AN ANTHROPOMETRIC STUDY OF THE LONG BONES OF THE "SHELL MOUND" INDIANS

by

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INTRODUCTION

Various anthropometric long bone and cranial studies of human skeletal material have been undertaken to ascertain gross similarities or differences that might exist in the races of man. As a part of these studies, attention has been given to long bone symmetry or asymmetry, comparative studies of radio-humeral and tibio-femoral lengths, femoral curvature, and possible skeletal differences between the sexes which might be of racial significance.

Schultz (1937) compiled data bearing upon variability and asymmetries in the long bones of Caucasians, American Negroes, North American Indians, Alaskan Eskimos, Chinese, and Australians. In the majority of these groups, asymmetries in the lengths of the humeri and the radii favored the right side. This was not the case, however, in the humeri of male Negroes. In the upper extremities, asymmetries favored the right side more frequently in females than in males among Caucasians, Negroes, Eskimos, and Indians. In the lower extremity, asymmetries favored the left side

more frequently than the right in all groups and both sexes, with the exception of the tibia of male Negroes.

Latimer and Lowrance (1965) studied the weights and lengths of 105 human skeletons from Asia to ascertain the degree of asymmetry exhibited by this group. In general, the bones of the upper extremity were longer on the right side, and less variability was noted in the lower extremity than in the upper extremity, with only the femur and tibia being longer on the left side.

A study of anterior femoral curvature in man was done by Walensky (1965). Variations in curvature of the femur were studied in Caucasians, American Indians, Eskimos, and Negroes. The Eskimo and Indian groups had the shortest and most curved femora. The Caucasians were intermediate, with the Negroes having the least curved femora. The right femora were found to be slightly longer than the left femora.

Hrdlicka (1932) found the radio-humeral index to be lowest in Caucasians, and highest in Indians and Negroes. The humero-femoral index was near alike in Caucasians and Indians, and lowest in Negroes. In all groups, the humero-femoral index was slightly lower on the left than on the right side.

Munter (1936), in studying Anglo-Saxon skeletons, reported the right arm bones longer than the left, on the average, with the femur being longer on the left side. Bilateral differences were greater for the arm than for the leg bones.

In a study of femoral curvature and race, Stewart (1962) concluded that the measurements of femoral curvature could not, as a rule, differentiate the skeletal material of Caucasians, American Negroes, and South Dakota Indians. However, when femoral curvature is combined with pronounced femoral torsion, the two characters distinguish a large proportion of the Indians from both the Negroes and the Caucasians.

Trotter and Gleser (1952) studied the long bones of 545 American male military personnel and found all of the bones of the upper extremity were longer on the right side, while all of the bones of the lower extremity were longer on the left side. The bones of the upper extremity were more variable than the bones of the lower extremity.

This study is concerned with the anthropometry of the long bones of the so-called "shell mound" Indians. There have been no studies on the long bones of the "shell mound" Indians to date. This Indian group represents a

homogeneous population, and their skeletal remains offer an excellent opportunity for anthropometric studies.

The "shell mound" occupants of the Perry Site, Lu°25, were the first of two groups to bury their dead in the area located near Sheffield, Alabama. The second, and later group to use this site, has been designated "Koger's Island" or Moundville Complex. Their form of burial was extended, or very slightly flexed. The "shell mound" dead were buried closely flexed in small pits which may be the result of a practice of rolling the body into a small bundle when prepared for burial. If the bodies were placed on their sides or backs, or face down in a circular pit, the "round grave" burials were produced. If the bundles were merely laid on the midden with no pit being dug, a typical "fully flexed" burial resulted. If, however, the graves were small circular pits, the bundles which were "egg-shaped," might have been placed "on end" in the pits. This would have produced the so-called "sitting" burials common to the "shell mound" group. Physical anthropological studies seem to show no distinction in skeletal remains from the various burial types used by the "shell mound" Indians (Webb and DeJarnette, 1948).

I

MATERIALS AND METHODS

The long bones used in this study were from the "shell mound" Indian burials. Their remains were excavated from the Perry Site, Lu°25, on the northern end of Seven Mile Island in the Tennessee River near Sheffield, Alabama. There were 1031 burials recovered from this site, many of which were infants and juveniles not included in this work. Approximately 400 burials, incorporating 611 bones, comprised the material for this study.

Approximately 10% of the bones used were fragmented. These fragmented bones were cemented together with an acetone and alvar compound, and then placed in a rice bed until solidification. No attempt was made to repair bones which had lost either a proximal or distal process. All bones used were free from any severe pathological state, and were in good physical condition with all processes intact (Plates 1, 2, and 3). All bones were grouped as to sex and only adult skeletal material was measured.

