THE GINKGO-TREE.

AN event of considerable interest to botanists has just occurred at Washington in the flowering, for the first time, of two of the ginkgo-trees in the U. S. botanic garden.

In passing the grounds on Saturday evening, May 6, after the gates were closed, my attention was attracted to a tree standing just inside the enclosure, which, though as yet nearly leafless, was loaded with staminate aments borne in terminal clusters on very short branchlets all along the branches, even down to the base of the larger ramifications. A glance showed that it was a ginkgo, though I had never seen one in flower before; and, after examining it sufficiently, I went away, and was obliged to wait until Monday morning before I could notify the superintendent, Mr. W. R. Smith, and institute a search for other trees in the same condition.

Presuming that, as is usually the case in public gardens and parks, all the trees in the city would also be males, so that no opportunity would exist for witnessing the fruiting of this tree, I was most agreeably disappointed when I learned that Mr. A. L. Schott had found another tree in flower in the same enclosure, and that this tree was a female. I thereupon carefully inspected both these trees, and found that anthesis was so nearly synchronous in the two sexes that I was able on the 5th to pronounce them ready for fertilization. But as they stand some seventy-five yards apart, with the superintendent's house and other obstacles between them, it was evident that this could not take place unaided; and accordingly, with the hearty co-operation of Mr. Smith, the work of artificial pollinization was undertaken. This has been repeated several times at different hours of the day, and so thoroughly performed that it is hoped the result will be successful,[1] and that fruit will be borne this season.

The so-called Japanese ginkgo,[2] or maiden-hair tree (Ginkgo biloba, Linn.; Salisburia adiantifolia, Smith), is one of the most interesting trees that have been introduced into the landscape plantations of Europe and America. Although possessing deciduous foliage and broad green leaves, it nevertheless belongs to the Coniferae, though its affinities with the rest of that family are anomalous, being closest with the yew tribe. An examination of its leaves shows them to be wholly unlike those of any other phenogamous plant. They are deltoid in outline, and the fine nerves that run from the narrow base to the broad apex fork several times in their course, after the manner of ferns. In fact, a ginkgo leaf very closely resembles a much enlarged and thickened pinnule of the maiden-hair fern (Adiantum), — a resemblance which not only suggested to Smith the specific name adiantifolia, but has caused the tree to be popularly called in some localities the maiden-hair tree.

A study of the paleontological history of this remarkable plant reveals the fact that it is an archaic form, and the sole survivor of an otherwise extinct type of vegetation which had numerous representatives in the remote geologic past. The Salisburia adiantoides of Unger, found in the upper miocene of Senegal, is not essentially different from the living species; and Professor Heer detected it again in the miocene strata of Greenland. In 1881 I was so fortunate as to obtain from Laramie strata at Point of Rocks Station, Wyoming Territory, a form which, except for its smaller leaves, appears to be identical with the living one; and in 1883 I found in Fort Union strata, on the lower Yellowstone, a slightly different form, with larger leaves, showing no lobes, proving that the present living form has come down to us, almost unchanged, from a period as remote at least as the cretaceous age. But other and distinct forms are found in the cretaceous, and still others, showing greater and greater divergence, as far back as the Jurassic; those of the oolite bearing clear evidences of having been derived from a series of still older, digitate-leaved forms (Jeanpaulia, Baiera, etc.) whose relationship with the ginkgo was not suspected until these intermediate ones had been brought to light by Heer from the mesozoic rocks of Spitzbergen and Siberia. In fact, until recently these earlier Jurassic forms, which had been long well known, were from their nervation referred to the family of ferns; as, indeed, a fossil leaf of the ginkgo would probably be now, if the living plant were unknown.

But even this is not all. By another series of far more ancient forms (Trichopitys, Psygmophyllum, Noeggerathia), this persistent type may be traced still farther back, even across the boundary between mesozoic and paleozoic time, until, in the great carboniferous flora, it has been connected, almost without

