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METASEQUOIA, ANOTHER "LIVING FOSSIL"

GINKGO BILOBA, a monotypic genus of very ancient lineage, in fact from the standpoint of geologic history, outside of the Cycadaceae, the most ancient of living trees, is often spoken of as a "living fossil." The sole species, once of very wide geographic distribution in the North Temperate Zone of both hemispheres, can scarcely be distinguished from fossil forms of ancient Mesozoic times. This is a beautiful example of the persistence of selected life forms, in highly organized groups, through many millions of years. *Ginkgo* has persisted in cultivation in China, but there are a few places in that country where it is spontaneous in limited forested areas. Whether or not it is truly native in such places, or merely occurs as a descendant from planted trees, is not definitely known. It was introduced into Japan about 700 A.D., into Europe about 1730 and into the United States in 1784. Now another striking case develops, not quite as old geologically as is the *Ginkgo*, through a remarkable discovery originally made by Mr. T. Wang in 1945. *Metasequoia*, previously known only from paleobotanic records is now shown to exist in the form of a single living species in a very limited area, and it, or its immediate ancestry, goes back to Mesozoic times.

One of the leading articles of the issue of the Saturday Evening Post for January 3, 1947, is entitled, "There could be Dinosaurs." Its author discusses the possibility of some of the giant reptiles whose kin dominated the fauna of the earth in the Mesozoic era, through the Triassic, the Jurassic, and the Cretaceous times, actually existing today in the unexplored swamps of tropical Africa. He admitted that wishful thinking and vague rumors were involved and after considering the possibilities frankly stated that there is, as yet, no positive evidence that these giant reptiles do still exist. Much more than a strictly popular account will be needed to convince the herpetologists, although some representatives of the general public, reading the article, may be persuaded that there is the possi-

bility that somewhere in the world there still exist a few representatives of these ancient giant reptiles.

I have deliberately referred to the above admittedly popular article for the simple reason that in the same geologic era, the Mesozoic, when the world fauna was dominated by the great reptiles, the land vegetation was largely dominated by the Gymnosperms, the primitive flowering plants, and that a great many of the genera which then evolved are still represented by living species. This was particularly true of the Triassic and Jurassic times, but in the Cretaceous many types of Angiosperms, the highest group of flowering plants, had appeared on the scene. Various genera of these ancient Gymnosperms have persisted throughout geologic time to the present including *Ginkgo*, mentioned above, the genera of living Cycadaceae (the most primitive of living flowering plants) and many of the genera of that large group commonly known as the Coniferae, which make up the great evergreen forests of temperate regions with which we are so familiar. Thus it was, as to time of origin from a geologic standpoint, that the period of development of and dominance of the great reptiles coincided with that of the primitive flowering plants; but while the great reptiles have disappeared from the scene, many of the genera of Gymnosperms have persisted, and, especially in the temperate regions, still dominate the vegetation of vast areas, particularly in the North Temperate Zone. Actually some of the living Gymnosperms can scarcely be distinguished from the fossil forms of ancient Mesozoic times.

The Mesozoic era has been defined as a succession of ages extending over a few hundred million years, but modern estimates place its duration as about 130 million years; even this last estimate is impressive enough, for to it must be added perhaps another 50 million years covered by the Tertiary down to the present time. It was toward the end of the Mesozoic era, in the Cretaceous, that the families and genera of many of the striking and most highly developed groups of flowering plants originated, the Angiosperms as contrasted to the more primitive Gymnosperms. While the animal kingdom in Mesozoic times was dominated by the great reptiles, particularly toward the end of that era, in the Cretaceous, the mammals were also developing, although during the Mesozoic none of the modern types was known and none of the immediate ancestors of man had appeared on the scene.