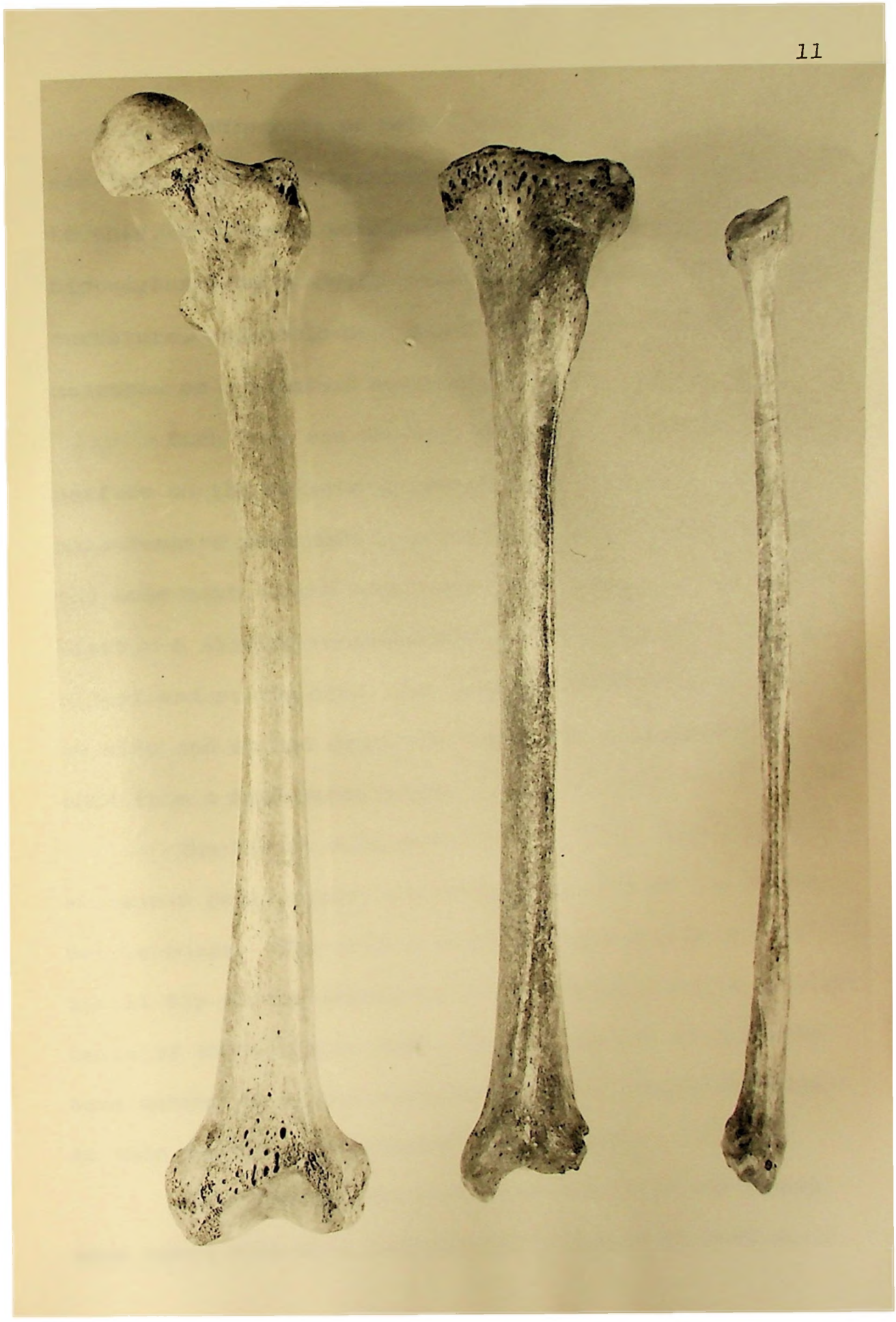
PLATE 1: A Graded Series of Humeri Showing Degree of Fragmentation and General Physical Condition


LU°25-415
LU°25-779
LU°25-161

PLATE 2: Representative Long Bones of the Male Upper Extremity (Humerus, Ulna, and Radius)

LU°25-415

PLATE 3: Representative Long Bones of the Male Lower Extremity (Femur, Tibia, and Fibula)



Measurements of both rights and lefts were taken on six long bones to determine maximum length. In addition to this, the femora were measured for trochanter length, bicondylar length, degree of anterior-posterior diaphyseal curvature, and collo-diaphyseal angle. All bones were measured on a standard osteometric board.

Each bone was measured by placing it on its dorsal surface on the osteometric board. The maximum length measurements were made by positioning the proximal end of the bone next to the stationary vertical section of the board. A sliding wooden block was then applied to the distal end of the bone, and in moving the bone from side to side and up and down, the length was determined and read from a millimeter scale.

The tibiae were measured with both intercondylar eminences full against the vertical section of the osteometric board. The sliding block was then applied to the distal tip of the medial malleolus. Maximum length measurements of the tibia by other workers were not taken in the same manner as herein described, and the lengths recorded in this work are therefore slightly longer.

Measurements for bicondylar lengths of the femora were taken with both condyles full against the vertical

section of the osteometric board. The sliding block was then applied to the most proximal point of the head. Trochanter lengths of the femora were taken by applying the most distal portion of the medial condyle to the vertical section of the board, and then placing the wooden block on the proximal tip of the greater trochanter (Figure 1).

The method employed for determination of femoral curvature was adopted from Stewart (1962). The bone was placed on its dorsal surface on a horizontal table (Figure 2). The lowest point on the distal end of the shaft was sighted and measured with a small sliding caliper. The low point on the proximal end of the shaft was next determined and marked. As the distal end of the femur is usually higher than the proximal end when in this position, a wooden wedge was used to raise the proximal end until its low point measurement was the same as that of the distal end. The sliding caliper was then moved along the anterior surface of the shaft until the point of maximum curvature was determined. During this procedure, the stationary arm of the caliper rests on the flat surface of the table.

