The effects of pre-breeding and post-breeding feed treatments on reproductive phenomena of ewes managed under range conditions
by Victor L Hoxsey

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Animal Industry
Montana State University

Abstract:
The effects of pre-breeding and post-breeding treatments on reproductive phenomena of eves managed under range condition were studied. Experimental animals (203) were from a band pf approximately 840 grade ewes, of which 36 animals were identified to be Slaughtered 3 days postbreeding . Observations were made on ovulation rate, fertilization rate, abnormal ova, and any abnormalities in the slaughter ewes which could prevent or cause the afore mentioned. The remainder of the ewes Served as a control group,and allowed to lamb using this information to compare with slaughter ewe data. Two pre-breeding treatment's were established., flushed and non-flushed (of which all ewes were on), The non-slaughter ewes Were placed on 3 post-breeding treatments.

Ovulation rate and fertilization rate were 1.31 and 82.4 percent and 1.12 and 76,9 percent for the flushed and non-flushed slaughter eweS respectively. The number of abnormal ova was the same for ,both groups, flushing resulted in a higher percent of twin births, a higher percent of ewes lambing and a higher lambing percent per eWe bred in the- un-Slaughtered group, resulting from first breeding only.

EweS On the three post-breeding treatments- showed a consistent difference in body weight and condition scope throughput the gestation period,, there was also a difference between age, where the mature eWeS, seemed mope able to cope with the environmental conditions than did the two-year-old ewes. The average pounds of lamb born per ewe bred .showed a significant difference between ages and among post-breeding treatments.

Estimated embryonic death loss in this .Study was calculated to be 12.5 percent and 7.6 percent in the flushed and non-flushed groups,, ' respectively.

10488

THE EFFECTS OF PRE-BREEDING AND POST-BREEDING FEED TREATMENTS ON REPRODUCTIVE PHENOMENA OF EWES MANAGED UNDER RANGE CONDITIONS

39

by

VICTOR L. HOXSEY

A THESIS

Submitted to the Graduate Faculty

in

partial fulfillment of the requirements

for the degree of

Master of Science in Animal Industry

at

Montana State College

Approved:

Fred S. Willson
Head, Major Department

Arthur Howerland
Chairman, Examining Committee

Leon H Johnson
Dean, Graduate Division

Bozeman, Montana
August, 1959

ACKNOWLEDGEMENT

The writer is very grateful for the assistance and inspiration given to him by his advisor, Arthur S. Hoversland and his joint-advisor, J. L. Van Horn.

I wish to express my appreciation to Dr. David W. Blackmore and Kenneth Colman for their suggestions and assistance in statistical analysis; to Dr. O. O. Thomas and Dr. C. J. D. Brown for their assistance in reviewing this thesis; to G. M. Van Dyne for assistance in describing the native range upon which the trial was conducted; and to staff members, graduate students, and the ranch crew for their assistance and advice in collection and interpretation of the data.

I wish to thank my wife, Evelyn, for her devoted time and understanding in the preparation of this thesis.

The writer is very appreciative of the financial assistance granted him throughout his graduate program in the form of a graduate assistantship.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd.)

INDEX TO FIGURES

INDEX TO TABLES

INDEX TO APPENDIX

ABSTRACT

The effects of pre-breeding and post-breeding treatments on reproductive phenomena of ewes managed under range condition were studied. Experimental animals (203) were from a band of approximately 840 grade ewes, of which 36 animals were identified to be slaughtered 3 days post-breeding. Observations were made on ovulation rate, fertilization rate, abnormal ova, and any abnormalities in the slaughter ewes which could prevent or cause the afore mentioned. The remainder of the ewes served as a control group and allowed to lamb using this information to compare with slaughter ewe data. Two pre-breeding treatments were established, flushed and non-flushed (of which all ewes were on). The non-slaughter ewes were placed on 3 post-breeding treatments.

Ovulation rate and fertilization rate were 1.31 and 82.4 percent and 1.12 and 76.9 percent for the flushed and non-flushed slaughter ewes respectively. The number of abnormal ova was the same for both groups. Flushing resulted in a higher percent of twin births, a higher percent of ewes lambing and a higher lambing percent per ewe bred in the unslaughtered group, resulting from first breeding only.

Ewes on the three post-breeding treatments showed a consistent difference in body weight and condition score throughout the gestation period. There was also a difference between age, where the mature ewes seemed more able to cope with the environmental conditions than did the two-year-old ewes. The average pounds of lamb born per ewe bred showed a significant difference between ages and among post-breeding treatments.

Estimated embryonic death loss in this study was calculated to be 12.5 percent and 7.6 percent in the flushed and non-flushed groups, respectively.

INTRODUCTION

Scientists have adopted numerous methods in the study of lowered fertility in domestic animals and many contributions have been made to the over-all problem. A large amount of the work has been concentrated on the male's part in fertility and now sperm can be handled without fear of damage, and stored for almost an indefinite period of time with little or no loss of potency.

Since the mammalian ovum was first recovered, investigators have been studying methods for its isolation and techniques which will allow work with ova for more than a few hours without deterioration resulting. Greater interest has been aroused during recent years as a result of the more intensive efforts made to analyze the causes of reproductive failure. While it has been recognized that on some occasions embryonic mortality may be the result of infectious disease, that which has attracted a great deal of interest appears to arise apart from infection.

The number of living young depends on the number of ovulations, the number of eggs fertilized, the number of fertilized eggs that are capable of normal development and later implantation and survival of embyros or fetae throughout gestation. A variety of factors play a significant role in each of these critical events. It is of great economic importance that each animal should produce to the maximum of its capabilities. Efficiency of animal production may very well mean the difference between profit and loss to the stockman. One means of increasing efficiency is through increasing higher reproduction rates.

Embryonic mortality as indicated by many research workers contributes greatly to the inefficiency of reproduction. Therefore, this study was designed to investigate the effect of pre-breeding and post-breeding supplementary feeding on ovulation rate, fertilization rate, and estimated embryonic mortality of range ewes.

LITERATURE REVIEW

It has been recognized that the reproductive system of domestic animals can be influenced very materially by changes in environment. Some of the early observers and research workers (Heape, 1899; Aristotle, 1910; Darwin, 1905; and Marshall, 1908) commented on the increased fertility of sheep under favorable environmental conditions.

Ovulation and fertilization rate in general.

Clark (1934) states that Von Baer recovered sheep ova from the oviducts in the year 1828. He described the nucleus as being loose and shrunken with the yolk particle being held together on the outer surface, and referred to the zona pellucida as the "slim."

Bonnet (1884) was unable to follow the stages of development prior to the twelfth day. Assheton (1898) described the ova and embryos of sheep quite accurately and noted that the ovum reached the uterus early on the third day while in the 8 cell stage.

Allen *et al*. (1931) reported that the earliest ovulation occurred $23\frac{3}{4}$ hours after the first signs of heat and the ovum remained unsegmented up to 50 hours. By 66 to 98 hours, the 4 to 6 cell stage had been reached.

Green and Winters (1935) also stated that ovulation occurred as the animal was passing from heat. It was found that sperm reached the infundibulum of the oviduct within 5 hours after copulation with the time of travel the same in ewes that are not in heat. The life of the unfertilized sheep ovum was estimated at less than 24 hours while that of the sperm was about 24 hours.

There is evidence that all of the ova released from the follicles are not fertilized. Corner (1921) was able to recover 213 (91.8 percent) of the ova from the fallopian tubes of 26 sows whose ovaries contained a total of 220 corpora lutea. The loss of ova may be ascribed to their disappearance in the body cavity or to their incomplete recovery from the tubes. However, Corner's results substantiate the reliability of the corpora lutea count as an index of the number of ova released from the ovaries.

Squiers et al. (1952) working with swine, recovered 80 percent of the ova shed and found that 95 percent of these had been cleaved approximately 25 hours after coitus. They used cleavage as a criterion for fertilization. They found that 37 of the 52 sows from which cleaved ova were recovered had all of their ova fertilized. Further observations by Squiers was that 23 percent of the ova could not be accounted for 25 days after mating. Five percent of the ova were considered lost due to non-fertilization. Regressing embryos found at 25 days accounted for 7 percent of the death loss. The total loss represented an embryonic mortality of 35 percent on the 25th day after mating; the remaining 65 percent apparently represented normal embryos.

Wilson et al. (1948) working with swine found that 25.8 percent of the ova ovulated were either not fertilized or failed to develop into embryos.

Dutt et al. (1954) divided 180 crossbred yearling ewes into two groups as they came into heat and were bred. Ninety of the ewes were slaughtered three days after breeding to determine the ovulation rate, the fertilization rate and the condition of the ova. The other ninety ewes were allowed to go to lambing time. The following results were reported: All ewes slaughtered had ovulated as indicated by 132 corpora lutea present when the ovaries were examined. Recovery rate was 96 percent and of the 127 ova recovered, 70 were fertilized and 57 non-fertilized. Several abnormal conditions were also reported.

Fifty-three lambs were born of the control ewes. This represented a lambing rate of 42 percent based on 127 ova ovulated or 59 percent of the 90 ewes bred. The authors stated that failure of the ova to become fertilized was the most important factor in accounting for the low lambing rate.

The reproductive rate of the ewe varies considerably from one year to another. Van Horn _et al._ (1952) reported that over a four-year period the percent of live lambs recorded per ewe bred varied from a low of 98.9 percent to a high of 125.1 percent. Asker and Ragab (1954) reported lambing percentages between years in one flock as low as 106 percent and a high of 143 percent.

One could very well conclude that from the above, ovulation rate, fertilization rate and embryonic mortality may have an important role in lamb production from year to year.

Research workers in New Zealand (New Zealand Department of Agriculture, 1950) obtained the ovulation rate that occurred at various heat periods from slaughter ewes. The maxima potential lambing rate from these 5-year old Romney ewes if they had been mated at the first, second, and third heat period were 116, 180, and 170 lambs, respectively, per 100 ewes mated. The greater number of eggs released at the second or third heat periods when compared with the first heat period is of considerable interest. It suggests the possibility that mating the ewes at their second or third heat period may cause an increase in the lambing potential.

Abnormalities of fertilized bovine ova were shown by Winters _et al_. (1942), and they called attention to the possible role of such abnormalities in lowered fertility. Laing (1949) had data on 11 virgin heifers, inseminated to a single bull of known high fertility, which showed 100 percent fertilization. His observation was at least suggestive that the normal fertilization rate is high.

Evidence for the postulation that sterility may result from over fatness was presented by Asdell (1949). Reproductive tracts of 7 heifers and cows that were fat and sterile were examined. In all animals, there were fatty deposits in the ovaries, few follicles and an unusually large amount of orange pigment in the stroma. Although the ovaries were normal, they were smaller than usual and there was an absence of large follicles.

Effects of nutrition on ovulation rate.

Marshall and Potts (1921) reported that by flushing Southdown ewes the lambing percent at birth was increased by 18 percent. Nichols (1924) reported lambing rates of 150 and 125 lambs per 100 ewes flushed and non-flushed, respectively. Clark (1934) found that the number of eggs released from the ovary was greater from flushed ewes if they were thin at the start of the treatment. Clark (1934) found no evidence that flushing increased ovulation rate in a group of Shropshire ewes that were in good condition prior to flushing.

Marshall (1948) concluded there can be no doubt that whatever the actual condition of the animal, a rising or improving state of nutrition before service is more favorable to fertility than a stationery or falling one, indicating that the supply of additional foods given in this way has a stimulating effect upon the reproductive organs and favors follicular development and the maturation of a greater number of ova. He concluded the supply of good food raises the nutrition and increases bodily vigor and fertility, while over feeding and lack of sufficient exercise lead to excessive storage of fat and reduction of vigor and fertility.

Polovceva et al. (1938) stated that feeding a concentrate 20 days prior to breeding and continued to lambing, increased the number of multiple follicles and number of lambs born. The lamb crop was 133 percent and 119 percent for the flushed and control ewes respectively. McKenzie and Terrill (1937) reported that flushing Rambouillet ewes increased the ovulation rate from 1.06 to 1.15 per ewe.

Research workers in New Zealand (New Zealand Department of Agriculture, 1950) attributed the increased lamb crop in the flushed ewes to an increase in ovulation rate. Laing (1955) stated that flushing increased the number of follicles matured and the number of ova fertilized. Hammond (1957) quoted, "In all breeds the number of eggs shed at tupping, and hence the lambing percentage, can be increased by flushing the ewes before the rams are put in."

