

# GINKGO CHICHI

## In Nature, Legend & Cultivation

By Peter Del Tredici

The genus *Ginkgo*, represented today by the widely cultivated Chinese species *Ginkgo biloba*, is remarkable for its evolutionary lineage that dates back to the lower Jurassic, about 190 million years ago. The genus reached the apogee of its diversity during the early Cretaceous period, about 120 million years ago, with approximately six species distributed across the northern hemisphere. Over the course of its evolution the genus *Ginkgo* has undergone considerable change, yet fossil leaf and wood material from a species that originated during the Cretaceous, *Ginkgo adiantoides*, is considered nearly identical to that of *Ginkgo biloba*, making the tree a true "living fossil." As the only living representative of the division (phylum) Ginkgophyta, the ginkgo tree occupies a unique position in the plant kingdom, intermediate between the cycads and the conifers.

Native to the warm-temperature forests of China, the ginkgo was introduced into Korea at a very early date and into Japan about eight hundred years ago. From Japan, the tree was introduced into Europe at the Botanic Garden in Utrecht, Netherlands, about 1730, and into Kew Gardens, near London, England, around 1754. From England the tree was imported into North America in 1784 at Philadelphia, Pennsylvania. The great environmental adaptability of the ginkgo and its unparalleled tolerance of environmental stress have made the tree a favorite for planting in urban areas throughout the temperate world – an activity that has resulted in the re-establishment of the species across much of its ancestral range.

### Chichi Legends

While the ginkgo is distinct in many aspects of its biology, one characteristic, in particular, has captivated the interest and imagination of bonsai specialists: the tendency of very ancient specimens to produce bizarre, root-like structures that hang down

from their branches (Figure 1). These pendulous growths, which can make the trunk of an old tree look like a melted candle, are called "chichi" in Japanese, meaning nipple or breast, and "zhong-ru" in Chinese, meaning stalactite. Throughout Asia, trees that produce abundant chichi have inspired numerous legends, the most famous of which concerns an ancient tree still growing at Miyagi-no-Hara Temple in Sendai, Japan (Figure 2). As translated by Holtum the legend reads as follows:

*One day Sister Hakuko said to Sister Kohaku, 'Once I was favored with the office of wet nurse to the emperor, and now I am more than eighty years of age. I know not but what even today I may pass into paradise. When I am dead, please pile earth in a mound above my body and plant there an icho [ginkgo] tree as a*

*grave marker. For I have made a vow to the Buddha that unto future generations I will give milk to women of this world who are without milk. In this way will I help mankind.' Thus she spoke. Then after Sister Hakuko had died her body was buried in the ground at a spot eight cho removed from the garden of the Yakushi temple (Kokubun Amadera) at Kinoshita. There they made a mound and planted an icho tree as a grave marker, according to her dying request.*

*As the years passed by, this tree slowly branched and flourished. It grew large, and great breasts came to hang from it, and people began to call it the Icho Ubagami (Ginkgo Nurse Goddess).*

*If there is a woman who is unable to furnish milk, or if there is one whose supply of milk is limited, or again, if there is one who suffers from sickness*

**Figure 1.** An ancient ginkgo in western China showing extensive aerial chichi development. From Elwes and Henry, 1906.



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of the breasts – if such a one offers prayer to this icho milk tree with a believing heart, power to give milk is gained and sickness is healed in a truly marvelous manner. And now after the stars and frosts of more than eleven hundred years have come and gone, the miraculous power abides unchanged as of old and day by day the succession of worshippers ceases not.

A similar interpretation of chichi as a symbol of fertility and lactation comes from Korea, where it has been reported by the Korean Ginkgo Center that: "In olden times women longing for pregnancy often prayed toward the breast-like limbs [of the ginkgo tree], or took a decoction from its cut." The ability of ginkgo chichi to produce wondrous fluids is a common theme throughout all Asia, and I suspect that one curious story from modern Japan, quoted by Moule in 1937, is an oblique reference to this belief:

The great temple of Kwannon at Asakusa in Tokyo stands on slightly rising ground, and in the terrible fire which devastated the city after the big earthquake of September 1, 1923, the temple and compound were crowded with refugees. The fire came nearer and nearer, and finally surrounded the temple, which stood out like an island in a sea of fire. The temple, so it was believed, was specially guarded by Kwannon, who was said to have appeared hovering above the temple roof, and it was also believed that the huge ginkgo tree near the building literally rained moisture on the roof, and put out the burning fragments of wood carried by the wind from burning houses all round.