The collo-disphyseal angles were taken on 105 male and female femora. The method for determining this angle

FIGURE 1: Showing: A-Maximum Femoral Length; B-Trochanter Length; C-Bicondylar Length

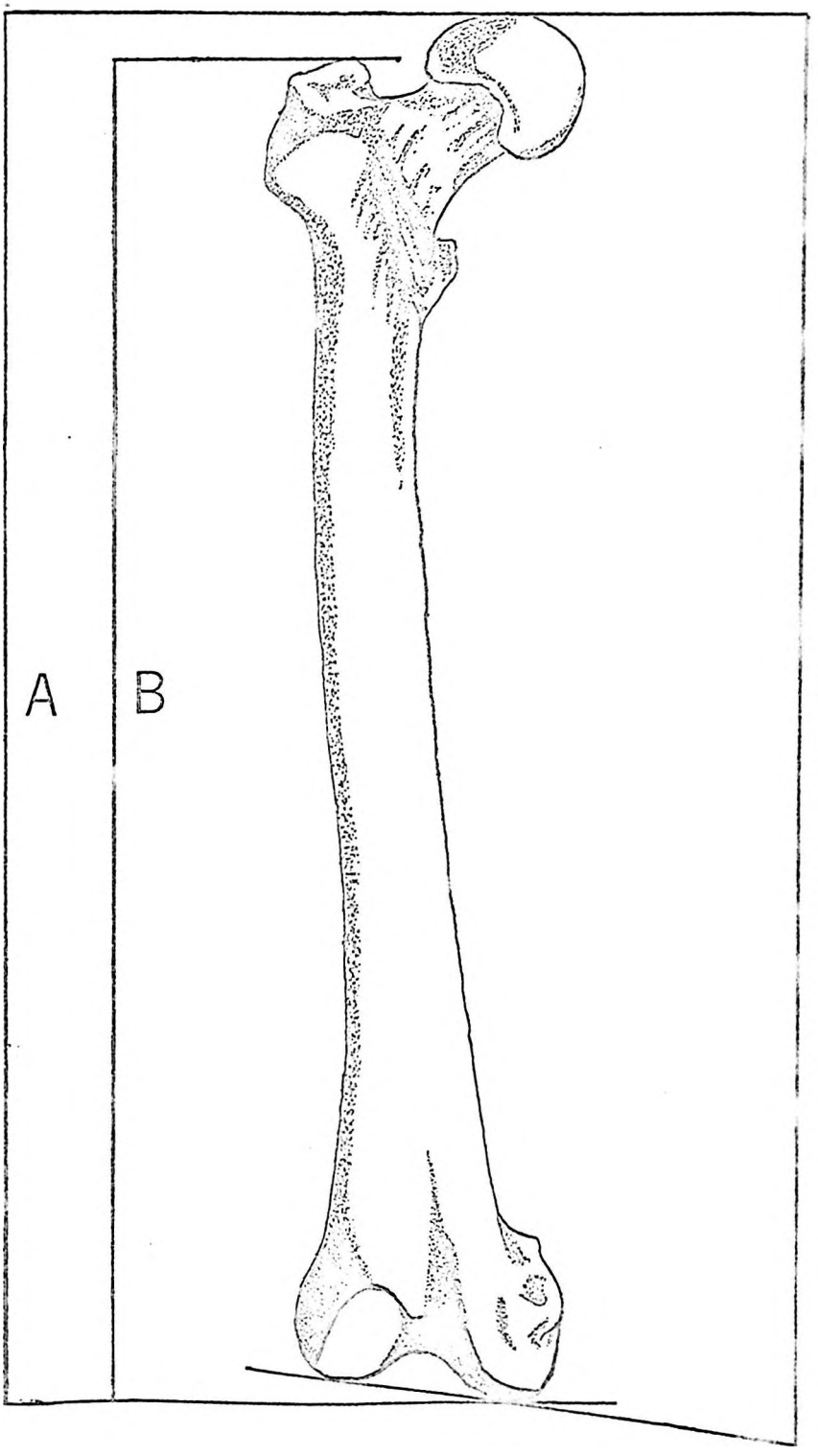
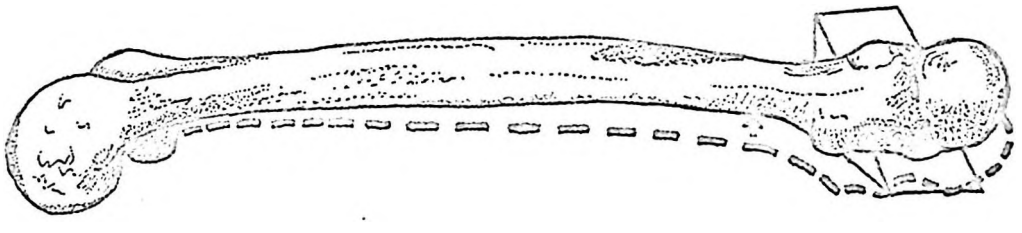

