middle of this spectacular lake, the outlet of which forms a 68-meter- (225-foot-) high waterfall. Both the lake and its waterfall are famous scenic spots in China and popular with tourists from all over Asia, especially those from South Korea, who consider the mountain to be the epicenter of their ancestral homeland.

The South Koreans, who make the pilgrimage to Changbai Shan by coming up from the Chinese side of the mountain, stay in fancy new hotels and shop at the flourishing herbal markets that sell every imaginable herb or animal product—with real or imagined medicinal properties—that are collected or cultivated on the mountain. The most popular medicinal product is the ginseng root, which is considered the best in all Asia. While the cultivation of this plant on Changbai Shan goes back many hundreds of years, its extent has increased dramatically in recent years, resulting in the clearing of large tracts of land on the lower slopes of the mountain. Such practices are ecologically destructive, given that they involve the removal of all existing vegetation, including the stumps, followed by a thorough plowing of the land. Because of disease organisms, only two five-year crop cycles of ginseng can be grown on a typical site before it has to be abandoned for other purposes. Since the land is usually not replanted with trees, this pattern of use has led to serious erosion problems throughout the area.

The NACPEC group selected Changbai Shan as a target for collecting because of the richness and hardiness of its vegetation, and we were not disappointed. Our sampling strategy was fairly simple: to more or less follow the course of the Yalu River, which separates China from North Korea, stopping wherever the vegetation looked promising. On our very first day of collecting, just outside the county seat of Changbai Xian, we spotted a tree growing along the Yalu that roused everyone's curiosity. It was early in the morning and the sun was rising up over the hills. The light was such that it was reflecting off hundreds of tiny seeds blowing in the breeze. Against the shady black background, the seeds stood out like tiny silver fireflies. "Stop the van," we all shouted, "there's a willow shedding its seed." And out we piled to examine this tree that none of us could quite identify. Clearly it was a willow, but one with a tall, straight trunk and a strong conical growth habit. It also had a distinctive bark that was flaking off in long, thin plates. We collected as many seeds as we could find, along with some stem cuttings, hoping they

Above, clearing the land in preparation for planting a new crop of ginseng. Right, Panax ginseng *being cultivated under polyethylene tents on Changbai Shan.*

A view of the Yalu River looking into North Korea from the Chinese side. The river forms the boundary between the two countries.

would root once we got them home. After all, it was a willow and everyone knows how easily they grow from cuttings.

We continued to see the mystery willow throughout our trip, its distinctive conical shape always along the river, which is around 700 meters (2,300 feet) in altitude. The largest specimen we encountered had a ramrod-straight trunk with a diameter at breast height of 1.1 meters (3 1/2 feet). But none of the assembled collectors, including our Chinese hosts, could say for sure what species it was, and we never found another tree in seed after that first day.

The scientific identity of the mystery willow remained unknown until I got back to the Arboretum with my seeds and cuttings. In talking with the greenhouse staff about my collections I described the plant, at which point Irina Kadis, a native Russian who has worked in the far eastern part of that country, said matter-of-factly, "Oh, that's *Chosenia.* I saw it a lot when I was doing ecological work in Russia." A quick check of the descriptions in various reference books showed that Irina had nailed the identification in an instant.

Unfortunately, none of the cuttings we brought back rooted and none of the seed germinated, having spent too long in transit. Now at least I knew what the plant was even though I failed to bring it back alive. But my imagination had been fired up by the encounter, and I decided to learn more about the plant that, along with *Salix* and *Populus,* is the only other genus in the willow family, Salicaceae. The plant is distinguished from the willows and the poplars by the structure of its flowers, which bloom in early spring. It typically sheds its tiny, plumed seeds anywhere from late spring to midsummer depending upon latitude, a time when few plant collectors are out and about. And finally, it doesn't seem to root from cuttings, another trait that clearly distinguishes it from the willows and poplars.

To my utter amazement, I also discovered that the plant did not appear to be presently in cultivation in either North America or western Europe. The Arnold Arboretum once had a plant labeled as *Chosenia bracteosa* that we got from the Morton Arboretum in Lisle, Illinois, in 1952 (#805-52-A). However, subsequent research in 1985 by George Argus of the National Museum of Canada, Ottawa, showed that the plant was not *Chosenia* at all, but *Salix daphnoides,* a shrubby European species.

Here was a plant—a magnificent tree—that had somehow fallen through a rather large horticultural crack. Not one to shy away from a challenge, I determined to bring the plant into cultivation. So I wrote to our Chinese collaborator at Changbai, Sun Long Xing, and asked him to collect seed when they were likely to reach full maturity in early summer. Later that spring, while doing a literature search on *Chosenia,*

Propagation from Cuttings

While *Chosenia* is notoriously difficult to root from cuttings of a mature plant, I experimented with taking cuttings from the plants when they were only three years old, on March 29, 2001. The results of the experiment, evaluated on June 17, 2001, indicated that cuttings taken from young plants are relatively easy to root.

Treatment	# cuttings	Results	% rooting
control	24	1	4.2
HRB (powder)	75	15	20.0
2500 ppm KIBA (quick dip)	50	13	26.0
5000 ppm KIBA (quick dip)	24	6	25.0

I came across an article published in 1994 by a Japanese scientist, Shingo Ishikawa, who described a series of experiments he had performed with *Chosenia* that he had raised from seed collected from an isolated population growing in the Azusa River floodplain in Nagano Prefecture in central Honshu. I wrote to Professor Ishikawa and asked whether it might be possible to send me seeds for my introduction project. Fortuitously, he wrote back in the affirmative, and seeds from the Nagano population arrived by DHL express a month later.

The seeds—which were assigned the accession number 176-98—were collected on June 15 and arrived at the Dana Greenhouses eight days later, June 23. I immediately sowed them in a coarse, sandy mix and placed them under the intermittent mist system we use for rooting softwood cuttings. Within three days, the cotyledons shot up above the soil surface and I had seedlings growing as thick as dog's hair. Not having much experience growing willows from seed, I was amazed at this incredible burst of germination energy.

About two weeks after the seeds arrived from Professor Ishikawa, a second package of seed arrived from Professor Sun (AA #184-98). Unfortunately, these had spent more time in transit than Professor Isikawa's. Consequently they arrived desiccated and failed to germinate. But at least I had *Chosenia,* albeit from a wild Japanese population.

The seedlings grew extremely fast throughout the summer, and when they were several inches tall, I carefully transplanted them into individual pots. Based on her experience, Irina had warned me that *Chosenia* produces a long taproot that, when damaged, usually results in death, so I treated them with kid gloves.

The seedlings were big enough to be planted outside in the nursery a year later, during the spring of 1999, and they were moved to their permanent locations on the grounds in the spring of 2001. From what I could see, *Chosenia* was a plant that was programmed to grow like crazy. In the spring of 2004, the seedlings—now six years old and between eight and twelve feet tall—produced their first flowers, which opened on April 21. Nine plants had been set out and eight of them produced flowers in 2004; three were females and five were males. To my delight, the female plants set mature seed, which I collected on June 9, 2004. After letting the seed air-dry for a few days, I sowed them as I had sown their parent's seed, under intermittent mist in the greenhouses. And again, the result was dog-hair germination within a few days. So the cycle is complete with the production of the second generation of seedlings in the Arboretum and with the promise of many more generations to come.

