

By comparison of the respective life-cycles and the ages of sexual maturity, it is estimated that in the sheep brain weight is likely to have reached its maximum at the age of $2\frac{1}{2}$ years. Therefore, in sheep older than 3 years, but not yet "aged," brain weight should not be affected by small differences in age. Further, it has been shown in the rat that the coefficient of variability of the brain is considerably lower than that of most organs or of the body as a whole, (Jackson, 1913.) It is evident that from day to day the brain weight of an individual is not likely to change in the same proportion as the body weight which, especially in the ruminant (Bartlett, 1926 a), is subject to large daily variations. Kappers (1936) states that in the human being body weight and brain weight are correlated. It is felt that these facts go far to justify the use of brain weight as an index of body size.

In table 1 are given the mean brain weights of the ewes when placed in monthly groups according to the stages of pregnancy reached at the time of slaughter.

When tested by Fischer's (1936) "Analysis of Variance" method these figures show no significant differences.

TABLE 1. BRAIN WEIGHTS OF EWES.

<u>Groups of Ewes.</u>	<u>No. of</u>	<u>Mean</u>
<u>No. : Class.</u>	<u>Ewes.</u>	<u>Brain Weight.</u>
1. : Non-preg. :	11. :	107.73.
2. : 1st Month :	12. :	104.42.
3. : 2nd " :	8. :	103.25.
4. : 3rd " :	6. :	106.17.
5. : 4th " :	7. :	107.43.
6. : 5th " :	5. :	104.60.

Weights in Grams.

In table 2 the conception ages of the same groups of ewes are treated in a similar manner. Again the differences are insignificant. From these tests it is concluded that, although the ewes did show variations both as regards size and age, the effect of the random selection was such as to spread the differences evenly throughout the six groups, there being no "prejudice" in favour of any particular group.

TABLE 2. AGES OF EWES.

<u>Groups of Ewes.</u>	<u>No. of</u>	<u>Mean age</u>
<u>No. : Class.</u>	<u>Ewes.</u>	<u>of Group.</u>
1. : Non-preg.	11.	3.72.
2. : 1st Month	12.	3.75.
3. : 2nd "	8.	3.60.
4. : 3rd "	6.	3.67.
5. : 4th "	7.	3.63.
6. : 5th "	5.	3.77.

Age in Years.

All details regarding dates and times of service and of slaughter are to be found in tabular form in Appendix A.

(b) PROCEDURE.

1. COLLECTION OF DATA.

Immediately before slaughter the ewe was weighed and a clinical examination was made. Age was determined according to the teeth, while the degree of development of the mammary^e and of enlargement of the abdomen were determined both by visual inspection and by palpation. Then the animal was placed on its left side and was held firmly while its throat was cut and the spinal cord severed.

Immediately after death the mammary gland was removed: the skin was incised transversely in the region of the umbilicus and the gland was loosened from the abdominal wall; at its caudal border the mammary vessels were examined before being cut through. When the organ, together with its lymph glands, had been freed, the incision through the skin was continued along the circumference of the base. The gland, removed with its covering skin, was laid flat on its base, and left in a cool place until its adipose tissue had set. X

X
In some instances it was necessary (for the purposes of a different investigation) to inject into the lactiferous sinus a solution of gellatine coloured with Giemsa. The injection was carried out immediately after removal of the gland. The quantity of fluid injected, as well as its specific gravity, was noted.

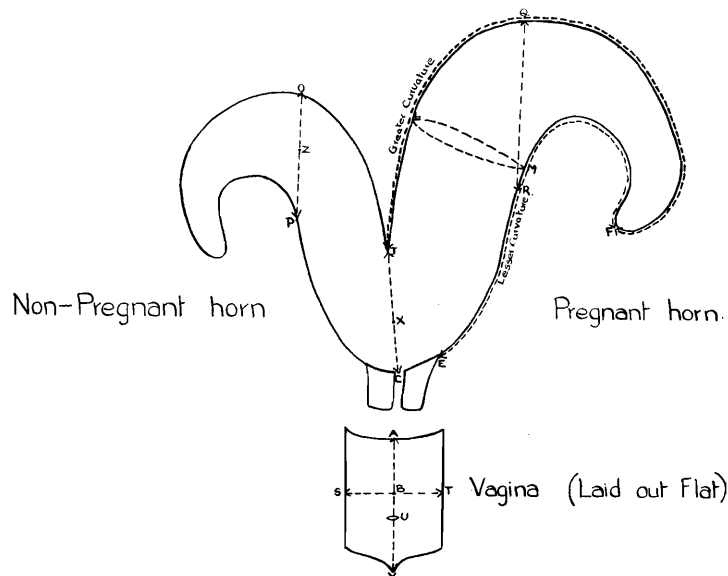


PLATE 1. OUTLINES OF GRAVID UTERUS
SHOWING HOW MEASUREMENTS
ARE MADE.

LETTERING.

- A. - middle of anterior edge of vagina;
- B - middle of length of vagina;
- C - internal uterine os;
- E - junction of horn, body & cervix;
- F - Fallopian end of uterine horn;
- J - junction of greater curvatures;
- L & M - points on greatest circumference of horn;
- O, P, Q & R - mid-points of curvatures;
- X, Y & Z - mid-points of C - J, Q + R & O - P;
- S - T is a straight line at right angles to A - V;
- U - external opening of urethra;
- V - ventral commissure of vulva.

MEASUREMENTS.

- Greater curvature - J to F.
- Lesser curvature - E " F.
- Circumference - through L & M.
- Length of body - J to O.
- Thickness of wall of body - at X.
- " " " " pregnant horn - at Y.
- " " " " non-preg. " - at Z.
- Length of Vagina - A to V.
- Width of " - S to T.
- Thickness of Vagina wall - at B.

Each Fallopian tube, having been freed from its mesosalpinx, was weighed. The length was measured and at the middle of this the diameter was taken.

The ovaries were cleaned and were measured as follows : Length (in a cranio-caudal direction,) width [from side to side] and depth (in the sagittal plane.) In each case the maximum measurement was recorded. The presence and appearance of Graafian follicles and corpora lutea were noted and then each ovary was weighed.

Attention was now transferred to the gravid uterus. The broad ligaments were severed in such a way as to allow of the organ being laid out as illustrated in outline in plate 1. Using a piece of twine, the lengths of the greater and the lesser curvatures and the circumferences of the horns were measured. (See plate 1.)

Starting from the tip of each horn, and using small blunt-nosed scissors to avoid injury to the underlying sacs, the uterine wall was incised along the greater curvatures. Any strain on the membranes due to their cotyledonary attachments was relieved by cutting through the peduncles of the maternal cotyledons. In this way the uterus was opened completely, leaving the entire foetal system exposed.

At this juncture the situation and the posture of the foetus (visible through the membranes) were noted, as were details of the appearance of the allanto-chorion, the placenta and the uterine mucosa.

