UTERINE INVOLUTION AND POSTPARTUM CONCEPTION IN THE EWE

by 6408

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B. S., Kansas State University, 1969

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Animal Science and Industry

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

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THIS BOOK CONTAINS NUMEROUS PAGES WITH THE ORIGINAL PRINTING BEING SKEWED DIFFERENTLY FROM THE TOP OF THE PAGE TO THE BOTTOM.

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The desire by sheep producers to get more lambs marketed per ewe per year has stimulated research in the area of accelerated lambing. Recent work has been concerned with getting three lamb crops in 2 years but few attempts have been made to shorten the postpartum interval to get two lamb crops a year. Little has been done to determine what sequence of physiological events are necessary for conception and implantation of embryos in postpartum ewes. Foote (1968) and Uren (1935) described uterine involution in the ewe but neither showed any conception data. If the uterus is capable of two gestations per year then research efforts in this area should be continued.

This study was designed to determine the rate of uterine involution and epithelial regeneration in the ewe and to determine the minimum postpartum interval after which a ewe can ovulate, conceive and support another fetus. Conception rates were compared to uterine environment to determine the uterine conditions responsible for postpartum infertility.

REVIEW OF LITERATURE

Sheep in their matural state are seasonal breeders. The photoperiod is the major regulating factor in determining the breeding season but other factors such as temperature, breed, age, lactation, condition, presence of the male, and geographic location have been shown to play a role in the occurrence of estrus (Shelton, 1968).

To get two lamb crops per year requires out of season breeding. Hormonal therapy can be used to counteract the above mentioned environmental and physiological conditions. Numerous workers have developed various treatments that induce estrus in anestrous ewes. Some of these treatments are shown in table 1. In most treatments progesterone, FSH (follicle stimulating hormone), and LH (luteinizing hormone) are used in varying combinations, amounts and sequences. These hormones may be either natural occurring or synthetically produced. Dutt (1953) and Robins (1954) showed that progesterone preceeding PMS (pregnant mares serum) in anestrous ewes increased the estrus and ovulation response to PMS. Hulet and Foote (1967) found CAP (6-chloro 6-17-acetoxy-progesterone) and MAP (6-methyl-17-acetoxy-progesterone) both equally effective as a synthetic progesterone in synchronizing estrus when administered orally. Moore and Holst (1967) injected anestrous ewes with PMS at 0, 24, or

48 hours after progesterone withdrawal. They received best results when PMS was given at 0 or 24 hours after progesterone withdrawal. Holst (1969) administered various levels of PMS to determine the optimum level in anestrous ewes. He gave 250, 500, 750, 1000, and 1,250 IU of PMS at time of progesterone removal and obtained 2.0, 3.4, 3.7, 6.4, and 7.2 CL (corpus lutea) per ewe, respectively. In this study he found anestrous

TABLE 1. HORMONAL INDUCTION OF ESTRUS IN NON-LACTATING ANESTROUS EWES

Worker	Treatment	No. of Ewes	% bred	% lambing[j]
Hansel (1964)	Control	35	3	0
	MAP[a]	15	0	0
	MAP-PMS[b]	43	77	49
	MAP-PMS[c]	56	71	41
Wagner (1964)	CAP-PMS[d]	85	45.9	19
Hulet & Foote (1967)	MAP-PMS[e]	20	----	55
	MAP-PMS-PMS[f]	16	----	56
Wagner & Veenhuizen (1968)	CAP-PMS[g]	27	30	----
	Prog-Est-CAP-PMS[h]	28	57	----
	Est-CAP-PMS[i]	27	63	----

[a]MAP-60 mg/ewe/day for 20 days.
[b]MAP-60 mg/ewe/day on days 1-8 & 15-22; 750 IU of PMS on days 9 & 23.
[c]MAP-50 mg/ewe/day on days 1-8 & 15-23; 750 IU of PMS on days 9 & 24.
[d]CAP-1 mg/ewe/day on days 1-16 & 1000 IU PMS on day 17.
[e]MAP-60 mg/ewe/day on days 1-3 & 12-17; 750 IU PMS 36 hrs. after MAP; 850 IU PMS 16 days later.
[f]MAP-60 mg/ewe/day for 14 days; 750 IU PMS 36 hrs. after MAP; 850 IU PMS 16 days later.
[g]1.0 mg CAP/ewe/day for 14 days; 1000 IU PMS 2 days later.
[h]Same as g except pretreated with 1 injection of 20 mg prog. 5 days and 1 injection of 2 mg estradiol 17β 3 days before start of CAP.
[i]Same as g except pretreated with 1 injection of 2 mg estradiol 17β, 1 day before start of CAP.
[j]Percent of treated ewes lambing.

ewes to be more responsive to PMS than cycling ewes. Workers have had varying degrees of success with the previous mentioned ways of inducing estrus and conception in anestrous ewes.

There are two factors which affect lambing interval: (1) length of gestation and (2) interval from parturition to conception, (Hulet, 1968). The length of gestation is of little importance except in twice a year lambing, where every day becomes important. Yeates (1958) and Shelton (1968) showed that high temperature shortened gestation. Hulet (1968) reported gestation length to be shorter in the mutton breeds than in the wool breeds. Hulet (1968) showed that high levels of nutrition shorten gestation. Methods of shortening gestation do not appear to be conducive to good management; therefore cannot be considered as an aid in reducing lambing interval.