The Arnold Arboretum is pleased to offer to our Friends plants of *Chosenia arbutifolia.* The plants were raised from seed produced by Arboretum plants and are between 2 and 8 inches tall. A donation of $40 per plant or three for $100 will cover the cultivation, handling, and postage. Shipment will be in the spring of 2005. Send orders ASAP to:

Chosenia Distribution
Dana Greenhouses
The Arnold Arboretum
125 Arborway
Jamaica Plain, MA 02130

Chosenia seeds carried by the wind.

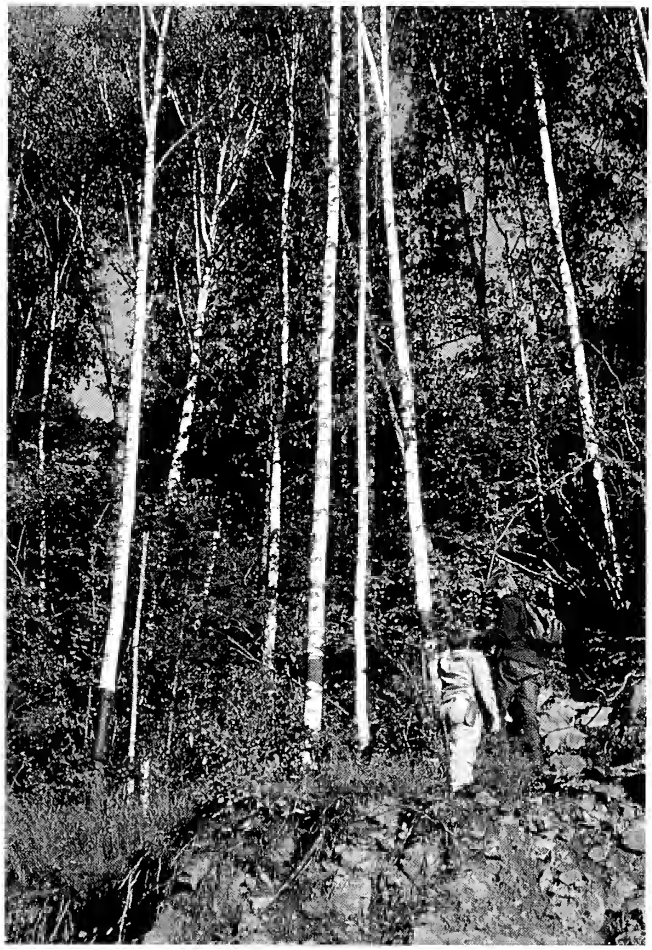
Chosenia seedlings growing like "dog's hair" in the Dana Greenhouses.

Two seedlings of Chosenia arbutifolia *(AA# 176–98) growing side by side at the Arnold Arboretum. They were sown from seed in 1998 and photographed in February 2004.*

Trees of Changbai Shan

The climate of Changbai Shan is continental and dominated by monsoons, which means cold, dry winters and warm, moist summers. Its vegetation includes 1,500 species of vascular plants and 500 species of cryptograms. It is also famous for the imposing stature of its trees, particularly the Korean pine *(Pinus koraiensis)*. Moving up the north side of the mountain, botanists have identified four distinct vegetation belts. At the lowest elevations, starting around 550 meters (1,800 feet) and extending to 1,150 meters (3,770 feet), is the mixed forest of broad-leaved deciduous trees and conifers dominated by magnificent specimens of *Pinus koraiensis* along with *Acer mono, Tilia amurensis, Fraxinus mandshurica, Quercus mongolica, Betula platyphylla,* and *Ulmus japonica* with *Acer pseudosieboldianum* and *A. triflorum* in the understory.

Pinus koraiensis *and on the right,* P. sylvestriformis.



Betula platyphylla.

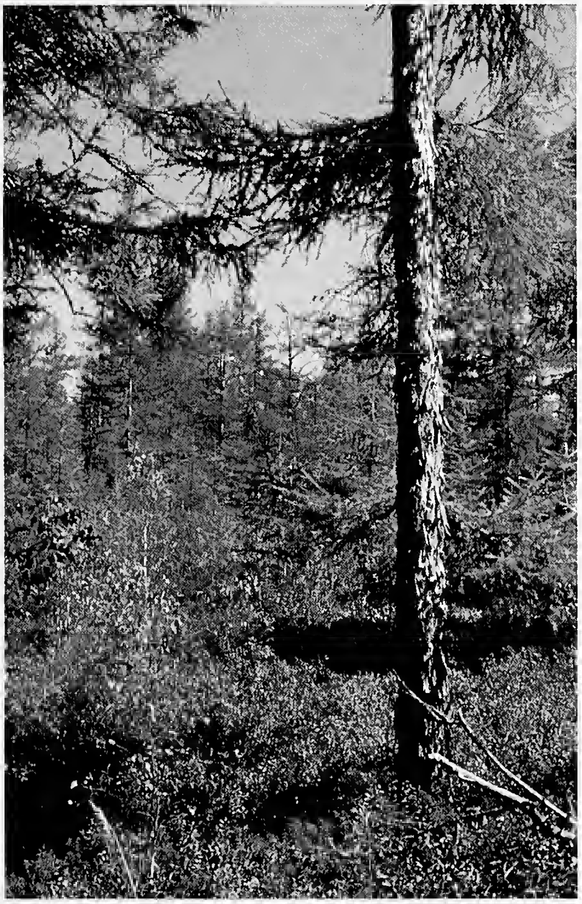
Next comes the conifer forest, from 1,150 to 1,700 meters (3,770 to 5,575 feet), where large trees of *Abies nephrolepis, Picea jezoensis, Pinus koraiensis,* and the rare *Pinus sylvestriformis* dominate, with *Betula costata* and various maples in the understory. The subalpine birch forest, between 1,700 and 2,000 meters (5,575 to 6,560 feet), is dominated by pure stands of windblown *Betula ermanii* with *Rhododendron dauricum* in the understory and *R. aureum* growing in open, exposed sites. At the highest levels of the mountain, from 2,000 meters to 2,300 meters (6,560 to 7,545 feet), is an alpine tundra covered with herbaceous plants and dwarf shrubs, including *Vaccinium vitis-idaea, Phyllodoce coerulea,* and *Rhododendron redowskianum.*

The author harvesting cones from Abies nephrolepis.

Windswept specimens of Betula ermanii *below the summit of Changbai Shan.*

	740 meters	1250 meters	1900 meters
Annual Mean Temperature	3.1º C	– 0.2º C	– 3.6º C
Monthly Mean Temperature: July	18.5º C	15.5º C	12.7
Monthly Mean Temperature: Jan	– 14.5º C	—	—
Maximum Temperature	31.5º C	24.5º C	21.7
Minimum Temperature	– 32º C	– 33.6º C	– 36.5
Number of Days w/ Temps > 10º C	130	90	54
Annual Mean Precipitation	723 mm	840 mm	1057 mm

Temperature records for Changbai Shan between 1980 and 1983 (from Öberg and Bäck 1996).



