with any published species, and the Rhizosoleniæ were all too much broken to afford specific characters.

Melosira granulata is said by all the authorities to be a fresh water form, but the specimens have all the characters of that species.

It would be an unwarranted conclusion that these organisms were obtained from their native locality. From their minute size they may have been brought by currents or winds, or in the intestines of fish or birds from far distant places.

The Melosira sulcata is the only one sufficiently abundant to indicate that it was found in its native habitat.

April 15, 1868.

The President in the chair. Thirty-five members present.

The following paper was read: —

Observations on Crania. By Jeffries Wyman, M.D.

1. Measurement of Skulls.

Tiedemann appears to have been the first to attempt anything like an extensive comparison of human crania based upon their capacity.* To this end, 1, he weighed the skull without the lower jaw; 2, filled the skull with dried millet seed and weighed again; 3, deducting the weight of the skull he obtained the weight of the millet seed filling it. Thus a means for determining the comparative size of the cranial cavity in different individuals or races was obtained, but it failed to give any exact idea of the volume of the brain. The method proposed by Sir William Hamilton was more successful; he filled the cranium with fine sand, which was measured in cubic inches; having determined the weight of a cubic inch of sand, he multiplied this by the number of cubic inches contained in the skull, and making a correction for the difference in the specific gravities of brain and sand, the weight of the brain was approximately reached.† Prof. Daniel Treadwell has proposed a somewhat similar, but more simple method than this; it consists in determining, by any given method, the capacity of the skull in cubic inches, multiplying this by the weight of a cubic inch of water, and correcting for the difference between the specific gravities of brain and water, we have, as in the

* Philos. Trans. of the Royal Society of London, 1836, p. 497.

† Lects. on Metaphysics and Logic. Edinburgh, 1860. Vol. I.; p. 240.

other case, cubic contents converted into brain weight.* The method proposed by Prof. Treadwell has an advantage in the fact that the weight of a cubic inch of water (252.5 grains, or 16.4 grams) has been determined with great accuracy, and is a constant quantity; while that of a cubic inch of sand varies according to locality, requiring a fresh determination each time a different kind of sand is used.

The nature of the material used for measuring the capacity of the skull is important, but observers have had recourse to very different kinds. Water would unquestionably be the best, but its use is impracticable owing to the great difficulty in making the cranium sufficiently tight to retain it. The late Dr. Samuel George Morton, having used white mustard seed "on account of its spherical form, its hardness, and the equal size of its grains," afterwards, at the suggestion of Mr. J. S. Phillips, substituted No. 8 shot which he found to give much more precise results, and with these all the measurements recorded in his tables were made.† Sir William Hamilton sharply criticises Dr. Morton's method as "only a clumsy and unsatisfactory imitation of mine," asserting that "pure silicious sand was the best means of accomplishing the purpose, from its suitable ponderosity, incompressibility, equality of weight in all weathers, and tenuity."‡ Dr. J. Barnard Davis, whose practical knowledge of the subject makes his opinion worthy of high consideration, also recommends the use of fine sand, § but instead of measuring he weighs the quantity the skull holds. Having ascertained the cubic measure of an ounce of sand, the whole quantity is readily converted into cubic inches, or by making a correction for difference in specific gravity, into brain weight. Various other substances, such as peas, flax seed, rice, etc., have been used. Welcker recommends the grains of husked wheat. For a full account of these and of the different methods of comparing crania, the reader is referred to the valuable and instructive memoir of Dr. J. Aitken Meigs, on the Mensuration of the Human Skull.‖

From the following table, the result of careful comparative experiments, it will be seen that, for exactness, shot are far preferable to sand, and that Sir William Hamilton's criticisms are unjust. The chief requisites for a good material for measuring crania, are lightness and uniformity in the size of the particles or component bodies; the size should be such that they will not escape from the foramina in the orbit, and their shape such that they will occupy the smallest

* American Journal of Medical Science, in the account of the last illness of the Hon. Daniel Webster. January, 1853.

† Crania Americana, p. 253.

‡ Op. cit. Vol. I., p. 240.

§ Crania Britannica.

‖ North American Med. Chirur. Review, Sept. 1861, p. 837.

compass with the least amount of shaking or compression. All these conditions were very nearly found in peas, and with the exception of lightness were realized in shot, the diameter in the second case being about 0.18 inch, and in the first 0.23 to 0.25 inch. Shot have the advantage over all other materials in their spherical shape, but their weight is such that fragile crania would be destroyed by them, though they may be safely used with those of ordinary strength. A skull having a capacity of ninety cubic inches when filled with shot weighs more then twenty pounds, which is altogether too heavy a mass to handle when many crania are to be examined.

With the view of determining the relative value of different materials, one and the same skull was measured eight times with each of the different kinds mentioned at the head of the columns of the table. The cranium was filled with a given material, which was well shaken down and compressed until no more could be received. The contents were then poured into a measure, care being taken that this should be done in each case at a uniform rate, but *without* being afterwards shaken or pressed down. The measure used was a litre, and the measurements are noted in cubic centimetres.

	Peas.	Shot.	Beans.	Rice.	Flaxseed.	Coarse Sand.	Fine Sand.
1	1190	1200	1210	1220	1250	1250	1315
2	1190	1205	1210	1222	1250	1260	1320
3	1190	1205	1210	1220	1240	1250	1290
4	1195	1200	1205	1220	1255	1260	1290
5	1198	1200	1210	1215	1250	1270	1320
6	1190	1200	1200	1220	1250	1250	1290
7	1195	1200	1205	1225	1240	1260	1350
8	1196	1205	1200	1220	1245	1260	1330
Aver'ge.	1193	1201.8	1206.2	1220.2	1247.5	1257.5	1313
Range.	8	5	10	10	15	20	60

