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Article V.—OBSERVATIONS ON *COLOBUS* FETUSES[1]

By Adolph H. Schultz[2]

At present we have an exceedingly limited literature on the fetal development of monkeys and apes, so that any new observation in this line is a contribution to a practically unknown field. In the study of fetal material of primates the changes in proportions during development are of special interest, particularly when compared with the conditions in adults of corresponding species. Such investigations should eventually reveal the general laws governing growth in all primates, and also the reasons for and the time of appearance of the various physical specializations found in this group of mammals.

The following notes form a small contribution in this direction. They have been made possible through the generous loan, by The American Museum of Natural History, of three fetuses and two adult skeletons of the *Colobus* monkey. In addition, use has been made of observations on the preserved bodies of one juvenile and one adult *Colobus* monkey in the anatomical collection of the University of Zürich. The author wishes to express his sincerest thanks to Dr. F. A. Lucas and Mr. H. Lang, of the American Museum, and to Prof. W. Felix, of the University of Zürich, for their kind permission to study this material.

Two of the fetuses (1 and 2) and one skeleton (4) belong to the species *Colobus abyssinicus ituricus;* one fetus (3) and one skeleton (5) to *Colobus angolensis cottoni;* and the two preserved bodies (6 and 7) are of the species *Colobus vellerosus* J. Geoffroy.[3] In their state of development the three *Colobus* fetuses correspond closely to human fetuses of the 20th to the 24th week; in all probability, however, their actual age is not so great as that. A careful comparison of the lanugo, cutaneous ridges, ears, hands and feet, genitals, and especially the ossification, in the *Colobus* and the human fetuses, shows that *Colobus* fetus 1 corresponds to a human fetus of 20 weeks, fetus 2 to one of 23 weeks, and fetus 3 to one of 24 weeks. The *Colobus* fetuses are considerably smaller, however, than the human fetuses of corresponding stages of development. This is best shown by their respective sitting-height (crown-rump)

[1]Scientific Results of the American Museum Congo Expedition. Mammalogy, No. 9.

[2]Research Associate, Department of Embryology, Carnegie Institution of Washington.

[3]The following are the catalogue numbers of the different collections. American Museum of Natural History: 1, 52250; 2, 52246, 3, 52192; 4, 52223; 5, 52149. Anatomical collection, University Zürich: 6, 589; 7, 98. Carnegie Laboratory of Embryology: 1, C 38; 2, C 35; 3, C 37. With the exception of skeleton 5 all these specimens are female.

Table I.—Absolute Measurements of *Colobus* Fetuses

No.	Measurements (in millimeters)	*Colobus* Fetus 1	2	3
1.	Sitting height: Top of head to lowest point on buttocks	112.0	134.0	147.0
2.	Thoraco-abdominal height: Symphysion (upper border of symphysis pubis) to suprasternal notch	59.0	71.0	85.0
3.	Symphysion to nipple (the latter projected on midsagittal plane)	50.5	61.0	74.0
4.	Symphysion to omphalion (center of attachment of umbilical cord)	22.0	24.0	26.0
5.	Biacromial diameter: Distance between the acromial processes	26.8	35.0	34.0
6.	Bimammillary diameter: Distance between niples	12.5	15.0	14.5
7.	Bitrochanteric diameter: Distance between the great trochanters	24.0	29.0	28.0
8.	Transverse diameter of chest (at nipple height)	24.0	30.0	32.0
9.	Sagittal diameter of chest (at nipple height)	23.0	31.0	31.0
10.	Circumference of chest (at nipple height)	85.0	103.0	106.0
11.	Length of upper arm: Top of caput humeri to humeroradial joint (radiale)	30.0	35.5	40.0
12.	Length of forearm: Radiale to tip of styloid process (stylion)	26.1	33.5	36.7
13.	Length of hand: Middle of line combining styloid processes of radius and ulna to tip of middle finger	21.5	30.5	34.0
14.	Length of thumb: Stylion to tip of thumb	9.6	9.3	10.4
15.	Breadth of hand (across metacarpo-phalangeal joints II to V)	8.9	11.6	12.0
16.	Length of thigh: Top of great trochanter to lateral point of knee joint	33.0	41.5	46.7
17.	Length of leg: Medial point of knee joint (tibiale) to tip of internal malleolus	29.3	35.8	40.0
18.	Tibiale to sole of foot	32.0	41.0	45.5
19.	Length of foot: Heel to tip of longest toe	34.3	46.0	49.5
20.	Breadth of foot (across metatarso-phalangeal joints II to V + breadth of this joint on great toe)	10.2	13.0	13.0
21.	Greatest length of head: Glabella to most distant point on occiput	36.0	44.0	50.5
22.	Greatest breadth of head (over temporal or parietal bones)	30.5	38.0	41.0
23.	Auricular height of head: Tragion (upper border of tragus) projected on midsagittal plane to vertex (perpendicular to ear-eye horizon)	21.5	27.5	29.0
24.	Nasion-inion diameter: Point over middle of naso-frontal suture (nasion) to occipital protuberance (inion)	35.0	41.5	48.5

Table I.—Absolute Measurements *Colobus* Fetuses (Continued)

