EARLY weaning of lambs followed by use of natural or synthetic hormones to control ovarian activity offers considerable potential for increasing the reproductive efficiency of ewes. Simplified methods of hormonal administration and effective control of ovarian activity with resulting high fertility during both anestrus and the breeding season are requisites for effective application. Although considerable progress has been achieved in meeting these conditions, additional improvement is needed.

Ellington, England and Oldfield (1965) found fluorogestone acetate to be a potent inhibitor of ovarian activity in gilts. Robinson (1965) reported that intravaginal placement of polyurethane sponges impregnated with the same progestogen was effective in synchronizing estrus in cycling sheep. However, fertility resulting from breeding at the synchronized estrus has been exceedingly variable (Robinson and Lamond, 1966). Ellington and Fox (1964) presented results showing that experimentation with the second post-treatment estrus following withdrawal of progestogen administration in cycling ewes has merit in terms of estrous control and resulting fertility.

This study was conducted to investigate reproductive performance of ewes placed in a four consecutive lamb crop program which included early weaning and subsequent breeding control treatments. Treatments included the use of fluorogestone acetate-impregnated pessaries and equine gonadotropin injections. One treatment emphasized experimentation with the second post-treatment estrus that occurs following an initial period of progestogen administration.

Materials and Methods

A total of 48 crossbred ewes which were from a mating involving Hampshire rams and Columbia or Targhee ewes was used. At the initiation of the first of the four sequential studies, 32 of the ewes were yearlings, and the remaining 16 were 2-year-old animals. All ewes except eight of the yearlings had produced a lamb during the previous lambing season. Lambs were removed from the ewes 2 weeks prior to initiation of treatment. This resulted in an average weaning age of 61 days.

On May 5, 1965, the ewes were allotted at random into one of four groups by age and whether or not they had previously lambed. The following groups were used: 1. control; 2. 30 mg fluorogestone acetate-impregnated pessaries intravaginally for a 16-day period (single treatment); 3. treatment for group 2 plus 750 IU PMSG subcutaneously at the time of pessary removal (single + PMSG); and 4. treatment same as group 2 plus an additional 9-day treatment with impregnated pessaries after an 8-day pause (double treatment). A graphic representation of the treatment schedules imposed is presented in figure 1. Unimpregnated pessaries were used in the control group. One half of the control ewes received a double pessary treatment as was given to group 4 and the others received a single pessary treatment as was given to groups 2 and 3. The hormonal treatments and assignment of ewes to treatment groups remained unchanged throughout the remaining three studies.

The pessaries were cylindrical polyurethane plugs 4 cm in diameter and 2.5 cm in height. A doubled linen drawstring was attached to each pessary to facilitate removal from the ewes. Impregnated pessaries were prepared by injecting each with 30 mg of fluorogestone acetate in ethanol followed by oven drying for 30 min. at 60°C. Pessaries were inserted into the anterior vagina with the aid of a tube speculum.

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Lambs of all studies were weaned at an average age of two months and ewe treatment was initiated (double treatment only) 2 weeks subsequent to weaning. Treatments were scheduled within each study so that the final day of treatment, which was also the first day of the breeding period, would be the same for all groups. These dates were June 7, 1965 (study I), February 17, 1966 (study II), October 29, 1966 (study III) and July 15, 1967 (study IV).

In all four studies vasectomized rams equipped with ewe marking harnesses (Radford, Watson and Wood, 1960) were placed with the ewes from the time of weaning through the entire hormonal administration period. Intact rams similarly equipped with marking harnesses were used to replace the vasectomized rams starting the day of final pessary removal. Ewes were checked once daily for occurrence of estrus which was noted by crayon markings on the back or rump of the ewe. To avoid complications associated with variations in ram fertility, an equal number of ewes from each group was placed with each of four intact rams. Only rams that had previously given fertile matings and having motile spermatozoa in semen tests were utilized for breeding purposes. After a 14-day breeding period, all intact rams were rotated so that ewes in each breeding groups would be exposed to a ram of a different breed for a second 14-day breeding period. Rotation of whiteface and blackface rams resulted in a genetic marker of newborn lambs which, together with lambing dates, was indicative of the breeding dates at which conception occurred. In study I only, harnessed vasectomized rams were placed with ewes following the breeding period for an additional 76 days.

The ewes in all studies were maintained under sheltered conditions on a pelleted concentrate ration supplemented with alfalfa hay from the time of weaning through the breeding period and during the winter months. At all other times they were maintained unsupplemented on pasture.

