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.

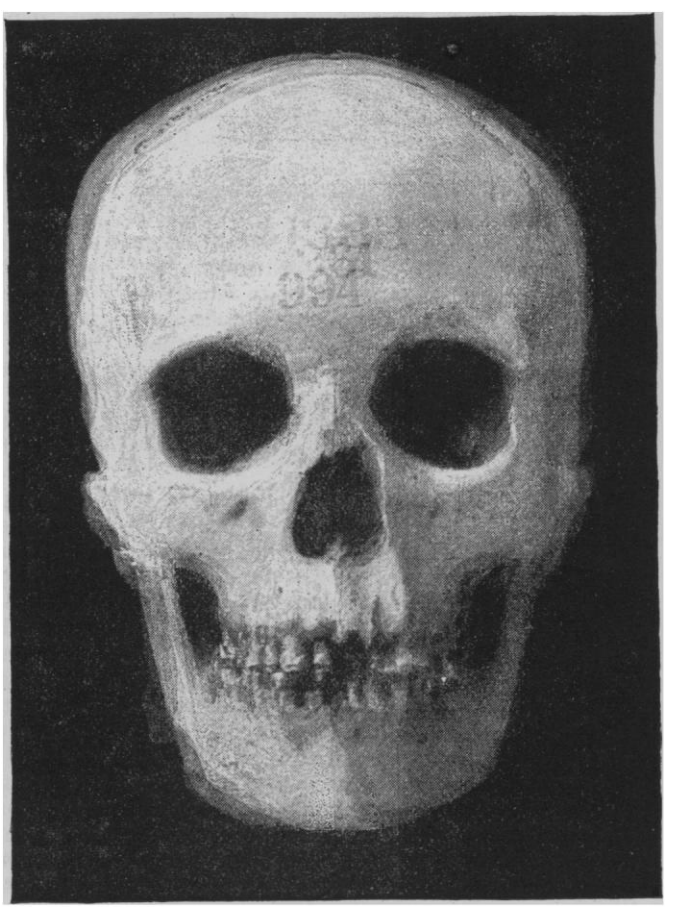
MEASURING THE CUBIC CAPACITY OF SKULLS.[1]

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.

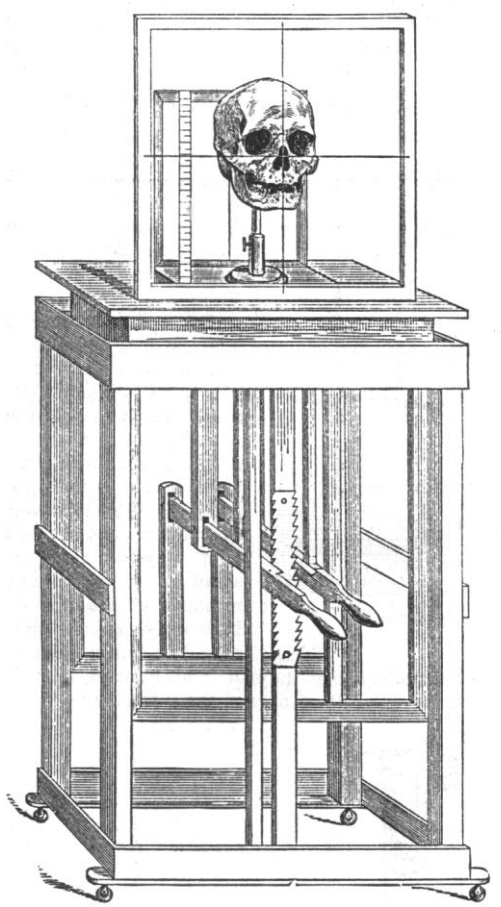


SIX ADULT MALE ANCIENT CALIFORNIANS FROM SAN NICHOLAS ISLAND. Exposure of each skull 10–20 seconds, according to color.

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.

ments d'anthropologie générale' (Paris, 1885), states that the chief difficulties with water are: first, that the water, wetting the sides of the measuring-glass, rises on it, and makes it impossible for the observer to read correctly; and, second, that the water penetrates to the sinuses and vacuoles of the skull, and returns, when the skull is drained, to augment unduly the water belonging to the cavity proper. The experiments of Dr. Matthews indicated that the greatest source of uncertainty lay in the fact that the skull, when moistened, increases rapidly in cubic capacity. His method is as follows:—



ELEVATING-TABLE, CRANIOPHORE, AND CROSS-LINE FRAME FOR ADJUSTING SKULLS IN COMPOSITE PHOTOGRAPHY.

After recording the weight of the skull, it is varnished inside with thin shellac varnish, applied by means of a reversible spray apparatus. Artificial or accidental orifices are closed with India-rubber adhesive plaster. The foramina and fossae are filled with putty. The skull is wrapped in a coating of putty an inch or more in thickness, which renders it water-tight. It is filled with water by special apparatus in forty-five seconds, and emptied in fifteen seconds. The rapidity of this manipulation, in conjunction with the varnishing, prevents soaking into the sinuses, and the undue measurement of water which does not pertain to the cranial cavity. The water is poured into a measuring-glass of two thousand cubic centimetres capacity, and lycopodium is scattered on the water to define the true surface. The putty is taken from the skull: the latter is cleaned, and placed in a dry, warm apartment, until by slow evaporation it has been reduced to its former weight, and consequently to its former capacity. Then it is measured a second time to verify the results of the first measurement. The author did not claim rapidity as an advantage of the system, but believed that it removed to a great extent the effect of varying muscular effort, which was such a disturbing factor in other methods. "With the most important operations, the unchangeable element of time takes the place of the fickle element of vital force."

Although the method is new, and still susceptible of improvement, it is thought that the results as shown in the following table have not been excelled.

Comparative measurements of varnished and unvarnished skulls.

	Museum number of skull.	Unvarnished.			Varnished.			Date of measurement.	
		First measurement.	Second measurement.	Difference.	First measurement.	Second measurement.	Difference.		
		c.c.	c.c.		c.c.	c.c.			
1	199	1,400	1,390	10	1,400	1,400	–	March 26	April 2
2	359	1,450	1,445	5	1,450	1,450	–	" 23	" 3
3	362	1,275	1,270	5	1,270	1,265	5	" 26	" 2
4	373	1,455	1,455	–	1,450	1,450	–	" 24	" 2
5	375	1,305	1,305	–	1,300	1,300	–	" 24	" 3
6	481	1,455	1,455	–	1,445	1,445	–	" 24	" 2
7	1,516	1,160	1,155	5	1,160	1,160	–	" 23	" 3
8	1,914	1,285	1,280	5	1,285	1,285	–	" 27	" 3
9	1,915	1,450	1,440	10	1,440	1,435	5	" 21	" 2
10	2,034	1,200	1,195	5	1,190	1,190	–	" 26	" 2
	Sum of	differ	ence.	45	. .	. .	10		

Average variation in unvarnished skulls . . . . . 4.5 c.c.
Average variation in varnished skulls . . . . . 1.0 c.c.

THE CULTIVATION OF MICROBES.[1]

IT is possible to obtain a perfectly sterile liquid (that is to say, one deprived of all living germs) by one of four methods:—

1. Filtering through some material whose meshes are sufficiently fine to arrest the smallest organisms. The only material really practicable for this purpose is the unglazed porcelain used by Pasteur and Chamberland.

2. Obtaining the liquid directly from the internal organs of one of the superior animals; the digestive tract being considered, for this purpose, an *external* organ. Pasteur's experiments have shown that the

[1] Abridged from an article by Dr. HERMANN FOL of the University of Geneva, in *La Nature*.