Mr. Wang's fragmentary specimens of 1945 were supplemented by additional material collected in the following year, originally three large trees representing this strange conifer having been located in northeastern Szechuan, very close to the Hupeh border. With the additional collections made in 1946, the discovery then developed into one of extraordinary interest in that the tree proved to be a living species of a genus, *Metasequoia*, which, up to that time, had been known only from paleobotanic records. Various species of North America and Asia originally ascribed to the genus *Sequoia* as fossil forms, proved not to belong in that genus, and in 1941 the new genus *Metasequoia* was proposed to accommodate

PLATE I

The type tree of the new Metasequoia at Mou-tao-chi. This is a sacred tree as indicated by the small Todee temple in front of the tree, Todee meaning God of the Land. Courtesy of Dr. H. H. Hu.

these; and only four years after that genus was described, a living species was actually found in China. This, because of the ancient lineage of *Metasequoia*, and its former wide geographic distribution (various parts of North America, Japan, Saghalien, Manchuria), is a most extraordinary circumstance. The proposed paleobotanic species are *Metasequoia heerii* from North America, *M. japonica* and *M. disticha* from Japan, and *M. chinensis* from Manchuria and Saghalien. Assuming that all of these extinct species are actually congeneric, then, in former geologic times, *Metasequoia* was a genus of very wide geographic distribution, as was *Ginkgo*. The latter is represented by only a single living species and this apparently now persisting only because it was preserved in cultivation in China. And now this striking *Metasequoia* is found, confined to a relatively few individual trees scattered along small streams and on the slopes of northeastern Szechuan and the adjacent parts of Hupeh.

It is sufficiently extraordinary that only four years after *Metasequoia* was actually described from the fossil records, that a living species of the genus should be found in China; but what is perhaps even more extraordinary is that when found, this living species, the sole surviving representative of a former widely distributed genus, was apparently not far from the verge of extinction as a living entity in its native habitat.

As noted above, the first observer located only three trees. A second expedition was sent out by Professor Wan-Chun Cheng of the National Central University, Nanking, in 1946, and Mr. C. J. Hsueh, his assistant, who led this expedition, brought the census up to about 25 trees. When botanical specimens were received at the Arnold Arboretum in the latter part of 1946 I immediately became interested in the possibility of securing seeds of this extraordinary species, and accordingly communicated with Dr. H. H. Hu, Director of the Fan Memorial Institute of Biology in Peiping, one of the joint authors concerned with the actual description of the species. Incidentally Dr. Hu was trained at the Arnold Arboretum, receiving his Sc.D. degree from Harvard University in 1925. Dr. Hu responded favorably and accordingly a modest grant was made from the Arnold Arboretum restricted Chinese exploration fund provided by the late Harrison W. Smith of Tahiti, himself a graduate of Harvard in 1895 and long interested in matters Chinese. On the basis of this grant Professor Cheng organized a third expedition to the type locality, this also led by his assistant Mr. Hsueh. He flew from Nanking to Chungking on September 3, 1947, and arrived at Mou-tao-chi, 110 km. east of Wan-hsien, Szechuan, on September 11, where the type of the species was originally discovered. This is very close to the Hupeh border. He spent approximately three months prosecuting field work in this part of Szechuan and in adjacent parts of Hupeh. He reports somewhat more than 100 large trees representing the species, occurring on slopes, along small streams, and near rice paddies (some of the trees planted) between the altitudes of 900 and 1,300 m. scattered over an area of about 800 square kilometers. This is a region of con-

