VARIATION IN OVARIAN ACTIVITY OF ROMNEY MARSH EWES

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SUMMARY

Ovulatory activity (number of corpora lutea) was examined in Romney Marsh ewes at laparotomy after the first and second oestrous periods of the breeding season. Ewes were mated to entire rams at third oestrus and slaughtered nineteen days later.

Following laparotomy, oestrous cycles were normal in length, few ewes showed silent oestrus, and a good conception rate resulted to mating at third oestrus.

Ewes of similar genetic origin, although bred at two farms for five years, when brought into a common environment showed marked differences in ovulatory activity several months later. Irrespective of the farm of origin, twin-born ewes shed more ova than single-born ewes and there was an increase in ovulation rate with advancement in order of oestrus.

Use of the cumulative number of corpora lutea formed over several oestrous periods, as a criterion of reproductive function, is discussed.

THE number of lambs born per ewe is widely used as a measure of fertility in the ewe. It is generally recognized also that the number of lambs born per ewe is the end result dependent on the successful completion of several preceding processes. Consequently, a more adequate description of fertility in the ewe requires a stepwise study of the various stages of reproduction. While the delineation of each stage involved in reproduction is somewhat arbitrary, the number of ova shed either following a single oestrus or over several oestrous periods is a phenomenon which readily lends itself to biological investigations.

The importance of ovulation rate as a contributing source of variation in fecundity is well known. Earlier work in New Zealand (McDonald, 1958; Averill, 1959, 1964) has suggested that the average ovulation rate tends to increase with advancement of the breeding season or with each successive oestrus. However, in order to examine the ovaries for evidence of ovulation these workers slaughtered groups of ewes at intervals during the season or after each oestrous period. The slaughter technique clearly does not permit an assessment of the relationship between the number of ova shed and the order of oestrus on a *within-ewe basis*. Recently a technique of laparotomy, which is rapid and

thus suitable for studies using large numbers of ewes, has been described by Lamond and Urquhart (1961) and Lamond (1963). The successful application of the laparotomy technique would enable a series of observations to be made on the ovulatory activity in the same ewe, over several oestrous periods.

The purpose of this paper is to report:

(1) The usefulness of repeated laparotomy for studies on ovarian activity;

(2) The influence of several factors on variation in ovarian activity.

EXPERIMENTAL

One hundred and thirty-three five-and-a-half-year-old Romney Marsh ewes were available from the flocks kept at the "Terrace" and "Tuapaka" farms of Massey University. Essentially all ewes were of similar origin having been derived from a randomly-bred flock maintained at the University since 1944 — they differed in that they were born and reared at either of the two farms. Full details of their individual history and life-time production were known.

In December, 1964, the ewes from both farms were brought together and joined with vasectomized rams fitted with sire-sine harness and managed as one mob on the "Terrace" farm. The animals were grazed on predominantly ryegrass-white clover pasture and the management was aimed to keep their liveweight constant. Liveweights were recorded at regular intervals prior to and during the mating season. Although the ewes gained, on average, 3.6 lb from March to May, if allowance was made for the weight of wool grown during this period then it would be unlikely that any marked increase in liveweight had occurred. Ewes were identified by ear-tags and numbers branded on to their sides and observations were made daily for mating marks.

Following both the first and second oestrous periods of the season, laparotomy using a cradle (Lamond and Urquhart, 1961) was conducted four, five or six days *post oestrus*. The animals were tranquillized with chlorpromazine and light anaesthesia induced with Nembutal. Through a mid-ventral incision, the ovaries were carefully brought to the exterior and the numbers of recently-formed and older-aged corpora lutea recorded. Handling of the reproductive tract was kept to a minimum, yet allowing observation of all surface area of both ovaries. Penicillin was deposited in

the peritoneal cavity and the wound closed with two mattress sutures. A fresh site for abdominal incision was chosen for the second laparotomy. After surgery the ewes were returned to pasture.

Prior to the third oestrous period, the ewes were placed with three entire rams fitted with mating harnesses. The ewes were slaughtered nineteen days after mating. The reproductive tracts were collected and examined for numbers of corpora lutea and embryos formed after the third oestrus; the tracts of ewes which returned to oestrus within nineteen days after the third heat were examined to determine the numbers of corpora lutea of the third and fourth heats and for fertilization of ova.

