



## LIVING FOSSILS

**G**INKGOS AND DAWN REDWOODS are particularly fascinating plants because they are little altered from their prehistoric ancestors, which paleobotanists have traced back millions of years through the fossil record.

*Ginkgo biloba* is the sole living representative of the ginkgo family and quite probably the oldest living genus of seed-bearing plants, with a lineage going back 220 million years or more. Ginkgos were at peak abundance during the time of the dinosaurs, but fossil records indicate that about 18 species of ginkgolike plants have come and gone throughout geologic time. At one time or another, they were native to the areas that, after continental drift, became North America, Europe, and Asia, with the highest concentrations in what is now northeastern Siberia.

The native range of the ginkgo has shrunk considerably, and today the last wild stands are found in mountainous areas of southeastern China. Some botanists consider ginkgos to be extinct in the wild, arguing that the trees now found in natural areas were actually established by animals carrying seed from cultivated trees.

Often grown around temples and monasteries, ginkgos have been cultivated in China for centuries. From China, travelers to other parts of Asia spread the tree, which was introduced into Japan and Korea around the 12th century. A German physician, Engelbert Kaempfer, first described this remarkable tree in Japan in 1690 and seeds of the ginkgo soon made their way to the botanical garden in Utrecht, Holland. The first ginkgo in the Western world was planted there around 1730 and survives today. William Hamilton of Philadelphia introduced the ginkgo to the United States via England in 1784.

With only a 100-million-year history in the fossil record, dawn redwoods (*Metasequoia glyptostroboides*) are mere saplings compared with ginkgos, but they have a fascinating story all their own. In 1941, Japanese paleobotanist Shigeru Miki named a new genus of plants based on fossils found in Japan. He called the new genus *Metasequoia* (literally “akin to Sequoia”) to mark its close relationship with redwoods. Later that year, a Chinese forester noticed a small stand of unknown trees growing at an isolated site in central China’s Sichuan province. Specimens of those trees were later collected, and in 1946 Xian-su Hu, a Chinese botanist, recognized their connection to the recently named fossil genus.

Understanding the significance of the discovery, Elmer Drew Merrill—then director of Harvard University’s Arnold Arboretum—arranged funding for a Chinese seed-collecting expedition in 1947. Because locals were using the trees for firewood and lumber, only about 1,500 remained of what had once been a vast forest. American paleobotanist Ralph W. Chaney spearheaded an international conservation effort to preserve the trees from extinction in the wild. It was Chaney who coined the evocative common name “dawn redwood,” which helped fuel public support for the trees.

Seeds collected by the Arnold Arboretum-funded expedition and others were distributed to arboretums around the world, and the first generation of trees in America was planted in the late 1940s and early 1950s. (For more on the history of the dawn redwood’s discovery, see the following article by Susan Sand in *American Horticulturist*, Volume 71, Number 10, October 1992.)

—Carl Hahn

# The Dawn Redwood

*East and west cooperated to save this living fossil from extinction.*

**T**he discovery of the dawn redwood (*Metasequoia glyptostroboides*) in China half a century ago generated great excitement among scientists. By extraordinary coincidence the tree had been described from fossil evidence that same year but was believed to be extinct.

With a 100 million-year history that extends into the Cretaceous period of the Mesozoic era, *Metasequoia* dates to the age when dinosaurs were becoming extinct and flowering plants were appearing. By the time botanists had discovered dawn redwood, this lone survivor of a genus that had once been distributed throughout most of the Northern Hemisphere existed only in China, where it was near extinction. Although its long-term survival in its natural habitat is not assured, dawn redwood now appears to be thriving in cultivation in the United States and elsewhere.

For several years before World War II, Japanese paleobotanist Shigeru Miki had been searching for fossils of woody plants in Japan's Cenozoic clay deposits. He collected fossil female cones somewhat similar to redwoods (*Sequoia* spp.) but with stalks and opposite cone scales and found vegetative shoots resembling bald cypresses (*Taxodium* spp.) but with leaves that were opposite rather than alternate. In 1940, when he discovered better-preserved fossils of this conifer in clay deposits at Osusawa and elsewhere in central Hondo, he was able to determine that the tree was different enough from the other two genera to assign it to a new genus, which he named by adding the Greek *meta*, meaning "akin to," to *Sequoia*. Remarkably, the fossils he had found were so well-preserved and complete that Miki's descriptions and drawings recorded most of the external traits that were later found in the living

BY SUSAN SAND



*The feathery foliage of the dawn redwood, above, is bright green changing to russet in autumn. Its single straight trunk and pyramidal shape, right, make it a popular choice for the landscape.*

species, *Metasequoia glyptostroboides*. When he published the new name in 1941, Miki believed that *Metasequoia* represented a genus that had been extinct for twenty million years.