No.	Measurements (in millimeters)	*Colcbus* Fetus 1	2	3
25.	Biauricular breadth: Width between the tragion points	28.5	35.0	37.0
26.	Horizontal circumference of head (greatest circumference passing through glabella)	107.0	129.0	145.0
27.	Sagittal arc: Nasion to inion	63.0	75.5	82.0
28.	Transverse arc: Tragion to tragion (perpendicular to ear-eye horizon)	64.5	83.0	88.0
29.	Total head height: Lowest point of chin (gnathion) to vertex (perpendicular to ear-eye horizon)	37.0	46.0	47.0
30.	Total face height: Nasion to gnathion	16.0	21.6	22.4
31.	Upper face height: Nasion to middle of mouth	12.0	16.3	17.4
32.	Bizygomatic breadth: Greatest breadth between zygomatic arches	27.0	33.5	35.0
33.	Nasal height: Nasion to subnasal point (where nasal septum and upper lip meet)	11.0	14.0	14.0
34.	Nasal breadth	6.5	7.5	7.5
35.	Breadth of nasal septum: Smallest distance between nostrils	3.0	2.8	3.0
36.	Interocular breadth: Distance between medial angles of eyes	6.8	7.9	7.9
37.	Breadth of mouth	13.0	16.5	16.0
38.	Length of ear: Highest point on helix to lowest point on lobule	13.0	19.0	19.0
39.	Breadth of ear: Greatest breadth between anterior and posterior border of helix	8.3	13.0	13.0

measurements, which are as follows: *Colobus* fetus 1, 112 mm., human fetus of 20 weeks (average), 158 mm.; *Colobus* fetus 2, 134 mm., human fetus of 23 weeks, 191 mm.; *Colobus* fetus 3, 147 mm., human fetus of 24 weeks, 202 mm.

Before taking up the discussion of the outer form and proportions of the *Colobus* fetuses, attention is called to the measurements made, which are enumerated in Table 1. From these absolute measurements relative measurements or indices were constructed according to the formulæ given in Table 2 after the technical term of each index. Next to the indices for the *Colobus* fetuses are given the indices for the adult *Colobus* monkeys (Table 2); and, for further comparison, the average indices of groups of human white fetuses of stages of development corresponding to the *Colobus* fetuses are added. These groups are made up of 16 specimens of 20 weeks, 16 specimens of 23 weeks, and 17 specimens of 24 weeks.

A great many of the proportions which were studied on the fetus could not be obtained on the adult skeletons; therefore the bodies of the juvenile and adult *Colobus vellerosus* were used for comparison. It is not probable that the latter show any marked differences in proportions

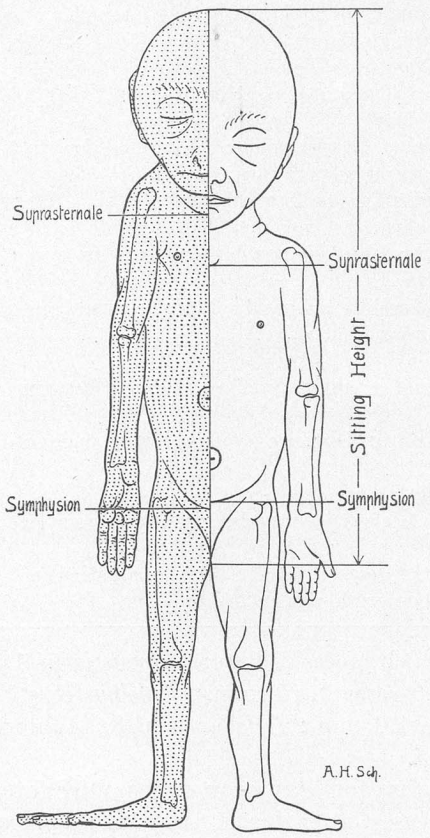

Fig. 1. Schematic drawing of body proportions of *Colobus* fetus 1 (dotted half, ⅔ nat. size) and of human fetus of 20 weeks.

from the adult *Colobus abyssinicus* or *angolensis*. Where analogous indices from all these species were obtained they did not differ more than the normal variation within one species. Moreover, the fact that the fetuses are of two different species has, according to Table 2, very little, if any, influence on their proportions. It seemed reasonably safe,

therefore, to study changes in proportions during growth on this series, even though it was composed of different species. Figure 1 shows in a schematic way the body proportions of *Colobus* fetus 1, and for comparison those of a human fetus of 20 weeks, reduced to a sitting-height equal to that of the *Colobus* fetus. The drawing is constructed from the measurements of fetus 1 and from the average measurements of the group of sixteen human fetuses of the 20th week.

The trunk of the *Colobus* fetus is relatively considerably longer than that of the human fetus; in width of trunk, however, the latter surpasses the former. The distance between the shoulders and between the hips, and the diameters and circumference of the chest, relative to the length of the trunk, are much less in the *Colobus* fetus than in the human fetus, but greater than in the juvenile or adult *Colobus*. The extreme slenderness of the trunk in the monkey is not attained, therefore, until adult age; in the fetus the trunk is stouter, but not as stout as in the human fetus, which shows early the relative broadness of the human trunk. According to the thoracic index, the transverse diameter of the chest is, on an average, about equal to the sagittal diameter of the *Colobus* fetus, whereas in the human fetus the width of the chest considerably exceeds its depth. In later stages of growth the chest of *Colobus* becomes narrower, its sagittal diameter being the greatest one. This deep and narrow chest is typical for all adult monkeys, and it was rather surprising to find that in fetal stages the chest was relatively broader. Whether this has any phylogenetic significance is at present difficult to decide. The nipples of the *Colobus* fetus lie relatively higher and closer together on the anterior wall of the trunk than in the human fetus; in the adult *Colobus* they are relatively even higher and farther apart than in the fetus. The shifting of the nipple to a relatively higher level on the trunk demonstrates that in *Colobus* the lower portion of the trunk grows faster than the upper, a fact which is further confirmed by the changes during growth in the proportional lengths of the different regions of the spine. These will be discussed later on. The point of attachment of the umbilical cord is relatively much higher in the *Colobus* than in the human fetus; on the bodies of the juvenile and adult *Colobus* no trace of an umbilicus could be found. This complete absence of any umbilical scar was also noted on different monkeys by Mollison[1] and on some other mammals by Levadoux.[2]

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[1]Mollison, Th. 1910. 'Die Körperproportionen der Primaten.' Morphol. Jahrb., XLII, p. 108.
[2]Levadoux, M. J., 1907. 'Variétés de l'ombilic et des ses annexes.' Fac. de Méd. et de Pharm. de Toulouse, No. 711.