RESULTS AND DISCUSSION

Effect of Laparotomy on Reproductive Performance

It is clear that the effect of repeated laparotomies on the reproductive system and especially ovulatory activity of the ewe cannot be evaluated by comparisons between animals subjected to laparotomy and non-operated control ewes. Thus the effects of repeated laparotomies on the reproductive system of the ewe were inferred from the regularity of occurrence of oestrus and from data on conception rate following mating at a single oestrous period.

Following the first laparotomy, eight ewes did not return to oestrus at the time normally expected. After the second laparotomy, five ewes did not show heat as anticipated and, in one of these, oestrous behaviour was absent after both operations. In all cases, however, ovulation had occurred and this was revealed by finding at subsequent laparotomy, or at slaughter, the corpora lutea whose appearance were consistent with ovulation at the predicted time.

The incidence of approximately 5% silent heat may well be owing to the stress of operation. However, there was no evidence to show that an increased incidence of occurrence of silent oestrus had resulted after the second laparotomy. Furthermore, as only definite mating marks were used as criteria of oestrus, the possibility remained that several ewes showing less clearly defined mating marks were incorrectly recorded as having exhibited silent oestrus.

The mean lengths of oestrous cycles following laparotomy were similar to those recorded for other Romney Marsh ewes in New Zealand (Goot, 1949). The intervals from the first to second oestrus and from the second to third oestrus were 17.1 and 17.4 days respectively.

Mating the ewes to fertile rams at third oestrus and recording the number of embryos alive at nineteen days of pregnancy provided further evidence that these laparotomies had negligible effects on subsequent reproductive function of the ewe. Thus, of 119 ewes examined on day 19, live embryos were recovered from 93 animals, *i.e.*, a conception rate of 78.2% to mating, during a single oestrous period.

Although ovulatory activity of the ewe may be observed by using the slaughter method, evidence presented in this study would suggest that the technique of laparotomy is feasible as an alternative. In general, provided laparotomy is carefully conducted, it enables a wide range of objectives to be included in the study of ovulatory activity. For example, it allows the evaluation of effects on the ovaries due to treatments imposed during intervals between oestrous periods. Or it may be used to describe the fate of ova on a within-ewe basis. If repeatability of ovulation rate is the purpose of an investigation, repeated laparotomy is the only technique which allows observations to be made over the successive oestrous periods.

Ovulation Rate per Oestrous Period

Order of Oestrus

The number of corpora lutea formed after each oestrus (and silent oestrus) was assumed to represent the number of ova shed by the ewes. Considering all ewes where complete data were available, the mean numbers of ova shed at first, second and third oestrus were 1.71 ± 0.06, 1.85 ± 0.05 and 1.88 ± 0.05 ova, respectively. There is an apparent increase in ovulation rate with successive heat periods. Analysis by chi-square of the distribution of ewes classified according to the number of corpora lutea at the first and second oestrus showed that the value was just short of the 5% level of significance ($\chi^2 = 4.8$, $p > 0.05$). The same method was used for analysis of data between the first and third oestrus. The value of chi-square found was significant ($\chi^2 = 8.2$, $p < 0.02$).

These results are in agreement with earlier studies of ovulation rate in Romney Marsh ewes. However, it is worth while to stress that previous investigations of ovulation rate were made between groups of ewes slaughtered at intervals, whereas the present findings were based on repeated observations made on the same ewes. In addition, the variation in plane of nutrition over the experimental period was considered to have a negligible effect on the present results,

since the average liveweight of the animals remained practically constant. The evidence therefore supports the conclusion that increased ovulatory activity was associated with each successive oestrus or with advancement in time within the breeding season.

Previous Environment

Marked differences in ovulation rate were apparent between groups of ewes differing in previous environment. Analysis by chi-square of the distribution of ewes with one, two, or more corpora lutea between "Tuapaka"-bred and "Terrace"-bred animals at each heat showed significant differences (heat 1: $\chi^2=6.4$, $p<0.05$; heat 2: $\chi^2=12.6$, $p<0.01$; heat 3: $\chi^2=6.8$, $p<0.01$).

The data also indicated that within each group the average ovulation rate increased with each successive oestrus. These results are further illustrated in Fig. 1 where, for each group of ewes, the average ovulation rates have been plotted at weekly intervals throughout the mating period. The mean onset of first oestrus was March 20 and, since successive heats occurred at mean intervals of seventeen days, each point represents the average weekly number of corpora lutea produced by ewes in heat during that week and experiencing either their first, second, or third oestrous periods of the breeding season.