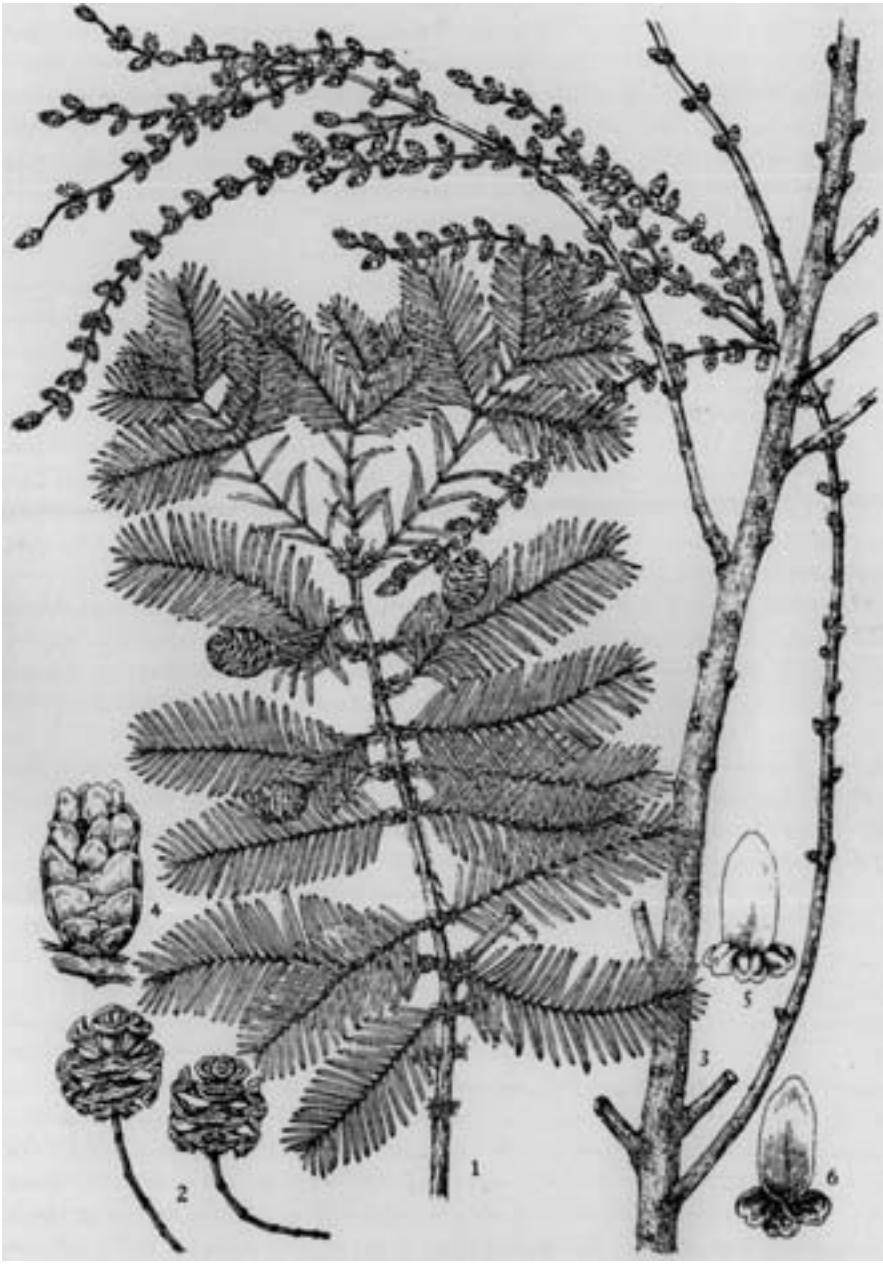

PLATE II

Metasequoia, showing botanical characters, courtesy of Dr. H. H. Hu.

siderable rainfall, with some ice and snow in the winter months. The center of its greatest abundance is in the Shui-sa-pa valley in Hupeh Province, where there are at least 1,000 of the trees, including the small ones; but there are no groves or forests made up of the species. In other places such as Houng-pin-ying and Mou-tao-chi, there are only a very few trees. It is of interest to note that the valley where most of the trees are now found takes its name from that of the tree, the tree itself known as *shui-sa* (*shui* = water, *sa* = fir or spruce), the place of its greatest occurrence being Shui-sa-pa.

The largest tree which was measured was 35 m. high, its trunk 2.3 m. in diameter. While 1947 was reported as not being a good seed year, an ample supply of seeds was secured during the time that Mr. Hsueh was in the field. These were delivered in Nanking early in December; the first small sending reached Boston January 5, 1948, and a second and larger shipment is now in transit. Seeds were planted in our propagating house early in January, and many of these germinated before the end of the month. Thus it is that in due time the Arnold Arboretum will have a certain number of living plants for distribution.