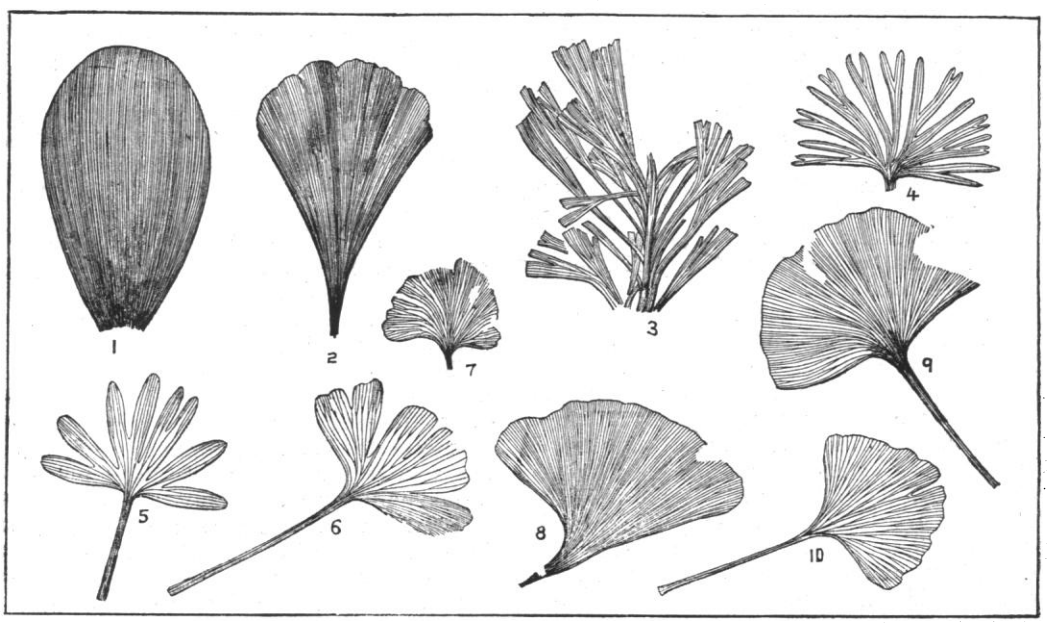
[1] Evidence is abundant (June 15) that artificial pollinization was successful.

[2] The orthography of this word is not settled. Linné (Mantissa plantarum, Holmiae, p. 313) wrote *ginkgo*, as did also, apparently, Kaempfer before him (Amoenitat. exotic., 1712), and as all botanists since have done, and do still; but nearly all lexicographers reverse the consonants, and write *gingko*, usually without explanation. Littré alone, of all I have consulted, gives both spellings. In the supplement to Webster's dictionary the word is said to signify silver-fruit, and it would seem that the etymology ought to determine the orthography.

question, with the abundant and so long enigmatic Cordaites. This ancient plant was formerly regarded as the forerunner of the family of cycads; but now, in the light of these discoveries, it is almost universally regarded as coniferous. It was one of the earliest types of land vegetation to appear on the globe, running far back into Devonian, and even into Silurian time.

The figures of the accompanying plate, remarkable manner the almond-shaped nuts borne by the present maiden-hair tree.

Though these carboniferous plants were at first commonly regarded as cycadaceous, still the long, ribbon-like leaves of certain cordaitean forms (Poa-Cordaites of Grand'Eury) led some eminent authors, including the late Professor Göppert, to consider them monocotyledonous, and the precursors of our lilies, reeds, grasses, and also of the palms. But even these mis-



PHYLOGENY OF THE GENUS GINKGO.

1. Cordaites lingulatus, Grand'Eury: carboniferous, Central France. 2. Psygmophyllum (Noeggerathia) flabellatum (Lind. & Hutt.), Schimp.: carboniferous, England. 3. Ginkgophyllum Grasseti, Saporta: Permian, Hérault. 4. Baiera (Jeanpaulia) Münsteriana (Presl), Heer: rhaetic, Bayreuth. 5. Ginkgo Sibirica, Heer: oolite, Siberia (restored by Heer). 6. Ginkgo digitata (Brongn.), Heer: oolite, Cape Boheman, Spitzbergen. 7. Ginkgo Laramiensis, n. sp.: Laramie, Point of Rocks, Wyoming Territory. 8. Ginkgo (Salisburia) adiantoides, Unger: Fort Union beds, lower Yellowstone. 9. Ginkgo (Salisburia) adiantoides, Unger: miocene, Greenland. 10. Ginkgo biloba, L.: living, Washington, D.C. All the figures are reduced one-half.

kindly drawn for me by Ensign Everett Hayden, U. S. navy, have been selected with a view to illustrating the phylogeny of the genus Ginkgo: and they are numbered, and as nearly as practicable arranged upon the plate, in the order of supposed development, from the true Cordaites to the living Ginkgo biloba; this being also, as will be observed, substantially the chronological order of their appearance.