Barker and Wiggins (1964) reported that ewes lambing in the fall will rebreed and lamb again in the spring, while most of the ewes lambing in the spring will not lamb again until the next spring. There were some breed differences as to how soon ewes breed back but individual variation was greater than breed differences. They also found the postpartum interval to be 73 and 86 days in two groups of Rambouillets and 39 and 66 days in two groups of Dorsets. Wagner (1964) found the postpartum interval to be 48.5 ±14.9 days when he bred 87 ewes in the fall. In another experiment, Wagner (1968) reported 91% of the ewes lambing in September and October conceived an average of 42 days postpartum with no treatment. Hulet (1968) also reported that ewes lambing in August through October came into heat while lactating and lambed again within eight months with no treatment. Some ewes reported by Boyd (1968) were receptive to a ram within 48 hours following lambing; however, most ewes did not exhibit estrus until the next breeding season. Some ewes returned to estrus 6-8 weeks after parturition but the highest incidence of post-lambing estrus occurs about 2 weeks after weaning.

Foote et al. (1967) reported the first postpartum ovulation occurred 35 days postpartum while ovulation accompanying estrus occurs 47 days postpartum in non-lactating ewes. Hunter and Lishman (1967) reported first ovulation occurred 32 days postpartum and first estrus occurred 57 days postpartum. There is some disagreement among workers as to the length of the interval between parturition and first ovulation accompanying estrus. To shorten this interval the uterus must involute and its environment be made ready to support another pregnancy (Foote, 1968). Gier and Marion (1968) described in the bovine involution to have three overlaping processes; (1) reduction in size, (2) loss of tissue, and (3) repair. The reduction in size is the shrinking of the uterus after expulsion of the lamb or lambs and further shrinking after the necrotic tissue is reabsorbed. The loss of tissue is the sloughing of caruncle caps, mostly of maternal origin which must be reabsorbed by the circulation. Repair is the regeneration of epithelium over the intercaruncular area and then over the caruncle area after the caruncle caps are sloughed.

According to Foote (1968) uterine involution is mostly completed by 17 days postpartum thus the uterus is prepared to support a pregnancy by this time. Hulet (1968) stated that the uterus is back to prepregnant size two weeks after parturition. The uterus is regressed to prepregnant size and histological condition between 10 and 24 days postpartum (Foote et al, 1967).

According to Uren (1935) epithelium regeneration over the caruncle was not complete by day 26 but was complete by day 30 postpartum. He also noted that involution of the uterine glands was relatively rapid in comparison with other parts of the mucosa. He found by day 15 postpartum the necrotic tissue over the caruncle was very loosely attached and by day 20 most of this necrotic tissue had sloughed off but was not removed (reabsorbed) from the uterus until day 25. Foote (1968) found no difference in involution rate between lactating and non-lactating ewes. He was unable to speed up involution by administering estrogen, progesterone and ergot.

Wagner (1964) found that fertility reaches a plateau about 50 days postpartum after which he was able to get one lamb born for every ewe treated. The shortest interval between two breedings was 186 days when ewes were continuously exposed to rams (Terrill, 1968). With no treatment, Hulet (1968) had a ewe conceive as early as 9 days postpartum in the fall but the averages were between 40 and 80 days. Foote (1968) was able to induce ewes into estrus and ovulate consistently 18-35 days postpartum. He concluded that twice a year lambing is possible, provided the uterine environment can be duplicated so fertilization can take place and the embryo can survive. Various methods to induce estrus in lactating ewes are shown on table 2.

Hulet (1968) also found that ovulation and estrus was quite normal in hormone treated ewes but had problems in maintaining the embryo after fertilization. He treated anestrous ewes with estrogen followed by progesterone and improved embryo survival. He had 3 of 14 ewes[1] lamb that had no estrogen treatment and 10 of 15 ewes[2] lamb that were pretreated with estrogen.

Foote and Hulet (1966) were able to get more lactating and non-lactating ewes to become pregnant when treated with estrogen prior to progesterone and PMS. Shelton (1968) found it much easier to breed non-lactating ewes than lactating ewes. Normally, lactating ewes have a longer postpartum interval than non-lactating ewes but this is not true in hormone treated ewes (Wagner, 1964) and (Hulet and Foote, 1967).

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[1]Seven ewes received 40 mg progesterone over 4 days and 7 ewes had no treatment.

[2]Eight ewes received estrogen and progesterone treatment and 7 ewes received just estrogen treatment.

TABLE 2. HORMONAL INDUCTION OF ESTRUS IN LACTATING ANESTROUS EWES

Worker	Treatment	No. of Ewes	% bred	% lambing[o]
Hansel (1964)	Control	17	0	0
	MAP[a]	17	0	0
	MAP-PMS[b]	17	76	65
Wagner (1964)	CAP-PMS[c]	84	65.4	37
Hulet & Foote (1967)	CAP-PMS[d]	34	----	35
	MAP-PMS[e]	30	----	40
	CAP-PMS[f]	34	----	59
	MAP-PMS[g]	30	----	60
	MAP-PMS[h]	28	----	43
Wagner & Veenhuizen (1968)	CAP-PMS[i]	35	37	--
	Prog-Est-CAP-PMS[j]	35	54	--
	Est-CAP-PMS[k]	37	57	--
Hulet (1968)	Control	7	----	14
	Prog-Est[l]	7	----	29
	Est-Prog-Est[m]	8	----	50
	Est[n]	7	----	86