A
B
C

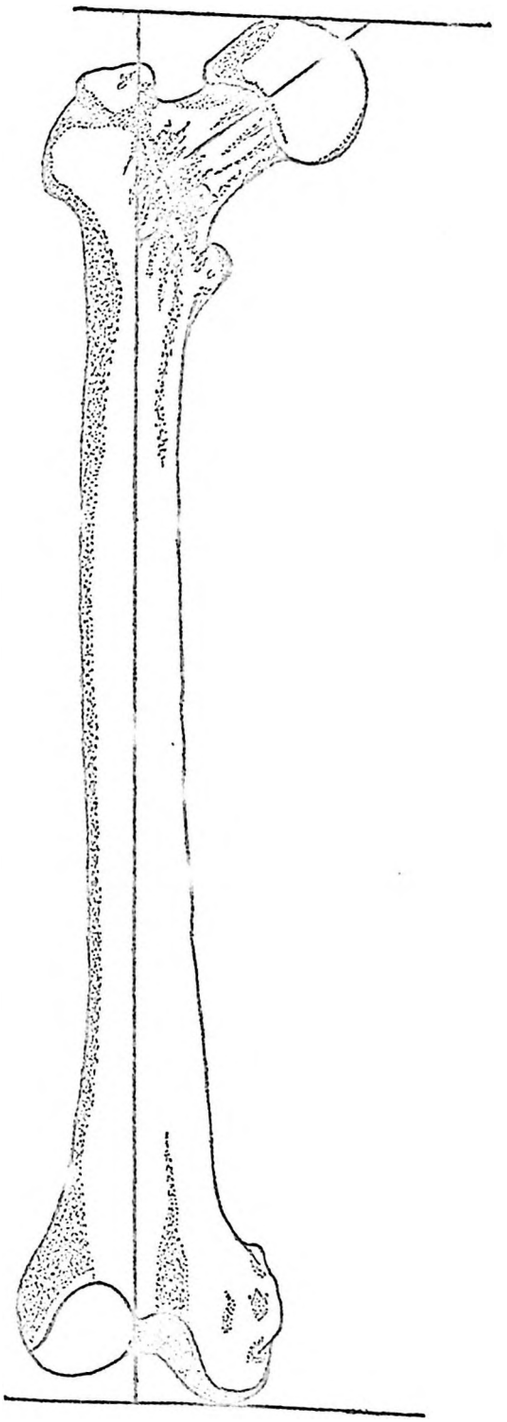
FIGURE 2: Medial View of Femur Showing Position for Determination of Diaphyseal Curvature



is a variation of that used by Pearson (cited Ingalls, 1924). The axis of the head and neck of the femur was determined by what Peason termed "appreciation"; that is, the axis was determined by sight rather than by measurement. The midpoint of the minimum diameter of the neck of the femur was determined. A point in the center of the head was sighted, and a straight line was projected from this point through the midpoint of the neck. The lowest point in the intercondylar fossa was next determined. The midpoint on the narrowest portion of the shaft was sighted, and with the bone on its dorsal surface, a straight line was projected from the intercondylar low point through the midpoint on the shaft. An extension of this line through the projected head-neck axis formed the collo-diaphyseal angle (Figure 3).

This study employed a cardboard box similar to the osteometric board, but with vertical sections on both ends. The femur was placed in the box in the manner described for taking maximum length. A section of thread, running the length of the bone over its anterior surface, was aligned with the predetermined axis of the shaft. Another section of thread was extended from the vertical section of the box at the proximal end of the bone through the head-neck axis.

FIGURE 3: Posterior View of Femur with Points of Orientation for Determination of Collo-Diaphyseal Angle of the Femur



The intersection of these two sections of thread thus formed the collo-diaphyseal angle. The value for each angle was then determined by using a transparent protractor.

Two indices were taken when availability of material permitted. The radio-humeral index $\frac{\text{Maximum length of radius x 100}}{\text{Maximum length of humerus}}$ indicates the relative lengths of arm and forearm. A higher index means a relatively longer forearm. The humero-femoral index $\frac{\text{Maximum length of humerus x 100}}{\text{Bicondylar length of femur}}$ indicates the length relationships between the two bones. A high index means a relatively short femur in relation to the humerus. These indices were taken in order to make comparisons with indices reported in similar studies.

The statistical method employed in this study includes the Student's "t" test for determining significant differences in mean bone lengths.

II

RESULTS

The mean long bone lengths of the "shell mound" Indians for both males and females appear in Tables I and II respectively. Tables I, II, and III denote maximum length. None of the differences in mean lengths between right and left bones shown is statistically significant. The long bones of the upper extremity are, on the average, longer on the right side in the male, with the exception of the humerus. The left radius and humerus are longer in the female. Trotter and Gleser (1952), reporting on male military personnel, found higher averages for the upper extremity on the right side. Latimer and Lowrance (1965) also found the bones of the upper extremity to be longer on the right side in their series of unsexed skeletons.

There is no great degree of asymmetry noted in comparing the upper extremity to the lower. This is true of all male and female long bones except for the tibiae and radii in the female and the femora in the male which

TABLE I

MEAN LENGTHS OF MALE "SHELL MOUND" INDIAN LONG BONES WITH STANDARD DEVIATIONS AND "t" VALUES

Bone and Side		Mean Length (mm)	S. D.	"t" Value (.05% Level)
Radius	R	246.76	.603	2.000
Radius	L	245.17		
Ulna	R	267.17	.458	2.000
Ulna	L	262.15		
Humerus	R	318.00	1.570	2.000
Humerus	L	321.30		
Tibia	R	372.66	.151	2.000
Tibia	L	373.53		
Femur	R	446.72	.505	2.000
Femur	L	439.38		
Fibula	R	356.88	.686	2.042
Fibula	L	358.82		

TABLE II

MEAN LENGTHS OF FEMALE "SHELL MOUND" INDIAN LONG BONES WITH STANDARD DEVIATIONS AND "t" VALUES

Bone and Side		Mean Length (mm)	S. D.	"t" Value (.05% Level)
Radius	R	226.20	1.548	2.042
Radius	L	232.50		
Ulna	R	245.41	.079	2.042
Ulna	L	245.20		
Humerus	R	295.41	.991	2.042
Humerus	L	297.84		
Tibia	R	343.84	1.505	2.042
Tibia	L	339.58		
Femur	R	411.68	.435	2.042
Femur	L	410.45		
Fibula	R	333.63	.419	2.145
Fibula	L	335.25		

TABLE III

COMPARATIVE MEAN LENGTHS OF LONG BONES OF NEGROES, CAUCASIANS (TROTTER & GLESER), AND "SHELL MOUND" INDIANS (MALE)

