

THE PRE-NATAL DEVELOPMENT OF SKIN AND HAIR IN CATTLE*

II. *BOS INDICUS* L. $\times$ *B. TAURUS* L.

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[Manuscript received May 27, 1960]

Summary

A histological study has been made of the development of the skin and hair follicles in 22 crossbred (Brahman $\times$ Hereford or Brahman $\times$ Shorthorn) cattle fetuses, ranging in age from 77 to 263 days, and in three new-born calves.

Skin samples were examined from the head, midside, and back regions of the fetuses, but from the midside region only of the new-born calves.

The initiation of hair follicles begins at about the 78th day of gestation in all regions. It continues to about the 140th day on the head, about the 160th day on the back, and about the 180th day on the midside.

Three follicle types (first-, later-, and last-formed) are recognized. The first-formed follicles develop at about the same rate in the three regions studied, but they are slower than all the later- and last-formed follicles. All follicle types on the head are slightly more advanced than those on the trunk positions.

Up to about the 140th day of gestation the follicle density is greatest on the head. The density of the follicles on the midside resembles that found in *B. taurus*.

No difference in skin thickness between *B. indicus* $\times$ *B. taurus* and *B. taurus* can be detected.

I. INTRODUCTION

In a previous paper (Lyne and Heideman 1959) on the pre-natal development of skin and hair in *Bos taurus* attention was drawn to the need for further pre- and post-natal histological studies of the integument of different breeds of cattle.

It is the aim of this paper to give such an account of the pre-natal development in *B. indicus* $\times$ *B. taurus*, and to make a comparison of some of its features with those of *B. taurus*.

II. MATERIAL AND METHODS

(a) Animals

Details of the animals sampled are shown in Table 1. The dams (Hereford and Shorthorn) were mated with one Brahman (Zebu) bull and were maintained at the National Cattle Breeding Station, Rockhampton, Qld. Although the Brahman breed is derived from Indian breeds with probably some European blood (Mason 1951), the crossbreeds examined in the present study are referred to as *B. indicus* $\times$ *B. taurus*.

The body weights of all specimens sampled were obtained before fixation in formalin.

* For Part I in this series see *Aust. J. Biol. Sci.* **12**: 72.

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(b) Skin Sampling and Histological Methods

Initially, two skin samples were taken from the midside (mid-lateral region of the trunk) of the animals and were fixed in 5 per cent. formol saline. The foetuses were then preserved in 10 per cent. formalin and later some additional samples were taken from the head (midline between the eyes) and the back (posterior mid-dorsal region immediately in front of the tail). Additional samples (referred to as later samples) were also taken from the midside in order to make a comparison of the follicle and hair populations in samples taken at the same time from the different body regions. The samples were taken with 1-cm or, where this was not possible, with 0.5-cm dia. trephines. After paraffin embedding, serial sections were cut at $8\ \mu$ parallel to the skin surface. Some additional rectangular skin samples were cut

TABLE 1
DETAILS OF *B. INDICUS* $\times$ *B. TAURUS* SPECIMENS SAMPLED

Specimen No.	Foetal Age (days)	Sex	Breed	Specimen No.	Foetal Age (days)	Sex	Breed
B50	77	♀	H*	B63	143	♀	S
B48	78	♀	S†	B65	160	♀	S
B49	78	♀	S	B66	160	♀	H
B46	79	♀	H	B67	178	♂	H
B47	84	♂	H	B68	180	♀	S
B52	100	♀	H	B69	198	♂	H
B51	102	♂	H	B70	209	♂	S
B53	102	♂	S	B71	238	♀	H
B58	123	♂	H	B72	263	♀	H
B60	125	♂	S	B74	281 + 4‡	♀	S
B59	126	♂	S	B73	288 (birth)	♂	S
B61	141	♀	H	B75	289 (birth)	?	H
B62	141	♂	H				

* Brahman $\times$ Hereford.

† Brahman $\times$ Shorthorn.

‡ Four days old when sampled.

at 8, 15 or 20, and $40\ \mu$ parallel to the long axes of the follicles. Staining was with haemalum, eosin, and picric acid. Haemalum-stained whole mounts of skin from foetuses up to 102 days of age were also examined.

(c) Skin and Follicle Measurements

(i) *Macroscopic Measurements.*—After fixation the mean skin thickness (excluding the panniculus carnosus) of four samples at each position was estimated from measurements made with an instrument (Wodzicka 1958) which exerted a constant pressure of $50\ \text{g/cm}^2$. Where necessary hair was closely clipped.

To allow comparison with the present material, most of the *B. taurus* skin samples measured by Lyne and Heideman (1959) were remeasured with this instrument. Although all samples had been fixed in 10 per cent. formalin they had been stored in the fixation fluid for different periods ($1\text{--}2\frac{1}{2}$ yr) when the skin thickness measurements were carried out.