[a]MAP-60 mg/ewe/day for 20 days.
[b]MAP-60 mg/ewe on days 7-14; 750 IU PMS on days 1 & 15.
[c]0.5 or 1.0 mg CAP/ewe/day for 16 days, followed last CAP with PMS 1 day later.
[d]1.0 mg CAP/ewe, days 1-3 & 12-17; 750 IU PMS day 4 & 850 IU PMS day 18.
[e]Same as d except 60 mg MAP substituted for 1.0 mg CAP.
[f]1.0 mg CAP/ewe/day for 14 days; 750 IU PMS 36 hrs. after CAP; 850 IU PMS 16 days later.
[g]Same as f except 60 mg MAP substituted for 1.0 mg CAP.
[h]Same as g except only ewes coming in heat after first PMS injection were given no further treatment.
[i]1.0 mg CAP/ewe/day for 14 days; 1000 IU PMS 2 days later.
[j]Same as i except pretreated with 1 injection of 20 mg prog. 5 days and 1 injection of 2 mg estradiol 17β 3 days before start of CAP.
[k]Same as j except pretreated with 1 injection of 2 mg estradiol 17β day before start of CAP.
[l]20 mg prog. days 3, 5, & 7 postpartum; 3 mg estradiol 17β day 9 postpartum.
[m]1.0 mg estradiol 17β day 3 postpartum; 20 mg prog. day 5 & 7 postpartum; 3 mg estradiol 17β day 9 postpartum.
[n]3.0 mg estradiol 17β day 3 postpartum.
[o]Percent of treated ewes lambing.

MATERIALS AND METHODS

Ten pregnant western and black faced crossbred ewes were randomly assigned to be laparotomized at 5, 10, 15, 20, 25, or 30 days postpartum. All ewes lambed between March and April and were assigned to two laparotomy dates according to the design in table 3. Ewes received 3 cc of antibiotic following surgery.[3] The second operation was always at least 10 days following the first operation. Ewes having the first operation on day 25 or 30 had only one operation. Ovarian structures were measured and recorded. Uterine width was measured on the gravid and non-gravid horns at the external bifurcation and length was measured from the external bifurcation around the antimesimetrial side to the tip of the horn.

TABLE 3. EXPERIMENTAL DESIGN SHOWING DAYS ON WHICH POSTPARTUM EWES WERE LAPAROTOMIZED

Ewe No.	Group	5	10	15	20	25	30
1				x		x	
2						x	
3				x		x	
4		x			x		
5		x			x		
6			x				x
7						x	
8			x				x
9				x		x	
10					x		x

A biopsy was taken at the external bifurcation along the antimesimetrial side. Caution was taken to insure that the biopsy

[3]Combiotic, Pfizer, New York, New York.

contained both caruncular and intracaruncular tissue. Tissues were immediately fixed in chrom-acetic fixative consisting of 15 ml of 1.0% chromic acid and 1.0 ml glacial acetic acid. The tissues were dehydrated in a series of isopropyl alcohol and infiltrated with paraffin. They were embedded in fresh paraffin and sections were stained with Mallorys Triple, PAS (Periodic Acid Shiffs) or Hematoxylin.

Twenty-two Hampshire and Rambouillet crossbred ewes were randomly allotted to three groups which were bred either 25, 35, or 45 days postpartum. All ewes lambed between March and April 1970. Ewes received a progesterone implant[4] at varying times postpartum and 2 weeks later were injected intramuscular with 500 IU of PMS[5] at the time of progesterone implant removal (table 4).

TABLE 4. EXPERIMENTAL DESIGN OF HORMONAL TREATMENT TO INDUCE ESTRUS IN POSTPARTUM EWES

		Days Postpartum		
Treatments	Group	1	2	3
Stilbestrol		0	8	18
Progesterone		8-23	18-33	28-43
P.M.S.		23	33	43
Breeding		25	35	45

[4]SIL-ESTRUS Progesterone-Silastic Implants, supplied by Abbott Laboratories, North Chicago, Illinois.

[5]Equinex supplied by Ayerst Laboratories, New York, New York.

One half of the ewes in each group were pretreated with 5 mg of stilbesterol[6] ten days before insertion of implant. Fertile harnessed rams were used to detect estrus. All ewes were maintained in a dry lot on 1 lb. of milo and 3 lbs. of alfalfa hay per day from March to May. Ewes were maintained on sudan or brome pasture through summer months and lambing data were recorded in the fall.

RESULTS AND DISCUSSION

Uterine involution in the ewe appeared to occur in three distinct phases and by gross observation was completed by 30 days postpartum (table 5). The length of the uterine cornua was variable whereas the width at the external bifurcation was indicative of the stage of involution. As shown in table 6 the uterus decreases in size quite rapidly the first ten days postpartum. During this period the main reduction in size appeared to result from expulsion of the lamb or lambs. Within ten days after lambing the uterus was reduced to about one half the size of the uterus at parturition. The blood supply to the caruncles was apparently cut off at parturition by constriction of the caruncular arteries and caused the caruncle caps where fetal villi are attached to become necrotic. The uterine glands regressed in size the first ten days postpartum but

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[6]Repositol Diethylstilbestrol, Pitman-Moore, Indianapolis, Indiana.

their regression was not as rapid as that of the arteries (Plate I, Fig. 1,2,3). These findings are in agreement with Uren (1935).

