A SEXUAL STUDY OF THE SIZE OF THE ARTICULAR SURFACES OF THE LONG BONES IN ABORIGINAL AMERICAN SKELETONS.

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It seems to be pretty well established that there is a fairly distinct and constant line of demarcation in the size of the head of the humerus and the head of the femur for the two sexes in European skeletons. That this would hold good for these bones in prehistoric or savage races has been questioned by some anatomists. From the literature at hand I am not able to learn that the subject has been investigated with any degree of fulness, and indeed statistics on the subject for European skeletons even are not numerous.

The most general reference to the subject that I have seen is to be found in a paper by Prof. Thomas Dwight.¹ Speaking of the sexual differences of the arm, he says: "The articular ends of bone of both arm and forearm come to the rescue, but I regret that I have no series of measurements large enough to quote." And in another place he says:

"The small size of joints is characteristic of woman. They are the greatest diameter of the head of femur and the greatest transverse breadth through the condyles. The average diameter of the male head is 4.8 cm., that of the female 4.15 cm."

The only other observations, in addition to those of Professor Dwight's, with which I am acquainted are to be found in the valuable paper of Prof. David Hepburn on the Femur.² In that paper he gives the measurements of the diameter of the head of the femur in the skeletons of a large number of different races. His results are very interesting, for they confirm, at any rate so far as the femur is concerned, the results which I have reached in the present inquiry. Professor Hepburn has not arranged his measurements so that the mean average diameter of the two sexes can be seen at a glance, but from his tables I have selected such races as are represented by skeletons of both sexes, and have then determined the average for each sex, results of which are as follows:

Maori, males (5) 45 mm., females (1) 42 mm.; Australians, males (6) 44 mm., females (1) 33.5 mm.; Hindoo, males (2) 47 mm., females (1) 36.5 mm.; Laplander, males (1) 42 mm., females (1) 38.5 mm.; Eskimo, males (1) 46 mm., females (1) 40.5 mm.; Andaman, males (4) 37 mm., females (2) 35 mm. A comparison of these figures, together with mine, with those for Europeans, lends a suggestion to the possibility that, as in many other parts of the skeleton, sexual differences in the size of the articular surfaces have gone on further in the European than they have in the lower races of men.

The largest single diameter found by Professor Hepburn was 57 mm., in a British male; the smallest was 34 mm., in an Andamanese female. The maximum and minimum diameters determined by me are 54 mm. and 38 mm. In none of the Andamanese skeletons did the diameter of the head of the femur reach 40 mm. This is as we should expect, for the Andamanese have an average stature of only 1,492 mm.,³

and are, therefore, among the shortest people in the world.

The following two sentences from Professor Hepburn are especially interesting: "This diameter [of the head of the femur] was also found below 40 mm. in two Australian, two Negro, two Hindoo, two Lapp, two Sandwich Islander, and one dissecting-room femur; and in all of these cases they were from females. Except among the Andamans, no male femur had a head diameter less than 40 mm."

With the view of testing the observations of Professor Dwight on the European humerus and femur, and of Professor Hepburn on the femur in the tribes of the Pacific and Indian oceans, I have examined 135 skeletons which come from three widely separated regions of America. The first group comprises 19 Kwakiutl, 15 Sanitch, and 6 Chinook skeletons from the Northwest Coast; the second group is from the prehistoric mounds of Ohio, and comprises 27 skeletons; the last region represented is Peru, and includes 6 skeletons from Cuzco, 7 from Arica, and 50 from the Necropolis of Ancon. These may be regarded as fair representatives of the better class of aboriginal Americans. I may note also that I have examined only adult skeletons in which all the epiphyses were firmly united; and the sex in every instance has been determined by the pelvis, no skeleton having been considered in which the pelvis was not present.

After some deliberation I decided upon three measurements, namely, the maximum diameter of the head of the humerus and the head of the femur, and the maximum transverse diameter of the head of the tibia through the condyles. It would probably have been as well to have taken also the transverse diameter of the lower end of the femur through the condyles; but as Professor Dwight had found this measurement "less conclusive," I substituted the head of the tibia in its place. It would have made an interesting study to have noted also the size of the articular surfaces in connection with the length of the bones, but I did not have the time for this. I am convinced of the correctness for American bones of Professor Dwight's observation, "that in the woman there is a fairly regular increase in the size of the head, corresponding with the increase in the length of the femur." But I am not equally well convinced of his second observation, that "among men this is not so."