In relation to the trunk, both the upper and the lower extremities are shorter in the *Colobus* than in the human fetus, the difference being greater for the lower extremity. During postnatal development the lower extremities of *Colobus* grow at approximately the same rate as the trunk, so that their relation in length remains almost unchanged. The upper extremities, on the other hand, grow more slowly than the trunk, so that the two lengths approach each other more nearly in the adult than in the fetus. The intermembral index shows the direct relation between the length of the extremities, expressing the upper in percentage of the length of the lower. For the *Colobus* fetuses this percentage is on

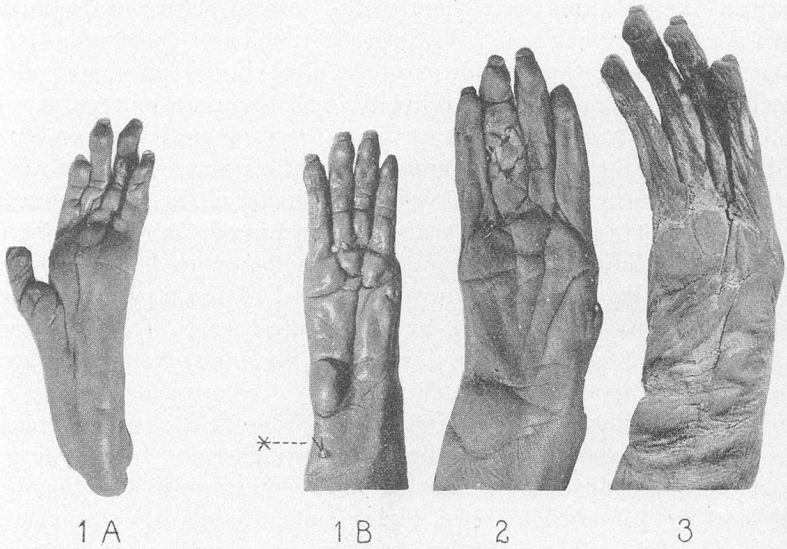


Fig. 2. 1A left foot, 1B right hand of *Colobus* fetus 1; 2 and 3 right hands of fetus 2 and 3 respectively; *vibrissæ (enlarged).

an average 120, for the human fetuses 106, for adult *Colobus* 109, and for adult man below 100. These figures show that in both man and *Colobus* the lower extremity grows faster than the upper one. From indices XVIII to XX (Table 2) it can be seen that the humerus relative to the femur, and the radius, relative to the tibia, are in *Colobus* shorter in the adult than in the fetus, and approximately equal in monkey and human fetuses. In *Colobus* the relation between the length of the hand and the length of the foot seems to remain constant throughout growth, and differs from that in man, in whom the hand length approaches more closely to the foot length. The relation in length between the radius

and humerus, and between the tibia and femur changes in *Colobus* during development, inasmuch as the rate of growth, for both upper and lower extremities, is less rapid in the proximal part than in the distal part. In both fetus and adult the forearm, relative to the upper arm, and the leg, relative to the thigh are shorter in man than in *Colobus*. The width of the hand relative to its length is less in the adult *Colobus* than in the fetus; while in the foot the relation of width to length remains unaltered during growth. Both hand and foot of the *Colobus* fetus are considerably more slender than in the human fetus (Fig. 2). The length of the great toe, measured from the heel, constitutes from 66 to 70% of the total foot length. This relation is the same in fetuses as in adults. The longest toes are III and IV; toe II is slightly shorter than toe V. These relative toe lengths remain unchanged throughout development. In adult, as well as in fetal *Colobus*, finger III is the longest, finger IV nearly as long, and finger II even shorter than finger V. The thumb in the genus *Colobus* is rudimentary, as in some of the platyrrhine monkeys (*Ateleus* and *Brachyteleus*). Johnston,[1] speaking of the species *Colobus tephrosceles* Elliot, says that there is only "the minutest trace of a thumb nail in the place where the thumb is missing . . . but the young *Colobuses* of this species have a complete thumb, only a little smaller than this finger would be in the *Cercopitheci*. As the animal grows to maturity, so its thumb dwindles, until in a very old male there may be absolutely no trace left of the missing finger."

Apparently the degree of reduction of the thumb and the age at which it disappears completely from the surface may vary in different species, inasmuch as the fetuses of *Colobus abyssinicus ituricus* (1 and 2) show but little evidence of a thumb (somewhat more in the younger specimen than in the older one) and there is no trace whatever of a thumb nail. In the skeleton of the adult of this species (4) a metacarpus, half the length of metacarpus II, and one short phalanx constitute the thumb. In the fetus of *Colobus angolensis cottoni* (3) no outer trace of a thumb can be seen although its end can be palpated, and in the adult skeleton of this species (5) a short metacarpus and a rudimentary phalanx form the thumb. Of the two specimens of *Colobus vellerosus*, the juvenile one shows the rudimentary outer thumb somewhat freer and slightly larger than the adult specimen; however, no sign of a thumb nail could be found in either of these. They both contain a well ossified metacarpus and one phalanx for the thumb. X-ray pic-

[1]Sir Harry Johnston. 1904. 'The Uganda Protectorate,' I, p. 362.

tures of all the fetuses showed on each hand a metacarpus I less than half the length of metacarpus II. The length of the rudimentary thumb, measured from the styloid process of the radius, varies from 30 to 44% of the total hand length, without showing a clear tendency either to reduce or increase during growth.