After collecting ^X some allantoic fluid for chemical analysis, the allanto-chorion was slit open and the fluid was allowed to escape. Then the loss of weight was determined, and from this and the specific gravity (determined in connection with the chemical investigation) the volume of allantoic fluid was calculated. This was repeated with the amniotic fluid.

After a double ligature had been applied at its foetal extremity, the umbilical cord was severed and the foetus removed. After the

^X
In order to obtain fluid free from any contamination or admixture, it was withdrawn through a hypodermic needle inserted into the sac.

adherent mucus and amniotic fluid had been rubbed off its coat the foetus was weighed. Then it was placed on its right side, with its neck and back in the same straight line and with the long axis of the head at right angles to this line.¹ Both the straight and the curved crown-rump lengths were measured (as shown in plate 2.) After this the foetus was placed in a flat-bottomed dish in the posture described above, and was covered with fixing fluid. For foetuses under the age of 45 days Professor Dart's solution² was used, while for all others the fluid employed was a 5 per cent. solution of neutralized formalin. Foetuses were allowed to remain in ~~their~~^{this} fluid for a few weeks.

By replacement of the foetal membranes upon the uterine wall, the detached cotyledons were returned to their original situations. By severing their placental attachments flush with the surfaces of the maternal cotyledons, the membranes were removed and weighed and their volume was determined by the displacement method. It will be noticed that the umbilical cord was included with the foetal envelopes.

After the weight of the empty uterus (i.e. the weight of the uterine wall plus that of the placenta) had been determined, the number of cotyledons in each half of the uterus was counted. For this purpose the line C - J (plate 1) was taken as the division between the two halves.

1.

In very young foetuses this was made impossible by the curvature of the body and neck. In these cases the maximum straight measurement was recorded as the straight crown-rump length.

2.

Neutralised formalin	300 ccm.
Sodium chloride	75 gm.
Tap water	9700 ccm.

The neutralised formalin is prepared from commercial formaldehyde (40% strength), to 1000 ccm. of which is added 2 ccm. of a N 10 solution of caustic potash. The precipitate is filtered off through pulp.

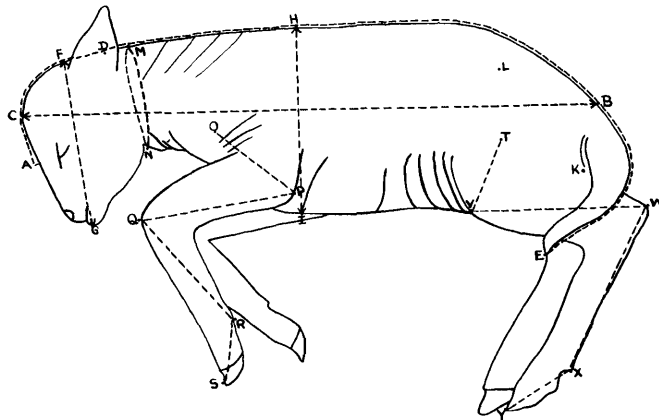


PLATE 2. OUTLINE OF FOETUS SHOWING DIMENSIONS MEASURED.

LETTERING.

- A - mid-point of line joining medial canthi;
- B - root of tail;
- C - frontal prominence;
- D - point of intersection of eye - ear & back lines;
- E - tip of tail;
- F - highest point of occipital region;
- G - chin;
- H & I - Vertical line just at caudal edge of triceps;
- K - Ischial tuberosity;
- O - point of shoulder;
- P - Olecranon process of ulna;
- Q - centre of carpal region;
- R & X - proximal sesamoids;
- T - hip joint;
- V - Patella;
- W - point of hock;
- S & Y - distal extremity of third phalanx.

MEASUREMENTS.

Straight crown-rump length	-	O to B.
Curved " " "	-	A to B.
Back-line length	-	D to B.
Vertebral column length	-	D to E.
Length of tail	-	B to E.
" " head	-	F to G.
Heart-girth (circumference)	-	through I & H.
Length of trunk	-	O to K.
" " forelimb	-	O - P + P - Q + Q - R + R - S.
" " hindlimb	-	T - V + V - W + W - X + X - Y.
" " neck	-	D to B less O to K.

N.B. These purely convenient, descriptive terms must not be interpreted according to strict anatomical terminology. The aim is to study growth of regions, not definite anatomical units.

The minute, very pale and non-functional cotyledons present in the tips of the cornua were not counted. In each horn the maximum diameter and height, both of the largest and of an average-sized cotyledon, were measured. In subjects pregnant for 59 days or more the cotyledons were removed from the uterine wall by cutting the mucosal peduncles, and their weight and volume ^X were determined. Then the uterine wall was weighed, after which it was again stretched out and the cervix was opened by a longitudinal incision. The procedure for determining the length, width and thickness of the cervix was similar to that described for the vagina. Notes were made of the amount and nature of the mucus contained in the cervical canal, while the appearance of the cut surface was also recorded. The length and thickness of the body, and the thickness of the wall of each of the horns of the uterus were measured. All the points for measurement are indicated in plate 1.

By this time the adipose tissue in the mammary gland had set. In removing the covering skin those portions enclosing the teats were left in position. The weight of the gland was determined and, where necessary, this was corrected for the weight of injection fluid present in the lactiferous sinus.

Later, as time permitted, the preserved foetuses were studied. The crown-rump lengths were re-measured to determine whether shrinkage had occurred. In no instance was any appreciable difference observed. The dimensions listed and illustrated in plate 2 were measured. Then the external appearance of the foetus was studied, special attention being devoted to the appearance of hair and the development of the appendages.

2. TREATMENT OF THE DATA.

A glance at the tables in the appendix will indicate the variability of most of the data relating to the genitalia, the fluids and the endocrines. In order to minimize this and to arrive at simpler indications of the growth processes involved, the data were grouped into six monthly groups according to the stage of pregnancy, (the

X

By the displacement method.

non-pregnant ewes being considered to be 0 months pregnant.) The means for the groups were calculated, and these were then tested by Fischer's (1936) "Analysis of Variance" method, the Z-test being employed to determine the existence of significant differences, while the significantly differing groups were picked out by means of the t-test.

Here it must be noted that, due to the continuous nature of growth, the differences within groups are not purely of an experimental nature, hence the accuracy of the tests is impaired. However, as the effect of the error is to obscure significance (by increasing "SD for a single observation") the results in the present work will not suffer adversely.

As standards for significance were taken the values of Z and t when $P = .05$ (i.e. 5% probability) and when $P = .01$ (i.e. 1% probability.) A positive result at the former level (which already indicates definite significance) is indicated by \times , while a similar result at the higher level of significance is indicated by $\times\times$. Where the figure is significantly greater than the one against which it is tested, the result is indicated thus $>\times$, and where it is smaller the sign is reversed i.e. $<\times$.