TABLE 2
SUMMARY OF STAGES IN THE DEVELOPMENT OF THE DIFFERENT TYPES OF HAIR FOLLICLES IN B. INDICUS X B. TAURUS

Specimen No.	Foetal Age (days)	Stage of Most Advanced First-formed Follicles			Stage of Most Advanced Later-formed Follicles			Stage of Least Advanced Last-formed Follicles			Stage of Least Advanced Follicles		
		Head	Midside	Back	Head	Midside	Back	Head	Midside	Back	Head	Midside	Back
B50	77	?	1a	—	—	—	—	—	—	—	?	1a	—
B48	78	1a	1a	1a	—	—	—	—	—	—	1a	1a	1a
B49	78	1a	1a	—	—	—	—	—	—	—	1a	1a	—
B46	79	1a	1a	1a	—	—	—	—	—	—	1a	1a	1a
B47	84	1a	1a	?	—	—	—	—	—	—	1a	1a	?
B52	100	2a	1b	1b	—	—	—	—	—	—	1a	1a	1a
B51	102	2a	1b	1b	—	—	—	—	—	—	1a	1a	1a
B53	102	2a	1b	1b	—	—	—	—	—	—	1a	1a	1a
B58	123	2a	2a	2a	2a	—	—	—	—	—	1a	1a	1a
B60	125	2a	2a	2a	2a	1b	—	1a	—	—	1a	1a	1a
B59	126	2b	2a	2a	2a	—	—	1a	—	—	1a	1a	1a
B61	141	2b	2a	2b	2a?	1b	2a	1b	—	1a	1b	1a	1a
B62	141	2b	2a	2a	2a	1b	2a	1a	—	1a	1a	1a	1a
B63	143	3a	2b	3a	3a	1b-2a?	2a	2a	1a	1a	2a	1a	1a
B65	160	3a	2b	3a	3a	2a	3a	2a	1a	1b	2a	1a	1b
B66	160	3a	3a	3a	3b	2a	3a	3a	1a	1b	3a	1a	1b
B67	178	3a	3a	3a	3b	2b	3b	3a	1a	2a	2b*	1a	2a
B68	180	4	3b	3b	3a-3b	3a	3b	3a	1a	2a	3a*,†	1a	2a
B69	198	6	4	3b	8-9	3b	6	6	3a	5-6	3b*	3a	3b*
B70	209	6	6	6	8-9	4	8	7	3a	7	4*	3a	4*
B71	238	9	9	9	10c	10c	10c	10b	5	10c	8-9*	5†	9*,†,‡
B72	263	10c	10c	10a	10c	10c	10c	10c	10c	10c	9*	9*	9*
B74	281+4§	?	10c	?	?	10c	?	?	?	?	?	?	?
B73	288	?	10c	?	?	10c	?	?	10c	?	?	9*	?
B75	289	?	10c	?	?	5¶	?	?	10c	?	?	10a*	?

* First-formed follicles. † Later-formed follicles. ‡ Last-formed follicles. § Four days old when sampled. || Birth samples. ¶ Second cycle.

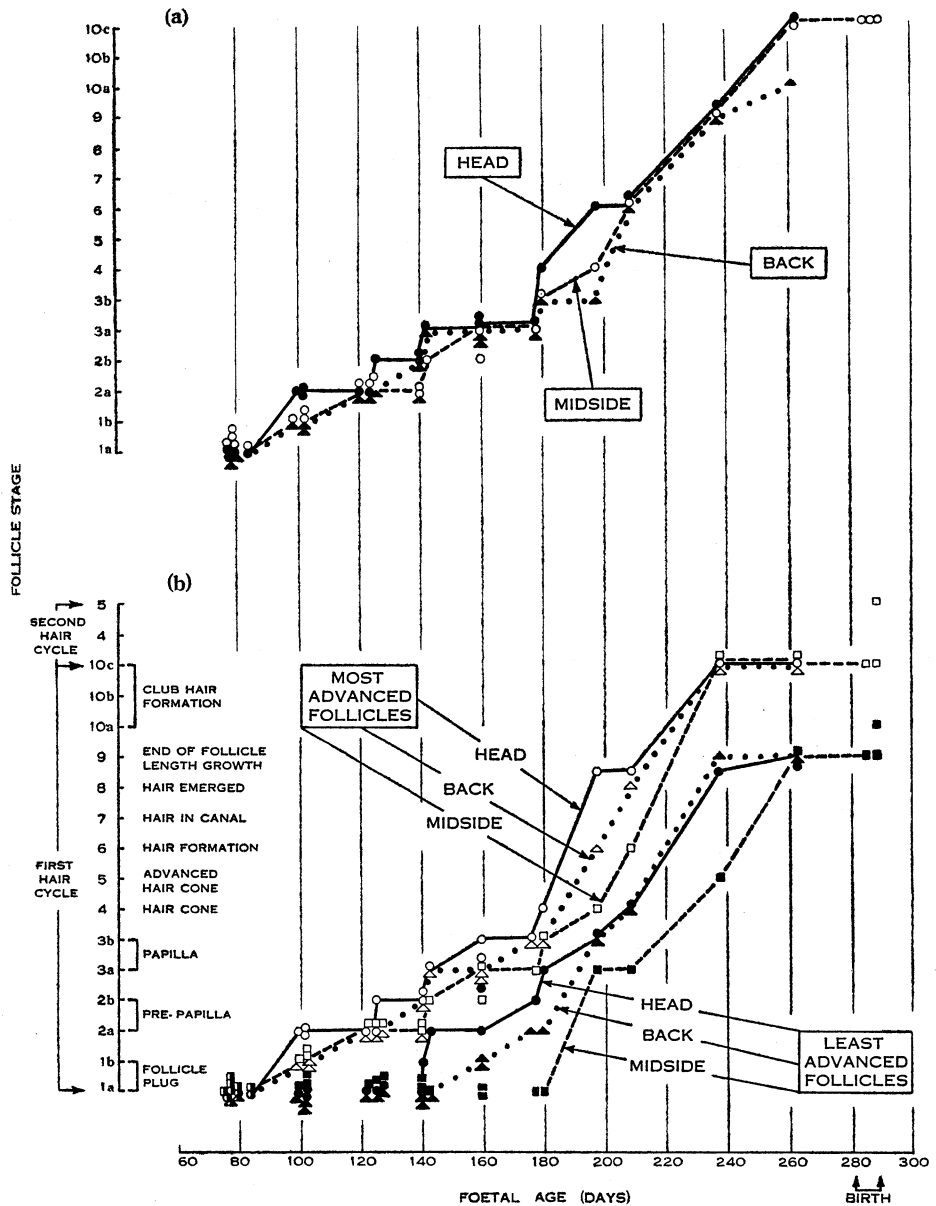


Fig. 1.—(a) Relation between foetal age and stage of development of the most advanced of the first-formed hair follicles on the head, midside, and back in *B. indicus* × *B. taurus*. (b) Relation between foetal age and stage of development of the most advanced and least advanced follicles (irrespective of type) on the head, midside, and back in *B. indicus* × *B. taurus*.

(ii) *Microscopic Measurements*.—Microscopic measurements of the dimensions of the hair follicles and associated structures and counts of the follicle and hair populations were made at a magnification of $\times 215$, as described by Lyne and Heideman (1959).

III. RESULTS

(a) *Development of Individual Follicles*

(i) *Stages of Development*.—The stages of hair follicle development, described for *B. taurus* by Lyne and Heideman (1959), are easily identified in the present material and all follicle types (first-, later-, and last-formed) follow the same developmental pattern. The first-formed follicles are associated with a pair of later-formed follicles situated on either side and at right angles to the ectal-ental axis. The last-formed follicles form groups associated with those formed earlier.