Before considering the three sets of measurements I may mention that in a recent study on the scapula of the Northwest Coast Indians, I measured the dimensions of the glenoid cavity in 20 specimens and found that in the males it measures 41 by 30 mm., and in the females 35 by 25 mm. It was shown, furthermore, that in not a single instance did the longest female cavity equal the shortest male cavity, and that in only one instance did the broadest cavity in the female series equal the narrowest of the males. One other point should be mentioned here, as the facts are brought out in the measurements but are not shown in the tables. There seems to be no uniformity in the comparative size of the heads of the humerus and the femur in the same skeleton. Thus, in the male series of the Northwest Coast tribes, the head of the humerus exceeds in size the head of the femur seven times, while the head of the femur is the larger nine times; in the female series each is the larger just eight times. This same observation holds good for both the Ohio and Peruvian series.

¹ The Range and Significance of Variation in the Human Skeleton, Boston Medical and Surgical Journal, July, 1894, pp. 73 and 97.

² The Platymetric, Pliastic and Popliteal Indices of the Race Collection of Femora in the Anatomical Museum of the University of Edinburgh, Journal of Anatomy and Physiology, October, 1896.

³ Report of Anthropometric Com., B.A.A.S. Report, 1883, p. 271.

I. NORTHWEST COAST INDIANS.

As the measurements from the three peoples from this region are so nearly alike, they may properly be considered together; and we have, therefore, 21 males and 19 females. The comparative frequency of distribution of the diameters of the articular surfaces for both sexes may be seen in the following table:

TABLE I.—NORTHWEST COAST INDIANS.

Humerus.			Femur.			Tibia.		
Mm.	M.	F.	Mm.	M.	F.	Mm.	M.	F.
39		2	39		2	65		2
40		6	40		4	66		3
41		4	41		5	67		5
42		4	42		6	68		5
43		2	43		1	69		1
44	3		44	1	1	70		1
45	2		45	4		71		1
46	4		46	5		72	3	
47	3		47	3		73	1	
48	2		48	3		74	1	
49	4		49	2		75	3	
50	1		50			76	2	
51	1		51	2		77		
			52			78	1	
			53			79	3	
			54	1		80	2	
						81		
						82		
						83	2	
						84		
						85		
						86	1	
Mean.	47.0	40.7	Mean.	47.2	41.1	Mean.	77.2	67.3

It is seen that the line of separation is clean cut, except for the femur; here a single measurement overlaps. The other two series are emphatic in their results. Thus, if we take the average for both sexes for the humerus as 43.5 mm., it will be seen that the measurement of no female humerus exceeds it, while that of no male falls below it. The range of variation for the tibia is, as we might expect, greater than that for the other two bones.

II. MOUNDS OF OHIO.

The skeletons here represented are from ancient graves and mounds in the Little Miami Valley, and are all prehistoric. Although two or three localities are represented, the material is so homogeneous that it may be considered as a whole. The measurements comprising 20 males and 7 females, are distributed as shown in Table II.

The line of demarcation here between the two sexes is not quite so sharply drawn as it was in the preceding one. It is to be noted, however, that the greatest amount of agreement is, as we might expect, in the

diameter of the head of the tibia. For the humerus and femur the differences between the two sexes is still a decided one and sufficiently marked to be of great value.

III. PERU.

Of the Peruvian skeletons, six are from the vicinity of Cuzco, being equally distributed between the two

TABLE II.—MOUNDS OF OHIO.

Humerus.			Femur.			Tibia.		
Mm.	M.	F.	Mm.	M.	F.	Mm.	M.	F.
40		1	40		1	67		1
41		2	41		2	68		
42		2	42		1	69		1
43		1	43		2	70	1	1
44	2		44			71		2
45	3		45	2	1	72	1	1
46	3		46	1		73		
47	5		47	6		74	1	
48	2		48	6		75		
49	4		49	2		76		
50			50	1		77	3	
51			51			78	2	
52	1		52	2		79	4	
						80	4	
						81	1	
						82	1	
Mean.	47.0	41.5	Mean.	47.8	42.1	Mean.	77.9	70.0

sexes; seven from Arica, three being males and four females; and 50 from Ancon,⁴ each sex being equally represented. Although skeletons from the first two localities are slightly taller in stature than those from Ancon, the difference does not affect to any appreciable extent the averages between the two groups, so that I have put them into a single table. (Table III.)

The result here shown is very satisfactory and even conclusive. Thus, in the humeri of 31 females there is not a single measurement which equals the lowest of the male series. The line of separation between the two sexes for the femur and the tibia is not so sharp as it is for the humerus, but it is very nearly so and in fact is more so than we might expect when we take into consideration the fact that the skeletons from Ancon are from people of exceptionally short stature, while those from Cuzco and Arica represent people of rather more than average stature. Another point which may be noted, although of no particular consequence, is the fact that in the South American humeri no measurement exceeds 48 mm., although in both the Northwest and Ohio groups some of the measurements exceeded 50 mm.