TABLE 5. AVERAGE LENGTH AND WIDTH OF THE UTERUS IN POSTPARTUM EWES

	Days Postpartum					
	5	10	15	20	25	30
Gravid Horn						
Width (mm)	45	33.3	23.2	18	16.25	15.5
Length (cm)	20.3	16.3	16.4	11	10.4	8.9
No. of observations	3	3	5	4	8	4
Non-Gravid Horn						
Width (mm)	30	24	23	18	13.5	13.5
Length (cm)	13	10	9	10.25	9.25	7.5
No. of observations	1	1	1	2	2	2

From day 10 to day 25 postpartum the uterus again reduced its size by approximately one half. This reduction in size was concurrent with reabsorption of necrotic tissue not expelled at parturition. Necrotic tissue consisted of caruncle caps that were damaged by the attachment of the fetal villi during pregnancy, and was mostly of maternal origin, but some fetal villi were also present. The necrotic tissue was firmly attached to the caruncle at 5 days postpartum, but this attachment gradually loosened until day 15 when the attachment was essentially broken (Plate II, Fig. 1,2,3; Plate III, Fig. 1,2). Any handling of the uterus on day 15 caused considerable sloughing or dislodging of the necrotic tissue from the rest of the caruncle. By day 20 postpartum little if any necrotic tissue was attached to the caruncle but a chocolate brown necrotic

TABLE 6. MEAN MEASUREMENTS OF UTERINE WIDTH AND LENGTH IN THE POSTPARTUM EWE[a]

	Days Postpartum					
	5	10	15	20	25	30
Width Gravid Horn (mm)	45.3	32.3	23.6	18.3	15.9	15.7
Width Non-Gravid Horn (mm)	29.3	25.9	21.8	17.7	14.6	13.5
Length Gravid Horn (cm)	20	17.7	15.0	12.3	10.1	9.0
Length Non-Gravid Horn (cm)	12.9	10.1	9.4	9.8	9.6	7.4

[a]Fourth order regression analysis.

mass was usually present in the lumen of the uterus (Plate II, Fig. 4; Plate III, Fig. 3). Visual observations indicated that the total volume of necrotic tissue in the lumen of the uterus decreased with increasing days postpartum and was usually gone by day 25 postpartum. The elimination of necrotic tissue appeared to be the main factor that regulated the time required for involution to be complete.

By day 25 the necrotic tissue had disappeared from the uterus. Once the uterus was free of necrotic tissue, epithelium regenerated over the caruncle in about 5 days (Plate II, Fig. 5,6; Plate III, Fig. 4,5). The process of uterine involution in the ewes was very similar to uterine involution in the cow as described by Gier and Marion (1968).

EXPLANATION OF PLATE I

Fig. 1. Uterine biopsy from ewe 5 days postpartum (42x). (A) Non-functional artery, probably supplied blood to fetus during pregnancy. (A') Functional artery that had collapsed when biopsy was taken; probably furnished blood to uterine myometrium. (E) Epithelium lining lumen of uterus. (G) Uterine gland. (V) Veins.

Fig. 2. Uterine biopsy from ewe 25 days postpartum (42x). (A) Uterine arteries, (G) uterine glands, compare size of these in relation to arteries and glands in fig. 1. and fig. 2. (V) Vein.

Fig. 3. Uterine biopsy from ewe 30 days postpartum (42x). Shows (E) epithelium continuing out of (G) uterine gland into lumen of uterus.

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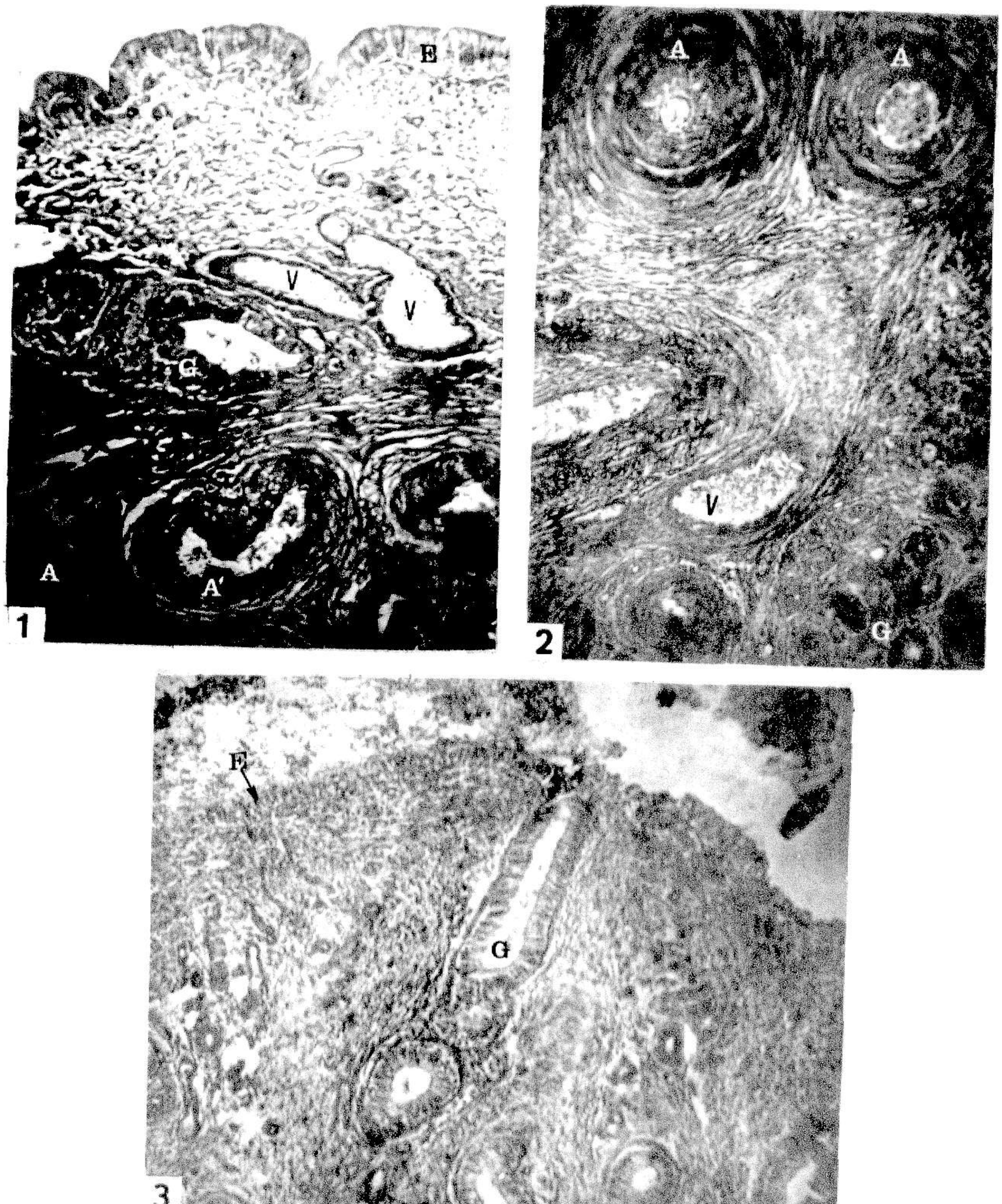
PLATE I