(ii) *Rate of Development*.—The relation between foetal age and stage of development of the different types of follicles is shown in Table 2 and Figures 1 and 2. Figure 1(a) shows the rate of development of the most advanced of the first-formed follicles in the three positions examined. These follicles begin their development at about the same foetal age (the 78th day of gestation) and progress at the same rate throughout the entire first hair cycle, which has been completed by birth. The first-formed follicles on the head are slightly more advanced than those on the two trunk positions, where the rates of development are very similar.

Figure 1(b) illustrates the rate of development of the most advanced and least advanced follicles (irrespective of follicle type) in the three positions. It is evident that the most advanced follicles are usually found on the head. In several of the older foetuses the follicles on the back are slightly ahead of those on the midside.

Considering the least advanced follicles, it is seen that on the head follicle initiation ceases at about the 140th day, on the back at about the 160th day, while on the midside new follicles are being formed until about the 180th day. Up to about the 200th day the rate of development of the least advanced follicles on the back is intermediate between that on the head and midside.

Figure 2(a) shows the relation between foetal age and stage of development of the three types of follicles on the head. The first-formed follicles develop at a slower rate than all the later- and last-formed follicles. The approximate range of developmental stages reached by the first-formed follicles is shown. The last of the last-formed follicles to be initiated develop at the fastest rate but at no stage do they quite overtake the most advanced of the later-formed type. At about the 200th day all the first-formed follicles have been overtaken by both later- and last-formed follicles and these therefore reach the end of the first hair cycle (stage 10c) before the first-formed follicles.

Figure 2(b) shows the similarity in rate of development of the first-formed follicles in *B. taurus* (Lyne and Heideman 1959) and in *B. indicus* $\times$ *B. taurus* as seen on the midside region. The stage-age curves coincide up to about the 180th day. Thereafter, the rate of development up to stages 8–9 is slightly faster in *B. taurus* but there is not sufficient material to establish breed differences. The later- and last-formed follicles develop at closely similar rates in the two breed types.

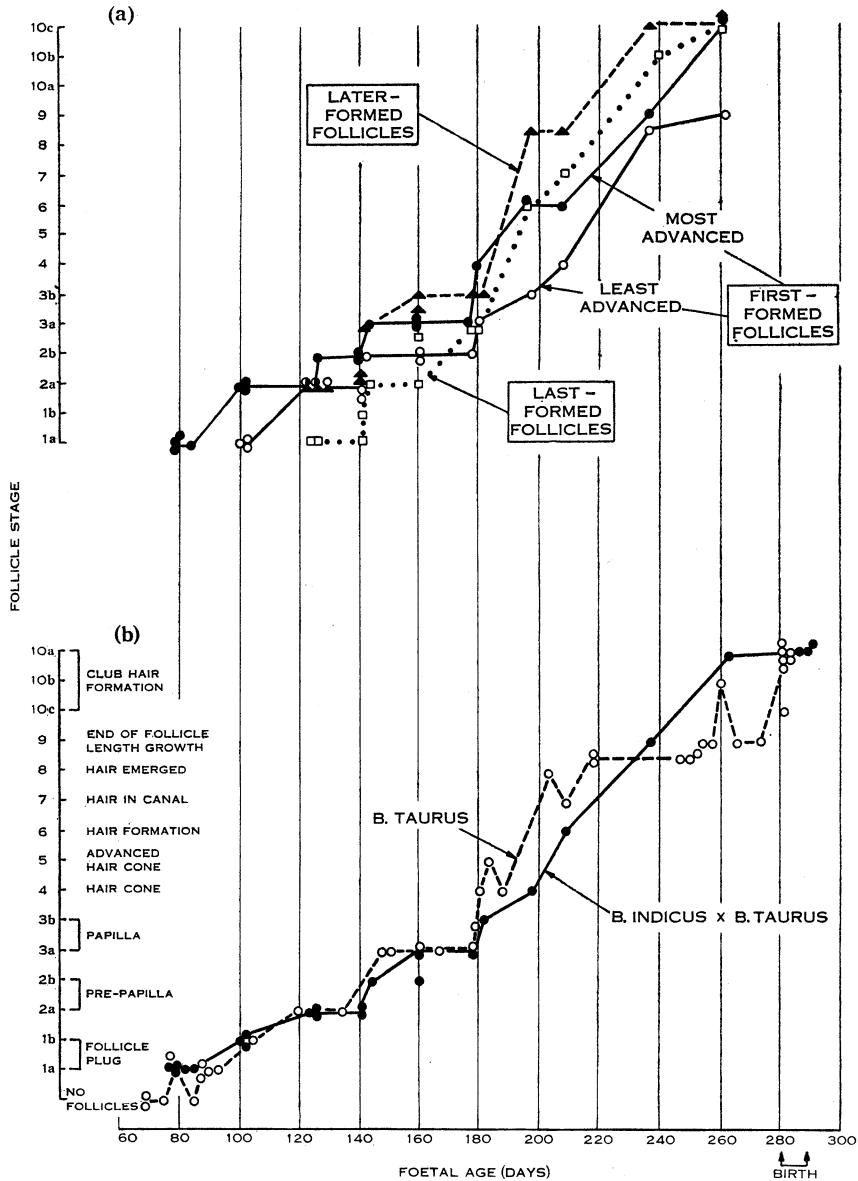


Fig. 2.—(a) Relation between foetal age and stage of development of different types of hair follicles (most advanced of the first- and later-formed follicles; least advanced of the last-formed) on the head in *B. indicus* × *B. taurus*. The approximate stage of development of the least advanced of the first-formed follicles is also shown. (b) Relation between foetal age and stage of development of the most advanced of the first-formed follicles on the midside in *B. indicus* × *B. taurus* and *B. taurus* (Lyne and Heideman 1959).