### Scientific Investigations Of Chichi

The explanation of chichi from the scientific perspective is a bit more prosaic than that found in folk tales. They were first systematically described by Fujii in 1895, who considered them a "pathological formation" that developed in association with an embedded shoot bud. Fujii demonstrated that chichi, despite their root-like appearance, were essentially leafless, downward growing shoots that were covered with developmentally suppressed vegetative buds. He also noted that chichi could grow to over two meters in length, and possessed the ability to form both roots and leafy shoots when they came in contact with the ground. A more recent scientific study by Li and Lin, published in 1991, elucidated the gross anatomy of chichi as well as their anomalous cell structure, but failed to shed light on what environmental factors might induce their formation. In this regard, the authors concluded that chichi "...are only formed in old trees, growing in a more or less humid environment."

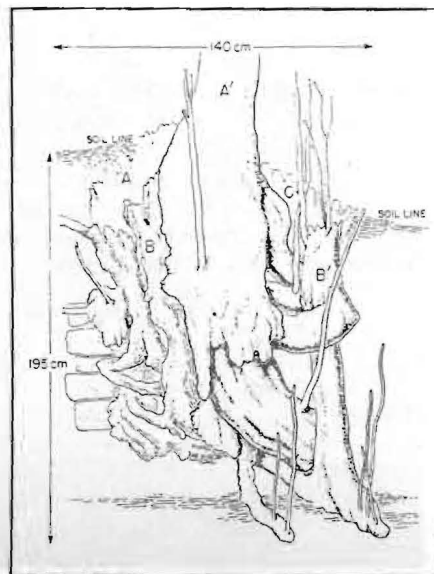
Also unknown at this point in time is the extent to which genetic differences among individuals effects chichi production, a state of ignorance that reflects the difficulty in setting up controlled experiments with ancient trees. About the only thing that one can say about chichi is that old age – probably at least a hundred years – is the single most important factor associated with their occurrence, and that traumatic injury to the trunk, the crown, or the root system can accelerate their formation.

**Figure 2.** The ancient "Nurse Goddess" ginkgo at Sendai, Japan. From Mobius, 1931.

**Figure 3.** The basal chichi-developed shoot system of an old ginkgo growing on top of a stone wall on Tian Mu Mountain in Zhejiang Province, China. At least three generations of stems can be seen: the oldest represented by the cut trunks A, B, and C (with diameters of 55, 40, and 37 cm respectively); the second by the living trunks A' and B' (with diameters of 26 and 20 cm); and the third by suckers arising from the zone of active chichi proliferation (stippled). From Del Tredici, Ling, and Yang, 1992.

In the course of my own research on the subject, I have been able to establish the fact that there are two distinct types of chichi formed by ginkgos: *aerial chichi* that grow down from the branches of very old cultivated trees, and *basal chichi* that are produced at or below ground level and give rise to new trunks following injury to the primary stem or the root system. I first observed basal chichi in 1989 while doing field work on a "semi-wild" ginkgo population on Tian Mu Mountain in Zhejiang Province, China, with two Chinese collaborators, Professor Ling Hsieh of the Zhejiang Forestry Department and Yang Guan of the Jiangsu Institute of Botany (Figure 3).

Our research has demonstrated that vegetative reproduction from basal chichi, or *lignotubers* as they are technically known, is an important factor in explaining the long-term persistence of the ginkgo population on the steep, rocky slopes where they are growing. Out of the 167 trees we located on Tian Mu Shan, 40% had at least two trunks greater than ten centimeters in diameter. In those areas where erosion was severe, it was clear that these secondary trunks arose from large, rhizome-like basal chichi. We also noticed that wherever the base of a large tree came in contact with a rock, basal chichi developed that either enveloped the rock or went around it, extending up to two meters from the parent trunk. When they reached friable soil, the basal chichi produced lateral roots and developed vigorous, vertically growing shoots and continued their downward growth. It is also worth noting that none of the Tian



Mu Shan ginkgos, despite their obvious antiquity, were producing aerial chichi.