During the winter of 1941 a Chinese forester, T. Kan, of the Department of Forestry of National Central University in Nanjing, was traveling near the village of Modaoqi in eastern Sichuan province in central China when he noticed three intriguing trees growing at the edge of rice paddies. But it would have been pointless to collect specimens, since it was winter and the trees were leafless. He did learn that the natives called the tree *shui-sa*, or

"water fir." A small shrine had been built beside the largest of the trees, for the local villagers considered it divine. They believed that its cone production indicated crop yields and that the withering of a twig or branch predicted someone's death.

The next year, Kan asked a local school principal, Long-xin Yang, to collect specimens for him. They were gathered but not identified. In 1944 Yang asked Z. Wang of the Central Bureau of Forest Research to stop at Modaoqi to investigate the unusual trees. Wang gathered both cones and branchlets, thinking the trees were Chinese swamp cypress (*Glyptostrobus lineatus* or *G. pensilis*), a deciduous conifer of south China. Eventually Wang's specimens reached Professor W. J. Zheng of the Department of Forestry at the National Central University. The herbarium material was incomplete and Zheng could not be sure of the tree's identity, so he sent his graduate student, Ji-ru Xue, on two collecting trips to Modaoqi, in February and May of 1946. Xue's journey required a two-day trip by steamboat and a seventy-two-mile hike on narrow mountain trails. His diligent efforts provided numerous complete specimens, and Zheng became convinced that the trees of Modaoqi represented a new genus. He sent some of Xue's samples to Dr. Xian-su Hu, director of the Fan Memorial Institute of Biology in Beijing. Hu had read Miki's paper on the fossil metasequoia and realized that the specimens from the live trees belonged to this very genus. In 1946 he published a paper announcing its discovery; two years later Zheng joined him in describing it fully and giving it a specific epithet in honor of its resemblance to the Chinese swamp cypress, *Glyptostrobus*, which Wang had noted. He later referred to this discovery of the living metasequoia as the most remark-



JERRY PAVIA

able botanical find of the century.

Miki's fossil discovery was also significant, for it solved a long-standing paleobotanical puzzle. For almost a century, paleobotanists had occasionally noted fossil features that suggested a new genus but continued to assign specimens to either *Sequoia* or *Taxodium*. Incorrectly named, they had been used to construct theories about migration, ecology, and evolution of Tertiary vegetation of the Northern Hemisphere. When paleontologist Ralph W. Chaney of the University of California-Berkeley reexamined the fossil evidence, he concluded that the dominant conifer of arctic forest communities in the Tertiary

period, 63 million to two million years ago, had been the deciduous *Metasequoia* rather than the evergreen *Sequoia*.

Today's wide distribution of this tree, so near extinction when it was discovered, can be attributed largely to the efforts of Dr. Elmer Drew Merrill, then director of Harvard University's Arnold Arboretum. When Merrill received some of Xue's herbarium specimens from Zheng in 1946, he realized the significance of the discovery. Working with Hu and Zheng, he arranged for the arboretum to fund a seed-collecting expedition for late summer and fall of 1947. Zheng's collectors visited Modaoqi and beyond and discovered about 1,000

trees in the neighboring twenty-five-mile-long Shuishaba Valley to the south, in western Hupei province. During this three-month expedition, they collected a little more than two pounds of seed. In January and March of 1948, Merrill received shipments of seed from Zheng, who also sent seeds to Copenhagen and Amsterdam, and arboretum staff immediately distributed more than 600 packets to arboreta, botanical gardens, and interested individuals throughout the world.

Eventually about 1,500 trees were found, but they were rapidly being destroyed by locals who were using them for firewood and for finishing the interiors of their homes. Chaney, during a hurried trip to observe the living tree in Modaoqi in March 1948, under the auspices of the Save-the-Redwood League, called on the American ambassador and other officials to launch an effort to conserve dawn redwoods. A conservation committee was established with representatives from both government and academic institutions, including Chaney as a foreign member.