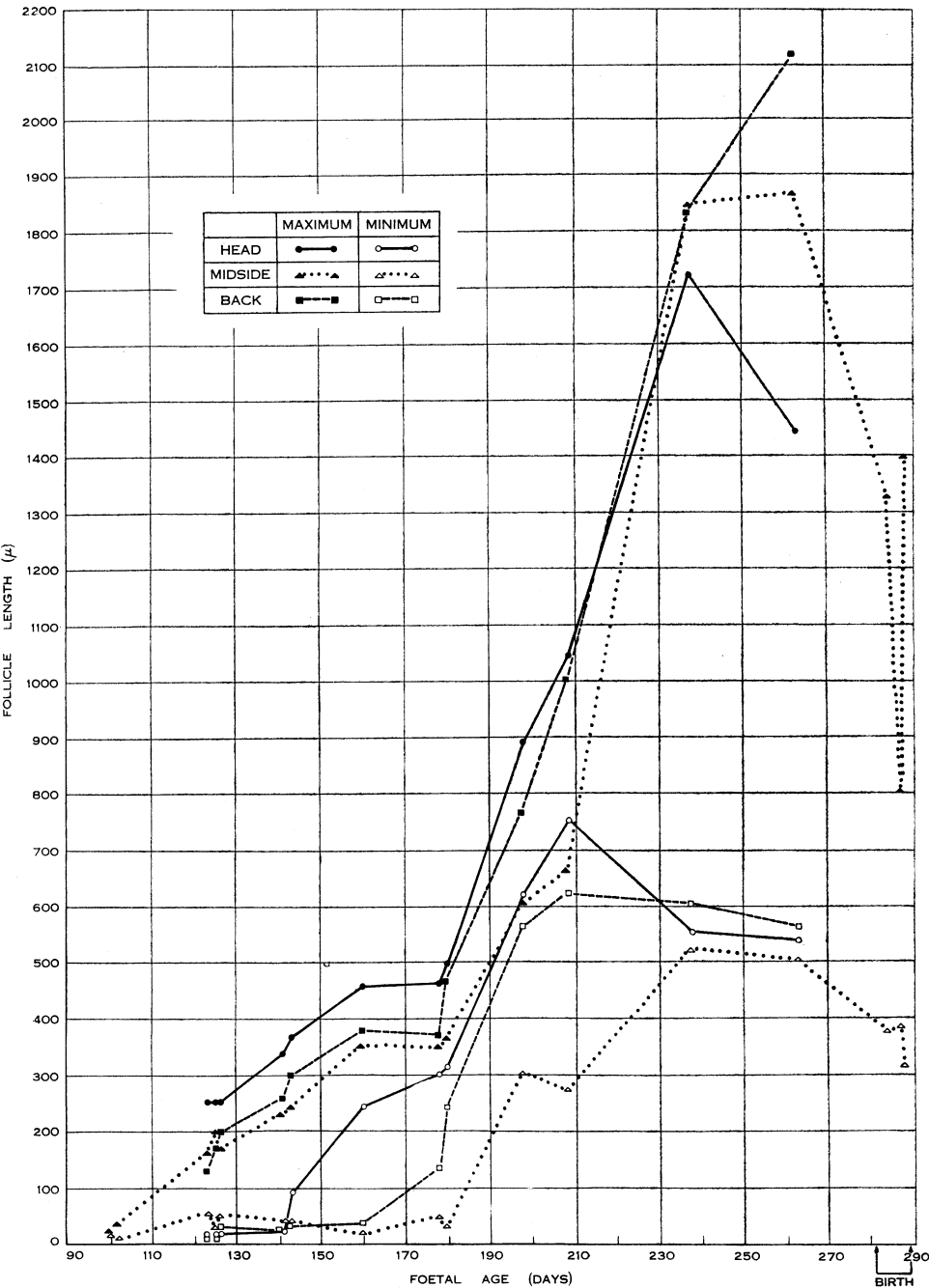


Fig. 3.—Relation between foetal age and maximum and minimum lengths of all follicles measured in *B. indicus* × *B. taurus*. The number of follicles measured is given in Table 3.

Follicle initiation in *B. taurus* ceases at about the 166th day (Lyne and Heideman 1959) whereas in *B. indicus* × *B. taurus* early follicle plugs (stage 1a) are still apparent at the 180th day (Table 2).

(iii) *Relation between Foetal Age and Follicle and Sweat Gland Length.*—The relation between foetal age and the maximum and minimum lengths of all the hair

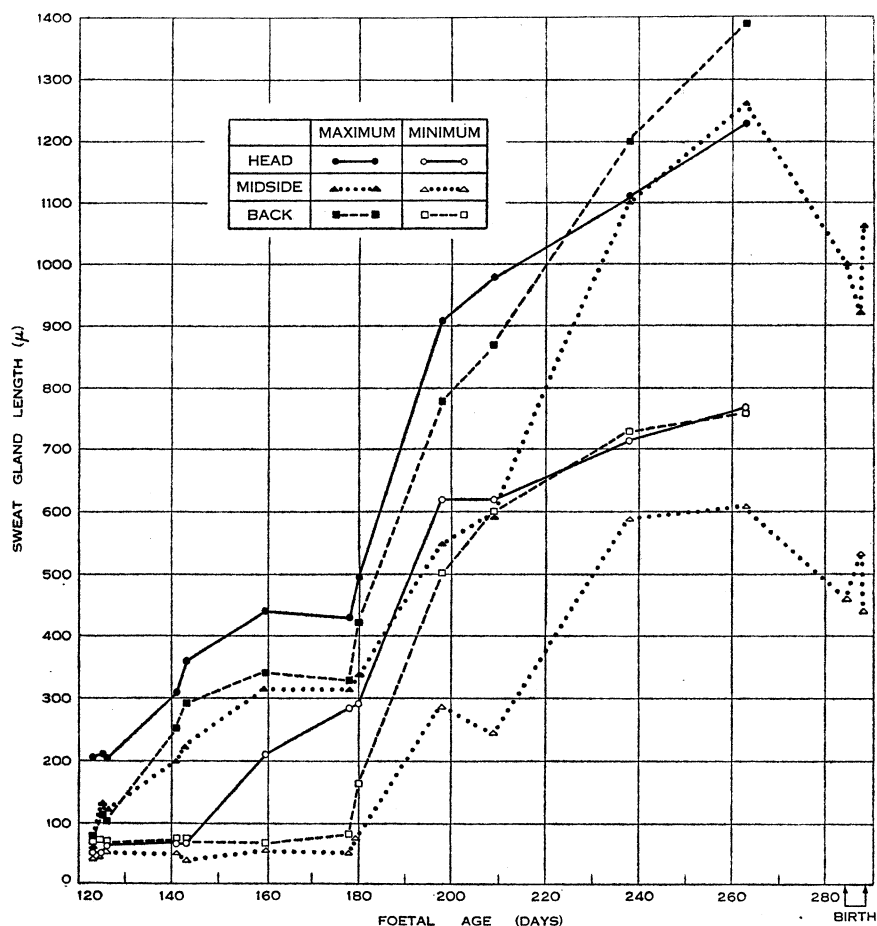


Fig. 4.—Relation between foetal age and maximum and minimum lengths of all sweat glands measured in *B. indicus* × *B. taurus*. The number of sweat glands measured is given in Table 3.

follicles and sweat glands measured is shown in Figures 3 and 4. Mean follicle and sweat gland lengths and the number measured are shown in Table 3.