Bone and Side		Mean Length (mm)		
		Negroes	Caucasians	Indians
Radius	R	266.51	253.06	246.76
Radius	L	265.18	251.47	245.17
Ulna	R	285.03	271.74	267.17
Ulna	L	283.15	270.05	262.15
Humerus	R	340.76	336.41	318.00
Humerus	L	340.75	335.62	321.30
Tibia	R	403.37	384.29	372.66
Tibia	L	403.18	384.57	373.53
Femur	R	482.20	470.77	446.72
Femur	L	483.88	471.50	439.38
Fibula	R	400.29	382.58	356.88
Fibula	L	399.68	382.76	358.82

exhibit a high degree of variation. In the lower extremity, the left tibia and fibula are longer in the male. The tibia of the female is longer on the right side, while the fibula is longer on the left side. There is a marked distinction in mean length differences for the radii between the sexes. The female radii differ by 6.3 mm, while the male radii differ by 1.59 mm. The ulnae in both sexes are longer on the right side.

The mean radio-humeral index (Table IV) is lower in the female (75.79 mm.) than in the male (76.97 mm.). Since the radius is relatively shorter in the female than in the male, the forearm and hence the "reach" of females is relatively shorter. This same correlation exists between males and females of Caucasians and Negroes (Hrdlicka, 1932).

Evidence for racial and sex differences in the humero-femoral indices for Caucasians and Negroes indicates a lower index for Negroes than for Caucasians (Hrdlicka, 1932). The humero-femoral indices of the "shell mound" Indians and Caucasians are closely related (Table V). The low index in the Negro indicates a relatively long femur. The relatively high index in the "shell mound" Indians correlates with their shorter femora in relation to the

TABLE IV

COMPARATIVE RADIO-HUMERAL INDICES OF NEGROES, CAUCASIANS (HRDLICKA) AND "SHELL MOUND" INDIANS (mm)

Race	Mean Index in Males	Mean Index in Females
Negroes	77.37	76.84
Caucasians	73.64	72.77
Indians	76.97	75.79

TABLE V

COMPARATIVE HUMERO-FEMORAL INDICES OF NEGROES, CAUCASIANS (HRDLICKA), AND "SHELL MOUND" INDIANS (mm)

Race	Mean Index in Males	Mean Index in Females
Negroes	71.58	70.29
Caucasians	72.36	71.54
Indians	72.75	72.13

femora of Caucasians and Negroes. The humero-femoral indices of the "shell mound" Indians for right and left sides are almost identical.

The most striking comparative difference noted is the degree of anterior-posterior curvature of the femur (Table VI). There is a high degree of femoral curvature, ranging from 8.5 mm to 25 mm in the male and from 8.5 mm to 20 mm in the female, with the right femur slightly more curved than the left in both sexes. It is interesting to note that the variations between right and left femora in both sexes of this series are almost identical: the male left and right femora differ in curvature by 1.34 mm and the female left and right femora differ by 1.38 mm. The degree of femoral curvature could probably be due to a number of factors: body weight, type of work done, posture, torsion, nutrition, and genetic effects could all be of significance.

The data given in Table VII show the comparative maximum and trochanter lengths of the femur for both sexes of the "shell mound" Indians. The trochanter lengths for both sexes are greater on the right side. There does not appear to be any correlation between the differences in means between right and left maximum lengths and right and

TABLE VI

COMPARATIVE FEMORAL CURVATURES OF CAUCASIANS, NEGROES (WALENSKY) AND "SHELL MOUND" INDIANS

Race			Mean Curvature (mm)
Caucasians			
	M	R	9.90
		L	9.66
	F	R	9.62
		L	9.10
Negroes			
	M	R	8.90
		L	8.32
	F	R	8.70
		L	8.00
Indians			
	M	R	16.15
		L	14.81
	F	R	13.70
		L	12.32

TABLE VII

COMPARISON OF MEAN TROCHANTER LENGTHS WITH MEAN MAXIMUM LENGTHS FOR THE FEMUR

Sex and Side	Mean Trochater Length (mm)	Mean Maximum Length (mm)	Difference in Maximum Length (mm)
Male			
R	433.33	446.72	13.39
L	424.27	439.38	15.11
Female			
R	400.35	411.68	11.33
L	397.37	410.45	13.08

left trochanter lengths within either sex. It is seen, however, that in subtracting the differences in means in column 3 that these figures are very closely correlated between the sexes. The right and left femora of the male differ by 1.72 mm, and the female femora differ by 1.75 mm. The left femora in both sexes exhibit the greater variation between maximum length and trochanter length.

The collo-diaphyseal angles of the femora (Table VIII) are, on the average, greater for the left side in both males and females of the "shell mound" group. The male Indian femora have a greater average angle for the right and left sides than do the femora of the male Caucasians. The average angle for right and left femora is greater in males than in females. The differences in mean angles between males (4.61°) and females (4.58°) are almost identical.

The data on individual long bone lengths are found in Tables IX, X, XII, and XIII. The individual femoral lengths with collo-diaphyseal angles, and curvatures are presented in Tables XI and XIV.