Vaccinium uliginosum *under* Larix olgensis.

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Verdant Letters: Hawthorne and Horticulture

Marta McDowell

Writer's block is not a new thing. Once when addressing his editor, Nathaniel Hawthorne explained his reluctant pen. "An engagement to write must in its nature be conditional; because stories grow like vegetables, and are not manufactured like a pine table." Throughout his life Hawthorne both laced his writing with horticultural references and grew actual vegetables.

Even his name has a horticultural ring to it. On reaching the age of majority, Nathaniel Hathorne changed the spelling of his family name. He chose an archaic spelling of a thorny tree, "hawthorne," common name for *Crataegus*, a genus grown across England and America. In his writings, Hawthorne grafted his own brand of nineteenth-century Transcendentalism onto Puritanism. His novel-length romances, short stories, and sketches use landscape imagery to evoke atmosphere, like the misty quality of Hudson River School paintings. Flowers in his writing signal beauty, innocence, and the ephemeral qualities of youth. Nature can be mysterious or euphoric. If Hawthorne's houses are haunted, his New England gardens are transcendent.

Hawthorne had a legitimate claim to a Yankee pedigree. Born on the Fourth of July, 1804, his roots ran deep into Massachusetts soil. "The spirit of my Puritan ancestors was mighty in me," Hawthorne declared, still clinging "with oyster-like tenacity." His notorious great-grandfather, John Hathorne, was a judge at the Salem witch trials; his grandparents were farmers. His father was a sea captain who died of yellow fever in Surinam when Nathaniel was four years old. He was raised by his mother and her siblings, especially his uncle Robert Manning, a horticulturist and nurseryman whose *Book of Fruits* (1838) was the standard text for mid-century Americans. In a letter to her brother, Hawthorne's Aunt Priscilla said, "Be so good Robert as to favour him with your advice (which I think will not fail to be influential) with regard to attending to writing and some of his lessons, regularly . . . However rich the soil, we do not expect fruit, unless good seed is sown, and the plants carefully cultivated." Years later in *The Blithedale Romance*, Hawthorne acknowledged his uncle's legacy in this description of an orchard.

> There were apple-trees, and pear and peach-trees, too, the fruit on which looked singularly large, luxuriant, and abundant; as well it might, in a situation so warm and sheltered, and where the soil had doubtless been

> enriched to a more than natural fertility. In two or three places, grape-vines clambered upon trellises, and bore clusters already purple, and promising the richness of Malta or Madeira in their ripened juice. The blighting winds of our rigid climate could not molest these trees and vines; the sunshine, though descending late into this area, and too early intercepted by the height of the surrounding houses, yet lay tropically there, even when less than temperate in every other region.

Manning cultivated his nephew's future, creating a microclimate with a steady education: tutors, boarding school, and a rich library. Hawthorne was fond of travel books, including the writings of American botanist John Bartram. His formal education culminated at Bowdoin College in Maine. There young Hawthorne decided that being a minister was "too dull a life" and "as to Lawyers there are so many of them already that one half of them (upon a moderate calculation) are in a state of actual starvation." Being a physician was out of the question since he "should not like to live by the diseases and Infirmities of my fellow Creatures." Finally, he preferred "becoming an Author and relying for support upon my pen."

His first major milestone was the publication of *Twice Told Tales* (1837). This collection of short stories, originally written for magazines, was well received by the critics. Of it, Longfellow, a Bowdoin classmate and already acclaimed poet, wrote, "A rose bathed and baptized in dew — a star in its first gentle emergence above the horizon — are types of the soul of Nathaniel Hawthorne." The tales included "The Hollow of Three Hills," an early example of Hawthorne painting a landscape as a backdrop for a plot.

> Three little hills stood near each other, and down in the midst of them sunk a hollow basin, almost mathematically circular, two or three hundred feet in breadth, and of such depth that a stately cedar might but just be visible above the sides. Dwarf pines were numerous upon the hills, and partly fringed the outer verge of the intermediate hollow, within which there was nothing but the brown grass of October, and here and there a tree trunk that had fallen long ago and lay mouldering with no green successor from its roots.

Even after the warm reception of his first book, Hawthorne was unsure about his ability to earn a full-time living from his pen. After a stint as a political appointee to the Salem Custom House, he spent part of 1841 as a member of the fledgling Brook Farm, a utopian experiment in West Roxbury, Massachusetts, hoping to find a bucolic situation for himself and his betrothed, Sophia Peabody. He arrived in spring with snow falling. In the six months from April to October, he worked the fields, milked cows, and spread mountains of manure. In the early weeks, he signed his letters "Nathaniel Hawthorne, Ploughman." But he quickly discovered that agricultural labor and intellectual pursuits don't necessarily mix. Writing to Sophia, he moaned, "A man's soul may be buried and perish under a dung-heap or in a furrow of the field, just as well as under a pile of money."

In the short months he spent at Brook Farm, Hawthorne did gather much of the material that appears later as *The Blithedale Romance.* Blithedale, a fictional but thinly disguised Brook Farm, is the stage set for the novel. The poet-protagonist, Miles Coverdale, meets two women there: Zenobia, daily adorned with an exotic hothouse flower, and Priscilla, who reminds him of "plants that one sometimes observes doing their best to vegetate among the bricks of an enclosed court, where there is scanty soil, and never any sunshine." Weeds, symbolic and real, grow at Blithedale, and Coverdale's enthusiasm for the project is "exhaled, together with the perspiration of many a hard days toil." Coverdale concludes, "Burns never made a song in haying time. He was no poet while a farmer, and no farmer while a poet." At the end of the story, Coverdale packs his bags and departs from his tarnished Arcadia, just as Hawthorne took his leave from Brook Farm.

After marrying in Boston the following year, Sophia and Nathaniel rented the Old Manse in Concord. The property boasted an ancient apple orchard installed by Emerson's stepfather, a Unitarian minister. They could hear apples falling, "from the mere necessity of perfect ripeness." Their vegetable garden had been planted by Thoreau. Ralph Waldo and Henry David were regular visitors, and the latter, describing the Hawthornes' home, said, "They had taken their Eden furnished." During their Concord sojourn they had their first real garden. Their daughter Una was born, the first of their three children. Hawthorne wrote many stories, collected and published as *Mosses from an Old Manse.* It includes "Rappaccini's Daughter," a tale in which evil, mad-scientist father Signor Rappaccini hybridizes his daughter with a poisonous shrub. "Flower and maiden were different, and yet the same, and fraught with some strange peril in either shape."

In the introduction to *Mosses from an Old Manse,* he gives us a glimpse into his own garden routine, much more benign than Rappaccini's.

> My garden, that skirted the avenue of the Manse, was of precisely the right extent. An hour or two of morning labor was all that it required. But I used to visit it and revisit it a dozen times a day, and stand in deep contemplation over my vegetable progeny with a love that nobody could share or conceive of, who had not taken part in the process of creation.