From this table, it will be seen that the skull being carefully filled in each case, its capacity apparently varied according to the different substances used in the measurement; with peas it was 1193 c. c. and with fine sand 1313 c. c., or 120 c. c. more. This difference depends upon the fact that the substances used, under similar circumstances, adjust themselves to the least space with different degrees of facility. Shot and peas having a spherical shape the position in which they happen to fall is a matter of indifference, since all their diameters are equal. The other bodies whose diameters are unequal, require more or less of shaking and pressure in order that they may be packed in the smallest compass and thus an exaggeration of the capacity avoided. With proper care, correct measurements can of course be made with either of the materials mentioned in the table, and in practice no one would omit to shake down and compress the material in the measure to the same degree that he would in the skull. The object of the table is only to show the comparative amount of compression and adjustment required. To present the subject in another way, if a litre is filled with peas, and then shaken, it will diminish one per cent. in bulk, while, under similar circumstances, coarse sand diminishes fifteen per cent. In the first case the error will not exceed one per cent.; in the second it may be, unless great care is taken, much more. Of the different substances used, peas and shot, on account of their spherical shape, gave the best results, and coarse and fine sand the worst, on account of the irregular shape of the grains, the small size of these, for the finer the material the greater the error, and the roughness of their surfaces. As to peas and shot, the last give the most accurate and uniform results, while the latter, being less perfect spheres, lead to a slight error, but have the advantage in lightness, thus making manipulation more easy. Sand has the further disadvantage of filling many angles, canals, and foramina not occupied by brain, and therefore of exaggerating the quantity of this last, and in requiring that the foramina in the orbit should be plugged to prevent its escape. This last objection is of little moment when a single skull is to be measured, but is considerable when the number is large. By using bodies of the size of peas or shot, the inconvenience and the exaggeration are both avoided. The difference in the table between the amount obtained by measuring with peas and shot depends upon the larger size of the latter.

There is still another step to be taken, even if an exact measurement of the cranium has been made. The brain, as already stated, does not fill the cranial cavity; a space, variously estimated, is occupied by the membranes and the vessels, which should be deducted from the general internal capacity. Welcker estimates this at from 11.6 to 14 per cent. of the whole cavity, according as the skull varies in size. Dr. J. Barnard Davis makes a correction of 10 per cent.

Brain, not cranial measurement, is, of course, the object of the study of the capacity of the skull; but until some definite results are obtained, which will enable the observer to make accurate corrections, we must remain content with cranial measurement for the present, and apply the corrections hereafter.

If we set aside shot as not well adapted to the purpose of measurement on account of their weight, a material suitable for equally accurate measurement is still a desideratum. Peas are not of a uniform size, though by sifting, uniformity may be approached, and there is a certain amount of error growing out of their want of sphericity, though this is quite small. Spheres of porcelain of the size indicated above, and still better of aluminium, on account of its lightness, would give the required qualities for accurate measurement.

The results obtained by various observers in making comparative measurements of crania point to one of the following methods as the most desirable.

I. *a.* Fill the skull and *weigh* the contained material.
   b. Convert weight of material into cubic measurement by determining the cubic measurement of a gram or an ounce of material, and multiplying this by the whole number of grams or ounces. With proper tables, this would be a quick and easy process, but otherwise a tedious one.
   c. Convert weight of material into brain weight by correcting for difference in specific gravity.

II. *a.* Fill the skull and *measure* the contained material.
   b. Convert cubic contents into brain weight by multiplying the number of cubic inches by the weight of a cubic inch of water (252.5 grains), or the number of cubic centimeters by the weight of a cubic centimeter of water (one gram), and allowing four per cent. for the difference of the specific gravities of brain and water.

The second has the advantage of being the more simple process, and requires the fewest steps, while the first has the advantage in weighing, which is a somewhat more accurate method than measuring. The weight, however, must be converted into cubic measure, if we compare skulls by their cubic contents. With care, either of them are sufficiently correct, and in his choice the observer can and will be guided by his likings.

2. Position of the Foramen Magnum.

The fact, to which attention was called by Daubenton, more than a century ago,* that the foramen magnum is situated farther back in apes than in man, naturally led anatomists to inquire whether any of the human races more nearly approach the apes in this respect than the rest. Soemmering made the assertion that such is the case

* Sur la Différence du Grand Trou Occipital dans l'Homme et dans les autres Animaux. Mémoires de l'Acad. des Sciences, 1764.

in the Negro, and his statement has been quite generally repeated by subsequent writers. Prichard, however, satisfied himself that such is not the case, and after having examined "many Negro skulls," states that the foramen corresponds in position with that of the white races, viz.: "exactly behind the middle of the antero-posterior diameter of the basis cranii."* He, however, finds it necessary, in order that this should be the case, to make some allowance for the projection of the jaws. We have seen no account of the manner in which the measurements on which this opinion rests were made, except that the jaws were included when the antero-posterior diameter of the head is spoken of. It is obvious that in comparing more or less prognathous races, the position of the foramen magnum may be found to vary, although there may be no variation when the cranium proper is alone considered. In other words, the bones of the face may vary independently of the cranium.

The more common method adopted has been to measure from the anterior edge of the foramen magnum to the edge of the alveoli in the middle of the upper jaw, and from the foramen to the most prominent point of the occiput. It seems to us more correct to determine the position of the foramen, with regard to the cranium, than with regard to the cranium and face, especially as the chief interest which attaches to the foramen is as an index of the relation of the spinal marrow to the cerebral mass.

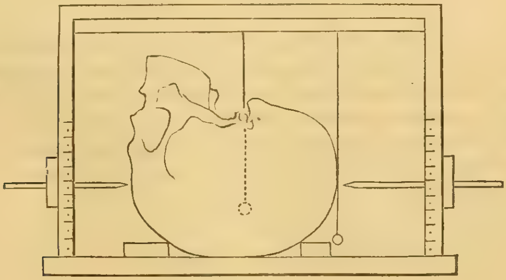

Fig. 1.

In making the measurements on which the following table is based, we have kept this circumstance in view, and have adopted the following method. The cranium is placed inverted in the instrument represented in the accompanying figure (Fig. 1,) the long diameter,

* Researches into the Physical History of Man. London, 1851. Vol. I., p. 285.

from the glabella to the occiput, having been previously measured with the callipers, is made horizontal by bringing the two ends of it to correspond with the points of the indices on the graduated uprights, and on which the indices are adjusted to the same elevation. Two moveable plumb lines, suspended from a wire stretched across the upper part of the frame, are then so adjusted that one dropping through the foramen magnum touches its anterior border, while the other touches the most prominent part of the occiput. The position of the foramen is indicated by the ratio of the distance comprised between the two plumb lines, to the long diameter of the cranium proper. The number expressing this ratio may be called *the index of the foramen magnum*, thus conforming to the method of expressing the ratio of the breadth, or the height to the length. When it is said that the index of the foramen magnum is 45.4, it is understood that the distance of the anterior edge of the foramen from the most projecting part of the occiput, is 45.4 parts of the long diameter, this last being considered 100, and both being projected on to the same plane.

