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.

LESTER F. WARD.

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

very large capacity, placed low enough in the Croton valley to increase to 361.82 square miles the available area of the watershed of Croton River. This reservoir is to have a capacity of 5,200,000,000 gallons, — a body of water which would cover 9,400 acres ten feet deep.

The dam which is to form this reservoir (the Quaker-bridge dam), 178 feet high above the bed of the river, is to be built of solid masonry, and the water behind it is to be 171 feet deep. As the foundations of the dam must be extended to the bed-rock, a distance of nearly 100 feet below the bed of the stream, the total height of the masonry structure will consequently be not far from 300 feet for a length of 400 feet in the deeper portion of the valley. On both sides of this deeper portion the rock-bottom rises gradually, and the total length of the dam is to be about 1,300 feet.

The height mentioned for a masonry dam is unprecedented; and the strains which will be transmitted to the base of the structure by the combined action of its own weight and of the water-pressure are such as to require in the design a departure from the methods used and recommended by the engineering authorities who have studied the question of high masonry dams of lesser magnitude. The width of the dam at its base, although not fully decided upon, is to be more than 200 feet.

The question of providing an overflow to liberate the surplus water which must be wasted over the dam is happily and economically solved by nature, which has provided in the immediate vicinity a depression in the rock-formation, of the required elevation and form for the safe disposal of the freshets.

The new aqueduct starts from a point near the present Croton dam, and follows a general southerly direction towards the city, to 135th Street, with a length of nearly thirty-one miles. For the remaining distance, from 135th Street to the reservoir in Central Park (two and one-third miles), the water is to be conveyed in pipes. Harlem River is crossed by means of an inverted siphon 150 feet below the water surface.

With the exception of three points where it comes to the surface of the ground for short distances, the aqueduct is to be wholly in tunnel; and from the indications furnished by the topographical character of the country, and by numerous borings made with the diamond drill, it is probable that the excavation is to be, almost for the whole length of the aqueduct, in solid rock. It is expected that a large proportion of the tunnel excavation is to be lined with masonry; but, wherever the character of the rock is such that it can remain exposed without danger of falls, the masonry is to be dispensed with. If the line of work had been so located as to allow of the construction of the aqueduct in open trenches of moderate depth, it would have been much longer, owing to the necessity of following the contours of the land; and it would have passed along the east shore of Hudson River, through thickly settled communities, where the land-damages would have been much higher. The tunnel presents also the important advantage of being almost wholly safe from the attacks of a mob or of a military foe.

From Croton dam to a point south of and near the boundary of the cities of Yonkers and New York, the aqueduct has a maximum flowing capacity of 320,000,000 gallons per day: it is 13.6 feet high and 13.6 feet wide; and its section is that of a semicircular arch, supported on slightly concave sides, the bottom being formed by a flat inverted arch.

At the point just mentioned, where it is expected that a large distributing reservoir is to be built to supply the annexed district, and where consequently a portion of the supply is to be diverted, the flowing capacity of the aqueduct is reduced to 250,000,000 gallons per day, and its form is circular, with a diameter of twelve feet three inches.

This part of the aqueduct, over six and a half miles in length, including the inverted siphon under Harlem River, is to be heavily lined with masonry; and, owing to the insufficient elevation of the land, it is depressed to a considerable depth, presenting the peculiar, and to a certain extent experimental, feature of a masonry channel built in solid rock, and subject to a considerable internal water-pressure. Its prototype, the tunnel under Dorchester Bay, which conveys the sewage of Boston to Moon Island, has been in successful operation for more than a year, but under somewhat different conditions of location, size, and pressures.

For the purposes of construction and of future maintenance of the aqueduct, thirty-two shafts are provided, of various depths, the greatest being 350 feet. Twenty-four shafts are under construction, twelve of which are already completed, or nearly so.

Six extensive gate-chambers are to be constructed, in connection with the aqueduct, for the purpose of emptying it when necessary, and of regulating the flow of water from the

storage-reservoir into the city. One of them, at the head of the aqueduct, near Croton dam, is to be of unusual size, and is to be constructed to support a maximum pressure of 65 feet of water.

The aqueduct from Croton dam to Harlem River is now under contract to the amount of $11,900,000. The rest of the work is to be commenced shortly. A. FTELEY, C.E.