In general, the follicles are longest on the head and shortest on the midside. The longest (first-formed) follicles reach their maximum length of 1700–2100 μ between the 240th and 260th day. At birth, the maximum length on the midside, the only position examined, is about 1400 μ . This is because many of the longest follicles have reached the end of the first hair cycle, and this is accompanied by a decrease in follicle length.

The maximum sweat gland length (1200–1400 μ) is reached at the 263rd day. At birth, on the midside, the maximum length is about 1000 μ ; sweat glands were not measured on the other regions at birth.

(iv) *Relation between Follicle Stage and Follicle and Sweat Gland Length.*—It is clear (Fig. 5) that on the head and back regions, follicles at stages 3, 4–5, and 6–7 are very similar, while at the same stages, follicles on the midside are much shorter.

TABLE 3
MEAN FOLLICLE AND SWEAT GLAND LENGTHS IN *B. INDICUS* × *B. TAURUS*
Number measured shown in parenthesis

Specimen No.	Foetal Age (days)	Mean Follicle Lengths (μ)			Mean Sweat Gland Lengths (μ)		
		Head	Midside	Back	Head	Midside	Back
B52	100	— —	20 (5)	— —	— —	— —	— —
B51	102	— —	17 (8)	— —	— —	— —	— —
B53	102	— —	27 (6)	— —	— —	— —	— —
B58	123	93 (48)	109 (29)	59 (48)	101 (14)	56 (13)	— —
B60	125	98 (36)	125 (48)	76 (48)	114 (13)	80 (27)	83 (8)
B59	126	112 (48)	121 (17)	107 (44)	114 (19)	67 (13)	77 (10)
B61	141	136 (57)	126 (48)	142 (50)	126 (21)	106 (27)	145 (28)
B62	141	141 (63)	138 (46)	126 (48)	148 (29)	116 (30)	129 (25)
B63	143	212 (47)	134 (50)	149 (51)	193 (36)	143 (26)	154 (32)
B65	160	326 (49)	118 (64)	131 (49)	318 (47)	138 (32)	133 (19)
B66	160	321 (58)	167 (48)	222 (58)	323 (40)	146 (42)	235 (20)
B67	178	354 (50)	144 (48)	234 (54)	352 (34)	135 (33)	180 (46)
B68	180	385 (50)	191 (79)	317 (50)	411 (30)	216 (25)	285 (38)
B69	198	782 (48)	401 (88)	653 (49)	731 (26)	381 (56)	643 (24)
B70	209	888 (79)	382 (94)	865 (57)	782 (60)	353 (61)	716 (38)
B71	238	963 (61)	879 (79)	889 (61)	880 (41)	725 (31)	859 (35)
B72	263	695 (25)	820 (79)	873 (63)	918 (14)	810 (61)	958 (29)
B74	281 + 4*	— —	594 (105)	— —	— —	677 (58)	— —
B73	288	— —	541 (92)	— —	— —	718 (56)	— —
	(birth)						
B75	289	— —	559 (88)	— —	— —	737 (53)	— —
	(birth)						

* Four days old when sampled.

As in *B. taurus* (Lyne and Heideman 1959) the end of the active growth of the hair (stage 10a) and the formation of a keratinized club hair (stage 10c) is marked by a decrease in follicle length. Up to stages 6–7 sweat glands (Fig. 5) are longest on the head and shortest on the midside.

(v) *Relation between Sweat Gland Length and Follicle Length.*—Figure 6 shows the relation between sweat gland length and follicle length (up to stage 9) in the three regions examined. The sweat glands are appendages of the follicles and start growing a little later. In their early stages of development the sweat glands grow faster than their follicles, especially on the head, so that sweat gland length soon equals follicle

length. Later the growth of the sweat glands lags behind the growth of the follicles so that almost all sweat glands end up being shorter than their associated follicles. This does not entirely hold for the head where some of the sweat glands keep growing at a faster rate for a longer period than those of the other follicles. Most of these sweat glands belong to follicles of the first-formed type.