The broad leaves of some species of Cordaites, though more or less elongated or elliptical in shape, possess a nervation strikingly similar to that of the later ginkgo-like forms; while the familiar fruits so abundant in the coal-measures, and which are now known to be those of Cordaites, resemble in an equally

takes have not been without their uses. It is the peculiarity of science that in its very errors knowledge is extended. The theory that Cordaites was cycadaceous was not wholly false; the suggestion that it might be monocotyledonous contained a 'soul of truth;' and the present opinion that it was coniferous is, I venture to assert, not wholly true. The truth lies in the midst of all these opinions. It seems to be this: there were no true paleozoic Cycadaceae, monocotyledons, nor Coniferae; but Cordaites was the prototype of them all. It was in the Trias, whose flora is unfortunately the least known of all the formations in past time, that all these definite types of vegetation were differentiated from this comprehensive type, — the Cycadaceae through their Macropterygiums

and Pterophyllums; the monocotyledons through their Aethophyllums and Yuccites; and the Coniferae through their Albertias, Walchias, and Voltzias; while the less modified ancestral type, which began even in the Permian to assume a distinct Salisburian aspect in the genus Ginkgophyllum, has come down to us, as already described, through the several successive modifications which culminated early in the tertiary in the modern form. This general form was somewhat varied, widely distributed, and quite abundant in miocene time; but it is now reduced to a single species, which was probably restricted to the warmer or more eastern districts of the Chinese empire before it was transferred by human agency, and acclimated in Japan, to which country it is now popularly credited. But it is said that there is now no part of the world in which it is found in a strictly wild state, being confined, even in China, to the near vicinity of temples and human habitations.

This interesting tree has for many years been cultivated on the continent of Europe, where it thrives as far north as Copenhagen, but only fruits freely in the more southern districts, notably in the botanic garden at Montpellier, France, where it has been exhaustively studied by Professor Charles Martins and the Marquis Saporta. In the United States there are now many fine trees; but they rarely flower, and, when they do so, the sexes are seldom together, so that fruit cannot be produced. The only exception to this known to me, or to any of whom I have inquired, is the case of a pair of these trees in the grounds adjacent to the University of Kentucky at Frankfort, which are in such close proximity to each other that fertilization regularly takes place, and fruit is borne.

It is owing to these circumstances that such special interest attaches to the coincident flowering this season, for the first time, of the pair of maiden-hair trees in the botanic garden at Washington; and the rare opportunity, should it be afforded, of witnessing all the steps in the reproductive process of this historic type of vegetable life, will be appreciated by both botanists and vegetable paleontologists.

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THE NEW CROTON AQUEDUCT.

THE necessity for an addition to the present supply of water of New York has been felt for many years, and the present Croton aqueduct, finished in 1842, has become entirely inadequate to meet the present requirements of the city. Never was the need of an additional supply better illustrated than in 1880, when the authorities in charge stated, at the end of a prolonged drought, that there was only fifteen days' supply at hand. Timely rains occurred shortly afterwards, and replenished the water-sources.

Since 1875, when two projects were presented for an additional water-supply, numerous surveys were made, extending in several instances beyond the limits of the present collecting-grounds; and in the beginning of 1883 a committee of citizens, appointed by the mayor at the request of the senate, presented to the legislature a report recommending that provision be made for the ultimate storage of all the water from the Croton basin, and for the immediate construction of a new aqueduct.

This scheme is now being carried out by a commission created by the legislature (May, 1883), and composed of the mayor, comptroller, and commissioner of public works, and of three citizens at large.

The available watershed of Croton River covers now 338.82 square miles. Its waters are at present collected in several storage-reservoirs, the lowest of which (Croton Lake) acts also as a settling-basin, from which the present aqueduct starts, and extends as far as the main distributing reservoir in Central Park. Owing to the limited capacity of the present storage-reservoirs and of the aqueduct, a very large proportion of the flow of the river is unavoidably wasted over Croton dam.

The present scheme consists in building reservoirs capacious enough to impound the copious spring flows, and in constructing a larger aqueduct, through which the necessary allowance of water can be drawn all the year round from the new reservoirs. It is consequently, in a general way, on a larger scale, a duplicate of the present system; but the very scale on which the work is to be built gives rise (as may be understood from the short description which follows) to many interesting and difficult engineering problems.

It is estimated, that, in the dryest years, the Croton watershed can furnish a daily supply of 250,000,000 gallons, equivalent to 100 gallons per head per day for a population of two million and a half souls, or to 75 gallons per head for a population of three and one-third millions.

In order to store the large amount of water necessary to provide this large daily supply during the dryer months, it has been found advisable to provide, at first, one reservoir of