Statistical analyses always involved comparisons within individual studies. Analysis of variance was used to test the effects of treatments on data involving intervals. The Chi-square test was used for data involving frequencies with orthogonal comparisons determined for each of the degrees of freedom as follows: Control vs. treatment groups, single vs. single+PMSG and double, and single-PMSG vs. double. As preliminary statistical analysis within studies indicated that the control ewes receiving single and double treatment with unimpregnated pessaries did not differ significantly in the responses measured, they were grouped together within studies for subsequent comparisons with the various treatment groups.

Results and Discussion

Ewes and Pessaries. Intravaginal retention of pessaries did not offer a particular problem in that of the 237 times that pessaries were intravaginally placed, only in 11 cases were they lost. Removal of pessaries could usually be accomplished without marked difficulty.
even though in a few cases slight vaginal infiltration of the pessaries was apparent. The pessaries at removal had a characteristic, disagreeable odor, and removal was typically associated with a cloudy vaginal discharge. Robinson (1965) and Foord (1966) reported similar observations regarding pessary retention and withdrawal.

During the course of the four studies, three ewes were lost but from causes unrelated to the treatments; one was lost from group 3 at the beginning of the third study and two from group 4 preceding the fourth study.

**Estrous Activity.** Studies II and III were initiated during times when the ewes were experiencing cyclic estrous activity while studies I and IV were initiated during anestrous periods. Estrous activity data along with other data on reproductive performance are summarized in table 1.

There appears to be considerable variation within the studies initiated during anestrous periods (studies I and IV) in the number of ewes that expressed estrus during the first 14-day breeding period. However, only in study IV were significant differences (P<.01) apparent and this existed between the control and treated groups, not among the various treated groups. In contrast to the two anestrous studies, essentially all ewes of all experimental groups in the two studies initiated during the breeding season (studies II and III) did experience estrus during the first 14-day breeding period.

The interval from the end of the treatment period to onset of estrus did not differ between control and treated ewes for studies I, II, and IV, but the average of 8.4 days for the control group in study III was significantly greater (P<.01) than each of the other three treatment groups. The occurrence of estrus 2.5±2.3 days in six of the control ewes of one of the anestrous studies (study I) suggests that removal of pessaries, even though unimpregnated, may have been a stimulus for inducing synchronized estrus. The expression of estrus in the control ewes of study II may also be related to removal of the unimpregnated pessaries. Introducing new males at the time of final pessary withdrawal could also be at least partially responsible for inducing observed expression of estrus (Hale, 1966). Nutritional factors were probably not the stimulus because the nutritional status always remained unchanged during the transition from the treatment to breeding time.

The standard deviations for the interval from the end of treatment to onset of estrus reflect the degree of estrous synchronization achieved. As indicated by the relatively low standard deviation values, the double treatment with impregnated pessaries appeared to be consistently effective in all four studies in synchronizing estrus. The single+PMSG treatment appeared equally effective in the two studies initiated during anestrous periods (studies I and IV); whereas, a comparable standard deviation was seen for the single treatment in only one study (study III).

Ewes exhibiting estrus during the second 14-day breeding period were actually those which returned to estrus after breeding during the first period. An exception was the control ewes of study IV. Nine of the 12 control ewes showed estrus during the second 14-day breeding period. The reason for this difference in this particular study is, no doubt, related to the onset of seasonal cyclic activity which would be expected to occur at this time.

In study I, where the ewes were maintained with vasectomized rams for an additional 76 days subsequent to intact ram exposure, a total of 36 control and treated ewes showed estrus at least one time during that period. Of the ewes expressing estrus during that time, 16 subsequently lambed. The fact that some ewes were experiencing estrus while pregnant may in some way be associated with the onset of the natural breeding season occurring during the pregnancy period. However, the expression of estrus appears to be common in the pregnant ewe. Williams et al. (1956) detected behavioral estrous in 62% of a flock of Rambouillet ewes during pregnancy, some as many as five times.

**Lambing Performance.** Variations in lambing performance are apparent with respect to conceptions resulting from breeding during the first 14-day breeding period (table 1). In the case of the two studies (II and III) conducted during the natural breeding season, the double treatment appeared especially promising in terms of lambing performance. In both studies, this group was comparable to the control group in number of ewes conceiving and number of lambs produced. With respect to studies conducted during anestrus, lambing performance was poor for all groups in the case of study IV. The most ewes lambing and the most lambs produced in a group were only four and six, respectively, for this study. However, in study I, nine of the 12 ewes in the single+PMSG group lambed and produced a total of 18 lambs. In this particu-
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**a** Date initiated is date double treatment was started. Termination date indicates date of final pessary removal for all groups.
**b** See figure 1 for treatment description.
**c** Indicates ewes showing estrus a second time except for controls of study IV which showed estrus for the first time during this 14-day period.
**d** Control vs. treatment groups differ significantly (P<.05).
**e** Control vs. treatment groups differ significantly (P<.01).
**f** Single vs. single+PMSG and double differ significantly (P<.05).
**g** Single+PMSG vs. double differ significantly (P<.01).
**h** Nine of the 12 ewes exhibited a synchronized estrus with a mean of 22.3 days post treatment and a standard deviation of 2.9 days. The three remaining treatment means of this study did not differ significantly.
**i** Control group is significantly (P<.01) different from treatment groups.