EXPLANATION OF PLATE II

Fig. 4. Uterine biopsy from ewe 5 days postpartum (42x). (C) Caruncular tissue. (N) Necrotic tissue that will slough. (S) Necrotic maternal septa.

Fig. 5. Uterine biopsy from ewe 10 days postpartum (42x). (C) Caruncle. (F) Necrotic fetal villi that broke off at parturition. (N) Area of necrotic tissue. (S) Necrotic maternal septa.

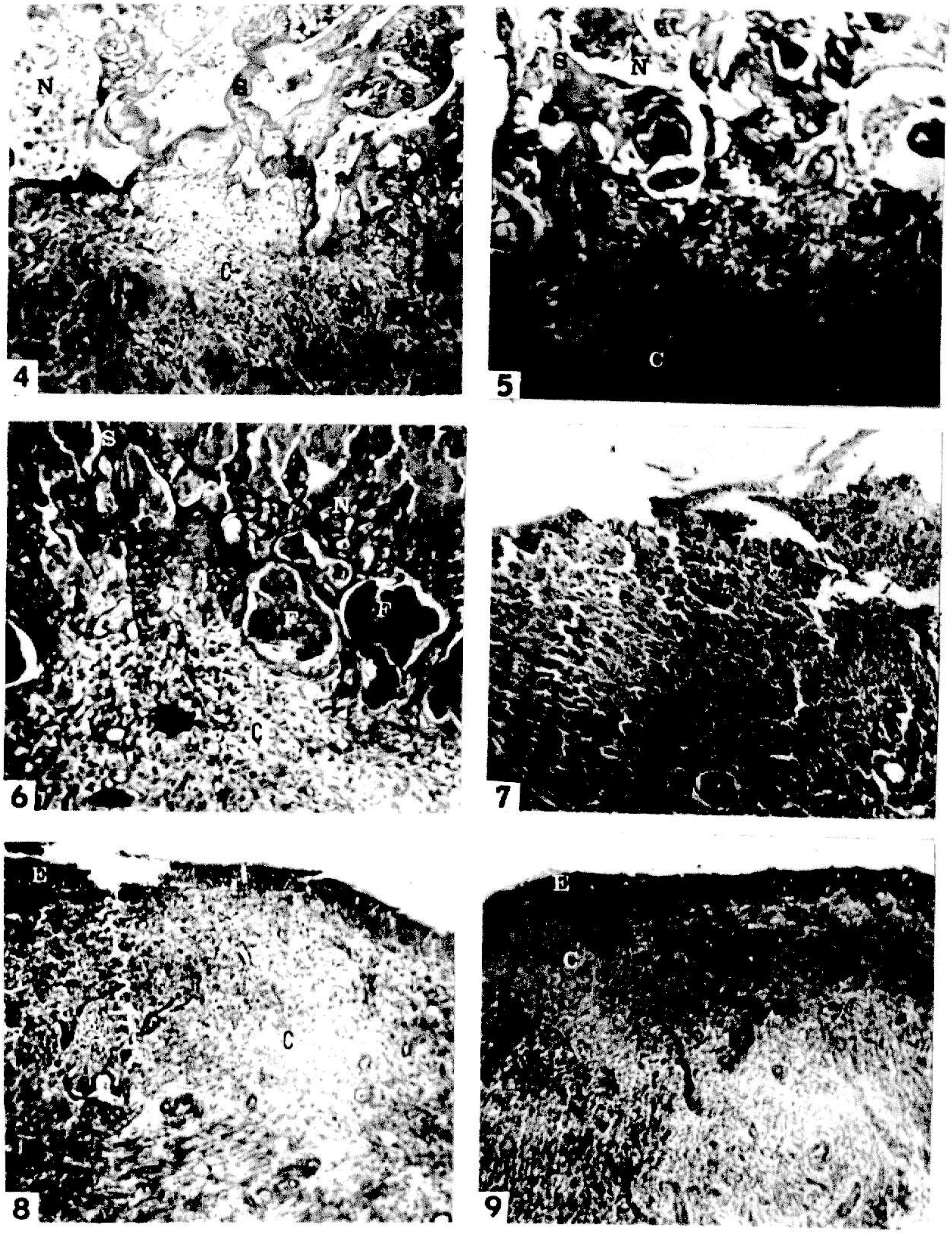
Fig. 6. Uterine biopsy from ewe 15 days postpartum (42x). Necrotic tissue (N) is more dense than normal at 15 days due to number of fetal villi that did not pull out at parturition. (C) Caruncle. (F) Fetal villi. (S) Septa.