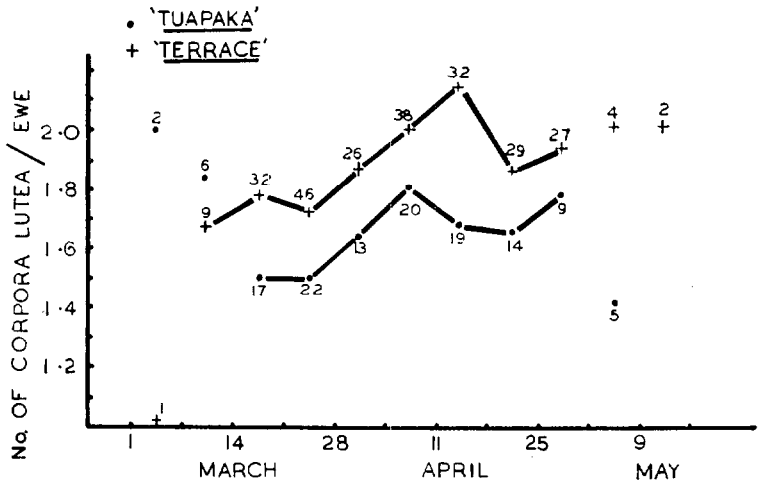

Fig. 1: Seasonal changes in ovulation rate of Romney ewes reared in different environments.

Type of Birth of Ewe

The mean numbers of corpora lutea produced by ewes which were themselves born either as singles or as twins are shown separately for each oestrus in Fig. 2. In each case, ewes born as twins shed more ova than did single-born ewes. This difference between twins and singles is seen in the ewes of both farms, with the higher rates of ovulation found in the "Terrace"-bred animals.

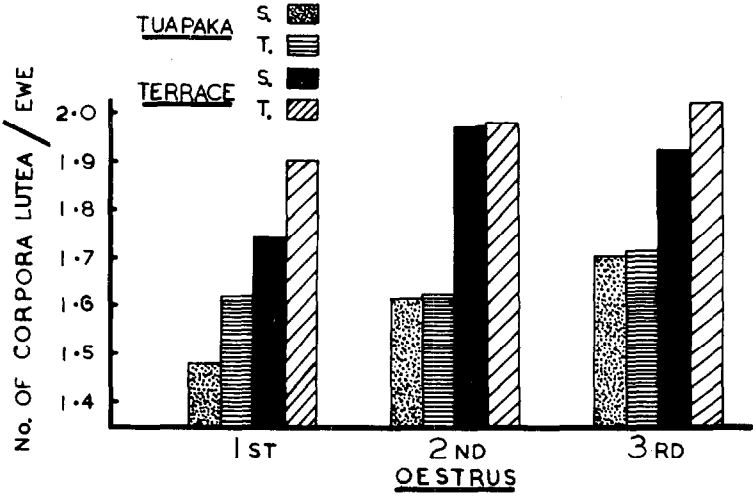

Fig. 2: Ovulation rate in Romney ewes relative to the type of birth.

Factors Affecting Variation in Ovulatory Activity

In the present study, ovulatory activity was measured by the total number of corpora lutea recorded for each ewe. Since it is seldom that all ewes will conceive following mating during a single oestrous period, a more adequate description of ovulatory activity requires the measurement of ova produced over several oestrous periods. If, on the other hand, ovulatory activity is the end point rather than an intermediate step in the study of reproduction, the total or the average number of ova shed over several oestrous periods for each ewe is still a useful measurement for exposing the inherent variation in this character between ewes. For instance, in the present work, 35% of the ewes each produced a single ovum, while 60% of the ewes produced two ova during the first oestrus; this is shown in

Fig. 3. Essentially, the variation in ovulation rate between ewes for this oestrus is confined to two distinguishable classes. In contrast, over the first three oestrous periods the total number of ova shed per ewe has a range from three to