The complete data are given in a series of tables in the appendix. In the text only the means for the groups are mentioned, these figures being employed in the graphs as well as the tables. In the latter are indicated the number of each group, the class (or description) and the number of ewes in the group. Then the mean for the group is stated and this is followed by the results of the tests for significance. The latter are given in two columns, the first showing the results when each group is tested against the non-pregnant group, while the second indicates the results of testing each group against the one immediately preceding it.

In that section dealing with the foetus the procedure outlined above was not followed. Details of the treatment in this, as well as in a few other special instances, are given at the appropriate places in the text.

The last point to be considered is the method of estimating

the age of the foetus. As testing for "heat" was carried out once every twelve hours, the "most probable" time of onset of oestrus was taken to be six hours earlier than the time at which its presence was detected. As the services were regulated ~~as~~ to ensure the presence of large numbers of active sperms in the Fallopian tubes at the time of ovulation, fertilization was presumed to occur at the thirtieth hour after the onset of heat. It will be seen that this time is determined with greater ease by simply adding twenty-four hours to the time of detection of "heat." The age of the foetus was calculated from the time of fertilization until the time of death of the mother, and this figure was then approximated to the nearest full day.

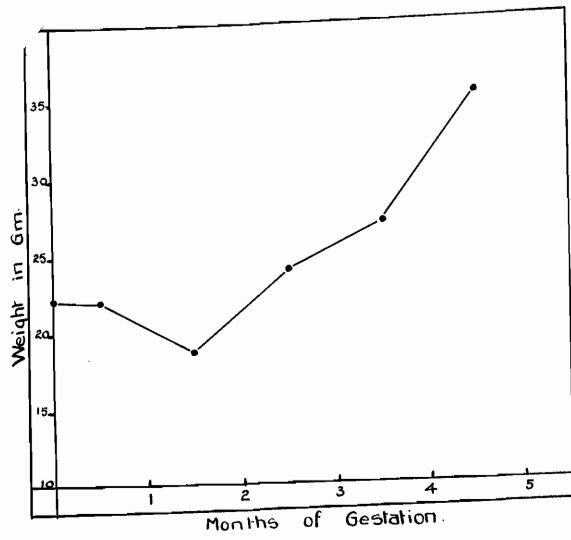


FIG. 1. WEIGHT OF VAGINA.



FIG. 2. LENGTH OF VAGINA.

CHAPTER 4.OBSERVATIONS.(a) GENITAL TRACT & PLACENTA.1. VAGINA.

In order to determine whether, during the course of pregnancy, there is definite growth of the vagina, the weight of this organ must be considered. The mean vagina weights in each of the six monthly groups are presented both in tabular and in graphic form (Table 3 & Fig.1.)

TABLE 3. WEIGHT OF VAGINA.

<u>GROUPS OF EWES.</u>		<u>No. of</u>	<u>Mean Vagina</u>	<u>Results of Signif. Test.</u>	
<u>No.</u>	<u>Class.</u>	<u>Ewes.</u>	<u>Weight, gm.</u>	<u>W. Group 1.</u>	<u>W. Preced. Gr.</u>
1.	Non-preg.	11.	22.45	:	:
2.	1st Month.	12.	22.25	:	-
3.	2nd "	8.	18.88	:	-
4.	3rd "	6.	24.83	:	-
5.	4th "	7.	27.29	:	-
6.	5th "	5.	35.20	:	X X

The most striking feature of the table is that, apart from the increase in the last month, all the variations are insignificant and may be due entirely to chance. Thus no importance is to be attached to the drop in weight in the second month. When this is disregarded it appears that, during the first half of pregnancy, the weight of the vagina remains unchanged. From the third month onwards there is to be detected an upward trend, which, however, becomes definitely significant in the last month only. By the end of gestation the mean vagina weight has reached a level 50 per cent. above that of the non-pregnant group. Of this increase almost 70 per cent. is added during the last month, the remainder being accounted for by the small but cumulative increases of the third and fourth months.

Having demonstrated an increase in mass, one may now consider the dimensions of the vagina with a view to determining the manner in which the additional substance is distributed. Length is considered in Table 4 & Fig.2.

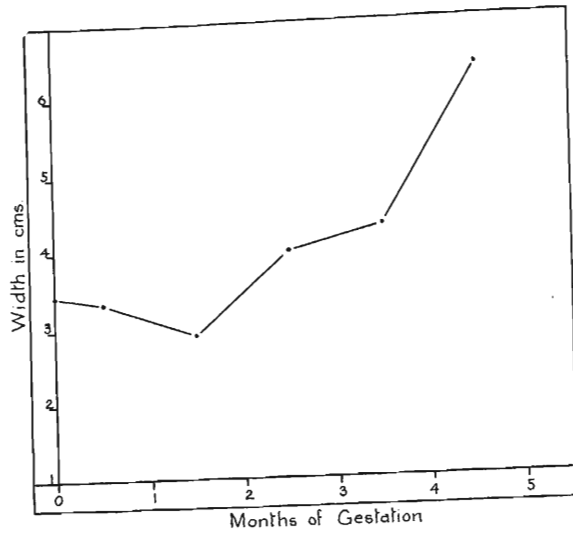


FIG. 3. WIDTH OF VAGINA.

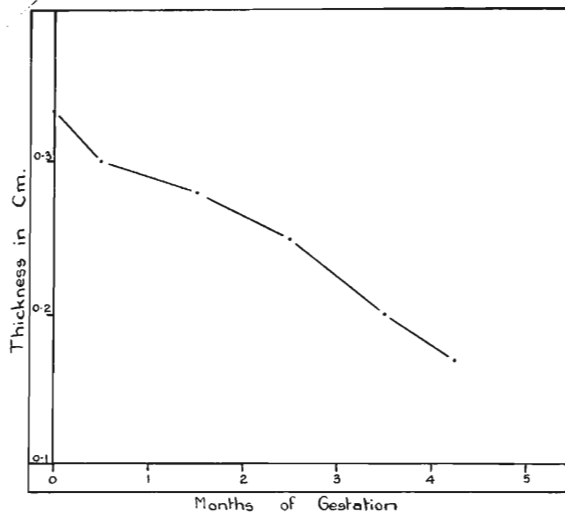


FIG. 4. THICKNESS OF VAGINA.

TABLE 4. LENGTH OF VAGINA.

Groups of Ewes. No. :	Class.	No. of Ewes :	Mean Vagina Length. Cm. :	Significance Tests.	
				W. Gr. 1.	W. preced. Gr.
1. :	Non-preg.	11. :	10.73	:	:
2. :	1st Month	12. :	11.08	:	-
3. :	2nd "	8. :	11.60	:	-
4. :	3rd "	6. :	13.33	:	X X
5. :	4th "	7. :	13.43	:	X X
6. :	5th "	5. :	15.60	:	X X

Apart from the absence of a drop in the second month, the general trend of this graph is similar to that of Fig.1. Again there is little or no change in the first three groups, followed by a definite increase in the following months. However, in its earlier stages the upward trend here is fairly definite, with the result that the total increase, far from being practically confined to the last group, is spread more or less evenly over the last three months.