To avoid error, it is important that the long diameter of the head should be made as nearly horizontal as possible, for the foramen magnum being on a higher plane, moves through an arc of a circle, which, as the long diameter is tilted backwards or forwards, changes the position of the point where the vertical cuts the horizontal line.

	20 White.	5 Tsuktchi.	17 Negroes.	28 S. Islanders.	19 Hindoos.	5 N. American Indians.	3 Gorillas.	1 young Gorilla.	1 Chimpanzee.	3 young Chimpanzees.
Maximum,	50.0	47.2	48.7	47.5	45.4	47.8	26.8			39
Mean,	45.6	45.3	44.4	41.8	41.4	40.9	22.7	40	21	35.3
Minimum,	41.7	44	38.7	36.1	35.6	34.8	17.7			32
Range,	8.3	3.2	10.0	11.4	9.8	13.0				

The preceding table, in which the number of the skulls of each race examined is given at the top of the respective columns, shows that there is an actual difference in the position of the foramen magnum in the races compared, and of such an amount as to make it desirable to test the result with much larger collections, in order to determine more precisely the value of the position of this opening as a race character.

As far as this table can be accepted, it shows that while there is a difference between the human races as regards the position of the foramen magnum, it is quite small when compared with the difference between the human races and the apes; and contrary to Soemmering's assertion, the Negro does not make the nearest approach to the latter. It is the North American Indian which has the lowest index.*

3. Crania from the Island of Kauai.

Mr. Horace Mann of Cambridge, soon after his return from a botanical excursion to the Hawaiian Islands, called my attention to the fact that large numbers of crania and bones of the natives could be had at Kauai. He kindly obtained for me the aid of Mr. Sanford B. Dole, at that time residing there, by whom the valuable collection described below was made, and to whom I would here express my indebtedness for the interest he has taken in the subject. The following letter, written by Mr. Dole after his arrival in the United States, will explain the circumstances under which they were found.

Williamstown, June 24, 1867.

Prof. Wyman:—

Dear Sir: On the southern shore of the Island of Kauai, for about four miles, there is a series of low, volcanic hills facing the sea, with precipices varying in height from twenty to sixty feet. Between these hills are several low sand beaches, from which the sand is ever carried inland by the trades. The windward slopes of these hills are covered with white sand of varying depth.

Over this whole extent of sand beaches and hills, human bones are thickly scattered, and here it was that I collected the skulls. Ten years ago they were much more numerous than now. The wind is constantly uncovering the skeletons, and, when exposed, they are quickly destroyed by the weather and the feet of cattle. At the time I speak of, it was easy to find perfect skeletons in the exact position in which they were buried. This is now impossible, and even perfect crania are becoming more scarce with every year. In olden times the natives often made use of the soft sand-banks for sepulture, but the immense number that was buried here forbids the idea that it was any common burying place. The present generation of natives know nothing definite on the subject. One of their traditions, as near as I can remember, is, that a fight between two large fleets of canoes took place off the coast, and that the defeated party was driven ashore at this place, and many of them killed. A second tradition is this; a tribe passing along the coast in canoes, and having landed in a secluded little cove which is now pointed out, to bathe and refresh themselves, a rival tribe charged down from the hills around and cut off almost the whole party.

* The position of the foramen magnum, as will be seen by this table, is very different in the young from what it is in the adult apes, the former approaching much nearer to the human races than the latter. We have pointed out in a former volume of the Proceedings (IX, p. 203) other striking resemblances between the cranium of the young gorilla and the adult man, which are much diminished as age advances.

CRANIA OBTAINED FROM

No.	Weight.	Capacity.	Length.	Breadth.	Frontal Diameter.	Height.	Index of Breadth.	Index of Height.	Index of F. Magnum.
1	710	1465	185	143	92	130	773	751	443
2	485	1280	170	141	90	130	829	794	435
3	757	1555	168	158	95	141	940	839	416
4	735	1490	178	138	91	135	720	700	496
5	782	1350	172	146	91	139	848	808	430
6	700	1370	177	136	96	142	767	802	401
7	845	1670	180	153	95	139	850	772	394
8	750	1560	177	148	95	141	836	796	361
9	562	1390	173	144	93	133	832	768	421
10	593	1400	165	138	97	137	833	830	375
11	575	1240	169	132	94	134	777	786	413
12	645	1280	174	135	95	133	775	764	413
13	377	1230	157	134	82	128	853	815	438
14	595	1170	160	132	87	131	824	818	406
15	677	1610	191	144	95	135	755	706	475
16	678	1470	180	147	98	132	816	733	405
17	494	1380	167	148	93	132	886	790	413
18	495	1350	180	135	88	130	750	722	394
19	512	1350	175	138	92	132	788	754	393
20	555	1160	165	134	90	127	812	769	396
21	663	1400	179	141	88	133	731	743	400
Max'm,	845	1670	191	158	98	142	940	839	475
Mean,	640.4	1397	174.2	141.5	92.7	134.3	807	770.7	413.5
Min'm,	485	1160	160	132	82	127	720	700	361
Range,	360	510	31	26	16	15	220	139	114

NOTE.—Weight in grams; capacity in cub. cent.; lengths in m.m. The Index of breadth, height, and of foramen magnum, is in thousandths of the long diameter. No. 13, being that of a child, is not taken into account in the averages.

THE ISLAND OF KAUI.