Hoversland *et al*. (1958) found ovulation rates of 1.25 and 1.20 for supplemented and control animals, respectively. Of the ova recovered, 9.1 and 17.6 percent were unfertilized in the supplemented and control groups, respectively.

These authors conclude that the results of this trial would indicate abnormal ova and lack of fertilization were the major factors in a lowered lamb drop. However, this information was based on small numbers.

El-Sheikh *et al*. (1954) reported ewes on high level nutrition had a significantly higher ovulation rate. Fertilization rate was also higher but not significantly for ewes on higher feeding level.

Smith (1937) indicated that the initiation of a flushing program for sows, resulting in a gain of $\frac{3}{4}$ to 1 pound daily a week before they are to be bred and until they are safely in pig, stimulates all the vital functions. It had been observed that sows, when gaining in flesh and thrift, tend to come in heat promptly and to be more susceptible to impregnation when bred. The above also applies to sows in thin condition.

Briggs *et al*. (1942) concluded from an eight-year study, practice of flushing was not profitable. The experiment further indicated that the economics of flushing depends upon the condition of the ewes before flushing. He stated that if the ewes are in good condition there is no significant value realized from flushing whereas if the ewes are in poor condition just prior to the breeding season there is a definite profit in flushing.

Darrock and co-workers (1950) stated that in the pre-breeding and breeding periods, the thin ewes showed greater response to feeding concentrates than ewes in good condition. During the early pregnancy period, the ewes in good condition gained the most. No important effects on birth or weaning weights were observed from the feed treatments. Flock fertility was increased by 10 and 9 percent by feeding supplement in the pre-breeding, and breeding periods, respectively. Good condition ewes produced 11 percent more lambs at birth and at weaning than the thin ewes.

Esplin and co-workers (1940) conducted an experiment on feeding ewe lambs during their first winter. Although there was only a 2 to 3 pound difference in weight as yearlings in October, there was a marked difference in breeding efficiency. The lot fed group had a 65 percent lamb crop while the range-fed had only a 45 percent lamb crop. The authors advanced the theory that there was better development of the reproductive tract while very young and also, possible storage of some essential element or elements in the body which are not available in sufficient amounts in range forage.

El-Sheikh et al. (1955) reported on the reproductive rate of yearling ewes which were given two different levels of feed. The ewes were started on feed in January and slaughtered in late summer or early fall. One group received hay for roughage and the other group received two pounds of a grain mixture in addition to the roughage.

They reported ovulation and fertilization rates for two consecutive years (1953-1954). The average number of ovulations per ewe for roughage plus grain was 1.81 and 1.66, whereas roughage only had rates of 1.27 and 1.04, respectively. The percentage fertilized ova was 66 and 83 for ewes on roughage plus grain, compared with 59 and 65 for ewes on roughage only.

Haines et al. (1956) studied effects of energy intake on reproduction of gilts. Limited fed gilts ovulated an average of 9.9 ova at first heat, compared to 12.8 ova by full fed gilts. These same gilts had mean ovulation rates of 10.8 and 13.8 in the second heat, respectively. The difference in ovulation rates between ration treatments shows the same trend as reported by Christian and Nofziger (1952), Robertson et al. (1951) and Self et al. (1955). However, Gossett and Sorensen (1956) found about the same ovulation rate under two levels of energy intake. The increased ovulation from first to second heat was apparently a normal phenomenon.

Effect of age on reproductive rate.

The ovulation rate was significantly affected by age. Marshall (1908) observed that starting with adolescent sterility, ovulation rate rose rather rapidly to its highest point then gradually fell with advancing age to senile sterility.

McKenzie and Terrill (1937) found ovulation rate increased to 3 or 4 years of age then decreased slightly. This increase is in close agreement with Goot (1951), who reported that the greatest rise in fertility takes place between age 2 and 3, gradually increasing to 5 years then declines. Terrill and Stoehr (1939) found that under range conditions there was a steady increase up to 5 years of age, in percentage of ewes lambing and percentage of live lambs born per ewe bred.

Most workers generally agree that there is a rise in reproductive rate up to the 5th or 6th year and then a gradual decline thereafter (Marshall and Potts, 1921; Hammond, 1948; Carlyle and McConnell, 1902; Nichols, 1924; Roberts, 1921; Johansson, 1932). Johansson (1932) reported about 22 percent increase in lambing rate from the first lambing to the fourth.

In swine, two separate effects of age were noted. Lush and Molln (1942) indicated that the third and fourth heats after puberty, ovulation rates were significantly higher than at the first and second. After the fourth or fifth cycle, the ovulation rate becomes stable. The second effect of aging shows up after the females have gone through one or more pregnancies.

Hoversland et al. (1958), studying the effect of flushing range ewes on reproductive performance, found a significant year effect as well as a significant year and treatment interaction. The combined data for the three-year period indicated that two-year-old ewes and mature ewes that gained in weight during the experimental period also reproduced at a higher rate as compared to ewes loosing weight. It also showed that flushing increased the proportion of multiple births by 9.9 percent and reduced the proportion of barren ewes by 2.2 percent. Two-year-old ewes responded quite differently to a flushing program than mature ewes under the conditions reported. The reproductive rate of two-year-old ewes was considerably lower than that of the mature ewes due to the higher rate of barren ewes.

Associated phenomena.

Marshall and Hammond (1948) reported that unfavorable weather conditions during the breeding season, such as snow-storms or drought will result in a decreased rate of twinning the following lambing season. Wallace (1907) reported that a low nutritive condition, when associated with exposure to cold wet weather, will cause temporary barrenness in cattle.

Phillips and Davies (1949) were able to show that, in West Wales, successful winter breeding of cattle was associated with areas of high winter temperature, but when other areas of Britain were examined it was not possible to demonstrate a similar clear correlation.

It is not easy to accurately apportion the incidence of lowered fertility among inherited and environmental causes, but the indication is that hereditary infertility is of low incidence. This can be inferred in cattle from the fact that most infertility is not repeated (Casida, 1950; Asdell, 1952).

Eriksson (1943) found in Swedish highland cattle that 30 percent of the cattle in these herds had hypoplasia of one, usually the left, ovary, and that 5 percent had bilateral hypoplasia. The hypoplastic ovary was significantly smaller than the normal ovary and was completely non-functional.

In a study involving 341 cows and 1,280 cow-service periods, Casida and Chapman, (1951) found that 18.8 percent of the cows had cystic ovaries. Confirming results obtained in Sweden and elsewhere, this study established the fact that the condition was inherited and that, in this particular herd, the heritability was 0.43.

Fertilization rates.

If the timing is proper and adequate quantities of viable sperm are present, the fertilization rate approaches 100 percent in polytocous females, Brambell, (1948). However, in cows and sheep, the species that have been studied most intensively, show fertilization rates varying from 60 to 85 percent (Wilson et al., 1948; Squires et al., 1952; Dutt, 1954; El-Sheikh et al., 1955).

Embryonic mortality in general.

Recognition of the importance of prenatal death in livestock production was first given special emphasis by Hammond (1914). He found on the basis of seven sows in various stages of pregnancy that the number of normal fetuses was 73 percent of the number of corpora lutea present in the ovaries. These data were increased in his 1921 report and on the basis of 22 sows the proportion of normal fetuses was 67 percent; the fetuses that were atrophic, 12 percent; and those missing entirely, 20 percent. He also presented data on 80 pregnant ewes which showed normal fetuses equal to 87 percent of the corpora lutea present. The number of atrophic fetuses and missing eggs were approximately equal.

The analysis of potential causes of embryonic death made by Hammond (1914) tended to eliminate disease as a factor. He believed this was true because dead and live embryos could exist side by side in the same uterus. Bacteria usually were not found and no particular pathology was usually present in the maternal tissues. The general nutrition of the mother did not seem to be a particular factor because much mortality occurred before embryos were large enough to be serious competitors for any restricted nutrient, and further he saw little relation between numbers of embryos in the early stages and amount of embryonic death. Hammond concluded that something inherent in the egg seemed the most likely cause. He suspected that the larger number of eggs produced by either ovary, the greater the amount of embryonic death, and interpreted it that ovarian nutrition was a limiting factor for the production of eggs capable of resulting in viable embryos. This hypothesis would at least be consistent with there being litter differences in embryonic death and also with the suspected difference between single and litter-bearing species in the amount of embryonic death.

In a later observation, Hammond (1921) found 32.6 percent fetal mortality in 22 sows. These animals had been slaughtered between the 14th and 60th day of gestation.

Corner (1921) was, in one case, able to recover 6 vesicles from a sow with 7 corpora lutea. Two of these were entirely normal, two were normal in texture but were collapsed and cup-shaped, two were abnormal, while one was unsegmented. The possible causes of early embryonic mortality were ascribed to: (a) pathological changes inherent in the germ-cells, (b) faults due to germ-cells, and (c) injuries which might affect the ovum during passage from the ovary to the uterus. Concerning the last cause cited, he mentioned the possiblility of chemically abnormal secretions from apparently normal uteri.

Corner (1923) studied the problem in swine and gave some recognition to the importance of stage of gestation in connection with the estimation of the embryonic death. He was puzzled by an apparent loss in his packing-house material of 40 percent of the embryos in the first few days of gestation whereas in later stages only 20 to 30 percent of the embryos appeared to be degenerate or missing. His explanation assumed that some sows which would appear at earlier stages as having both normal and abnormal embryos would finally lose all their embryos and thus would not be recognized as having been pregnant in later stages.

Warwick (1928) calculated the percent of ova lost at various stages of gestation. He concluded that the loss tended to increase as gestation advanced. Uteri from sows in the 20th to 40th-day period of gestation had from 20 to 25 percent of the ova missing. Degenerating embryos were found to be most common in the earlier stages.

Henning (1939) estimated the incidence of fetal mortality in sheep from the discrepancy between the number of corpora lutea in the ovaries and the number of live fetuses in the uteri. He pointed out the fact in his material that early embryonic death with complete absorption could not be detected. Over-all, he found 16 percent of the corpora lutea were not accounted for by live fetuses, a figure which is but slightly higher than that noted earlier by Hammond (1921).

Henning also called attention to the increase in the mortality of the fetuses with the increase in number of ova shed; 8 percent with one ovum, 26 percent with two, and 43 percent with three.

The authors reported that embryonic death appeared to be greater during the first 18 days following service (20%) than during the remainder of gestation (9%).

Nutrition.

Robertson et al. (1951) investigated pasture, protein level, and feeding level as factors that possibly affect variation in the embryonic death of swine. Limited effects only were noted for pasture and for level of protein. The most general effect was from full feeding. The percentage of eggs resulting in normal embryos at 25 days gestation was less by 25 percent in those animals that were full fed.

Christian et al. (1952) obtained similar results. They compared gilts that were on high and low planes of nutrition. The estimated prenatal death rate in the high plane animals was greater by 27 percent than in the low plane animals. They found that even though a higher ovulation rate was obtained by full feeding, the greater embryonic death resulted in smaller litters than from the gilts on the low plane of nutrition.

El-Sheikh et al. (1954) reported that the embryonic survival rate was lower in the ewes on the higher level of feeding. The difference in embryonic survival rate between the two groups of ewes was highly significant. Also there was a significant interaction between year and level of feeding on embryo survival.

Ova classification.

Hart (1956) examined over 1,000 ova and made certain classifications. He stated that a fertilized sheep's ovum may always be identified by the numerous surplus sperms which can be found adhering to or embedded in the zona pellucida. A single cell ovum was deemed to be normal, up to its present stage of development, if it was fertilized or able to be fertilized, when recovered. It was accepted that all dividing ova recovered had been and were normal up to their present stage of development unless obvious signs of abnormalities were then appearing.

Other workers have used cleavage as the critera for fertilization of the ova recovered (Dutt, 1954; El-Sheikh et al., 1955; Squires et al., 1952; Wilson et al., 1948).

CONDITIONS OF THE EXPERIMENT

Experimental animals.

The sheep used in this study were from a band of approximately 840 grade ewes, owned by the Montana Agricultural Experiment Station. They were Rambouillet, Targhee and Columbia ewes bred and managed at the Red Bluff Ranch near Norris, Montana. The ages varied from long yearlings to seven-year-olds. The entire band had previously been culled, eliminating all ewes of unsound condition.