Chaney was accompanied on his expedition by Milton Silverman, science editor of the *San Francisco Chronicle*. Chaney coined the name dawn redwood when they were discussing the upcoming journey. "I suggested the name 'Dawn Redwood' to the editor," Chaney later related, "when he complained that *Metasequoia glyptostroboides* would not go over in a news account." Actually, Chaney felt that Chinese redwood was a more appropriate name and he seldom used the term "dawn redwood" in print.

Chaney and Silverman were the first westerners to see dawn redwoods growing in their natural habitat. One more American expedition was made before the bamboo curtain fell in 1949. During the summer of 1948, J. Linsley Gressitt of the California Academy of Sciences headed the California Academy-Lignan University Dawn Redwood Expedition to the metasequoia area to study the flora and fauna of the region. He noted many familiar-looking trees in the valley, including beeches, willows, poplars, oaks, maples, chestnuts, and sassafrases, and later wrote that an American or European viewing only the trees might think himself near home.

The area was not visited by foreigners again for thirty-two years. Scientists with the Sino-American Botanical Expedition to western Hupei Province in 1980, in which five American scientists participated,



MICHAEL S. THOMPSON

*Solitary cones remain on the tree throughout the winter, then fall to the ground.*

found that the enormous dawn redwood at Modaoqi, then estimated to be about 450 years old, was still standing. But the shrine built in its honor was gone, as were the two smaller trees that had been near it.

Many other metasequoias had been planted along the road through the village. In the metasequoia valley south of Modaoqi, the local Bureau of Forestry had counted 5,420 trees with a diameter of at least eight inches. Yet although 1,700 to 1,800 of these metasequoias were seed-producing trees, expedition members saw no seedlings in the valley. In 1948, seedlings had been found in the dense growth around mature trees; now, that vegetation had been cleared. The government had forbid cutting the trees but had not protected their habitat so that they might reproduce.

In the paddies along the river floodplain, more than 200 metasequoia trunks, many over six-and-a-half feet in diameter, testified to their former range. Local residents had been using the tree for as long as three centuries. Metasequoia boards were used to construct some of the older homes in the valley, believed to be 200 to 300 years old. The valley, enclosed by mountains and offering no easy river access, was the last in the area to be settled, which probably helped the dawn redwood survive into the twentieth century. Even so, it now existed mainly at the end of ravines descending to the valley floor and along rocky stream banks. Locals had also planted some near their homes or along the rice fields and streams, by making cuttings or digging saplings. They believed heavy cone production on upper branches predicted a good rice harvest, while profuse cones on lower branches foretold the yield of hill crops such as corn and herbs.

The range of survivors was originally thought to encompass about 320 square miles; Gressitt's maps showed the area about one-third larger. Nevertheless, it was such a limited area that several earlier plant explorers of the region failed to discover the tree. French missionary Armand David collected plants in central China in 1869, and almost twenty years later, Irishman Augustine Henry explored the mountainous, forested region of the Hupei-Sichuan border, discovering hundreds of new plants. Ernest Henry Wilson of England, who made four trips to China between 1899 and 1910 and introduced more than 1,000 plants to the western world, had explored both western Hupei province and eastern Sichuan province without spotting

metasequoia.

This remote region had such a mild and wet climate that scientists doubted that dawn redwood would survive in the United States north of Georgia. Annual rainfall was forty-eight inches with little snow, and the average low temperature was not much below freezing, similar to Georgia's coastal plain. However, because dawn redwood seed was so widely distributed—and its performance so carefully observed under various conditions—studies soon indicated that the tree was much hardier than anticipated. Early reports documented its success on the Pacific Coast and in eastern North America and Europe. It grows best where ample moisture is available year round and in USDA hardiness zones 5 to 8.