### Aerial Chichi As Propagation Material

It has long been known that aerial chichi can be used as a source of propagation material. As noted above, Fujii observed in 1895 that they produced both roots and shoots when, and if, they reached the ground. In 1987, the great penjing master, Hu Yunhua, published a photograph of a "stalactite" ginkgo penjing, titled "Single Peak Piercing the Clouds" (Figure 4), with the following caption:

*This penjing created by an artist of the Sichuan School displays a highly unusual shape. The trunk resembles stalactite, a mineral formed through limestone corrosion. No human effort could possibly sculpture this kind of bole. In nature, ginkgo trees of several hundred or even over a thousand years of age frequently develop a host of stalactite-shaped substances which suspend from the trunk. If these are removed in the winter and planted upside down, an incredible thing will happen — foliage will sprout off the "stalactite." The branches can later be*

*wired. A penjing of unique style, known as "Stalactite Trunk" or "Bamboo Shoot Ginkgo," will result (page 95).*

As Li noted in their 1991 paper, using aerial chichi for propagation has a long tradition in China.

*It is quite interesting to find in the Chinese local chronicles that in several places like Chengdu, Sichuan Province, the Taoist priests cut down these [stalactite-like] branches from the bases and planted them in pots. Eventually they grew into miniature plants [penjing] as commercial ornamentals. This practice has been carried on for generations. Thus the stalactite-like branches seem to lack the polarity present in normal branches.*

How far back into antiquity this practice goes is hard to say, but in my opinion an old Chinese legend cited by Hu Lin Li in his now classic paper, "A Horticultural and Botanical History of Ginkgo," clearly refers to propagation via aerial chichi:

*It is said that when Emperor Kao Tsung moved from Kaifeng in the north to Nanking and Hangchow in the south in 1127, the imperial cavalcade crossed the Yangtze River into southern*

*Kiangsu. Coming to a town call Chen I, near the city Kunshan between Soochow and Shanghai, an official named Kung I, a native of the northern capital Kaifeng, picked a branch of ginkgo, sticking it into the ground and prayed that if the branch lived, he would settle there. The branch later developed into a huge tree and in later years the trunk became gnarled and twisted and adorned with many hanging 'nipples' as in other venerable trees of this same kind.*

In my own experience of trying to root aerial chichi, I have found it imperative to follow Hu Yunhua's dictate about always planting them upside down in the potting medium. It is difficult to say why this would be so, except to speculate that the treatment serves to disrupt the polarity of growth regulators that typically keeps the shoot buds in the suppressed state. Even when I did succeed in producing shoots and roots on detached aerial chichi (Figure 5), I still had problems keeping them healthy and vigorous, and most of them eventually rotted.

### Chichi Bonsai

According to Yuji Yoshimura, former Bonsai Curator at the Brooklyn Botanic Garden, most of the ancient ginkgos in Japan, regardless of whether or not they have been injured, seem to pro-



**Figure 4.** The "Single Peak Piercing the Clouds" ginkgo penjing. From Hu Yunhua, 1987.

**Figure 5.** An aerial chichi that produced both roots and shoots after being removed from its parent branch and planted in sand. Scale in centimeters.



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duce aerial chichi. As to the question of whether there are specific clones of ginkgo that produce chichi more readily than others, Mr. Yoshimura says that any old ginkgo that has started producing abundant aerial chichi is referred to as "chichi icho" (chichi ginkgo), and that any such tree can serve as the source of propagation material for the production of bonsai. It has also been noted by both Oyama and Mobius that female ginkgos which produce extensive aerial chichi generally fail to produce seed — an observation that suggests the existence of some sort of developmental "switch" in senescent ginkgos which diverts energy from sexual (seed) to vegetative (chichi) reproduction.

Typically chichi bonsai are produced by one of three methods: air layering relatively large branches from an existing chichi ginkgo, grafting scions from a chichi ginkgo onto seedling understock, or rooting chichi ginkgo stem cuttings. According to Takeuchi, air layering is far and away the preferred technique because it produces a large plant within three years (Figure 6). In contrast, grafted or rooted plants can take many years to form aerial chichi. It seems likely that the rapidity of chichi production by bonsai plants is a function of the extent of chichi development on the propagation material when it was removed from the parent plant.