This fertile Concord ground also yielded Hawthorne's first and arguably most famous novel, *The Scarlet Letter.* Action opens in front of the seventeenth-century Boston prison door. A wild rosebush blooms. The rose "may serve, let us hope, to symbolize some sweet moral blossom,

A postcard rendering of Nathaniel Hawthorne's Wayside, on Lexington Road in Concord, Massachusetts. His portrait is inset.

that may be found along the track, or relieve the darkening close of a tale of human frailty and sorrow." Hester Prynne, wearing her embroidered scarlet A and carrying her daughter, Pearl, emerges from the prison to encounter her cowardly secret lover, Minister Arthur Dimmesdale, and her long missing husband, Roger Chillingworth. These four characters are locked together throughout the novel. "Let the black flower blossom as it may!" Chillingworth intones.

Hawthorne, ever critical of the Puritan hierarchy, pokes fun at it by describing the Governor's garden, where Hester and Pearl encounter Governor Bellingham in conversation with Dimmesdale and Chillingworth.

> [T]he proprietor appeared already to have relinquished, as hopeless, the effort to perpetuate on this side of the Atlantic, in a hard soil and amid the close struggle for subsistence, the native English taste for ornamental gardening. Cabbages grew in plain sight; and a pumpkin-vine, rooted at some distance, had run across the intervening space, and deposited one of its gigantic products directly beneath the hall-window; as if to warn the Governor that this great lump of vegetable gold was as rich an ornament as New England earth would offer him.

After the publication of *The Scarlet Letter* in 1850, the Hawthornes moved west to the Berkshire Mountains to a small farmhouse "as red as the Scarlet Letter" called "Tanglewood." It was on a Lenox estate, now a venue of the Boston Symphony Orchestra's famous summer music festival. Hawthorne "planted vegetables enough to supply all Salem." Sophia planted a flower garden overflowing with tiger lilies, peonies, and columbine.

In Lenox, Hawthorne befriended Melville and began work on *The House of the Seven Gables.* The gabled house with its elm "of wide circumference" holds a curse from the days of the early Puritan settlement. Its inhabitants, retiring and impoverished sister and brother, are Hepzibah and Clifford Pyncheon. They are joined by young, "blossoming," country cousin Phoebe.

Phoebe finds the garden. It fascinates, with its ancient rosebush and several "species of flowers growing there in a wilderness of neglect, and obstructing one another's development (as is often the parallel case in human society) by their uneducated entanglement and confusion." But someone is tending an assortment of summer vegetables there. "It being her first day of complete estrangement from rural objects, Phoebe found an unexpected charm in this little nook of grass, and foliage, and aristocratic flowers, and plebian vegetables." She discovers that the tenant, a daguerreotypist named Holgrave, is the secret gardener. Her cousin Clifford, recently and of course unjustly incarcerated, revives under the influence of the flowers, bees, and hummingbirds.

The House of the Seven Gables contrasts the garden with the decaying house. Hawthorne, while writing the novel, also contrasted his mood with the task at hand.

> The summer is not my natural season for work; and I often find myself gazing at Monument Mountain broad before my eyes, instead of the infernal sheet of paper under my hand. However, I make some little progress; and shall continue to lumber along with accelerated velocity; so I should not much wonder if I were to be ready by November. If not, it can't be helped. I must not pull up my cabbage by the roots, by way of hastening its growth.

Even with Monument Mountain and the attractions of the western Massachusetts landscape, Hawthorne managed to finish his book that year. But his wanderlust resurfaced. He missed the sea. "Oh that Providence would build me the merest little shanty, and mark me out a rood or two of garden-ground near the sea-coast," he wrote to a friend. And so the Hawthornes moved again, not, as it turns out, to the sea. Eventually they bought their first property, "The Wayside," the former Concord home of Bronson Alcott.

It turned out to be a temporary wayside, since the next year his friend and fellow Bowdoin alumnus Franklin Pierce was elected President of the United States and appointed Hawthorne U.S. Consul to England. Off the

Hawthornes went, bag and baggage to Liverpool. In addition to his duties, Hawthorne enjoyed excursions to English gardens such as Blenheim. But for the next four years his literary output was almost nothing. Evidently the diplomatic service sapped his pen just as much as farm labor. After his term as Consul expired, Hawthorne chose the route of many artists in midcentury and transferred his household to Italy.

In Florence, the Hawthornes occupied the ground-floor suite of the Casa del Bello. It had a garden, "a little wilderness of shrubbery and roses," Sophia wrote, with a terrace and summerhouse where her husband could sit "dreaming of a story." His study overlooked the garden. The next year they lived in Rome and spent time strolling the villa gardens of the Medici and the Borghese. In Italy, Hawthorne conceived his final novel, *The Marble Faun.* In its introduction he notes, "Romance and poetry, ivy, lichens, and wall-flowers, need ruin to make them grow."

The Marble Faun, like all of Hawthorne's fiction, asks the reader to suspend disbelief. In this case, we are asked to accept the young Count Donatello as an actual descendant of a faun, a sort of demigod. This faun, and the artist-expatriates that surround him, stroll through many famous Italian sites, including the Medici garden:

> The grounds are there laid out in the old fashion of straight paths, with borders of box, which form hedges of great height and density, and are shorn and trimmed to the evenness of a wall of stone, at the top and sides. There are green alleys, with long vistas overshadowed by ilex-trees; and at each intersection of the paths, the visitor finds seats of lichen-covered stone to repose upon, and marble statues that look forlornly at him, regretful of their lost noses. In the more open portions of the garden, before the sculptured front of the villa, you see fountains and flower-beds, and, in their season, a profusion of roses, from which the genial sun of Italy distills a fragrance, to be scattered abroad by the no less genial breeze.

This description, written in the late 1850s, predates the observations of Charles Platt and Edith Wharton, who popularized the Italian villa-style garden in America at the turn of the century.

From Italy, Hawthorne moved first to England and then back to Concord, rounding out the travelogue that is his biography. Still he enjoyed his plants and gardens. In his final collection of stories and observations, *Our Old House,* Hawthorne, whose language has always struck me as vaguely archaic, sounds like an ecologist quoted on yesterday's *New York Times* science page. "Perhaps if we could penetrate Nature's secrets we should find that what we call weeds are more essential to the well-being of the world, than the most precious fruit or grain."

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The Nature of Eastern Asia: Botanical and Cultural Images from the Arnold Arboretum Archives

Sheila Connor

The Arnold Arboretum's collection of eastern Asian photographs represents the work of several intrepid plant explorers who traveled to exotic lands in the early years of the twentieth century and returned with not only seeds, live plants, and dried herbarium specimens, but with stunning images of plants, people, and landscapes as well. We owe these images to the foresight of Charles Sprague Sargent, the director of the Arboretum during its first fifty years. In December 1906, when E. H. Wilson signed an agreement to collect in China for the Arboretum, Sargent set the precedent of asking all his explorers to document their expeditions with photographs: "A good set of photographs are really about as important as anything you can bring back with you," he wrote. He would later urge William Purdom to "take views of villages and other striking and interesting objects as the world knows little of the appearance of those parts of China which you are to visit." And to Joseph Rock, the last of the great explorers who would work for him, Sargent wrote, somewhat peevishly, "I don't know how you got the idea that we didn't want scenery. These are always important and interesting additions to our collection, and you may be sure you cannot send us too many of them."