The relatively small size of the head of the *Colobus* fetus is first noted when compared with human fetuses of corresponding development. The average circumference of the brain part of the head is considerably less than the sitting height (index XXI) in the *Colobus* fetuses, whereas it is greater in the human fetuses. In adult *Colobus* the average circumference amounts to less than half the sitting height. The average diameter of

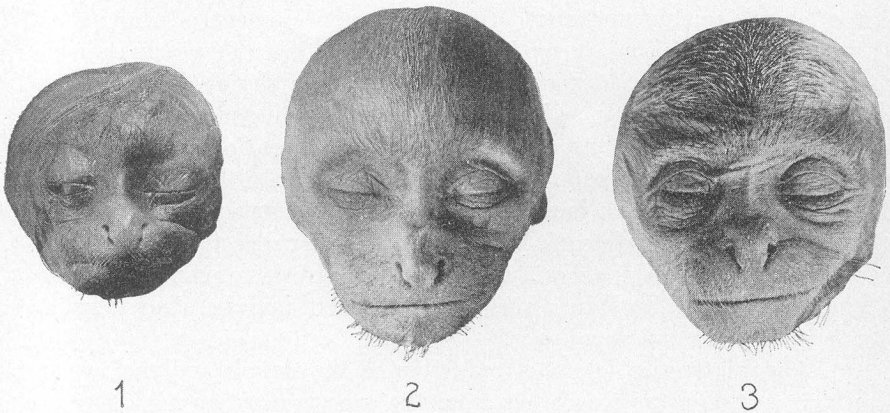


Fig. 3. Front views of the heads of the *Colobus* fetuses 1, 2, and 3 (approximately nat. size).

the head is about 50% of the trunk length (index XXII) in the *Colobus* fetus, 70 to 78% in the human fetus, and only 20% in adult *Colobus*. Besides this difference in the size of the head in *Colobus* and human fetuses, there is a marked difference in shape, the height of the head in relation to its length being much less in the former than in the human fetus. In adult *Colobus* the head is relatively lower still than in the fetus. The face part of the head in the *Colobus* fetus is smaller, relative to the trunk, than in the human fetus, but considerably larger in relation to the brain part. The nose is relatively longer and narrower than that of the human fetus. The nasal index is unusually low and drops during growth, just as in man.[1] The width of the nasal septum is greatest, relatively,

[1]Schultz, A. H. 1920. 'The development of the external nose in whites and negroes.' Contrib. to Embryology, No. 34; Pub. 272, Carnegie Inst.

in the smallest of the monkey fetuses, and in all of the specimens of *Colobus* is rather broad for catarrhine monkeys. The relative interocular breadth is slightly less in the *Colobus* than in the human fetus and decreases with advancing development. The high value for this index (XXXIII) in the adult *Colobus* (7) is very probably an extreme variation and rarely to be found in monkeys, whose eyes, as a rule, are relatively closer together than those of man. The ear, relative to the size of the head (XXXV) is very much larger in the *Colobus* than in the human fetus. Figure 4 shows the gradual rolling in of the helix edge during development; in fetus 3 this has occurred at two independent points, the apex of the ear bending over earlier than the portion of the helix immediately above. The ear opening in the human fetus lies about equidistant

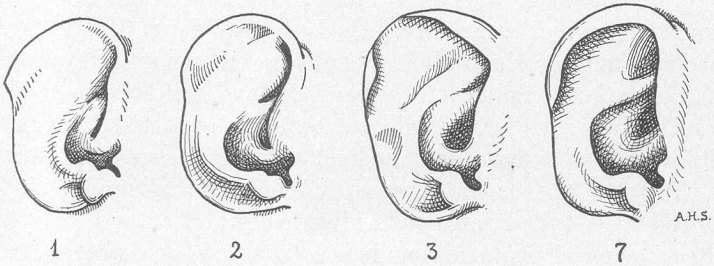


Fig. 4. Sketches of the outer ears of *Colobus* fetus 1, 2, and 3 and of adult *Colobus* 7.

between the extreme oral and aboral points on the head; in the *Colobus* fetus it is situated farther back, though not quite so far back as in adult *Colobus*.

The lanugo of the *Colobus* fetus apparently makes its appearance at a slightly earlier stage of development than is represented by fetus 1, as the latter has a very few light microscopic hairs on the back and a few on the tip of the tail; with the exception of these and the hair on the head, the fetus is still entirely naked. The longest hair is found in the eyebrows, which are formed of black vibrissæ which are densest over the glabella. The eyelashes are composed of a few short black hairs. There are a few somewhat longer black hairs on the upper lip and chin, and close around the mouth are fairly strong light hairs. The scalp bears fine, very short light hair, directed backwards. Among these hairs are three somewhat longer black hairs on each side of the head, in front and above the ears. On the external ears a few short black hairs are found on