In this regard it should also be noted that girdling the stem of young

ginkgos, either with wire or by bark ringing, typically stimulates the formation of a chichi-like structure above the girdle. I have also observed chichi-like growths develop in association with the callus formation that accompanies both wound healing and grafting in seedlings (Figure 7). According to Oyama, girdling or wounding techniques are often applied to the upper branches of an existing chichi bonsai as a way of producing propagation material for the creation of future chichi bonsai. Taken together, the evidence from botany and horticulture indicates that aerial chichi production is a developmental phenomenon, characteristic of the senescent phase of the ginkgo life-cycle, that can be perpetuated through vegetative propagation.

### Basal Chichi Development

After considerable research in the greenhouses and the nurseries of the Arnold Arboretum, I have been able to establish the fact that basal chichi in ginkgo originate from buds located in the axils of the cotyledons, and that one of these buds typically proliferates to produce a downward growing shoot that is literally covered with suppressed buds (Figure 8). Basal chichi are identical to aerial chichi in their anomalous anatomy and morphology, and in the fact that they always develop from a preexisting shoot bud. They are dif-

ferent in that they form predictably at one of the cotyledonary nodes of all ginkgo seedlings as part of their normal development, as opposed to aerial chichi, which tend to develop unpredictably from the branches of very old cultivated trees, often in response to severe trunk or crown damage.

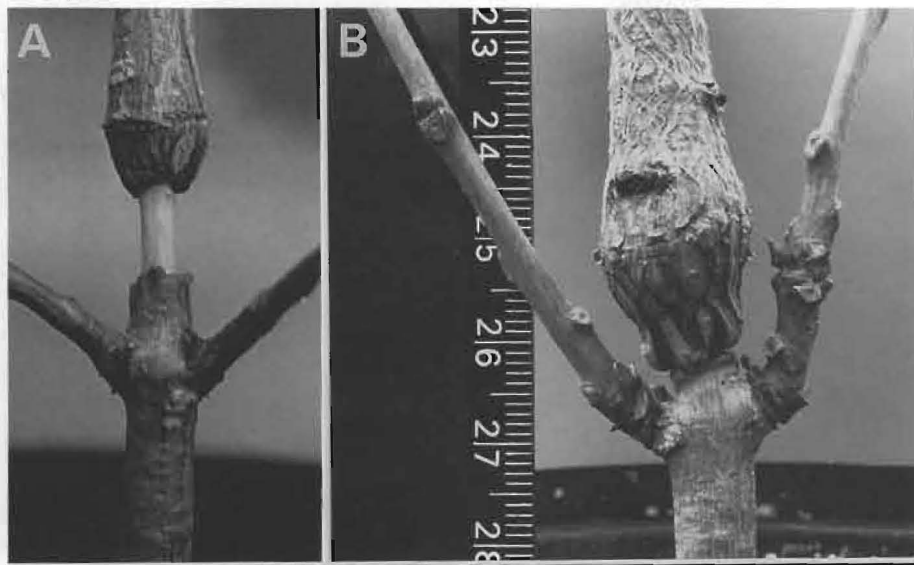
I have made numerous observations on basal chichi development in Sumter, South Carolina, where a thousand acres of ginkgo — roughly ten million trees — are being cultivated for the production of leaves for medicinal purposes. Among seedlings that were raised under crowded nursery conditions, I found that eleven percent of one thousand randomly selected, three-year-old plants had produced a downward growing basal chichi longer than one centimeter, with the longest being seven centimeters long (Figure 9). In all of these seedlings, only one of the cotyledonary buds ever formed a basal chichi, the others remaining comparatively undeveloped. While none of the observed chichi were producing shoots, many of them had produced large, adventitious roots.

At the Sumter plantation, seedlings are planted out in the field at three or four years of age. Once established, two years later, the plants are cut back to near ground level following leaf harvest. Most of the plants respond to this brutal treatment by producing

**Figure 6.** The trunk of an old "chichi icho" bonsai from Japan, the segment of stem shown is about 30 centimeters tall.