Description and location of the range.

The ranges grazed by the experimental band were on the Red Bluff Ranch. The elevation varies on the portion of the range grazed from approximately 4650 feet up to 5400 feet. Most of the range was characterized by relatively steep slopes dissected by deep drainages. Slopes vary from approximately 0 to 34 percent. Portions of the winter range were largely on south-facing slopes, whereas much of the fall range was on gentle north-facing slopes. Much of the spring range was on relatively steep, south-facing slopes.

Soils on the range grazed by the experimental band were largely light-textured with heavier textures occurring at the lower elevations and more gently sloping portions of the range. The higher portions of area grazed were characterized by rockiness and uneven topography.

Water was available from springs and Hot Springs Creek. In general, the water is of good quality and was plentiful for the sheep. In addition, snow water was available during portions of the late fall and winter months.

The sheep were not forced to trail excessive distances to secure water.

The vegetation on the ranch grazed by the experimental band is dominated by bluebunch wheatgrass (Agropyron spicatum). Other grasses of considerable importance on the winter range were needle and thread (Stipa comata), junegrass (Koeleria cristata), western wheatgrass (Agropyron smithii), bluegrasses (Poa spp.), and sedges (Carex spp.). Forbs on the winter range were unimportant as a source of feed. The only forbs grazed to any extent were the dried twigs, leaves, and pods of several of the locos (Oxytropis spp.), lupines (Lupinus spp.), and milkvetches (Astragalus spp.). An important halfshrub common on the winter range and highly palatable to the sheep was fringed sagewort (Artemisia frigida). Shrubs of importance included bitterbrush (Purshia tridentata), rabbitbrushes (Chrysothamnus spp.), and scattered plants of big sagebrush and silver sagebrush (Artemisia tridentata and Artemisia cana).

The spring range is characterized by essentially the same species as the winter range, with the exception of bitterbrush. Spring ranges are perhaps steeper with sharper draws. Along the bottom of the draws and the slopes there are extensive stands of various browse plants, including shunk-brush sumac (Rhus trilobata), ninebark (Physocarpus malvaceus), squaw current (Ribes cereum).

Most of the fall range is comparatively free of browse plants. It is dominated by the grasses common on the winter and spring ranges and, in addition, at the higher elevations there are considerable stands of Idaho fescue (Festuca idahoensis). The forbs common on the winter range are present on the fall range with extensive stands in certain locations of white pointloco (*Oxtyropis serecia*) and prairie milkvetch (*Astragalus straiatus*).

These ranges are open to grazing during most of the winter except when there is extreme accumulation of snow. Even during heavy snow periods, the south-facing slopes of the winter range are available for grazing.

METHODS AND PROCEDURE

Three wintering regimes and two pre-breeding treatments were established. All ewes (203) were assigned at random, within breed, age and pre-breeding groupings.

Eighteen ewes from each of the pre-breeding treatments were identified with a red ear tag to be slaughtered 3 days post-breeding to determine ovulation and fertilization rates. The remainder of the ewes were allowed to lamb and lambing data were collected to compare with slaughter data.

Throughout the experimental period all ewes were individually weighed with approximately 16 hours shrink previous to weighing.

Pre-breeding.

All ewes were weighed November 5, 1958 and half of the ewes assigned to each wintering regime were fed one pound of a 30 percent protein pellet per head per day 14 days prior to breeding and continued until they were bred. The ingredients of this protein pellet are shown in Table I.

TABLE I. Feed composition of the supplement fed.

Ingredients:	%
Barley	11.8
Cane molasses	6.0
Cottonseed meal	20.3
Linseed meal	20.3
Soybean meal	20.4
Dehydrated alfalfa meal	20.0
Salt	1.0
Trace mineral	0.15
AD-SEAL-IN	0.05
	100.00
Percent crude protein	31.1

The flushing period started November 8. Each morning the ewes were divided into two groups and the flushed ewes were group fed one pound of supplemental pellet per head. After supplemental feeding, which took only a short time, all ewes were herded on the range together. All ewes were individually weighed on November 19.

Breeding.

Breeding began November 22. Each night the ewes were brought in from the range and by means of a cutting chute, they were separated into three breeding pens. Rams of the three breeds were turned into their respective breeding pens at the rate of 3 rams per 100 ewes. All rams were ochred on the brisket to facilitate detection of ewes bred during the night. The following morning the rams were taken out and put into a day holding area with available feed and water. Each morning ewes marked by the ram and designated for slaughter were identified and breeding dates recorded. On the third day post-breeding they were transported to the meats laboratory at Montana State College and slaughtered the same day. Upon slaughter, the reproductive tract was removed and trimmed of all excess connective tissue and recent ovulation points observed and recorded. The oviduct was severed from the mesosalpinx leaving one inch of the cornu attached. A small hypodermic needle with 3 cc. of physiological saline solution was used to flush the ova down the oviduct. Flushing was initiated by inserting the needle into the infundibulum end of the oviduct. The ova and saline solution were recovered in a watch glass. If the ova were not recovered from the oviducts after several flushings, the uterus was then flushed. With the aid of a dissecting microscope the ova were located and transferred to a hanging drop slide by means of a capillary tube. The ova were then examined under a high power microscope for normality and cleavage.

The critera for fertilization in this study was cleavage, however ruptured ova where only the zona pellucida was recovered were classified as fertilized if sperm were present. This method of classification was based on work of Hart (1956). All uncleaved ova were classified as non-fertilized.

Post-breeding.

The Montana Agricultural Experiment Station nutrition band was on nine winter feed treatments. The ewes in this study were part of the band and in feed treatments 0, 7 and 8. Treatment (0) consisted of range forage with no supplementation and treatment (7) consisted of range forage plus one pound per head per day of the pellet used for flushing (Table I). Ewes in treatment (8) were separated from the band three days after being marked by the ram and placed in dry lot. They were fed grass hay at the rate of $4\frac{1}{2}$ pounds per head per day.

Throughout the gestation period all ewes on the above post-breeding treatments were weighed periodically. Individual condition scores were recorded during the December and April weighing dates. The last period for weight records was prior to lambing. Ten days before lambing the entire band was managed under the same conditions. They were lambed under shed conditions equipped with individual jugs. The drop area was located adjacent to the shed and as the ewes dropped their lambs they were transferred to the shed. Each morning lambing data were recorded for the previous days drop. Under these conditions all lambs were weighed within 24 hours from the time of birth.

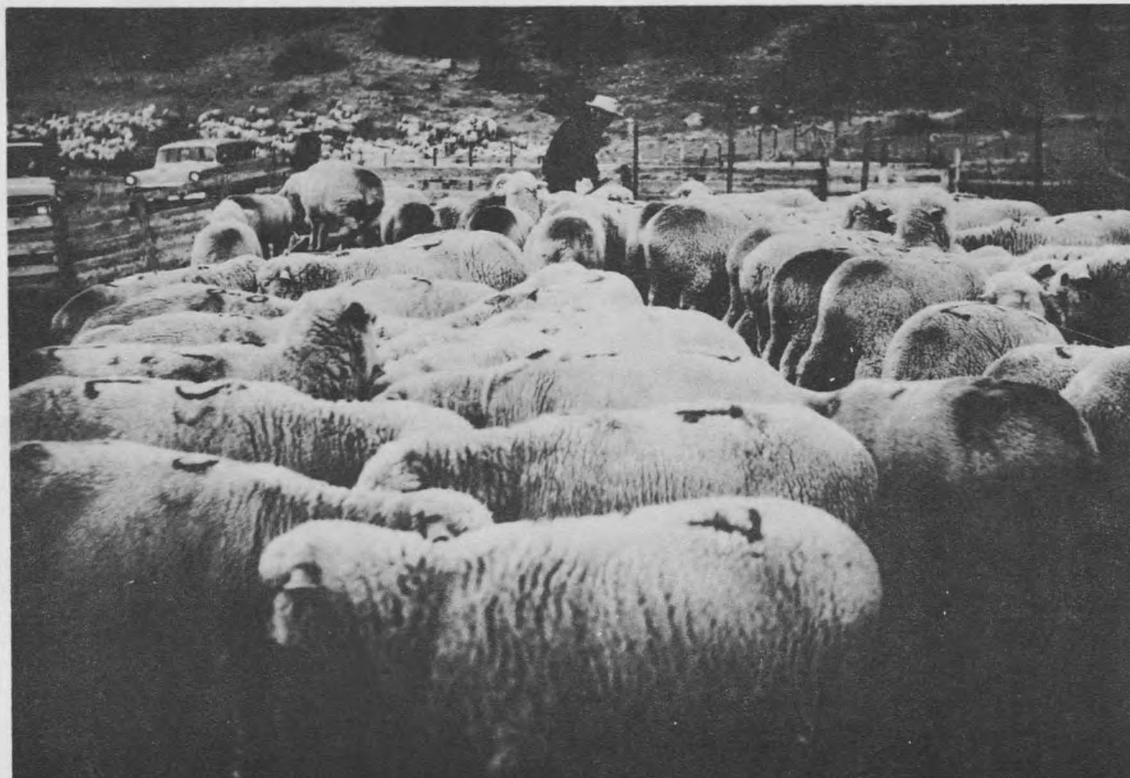

Figure 1. Supplemental feeding the flushed group of ewes.

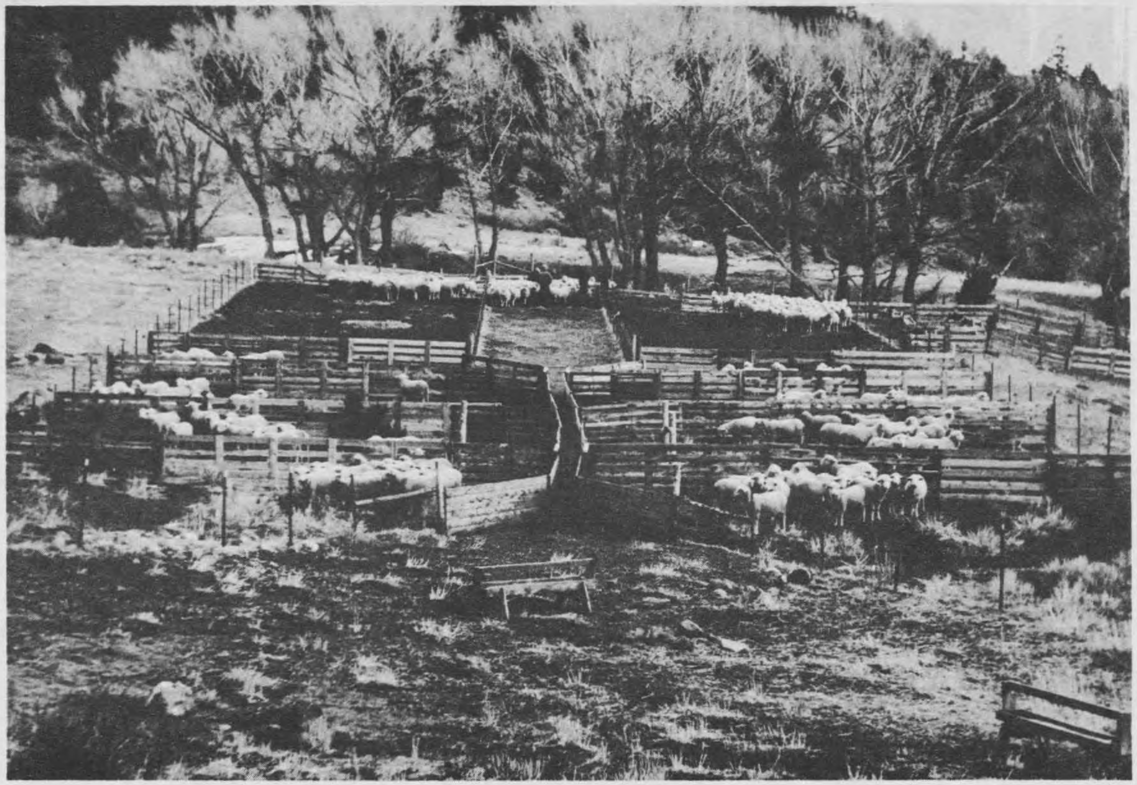

Figure 2. Breeding pens used in the study.