the tragus, antitragus, crus helicis, and anthelix. Over the entire body surface of fetus 2 are fine, very short, light hairs. On the arms and thighs, on the proximal dorsal part of the tail, and on the dorsal surface of the hands and feet are scattered some slightly longer black hairs. The entire head, including the face, is covered by a thick growth of fine light hair which, on the forehead and scalp, is directed straight backward without any parting at the center, or any whorls such as are seen in human fetuses. Even the eyelids bear a coat of fine short light hair. In fetuses 2 and 3, as in fetus 1, the eyebrows are composed of black vibrissæ, the eyelashes are black, and there are some fairly long black hairs on the upper lip and chin. Fetus 3 is also entirely covered with light hair, which is somewhat longer than in fetus 2, rather glossy, and almost white in color. The upper extremities bear a thicker coat than the lower ones, where the hair seems to have made its appearance later. The inner sides of the thighs are almost naked. The fine white body hair of fetus 3 extends for a distance of 5 mm. on the umbilical cord where it points away from the body. The rather long hair on the forehead and scalp is directed backward and slightly sidewise, but without being really parted in the middle. On all parts of the external ear fine light hair and longer black hairs are found. In fetus 2 the ear is covered by fine black hairs only. In both fetus 2 and fetus 3 the lanugo on the hands and feet extends only to the last interphalangeal joints, and no hair is found on the dorsal side of the last phalanges. In all three specimens there is a fairly large bald area on each buttock which later develops into a callosity.

Fetus 1, the youngest of the series, shows a very small but distinct round elevation of the skin on the inner, ulnar side of the forearm, just proximal to the carpus, on which two black vibrissæ (sinus hairs) can be detected on close examination (Fig. 2). These two hairs are the only ones on the arm and, like the vibrissæ on the face, most probably make their appearance before the lanugo. Among the short hair on the forearm of fetus 2, two considerably longer and stronger black vibrissæ are found at a place analogous to that on which they appear on the younger fetus. Fetus 3, of a different species, has four long black vibrissæ at the same place on the forearm. These can be easily seen among the light and shorter hairs. In the two older fetuses the skin elevation at the base of the vibrissæ is less pronounced than in the youngest fetus. In all three fetuses these vibrissæ are present on each arm and point straight forward towards the hand.[1] In the adult *Colobus* no trace of these vibrissæ

[1]Analogous sinus hairs were observed by the author in a fourth *Colobus* fetus of a different species; see Schultz, A. H., 1924, 'Growth studies on primates bearing upon man's evolution,' Amer. Journ. Phys. Anthrop., VII.

can be seen. It seems quite safe to the author to assume that these vibrissæ of the *Colobus* fetuses are identical with those described by Beddard[1] under the term "carpal vibrissæ." This author states that they are situated "on the wrist close to the root of the thumb and generally on that (the radial) side of the forearm." However, from his and Sutton's[2] illustrations, it seems that they are not infrequently situated somewhat proximal to the carpus and may also extend to at least the middle of the inner side of the forearm, so that there seems to be no fundamental difference in the location of these vibrissæ as found by Beddard and by the author. Beddard mentions a carpal tuft, containing from one to twenty vibrissæ, in many groups of mammals, and states that "the most salient feature as to its absence or presence is its nearly universal existence in the lemurs and the absolutely universal absence in the monkeys . . . It is not without interest to be able to bring forward a character which seems to absolutely distinguish these two divisions of the Primates."

In this connection the finding of carpal vibrissæ in a catarrhine monkey fetus, where they develop only to disappear again in later stages of growth, is quite significant. The very frequent occurrence of carpal vibrissæ in Prosimiæ, and their reappearance in the fetal stage of a monkey constitutes further proof of a close relationship between these two groups of mammals. Among platyrrhine monkeys Frédéric[3] found sinus hairs on the forearm of *Hapale jacchus*, so we now know that carpal vibrissæ are represented in monkeys of both the Old and the New World.

For the study of the skeletal system several X-ray photographs were taken of each *Colobus* fetus. In addition, fetus 2 was stained with toluidin blue and cleared in a 2 per cent solution of potassium hydroxide, a process which, in addition to the ossified parts, shows the cartilage in blue color. Figure 5 is an exact drawing of the cleared specimen and may serve to illustrate the following description.

The spinal column consists of 55 vertebræ: 7 cervical, 12 thoracic, 7 lumbar,[4] 3 sacral, and, on an average, 26 caudal. Marked variations in these numbers occur in the caudal vertebræ, which were 28 in fetus 1, 25 in fetus 2, 27 in fetus 3, 25 in skeleton 4, and 26 in skeleton 5. In table 3 the lengths of the different spinal regions are expressed in percentages of the præcaudal length of the spine. The values for the human fetuses are

[1]Beddard, F. E. 1902. 'Observations upon the carpal vibrissæ in mammals.' Proc. Zoöl. Soc. London, I, p. 127.
[2]Sutton, B. 1887. 'On the arm-gland of the lemurs.' Proc. Zoöl. Soc. London, p. 369.
[3]Frédéric, J. 1905. 'Untersuchungen über die Sinushaare der Affen, nebst Bemerkungen über die Augenbrauen und den Schnurrbart des Menschen.' Zeitschr. f. Morph. u. Anthropol., VIII, p. 239.
[4]Fetus 2 has only 6 lumbar vertebræ.