When each group is compared with the one immediately preceding it, it is found that group 5 does ~~not~~ not show significance, whereas both groups 4 & 6 do. This is to be expected from the marked flattening of the graph between the third and fourth months. For this no reason is apparent and it might be that it is a discrepancy due to the manner of grouping. It is quite possible that with different grouping the shape of the graph between its two extremities would be altered.

The next dimension to be considered is the width, (Table 5 & Fig 3.)

TABLE 5. WIDTH OF VAGINA.

Groups of Ewes. No.:	Class	No. of Ewes. :	Mean Vagina Width. Cm. :	SIGNIFICANCE TESTS.	
				W. Gr. 1.	W. Preced. Gr.
1. :	Non-preg.	11. :	3.47	:	:
2. :	1st Month.	12. :	3.39	:	-
3. :	2nd "	8. :	2.92	:	-
4. :	3rd "	6. :	4.00	:	X
5. :	4th "	7. :	4.30	:	X
6. :	5th "	5. :	6.40	:	X X

The shape of this graph bears a close resemblance to that of the weight (Fig.1.) The increase in width becomes significant in the last two months only. The positive result obtained when group 4 ~~is~~

is tested against group 3 is undoubtedly due to the accident of a low figure in the second month, rather than to a marked increase in the third. As a result of the very steep rise during the last month, the total increase in width amounts to almost 100 per cent. of the width of the non-pregnant group.

Figure 4 (Thickness of vaginal wall) gives the impression that during pregnancy the vaginal wall is reduced steadily to half its original thickness. However, in Table 6 it is seen that not one of the variations is significant and that all may be due to chance alone. This finding is due to the large degree of variation in the original data (see Appendix,) in which consecutive figures in the same group are seen to differ by as much as 400 per cent. These widely differing figures are comparatively few. However, under the circumstances, all that can be said is that there is apparently a slight tendency for the thickness of the vaginal wall to be reduced during gestation.

TABLE 6. VAGINA THICKNESS.

Groups of Ewes.		No. of	Mean Vaginal	Significance Tests.	
No.:	Class.	Ewes.	Thickness. Cm.:	W.Gr.1.	W.Preced.Gr.
1.	Non-preg.	11.	.33	:	:
2.	1st Month	12.	.30	-	-
3.	2nd "	8.	.28	-	-
4.	3rd "	6.	.25	-	-
5.	4th "	7.	.20	-	-
6.	5th "	5.	.17	-	-

DISCUSSION. From a consideration of the length and the width of the vagina it becomes evident that, with the advance of pregnancy, the surface area of this organ is increased. This must mean that the lumen of the vagina is enlarged. To a certain extent the reduction in thickness contributes towards this increase in surface area. However, the main factor is undoubtedly the actual increase of vaginal substance. As there is no internal pressure in the vagina the thinning cannot be due to passive stretching. There must be active re-distribution of the tissue-elements. These processes all indicate a slow preparation of the vagina for the stretching due to occur at parturition. It is presumed that the

Individual muscle fibres increase in size and become re-distributed to form a thinner layer.

All these changes are recognisable upon macroscopic inspection. The vagina of the non-pregnant ewe is small and compact and ordinarily its lateral walls are in apposition. The labia of the vulva are firm and the opening between them is a mere slit, while the whole of the vaginal lumen is merely a potential space. The mucosa is smooth, only slightly moist and is usually pale. Posterior to the external urethral opening it often has a pinkish-brown colour. During oestrus the mucosa becomes hyperaemic and some clear mucus is present on its surface, while there is a suggestion of increased turgidity of the vulval labia.

For the greater part of the first month of gestation the picture resembles that of the oestral period. Probably this is the effect of the last "heat" period rather than of pregnancy. By the end of the first month the appearance is that of the anoestral period. This return to the less vascular "inactive" state probably accounts for the slight drops during the second month in Figs. 1 & 3.

Not until the 110th day of gestation is it possible to observe definite departures from this state. At this stage the vagina has become loose and flabby, the labia of the vulva are soft and are no longer in close apposition. From now on these changes become more marked until at the approach of parturition the whole organ is soft and flabby and the lumen is large and fairly patent. In its anterior half a fair amount of white, cloudy and viscid mucus is present, while the mucosa is pale and smooth.

2. CERVIX.

As the weight of this organ was not recorded separately, it is not possible to determine directly the changes in mass that may occur during the course of gestation. However, these may be deduced from a study of the dimensions of the cervix.

Length is considered in Table 7 & Fig. 5.

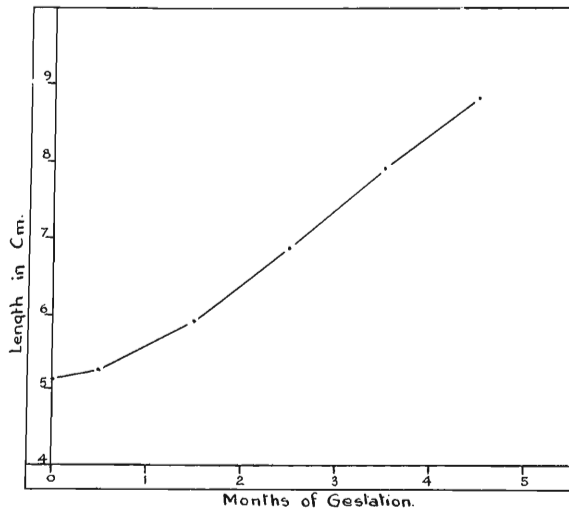


FIG. 5. LENGTH OF CERVIX.

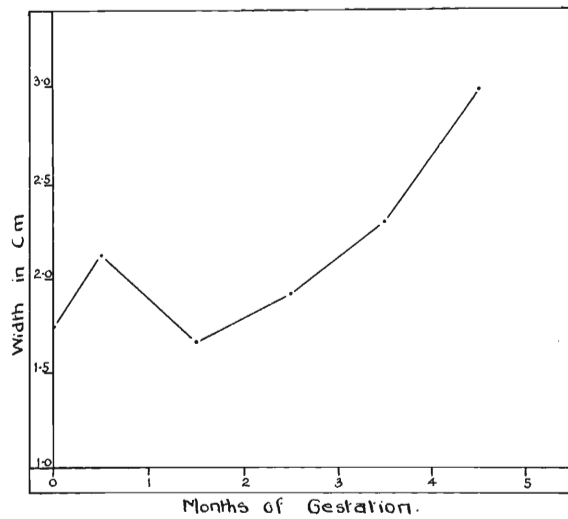


FIG. 6. WIDTH OF CERVIX.

TABLE 7. LENGTH OF CERVIX.

Groups of Ewes. No. Class	: No. of : Ewes.	: Mean Length : of Cervix.Cm:	: Significance Tests.	
			W.Gr.1.	W.Preced.Gr.
1. : Non-preg.	: 11.	: 5.14	:	:
2. : 1st Month	: 12.	: 5.23	:	-
3. : 2nd "	: 8.	: 5.94	:	X (1)
4. : 3rd "	: 6.	: 6.87	:	X X
5. : 4th "	: 7.	: 7.93	:	X X
6. : 5th "	: 5.	: 8.80	:	X X (1)

(1) Here significance at $P = .05$ is just missed.