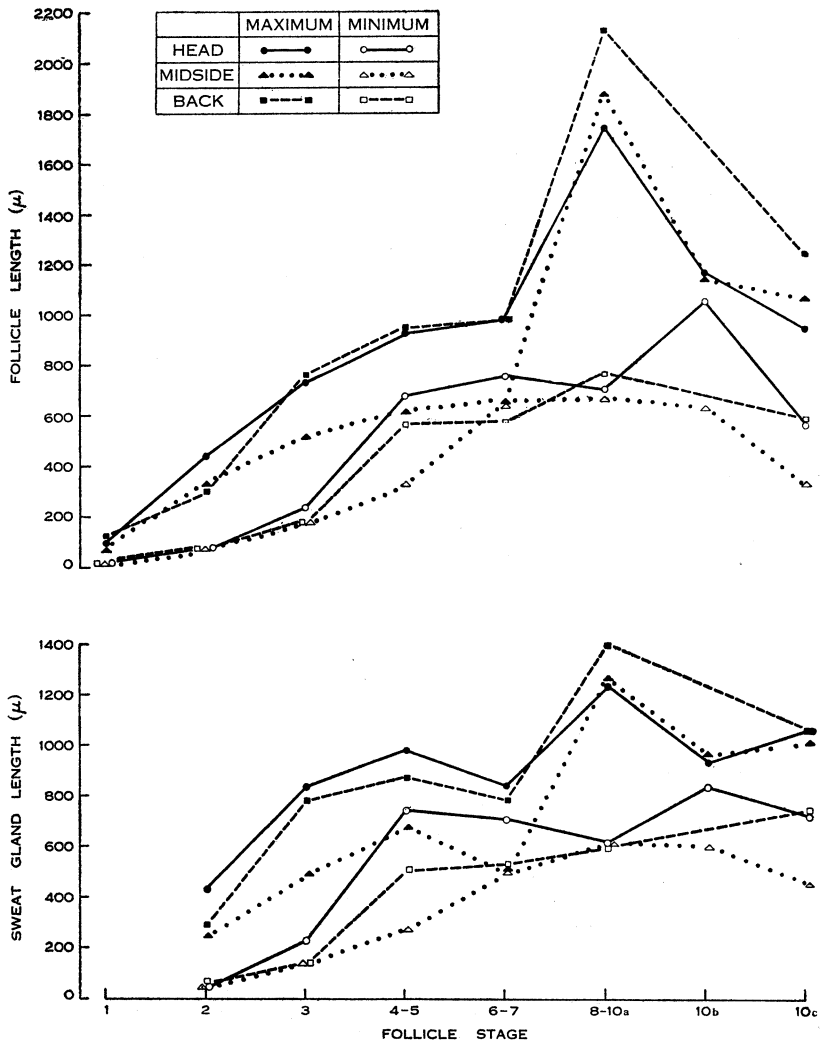


Fig. 5.—Relation between follicle stage, maximum and minimum follicle length, and sweat gland length in *B. indicus* × *B. taurus*.

(b) *Development of the Follicle and Hair Population*

(i) *Follicle Density*.—Observations on the density of the follicle and hair population are summarized in Table 4 and illustrated in Figure 7. Up to the 141st day of gestation the follicle density is greatest on the head; during this period there

is little difference in density between the two trunk positions. Follicle density on the head rises relatively sharply to a peak (about 194 per mm^2) at the 141st day, but thereafter falls slowly throughout the rest of the period studied. In the oldest foetus (263 days) the total number of follicles on the head is of the order of 42 per mm^2 .

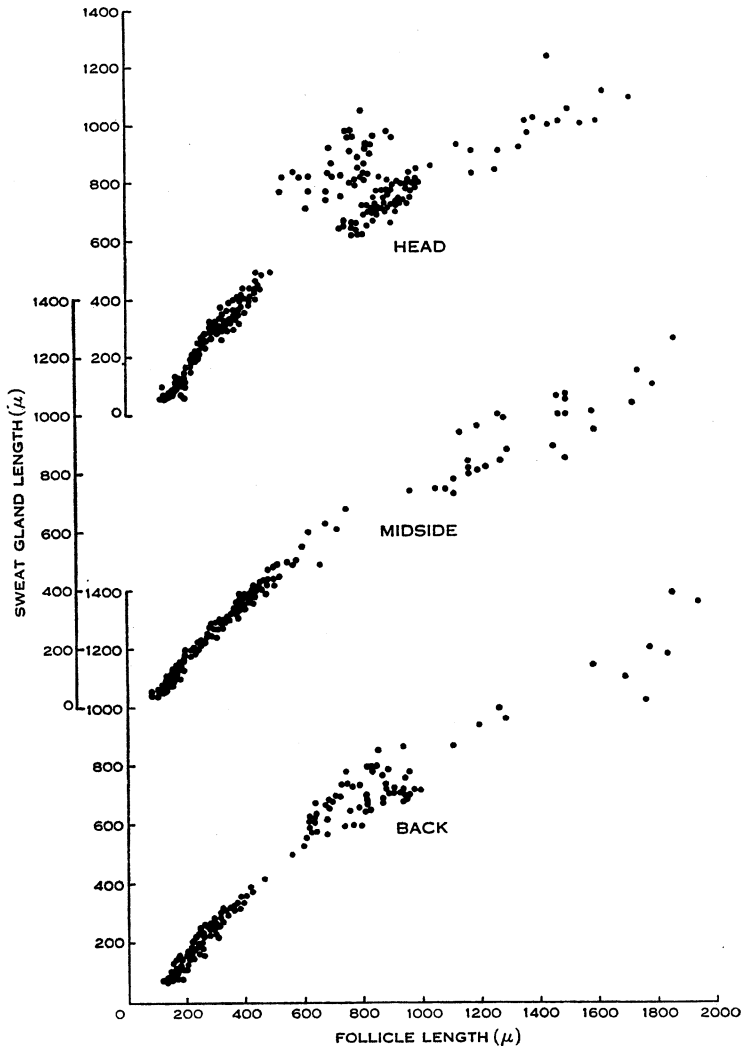


Fig. 6.—Relation between sweat gland length and individual follicle length in *B. indicus* $\times$ *B. taurus*. Many of the points are too numerous to be shown separately.

On the midside (later samples shown in Table 4) the follicle density reaches a peak of about 355 per mm^2 at about the 180th day, and then falls, rapidly at first and later more slowly, to approximately 120 per mm^2 at the 263rd day.

Because the maximum observed follicle density on the back occurs in a specimen (B67) in which the least advanced follicles are at stage 2a, the peak density in this region must occur earlier; i.e. approximately 160 days. From about 160–263 days the density on the back is approximately intermediate between the head and the midside.

Since the peak of follicle density must occur at or before the end of follicle initiation (i.e. 141 days on the head region; 160–180 days on the trunk positions), after this time the follicle density must be inversely proportional to the increase in surface area. The approximate change in skin area deduced from foetal body weight raised to the power of 0.67 is plotted in Figure 7.