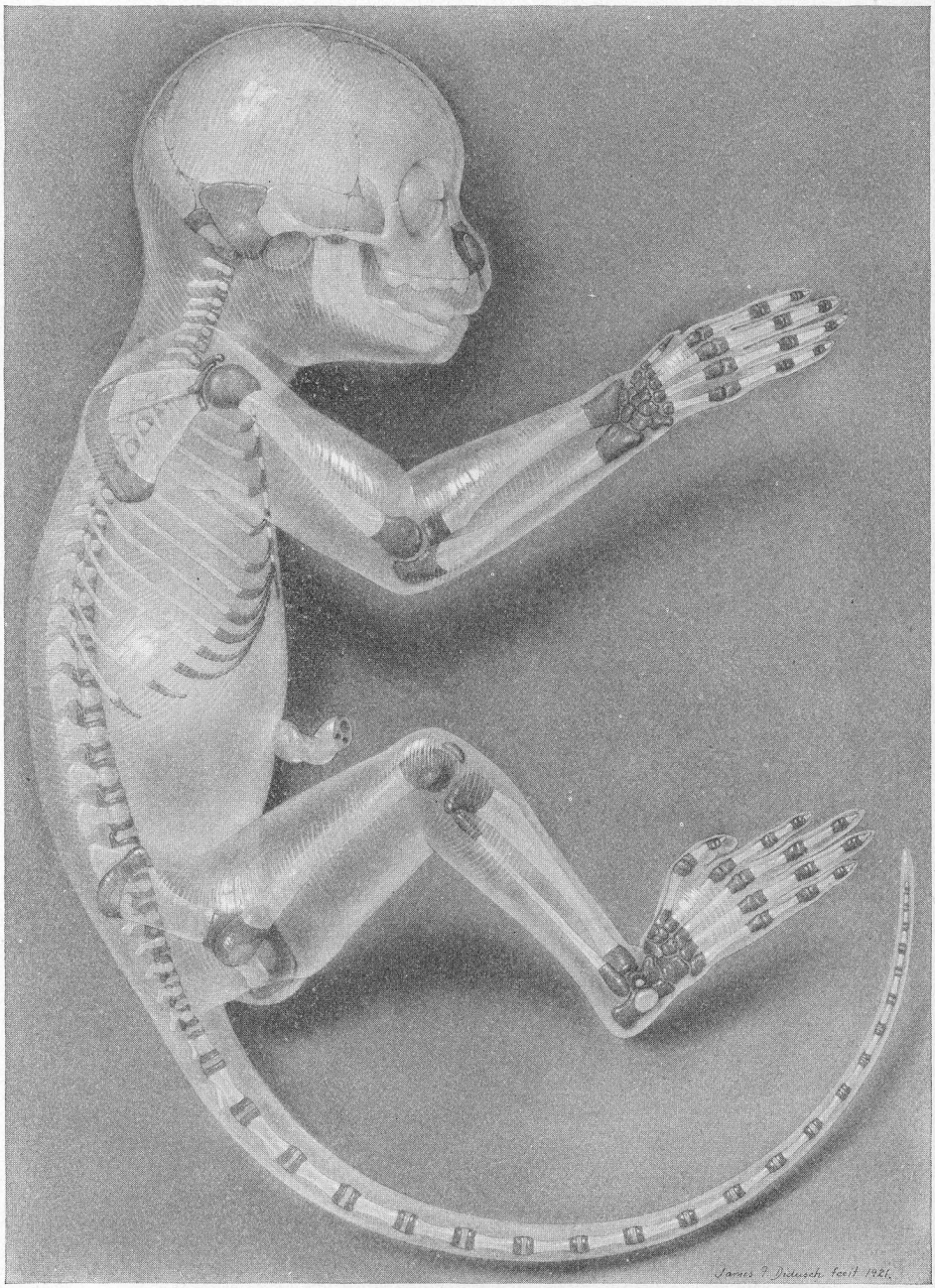
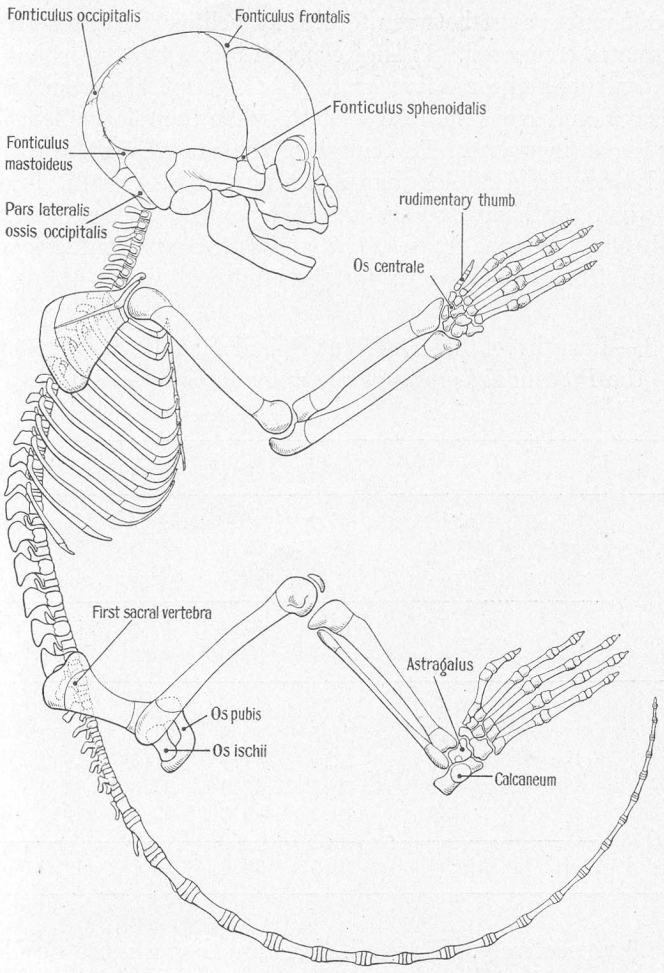


Fig. 5. Side view of cleared fetus 2 (slightly less than nat. size).



(Diagrammatic explanation of Figure 5)

the averages of two to four specimens for each age group. Those for human adults are taken from Martin.[1]

Table 3 shows that the relative length of the cervical region is considerably less, and that of the thoracic region slightly less in *Colobus* than in man. The relative length of the lumbar region is very much greater, and that of the sacral region markedly less in *Colobus* than in man.