It is seen that there is a definite increase, which is distributed evenly over the entire period of pregnancy. By the second month the increase has become significant and from now on during each month approximately equal amounts are added. This is indicated by the straight line which this portion of the graph assumes.

The width (Table 8 & Fig.6) does not exhibit this same regular growth. The peak in the first month is definitely significant. This is followed by a drop in the second month, the figure here being slightly lower than that of group 1. From here onward there is an increase in width, the increment for each succeeding group being larger than that of the preceding one. By the fourth month the width is again significantly larger than that of the non-pregnant group.

TABLE 8. WIDTH OF CERVIX.

Groups of Ewes. No. Class.	: No. of : Ewes.	: Mean Width : of Cervix.Cm:	: Significance Tests.	
			W.Gr.1.	W.Preced.Gr.
1. : Non-preg.	: 11.	: 1.75	:	:
2. : 1st Month	: 12.	: 2.13	:	X
3. : 2nd "	: 8.	: 1.68	:	-
4. : 3rd "	: 6.	: 1.92	:	-
5. : 4th "	: 7.	: 2.29	:	X
6. : 5th "	: 5.	: 2.98	:	X X

In Table 9 & Fig. 7 are given details of the thickness of the wall of the cervix. During the first three months of gestation this dimension decreases until during the third month the lowest level is reached. In the following two months there are definite increases, that for the last month being very large indeed. This

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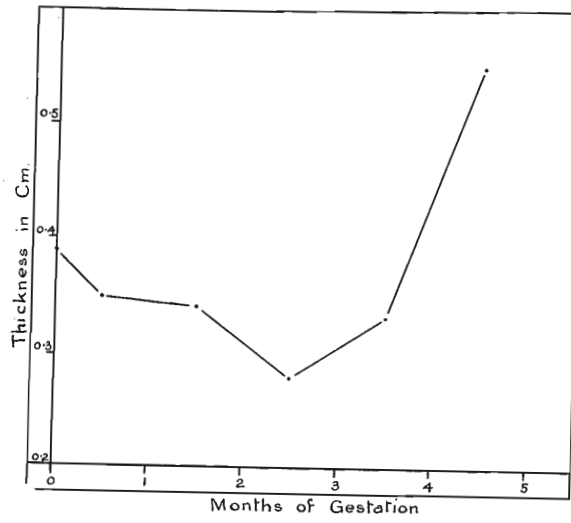


FIG. 7. THICKNESS OF WALL OF CERVIX.

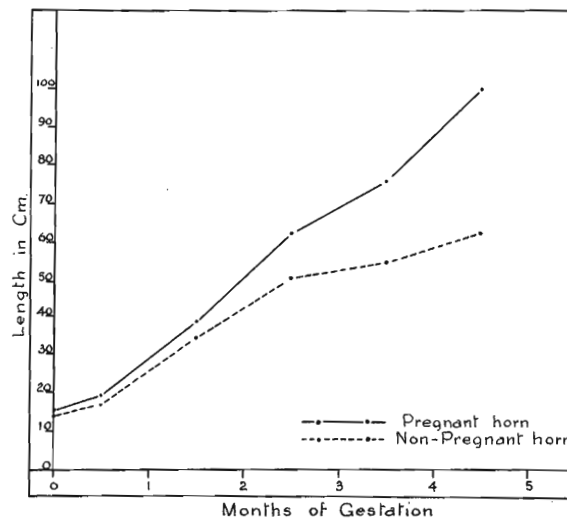


FIG. 8. GREATER CURVATURES OF CORNUA.

part of the graph rises almost vertically. When compared with the figure of the non-pregnant group all these variations are found to be significant, and in the last column of the table, Group 3 only fails to give a positive result: (note the flattening of the graph at this point.)

TABLE 9. THICKNESS OF WALL OF CERVIX.

Groups of Ewes.		No. of	Mean Cervical	Significance Tests.	
No.:	Class.	Ewes.	Thickness. Cm.	W. Gr. I.	W. Preced. Gr.
1.	Non-preg.	11.	.39	:	:
2.	1st Month	12.	.35	X X	X X
3.	2nd "	8.	.34	X X	-
4.	3rd "	6.	.28	X X	X X
5.	4th "	7.	.33	X X	X X
6.	5th "	5.	.55	X X	X X

DISCUSSION.

Before discussing these results it is necessary to consider some details concerning the uterine seal, the development of which appears to be closely associated with the changes in the wall of the cervix. Only once (ewe No. 44326 at 130 days) was anything resembling a definite "plug" seen, hence the term "seal" is preferred, as it describes more accurately the appearance and distribution of the mucous secretion in the cervix. By the end of the first month of pregnancy small accumulations of mucus may be detected in the depressions between the cervical folds. This is more noticeable in the cranial portions of the organ. As the amount of mucus increases it appears to "glue" together the adjacent surfaces of the folds, and by the 45th day of pregnancy this sealing is complete and a small amount of free mucus is seen in the lumen of the cervix. This tends to collect in the more cranial portions of the organ, where the tissue is less tense and where the folds are small. Gradually the quantity of this cloudy, white, sticky mucus increases, and as this happens the free mucus is no longer found only in the cranial portion, but spreads in a caudal direction. At no stage of pregnancy was the mucus seal found to protrude at the external uterine os.

Whereas the length of the cervix undergoes a steady increase,

TABLE 10.

GREATER CURVATURES OF CORNUA.

Groups of Ewes No. : Class	No. of Ewes.	Mean Length-Cm:		Significance Tests.		Mean Length Cm:		Significance Tests.	
		Pregnant Horn	W.Gr.1	W.Preced.Gr.	Non Preg.Horn.	W.Gr.1.	W.Preced.Gr.		
1. : Non-Preg :	11	15.59	:	:	15.18	:	:		
2. : 1st Month: t	12	19.12	:	-	17.58	:	-		
3. : 2nd "	8	38.06	:	X X	34.25	:	X X		
4. : 3rd "	6	62.67	:	X X	50.17	:	X X		
5. : 4th	7	74.86	:	X X	54.57	:	X X		
6. : 5th "	5	100.00	:	X X	62.60	:	X X		

1) Significance at 1% level is just missed.