Combining the results as shown in Tables I, II, and III, we have Table IV, which gives the distribution for 135 skeletons.

For reasons which have already been given, this

⁴ It may be proper to state that the Ancon skeletons were taken at random from a much larger number which are in the Museum. The number 50 was arbitrarily chosen because it was thought sufficiently large to be considered as representing the entire series.

table is not perfectly conclusive in its results, for the skeletons from Ancon are from very short people, while those from the Ohio Mounds and the Northwest Coast represent people who are above the average in stature. For this reason we might be prepared to find the largest measurements of the females of North America equalling or surpassing the smallest males from Ancon. Thus, to take a single instance, if we

TABLE III.—PERU.								
Humerus.			Femur.			Tibia.		
Mm.	M.	F.	Mm.	M.	F.	Mm.	M.	F.
36		1	38		1	62		2
37		5	39		6	63		3
38		7	40		8	64		1
39		6	41		7	65		5
40		6	42		6	66		3
41		6	43		1	67		5
42		1	44	1	3	68		4
43	1		45	7		69		
44	9		46	7		70		5
45	7		47	6		71	1	3
46	7		48	5		72		1
47	4		49	4		73	3	
48	2		50			74		
			51			75	9	
			52	1		76	3	
			53	1		77	2	
						78	8	
						79	2	
						80	3	
						81	1	
Mean.	45.3	39.0	Mean.	47.0	40.8	Mean.	76.5	66.9

analyze the figures given for the humerus we shall find that of the three females with a diameter of 43 mm., two come from the Northwest Coast and the other one from Ohio; while of the 13 males with a diameter of only 44 mm., three are from the Northwest Coast, one from Ohio, and *nine* from Peru, seven being from Ancon and two from Cuzco.

But even if these considerations be waived, the results of Table IV are remarkably decisive. Thus, if the maximum diameter of the head of the humerus of any American skeleton measure 44 mm., the chances are extremely great that it is a male; if it measure 45 mm., it is a male to a practical certainty. The inferences to be drawn from the measurements of the femur seem almost, if not quite, equally valuable; and it would almost seem that we could determine sex from the femur alone with a great deal more certainty than we could from the skull. After Professor Dwight's disparaging remarks about his results from measurements through the condyles of the femur, I was quite unprepared for the results which have been derived from the tibia. The range of variation is, to be sure, greater than it is for either the humerus or the femur; and this, it may be repeated, is largely due to the dis-

crepancy in stature between the North and South American skeletons, but the dividing line for the two sexes, between 71 mm. and 72 mm. is almost as sharp as it is in the femur, and makes the tibia a valuable aid for the determination of sex.

In conclusion, apart from the value of any one of these three bones as important and practically decisive factors in determining sex, we must not lose sight of

TABLE IV.								
Humerus.			Femur.			Tibia.		
Mm.	M.	F.	Mm.	M.	F.	Mm.	M.	F.
36		1	38		1	62		2
37		5	39		8	63		3
38		7	40		13	64		1
39		8	41		14	65		7
40		13	42		13	66		6
41		12	43		4	67		11
42		7	44	2	4	68		9
43	1	3	45	13	1	69		2
44	14		46	13		70	1	7
45	12		47	15		71	1	6
46	14		48	14		72	4	2
47	12		49	8		73	4	
48	6		50	1		74	2	
49	8		51	2		75	12	
50	1		52	3		76	5	
51	1		53	1		77	5	
52	1		54	1		78	11	
						79	9	
						80	9	
						81	2	
						82	1	
						83	2	
						84		
						85		
						86	1	
Mean.	46.3	37.3	Mean.	47.3	41.0	Mean.	78.5	67.4

the original purpose of this inquiry, which was: What light do American skeletons throw on the theory that the articular surfaces are larger in the males than in the females? or to put it in Professor Dwight's words, "that the small size of joints is characteristic of woman"? The answer is, perhaps, best given by repeating the averages as determined in Table IV.

The average maximum diameter of the head of the humerus in the male is 46.3 mm.; in the female, 37.7 mm. The average maximum diameter of the head of the femur in the male is 47.3 mm.; in the female, 41 mm. The average maximum diameter of the head of the tibia through the condyles in the males is 78.5; in the females, 67.4 mm.

THE STATUE OF CHARCOT, by the sculptor Falguière, is nearly finished, and will soon be erected at the Salpêtrière.