Sargent's repeated insistence that these plant collectors document their travels in photographs resulted in a collection of more than 4,500 historic images of eastern Asia. With the exception of the E. H. Wilson collection, which we have just begun to process (and some of which can already be viewed at arboretum.harvard.edu/programs/eastern_asia/wilson.html), all of these

From left to right: J. G. Jack with one of his Chinese students, E. H. Wilson, and Frank Meyer.

images are now available on VIA, the Harvard University Library catalog of visual resources, at via.harvard.edu. We invite all armchair travelers who have become desktop explorers to see Asia through the photographs of our earliest plant collectors.

John George Jack (1861–1949)
167 images (1905)

J. G. Jack was already experienced in plant exploration when he became the first staff member after Sargent to visit Asia. Jack had joined the Arboretum in 1886 and almost immediately began collecting and photographing plants in the U.S. and abroad. Between 1898 and 1900 he spent summers working for the U.S. Geological Survey, exploring and photographing the forests of Colorado and the Big Horn Mountains of Wyoming. In 1891, he visited botanic gardens and nurseries in England and on the continent, and in 1904, he and Arboretum taxonomist Alfred Rehder collected specimens in the western United States and in Canada. It is likely that his yearlong Asian journey was self-financed; although Sargent's Annual Report for the Year Ending July 31, 1905, states that "Mr. J. G. Jack has started on a journey to the East to obtain material for the Arboretum in Japan, Korea, and northern China," no record of the Arboretum underwriting this expedition appears in the archives. Jack's introduction to an undated, unpublished manuscript entitled "Notes on Some Recently Introduced Trees and Shrubs" may explain why.

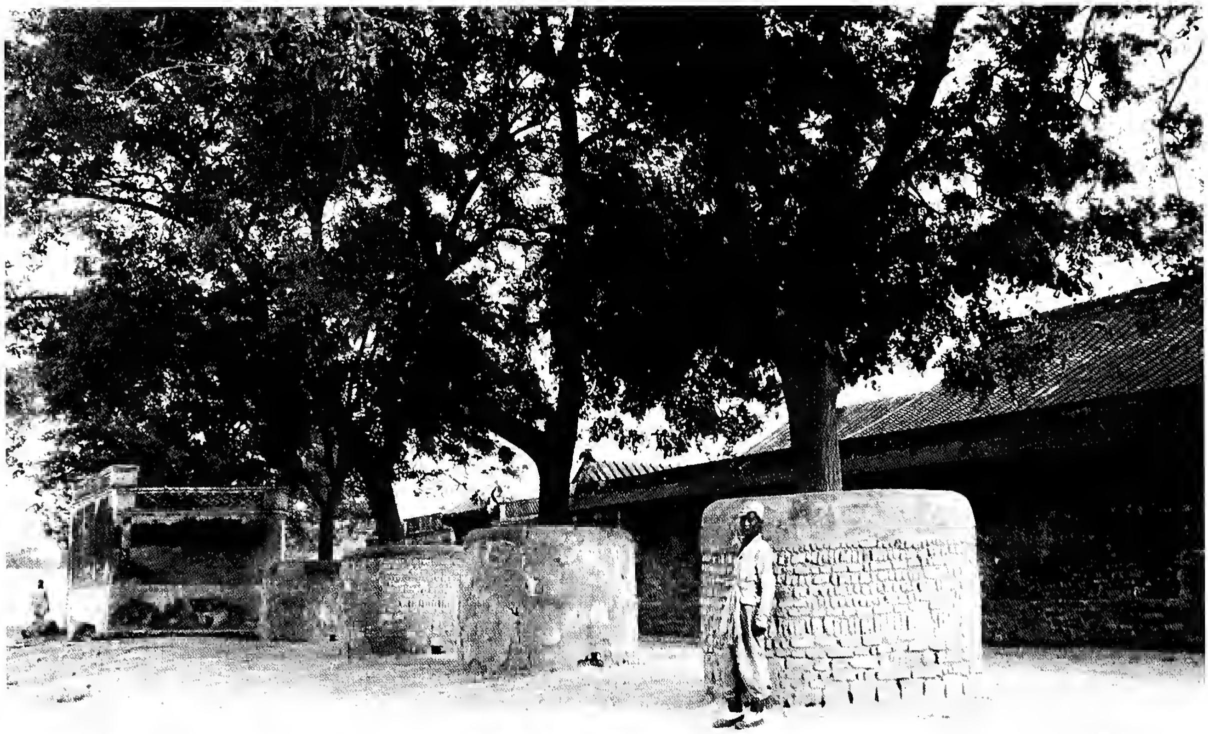
> On the first of July, 1905, I left Boston for Japan . . . The object of my trip was primarily rest and recreation for three or four months, combined with a desire to observe some of the interesting arborescent flora of central and northeastern Japan . . . A short visit was also made to Korea and to Peking in China.

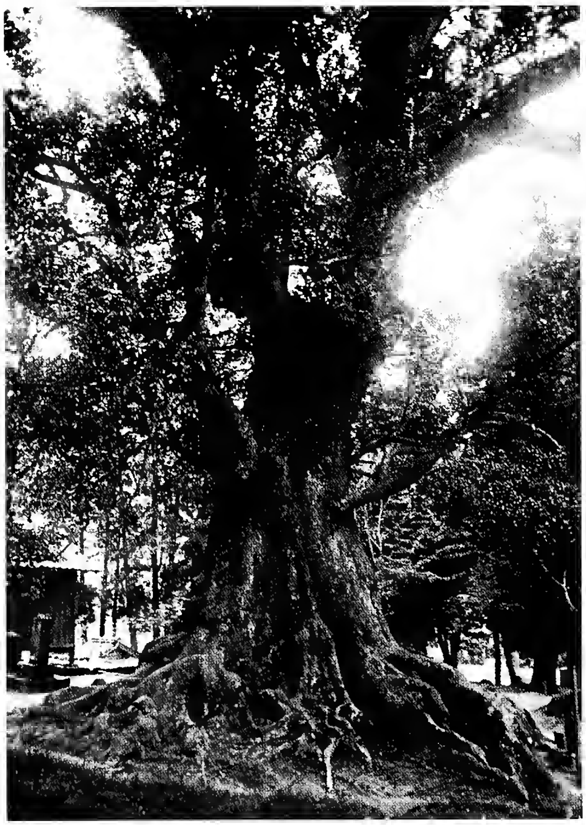
Apparently Jack wanted to travel at his own pace. Perhaps he also wished to spend time with his younger brother, the Reverend Milton Jack of the Presbyterian Foreign Ministry, who had long been stationed in Taiwan.

Forestry was a lifelong interest for Jack. Covering some of the ground that E. H. Wilson would later visit, Jack photographed the forest preserves around Mt. Fuji and elsewhere in Japan, as well as the forests of Taiwan and Korea. The scenes he captured in Beijing include formal portraits of people in traditional costumes.



William Purdom, Joseph Hers, and Joseph Rock.