Figure 3. Cutting the rams into the day holding area.

RESULTS AND DISCUSSION

Symbols

Throughout the remainder of this report the following symbols or combination of symbols will be used:

M - Mature ewes.

T - Two-year-old ewes.

F - Flushed, fed 1 pound of a 30 percent protein pellet per head per day prior to breeding until bred.

C - Control (non-flushed), no supplementation prior to breeding.

O - Grazed only on native range.

7 - Grazed on native range plus 1 pound of a 30 percent protein pellet. (Table I)

8 - Lot fed $4\frac{1}{2}$ pounds of grass hay per head per day.

S - Summation.

* - Significant beyond the 5% level.

** - Significant beyond the 1% level.

Effects of flushing on body weight change.

The body weights as influenced by flushing have been analyzed as two age groups within two treatments. All older ewes were designated as mature, and two-year-old ewes were those lambing at two years of age.

Mature ewes.

During the pre-breeding period, (Nov. 5 - Nov. 19) both the flushed and control groups lost weight prior to breeding and both gained weight during breeding. This resulted in a net weight gain for both groups during the pre-breeding and breeding period. A weight gain advantage of 3.1 pounds is noted for the flushed group of ewes during this period. Even though both groups lost during pre-breeding, the flushed group of ewes lost the least, showing a difference of 5.8, which was highly significant ($p < 01$). Statistical methods were that of Ostle (1954).

Two-year-old ewes.

During the pre-breeding period, both the flushed and control groups lost weight prior to breeding and both gained weight during breeding. The two-year-old ewes followed the same pattern as the mature ewes, however, the net weight change from November 5 to December 30 showed a negative difference. This may be explained by the fact that the December weights were positive in regard to the November 19 weight. During the pre-breeding period, the difference in weight loss was 3.4, which was highly significant ($p < 01$). The analysis of variance table for body weight change appears in Table I of the Appendix. The influence of supplemental feeding on body weight change is shown in Table II.

TABLE II. Effects of flushing on body weights of mature and coming two-year-old ewes.

Treatment	Body wt. Nov. 5 lbs.	Nov. 19	Dec. 30	Total lbs.	Body wt. Apr. 10 lbs.
FM	132.4	-2.9	+8.6	+5.7	145.8
CM	133.8	-8.7	+11.3	+2.6	143.4
Difference in wt. change		5.8**	2.7	3.1	
FT	128.5	-4.8	+2.4	-2.4	128.7
CT	123.5	-8.2	+7.3	-0.9	127.9
Difference in wt. change		3.4**	4.9	1.5	

The body weight change and average daily temperature during the flushing period is shown in Fig. 4. Three breaks in the weather were evident durind the flushing and breeding period. The first drop in temperature occurred prior to breeding and two were early in the breeding season. The most severe drop of -4° fahrenheit came five days after the rams were put in. Marshall and Hammond (1948) reported that unfavorable weather conditions during the breeding season, such as snowstorms or drought, will result in a decreased rate of twinning the following lambing season. Bad weather previous to and during breeding may have been associated with the low rate of twinning.

<u>Effects of flushing on reproductive phenomena.</u>

The influence of flushing on ovulation rate, fertilization rate and normality of ova 3 days post-breeding was one of the major objectives of this study.

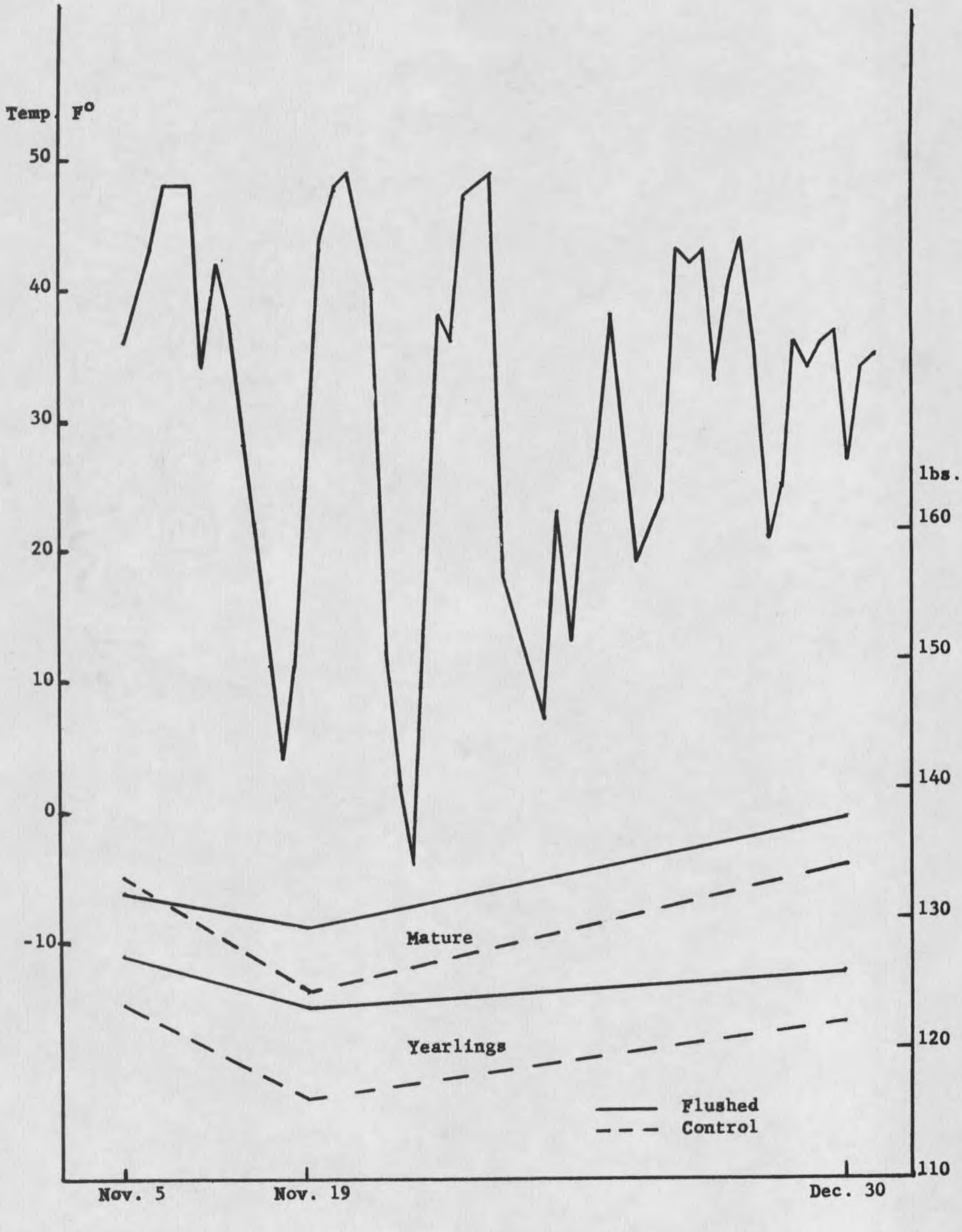

Figure 4. The effects of flushing on body weights during the pre-breeding and breeding period, including average daily temperature.

Ovulation rate.

All but two ewes in the slaughter group had at least one recently formed corpus luteum. The two ewes with no recent corpus luteum were eliminated from this data because it was assumed they were mis-marked by the ram. A total of 21 ovulations were evident as determined by the corpus luteum count with an average of 1.31 ovulations per ewe in the flushed group. In the control group, 19 ovulations were observed with an average of 1.12 ovulations per ewe. From the control group it was observed in one case, that two normal ova were recovered where only one corpus luteum was present. Upon analyzing the technique, it was concluded that 2 ova were extruded from one corpus luteum. Dutt (1954) reported in one case two normal-appearing ova and one with shrunken cytoplasm were recovered from the fallopian tube of a ewe having only two recent ovulation points. Dutt suggested that the ova with shrunken cytoplasm may have been a holdover in the fallopian tube from a previous heat period. This may raise the question: Are more ova shed and possibly not recovered than are determined by the corpus luteum count? In one case, two ovulation points were observed on the left ovary, however the infundibulum end of the oviduct was closed and closely adhered to the ovary. Such structural abnormalities could prevent passage of the ova into the oviduct. No other occlusions were found that would prevent sperm or ova passage. Hoversland _et al._ (1958) reported cases of occlusions of the oviduct, which prevented the passage of saline solution under considerable pressure.

The number of ova recovered was 17, or 81.0 percent and 13, or 68.4

percent for the flushed and control ewes, respectively. It is possible that faulty technique may be responsible for failure to locate the missing ova.

Fertilization rate.

Of the 17 ova recovered from the flushed group, 14 or 82.4 percent were fertilized as was determined by the presence of cleavage. Two ova were classed as fertilized where only the zona pellucida was recovered and the presence of sperm was evident. This was based on work by Hart (1956) who stated that a fertilized sheep's ovum may always be identified by the numerous surplus sperm which can be found embedded in the zona pellucida. The fertilization rate in the control group was 76.9 percent. Most of the cleaved ova recovered were found to be in the 4 to 8-cell stage of development.

Abnormal ova.

Four of the 30 ova recovered were abnormal, representing 13.3 percent of all ova recovered. Two of these had a ruptured zona pellucida with the cytoplasm missing, one ovum had vacuoles present near the blastomeres and in one ovum the cytoplasm had shrunken away considerably from the zona pellucida. Three of the abnormal ova were recovered from mature ewes and one from a yearling ewe. The abnormal ova were equally distributed among the flushed and control group of ewes. The observations on ovulation rate, fertilization rate and abnormal ova are recorded in Table III. This study indicates that lack of ova fertilization and abnormal ova represent the major factors in the reproductive loss in the ewe.

TABLE III. Ovulation rate, fertilization rate, and abnormal ova in the slaughter group of ewes.

Treatment	No. of Ewes	No. of Ovulations	Ova recovered			Abnormal ova		
			Fert.	Unfert.	Total	Fert.	Unfert.	Total
FM	10	13	8	3	11	1	0	1
CM	12	14	6	3	9	1	1	2
FT	6	8	6	0	6	1	0	1
CT	5	5	4	0	4	0	0	0
SM	22	27	14	6	20	2	1	3
Percent	--	--	70.0	30.0	74.1	10.0	5.0	15.0
ST	11	13	10	0	10	1	0	1
Percent	--	--	100.0*	0.0	76.9	10.0	0.0	10.0
SF	16	21	14	3	17	2	0	2
Percent	--	--	82.4	17.6	81.0	11.8	0.0	11.8
SC	17	19	10	3	13	1	1	2
Percent	--	--	76.9	23.1	68.4	7.7	7.7	15.4

A significant difference between age of ewe and the percentage of fertilized ova was found when the data were tested by Chi square. It should be remembered however, that this is based on small numbers.

Photomicrographs of some of the ova recovered are shown in Figs. 5, 6 and 7. The ovum in Fig. 5 had an abundance of sperm adhering to and imbedded in the zona pellucida. This was unusual when compared to other fertilized ova recovered.