**Figure 7.** Wound healing in a ginkgo seedling. **A.** Close-up photograph of the chichi-like callus formation that developed on a ginkgo seedling that had a one centimeter ring of bark removed. The shoots below the girdle arose from cotyledonary buds following the wounding treatment. **B.** The same seedling a year later showing how the upper callus has nearly completed reestablishing a connection with the lower portion of the girdle. Remarkably, the primary stem continued to grow throughout the entire healing process, and is still alive three years after the treatment. Scale in centimeters.



massive basal chichi that give rise to new shoots as well as new roots. Shoot production by basal chichi, which does not begin until the plants are a minimum of five years old, was most frequent among those plants that had

been pushed over and partially uprooted by the harvesting equipment. This would suggest that damage to the root system may be as important a factor in stimulating the basal chichi development as damage to the shoot

system. While much more work needs to be done, it is clear that basal chichi development is stimulated by conditions of *continuous stress over a long period of time*, and that one-time treatments, such as shoot decapitation or the tipping of seedlings at a forty-five degree angle, do not seem to stimulate basal chichi development beyond that which occurs in untreated controls.

The phenomenon of secondary sprouting from basal chichi opens up the possibility of creating multi-stemmed ginkgo bonsai that mimic the form of trees growing naturally on steep, eroding mountain slopes. With proper training, such "basal chichi" bonsai have the potential to develop into a "forest" of stems, analogous to a group planting of seedlings, but with a more rugged, individualistic appearance (Figure 10).