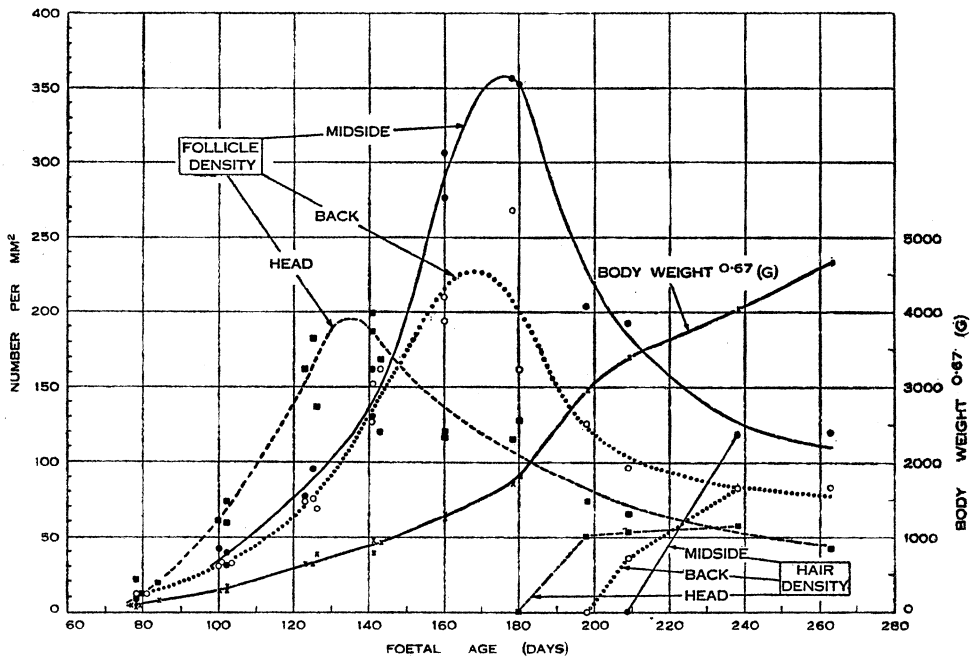


Fig. 7.—Relation between foetal age and follicle and hair density (later skin samples only included) on the head, midside, and back in *B. indicus* × *B. taurus*. The curves through the follicle density points have been drawn by freehand. The index of skin area is given by body weight raised to the power 0.67 (g).

Table 4 shows that from 160 to 263 days on the midside the number of follicles per mm² in the initial samples is markedly less than in the later samples. This difference is possibly due to shrinkage of the skin in this region when the foetus is fixed entire. No difference can be detected between the follicle densities of the initial midside samples of the crossbred material and those of similar samples of *B. taurus* (Lyne and Heideman 1959). Later samples from the *B. taurus* material have not been examined.

(ii) *Hair Density*.—In *B. indicus* × *B. taurus* hairs were first seen on the head at 198 days; on the trunk, follicles on the back contained keratinized hairs before

TABLE 4
SUMMARY OF OBSERVATIONS ON THE FOLLICLE AND HAIR POPULATION IN B. INDICUS X B. TAURUS
Number of fields counted shown in parenthesis. Area of field = 1 mm²

Specimen No.	Foetal Age (days)	No. of Follicles per Field				No. of Hairs per Field			
		Head	Midside		Back	Head	Midside		Back
			Initial Samples	Later Samples			Initial Samples	Later Samples	
B50	77	?	?	} No samples taken	—	—	—	—	—
B48	78	10.2 (1)	?		11.0 (1)	—	—	—	—
B49	78	22.4 (2)	?		—	—	—	—	—
B46	79	11.2 (1)	?		11.5 (2)	—	—	—	—
B47	84	19.2 (1)	?	13.1 (3)	?	—	—	—	—
B52	100	61.2 (6)	35.5 (3)	42.1 (6)	30.8 (6)	—	—	—	—
B51	102	74.0 (6)	42.2 (6)	39.6 (6)	31.8 (3)	—	—	—	—
B53	102	59.6 (5)	36.6 (6)	31.2 (5)	31.8 (6)	—	—	—	—
B58	123	161.9 (6)	99.0 (6)	77.1 (6)	74.6 (6)	—	—	—	—
B60	125	182.8 (6)	80.0 (6)	95.3 (6)	75.6 (6)	—	—	—	—
B59	126	136.4 (6)	64.6 (6)	?	69.3 (6)	—	—	—	—
B61	141	187.4 (6)	122.6 (4)	161.6 (6)	152.2 (6)	—	—	—	—
B62	141	200.0 (6)	150.9 (5)	130.3 (2)	126.6 (6)	—	—	—	—
B63	143	168.4 (6)	149.3 (6)	119.8 (6)	161.6 (6)	—	—	—	—
B65	160	119.7 (12)	209.4 (6)	276.6 (6)	194.2 (12)	—	—	—	—
B66	160	117.0 (12)	171.9 (6)	306.8 (6)	210.1 (12)	—	—	—	—
B67	178	115.0 (12)	216.3 (6)	356.0 (10)	269.3 (18)	—	—	—	—
B68	180	126.8 (12)	267.8 (6)	354.9 (10)	162.2 (18)	—	—	—	—
B69	198	74.3 (12)	131.9 (6)	203.2 (6)	124.9 (12)	51.3 (12)	—	—	—
B70	209	64.8 (6)	130.4 (6)	191.9 (6)	96.3 (6)	53.5 (6)	?	—	36.0 (6)
B71	238	57.3 (6)	102.5 (6)	117.4 (6)	81.6 (6)	57.3 (6)	?	114.7 (6)	81.3 (6)
B72	263	41.7 (6)	70.6 (6)	118.7 (6)	83.2 (6)	41.2 (6)	70.4 (6)	117.3 (6)	81.8 (6)
B74	281 + 4*	?	68.2 (6)	?	?	?	67.3 (6)	?	?
B73	288 (birth)	?	88.9 (6)	?	?	?	85.0 (6)	?	?
B75	289 (birth)	?	73.3 (6)	?	?	?	71.3 (6)	?	?

* Four days old when sampled.

those on the midside. By 238 days all follicles on the head and back, and nearly all on the midside, had grown keratinized hairs.