No.	Frontal Arch.	Parietal Arch.	Occipital Arch.	Circumference.	Longitudinal Arch.	Length of Frontal.	Length of Parietal.	Length of Occipital.	Zygomatic Diameter.
1	303	318	232	524	380	140	124	114	142
2	281	326	210	484	348	126	113	108	126
3	307	380	226	522	370	133	130	107	139
4	300	340	227	512	378	140	130	107	136
5	279	334	229	502	362	127	120	115	125
6	300	326	237	502	376	126	124	116	——
7	302	360	223	528	390	136	135	117	138
8	302	352	220	510	374	135	131	106	133
9	295	333	220	504	368	135	119	112	128
10	283	340	238	450	342	127	122	103	137
11	282	338	232	486	358	120	122	114	132
12	286	328	219	480	346	122	111	110	128
13	262	330	184	456	338	116	115	107	101
14	279	328	200	464	346	120	117	107	122
15	295	344	260	536	390	136	143	111	132
16	302	346	245	532	370	133	110	125	——
17	291	334	225	504	358	127	120	112	137
18	297	328	225	504	368	125	131	112	129
19	300	332	225	506	358	126	120	110	127
20	290	316	215	482	346	123	114	109	133
21	299	338	235	510	370	132	125	112	131
Max'm,	307	380	260	536	390	140	143	125	142
Mean,	290.5	337	227	502	364.9	127.9	123	111.3	131.3
Min'm,	279	316	200	450	342	120	110	103	122
Range,	28	64	60	86	48	20	33	22	20

NOTE.—Weight in grams; capacity in cub. cent.; lengths in m.m. The Index of breadth, height, and of foramen magnum, is in thousandths of the long diameter. No. 13, being that of a child, is not taken into account in the averages.

Those who have studied the subject, I think, give to the great pestilence, *Mai Ahulau*, which raged through the islands soon after their discovery, the credit of peopling this and other similar graveyards. Infant skulls are sometimes found, and also skulls that appear as if they had been pierced by spears, or fractured with clubs. The skulls which I collected for you were some of them above, and some below, the surface of the sand.

Yours truly,

S. B. Dole.

The collection is the more valuable, from the fact that the crania were all obtained from the same place, and from an island not commonly mentioned in the catalogues. Dr. J. Barnard Davis, in his Thesaurus Craniorum, out of one hundred and thirty-nine Kanaka skulls, does not mention one from Kauai. They are nearly all adult, No. 13 being the only one belonging to a child. As far as they go, they do not afford evidence of having been killed in battle, as they bear no marks of injuries inflicted by weapons. A few show signs of disease, as if they had been the seat of periosteal inflammation.

The average internal capacity, 1397 c. c., is 127 c. c. less than that of the average European, 1524 c. c., according to the tables of Morton. The largest is 1671 c. c., or a little less than one hundred and two cubic inches. The average capacity of one hundred and twenty-one Kanaka skulls from Hawaii and Oahu, as stated by Dr. Davis in his Thesaurus, is 89.6 cubic inches, or 1466.7 c. c. As the average index of breadth is 80.7, the skulls, as a whole, must be considered as brachycephalic. Nevertheless some of them have the dolichocephalic proportions strongly marked; for while No. 7 has an index of 85.0, and No. 3 of 94.0, No. 4 has an index of only 72.0. We have here the same result as that arrived at in the study of other races, especially in the North American Indians, as seen in the extended and careful comparisons of Dr. Meigs, showing the necessity of having as large a number of crania as possible for comparison, and the worthlessness of observations made on a single skull. As each race exhibits a wide range of variation in each of its characters, a given race can be rightly defined only when its predominant features, seen in many individuals, have been ascertained.

The index of the foramen magnum is only 41.2, and this opening is therefore much farther back than in the European races, and, as seen in the table, p. 446, has nearly the position of that of the North American Indians. In more than one half of the specimens the portion of the occiput surrounding the foramen is somewhat raised (the skull being inverted), giving it a funnel-shaped appearaace.

More than one-half of the crania have the peculiarity in the opening of the nostrils, to which attention was first called by Dr. John Neil of Philadelphia, as characterizing the skulls of negroes, viz.: the deficiency of the sharp ridge which forms the lower border of this opening, and in the place of it a rounded border, or an inclined plane. This feature is, however, found very frequently in different races, but more rarely in Europeans than the others. The ridge in question is always absent in the apes.

In many of the crania the occiput was somewhat flattened, but the outlines form regular curves, and the usual signs that the flattening is artificial are not seen.

Four of the crania have small bony nodules, varying from one to three in number, developed in the auditory meatus, which in one case, with the integument, must have quite closed it. Dr. J. Barnard Davis informs me that similar nodules were discovered by Prof. Seligmann of Vienna, in ancient Peruvian crania, and have been observed by himself and Welcker in other cases.* They appear, however, to be the most common in the ancient Peruvians and the inhabitants of the Pacific Islands.

There is only one instance in which the incisors have been punched out, while in the one hundred and forty crania from Hawaii and Oahu, described by Dr. Davis, more than one-third had been so deformed. A few anomalies of the teeth are noticeable, as in some cases the small size, in others the retention in the alveoli, and in others the absence of the wisdom teeth. In one case a præmolar was rotated so as to present its two cusps in a line from before backwards, instead of from side to side.

4. Crania of Tsuktshi.

The writer is indebted to the liberality of the Smithsonian Institution for the opportunity of examining the crania described below. The first five are those of the Wandering or Reindeer Tsuktshi, and were all obtained from the Asiatic side of Behring's Straits. Three are from Plover Bay, which is just west of Cape Choukotski, and were collected by Mr. William H. Dall, a zealous explorer, and one of the Scientific Corps of the Western Union Telegraph Company; the fourth is from Arikamcheche Island (Kayne Island of the United States Coast Survey Map of 1867), and was obtained by Dr. William Stimpson, one of the naturalists of the North Pacific Exploring Expedition, under Com. Rodgers; the locality of the fifth is not stated.

For the purpose of comparison, there are given in the table the measurements of five crania from the Yukon River, three of which are Mahlemuts, also collected by Mr. Dall, of eleven from California, and of eight Flatheads from Washington Territory and Oregon, nearly all of which belong to the collections of the Smithsonian Insti-

* See Thesaurus Craniorum.