Fig. 7. Uterine biopsy from ewe 20 days postpartum (42x). (C) Caruncle, surface rough with no epithelial covering. Necrotic tissue has sloughed.

Fig. 8. Uterine biopsy from ewe 25 days postpartum (42x). Caruncle (C) partially covered by (E) epithelium.

Fig. 9. Uterine biopsy from ewe 30 days postpartum (42x). Caruncle (C) completely covered by (E) epithelium.

PLATE II



EXPLANATION OF PLATE III

Fig. 10. Uterine biopsy from ewe 5 days postpartum (17x). (C) Caruncle. (N) Necrotic tissue.

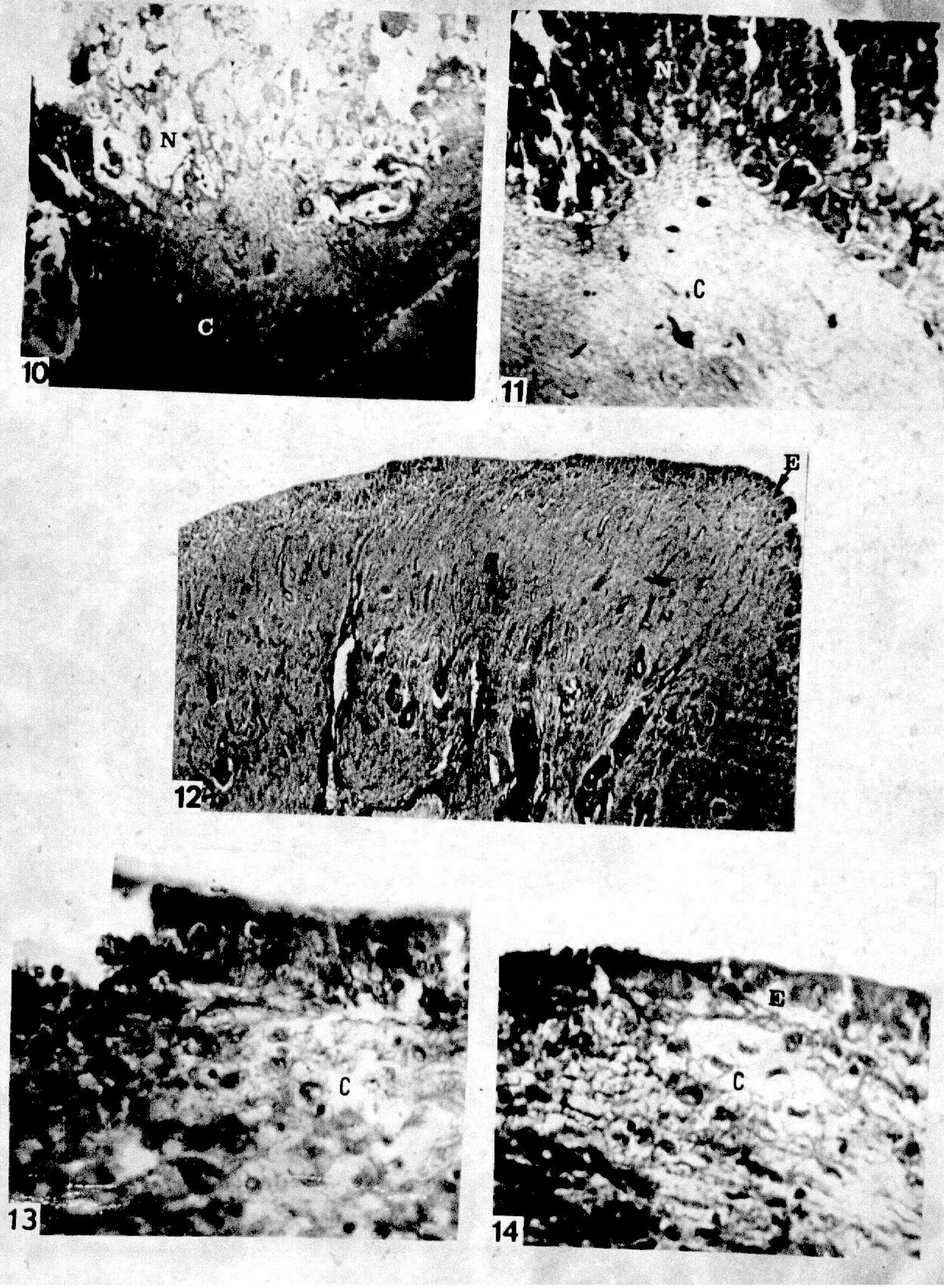
Fig. 11. Uterine biopsy from ewe 15 days postpartum (17x). (C) Caruncle. (N) Necrotic tissue.

Fig. 12. Uterine biopsy from ewe 20 days postpartum (17x). (C) Caruncle after necrotic tissue has sloughed. (E) Epithelium just beginning to form over caruncle.

Fig. 13. Uterine biopsy from ewe 25 days postpartum (270x). (C) Caruncle. (E) Epithelium.

Fig. 14. Uterine biopsy from ewe 30 days postpartum (180x). (C) Caruncle completely covered by (E) epithelium.

PLATE III



It was of interest to determine if surgery affected the rate of involution. As shown in table 7, when comparing 20 and 25 day first laparotomy ewes with 20 and 25 day second laparotomy ewes, respectively, there was no apparent detrimental effects of the surgery on involution processes.