Following long established Arnold Arboretum practice, packets of seeds have been widely distributed to institutions in the United States and Europe. It is, of course, not known whether or not this remarkable species will prove to be hardy under the rather difficult climatic conditions characteristic of the Boston area. With excellent germination records it is now certain that we shall be able to establish this ancient but now nearly extinct type in various parts of the United States and elsewhere, for somewhere, with us, favorable climatic conditions will be found — if not in the northeast, then in the south or on the west coast. The point is emphasized that in spite of the present unfavorable economic conditions, in spite of adversities in China rendering travel difficult, and in spite of unfavorable exchange conditions, this cooperative project did succeed; that as a result an ample supply of seeds is available; that the seeds are viable; and, this being the case, the Arnold Arboretum has made an important contribution, working through its Chinese associates, in thus being involved in an attempt to preserve a remarkable conifer, and a species that in its native habitat is apparently not far from the verge of extinction. Incidentally Professor Cheng who, with Dr. Hu, cooperated with us, writes that without the modest grant made by the Arnold Arboretum, it would have been impossible for his representative to make the trip to Szechuan and Hupeh in 1947, and comments on the fact that trees are being rapidly destroyed by cutting in this region as well as in various other parts of China. He specifically mentioned *Picea heterolepis* Rehder & Wilson, which was described in 1914 from collections made by E. H. Wilson for the Arnold Arboretum in western Szechuan, in 1910, and a species now growing in our grounds. Not a single tree can now be found in the type locality, nor have the Chinese botanists been able to locate the species anywhere since 1932. The actual grant made by the Arnold Arboretum to finance this trip to Szechuan in 1947 was only

$250.00 which, because of the extreme inflation, actually yielded $9,750,000 in Chinese currency. This will give some idea of the current financial difficulties under which the Chinese botanists are carrying on their work.

This new "living fossil" is a large tree, attaining a height of at least 115 feet with a trunk diameter of at least $7\frac{1}{2}$ feet. One of its striking characteristics is that, like the various species of *Larix* (larch) and *Pseudolarix* (golden larch), and our *Taxodium* (swamp cypress) its leaves are deciduous, the trees being leafless in the winter months. In general appearance the leafy branchlets suggest those of

Fig. 3. Sketch map showing the limited geographic area of Metasequoia. drawn from data provided by Prof. Wan-Chun Cheng.

the genus *Glyptostrobus*. It is needless to repeat here the technical characters of this remarkable species, as these will be available when the formal description is published. All I have attempted to do has been to give the high lights regarding this remarkable discovery, and to call attention to the fact that viable seeds of the species have been received, from which young plants are now being grown.

It has been argued in some quarters that we approach the condition of diminishing returns in the botanical exploration of China, a field that has long been one in which the Arnold Arboretum has specialized. This statement is doubtless true to a certain degree, but from what has appeared in extensive collections made within the past three decades, I am still of the opinion that a vast amount of field work is still called for and is still justified. This remarkable *Metasequoia* find bears out this belief. In spite of all that has been published on the enormously rich flora of China in the past century, and particularly within the past four or five decades, there are vast areas still remaining to be explored, and the already known flora will be very greatly increased, as to the number of actually known species, when the more recently assembled collections are studied in detail.

This *Metasequoia* case is by no means the only one where living species of Chinese plants have generic names which were originally based on fossil forms. In the walnut family (Juglandaceae) two cases occur to me. In eastern Asia one finds the very characteristic monotypic genus *Platycarya*, this name proposed in 1843. An earlier name for the same group is the paleobotanic one *Petrophiloides* (1840). Actually in 1933 Messrs. Reid and Chandler in their large volume devoted to a description of the London clay flora, i.e., the fossil plants found in the clay deposits which underlie the City of London, abandoned *Platycarya* as the generic name for this group and accepted the earlier *Petrophiloides*, with the binomial *Petrophiloides strobilacea* (Sieb. & Zucc.) Reid & Chandl. for the living eastern Asiatic tree. The other case is more recent. In 1941 the very striking new genus *Rhamphocarya*, with a single species, was described from recently collected Yunnan material; but shortly after the description was published it was discovered that the earlier paleobotanic generic name *Caryojuglans* (1935), which had been proposed to take a European fossil form, represented the same group. While in a way these two cases parallel *Metasequoia*, they are not as striking, for the Juglandaceae is, geologically speaking, a much more recent group than is the Coniferae; yet all three genera were formerly of very wide geographic distribution in the North Temperate Zone although the three living representatives, one in each genus, are now of distinctly restricted ranges in eastern Asia.

I am able to reproduce the figures, plates I and II, through the courtesy of Dr. H. H. Hu, one showing the type tree of the species, while the other the botanical characters. The map (fig. 3) was based on data provided by Professor Cheng. Dr. Ralph W. Chaney of the University of California kindly checked the geologic and paleobotanic aspects of this short paper.

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