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the width displays a sharp peak, followed firstly by a drop and then by a gradual increase. The first rise may be the result of dilatation of the cervix caused by an increased secretion of mucus during oestrus. As this effect passes off the organ returns to its contracted, dioestral state. Later the effects of pregnancy being about a steady increase in the width of the cervix. This theory receives support from the fact that in the first month of gestation the thickness of the wall of the cervix is greatly reduced - just what would be expected to result from stretching of the organ caused by pressure in its lumen. As the seal substance accumulates in the cervix the stretching is intensified, ^{hence} during the third month there is a further decrease in thickness. After mid-term there is active growth of the organ, with a consequent increase in all its dimensions. The thickened wall loses its firmness and becomes soft and slightly oedematous. These changes are first detectable at the 89th day of pregnancy. By this time the accumulation of mucus has increased the size of the lumen, and the whole organ appears enlarged, soft and spongy. At the 110th day these changes are more noticeable and due to the stretching and the accumulation of mucus the folds are well separated. Nine days later the canal is still more dilated and at this stage it is an easy matter to insert a probe into the cervix. At the 130th day the lumen has a diameter of 0.5 cm. and at the 140th day this has increased to 1.0 cm. The whole organ is extremely soft and spongy and it appears ~~markedly~~ oedematous. The tense cervix of the non-pregnant sheep has now become markedly loose and elastic and is capable of extreme dilatation.

3. BODY & CORNUA.

From a consideration of its curvatures an indication of the growth in length of the uterus is obtained. In Table 10 & Fig. 8 are to be found details concerning the length of the greater curvatures of both horns.^X

^X
Here and in all similar cases in Group 1 the left horn has been classed as the gravid one (pregnant 0 days) while the right horn is regarded as being non-gravid at 0 days.

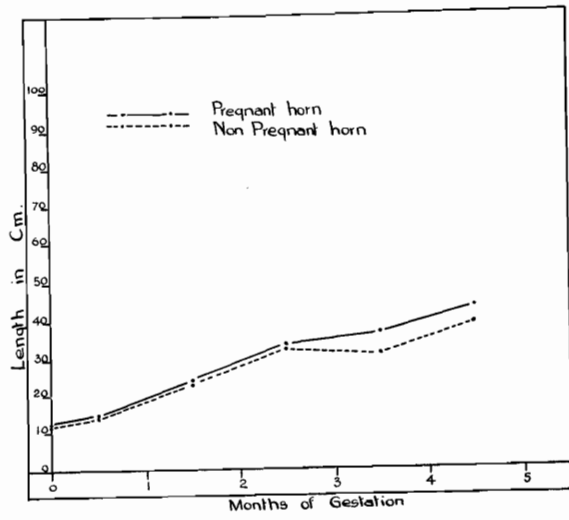


FIG. 9. LESSER CURVATURES OF CORNUA.

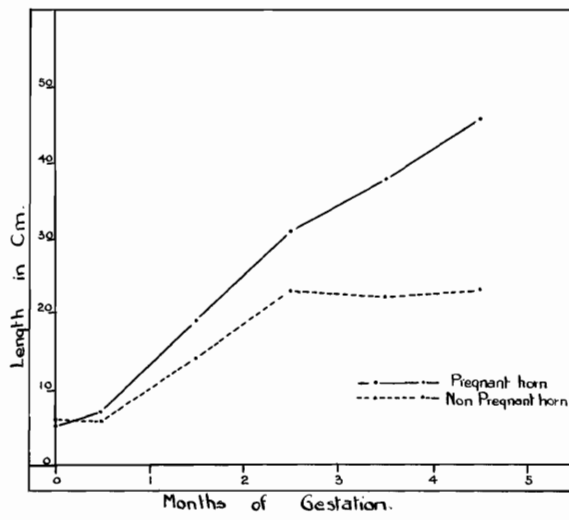


FIG. 10. CIRCUMFERENCES OF CORNUA.

TABLE 11.

LESSER CURVATURES OF CORNUA.

Groups of Ewes. No.: Class	No. of Ewes.	Mean Length- ^{CM}	Significance Tests.		Mean Length- ^{CM}	Significance Tests.	
		Preg. Horn.	W.Gr.l.	W.Preced.Gr.	Non-preg. horn.	W.Gr.l.	W.Preced.Gr.
1. : Non-Preg.	11	11.59			11.18		
2. : 1st Month	12	13.96	-	-	13.63	-	-
3. : 2nd "	8	22.81	X X	X X	22.50	X X	X X
4. : 3rd "	6	33.17	X X	X X	32.83	X X	X X
5. : 4th "	7	36.86	X X	-	31.71	X X	-
6. : 5th "	5	43.80	X X	X X	39.80	X X	X X

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In the pregnant horn there is a steady increase throughout pregnancy. Significance is reached in the second month. The greater curvature of the non-pregnant horn also undergoes much elongation, although its graph always remains below that of the gravid horn. For the first three months the general trend of the two lines is very similar, although from their gradual divergence it is evident that the non-pregnant horn grows at the slower rate. In the last two months the latter curve flattens out considerably, making for much greater dissimilarity between the two curves. The increments for the last two months are much more significant in the gravid horn than in the opposite one, (see Table 10 - second columns of significance tests.)

Table 11 & Fig.9 show that, regarding the lesser curvatures, there are no marked differences between the two horns. The two graphs assume similar courses with that of the non-gravid horn always just below the other. The amount of divergence, even at its maximum (in the fourth month) is comparatively small. As is the case with the greater curvatures, here again significance is reached early on in pregnancy i.e. in the second month.

It appears that in both horns there is considerable growth in length. That there is uneven growth on the two sides of the uterus is evident from the different slopes of the curves in Figs.9 & 10 (drawn to the same scale.) Here it is seen that in each horn the greater curvature outgrows the lesser, this being particularly noticeable in the last two months. The larger size of the gravid horn is due almost entirely to more extensive development of the greater curvature.

A peculiar feature of both these graphs is the distinct flattening between the third and fourth months. Further, it will be noticed that only in the case of the greater curvature of the pregnant horn is Group 5 significantly larger than Group 4, and even in this instance the level of significance is lower than that of the immediately preceding and following groups. An apparent explanation for this anomalous behaviour will suggest itself later when the volumes of the foetal fluids are studied.