Chinese scholar trees (Styphnolobium japonicum) *are used extensively as street trees. Jack photographed these in Beijing, where they had been planted in immense pots for protection.*

In 1905 when Jack photographed this camphor tree (Cinnamomom camphora) *at the Umi Hachiman Shrine on Kyushu Island, he estimated it at 100 feet tall and 45 feet in diameter at breast height. In 2001 a national survey listed it as Japan's seventh largest tree (65-foot diameter at 4.3 feet from the ground). The survey notes that Japan's big trees "furnish regional symbols and nourish the soul.*

In addition to herbarium specimens representing 258 plants, Jack returned with 171 images, many of them in a format especially useful for him—lantern slides. Jack had been appointed Harvard University lecturer on arboriculture in 1890 (the title was changed to lecturer in forestry in 1903) and he continued teaching throughout his career. In the fall and spring of each year he taught courses in dendrology to students and teachers using the Arboretum's living collections as his classroom, and he taught forestry both at Harvard (often with Richard T. Fisher, the first director of the Harvard Forest) and at the Massachusetts Institute of Technology, where he also held a lectureship.

Ernest Henry Wilson
(1876–1930) 2,488 images (1907–09, 1910–11, 1914, 1917–19, 1920–22)

Born in England in 1876, Ernest Henry Wilson received his training in horticulture at the Birmingham Technical College and at the Royal Botanic Gardens, Kew. His career as an explorer began in 1899 when he traveled to China seeking the dove tree, *Davidia involucrata,* for the Veitch Nursery in England. A visit to the Arnold Arboretum on his way to China initiated a lifelong collaboration with Charles Sargent. As Wilson was preparing for his first Arboretum journey, Sargent insisted that he take along a large-format, Sanderson whole-plate field camera capable of recording both great detail and broad perspectives without distortion. The rest of his camera gear included a cumbersome wooden tripod and crates of heavy, fragile, 6 1/2-x-8 1/2-inch glass-plate negatives.

For three years Wilson explored western Hupeh and western Szechuan. He returned to Boston in 1909 via Beijing, Moscow, St. Petersburg, Berlin, Paris, and finally London, where he spent several months developing the glass-plate negatives and seeing for the first time his 720 images. The purpose of his second Arboretum expedition, which began in 1910, was to collect cones and conifer seeds in the central and southwestern parts of China. In September of that year, while he was traveling between Sungpan and Chengdu, a landslide hit the expedition group, crushing Wilson's leg. After several months in a hospital at Chengdu, Wilson returned to Boston in March 1911, much earlier than planned. Before the accident, however, he had managed to take 374 images and to collect and ship bulbs of *Lilium regale,* the Easter lily.

We began the process of putting these photographs online by digitizing both the print and negative of several images in order to compare their quality. When the glass-plate negative of E. H. Wilson's "memorial arch to the memory of a virtuous woman" (above) was digitized, revealing the remarkable detail in the stonework, it was clear that we should use the original glass plates for all of his photos.

Wilson described the beautiful photograph at right, taken during his first Arboretum expedition in June 1910, as simply "Sandstone bridge with Cypress, Bamboo, and Pistacia chinensis.

In January 1914, accompanied by his wife and daughter, Wilson sailed for Japan, where he would focus his attention on horticulture and cultivated plants including conifers, Kurume azaleas, and Japanese cherries. By the time the Wilsons returned to Boston at the beginning of 1915, there were 619 new images to add to the photograph collection. Wilson next undertook a "systematic exploration" of Korea. Beginning in 1917 with the Japanese islands and Taiwan, he then traveled along the Yalu River into the far northern reaches of Korea, returning to Boston in 1919 with seeds, living plants, 30,000 herbarium specimens, and 700 photographs. His last expedition, a tour of the gardens of the world, took place from 1920 to 1922 and included a stop at the Singapore Botanical Garden in June of 1921. Of the 250 images he shot during this journey, 15 were taken in Asia.

Frank Nicholas Meyer (1875–1918) 1,310 images (1905–08, 1909–12, 1912–15, 1916–18)

In 1905, the United States Department of Agriculture's Office of Seed and Plant Introduction recruited Frank Meyer, a native of Holland who had immigrated to America in 1901, to gather economically useful plants in China. Through an arrangement worked out between Sargent and David Fairchild of the USDA, Meyer was to send to the Arboretum trees and shrubs of ornamental value along with images of his travels. The photographs in the Meyer Collection document his four expeditions to western China and Manchuria. Unlike Wilson's highly composed photographs, Meyer's images have an immediate and spontaneous quality, perhaps because they document daily life in this remote region: farmers and other people going about their work, manufacturing techniques, and markets were all captured through his lens. Even his images of plants often include local people or architectural backgrounds.

Meyer and Wilson corresponded occasionally, trading information on routes, travel conditions, and collecting strategies. Occasionally their letters touched on personal matters. In a letter from Beijing in 1907 Meyer wrote, "This roaming about, always alone, takes lots of energy away from a fellow, don't you agree with me too, in this respect?" On June 2, 1918, Meyer disappeared from a steamer and although his body

was eventually recovered, the circumstances of his death remain a mystery.

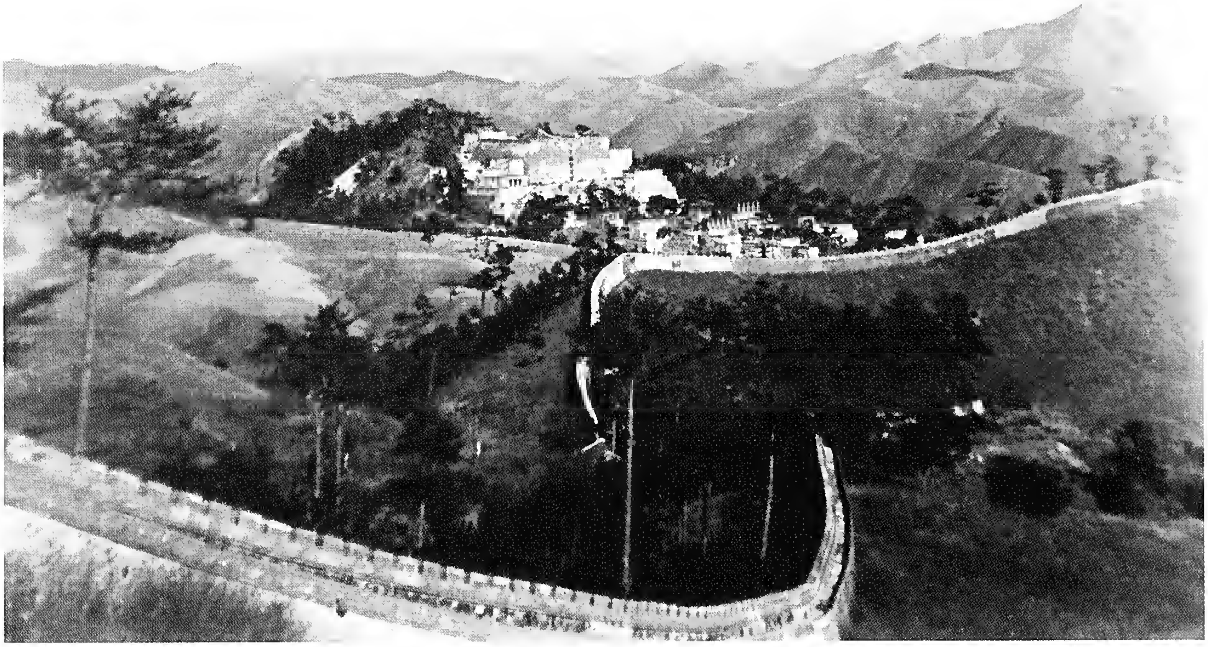
William Purdom (1880–1921)
161 images (1909–11)