Race.	No.*	Weight.	Capacity.	Length.	Breadth.	Breadth of Frontal.	Height.	Index of Breadth.	Index of Height.	Index of Foramen Magnum.
Tsuktshi,	4538	560	1425	171	141	102	133	824	777	450
"	4612	450	1400	176	137	94	134	778	761	448
"	7117	860	1570	180	148	95	132	822	733	472
"	7118	625	1490	177	135	103	130	762	734	440
	7120	610	1455	177	147	101	125	830	706	457
Mean,		621	1468	176.2	141.6	99	130.8	803.2	742.2	453.4
Tunguse,				190	148			778.9		
Esquimaux,										
Mean, 20 crania .			1475	178	133		139	720	758	
Cranium from Dr. Parks,		580	1440	183	138	94	131	754	715	437
Cast,				192	134			696		
Mean			1457.5	184.3	134.5		135	723.3	736.5	
Yukon River,	7530	710	1460	183	140	101	136	765	743	371
"	7531	735	1240	176	132	91	131	750	744	409
"	7532	545	1190	172	129	92	127	750	738	395
"	7533	781	1380	179	134	94	130	748	726	424
"	7534	445	1200	169	132	86	123	781	727	414
Mean,		643.2	1294	175.8	133.5	92.8	129.5	758.8	735.6	402.6
Mean of eleven Californians,		551.1	1259.2	170	150.5	93.5	120.8	833.4	717.5	422
Mean of eight Flat Heads,		582.1	1330	158.8	152	98	118.5	954	784.4	424
			Tsu.	Tun.	Cal.	Esq.	Esq.	Cal.	Tsu.	Tsu.
			Esq.	Esq.	Tun.	Tsu.	Tsu.	Tsu.	Esq.	Esq.
			Yuk.	Tsu.	Tsu.	Yuk.	Yuk.	Tun.	Yuk.	Cal.
			Cal.	Yuk.	Esq.	Cal.	Cal.	Yuk.	Cal.	Yuk.
				Cal.	Yuk.			Esq.		

* Numbers refer to Catalogues of the Smithsonian Institution. Weight in grams; capacity in cubic centimetres, other measurements in millimetres.

RACE.	No.*	Frontal Arch.	Parietal Arch.	Occipital Arch.	Longitudinal Arch.	Circumference.	Length of Frontal.	Length of Parietal.	Length of Occipital.	Zygomatic diameter.
Tsuktshi,	4738	300	316	259	360	508	124	112	123	146
"	4512	285	310	238	366	496	130	130	107	131
"	7117	292	358	277	384	530	130	125	132	132
"	7118	305	316	249	332	508	134	118	110	140
"	7120	300	326	285	336	530	125	126	115	143
Mean,		296.5	325.2	261.6	367.6	514.4	128.6	122.2	117.4	138.4
Tunguse,		297	310	295	376	538	130	125	119	148
Esquimaux,										
Mean, 20 crania					372	513	124	124	122	135
Cranium from Dr. Parks,		290	316	262	360	512	126	115	121	142
Cast,		303	324	281	382	530	127	130	126	136
Mean,		293.5	320	271.5	371.3	518.3	126.6	123	123	137.6
Yukon River,	7530	307	326	240	372	514	130	130	110	140
"	7531	284	304	265	354	492	124	119	112	130
"	7532	280	280	232	346	486	112	112	122	132
"	7533	291	314	253	370	480	127	111	131	129
"	7534	270	282	228	340	506	116	120	104	129
Mean,		285.5	301.2	243.6	356.4	495.6	121.8	118.5	115.8	132
Mean of eleven Californians.		260.1	312.4	256	346	495	117.4	111.2	114.7	134.9
Mean of eight Flatheads,		287	337.7	245.5	333	493	117	105.7	108	136
		Tun.	Tsu.	Esq.	Tun.	Tun.	Tun.	Tun.	Esq.	Tun.
		Tsu.	Esq.	Tsu.	Tsu.	Esq.	Tsu.	Esq.	Tun.	Tsu.
		Esq.	Cal.	Cal.	Esq.	Tsu.	Esq.	Tsu.	Tsu.	Esq.
		Yuk.	Yuk.	Yuk.	Yuk.	Yuk.	Yuk.	Yuk.	Yuk.	Cal.
		Cal.			Cal.	Cal.	Cal.	Cal.	Cal.	Yuk.

* Numbers refer to Catalogues of the Smithsonian Institution. Weight in grams; capacity in cubic centimetres, other measurements in millimetres.

tution. Besides the measurements of the above, I have added those of an Esquimau skull from Labrador, belonging to Dr. Luther Parks, of casts of the crania, one each, of an Esquimau and Tunguse in the Museum of Comparative Zoölogy in Cambridge, and of twenty crania of Esquimaux from the eastern and western shores of Arctic America and from Greenland. These last are the average of measurements extracted from the Thesaurus Craniorum of Dr. Davis.

The crania of Tsuktshi are so rare, that notwithstanding the small number, I have ventured to make comparison between these and crania from the arctic shores, and northwest portions of America. The crania from the Yukon River have an especial interest, since they come from a region so nearly adjoining that occupied by the Esquimaux, which last, of all the American races, most nearly resemble Mongolians.

Arranging the crania in three groups, viz.: the Tunguse and the Tsuktshi, the Esquimaux, and the North American Indians, it will be seen by an inspection of the table that the Tunguse, Tsuktshi and Esquimaux more nearly resemble each other, than either of these do the North American Indians. The largest number of maxima are found in the first and second groups, and of minima in the third. In the lower part of the table, under each of the different heads, the races are arranged in the order of the numerical superiority of their respective measurements. In the case of casts, several measurements were necessarily omitted.

The Californians are the most brachycephalic, and the Esquimaux the most dolichocephalic. The Esquimaux exceed all others in height, and all except the Tunguse in circumference. The Tsuktshi crania are the most capacious.

The position of the foramen magnum in the Tsuktshi, as will be seen by the table, p. 446, is very nearly the same as in the white races, the index being 45.3; in the single Esquimau in which it was determined it is 43.7, in the Californians it is 42.2, and in the Yukon River Indians only 40.2.

Excepting the crania cited from the Thesaurus Craniorum of Dr. Davis, where the peculiarity is not considered, all the others but four are deficient in the sharp ridge of bone which is so distinct in Europeans, and forms the boundary between the floor of the cavity of the nostrils, and the outer surface of the upper jaw.

The crania of the Flatheads exceed in capacity those from the Yukon River and California, showing that the artificial distortion does not necessarily diminish their size. The other measurements of this group serve to show the effects of compression, but are not suited for close comparisons with the other races.