TABLE 7. EFFECT OF FIRST LAPAROTOMY ON UTERINE INVOLUTION AT THE SECOND LAPAROTOMY

	20 Day		25 Day	
	1st	2nd	1st	2nd
Gravid Horn				
Width	18.0	17.6	13.3	18.0
Length	11.0	11.1	9.8	10.8
Non-Gravid Horn				
Width	19.0	18.0	13.0	14.0
Length	10.0	10.5	9.5	9.0

The CL of pregnancy generally was not visually detectable after 15 days postpartum. Follicles greater than 3 mm began appearing by 10 days postpartum and the number of follicles 3 mm or greater remained constant after 15 or 20 days postpartum (table 8). This follicular growth indicates the ovaries are capable of responding to gonadotropins at this point and if ovulation occurs by 20 days postpartum then the limiting factors in getting the ewe pregnant must be unfavorable uterine environment or defective ova. This is in agreement with Foote (1968). The breeding results as shown in table 9 indicate that anestrous ewes are as capable of exhibiting estrus and mating 25 days postpartum as they are 35 or 45 days postpartum. Although 68% of the ewes exhibited estrus and mated, none

TABLE 8. NUMBER AND SIZE OF FOLLICLES AND CORPORA LUTEA PRESENT DURING THE FIRST 30 DAYS AFTER PARTURITION

	Days Postpartum					
	5	10	15	20	25	30
Av. Size of Largest Follicle per Ewe	1.7(2)[a]	5 (2)	5 (3)	5 (2)	6.6(5)	6.0(3)[b]
Ovary Without C.L. of Pregnancy						
Av. No. of Follicles Over 3 mm per Ovary	0 (1)	1 (2)	2 (2)	2 (1)	1.3(3)	1.5(2)
Ovary With C.L. of Pregnancy						
Av. No. of Follicles Over 3 mm per Ovary	0 (3)	1.5(2)	.75(4)	2.3(3)	1.1(7)	1.5(4)
Av. Size of C.L. of Pregnancy	4.3(3)	4.3(3)	1.4(4)	0 (3)	0 (7)	0 (4)

[a]Number of observations.

[b]One ewe in group had just ovulated on day 29, thus it was calculated as a 10 mm follicle.

conceived from this mating. A higher percent of ewes that had twins mated at the designated time than ewes that had singles. Only 3 of 17 ewes that had 2 or more lambs failed to mate while 4 of 4 ewes that had singles failed to mate at the designated time.

Data in table 8 indicates follicular growth had resumed in comparable ewes by day 20; however, no ovulations had occurred. This is probably because the ewes were in anestrous during this time of year. According to Foote (1968) ewes marked by rams following PMS injection have most likely experienced ovulation along with estrus. If this is true then one reason for low conception could be unfavorable uterine environment. It is not known if the uterine environment caused poor sperm transport or if fertilization occurred without implantation. Hulet (1968) reported improved embryo survival in estrogen treated ewes. In this experiment estrogen pretreatment

TABLE 9. NUMBER OF EWES MATING AT 25, 35, OR 45 DAYS POSTPARTUM

Days Postpartum	No. of Animals	No. in Estrus	Not in Estrus	No. Lambed
25	8	6	2	0
35	8	5	3	0
45	6	4	2	0

did not improve conception rate (table 10). Dosage differences in days ewes were bred postpartum and the season of the year they are bred may account for the dissimilar results.

TABLE 10. MATING RESPONSE FOLLOWING ESTRUS SYNCHRONIZATION OF POSTPARTUM EWES WITH OR WITHOUT STILBESTROL PRETREATMENT

	No Estrogen Pretreatment	Estrogen Pretreatment	Total
Group 1			
Marked	3	3	6
Not Marked	1	1	2
Group 2			
Marked	2	3	5
Not Marked	1	2	3
Group 3			
Marked	2	2	4
Not Marked	1	1	2
Total No. of Ewes	10	12	22

SUMMARY

Data collected on ten lactating western and black faced ewes indicated that uterine involution occurs in three stages: (1) reduction in size, (2) loss of necrotic tissue, and (3) epithelial repair. These processes are generally complete 25 to 30 days postpartum with reabsorption of necrotic tissue requiring the longest period of time. The CL of pregnancy regressed and follicular growth began by day 15 postpartum.

A breeding trial involving 22 postpartum western and black faced ewes indicated that estrus could be induced with progesterone and PMS. Ewes were as sexually receptive to rams when estrus was induced 25 days postpartum as they were when estrus was induced 35 or 45 days postpartum. No ewes lambed as a result of the mating regardless of the time of mating or if stilbestrol was used as a pretreatment.

Estrus occurred as early as 25 days postpartum but no conception resulted. It is hypothesized that if uterine involution in general and more specifically the absorption of the necrotic tissue could be hastened by some means then the occurrence of twice a year lambing would be enhanced.

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to his major professor, Dr. Guy Kiracofe, for his guidance throughout the author's graduate studies and his assistance and consideration in preparing this manuscript.

The author is also indebted to committee members Dr. David Ames for his guidance in procurement of animals and to Dr. Robert Schalles for his expert help in statistical analysis.

The author is indebted to Dr. H. T. Gier, Department of Zoology, for his aid in histological preparations and observations. He is also appreciative for his advice and for the use of his photographic equipment and facilities.

The author also wishes to express his appreciation to his fellow graduate students, Mr. Frank Masincupp and Mr. Gary Brower, for their assistance with the laparotomies and the many noon hour conferences.

The author is also indebted to Marsha Gum for her typing assistance in preparing this manuscript.

The author is especially indebted to his parents, Mr.and Mrs. Leslie W. Kohl, for their support and understanding during the author's graduate career, and to his wife, Joanne, for her patience, encouragement, and thoughtful aid.

LITERATURE CITED

Barker, H. B., and E. L. Wiggins. 1964. Estrual activity in lactating ewes. J. Animal Sci. 23:973.