[1]Martin, R. 1914. 'Lehrbuch der Anthropologie.' Jena, G. Fischer.

These differences exist between fetuses as well as between adults of the two primates compared. It is of especial interest to note that in both *Colobus* and man the relative length of the cervical region and of the thoracic region decreases during growth, while the relative length of the lumbar region increases. The length of the caudal region of *Colobus* is relatively greater in adults than in fetuses. This is still more clearly shown when the length of the tail is expressed in percentage of the sitting-height. For the fetuses (1, 2, and 3) these percentages are 104.4, 110.4, and 109.5 respectively; for the adults (6 and 7) they are 167.5

Table 3.—Lengths of the Different Spinal Regions in Percentages of the Precaudal Length of the Spine in *Colobus* and Man

			Region of Spine				
			Cervical	Thoracic	Lumbar	Sacral	Caudal
COLOBUS	Fetus	No. 1	15.6	40.0	34.4	10.0	137.8
		2	14.2	39.6	35.8	10.4	136.8
		3	14.4	39.5	34.9	11.2	149.6
	Adult	4	12.7	37.4	40.2	9.7	152.1
		5	12.7	37.6	39.8	9.9	166.0
MAN (white)	Fetus	Weeks					
		14	21.5	40.5	21.1	16.9	....
		18	21.9	41.7	21.5	14.9	....
		22	20.5	41.3	22.3	15.9	....
		39	19.2	40.0	22.8	18.0	....
	Adult		16.0	39.0	25.0	19.0	....

and 158.5 respectively. The tail, therefore, has a more rapid rate of growth than the body.

There are twelve pairs of ribs which are well ossified in all of the fetuses. Their osseous shafts seem to have about the same proportional length, in regard to the costal cartilages, as in the adult stage. The first seven pairs of ribs insert directly on the sternum; the next three pairs insert indirectly; and the last two pairs are floating ribs. In fetus 2 and fetus 3 the sternum shows five ossification centers: a large one for the manubrium and four shorter ones for the corpus. The xyphoid process shows no ossification as yet. The sternum of fetus 1 is still entirely cartilaginous. The shafts of the clavicles are well ossified in all three

fetuses, as are also the blades of the scapulæ; but no centers are found in the acromion, coracoid process or the cartilage of the vertebral margin of the scapula in any of the specimens. In the fetus the scapula is relatively much longer in the direction of the scapular spine and narrower, perpendicular to the latter, than in the adult. The scapular index (distance between center of glenoid fossa and terminus of spinal axis on vertebral margin × 100, divided by distance between superior and inferior angles) amounts to 127 in fetus 1 and to 96 in the adult (average of skeletons 4 and 5). The pelvis, even in the youngest fetus, contains two pairs of ossification centers; one in the ilia and one in the ischia. The pubic bone, even in fetus 3, is still entirely cartilaginous. All the shafts of the long bones of the extremities are ossified, but their epiphyseal ends show no sign of ossification. The tibia has a rather marked proximal retroflexion, a condition which is but little more pronounced in the adult *Colobus*. The carpus in all three fetuses is completely cartilaginous and contains a well-developed free centrale. Among the tarsal cartilages the calcaneum in fetuses 2 and 3 possesses a large, the talus a small ossified zone. Fetus 1 has only an ossification center in the calcaneum. It is in the tarsus that ossification appears to have begun at a slightly earlier stage of development than in the human fetus. The sternum is probably the only other skeletal structure which shows a similar behavior, inasmuch as in man centers for the corpus sterni normally do not appear until the end of fetal life, whereas they are already present in *Colobus* fetuses 2 and 3. Ossification in all the others parts of the body seems to correspond fairly closely to the process in human fetuses of 20 to 24 weeks.

Most of the elements of the skull are already ossified to a considerable extent, evne in fetus 1. In this and fetus 2 only the cranial surface of the petrosum seems to be still entirely cartilaginous. In all three fetuses the lateral occipital bones still have a broad cartilaginous zone at their posterior ends. The orbits are relatively larger and the frontal bones more highly arched in the fetus than in the adult *Colobus*. The anterior fontanelle is fairly large, extending in a long arm halfway between the frontal bones. The posterior and the two pairs of lateral fontanelles (fonticulus mastoideus and sphenoidalis) are small and not quite the same relative size as those of human fetuses of corresponding stages of development.

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New taxonomic names are printed in **heavy-faced type**, also the main reference in a series of references.

Table 2.—Indices of Fetuses and Adults of *Colobus* and of Human Fetuses.

A number in parenthesis refers to the number of the measurement as listed in Table 1.