In 1909, with Wilson about to return from southern China and the agreement with the USDA in place to ensure that Frank Meyer's Asian collections would be shared with the Arboretum, Sargent was eager to dispatch yet another plant collector to the largely unexplored northeastern provinces of China. Hoping, in Sargent's words, to "bring into our gardens Chinese plants from regions with climates even more severe than those of New England," William Purdom—the most inexperienced of Arboretum explorers—embarked on his first expedition in February of that year. Like Wilson, Purdom had worked at Kew and had once been employed at the Veitch Nursery, which cosponsored this expedition as they had Wilson's. For three years the shy and retiring novice followed the Yellow River north, his work always overshadowed by, and his meager results compared to, the successful exploits of the gregarious, prolific Wilson. His collection techniques improved, however, and he is now

Opposite above: These square, stamped tablets of persimmon sugar, photographed in 1912, are rare today. Unlike contemporary "moon cakes," these were made from dried fruits of an exceptionally sweet variety that Meyer described as Diospyros kaki *'Pen sze sse'.*

Opposite below: Meyer collected a specimen of this persimmon, which he labeled "Diospyros kaki. Siku, Kansu, China. Persimmons strung on strong strings to dry in the sun and wind on the top of the inn at which we stayed in Siku. This variety is locally called Fang sze tze or square persimmon. It contains considerable pucker when fresh; when dried, however, all traces have disappeared. November 16, 1914."

Above: Meyer was as interested in how plants were used as he was in the plants themselves. This "strong bamboo fence along a canal near Tang hsi" captured his attention in February 1906.



At top: Purdom visited the "palace grounds with wall and large temple in the distance" sometime between 1909 and 1911. His image of Chengde in Hebei Province captures part of the six-mile-long wall that encloses the imperial Jehol Summer Palace. Placed on the World Cultural Heritage list in 1994, the palace was begun in 1703, with construction continuing until 1790.

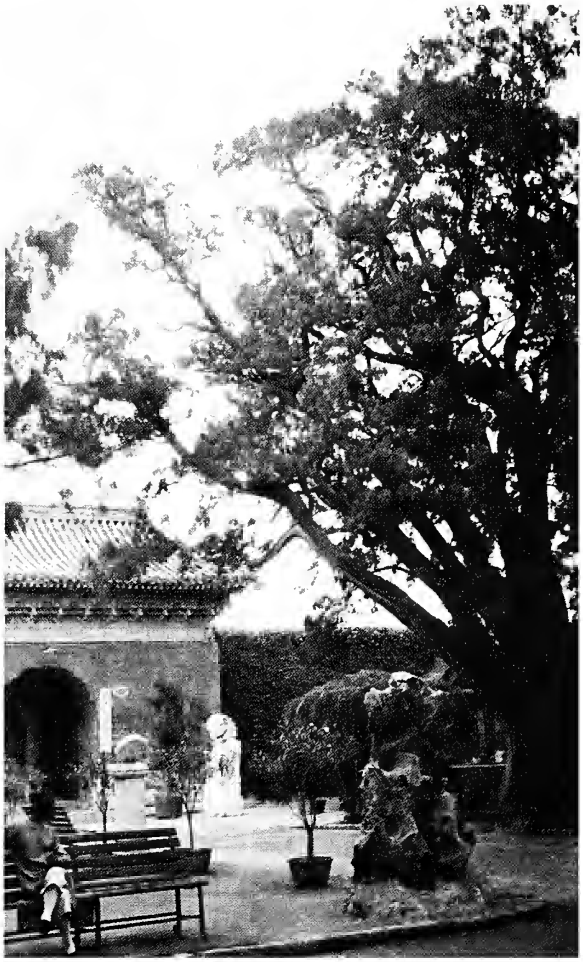
Purdom labeled the photograph below, "Strong men at August games." Mongolian athletes in traditional clothing were preparing for wrestling games at a harvest fair. Usually lasting several days, these fairs also included archery and horse-racing.

known for his later successes, when he worked with Reginald Farrer. Eventually he accepted a post as inspector of forests for the Chinese government. He must have been glad to be relieved of Sargent's exacting photographic demands, for although he never complained to Sargent himself, in 1909 he wrote to Veitch:

> I am not a specialist at photography and do not wish to infer that my camera is not a good one but I do now believe that a camera to carry on one's back with films is the most serviceable thing out here on these rough roads for it is nearly impossible to carry the plates. No end of mine got smashed.

Joseph Hers (1884–1965)
63 images (1919, 1923–24)

It was Hers, a railroad engineer and administrator of the Lung-Hai and Pien-Lo railways, who approached Sargent with a proposal to collect



*These photographs are of Beijing's Central Park, which dates from 1429. Hers' photo below, dated July 1923, shows potted ornamentals, most of them a juniper—*Juniperus squamata *var.* meyeri*—introduced into Western gardens by, and named for, Frank Meyer. Three years later, in August 1926, Hers highlighted a large oriental arborvitae,* Platycladus orientalis *(formerly* Thuja orientalis*). In 1928 the garden was renamed Zhongshan Park, thus becoming one of 35 Chinese parks that commemorate Dr. Sun Yat-sen (Sun Zhongshan)*

specimens for the Arboretum. Stationed in Chengchow, a city on the Huang Ho River that had become an important railroad center thanks to its position at the junction of the Longhai (east-west) and the Beijing-Guangzhou (north-south) lines, Hers was superbly situated, with a job that enabled him to range far and wide collecting plants. In a letter of July 18, 1919, he wrote,

> [Although my] own knowledge of botany is, I regret to say, very limited, I happen to live in a part of China where very few botanical collections, if any, have been made, and as I enjoy frequent opportunities to travel in little known districts . . .

Above: The plant collector spends as much time, if not more, processing the fruits of his labor as he does searching for them. The tedium of making lists, annotating labels, cleaning and packaging seeds, and drying and pressing herbarium specimens is experienced today just as it was when Rock's assistants Lan Lee and Sin No worked in the courtyard of his Moso house in Yunnan in 1922. According to Rock's legend they are changing driers on plants collected in the Lichiang snow range.

Opposite at top: Rock attributed the ruination of these houses to raids by the Pei-lang, the White Wolves. He took this haunting photograph of the walled city of Tao-chow in July 1925.