Boyd, Leroy H. 1968. Effect of management and environment on lambing rates. Proc. from Symp. on Physiol. of Reprod. in Sheep. American Sheep Producers Council.

Dutt, R. H. 1953. The effect of low environmental temperature on initiation of the breeding season and fertility in sheep. J. Animal Sci. 12:945.

Foote, W. C. 1968. Control of reproduction with or without hormones. Proc. from Symp. on Physiol of Reprod. in Sheep. American Sheep Producers Council.

Foote, W. C., J. W. Call, and C. V. Hulet. 1967. Effects of lactation and hormone treatment on ovulation, estrus and uterine involution in the ewe. J. Animal Sci. 26:943. (abstr.)

Foote, W. C., and C. V. Hulet. 1966. Ovarian and uterine responses to PMS and 17-B-oestradiol in progesterone-treated ewes. J. Reprod. Fert. 11:51.

Gier, H. T., and G. B. Marion. 1968. Uterus of the cow after parturition: Involutional changes. Am. J. Vet. Res. 29:83.

Hansel, W. 1964. A summary of estrous cycle synchronization experiments. Proc. Conf. on Estrous Cycle Control in Domestic Animals. USDA Miscellaneous Publication No. 1005.

Holst, P. J. 1969. The ovarian response to pregnant mare serum (PMS) administered after intravaginal progestagen treatment of cyclic and anoestrous ewes. Aust. J. of Ag. Res. 20:1143.

Hulet, C. V. 1968. Factors affecting fertility in the ewe and ram. Proc. from Symp. on Physiol. of Reprod. in Sheep. American Sheep Producers Council.

Hulet, C. V., and W. C. Foote. 1967. Induction of fertile estrus in lactating and dry anestrous ewes using oral progestagens and repeated PMS treatment. J. Animal Sci. 26:545.

Hunter, G. L., and A. W. Lishman. 1967. Postpartum ovulation and estrus in spring lambing ewes. J. Reprod. and Fert. 14:473.

Moore, N. W., and P. J. Holst. 1967. The evaluation of progesterone and SC-9880-impregnated intravaginal sponges used with PMS for the induction of breeding in the anoestrous crossbred ewe. "In the Control of the Ovarian Cycle in the Sheep." pp. 167-180. Sydney University Press.

Robinson, T. J. 1954. The production of coincident oestrus and ovulation in the anoestrous ewe with progesterone and pregnant mare serum. J. Endocr. 10:117.

Shelton, Maurice. 1968. Lambing out of season and accelerated lambing. Proc. from Symp. on Physiol. of Reprod. in Sheep. American Sheep Producers Council.

Terrill, C. 1968. Proceedings from Symposium on Physiology of Reproduction in Sheep. American Sheep Producers Council. p. 156.

Wagner, J. F. 1964. Hormonal control of reproductive activity in the ewe. Proc. Conf. on Estrous Cycle Control in Domestic Animals. USDA Miscellaneous Publication No. 1005.

Wagner, J. F. 1968. Proceedings from Symposium on Physiology of Reproduction in Sheep. American Sheep Producers Council. p. 64.

Wagner, J. F., and E. L. Veenhuizen. 1968. Proceedings from Symposium on Physiology of Reproduction in Sheep. American Sheep Producers Council. p. 122.

Uren, Andrew W. 1935. Involution of the uterine mucosa in the ewe. Michigan State College of Agri. and Applied Sci. Tech. Bull. No. 144.

Yeates, N. T. M. 1958. Foetal dwarfism in sheep. An effect of high atmosphere temperature during gestation. J. Agri. Sci. 51:84.

UTERINE INVOLUTION AND POSTPARTUM CONCEPTION IN THE EWE

by

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B. S., Kansas State University, 1969

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Animal Science and Industry

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

Ten ewes were laparotomized either once or twice and tissue biopsies were taken at 5, 10, 15, 20, 25, and 30 days postpartum in order to determine the normal involution process of the ovine uterus after lambing. A concurrent breeding trial was conducted to correlate uterine events with the ability to conceive and maintain pregnancy.

Laparotomy results indicated that extensive uterine shrinkage occurred the first five days postpartum. Shrinkage continued with the day ten uterus being approximately one half the width of the day ten uterus. After day 25 the decrease in size was slow and began to level off by 30 days. The decrease in size of the uterus the first ten days appeared to be from expulsion of the lamb (s). After day ten the necrotic tissue (mostly of maternal origin) began to slough and be reabsorbed; this was complete by day 25. The necrotic tissue was primarily caruncle caps and fetal villi that were not expelled at birth. Once the necrotic tissue was sloughed, the epithelium which lines the lumen of the uterus regenerated over the caruncle by growing from the uterine glands.

The breeding trial consisted of randomly allotting 22 Hampshire and Rambouillet crossbred ewes to three groups to be bred either 25, 35, or 45 days postpartum. Estrus was induced on these days by implanting progesterone and administering PMS at the time of implant removal. One half of the ewes in each group was injected with stilbestrol ten days prior to the progesterone implant. Results indicate that the postpartum ewes were as capable of exhibiting estrus and mating 25 days postpartum as they were 35 or 45 days postpartum. The percent of the ewes showing estrus (marked by ram) in 25, 35, and 45 day groups were 75, 62.5, and 66.6, respectively. None of the ewes conceived as a result of this mating.

These data indicate that estrus can be induced in ewes within 30 days after parturition and during the normal anestrous period, but conception rate is low. Uterine environment may not be suitable to maintain a pregnancy at this time, although histologically involution appears complete.