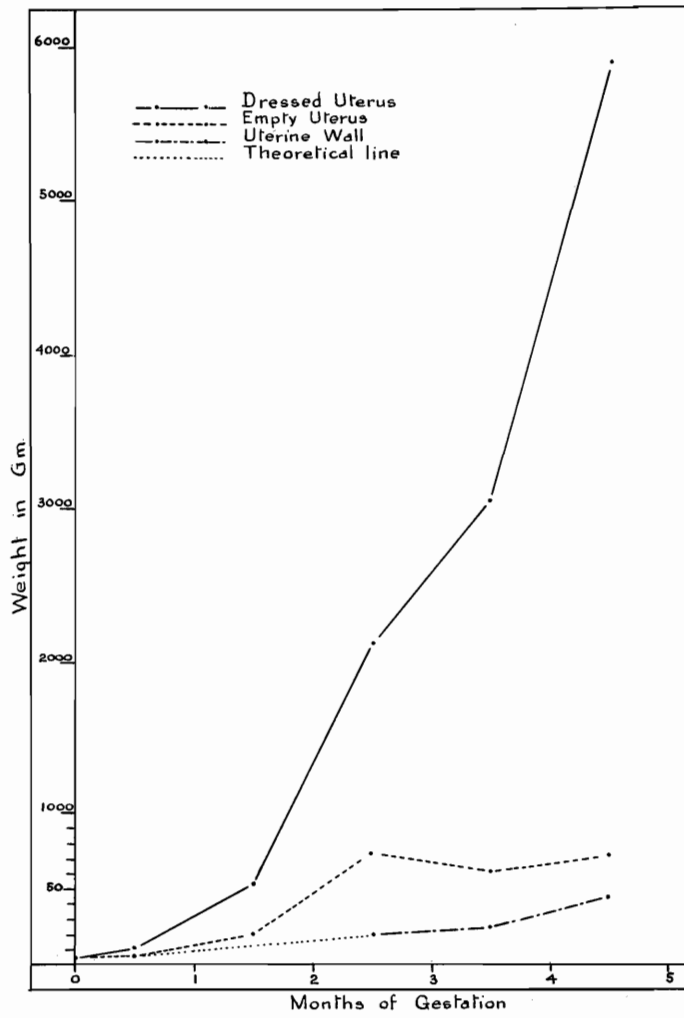


FIG. 11. WEIGHTS OF DRESSED UTERUS, EMPTY UTERUS & UTERINE WALL.

TABLE 12.

CIRCUMFERENCES OF CORNUA.

Groups of Ewes. No.: Class.	No. of Ewes.	Mean Circumf. CM:		Significance Tests.		Mean Circumf. CM:		Significance Tests.	
		Preg. horn.	W. Gr. 1.	W. Preced. Gr.	Non-preg. horn.	W. Gr. 1.	W. Preced. Gr.		
1. : Non-preg.	11	5.05	:	:	5.23	:	:		
2. : 1st Month	12	6.87	:	-	5.73	:	-		
3. : 2nd "	8	18.75	:	X X	14.00	:	X X		
4. : 3rd "	6	31.08	:	X X	23.00	:	X X		
5. : 4th "	7	37.57	:	X X	22.00	:	-		
6. : 5th "	5	45.40	:	X X	23.00	:	-		

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TABLE 13.

WEIGHTS OF DRESSED UTERUS, EMPTY UTERUS & UTERINE WALL.

Groups of Ewes. No : Class	No. of Ewes :	Mean Weight G_M :		Significance Tests :		Mean Weight G_M :		Significance Tests :		Mean Weight G_M :		Significance Tests :	
		Dressed Uterus :	W.Gr.1 :	W.prec.Gr. :	Empty Uterus :	W.Gr.1 :	W.prec.Gr. :	Uterine Wall :	W.Gr.1 :	W.Prec.Gr. :	W.Gr.1 :	W.Prec.Gr. :	
1. : Non-preg	: 11	: 42.73	:	:	: 42.73	:	:	:	:	: 42.73	:	:	:
2. : 1st Month	: 12	: 65.92	:	- :	: 39.67	:	- :	- :	:	: ?	:	: ?	: ? :
3 : 2nd "	: 8	: 519.75	:	X :	: 202.75	:	X X :	X X :	:	: ?	:	: ?	: ? :
4. : 3rd "	: 6	: 2128.67	:	X X :	: 740.17	:	X X :	X X :	:	: 221.00	:	X X :	: ? :
5. : 4th "	: 7	: 3026.57	:	X X :	: 597.43	:	X X :	X :	:	: 248.00	:	X X :	: - :
6. : 5th "	: 5	: 5880.80	:	X X :	: 708.80	:	X X :	- :	:	: 442.00	:	X X :	: X X :

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There is a fairly close resemblance between the graphs of the circumferences (Fig.10) and those of the greater curvatures (Fig.8) Again the line for the non-gravid horn lies below the other and diverges from it, slowly up to the third month and then more rapidly. After the third month the circumference of the non-pregnant horn does not increase at all, whereas during the same time the monthly increments of the gravid horn remain definitely significant (Table 12.) Here too the peculiar flattening of the curve, referred to above, is evident. In the pregnant horn it is of only slight degree, yet in the other horn it is most marked.

DISCUSSION.

It is only to be expected that with the advance of pregnancy there will be an increase in the size of the uterine horns. Here it is seen that during the first half of gestation both horns increase fairly steadily, with but a slight difference in favour of the pregnant horn. However, during the second half of pregnancy the horn in which the foetus lies completely outgrows the other, this being noticeable in both curvatures (not marked in the lesser) as well as in ^{the} circumference. As a result of the uneven distribution of the increase, the enlargement of the horns is accompanied by a change in shape. All these changes are well illustrated in the photographic plates presented by Curson & Quinlan (1934) and Curson & Mare (1934.)

The growth of the uterus in weight is considered in Table 13 & Fig.11. By the end of pregnancy the "dressed" uterus has reached the relatively enormous weight of approximately 6 Kg. The graph rises ~~to~~ but little in the first month, more in the second (at this stage the increase becomes significant) and then assumes an exceedingly steep slope. Between the third and fourth months there is a distinct flattening of the curve. Later it will be seen that this is caused in part by a decrease in the total volume of foetal fluid and in part by a drop in placental weight.

The weight of the empty uterus is the sum of the weights of the uterine wall and the placenta. Details of the latter are presented in Table 14 & Fig.13. For the first four months of pregnancy the course of the graph of the empty uterus is governed

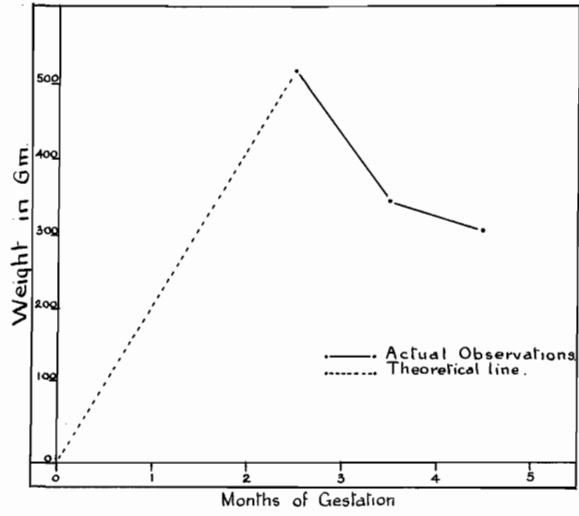


FIG. 12. WEIGHT OF PLACENTA.