No.	Index	Formula	*COLOBUS*							HUMAN FETUS		
			Fetus			Skeleton Adult		Body Juvenile	Body Adult	Weeks		
			1	2	3	4	5	6	7	20	23	24
I.	Relative biacromial diameter	$\frac{(5)}{(2)}\times 100$	45.5	49.3	40.0	....	....	38.5	29.8	73.4	67.1	67.1
II.	Relative bitrochanteric diameter	$\frac{(7)}{(2)}\times 100$	40.7	40.8	32.9	....	....	33.0	31.1	57.4	54.8	55.9
III.	Relative circumference of chest	$\frac{(10)}{(2)}\times 100$	144.0	145.0	124.7	....	....	98.7	90.7	227.0	210.6	209.0
IV.	Thoracic index	$\frac{(8)}{(9)}\times 100$	104.3	96.8	103.2	....	....	89.8	90.4	115.8	115.1	113.8
V.	Relative bimammillary diameter	$\frac{(6)}{(8)}\times 100$	52.1	50.0	45.3	....	....	61.3	58.6	60.0	61.1	60.1
VI.	Relative position of nipple	$\frac{(3)}{(2)}\times 100$	85.6	85.9	87.1	....	....	90.8	90.3	73.6	74.8	76.8
VII.	Relative position of umbilicus	$\frac{(4)}{(2)}\times 100$	37.3	33.8	30.6	....	....	.....	.....	17.5	18.2	21.4
VIII.	Relative length of upper extremity	$\frac{(11)+(12)+(13)}{(2)}\times 100$	131.4	140.0	130.3	....	....	119.2	114.6	151.5	139.0	138.1
IX.	Humero-radial index	$\frac{(12)}{(11)}\times 100$	87.0	94.4	91.8	91.2	97.5	97.3	101.6	78.0	77.6	78.1
X.	Forearm-hand index	$\frac{(13)}{(12)}\times 100$	82.4	91.1	92.6	83.6[1]	....	89.4	85.2	77.4	82.6	83.7
XI.	Relative length of thumb	$\frac{(14)}{(13)}\times 100$	44.6	30.5	30.6	36.6	....	40.3	35.9	70.1	70.2	68.7
XII.	Hand index	$\frac{(15)}{(13)}\times 100$	41.4	38.0	35.3	....	....	31.5	29.1	52.3	51.9	52.4
XIII.	Relative length of lower extremity	$\frac{(16)+(18)}{(2)}\times 100$	110.2	116.1	108.5	....	....	110.0	105.0	140.2	131.6	133.0
XIV.	Femoro-tibial index	$\frac{(17)}{(16)}\times 100$	88.8	86.2	85.6	91.4	93.3	92.4	96.1	80.3	82.3	80.9
XV.	Leg-foot index	$\frac{(19)}{(17)}\times 100$	117.0	128.5	123.7	98.8[1]	....	107.3	102.7	83.4	85.0	88.1
XVI.	Foot index	$\frac{(20)}{(19)}\times 100$	29.7	28.3	26.3	....	....	28.2	28.2	42.1	40.7	40.9
XVII.	Intermembral index	$\frac{(11)+(12)+(13)}{(16)+(18)}\times 100$	119.3	120.5	120.1	....	....	108.3	109.2	108.2	105.6	103.8
XVIII.	Femoro-humeral index	$\frac{(11)}{(16)}\times 100$	90.9	85.6	85.6	78.6	78.0	77.5	78.8	90.9	88.4	85.6
XIX.	Tibio-radial index	$\frac{(12)}{(17)}\times 100$	89.1	93.6	91.8	78.4	81.5	81.6	83.5	88.1	86.6	85.4
XX.	Foot-hand index	$\frac{(13)}{(19)}\times 100$	62.7	66.3	68.7	66.3	....	67.9	69.2	81.8	80.9	79.2
XXI.	Relative size of head	$\frac{(26)+(27)+(24)+(28)+(25)}{3\times(1)}\times 100$	88.7	90.6	90.9	....	....	.....	46.8	109.2	103.6	105.0
XXII.	Head-trunk index	$\frac{(21)+(22)+(23)}{3\times(2)}\times 100$	49.7	51.4	47.3	....	....	.....	20.1	78.6	70.5	69.8
XXIII.	Cephalic index	$\frac{(22)}{(21)}\times 100$	84.8	86.4	81.2	....	....	83.1	75.0	84.6	81.6	82.0
XXIV.	Length-height index of head	$\frac{(23)}{(21)}\times 100$	59.7	62.5	57.4	....	....	.....	50.0	75.6	74.3	71.6
XXV.	Sagittal vault index	$\frac{(24)}{(27)}\times 100$	55.6	55.0	59.1	....	....	.....	76.9	44.8	46.5	45.8
XXVI.	Face-trunk index	$\frac{(30)}{(2)}\times 100$	27.1	30.4	26.4	....	....	19.7	16.1	37.6	34.4	34.4
XXVII.	Relative size of upper face	$\frac{(31)\times 3\times 100}{(26)+(27)+(24)+(28)+(25)}$	12.1	13.4	13.0	....	....	.....	18.5	9.5	9.9	9.6
XXVIII.	Vertical cephalo-facial index	$\frac{(30)}{(23)}\times 100$	74.4	78.6	77.3	....	....	.....	120.0	54.8	56.1	58.3
XXIX.	Upper face index	$\frac{(31)}{(32)}\times 100$	44.4	48.7	49.7	....	....	57.2	59.4	36.7	38.4	37.5
XXX.	Relative nasal height	$\frac{(33)}{(31)}\times 100$	91.7	86.0	80.5	....	....	90.6	92.1	69.1	67.3	66.7
XXXI.	Relative nasal breadth	$\frac{(34)}{(32)}\times 100$	24.1	22.4	21.4	....	....	21.4	24.2	23.8	25.5	25.1
XXXII.	Nasal index	$\frac{(34)}{(33)}\times 100$	59.1	53.6	53.6	....	....	41.4	44.3	94.5	98.9	100.7
XXXIII.	Relative interocular breadth	$\frac{(36)}{(32)}\times 100$	25.2	23.6	22.5	....	....	20.2	26.6	29.0	27.1	27.9
XXXIV.	Ear index	$\frac{(39)}{(38)}\times 100$	63.8	68.4	68.4	....	....	67.2	62.9	65.0	63.5	67.4
XXXV.	Relative size of ear	$\frac{(38)\times(39)}{(21)\times(29)}\times 100$	8.1	12.2	10.4	....	....	13.3	13.6	3.4	3.8	4.1

[1]This index, when formed by measurements taken on the body instead of on the skeleton, becomes slightly larger.