(e) *Skin Thickness in B. indicus* $\times$ *B. taurus* and *B. taurus*

Macroscopic measurements of the thickness of skin samples from *B. indicus* $\times$ *B. taurus* and *B. taurus* clearly show that the total skin thickness increases from about the 80th day, when hair follicle initiation begins to birth (Fig. 8). In both *B. taurus* and the crossbreds the skin on the head is distinctly thicker than that on

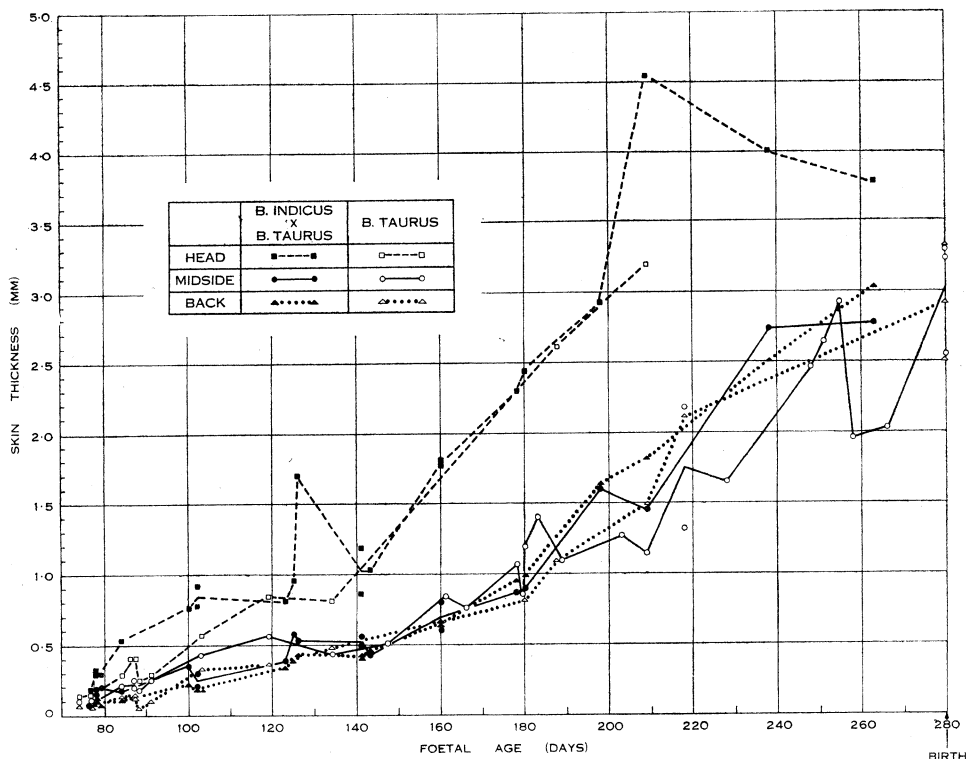


Fig. 8.—Relation between the foetal age and skin thickness on the head, midside, and back in *B. indicus* $\times$ *B. taurus* and *B. taurus*.

the two trunk positions. No difference can be detected between the midside and back. Because of the limited amount of material available none of the variations between individual animals can be attributed to difference between breeds.

IV. DISCUSSION

The slower rate of development of the first-formed follicles compared with the later- and last-formed follicles in the three positions (Table 2) was also found on the midside of *B. taurus* (Lyne and Heideman 1959). In other mammals—for example, in the bandicoot *Perameles nasuta* (Lyne 1957)—the rate of development of the first-formed follicles is also much slower than it is for the last-formed follicles,

excluding the follicles which develop by branching. In the brush-tailed possum *Trichosurus vulpecula* (Lyne, unpublished observations), however, the rate of development of the first-initiated follicles is much greater than it is for follicles formed later. Also, it is of interest to note that in the bovine and bandicoot, the first-formed follicles, which always develop relatively slowly, are the largest while the last-formed follicles are much smaller and develop at a faster rate. By contrast, in *Trichosurus*, the first-formed follicles are very small—so small in fact, that their hairs, about 0.5 mm in total length, project only 0.25 mm above the epidermis, and they develop very rapidly. From this evidence it is concluded that the rate of follicle development, at least in these species, is closely related to mature size of the follicle.

To our knowledge, very little has been published on the rate of development of the different types of follicles in other species. In the Merino sheep there is no marked difference in the mature size of the different follicle types but some of the smallest follicles (derived secondaries) appear to develop at the fastest rate (Hardy and Lyne 1956). The slower rate of development of large pelage follicles compared with small ones is possibly a general mammalian feature. Vibrissal follicles, however, appear to develop more rapidly than pelage follicles. In the mouse (Davidson and Hardy 1952) the vibrissal follicles, which are larger and stouter than those of the pelage, develop from stage 1 to stage 8 in approximately 6 days compared with 9 days for the most advanced pelage follicles. In addition to being larger, all vibrissal follicles possess blood sinuses and abundant nerve endings which distinguish them from pelage hair follicles.

The rate of development of the most advanced first-formed follicles in *B. indicus* $\times$ *B. taurus* is very similar on the head and trunk positions despite differences in follicle density.

Comparison of Figures 1(b) and 7 shows that the cessation of follicle initiation and the peaks of follicle density are approximately contemporaneous, and on the head region this occurs 40 days earlier (140 days gestation) than on the midside. The greater density of the follicles on the midside region after 150 days is probably due to the formation of larger follicle groups; the midside maintains a higher density than the other regions, at least up to birth.

In the midside region, the rate of development of the different follicle types in the crossbreds is practically identical with that found in *B. taurus* (Lyne and Heideman 1959). Although the follicle densities are similar in foetuses of the two breed types they are distinctly different in the adult animal. For example, in various European breeds (*B. taurus*) the follicle densities in mature animals in good condition range from 733 to 1111 per cm² (Carter and Dowling 1954; Dowling 1955; Nay and Hayman 1956). In contrast, the mean number of follicles per cm² is 1321 in mature Zebu crossbreds (*B. indicus* $\times$ *B. taurus*) (Dowling 1955), and 1507–1698 in mature Zebus (*B. indicus*) (Dowling 1955; Nay and Hayman 1956). Dowling found highly significant differences in hair follicle population between *B. indicus* and *B. taurus* species of cattle after allowing for the regression of follicle density on heart girth. Further studies are needed in order to determine why the follicle density declines to the lowest level in *B. taurus*.

The studies reported in this paper, and in a previous paper (Lyne and Heideman 1959), are necessary as an initial step to further qualitative and quantitative investigations of the integument of different breeds of cattle.

V. ACKNOWLEDGMENTS

The authors are particularly indebted to Mr. J. F. Kennedy, Officer-in-Charge, National Cattle Breeding Station, "Belmont", Rockhampton, Qld., for all the material of *B. indicus* × *B. taurus*. Also, we wish to thank Mr. W. H. Clarke and Mr. E. W. Taylor for technical assistance and Mr. M. R. F. Blair for preparing the figures for publication.

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