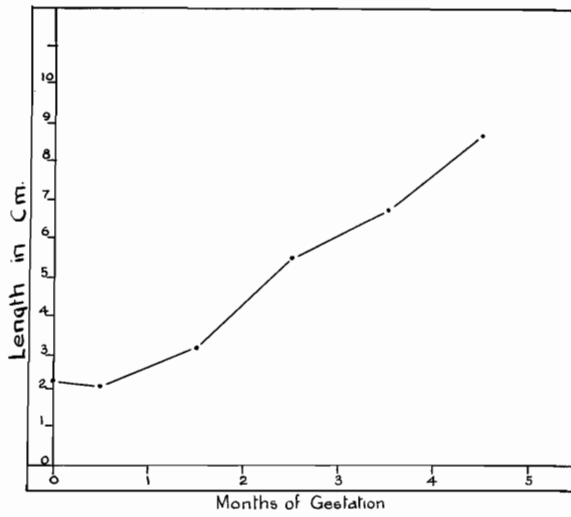


FIG. 13. LENGTH OF BODY OF UTERUS.

mainly by the weight of the placenta. Until the end of the second month there is a gradual rise and then in the third month there is a sudden peak, followed by a drop. Meanwhile the weight of the uterine wall has increased steadily, but this has not been sufficient to influence to any great extent the weight of the empty uterus. In the last month there is a highly significant increase in the weight of the wall, and as a result of this the graph of the empty uterus rises again to the level of the third month, in spite of the fact that at this stage the placental weight undergoes a further (but insignificant) reduction.

TABLE 14. WEIGHT OF PLACENTA.

Groups of Ewes.		No. of Ewes.	Mean weight of Placenta.	Significance Tests.	
No.	Class.			W.Gr.1	W.Preced.Gr.
1	: Non-preg.	: 11	: Nil	: :	:
2.	: 1st Month	: 12	: ?	: :	:
3.	: 2nd "	: 8	: ?	: :	:
4.	: 3rd "	: 6	: 519	: XX	: ?
5.	: 4th "	: 7	: 349	: XX	: X
6.	: 5th "	: 5	: 307	: XX	: -

The increase in size of the uterus is not limited to its horns, but is also evident in the body. When it is remembered that the body is the portal through which the cornua communicate with each other, it is not surprising to find that in its increase in length (Table 15 & Fig.13) this portion of the uterus follows a course closely resembling, and more or less intermediate between, those observed in connection with the greater curvatures of the cornua. Here too a slight flattening of the curve in the fourth month of pregnancy, is observed.

From the fact that by the end of the second month of gestation the body is not yet ^X significantly longer than in the non-pregnant group, it is concluded that in this part of the uterus growth is

^X
By how little significance is missed is indicated by the fact that Group 3 is significantly larger than Group 2, which is but slightly lower than Group 1.

TABLE 16.

THICKNESS OF UTERINE WALL.

Groups of Ewes. No. : Class	No. of Ewes.	Thickness of Uterine Wall <i>117 cm</i>			Total Groups.:	Significance Test.	
		Body	Preg. Horn	Non-preg. horn		W.Gr.1	W.Preced.Gr.
1. : Non-preg.	11	.45cm	.45cm	: .46cm	.45cm	:	:
2. : 1st Month	12	.39cm	.38cm	: .38cm	.38cm	: X X	: X X
3. : 2nd "	8	.29cm	.30cm	: .30cm	.30cm	: XX	: X X
4. : 3rd "	6	.23cm	.22cm	: .23cm	.23cm	: X X	: X X
5. : 4th "	7	.20cm	.17cm	: .18cm	.18cm	: X X	: X
6. : 5th "	5	.27cm	.18cm	: .22cm	.22cm	: X X	: -
Average		.33cm	.31cm	: .32cm			

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initiated later than in the horns. In this connection it is to be observed that during the first month there is no change from the non-pregnant state, in fact the mean of Group 2 is slightly (but not significantly) lower than that of Group 1.

TABLE 15. LENGTH OF BODY OF UTERUS.

Groups of Ewes.	No. of	Mean length	Significance Tests.
No. : Class.	Ewes.	of Body. <i>CM.</i>	W. Gr. 1. : W. Preced. Gr.
1. : Non-preg	: 11	: 2.16	: :
2. : 1st Month	: 12	: 2.07	: - : -
3. : 2nd "	: 8	: 3.19	: - 1 : X
4. : 3rd "	: 6	: 5.50	: X X : X X
5. : 4th "	: 7	: 6.71	: X X : X X
6. : 5th "	: 5	: 8.70	: X X : X X

1.

Just misses Significance at 5% level.

In each of the three portions of the uterus (the two horns & the body) the thickness of the wall was measured. Details are presented in Table 16. In the column headed "Total Groups" are tabulated the means of all the measurements recorded in each month, while in the last line of the table are given the "Averages" for all the readings (throughout pregnancy) at each point.

When these data are analyzed, by means of Fisher's Z-test, to show the effects of (a) stage of gestation (total groups), (b) position (in pregnant or non-pregnant horn or in body) and (c) interaction between stage of gestation and position, a positive result is obtained in the first instance only. From this it is concluded that the effect of pregnancy is to cause a reduction in the thickness of the uterine wall, that this influence is exerted ~~evenly~~ evenly over the whole wall, and that in their response to this effect all three parts behave identically.

The significance tests referred to in Table 16 are those concerning the "total groups." These indicate that as early as the first month of gestation there is a significant reduction of the thickness of the uterine wall. In each of the following three months a further significant decrease occurs, so that, by the end of

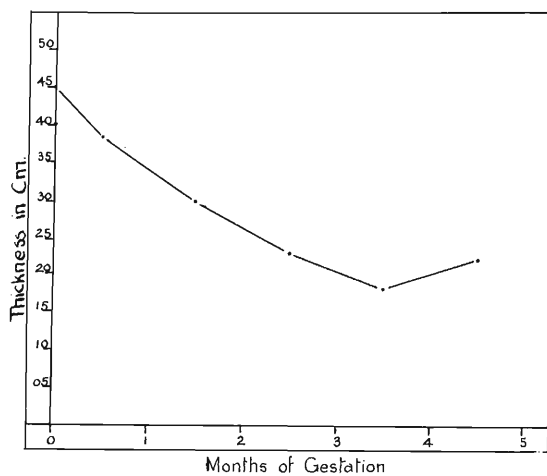


FIG. 14. THICKNESS OF UTERINE WALL.

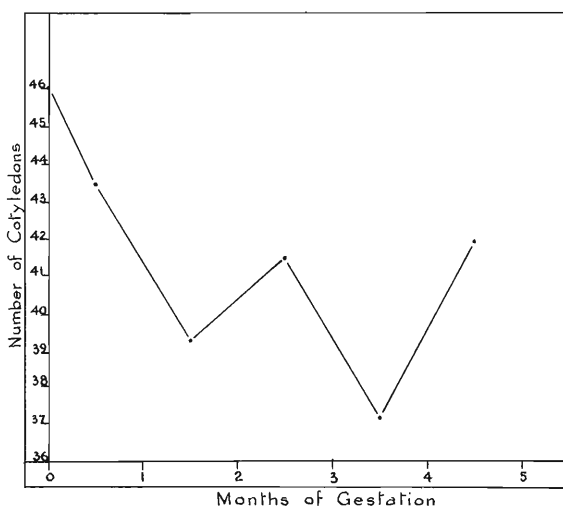


FIG. 15. NUMBER OF COTYLEDONS.