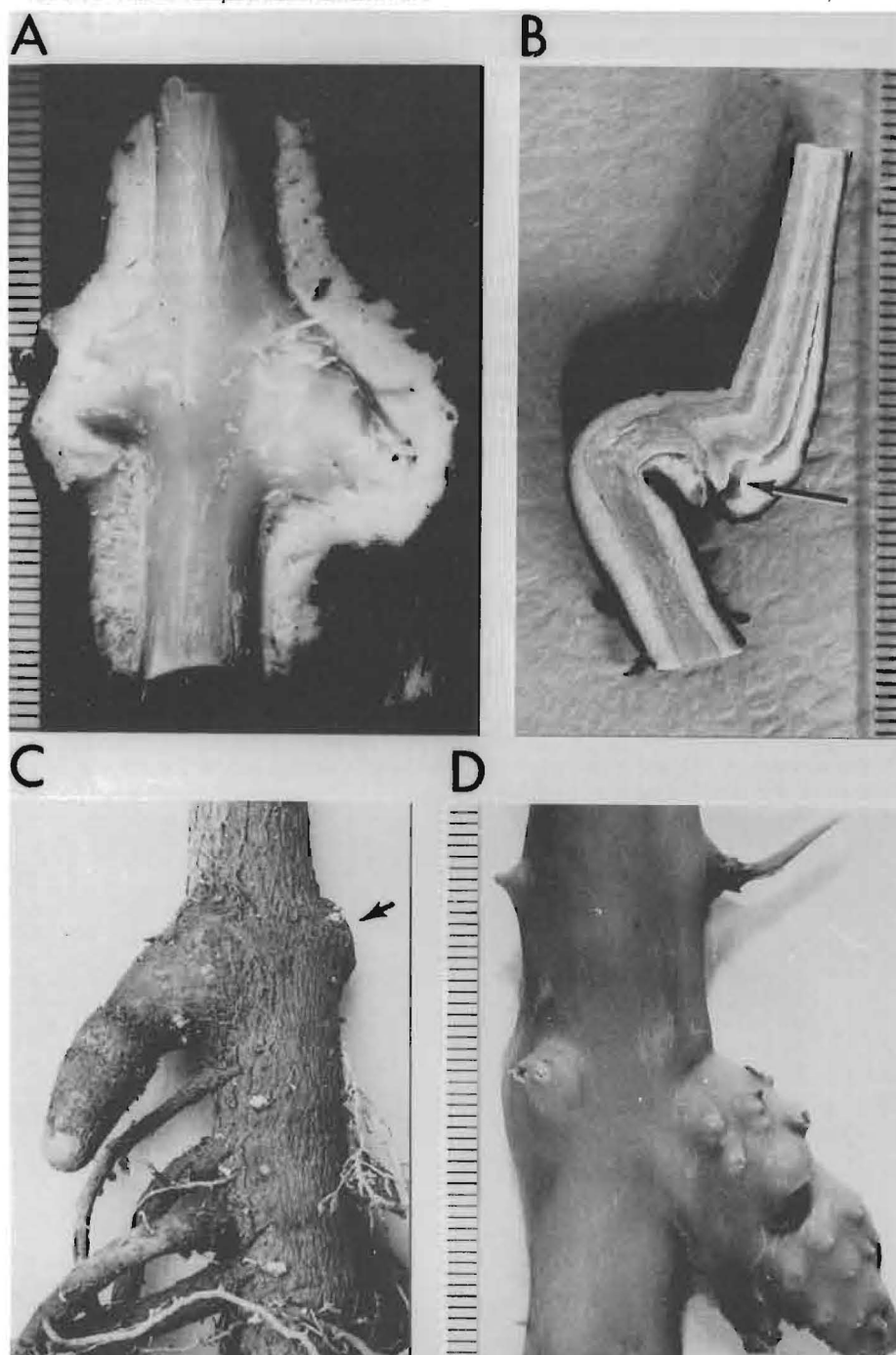
### Conclusions

Based on information presented in this article, three distinct styles of ginkgo bonsai/penjing based on chichi production can now be identified: 1) the "chichi" style produced by layering branches of trees that are already producing chichi; 2) the "stalactite" style produced by removing aerial chichi from old trees and planting them upside down; and 3) the "clump" style produced by suckering from basal chichi. All three forms, despite their obvious differences, clearly illustrate the close link in ginkgo between longevity and eccentricity.

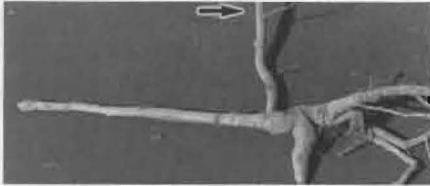
While ginkgo chichi are of interest for a variety of cultural, scientific, and aesthetic reasons, they are most significant for the ecological role they play as an organ of vegetative rejuvenation following traumatic disturbance (Figure 11). Indeed, clonal regeneration from basal chichi has not only contributed to the long-term persistence of ginkgo in the forests of China, but also to the extraordinary persistence of the species throughout geological time. From the symbolic point of view, ginkgo chichi can be seen as a manifestation of the indomitable vitality of a tree that has survived countless calamities during the course of its existence on planet Earth.



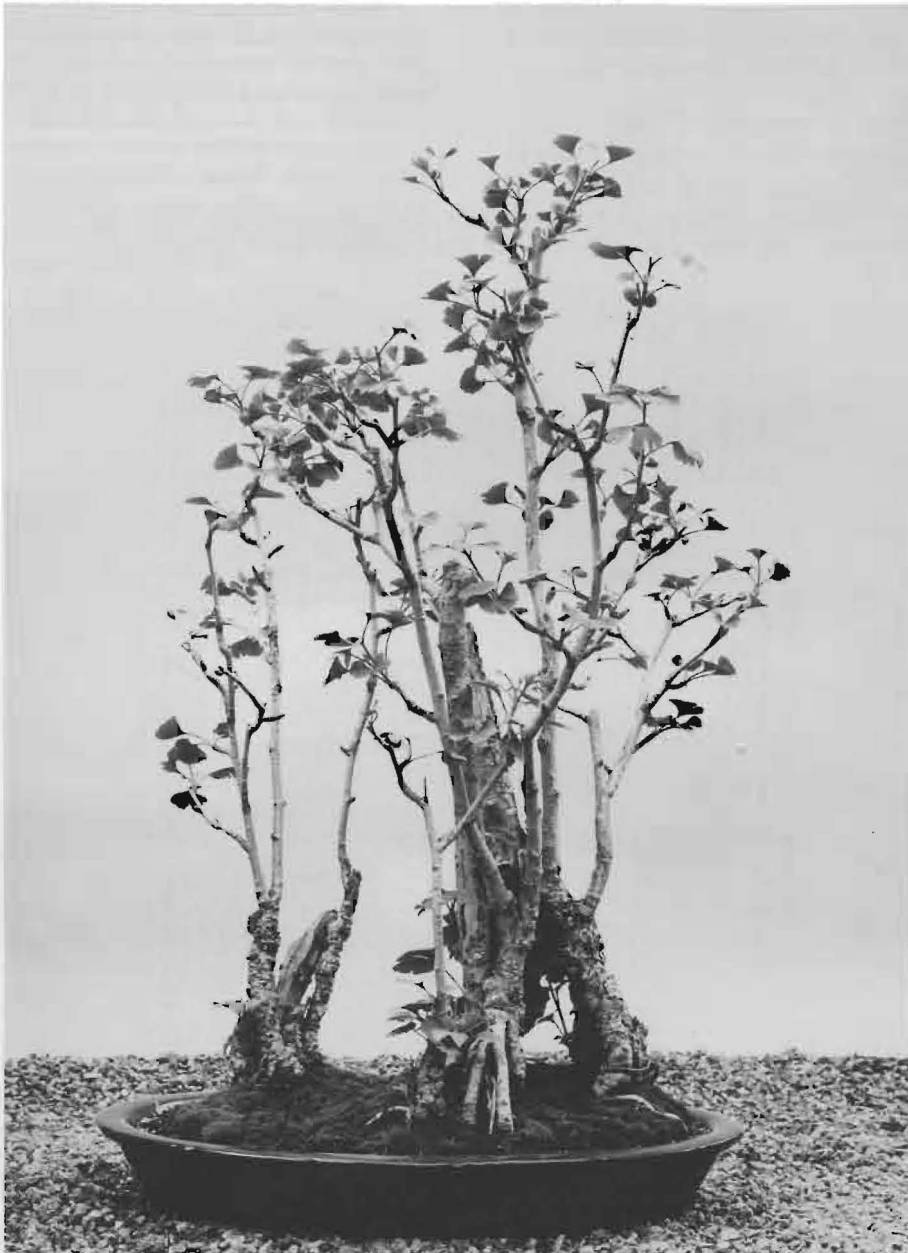
**Figure 8.** The early stages of basal chichi development in two to three year old ginkgo seedlings. **A.** A partially debarked two year old seedling showing the unequal development of the cotyledonary buds. The bud on the right might well have developed into a basal chichi, while the one on the left would probably have formed a suppressed bud-complex. **B.** Longitudinal section of a partially debarked two year old seedling showing the strongly kinked stem that is often associated with the basal chichi development. Arrow indicates the developing basal chichi. **C.** A three year old seedling in which one of the cotyledonary buds has developed into a prominent basal chichi while the other has not (arrow). **D.** A debarked three year old seedling showing the xylem traces of the numerous dormant shoot buds on a well-developed basal chichi. All scales are in centimeters. From Del Tredici, 1992.