TABLE VIII

MEAN COLLO-DIAPHYSEAL ANGLES OF THE FEMORA OF "SHELL MOUND" INDIANS AND CAUCASIANS (INGALLS)

Sex and Side		Indians	Caucasians
Male			
	R	136.06°	129.64°
	L	140.67°	127.10°
Female			
	R	132.81°	--
	L	137.39°	--

TABLE IX

MAXIMUM LENGTH MEASUREMENTS IN MILLIMETERS
OF THE LONG BONES OF THE UPPER EXTREMITY
OF THE MALE "SHELL MOUND" INDIANS

Radius		Ulna		Humerus	
R	L	R	L	R	L
259	259	282	279	340	342
231	237	279	280	297	339
248	246	273	269	297	332
259	261	268	268	336	323
253	247	264	246	331	332
251	249	263	266	322	334
248	242	283	270	336	315
249	269	255	264	319	324
240	246	260	282	325	343
255	268	285	268	315	305
266	241	284	257	301	329
241	234	256	287	337	337
269	250	281	248	309	330
229	238	281	260	282	305
226	262	257	280	334	326
239	247	270	254	333	325
262	246	256	265	326	322
248	237	256	251	316	331
254	259	256	273	313	317
239	240	250	256	324	321
261	240	259	253	293	313
241	236	257	256	311	336
254	234	255	253	295	297
238	238	258	240	325	313
236	228	256	226	310	331
235	233	277	254	307	296
232	227	276	250	297	318
240	237	278	276	290	306
244	238	273	265	305	314

TABLE IX--Continued

Radius		Ulna		Humerus	
R	L	R	L	R	L
241	237		284	316	302
235	232		244	301	302
259	234		276	305	297
259	239			338	313
241	265			332	331
254	261			341	329
233	251			336	333
270	256			332	325
238	237			338	
				345	
				320	

TABLE X

MAXIMUM LENGTH MEASUREMENTS IN MILLIMETERS OF THE TIBIA AND FIBULA OF THE MALE "SHELL MOUND" INDIANS

Tibia		Fibula	
R	L	R	L
408	410	355	392
375	373	372	348
382	384	369	378
382	360	377	351
361	386	347	375
470	355	351	344
367	469	372	367
339	382	376	343
391	367	368	346
342	395	350	364
380	379	332	353
369	371	336	330
372	385	339	339
371	368	372	374
354	382	366	367
386	346	335	380
363	383	350	349
350	394		
386	367		
327	348		
364	382		
390	364		
378	361		
362	361		
386	385		
339	360		
340	361		
357	367		
361	360		

TABLE X--Continued

Tibia		Fibula	
R	L	R	L
348	339		
355	342		
382	349		
388	359		
383	346		
386	363		
369	385		
394	385		
352	368		
398	398		
413	400		
359	352		
	415		
	356		

TABLE XI

MEASUREMENTS OF THE MALE FEMORA OF THE "SHELL MOUND" INDIANS SHOWING MAXIMUM LENGTH, COLLO-DIAPHYSEAL ANGLE, AND CURVATURE

R			L		
Maximum Length	Angle	Curvature	Maximum Length	Angle	Curvature
399	129°	12.5	399	140°	11.0
420	132°	13.0	411	140°	8.5
422	147°	21.0	411	134°	13.0
424	136°	15.5	418	146°	19.0
425	130°	14.0	418	137°	11.0
425	125°	15.0	419	155°	23.5
426	137°	18.0	426	145°	15.0
430	147°	25.0	427	140°	12.5
433	133°	17.0	428	138°	17.5
434	135°	11.0	428	143°	14.0
440	147°	15.0	430	142°	14.5
442	133°	17.0	433	143°	18.0
442	143°	10.0	434	157°	13.0
444	134°	10.0	435	142°	10.0
445	136°	9.5	435	132°	14.0
447	140°	14.0	438	137°	18.0
452	138°	21.0	441	131°	11.0
453	134°	18.0	441	135°	15.5
453	132°	17.0	442	156°	13.0
453	128°	15.5	445	135°	12.0
455	131°	18.5	446	148°	13.5
457	131°	16.0	448	139°	20.0
458	146°	19.5	451	144°	19.0
459	136°	19.0	451	131°	14.5
461	140°	20.0	453	125°	11.0

TABLE XI--Continued

R			L		
Maximum Length	Angle	Curvature	Maximum Length	Angle	Curvature
462	143°	14.5	458	144°	15.0
466	134°	15.5	459	139°	20.5
472	138°	13.5	462	140°	12.5
475	128°	16.5	464	143°	16.0
477	135°	19.5	471	135°	19.0
			478	140°	14.5

TABLE XII

MAXIMUM LENGTH MEASUREMENTS IN MILLIMETERS OF THE LONG BONES OF THE UPPER EXTREMITY OF THE FEMALE "SHELL MOUND" INDIANS

Radius		Ulna		Humerus	
R	L	R	L	R	L
226	229	251	250	307	276
213	242	259	267	278	306
216	223	254	235	286	321
218	233	234	244	309	299
234	245	256	243	289	279
241	234	251	277	308	278
231	252	241	240	315	305
217	229	263	263	287	290
227	240	236	235	303	297
227	260	260	225	301	305
242	224	237	235	283	291
216	239	231	242	309	302
221	219	235	221	286	315
225	224	243	251	298	290
247	203	220	260	289	322
220	218	245		273	296
238	232	256		282	278
201	239			295	298
223				281	311
241				300	
				299	
				321	

TABLE XIII

MAXIMUM LENGTH MEASUREMENTS IN MILLIMETERS OF THE LONG BONES OF THE TIBIA AND FIBULA OF THE FEMALE "SHELL MOUND" INDIANS

Tibia		Fibula	
R	L	R	L
340	342	329	306
330	332	337	314
360	344	319	362
327	348	360	359
336	318	294	327
333	341	333	325
340	327	342	334
331	345	355	355
374	297		
358	341		
351	331		
322	374		
349	353		
372	355		
341	348		
310	332		
351	310		
362	353		
346	362		