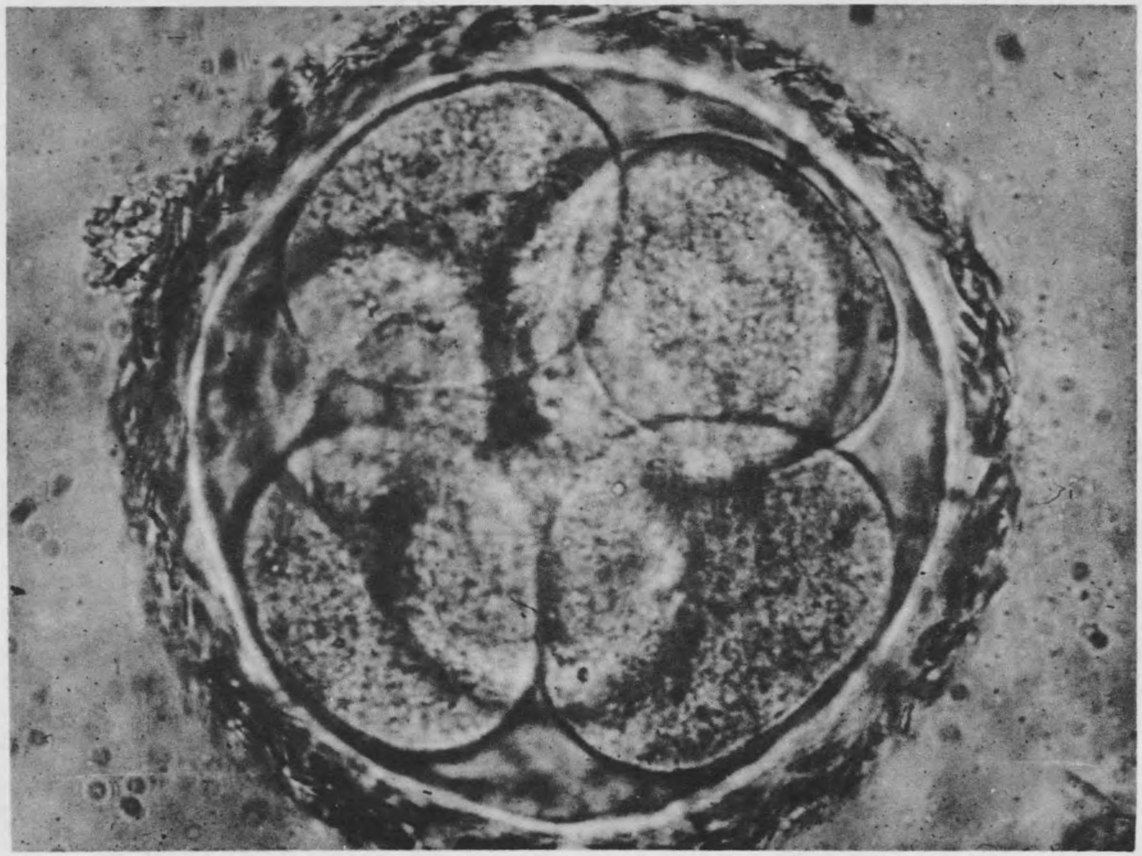

Figure 5. Normal fertilized ovum X950.

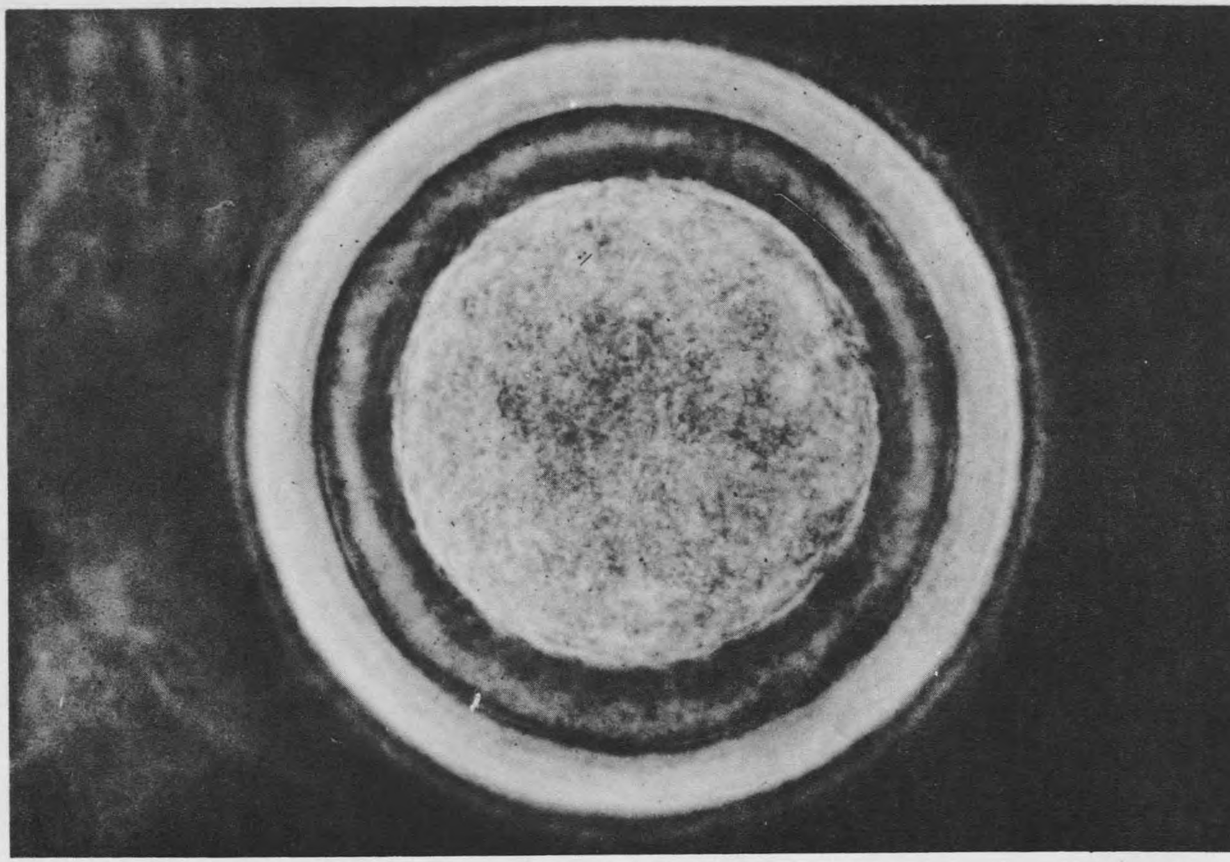

Figure 6. Unfertilized ovum with absence of cleavage or sperm in the zona pellucida. X960.

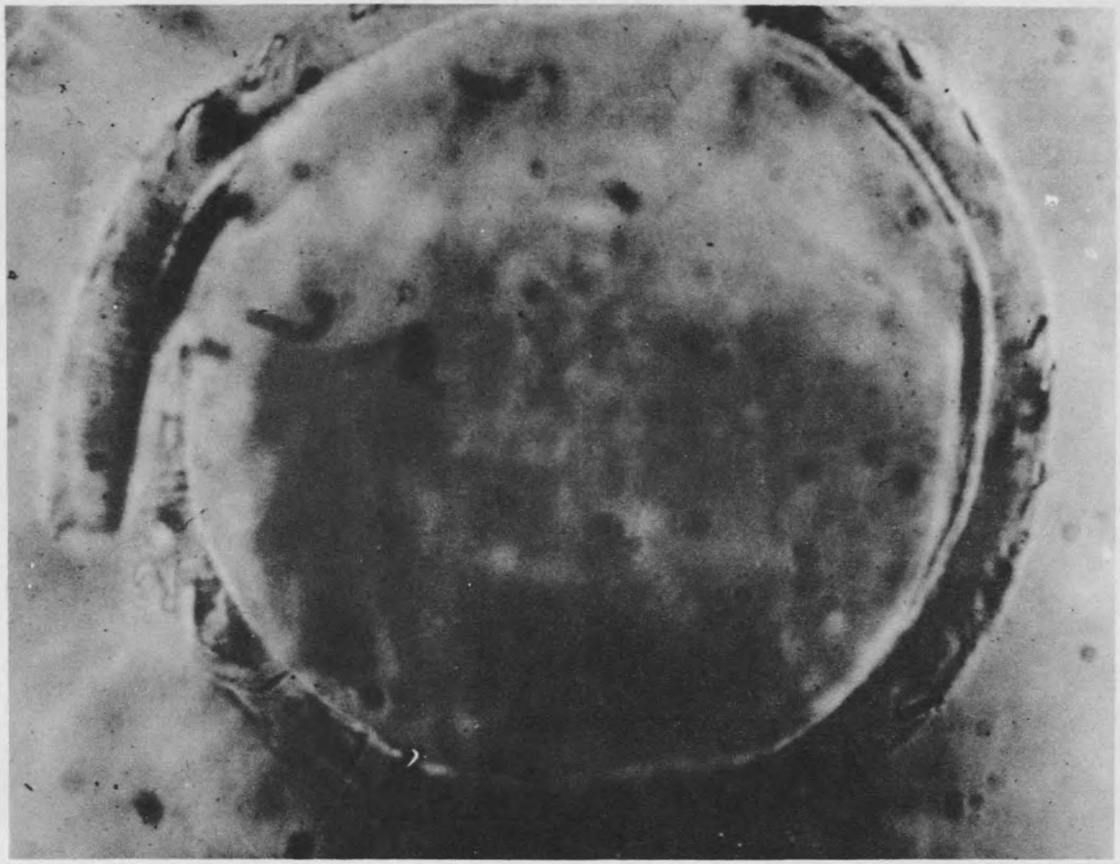

Figure 7. Abnormal ovum with sperm present in the remaining zona pellucida. X950.

Effects of post-breeding treatments on body weight and condition score.

It appears quite evident that post-breeding treatments do have an effect. When the combined weight difference and condition score change are considered the ewes in feed treatment (0) show a weight loss of 4.0 pounds and a decrease in condition score of 0.8 for the entire period. Ewes on feed treatment (7) and (8) have a weight gain of 9.3 and 4.3 pounds, with a score change of +0.1 and +0.4, respectively. Mature ewes had a weight gain advantage of 4.3 pounds over the two-year-old ewes and a positive score change, while the two-year-old ewes lost 0.4 of a score. The mature and two-year-old ewes in treatment (7) both had a weight gain advantage above the other two treatment groups. Treatment (0), however, was the most severe of the three post-breeding treatments.

Body weights and condition scores are recorded in Table IV. The body weights of mature and two-year-old ewes are shown in graph form for the entire period in Figs. 8, 9, and 10. It is noted in treatment (0) that any weight gain advantage obtained during the pre-breeding treatment was maintained throughout the gestation period. This is in agreement with a three year flushing study by Hoversland (1958). Mature ewes on feed treatment (8) show the same trend; however, the two-year-old ewes in the control group surpassed the flushed group near the middle of gestation. Treatment (7) is quite different from the other two treatments in that the controls have heavier body weights near the end of gestation. This may, in part, be explained by the 3:1 ratio of twins in the control group. Due to small numbers no definite conclusions are drawn.

TABLE IV. Post-breeding weight and condition score change.

Treatment	December 30 Weight on	December 30 Condition score	April 10 Weight off	April 10 Condition score	weight Difference lbs.	Condition score difference
FMO	133.3	3.3	134.6	3.9	+ 1.3	-0.6
CMO	126.7	3.6	126.5	4.1	- 0.2	-0.5
FM7	143.4	2.5	155.5	2.3	+12.1	+0.2
CM7	143.8	2.4	162.0	2.3	+18.2	+0.1
FM8	137.5	3.0	147.4	2.4	+ 9.9	+0.6
CM8	132.8	3.2	141.6	2.7	+ 8.8	-0.5
FTO	121.8	2.5	119.1	3.8	- 2.7	-1.3
CTO	113.3	2.5	111.9	3.7	- 1.4	-1.2
FT7	133.3	2.2	139.9	2.6	+ 6.6	-0.4
CT7	132.4	2.3	143.0	2.1	+10.6	+0.2
FT8	123.3	2.3	127.1	2.3	+ 3.8	0.0
CT8	121.3	2.5	128.7	2.5	+ 7.4	0.0
SFM	138.1	2.9	145.8	2.8	+ 7.7	+0.1
SCM	134.5	3.1	143.4	3.1	+ 8.9	0.0
SFT	126.3	2.3	128.7	3.0	+ 2.4	-0.1
SCT	122.3	2.4	127.9	2.8	+ 5.6	-0.4
SF	135.2	2.8	137.3	2.9	+ 2.1	-0.1
SC	133.0	2.8	135.6	2.9	+ 2.6	+0.2
SM	136.3	3.0	144.6	2.9	+ 8.3	+0.1
ST	124.3	2.4	128.3	2.8	+ 4.0	-0.4
SO	127.0	3.2	123.0	3.9	- 4.0	-0.8
S7	140.8	2.4	150.1	2.3	+ 9.3	+0.1
S8	131.9	2.9	136.2	2.5	+ 4.3	+0.4