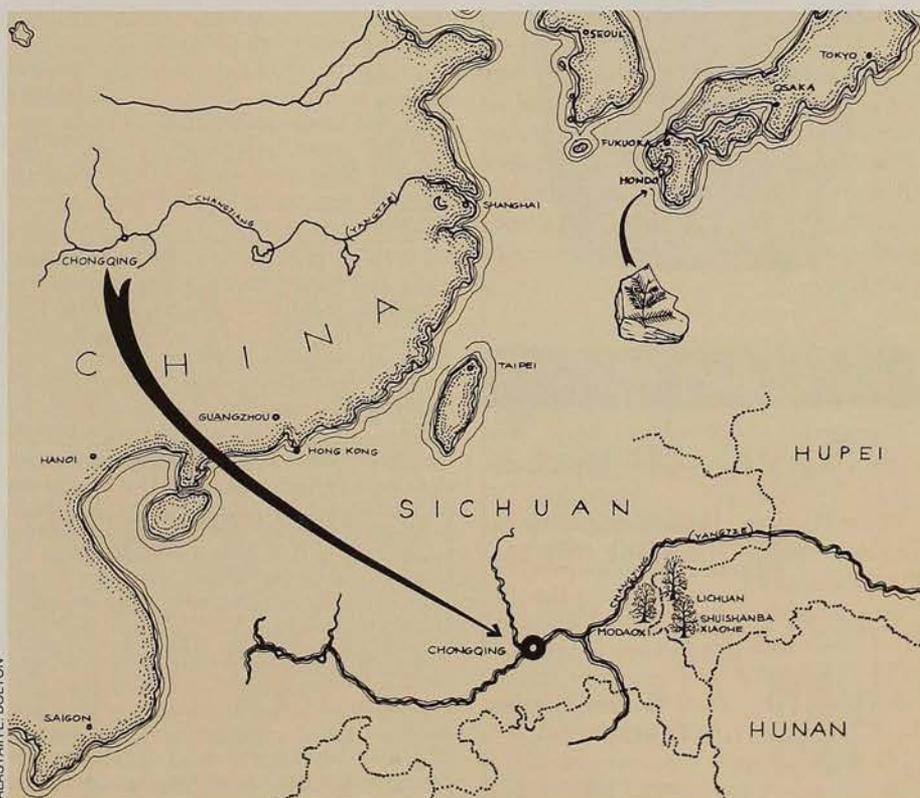
Another surprising discovery was its rapid growth rate, possibly the fastest among conifers. Near Philadelphia, plants grown outdoors from seed reached almost six feet in eighteen months with stem diameters of an inch and a half two inches above ground. Twenty years after seed had been distributed, some trees were sixty feet tall; at thirty-two years, some specimens approached or exceeded 100 feet.

Many other features have made dawn redwood popular as a landscape plant. It

develops a single straight trunk with a shapely pyramidal form and feathery bright green foliage that changes to brown or russet before both leaves and branchlets fall in autumn. The flat, linear, half-inch leaves, up to an inch and a half long on younger trees, are opposite each other on opposite branchlets. Solitary, pendant cones that grow to an inch around turn to brown and stay on the tree through winter. The base of the tapering trunk becomes buttressed and fluted and the reddish brown bark grays with age and exfoliates in narrow strips.

This lovely tree is readily available from nurseries and transplants easily. It prefers moist, well-drained, slightly acid soil and a location in full sun. Low sites make it susceptible to frost damage because the tree has a long growing season: It initiates new growth in early spring and foliage does not mature until mid- to late fall. The foliage is also susceptible to damage by Japanese beetles, and the U.S. National Arboretum in Washington, D.C., has lost several trees to a fungal disease called *Dothiorella* canker. In general, however, metasequoia has been relatively free of insect or disease problems.

Because it can reach 70 to 120 feet at



*In 1941 three dawn redwoods were seen near Modaoqi in eastern Sichuan province. Fossils of the tree were found in Japan a year earlier.*



# CLASSIFIEDS

maturity and spread to one-fourth its height, dawn redwood requires ample space. It is versatile and can be planted in groups or as a screen, and cities such as St. Louis, Missouri, and Maplewood, New Jersey, have used it as a street tree. But for it to develop its graceful, naturally symmetrical cone-shape, it should be planted as a specimen, away from buildings and preferably on an open lawn.

With the widespread planting of dawn redwood, *Metasequoia* has returned to North America after an absence estimated by Berkeley's Chaney at 15 million years. He believed that the tree moved south from the arctic forests as northern latitudes became drier and colder, eventually becoming the most abundant conifer in western North America, with a range extending throughout most of the Northern Hemisphere. But as summers became drier it retreated, until there was only the single species surviving in central China, where summers are wet. It has not only made a phenomenal comeback to this continent, but is widely grown in Asia, Europe, and some areas of the Southern Hemisphere as well. Dawn redwood's discovery in Modaoqi, Merrill's generous and prompt seed distribution, and the enthusiasm of scientists and gardeners around the world helped rescue it from the edge of extinction.

*Susan Sand is a horticulture and biology instructor at Damascus High School in Damascus, Maryland. This is the fifth in a series of tree histories by Sand. Modern Chinese translations were provided by Gang Li, a native of China and a graduate student of taxonomy at the University of Maryland.*

## SOURCES

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