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lar study, statistical comparisons showed that the treated groups had more ewes lambing and a higher lambing rate \((P<.05)\) than the control group. The single treatment resulted in fewer ewes lambing than the single-PMSG and double treatment groups \((P<.05)\), but the single-PMSG group had a higher lambing rate \((P<.01)\) than the double treatment group. Six of the control ewes of study I, which were mated during the first breeding period, failed to conceive. One of these ewes did, however, lamb but to a mating during the second breeding period.

Exposure of the ewes to intact rams for a second 14-day period resulted in an increased number of lambs, especially in studies III and IV (table 1). As with conception rates for the first breeding period, the chi-square test indicated lack of independence from treatment effects only in the case of study I. The ewes in the control group of this study had fewer lambs and a lower lambing rate than ewes of the treated groups \((P<.05)\) and the single treatment resulted in fewer ewes lambing than the other two hormone treatment groups \((P<.05)\). The single-PMSG vs. double treatment comparison showed the single-PMSG group to have a significantly higher lambing rate \((P<.01)\). No other statistically significant differences were found for overall lambing rate in any of the other studies.

Considering both breeding and lambing performance, the gradual approach of inducing synchronized estrus as in the case of the double treatment procedure appeared most promising in the two studies in which the ewes were cyclic at the time of treatment initiation. This is in agreement with an earlier report (Ellington and Fox, 1964) in which another progestogen, 6-methyl-17-acetoxyprogesterone, was tested in a double treatment procedure. As compared to procedures involving a single period of progestogen administration with breeding at either the first or second estrus following treatment withdrawal, the double treatment procedure of the earlier study was especially effective in terms of improving lambing performance. In view of the complexity of the physiological events involved in the estrous cycle and the fact that a group of cyclic ewes at the onset of treatment would be representing many phases of the cycle, it could be that a gradual approach to synchronization of estrus minimizes disturbances that might otherwise be present at the controlled estrous period. As a result, fertility may not be impaired at the estrus which occurs subsequent to the second period of progestogen treatment.

As to the anestrous season studies, the single-PMSG treatment resulted in the best breeding and lambing performance (study I). Of the 12 ewes receiving this treatment, 11 showed onset of estrus within a 2-day period and 9 lambed to service at this estrus producing a total of 18 lambs. This is a rather remarkable performance to be induced during anestrus because treatment procedures involving progestogen administration followed by an injection of PMSG have in the past typically resulted in fertility that falls below that which occurs during the natural breeding season (Anderson, Schultz and Melampy, 1964).

The single-PMSG treatment as well as the other treatments tested in study IV were relatively ineffective in terms of lambing performance resulting from conceptions during the first breeding period. It may well be that the first 14-day breeding period of this study was actually during what might be considered a transition period (anestrous to breeding season) which in some manner made the reproductive structures less receptive to the imposed hormonal treatments. Another possibility is that this poor reproductive performance could be a cumulative effect caused by the intensive lambing program in which the ewes were involved. The fact that the majority of the ewes did breed and conceive during the second 14-day breeding period of study IV in spite of fertility typically being impaired at this stage of the season (Dutt, 1954) tends, however, to argue against a detrimental cumulative effect.

**Summary**

A total of 48 crossbred ewes was used to study reproductive performance in a four consecutive lamb crop program which included early weaning (2 months) and subsequent breeding control treatments. Hormonal treatments included the use of fluorogestone acetate impregnated pessaries which were intravaginally placed and equine gonadotropin injections. Removal of the impregnated pessaries resulted in estrous activity within 2 to 3 days in the majority of both cyclic and anestrous ewes. In regard to total reproductive performance (breeding and lambing), a procedure involving utilization of the impregnated pessaries during two spaced periods was the most consistently effective procedure.
tested. An exception to this was in one study where treatment was initiated during anestrus in which an injection of equine gonadotropin given at the time of pessary withdrawal was the most effective treatment.

**Literature Cited**