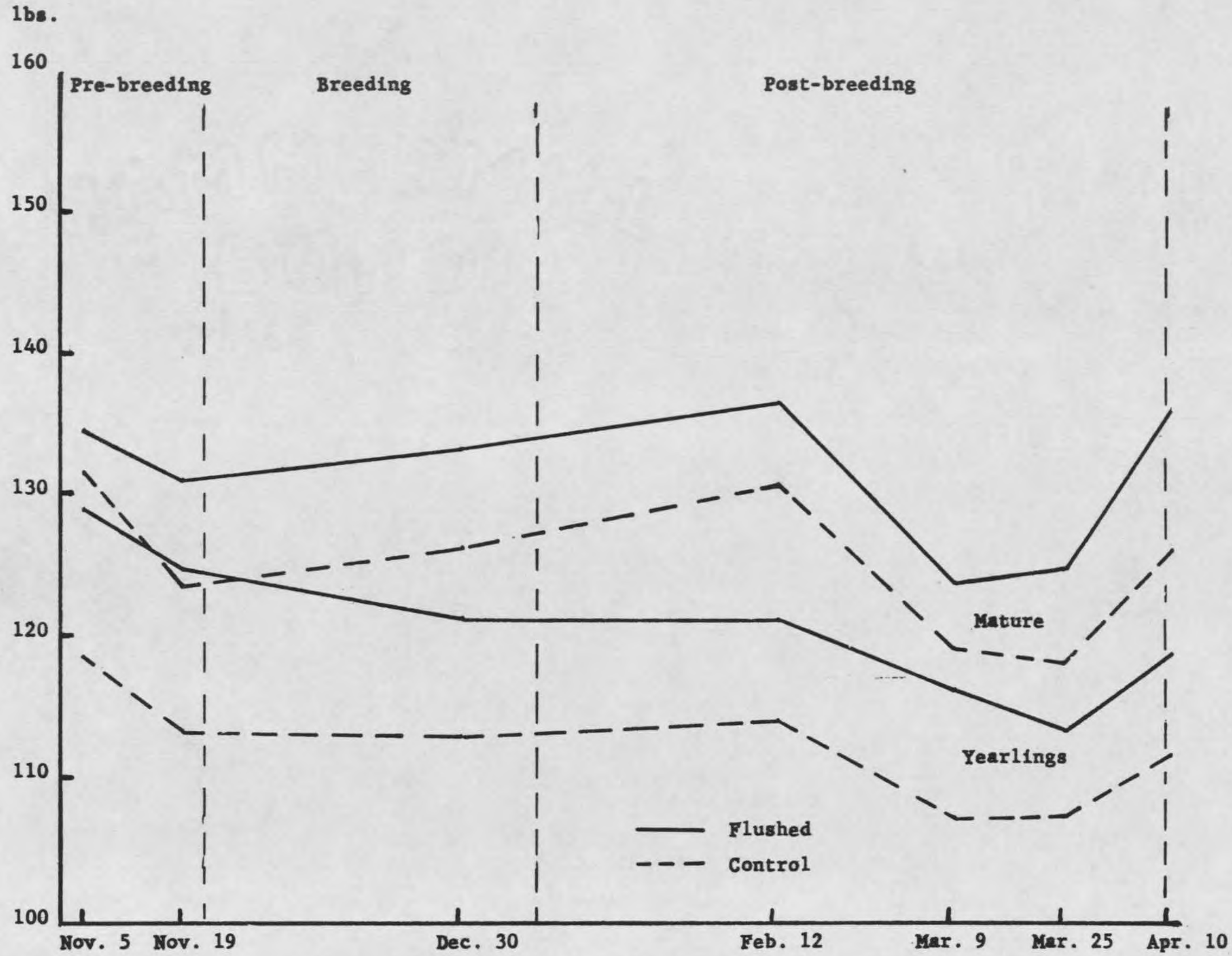

Figure 8. Ewe body weight change for entire period, treatment (0).

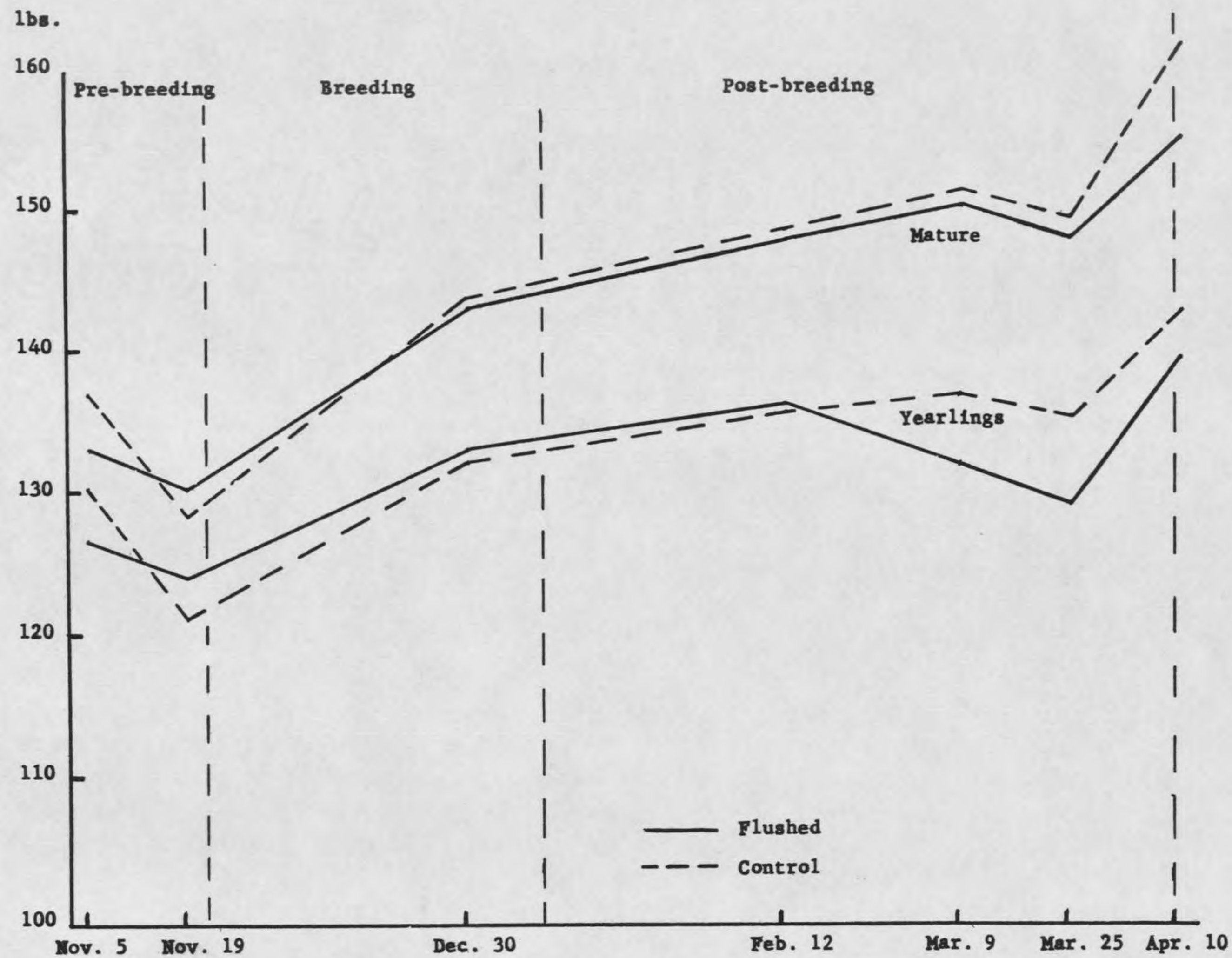

Figure 9. Ewe body weight change for entire period, treatment (7).

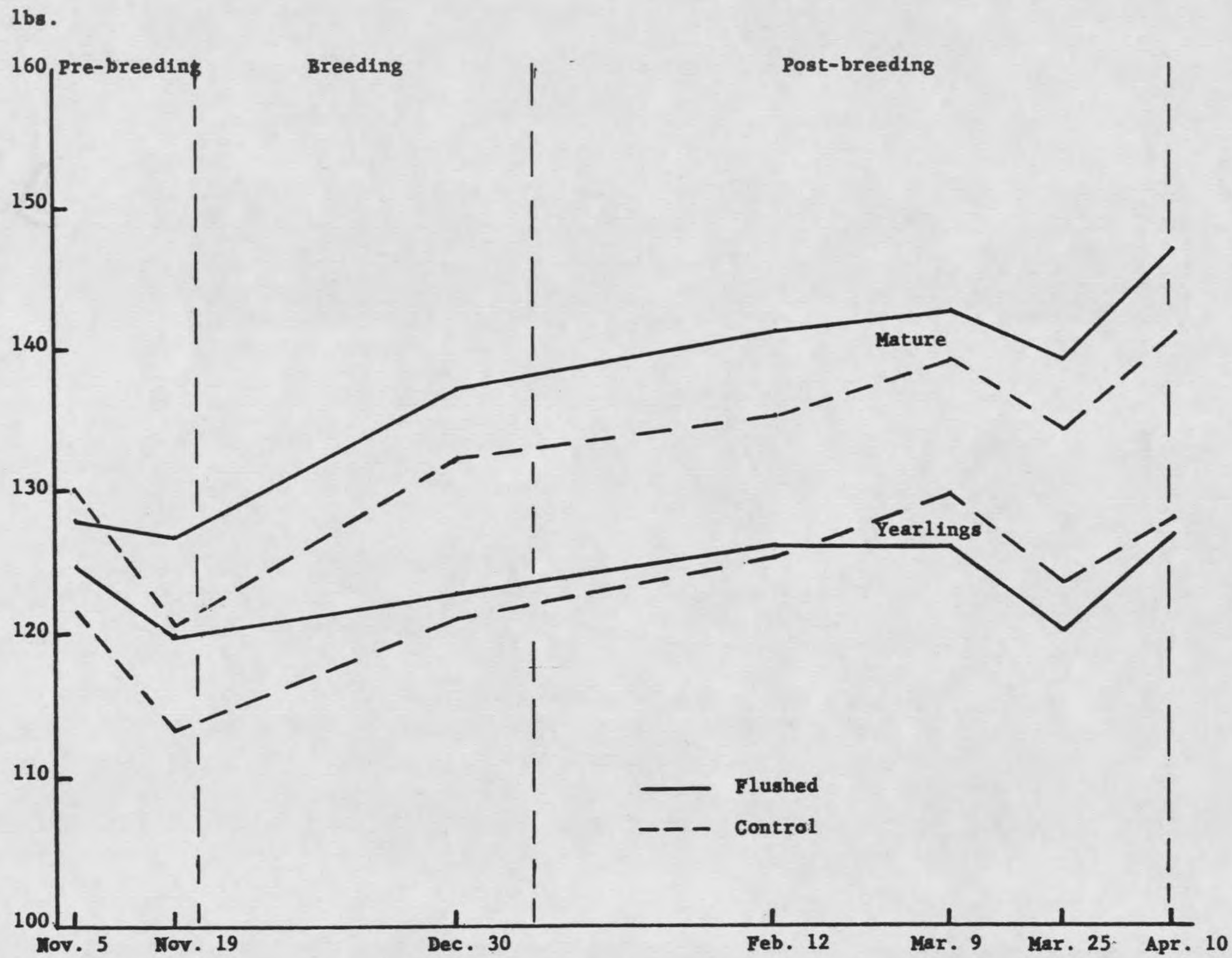

Figure 10. Ewe body weight change for entire period, treatment (8).