Among the crania from California are two taken from a cave, incrusted both on the outer and inner surface with stalagmite. Attention to the locality was directed by Mr. George Gibbs of Washington, and the crania were obtained by Prof. J. D. Whitney, State Geologist. They show no peculiarities in which they are distinguished from other crania from California. A complete series of measurements could not be given without removing the stalagmite, which incrusted nearly the whole surface of each.

5. Synostotic Crania.

Deformities of the head accompanying a premature closing of the sutures, were first treated of at length by Virchow, Lucae and Welcker in Germany, and subsequently by Drs. Minchin, Turner, Bhurnham, J. Barnard Davis and Prof. Huxley in England.* The three chief kinds recognized are, 1st, the long head, accompanying the closure of the sagittal suture; 2d, the short and high head, associated with the closure of the coronal and lambdoidal sutures; and, 3d, the curved head, in which these last sutures are closed only on one side. The crania here described belong to the first group, and are all long.

I. This cranium belonged to the collection of Dr. Gaspard Spurzheim, and is deposited in the Anatomical Museum of Harvard College at Cambridge. Nothing is known of its history. It came from a subject somewhat advanced in life; the bones have a dense texture, the coronal suture is partially, and the sagittal and lambdoidal sutures are wholly closed. The lengthening of the head has taken place mostly forwards, as appears from the fact that the forehead is very protuberant, and the index of the foramen magnum is only 40.3; Viewed from above, the cranium is somewhat contracted behind the coronal suture, and the whole is slightly curved with a concavity to the left side. The occipital condyles are anomalous, that on the right being almost flat, except at the outer edge, where it is vertical, and the left being divided into two distinct facets, also flat, which are on different planes, the ordinary movements of the head on these surfaces must have been almost null.

* For a full discussion of the subject by English authorities see the following articles:—

On Cranial Deformities, and more especially on the Scaphocephalic Skull. By William Turner, M. B. Nat. Hist. Review, Vol. IV., 1864, p. 88.

On Synostosis of the Cranial Bones Regarded as a Race-Character in one Class of Ancient British and in African Skulls. By John Thurnham, M. D. Nat. Hist. Review, Vol. V., 1865, p. 242.

On Synostotic Crania Among Aboriginal Races of Men. By J. Barnard Davis, M. D. With eleven plates. London, Williams and Norgate.

Thesaurus Craniorum. By Joseph Barnard Davis, M. D. London, 1867.

Prof. Thomas H. Huxley in Laing & Huxley's Prehistoric Remains of Caithness. London, 1866.

II. From the Warren Museum in the Harvard Medical College, is also from a somewhat aged subject. The sagittal suture is wholly, and the coronal, lambdoidal and squamous sutures are partially closed. The index of the foramen magnum is 43.9, showing that the head has been lengthened forwards more than backwards. A third articular surface exists on the middle of the fore-edge of the foramen magnum, and corresponds with the apex of the odontoid process of the axis. It is a smooth, oval depression, with slightly raised borders, and has the appearance of having been covered with an articular cartilage; it is supported by a very slight elevation of bone, as in the cases of *condylus tertius* described by Dr. Halbertsma. When viewed from behind, as in Fig. 2, this cranium is remarkable for the manner in which the lateral walls slope towards the vertex.

Fig. 2.

III. From the Anatomical Museum at Cambridge. This cranium belonged to a dissecting room subject, is that of an adult, is of a rough texture, but its deformity is not strongly marked. The sagittal suture is wholly closed, as is also the left squamosal, and, in addition, the spheno-parietal, the spheno-frontal, the left spheno-squamosal, and the lower ends of the coronal. The others are open, though showing a tendency to close. When viewed from the base, the cranium is slightly curved, having a concavity on the left side, that is, to the side where the sutures are most extensively closed.

IV. Cranium of a child from the Spurzheim collection. The age is presumed to be somewhat under seven years, but the process of dentition has gone on somewhat irregularly, and leaves the precise age doubtful. The sagittal suture is closed, except for about three-fourths of an inch at the fore part; the frontal suture is open at its hinder part to about the same extent. In the line of the union of the parietal bones is a slight ridge, and on each side of this a series of vascular openings and channels, which have a radiated arrangement, and which give an appearance as if the two parietals had been ossified from a single centre. All of the other sutures were open. The index of the foramen magnum is 51.8, which shows that the head has been lengthened backwards more than forwards. The side walls of this skull slope towards the vertex, but to a less degree than in the preceding specimen.

V. From the Warren Museum, and supposed to be from a subject about three years old, and is represented in Figs. 3 and 4. The milk teeth are fully developed, but the crowns of the permanent incisors are deeply buried in their alveoli. The sagittal suture is wholly obliterated; the median ridge and the vascular openings, with the peculiar radiated appearance described in the preceding specimen, as also the appearance of a median centre of ossification, exist here in a marked degree. This cranium is remarkable for its great length, the

Fig. 3.

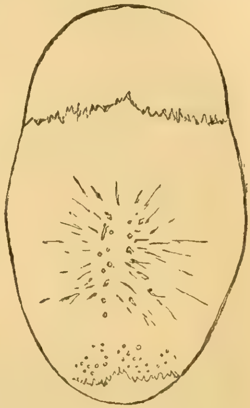

Fig. 4.

index of breadth being only 62.6. The foramen magnum is central, the increase in length having taken place equally forwards and backwards. This also appears from the equal protuberance of both forehead and occiput. The occipital region presents outwardly, as it were, a cast of the cerebellum, two bulgings corresponding with the lateral lobes, project downwards beyond the tips of the mastoid processes. The hinder lobes of the cerebrum can also be traced in a similar way, and form a third bulging in the outer surface of the occiput.

VI. Cranium of a fœtus from the Warren Museum, represented in Figs. 5 and 6, of a little less than one-half the natural size, linear measurement. In the preparation of the skull the bones were somewhat displaced in consequence of the extent to which decomposition had taken place, but are drawn as if in their natural position. Dr. J. B. S. Jackson, however, observed, when the head was still recent, that the deformity similar to that of the preceding specimens was quite marked. The measurements and proportions given below are, we believe, approximately exact. The lengthening of the head is almost wholly forwards, the index of the foramen magnum being

Fig. 5.