TABLE XIV

MEASUREMENTS OF THE FEMALE FEMORA OF THE "SHELL MOUND" INDIANS SHOWING MAXIMUM LENGTH COLLO-DIAPHYSEAL ANGLE, AND CURVATURE

R			L		
Maximum Length	Angle	Curvature	Maximum Length	Angle	Curvature
374	133°	10.5	374	136°	11.5
388	132°	11.5	382	142°	9.0
395	132°	15.5	388	123°	12.0
402	135°	10.5	395	134°	13.0
403	135°	8.5	400	135°	13.0
405	137°	12.5	404	138°	12.5
407	125°	9.5	405	132°	9.0
409	136°	12.0	408	137°	14.0
417	125°	18.0	414	138°	12.5
418	133°	19.0	415	138°	16.5
420	123°	20.0	417	153°	12.5
423	141°	16.5	418	131°	9.5
428	142°	19.5	428	141°	12.5
428	136°	10.5	429	140°	12.5
429	118°	15.0	433	144°	16.5
435	142°	13.0	434	143°	13.0

III

DISCUSSION

In comparative long bone lengths (Table III), the "shell mound" Indian long bones are shorter than both Caucasian and Negro long bones in every case. The data on Caucasian and Negro bones are from work by Trotter and Gleser (1958) on male military personnel who served in the Korean War (1950-1953).

Munter (1936), in measuring Anglo-Saxon skeletons, indicates that in the case of the humerus, females are more asymmetrical than males, and that this is also true of the radius, but to a lesser degree. No great degree of asymmetry between the humeri was noted in the "shell mound" group, but the radii show a high degree of variation. Schultz (1937) and Trotter and Gleser (1952) found a slightly longer left humerus in Negro skeletons which prompted some investigators to suggest that a racial difference might exist in regard to long bone asymmetry. This work found a longer left humerus in both males and females.

Trotter and Gleser (1952) found all of the bones of the lower extremity to be longer on the left side, while Latimer and Lowrance (1965), reporting on 105 Asian skeletons, found only the femur and tibia longer on the left side. In the "shell mound" series, the femur is longer on the right side in both males and females. The tibia and fibula in both sexes are longer on the left side except for the tibia of the female which is longer on the right side. Jolicoeur (1963) reports the tibia to be slightly longer on the right side in the male and on the left side in the female. Trotter and Gleser (1952) reported the left tibia longer, and Latimer and Lowrance (1965) reported the right tibia longer. The tibiae of Caucasians, Negroes, and "shell mound" Indians show the least variation in right and left sides. The femora show the greatest variation which is most pronounced in the Indian group. The fibulae show very little variation in any of the three groups.

The radio-humeral index demonstrates in skeletal material the forearm-arm proportion in the living. In studies by Hrdlicka (1932), the index showed both a race and sex variation. The material for Hrdlicka's work included the long bones of Caucasians, full-blood American Indians, and American Negroes.

For both males and females the index is higher in the "shell mound" Indians than in Caucasians, and very close to that of the Negroes. This is consistent with the findings in the full-blood American Indian group which showed indices very close to the "shell mound" group, and may therefore indicate a close relation to the full-blood American Indian and American Negroes in forearm-arm proportion.

The data on the Caucasians and Negroes in Table VI are from studies on the femur by Walensky (1965). A possible explanation for so wide a variation in these data and those recorded for the "shell mound" Indians is that the technique for ascertaining low points on the femoral shaft varied to some degree. It is also important at this point to mention the effect of torsion on degree of diaphyseal curvature. As the head and neck of the femur assume a more anterior position in positive torsion, the medial portion of the proximal anterior surface also moves forward. Thus, when determining the low point for the proximal end of the bone, this low point will be higher and thereby increasing the value of the curvature measurement. According to a study by Stewart (1962), a significantly greater amount of torsion occurs in Indian groups

as compared with both Caucasians and Negroes. As torsion was not considered in the present study, there is thus presented another factor which could account for the wider variations in amount of femoral curvature exhibited by the "shell mound" Indians when compared with femoral curvature in Caucasians and Negroes.

The collo-diaphyseal angle indicates the position of the neck of the femur in relation to the shaft. The angles for the femora in the "shell mound" series are greater on the left side. Pearson (cited by Ingalls, 1924) also found that the average of the collo-diaphyseal angles of the femora of male English skeletons was greater on the left side (131.474°) than on the right (130.404°). Ingalls (1924) reported a greater average angle for the right femora (129.64°) than for the left (127.10°) in Caucasian males.