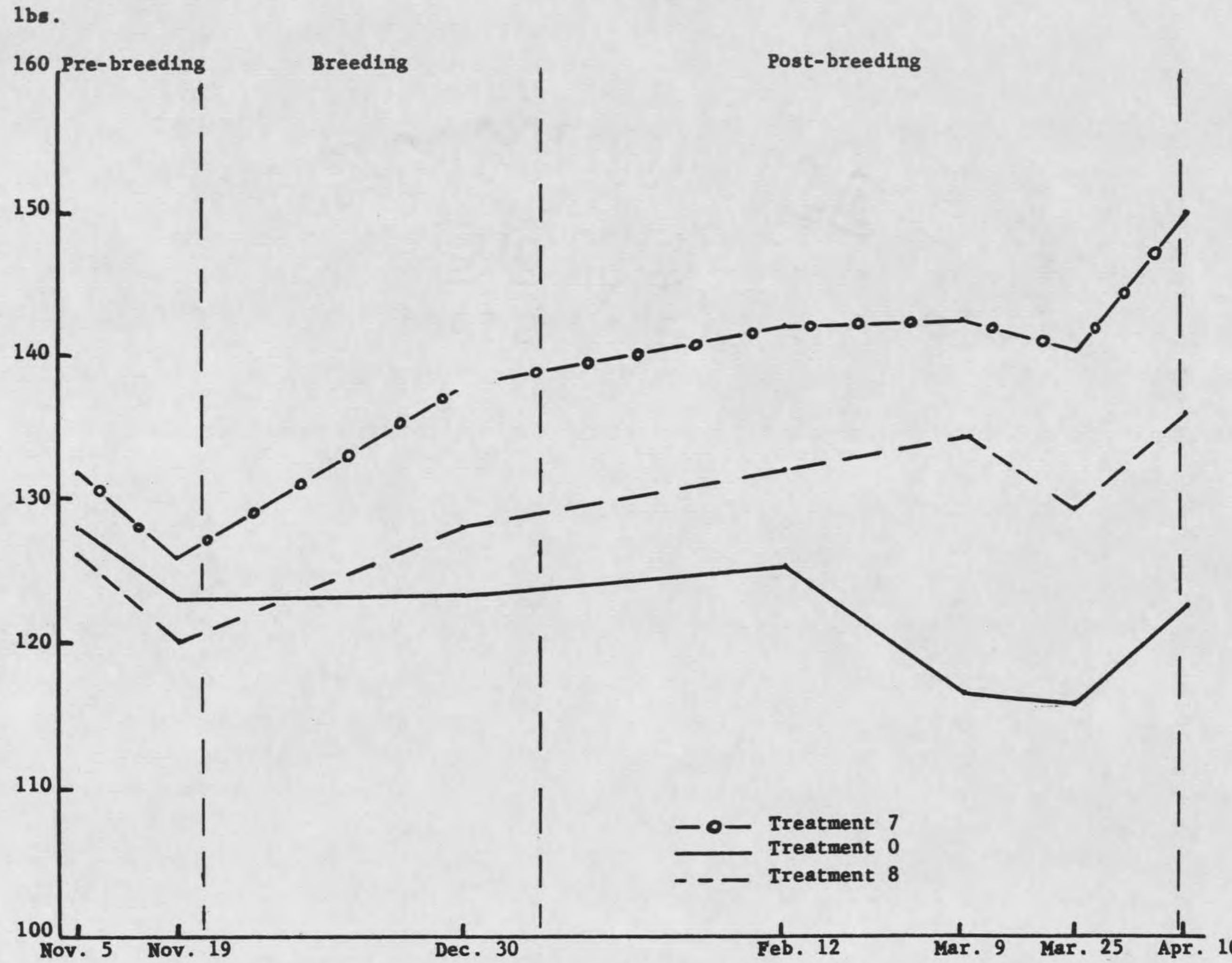

Figure 11. Ewe body weight change for entire period, treatment 7, 0, and 8.

When mature and two-year-old ewes are combined within post-breeding treatments and compared, a definite difference is noted in Fig. 11.

There was a highly significant difference between age and among post-breeding treatments for body weights and condition scores ($p<.01$).

Analysis of variance for weight and condition score difference are presented in Table V.

Type of birth distribution.

The effects of flushing on ovulation rate was one of the major objectives of this study. Ewes lambing to first breeding were used as a control group to compare with slaughter ewe data.

It may be noted in Table VI that when the ewes which lambed to first breeding in the flushed group are compared with the ewes in the non-flushed group there were 3.4% more twins. This would indicate that the flushed group of ewes had a higher ovulation rate, when compared closely with the slaughter ewe data. It is recalled from the slaughter data flushed ewes had an ovulation rate of 1.31 vs. 1.12 for the non-flushed group.

Mature ewes had 9.1 percent more twin births than did the two-year-old ewes. This is in agreement with Goot (1951), who reported that the greatest rise in fertility takes place between age 2 and 3, gradually increasing to 5 years of age and then declines. The mature non-flushed group in feed treatment (7) show a higher percent of twins. This of course can be misleading when percentages are based on small numbers. In this case one more twin birth based on 5 less ewes lambing from first breeding tends to make an extreme difference.

TABLE V. Analysis of variance of weight and condition score change during the gestation period.

Source of Variation	Degrees of freedom	Sum of squares	Mean square	F
	Body Weight			
Between pre-breeding treatment	1	93.31	93.31	1.45
Between ages	1	597.21	597.21	9.30**
Among post-breeding treatments	2	4763.09	2381.54	37.09**
Interactions				
Age x pre-breeding treatment	1	29.28	29.28	.46
Pre-breeding x post-breeding treatments	2	323.54	161.77	2.52
Age x post-breeding treatment	2	74.37	32.18	.50
Age x pre-breeding x post-breeding treatments	2	694.55	347.28	5.41*
Error	150	9631.00	64.21	
Total	161	16196.35		
	Score Change			
Between pre-breeding treatment	1	.24	.24	.69
Between Ages	1	10.37	10.37	29.63**
Among post-breeding treatment	2	39.37	19.68	56.23**
Interactions				
Age x pre-breeding treatment	1	.38	.38	1.09
Pre-breeding x post-breeding treatment	2	.42	.21	.60
Age x post-breeding treatment	2	.62	.31	.89
Post-breeding Treatment	2	.67	.34	.97
Error	150	52.89	.35	
Total	161	104.96		

TABLE VI. Type of birth distribution resulting from first breeding.

Treatment	No. of Ewes	Ewes Lambing %	Twins %	Singles %	Ewe not lambing %
F M O	19	89.5	11.8	88.2	10.5
C M O	20	70.0	0.0	100.0	30.0
F M 7	21	95.2	15.0	85.0	4.8
C M 7	21	71.4	26.7	73.3	28.6
F M 8	21	81.0	11.8	88.2	19.0
C M 8	21	71.4	6.7	93.3	28.6
F T 0	7	85.7	16.7	83.3	14.3
C T 0	7	85.7	0.0	100.0	14.3
F T 7	7	71.4	0.0	100.0	28.6
C T 7	7	85.7	0.0	100.0	14.3
F T 8	7	57.1	0.0	100.0	42.9
C T 8	7	71.4	0.0	100.0	28.6
S F M	61	88.5	13.0	87.0	11.5
S C M	62	71.0	11.4	88.6	29.0
S F T	21	71.4	6.7	93.3	28.6
S C T	21	81.0	0.0	100.0	19.0
S F	82	84.1	11.6	88.4	15.9
S C	83	73.5	8.2	91.8	26.5
S M	123	79.7	12.2	87.8	20.3
S T	42	76.2	3.1	96.9	23.8
S O	53	81.1	7.0	93.0	18.9
S 7	56	82.1	15.2	84.8	17.9
S 8	56	73.2	7.3	92.7	26.8

Lambing rate.

Lambing rate in the unslaughtered or control ewes in this study are the result of breeding at one heat period only. Control ewes that had returned to heat were considered not pregnant and none lambed to the experimental breeding. Of the 82 ewes marked by the ram in the flushed group 84.1 percent lambed and of the 83 ewes marked by the ram in the non-flushed group 73.5 percent lambed. The lambing rate per ewe bred was 93.9 percent and 79.5 percent for the flushed and non-flushed ewes, respectively. From the above percentages, it may also be inferred that the ovulation rate for the flushed ewes was higher, as indicated earlier by the higher rate of twinning. Lambing rates resulting from first breeding are recorded in Table VII.

Type of birth distribution and lambing rate of all ewes are recorded in Tables VIII and IX, respectively. The main point of interest here is the higher percent of ewes lambing, the higher lambing percent per ewe bred and the lower percent of barren ewes. The latter, however, in the experimental group of ewes based on first breeding is quite high, because most ewes classed as not lambing did lamb to a later breeding.

Pounds of lamb born.

The average pounds of lamb born per ewe lambing to first breeding only, was 9.67, 11.88, and 11.26 pounds in treatments 0, 7, and 8, respectively for mature ewes. Two-year-old ewes had average lamb weights of 9.10, 9.50, and 9.53 for treatments 0, 7, and 8, respectively. These weight differences should not be attributed to feed treatment effect only, because the result

TABLE VII. Lambing rate resulting from first breeding.

Treatment	No. of Ewes	Per Ewe Bred %	Per Ewe Lambing %
F M O	19	100.0	111.8
C M O	20	70.0	100.0
F M 7	21	109.5	115.0
C M 7	21	90.5	126.7
F M 8	21	90.5	111.8
C M 8	21	76.2	106.7
F T O	7	100.0	116.7
C T O	7	85.7	100.0
F T 7	7	71.5	100.0
C T 7	7	85.7	100.0
F T 8	7	57.1	100.0
C T 8	7	71.4	100.0
S F M	61	100.0	113.0
S C M	62	83.0	111.4
S F T	21	76.2	106.7
S C T	21	80.9	100.0
S F	82	93.9	111.6
S C	83	79.5	108.2
S M	123	89.4	111.2
S T	42	78.6	103.1
S O	53	86.8	107.0
S 7	56	94.6	115.2
S 8	56	78.6	107.3

TABLE VIII. Table of birth distribution of all ewes.

Treatment	No. of Ewes	Ewes lambing %	Twins %	Singles %	Barren %
F M O	19	94.7	11.2	88.8	5.3
C M O	20	90.0	5.0	95.0	10.0
F M 7	21	95.2	15.0	85.0	4.8
C M 7	21	95.2	40.0	60.0	4.8
F M 8	21	90.5	10.5	89.5	9.5
C M 8	21	85.7	11.5	88.5	14.3
F T O	7	100.0	28.6	71.4	0.0
C T O	7	100.0	0.0	100.0	0.0
F T 7	7	100.0	0.0	100.0	0.0
C T 7	7	100.0	14.3	85.7	0.0
F T 8	7	71.4	20.0	80.0	28.6
C T 8	7	100.0	0.0	100.0	0.0
S F M	61	93.4	12.3	87.7	6.6
S C M	62	90.3	19.6	80.4	9.7
S F T	21	90.5	15.8	84.2	9.5
S C T	21	100.0	4.8	95.2	0.0
S F	82	92.7	13.2	86.8	7.3
S C	83	92.8	15.6	84.4	7.2
S M	123	91.9	15.9	84.1	8.1
S T	42	95.2	10.0	90.0	4.8
S O	53	94.3	10.0	90.0	5.7
S 7	56	96.4	22.2	77.8	3.6
S 8	56	87.5	10.2	89.8	12.5

TABLE IX. Lambing rate for all ewes.

Treatment	No. of Ewes	Per Ewe Bred %	Per Ewe Lambing %
F M O	19	105.3	111.1
C M O	20	95.0	105.5
F M 7	21	109.5	115.0
C M 7	21	133.0	140.0
F M 8	21	100.0	110.5
C M 8	21	95.2	111.1
F T O	7	128.6	128.6
C T O	7	100.0	100.0
F T 7	7	100.0	100.0
C T 7	7	114.3	114.3
F T 8	7	85.7	120.0
C T 8	7	100.0	100.0
S F M	61	104.9	112.3
S C M	62	108.1	119.6
S F T	21	104.8	115.8
S C T	21	104.8	104.8
S F	82	104.9	113.2
S C	83	107.2	115.6
S M	123	106.5	115.9
S T	42	104.8	110.0
S O	53	103.8	110.0
S 7	56	119.6	124.1
S 8	56	96.4	110.2

of twinning could also have an effect, especially in the mature ewes. There was a highly significant difference among treatments and between ages as shown in Table X.

TABLE X. Analysis of variance of pounds of lamb born.

Source of variation	D.F.	SS	MS	F
Among treatments	2	74.42	37.21	5.93**
Between ages	1	61.52	61.52	9.81**
Treatment x age interaction	2	8.98	4.49	.72
Error	122	764.99	6.27	
Total	127	909.91		

Prenatal death loss.

The determination of embryonic death loss is an indirect procedure, however, estimates were made. If the number of ewes with fertilized ova from the slaughter group is taken as an estimate for the number of ewes in the control group having fertilized ova, then the estimated embryonic mortality rate may be calculated.