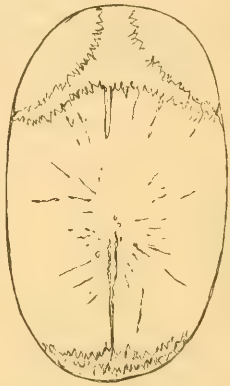

Fig. 6.

only 32.2. The anterior fontanelle is largely open, and is prolonged between the frontals by a space with parallel sides twenty millimetres in breadth, extending nearly to the nasals. The sagittal suture is completely obliterated in the middle portion for the space of nearly an inch, Fig. 6; for the rest of its extent it is open, the two parietals approaching each other quite closely; in the fore-part the edges are smooth and straight, and in the hinder somewhat serrated, but do not touch. The frontals are very protuberant, and on the inside of each, corresponding very nearly with the frontal eminences, are two marked depressions, causing the bone to appear diaphanous in some parts, but, in others, extending quite through; each of these is surrounded by a ridge of dense bone quite unusual in a fœtal cranium. These deformities may be compared to the digital impressions of the adult crania.

VII. To the above instances may be added the following interesting case communicated to me by Dr. W. G. Wheeler of Chelsea, Mass. A. B. was born with the fontanelles closed; when nine months old she had severe convulsions, after which her health remained feeble. When three years old the convulsions returned, with symptoms of effusion; these were at length followed by gradual recovery; she is now (1867)

TABLE OF MEASUREMENTS OF SYNOSTOTIC CRANIA.

	Capacity.	Length.	Breadth.	Height.	Index of Breadth.	Index of Height.	Index of Foramen Magnum.	Frontal Arch.	Parietal Arch.	Occipital Arch.	Circumference.	Longitudinal Arch.	Length of Frontal.	Length of Parietal.	Length of Occipital.	
I.	1440	202	135	120	675	600	413	304	290	273	548	404	145	140	116	Adult.
II.	1520	203	134	122	664	615	435	305	290	280	546	400	125	146	131	"
III.	1500	196	137	120	699	612	485	304	302	271	540	384	132	140	111	"
Average.	1486	200.3	135.3	120.6	679	609	444.3	304.3	294	274.6	544.6	396	134	142	119.3	
IV.	1405	189	126	126	666	666	518	280	293	254	504	392	125	146	120	Child.
V.	1010	186	116	114	626	616	473	265	265	231	482	372	120	140	112	"
Average.	1207.5	187.5	121	120	646	641	545.5	272.5	279	242.5	493	382	122.5	143	116	

Capacity in cubic centimeters; other measurements in millimeters.

seven years old, healthy, mind clear and memory good. The chief measurements of the head are as follows:—

Length	187 millimetres.
Breadth	133 "
Circumference	308 "
Parietal arch, "over top of head from ear to ear"	270 "
Index of breadth	71

The deformity, it will be seen, is not great, but the photograph of the patient which Dr. Wheeler sent with the notes of the case, shows the elongated form characteristic of synostotic skulls.

From a comparison of the above cases, it will be seen that the crania from the fœtal period, childhood, the adult and advanced periods of life, present a similar deformity, viz.: lengthening of the head attended with the closure of certain sutures. The closure of the sagittal suture is, however, the only constant condition. The theory of the deformity we are describing is as follows: increase in the length of the head, during growth, depends chiefly upon the deposit of new bone on the edges of the bones in the direction of the sagittal suture; if this be prematurely closed, increase of breadth being limited, the brain, as it continues to grow in order to be accommodated, compels an increase of the bones in other directions, especially in length; consequently there results a protuberant forehead and occiput, one or both.

If this theory be correct, then it seems clear that the closure of the sagittal suture in the above crania must have taken place at very different ages, otherwise their breadths would have been more uniform. In fact, the breadths of the first three differ but little from the normal quantity, measuring 135 instead of 142 m. m., while their length is obviously increased, this being 200 instead of 180 m. m.

It appears that the lengthening of the head depends chiefly upon the abnormal growth of the parietal bones, the others remaining scarcely altered, as will be seen by the following average measurements, in which eleven normal adult crania are compared with the three adult synostotic crania described above.

	Frontal.	*Parietal.*	*Occipital.*
Normal	125 m. m.	124 m. m.	117 m. m.
Synostotic	129.2 "	148 "	119 "

The anomaly, therefore, seems to pertain chiefly to the parietal region of the skull. Is it connected with an anomalous condition of the corresponding portion of the brain?

The peculiar appearance noticed in crania IV and V, consisting of radiating canals and foramina, would seem to give support to the statement of Von Baer, that in synostotic crania, the two parietals had but one centre of ossification. The fact that in IV the sagittal suture remains partially open at either end, and that in VI the parietals are united for so short a distance, seems to render it quite certain that they were originally separate.

The *height* of the crania is much below the average, being only 120.6 m. m., while according to Dr. Davis, the average height of one hundred and twenty-eight normal crania, consisting of those of English, Netherlanders, Chinese, Negroes, etc., was 142.6 m. m. This fact brings to notice a point which is worthy of careful attention. According to theory, the height of the head depends upon the growth of bone in the lateral sutures, viz.: the spheno-frontal, spheno-parietal and the squamosal. It appears that synostotic crania, attended with lengthening, are characterized by insufficient height. Nevertheless the obliteration of the sutures just mentioned is not constant; they are freely open in IV, V and VI, in which the longitudinal deformity is very strongly marked. Why is the compensatory growth only in longitudinal direction, when, as it would seem, the conditions favoring it upwards exist as well. Even in the fœtus, VI, the sagittal suture is only partially closed, while all the others are normally open, and yet the lengthening has become extreme. Is it certain that the closing of the suture precedes the deformity, and is therefore the cause of it?

The average capacity of the adult synostotic crania, 1486 c. c., is somewhat below the normal average (1524 c. c.), according to Morton's tables, but only 3 c. c. less than that of thirty-nine English crania (1489 c. c.), according to Davis. The average of eight Scaphocephalic crania in Dr. Thurnham's table is 1532 c. c., or 8 c. c. above the normal capacity, according to Morton. There is, on the whole, no marked deviation from the normal quantity.