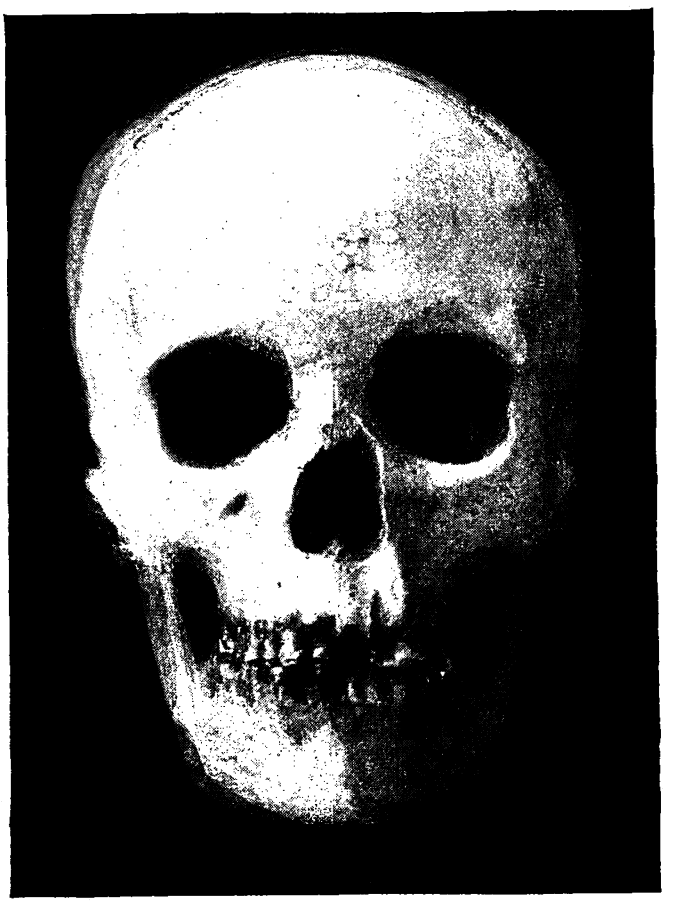
MEASURING THE CUBIC CAPACITY OF SKULLS.[1]

IN referring to the application of composite photography to craniological studies, Dr. Billings described the methods employed at the army medical museum in the preparation of such composites. They are made directly from the skulls, and not by combining separate pictures of individual crania. The skulls are adjusted in succession on the object-stand, in such a manner that the horizontal datum-plane adopted by German craniologists, and the subnasal and maximum occipital points (or the supra-auricular points in profile exposures), shall coincide; this being effected by movable frames on which are stretched a series of vertical and horizontal threads. It is very desirable that some uniform scale for the preparation of such photographs should be agreed upon by craniologists before the preparation of extended series is undertaken, and one-half of the natural size is suggested for this purpose.

These composite photographs should be studied in connection with the measurements of the crania included in them. It is a rapid and convenient means of obtaining graphic representations of a series of irregular objects, — representations which shall indicate not only the mean, but also, as far as possible, the maxima, of variations.

While something has been done in the study of the internal configuration of the cranial cavity, and more especially of the various fossae and projections at its base, with reference to their difference in various races, this field of inquiry is as yet comparatively unworked; and Dr. Billings thinks it very desirable to follow out this special line of investigation in connection with the large and valuable collection of crania of American races which now exists in the army medical museum and in the national museum. To do this, however, it is necessary that sections should be made of the skulls; and, before making such sections, it is desirable that all measurements, and especially the measurements of cubic capacity of these crania, should be made according to the best and most approved methods, and the results carefully recorded.

From the results of preliminary experiments upon the methods in use for measuring the cubic capacity of crania, Dr. Billings became dissatisfied with their accuracy, and accordingly requested Dr. W. Matthews to undertake a series of experiments for the purpose of obtaining, if possible, some more accurate and reliable method of ascertaining the cubic capacity. The following is an abstract of the report of Dr. Matthews, giving the results of his observations and experiments on measurements by means of water.



SIX ADULT MALE ANCIENT CALIFORNIANS FROM SAN NICHOLAS ISLAND.
Exposure of each skull 10–20 seconds, according to color.

Hitherto anthropologists have chiefly employed solid particles, such as shot or seeds, in the cubature of skulls. Water has been tried by former experimenters without success. Dr. Topinard, in his 'Élé-

[1] Abstract of a paper read to the National academy of sciences by Dr. WASHINGTON MATTHEWS, U.S.A. Presented, with introductory remarks, by Dr. J. S. BILLINGS, U.S.A.