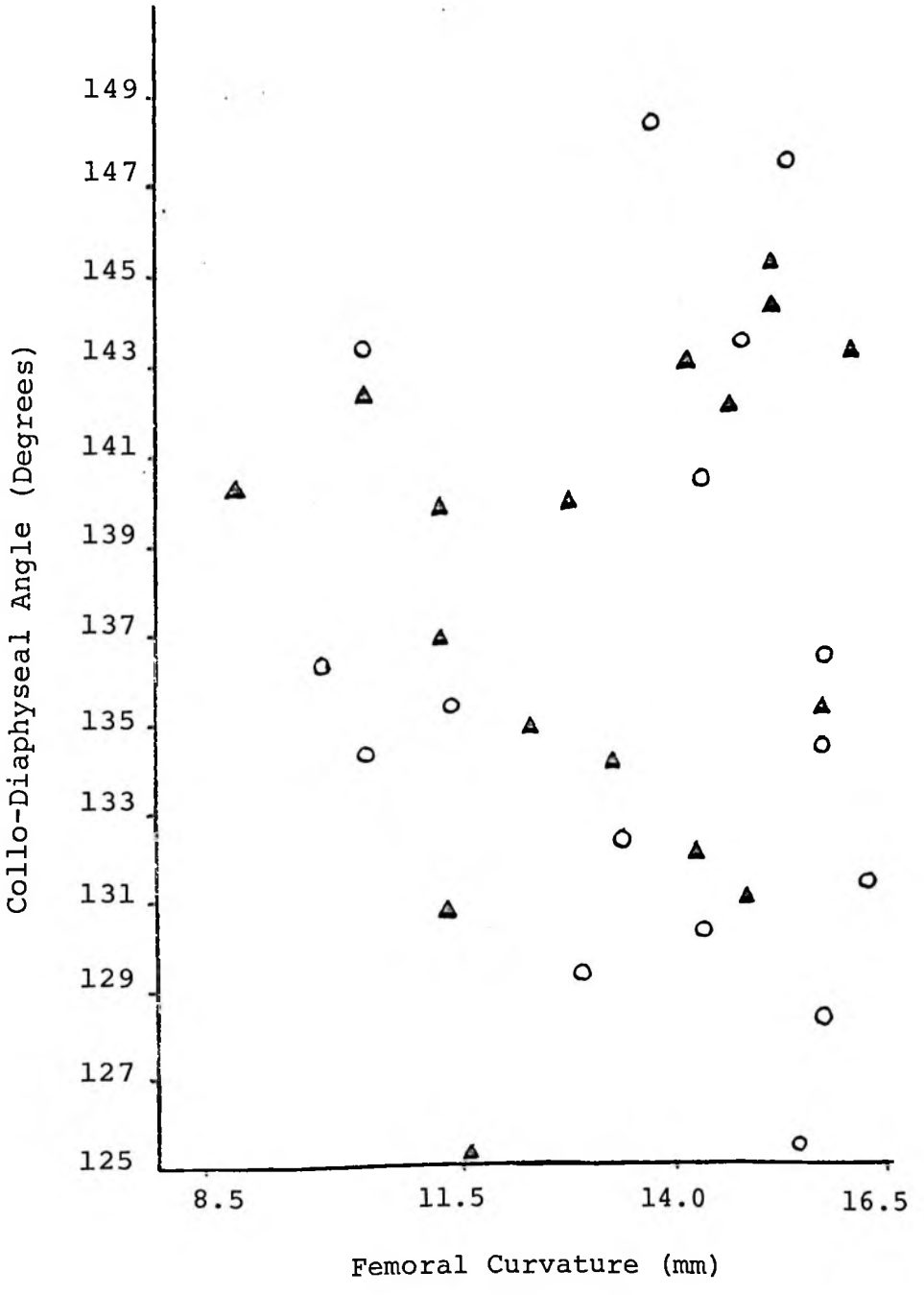
There is a close correlation in differences between mean right and left angles in males and females of the "shell mound" group. There is also a close correlation in right and left mean trochanteric differences between the sexes. One might expect to find some direct correlation between maximum femoral length, collo-diaphyseal angle, and curvature. There is, however, no apparent correlation

between these measurements. This lack of relationship is readily demonstrated in Figure 4 in which a plot of curvature versus angle shows a random pattern both in right and left femora in the male. The same random pattern would exist if a plot were made of maximum length versus curvature. However, the right femora are longer on the average in both sexes, and the trochanter lengths are also greater on the average on the right side. It may be that the left femora are compensated by having greater mean collo-diaphyseal angles which would keep them within reasonable range lengths of the right femora.

FIGURE 4: A Graph of the Angle Versus Curvature of the Right and Left Femora of the "Shell Mound" Indians (Male)

▲ = Right Femur

O = Left Femur



IV

SUMMARY

The "shell mound" Indians exhibit several variations in comparative long bone lengths. There is evidence of "leftsidedness" in regard to the humerus of both sexes. The ulna and radius are longer on the right side in the male, with the left radius and right ulna longer in the female. There is no high degree of asymmetry between the upper and lower extremities in either sex although the radius in the female and the femur in the male are somewhat variable. In the lower extremity, the femur is longer on the right side; the tibia and fibula are longer on the left side in the male, the left fibula and the right tibia are longer in the female.

The long bones of the "shell mound" Indians are shorter than those of either Caucasians or Negroes. The femora of this Indian group show the greatest variation between rights and lefts when compared with the femora of Caucasians and Negroes. The tibiae show the least variation.

The radio-humeral indices of the "shell mound" Indians are higher than those reported for Caucasians, and are close to those of the Negro group reported which indicates a relatively long forearm. The index is higher in males than in females.

In comparing the humero-femoral indices of the Indian series with those reported for Caucasians and Negroes, the higher index in the Indian group indicates a relatively short femur. The Caucasian group is intermediate, with the Negro group showing the lowest index and thus a relatively long femur.

The "shell mound" Indians exhibit a relatively high degree of anterior-posterior diaphyseal curvature of the femur in comparison to reported Caucasian and Negro groups. The right femur is slightly more curved than the left.

There is apparently no correlation between maximum femoral length and trochanter length in comparing right and left sides in either sex. The left femur exhibits the greater variation between maximum length and trochanter length.

The collo-diaphyseal angles are greater on the average on the left side in both sexes, and are greater in

males than in females. The femora of male "shell mound" Indians exhibit greater average collo-diaphyseal angles than the femora of male Caucasians.

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