6. Neanderthal Skull.

In connection with synostotic crania we will offer a single remark with regard to this much discussed cranium. Among the different views brought forward to account for its peculiar shape, is that of synostosis, which has been urged by Dr. Davis, and denied by Prof. Huxley. There is one fact which we have not seen noticed in the discussion of the question at issue, though it has doubtless been observed, and in which the Neanderthal differs from common synostotic skulls. From what has been stated on p. 460, it appears that in all of the latter, there described, the increased length of the head is chiefly due to the extension of the parietal bones from before backwards, the frontal and occipital being but slightly augmented. In the

Neanderthal skull, the length of the parietals is only 115 m. m., 9 m. m. *below* the average, while in the synostotic crania it is 148 m. m., or 24 m. m. *above* the average. How far this has any real bearing on the nature of the deformity of the Neanderthal cranium will depend upon the extent to which, when large collections are examined, the extension of the parietals and consequent lengthening of the sagittal suture is found to be a constant attendant on synostosis. As far as our own observations go they are constant; and consequently the fact that in the disputed skull, the parietals are shorter than the average, is opposed to the theory of synostosis.

Dr. C. T. Jackson called the attention of the Society to some of the modern methods for the preservation and coloration of wood.

The first experiments recorded are those of Champy, who stuffed wood with tallow at 200° centigrade, the heat driving out the moisture and air, while on lowering the temperature the atmospheric pressure drove the solution into the cells of the wood. Champy's process certainly did protect ship timber from the penetration of water to a great extent, and by induration of the albuminous matters in the wood, it was rendered less liable to decay; but it was found impossible to penetrate the whole thickness of hard wood timber with the solution.

Kyan preserved wood from decay by impregnating it with a solution of one one-hundreth part of bi-chloride of mercury. This prevented decay by poisoning the wood so that insects and parasitic vegetation would not destroy it, and the bi-chloride formed a well known combination with the albumen, and so conserved it.

Mohl removed the air from the cells of wood by steaming it, and then drove in the vapor of creosote, which has the property of preserving albuminous or nitrogenous substances, and of preventing insect depredations. This process is very similar to one recently patented in this country by a Mr. Robbins, and which is now in operation under the directions of the American Wood Preserving Company. Of this process I shall speak presently.

Boucherie employed the natural powers of absorption in living trees freshly cut down; a bag of impermeable stuff, india rubber cloth, or prepared leather, is firmly bound around the end of the cut-off stump end of the tree, and the preservative liquid supplied to this by a barrel placed a little above it, having a tube communicating with the bag. The liquid rapidly follows the sap of the tree, so that it is soon found in the branches and leaves. Dye stuffs, with their proper mordants are also introduced in the same way, and richly colored woods are produced. Even bleaching salts have thus been introduced into trees with acids to disengage the chlorine, and wood, white as ivory, has been made for ornamental use.

Perrin improved these processes and also was enabled to effect a more thorough impregnation of wood by making a vacuum at one end of the logs while the atmospheric pressure drove the dye stuffs into the wood. He was the first who introduced mordants to aid the action of the dyes. He colored wood with solutions of the different madder colors and fixed them with alum. He used logwood, Brazil wood, indigo, nitrate and acetate of copper and verdigris, giving a great variety of tints to the same wood. Pyrolignite of iron, or iron liquor of the calico printer, proved to be one of the most effective dyes and preservatives.

Some of the agents used in the preservation of wood act as follows:—tannin acts on the albuminous matters in the same way as on animal tissues; tar and creosote dissolved in pyroligneous acid are eminently antiseptic; oils, fats and resins keep out humidity; sea salt and chloride of calcium give flexibility to wood and prevent some chemical changes; sulphate of copper acts very much like the bi-chloride of mercury used by Kyan; pyrolignite of iron (Boucherie's process) both colors and conserves, the iron taking the tannin and producing a violet blueish tint, while the creosote in the acid is antiseptic; chloride of zinc (Burnet's proces) acts like the bi-chloride of mercury and is cheaper; acetate of lead tends to preserve the albumen; rosin dissolved in hot oil is principally used to keep out water; a hot mixture of wax and tallow is sometimes used; the wood absorbs from 15 to 60 per cent. of its weight and is much improved in imperviousness to water, but wax is too costly; marine glue or shellac and india rubber dissolved in coal tar are good, so far as they can be made to penetrate, and effectually prevent the wood from cracking.

I have found that the most effective and perfect stuffing of wood can be effected by immersing it in very hot paraffine, and withdrawing the air from the wood cells by the air pump and then letting on the atmospheric pressure. By means of paraffine we may preserve any kind of wood perfectly, and prevent its swelling or shrinking from moisture or dryness. The wood may be sand-papered, or pumiced and polished very highly.

Paraffine in vapor cannot be used, since the heat required to vaporize it is too great for wood to bear without becoming brown.

I have advised the manufacture of refrigerators with white wood boards stuffed with paraffine, since paraffine will not absorb or give out odors, nor will it admit moisture. Indeed, it is as its name signifies, almost without affinities.

The American patented process of Robbins is one of the most practicable methods for the preparation of heavy pieces of timber and for out-of-door work. It is especially adapted for the preparation of railway sleepers and ties, and for the preparation of wheel hubs, spokes and felloes. It is not so well adapted for furniture, since the wood smells strongly of carbolic acid or creosote. Green wood, as well as dry, is prepared by the wood preserving company. Sails, ropes, and rigging for ships is also prepared by the same process, so that they will not mildew or rot; but I have not yet seen samples of the sails and ropes thus prepared. The process is extremely simple. It is nothing more than exposing the wood in a steam box into which coal tar vapor is driven at a temperature of about 300° or 350°F. All the moisture and air are expelled from the wood-cells and coal tar products take their place. The charge of wood placed on an iron chariot may be run into the box, and in half an hour it may be withdrawn fully impregnated. It is proposed to place one of these machines on trucks to prepare the ties and sleepers on the railroads as the work progresses. There are two companies engaged in this work, one in New York and one in Boston.

Messrs. N. L. Hooper, R. C. Greenleaf and C. J. Sprague were chosen a committee to nominate officers for the ensuing year.