Opposite below: Photographed in July 1925 by Joseph Rock, this view of the densely forested Ta Ku, or Big Gorge Valley (Da Gorge, Min Mountains, Gansu Sheng), shows a spruce forest made up principally of another conifer named for Frank Meyer, Picea meyeri, *one of China's sixteen endemic spruce species.*

Enclosed with the letter was a list of trees and shrubs that included a number of new species, and Hers offered to send "seeds, or cuttings, or photos." After he had done so, Sargent wrote him that "this is one of the most important collections of Chinese plants which has been sent to the Arboretum and I am extremely obliged to you for sending it to us." Although we have only 63 of his images, Hers went on to collect seeds and specimens of more than 2,000 species, most of them sent to the Arnold Arboretum.

Joseph Charles Francis Rock (1884–1962) 320 images (1920–22)

Botanist, anthropologist, explorer, linguist, and author, Rock was the last of the great plant hunters employed by Sargent, who by then was elderly. Rock had immigrated to the United States from his native Austria in 1905, but between 1920 and 1949 he lived in China for extended periods, exploring, collecting plants and animals, and taking pictures for various United States agencies and other institutions, including The National Geographic Society, the U.S. Department of Agriculture, and the Arnold Arboretum. He is still remembered by the older villagers in the city of Lijiang, which was his home base for many years. The 653 photographs that Rock took during the Arboretum's 1924–27 expedition have already been digitized and are available on the VIA website; the remaining 320 photographs document his 1920-22 expedition to Thailand, Myanmar, and the Yunnan Province of China and include images of plants, landscapes, villages, architecture, and the ethnic minority peoples of the region.

Sheila Connor is the Arboretum's horticultural archivist.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Digitizing E. H. Wilson's Glass Plates

Digitizing and cataloguing the Arboretum's photographs is a multistep, multiperson procedure. In the case of our eastern Asian collections, the image scanned was usually in the form of a print, often the only available artifact. However, the clarity of detail captured in E. H. Wilson's glass-plate negatives dictated that we digitize directly from these fragile, almost century-old plates, making the process even more labor intensive and far more fraught with anxiety.

The first step is to catalog each Wilson image and document its many surrogates: the 6-x-8-inch glass-plate negative; the print bound in one of sixteen chronologically arranged albums; the mounted print stored in vertical files arranged either by genus and species or, in the case of landscape views, by place name. Duplicates as well as oversize prints are also counted, as are the black-and-white and hand-colored lantern slides made from Wilson's photographs.

After assigning an accession number to the image, the cataloguer describes it online in Harvard's database (OLIVIA), including enough detail to facilitate access. Villages are identified and located within provinces, if possible, and plant nomenclature is checked and updated when necessary.

Each glass plate is then inserted—very gently—between pieces of rigid foam in one of twelve special boxes, custom designed and built by our talented facilities manager. Each 14-x-10-x-8-inch box is snugly padded and holds thirty glass plates. Two members of the library staff (carefully) drive six boxes to the Digital Imaging Group (DIG) laboratory in Widener Library, located on Harvard's Cambridge campus, at the same time retrieving plates that have already been scanned. Once scanned, the images and data are deposited in the Digital Image Repository (DIR) and linked to the record previously created in OLIVIA. Once linked they are available online in VIA (Visual Information Access) and searchable by photographer, location, date, and keywords.

The success of this digitizing project required the skills of many people. Lisa Pearson and Beth Bayley organized, catalogued, and transported all of the material to the DIG, where David Remington oversaw the actual digitizing. Dave Russo built the safe and sturdy (and beautiful) boxes for transporting the glass plates. Wendy Gogel and Sue Kriegsman of Harvard's Library Digital Initiative gave guidance and assistance, and Harvard College Library, an anonymous donor, and several generous friends provided the funding.

Wendy Duan, the library's newest staff member, provided invaluable assistance by interpreting Chinese customs and identifying Chinese place names for this article.

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1. Publication Title: Arnoldia. 2. Publication No: 0004–2633. 3. Filing Date: 10 March 2005. 4. Issue Frequency: Quarterly. 5. No. of Issues Published Annually: 4. 6. Annual Subscription Price: $20.00 domestic; $25.00 foreign. 7. Complete Mailing Address of Known Office of Publication: Arnold Arboretum, 125 Arborway, Jamaica Plain, Suffolk County, MA 02130–3500. 8. Complete Mailing Address of Headquarters of General Business Office of Publisher: Arnold Arboretum, 125 Arborway, Jamaica Plain, Suffolk County, MA 02130–3500. 9. Full Names and Complete Mailing Address of Publisher, Editor, and Managing Editor: Arnold Arboretum, 125 Arborway, Jamaica Plain, Suffolk County, MA 02130–3500, publisher; Karen Madsen, Arnold Arboretum, 125 Arborway, Jamaica Plain, MA 02130–3500, editor. 10. Owner: The Arnold Arboretum of Harvard University, 125 Arborway, Jamaica Plain, Suffolk County, MA 02130–3500. 11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities: none. 12. The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes have not changed during the preceding 12 months. 13. Publication Name: *Arnoldia*. 14. Issue Date for Circulation Data Below: March 2005. 15. Extent and Nature of Circulation. a. Total No. Copies. Average No. Copies Each Issue During Preceding 12 Months: 3,325. Actual No. Copies of Single Issue Published Nearest to Filing Date: 3,200. b. Paid and/or Requested Circulation. (1) Paid/Requested Outside-County Mail Subscriptions. Average No. Copies Each Issue During Preceding 12 Months. Copies Each Issue During Preceding 12 Months: 2,511 No. Copies of Single Issue Published Nearest to Filing Date: 2,485. (2) Paid In-County Subscriptions: none. (3) Sales Through Dealers and Carriers, Street Vendors, and Counter Sales: none. (4) Other Classes Mailed Through the USPS: none. c. Total Paid and/or Requested Circulation. Average No. Copies Each Issue During Preceding 12 Months: 2,511. Actual No. Copies of Single Issue Published Nearest to Filing Date: 2,485. d. Free Distribution by Mail. Average No. Copies Each Issue During Preceding 12 Months: 124. Actual No. Copies of Single Issue Published Nearest to Filing Date: 150. e. Free Distribution Outside the Mail: Average No. Copies Each Issue During Preceding 12 Months: 195. Actual No. Copies of Single Issue Published Nearest to Filing Date: 198. f. Total Free Distribution: Average No. Copies Each Issue During Preceding 12 Months: 319. Actual No. Copies of Single Issue Published Nearest to Filing Date: 348. g. Total Distribution: Average No. Copies Each Issue During Preceding 12 Months: 2,830. Actual No. Copies of Single Issue Published Nearest to Filing Date: 2,833. h. Copies Not Distributed. Average No. Copies Each Issue During Preceding 12 Months: 495. Actual No. Copies of Single Issue Published Nearest to Filing Date: 367 i. Total. Average No. Copies Each Issue During Preceding 12 Months: 3,325 Actual No. Copies of Single Issue Published Nearest to Filing Date: 3,200. j. Percent Paid and/or Requested Circulation. Average No. Copies Each Issue During Preceding 12 Months: 89%. Actual No. Copies of Single Issue Published Nearest to Filing Date: 88%. I certify that all information furnished on this form is true and complete. Karen Madsen, Editor.