In this study, the method used to estimate embryonic death was that of Dutt (1957). Quote: "An estimate of embryonic death loss is calculated by subtracting the number of lambs born to the control ewes from the number of fertilized ova recovered from the slaughtered ewes which were bred. Thus, estimated percent embryonic death loss =

$$\frac{\text{Fertilized ova} - \text{lambs born}}{\text{Fertilized ova}} \times 100."$$

Any fertilized ova that failed to develop would be considered embryonic death. The estimated embryonic death loss for ewes in this study was 12.5 percent and 7.6 percent in the flushed and non-flushed ewes, respectively. This estimate is considerably lower than other workers report (Dutt, 1954; Dutt and Simpson, 1957; El-sheikh *et al.*, 1955). The conditions of this experiment were much different than those which were reviewed of other workers. Different environmental conditions, natural or induced as were used in some of the experimental work, could have a decided effect on embryonic death loss.

SUMMARY

A trial was initiated to study the effects of pre-breeding and post-breeding treatments on the reproductive phenomena of ewes managed under range conditions. The range consisted primarily of native grasses with some browse.

The experimental ewes were selected at random from a band of approximately 840 grade ewes of Rambouillet, Targhee and Columbia breeding. Of the 203 ewes on this study, 36 were identified with a red ear tag to be slaughtered 3 days post-breeding. One-half of the ewes, including 18 designated for slaughter were group-fed 1 pound per head per day a pelleted supplement 14 days prior to breeding until bred. The remaining one-half plus 18 slaughter controls received no supplement during the pre-breeding and breeding period.

Three days after being bred, as indicated by using ochred rams, the ewes allowed to go until lambing were put on one of three wintering regimes. All ewes were grazed on the range together each day except group number (8) which was lot fed. The ewes designated for slaughter were slaughtered and data recorded pertaining to reproductive potential. Body weights, condition score, and lambing data were collected from ewes allowed to lamb.

The ovulation rates were 1.31 and 1.12, while the percent ova fertilized was 82.4 and 76.9 percent for the flushed and non-flushed ewes, respectively. Two fertilized ova were abnormal in the flushed group and of the two abnormal ova in the control group one was fertilized and the other one was not. Total recovery rate was 81.0 percent for the flushed

ewes and 68.4 percent in the non-flushed ewes. One structural abnormality of the reproductive tract which may have been a barrier to fertilization and ova passage was noted. Using the ovulation and fertilization rate from the slaughter group as estimates for ewes in the group allowed to lamb, the calculated embryonic death loss was 12.5 and 7.6 percent for flushed and non-flushed ewes, respectively.

Body weight and condition score change indicated a definite difference among the three post-breeding treatments. A carry-over effect for weight gain during the pre-breeding period was noted in two of the three post-breeding treatments, however, the reverse was true for one treatment.

The percentage of ewes lambing to first breeding, lambing percent and multiple births was higher in the flushed ewes. Average pounds of lamb born per ewe lambing to first breeding was significantly different among post-breeding treatment and between ages.

LITERATURE CITED

Allen, E. 1931. Oestrus periods, ovarian changes, and tubal ova in the sheep. Ant. Rec. (Abst.) 48:9

Aristotle. 1910. Historia animalium. (Thompson's translation). Oxford.

Asdell, S. A. 1949. Nutrition and the treatment of sterility in dairy cattle; a review. J. Dairy Sci., 32:60.

Asdell, S. A. 1952. Proc. of the 2nd Int. Cong. Physiol. Path. Animal Prod. and Artif. Insem. p. 7.

Asker, A. A. and M. T. Ragab. 1954. Twinning in Ossimi sheep. Empire J. Exp. Agric., 22:224.

Assheton, R. 1898. The segmentation of the ovum of the sheep with observations of a hypoblastic origin for the trophoblast. Quart. J. Micr. Sci. 41:205.

Bonnet, R. 1884. Betrage zur Embryologie der Wiederkauer Gewonen am Schafel. Archiv fur Anatomie und Physiologie, Anatomische Abtheilung.

Brambell, F. W. R. 1948. Prenatal mortality in mammals. Biol. Revs. 23:370.

Briggs, H. M., A. E. Darlow, L. E. Hawkins, O. S. Willham and E. R. Hauser. 1942. The influence of nutrition on the reproduction of ewes. Okla. Agric. Exp. Sta. Bull. 255.

Carlyle, W. L. and T. F. McConnell. 1902. Some observations on sheep breeding from the experiment station flock records. Wisc. Agric. Exp. Sta. Bull. 95.

Casida, L. E. and W. Wisnicky. 1950. Effects of diethylstilbestrol dipropionate upon postportum changes in the cow. J. Animal Sci., 9:238.

Casida, L. E. and A. B. Chapman. 1951. Factors affecting the incidence of cystic ovaries in a herd of Holstein cows. J. Dairy Sci., 34:1200.

Christian, R. E. and J. C. Nofziger. 1952. Puberty and other reproductive phenomena in gilts as affected by plane of nutrition. J. Animal Sci., (Abstr) 11:789.

Clark, R. T. 1934. Studies on the physiology of reproduction in the sheep. I. The ovulation rate of the ewe as affected by the plane of nutrition. II. The cleavage stages of the ovum. Anat. Rec. 60:125-60:135.

Corner, G. W. 1921. Abnormalities of the mammalian embryo occurring before implantation. Contr. Embryol. 13. Carn. Inst. 276:61.

Corner, G. W. 1923. The problem of embryonic pathology in mammals, with observations upon intra-uterine mortality in the pig. The Am. J. Anat. 31:523.

Darroch, J. G., A. W. Nordskog and J. L. Van Horn. 1950. The effect of feeding concentrates to range ewes on lamb and wool productivity. J. Animal Sci., 9:431.

Darwin, C. 1905. In Hammond's Physiology of Farm Animals, Vol. 3, 1957, edited by Butterworths Scientific Publications, London.

Dutt, R. H. 1954. Fertility rate and embryonic death loss in ewes early in the breeding season. J. Animal Sci., 13:464.

Dutt, R. H. and E. C. Simpson. 1957. Environmental temperature and fertility of Southdown rams early in the breeding season. J. Animal Sci., 16:136.

El-Sheikh, A. S., C. V. Hulet, A. L. Pope and L. E. Casida. 1955. The effect of level of feeding on the reproductive capacity of the ewe. J. Animal Sci., 14:919.

Eriksson, K. 1943. Hereditary forms of sterility in cattle. Lund. (Ohlsson, Sweden).

Esplin, A. C., M. A. Madsen and R. W. Phillips. 1940. Effects of feeding ewe lambs during their first winter. Utah Agric. Exp. Sta. Bull. 292.

Goot, H. 1951. Statistical analysis of some measurements of fertility in sheep. J. Agric. Sci., 41:1.

Green, W. W., and L. M. Winters. 1935. Studies on the physiology of reproduction in the sheep. III. The time of ovulation and rate of sperm travel. Anat. Rec. 61:457.

Haines, C. E., A. C. Warnick, H. D. Wallace and G. M. Edwards. 1956. The effect of level of feeding and progesterone injections on reproductive performance in gilts. J. Animal Sci., 16:1099.

Hammond, J. 1914. On some factors controlling fertility in domestic animals. J. Agric. Sci., 6:262.

Hammond, J. 1921. Further observations on the factors controlling fertility and foetal atrophy. J. Agric. Sci., 11:337.

Hammond, J. 1948. Rep. 1st Int. Cong. Physiol. Path. Anim. Reprod. Artif. Insem.

Hammond, J. 1957. Fertility and the production of fat lambs. The Agric. Rev., III:23.

Hart, D. S. 1956. Sources of loss in the unfertilized and fertilized sheep's ova. Research Publication 51. (Reprinted from proceedings New Zealand Society of Animal Production, Vol. 16, 1956).

Heape, W. 1899. Abortion, barrenness and fertility in sheep. J. Res. Agric. Soc. 60:217.

Henning, W. L. 1939. Prenatal and postnatal sex ratio in sheep. J. Agric. Res. 58(8):565.

Hoversland, A. S., J. L. Van Horn, O. O. Thomas and Vic Hoxsey. 1958. Observed losses of reproductive potential of range ewes. Proc. Am. Soc. An. Prod. Western Section.

Hoversland, A. S. 1958. The effect of flushing on reproductive performance of ewes managed under range conditions. (Master Thesis, Montana State College).

Johansson, I. 1932. Multiple births in sheep. Proc. Amer. Soc. An. Prod. 285-291.

Laing, J. A. 1949. Infertility in cattle associated with the death of ova at early stages after fertilization. J. Comp. Pathol. 59:97.

Lush, J. L. and A. E. Molln. 1942. Relationship between parity and prolificacy in pigs. U.S.D.A. Tech. Bull. 836.

Marshall, F. H. A. 1908. Fertility in Scottish sheep. Trans. Highl. Agric. Soc. Scot. 20:139.

Marshall, F. R. and C. G. Potts, 1924. Flushing and other means of increasing lamb yield. U.S.D.A. Bull. 996. (revised).

Marshall, F. H. A. and J. Hammond. 1948. Fertility and animal breeding. Bull. 39. Minis. of Agric. and Fisheries. Sixth Edition.

McKenzie, F. F. and C. E. Terrill. 1937. Estrus, ovulation, and related phenomena in the ewe. Mo. Agric. Exp. Sta. Res. Bull. 264:88.

New Zealand Department of Agriculture. 1950. Anim. Res. Div., Ann. Rept.

New Zealand Department of Agriculture. 1958. Anim. Res. Div., Ann. Rept.

Nichols, J. E. 1924. Fertility in sheep. J. Minist. Agric., 31:835.

Ostle, Bernard, 1954. Statistics in research. Iowa State College Press. Ames, Iowa.

Phillips, R. and J. L. Davies. 1949. In Hammond's Physiology of farm animals, Vol. 3, 1957. Edited by Butterworths Scientific Publications, London.

Polovceva, V. V., G. A. Okulicev and S. S. Jûdovic. 1938. (Inst. Sheep and Goat Breed, Vorshelovsk). Effects of feeding on the fertility of ewes. Vliganie Kormlenija Na Polodovitostj Ovcematok. Probl. Zevotu, No. 1:55. (Anim. Breed. Abst. 8:52).

Roberts, E. 1921. Fertility in Shropshire sheep. J. Agric. Res. 12:231.

Robertson, G. L., R. R. Grummer, L. E. Casida and A. B. Chapman. 1951. Some feeding and management factors affecting age at puberty and related phenomena in Chester White and Poland China gilts. J. Animal Sci., 10:841.

Self, H. L., R. H. Grummer and L. E. Casida. 1955. The effects of various sequences of full and limited feeding on the reproductive phenomena in Chester White and Poland China gilts. J. Animal Sci., 14:573.

Smith, W. W. 1937. Pork Production, The MacMillan Co., New York.

Sorensen, A. M., and J. W. Gossett, 1956. A comparison of slaughter ages for determining embryonic mortality in swine. J. Animal Sci., 15:1207.

Squiers, C. D., G. E. Dickerson and D. T. Mayer. 1952. Influence of inbreeding, age and growth rate of sows on sexual maturity, rate of ovulation, fertilization and embryonic survival, Mo. Agr. Exp. Sta. Res. Bull. 494.

Terrill, Clair E. and J. A. Stoehr. 1939. Reproduction in range sheep. Proc. Am. Soc. An. Prod., 32nd Ann. Meet., 369.

Van Horn, J. L., O. O. Thomas, G. Payne, J. Drummond and F. S. Willson. 1952. Proc. Am. Soc. An. Prod. Western Section.

Wallace, R. 1907. Farm livestock of Great Britain. 4th Ed., Edinburgh. (Quoted in Marshall's Physiology of Reproduction, 3rd Ed., Vol. 2 1952. Edited by A. S. Parkes, Longman's Green and Co., London).

Warwick, B. L. 1928. Prenatal growth of swine. J. Morph. 46:59.

Wilson, R. F., A. V. Nalbandov and J. L. Krider. 1948. A study of impaired fertility in female swine. J. Animal Sci., 8:558.

Winters, L. M., W. W. Green, and R. E. Comstock. 1942. Prenatal development of the Bovine. Minn. Agr. Exp. Sta. Tech. Bull. 151.

APPENDIX

TABLE I. Analysis of variance of weight change during flushing.

Variation Due to:	D.F.	Sum of Squares	Mean Square	F
		(Mature Ewes)		
Treatment	1	1169.08	1169.08	52.35**
Error	121	2701.81	22.33	
Total	122	3870.89		
		Two-year-old Ewes		
Treatment	1	145.90	145.90	6.37**
Error	39	893.20	22.90	
Total	40	1039.10		