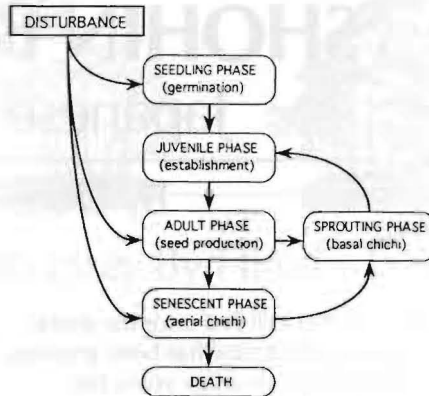
**Figure 9.** A three year old ginkgo seedling that was accidentally planted horizontally in the soil. Following this treatment, a new shoot developed at the base of the stem and grew vertically (arrow), while a single basal chichi developed from a cotyledonary node and grew down, perpendicular to the original stem. Such behavior clearly indicates that the orientation of basal chichi growth is positively geotropic.



**Figure 10.** A multistemmed penjing specimen of a "basal chichi" ginkgo, originally collected from the woods near Hangzhou, China. The plant is about a hundred years old and has been under cultivation since 1965. Originally styled by Hu Yunhua, the tree is now growing at the Arnold Arboretum. Photo taken in 1989 by Istvan Racz.



**Figure 11.** A schematic outline of the role of disturbance in the life cycle of *Ginkgo biloba*.



## ABOUT THE AUTHOR

### Peter Del Tredici

Peter Del Tredici is Director Of Living Collections at the Arnold Arboretum of Harvard University, Jamaica Plains, Massachusetts and Curator of The Larz Anderson Bonsai Collection that resides there.

Dr. Del Tredici holds degrees in Zoology and Biology and has worked on various aspects of both botany and horticulture over the last 20 years. During his past 14 years at the Arnold Arboretum he was a plant propagator and editor of *Arnoldia*, the magazine of the institution.

He has authored three books; two on Canadian Hemlocks and in 1989 wrote *Early American Bonsai: The Larz Anderson Collection Of The Arnold Arboretum*. His interests are wide ranging and include the specialties of bonsai, dwarf conifers, magnolias, root systems of plants and the architecture of trees. Mr. Del Tredici's current passion, and the subject of his Ph.D. dissertation, is the ginkgo tree.

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