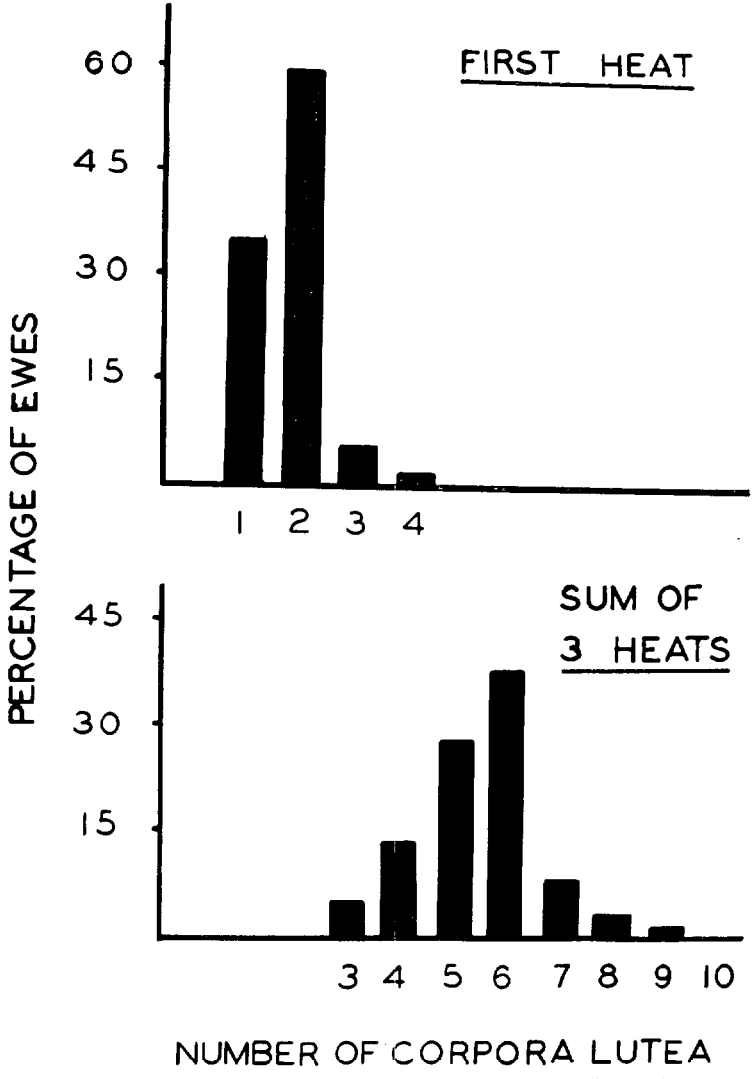

Fig. 3: Distribution of ewes relative to the number of corpora lutea formed at first oestrus (upper) and to cumulative total of corpora lutea after third oestrus (lower).

TABLE 1: THE MEANS AND ANALYSIS OF VARIANCE OF CUMULATIVE TOTAL OF CORPORA LUTEA FORMED OVER THREE OESTROUS PERIODS

Ewes	*Total No. Corpora Lutea*		*Difference*
"Tuapaka"	Singles	4.78	
	Twins	4.95	0.17
"Terrace"	Singles	5.64	
	Twins	5.88	0.24
"Tuapaka"		4.86	0.90
"Terrace"		5.76	

Source of Variation	*d.f.*	*Mean Squares*
Farms	1	22.93**
Type of birth	1	1.81
Error	121	1.27

** $p < 0.01$.

nine, thus enabling a more accurate distinction to be made among ewes differing in ovulatory activities.

An analysis of some factors affecting variation in ovulatory activity has been made using the total number of corpora lutea per ewe over the first three oestrous periods. The results are summarized in Table 1. The ewes which were themselves born as twins produced, on average, more ova than the ewes themselves born as singles. While the difference in average ovulation rate among ewes differing in type of birth was not statistically significant, it pointed to a higher level of potential fertility in the twin-born ewes. The results of previous studies (Rae and Ch'ang, 1955; Wallace, 1964) have shown that, within a flock, twin-born ewes are higher in lambing percentage than single-born ewes. The average difference of 0.90 ova attributable to previous environment between the "Terrace"-bred and the "Tuapaka"-bred ewes was significant at the 1% level. It was interesting to note that the effect of previous environment on the ewe had persisted to cause a marked difference in ovulatory activity despite the fact that the ewes were grazed as one mob for several months prior to the start of the breeding season. No explanation is available at present for this result. However, it does point to the need to allow for extraneous sources of variation in studies of reproduction.

ACKNOWLEDGEMENTS

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DISCUSSION

PROFESSOR I. E. COOP: *What is the relationship between time of occurrence and ovulation rate for a particular oestrus?*

DR MCDONALD: It has been shown that as the breeding season advances in time, the average ovulation rate tends to rise. Whether or not this relationship also exists for a particular oestrus cannot be decided with any certainty, since the data were insufficient for this type of analysis.

DR M. WODZISKA-TOMASZEWSKA: *Did the ewes from different farms differ markedly in hogget liveweight?*

DR MCDONALD: No. The average hogget liveweights measured post-shearing were 90 lb and 89 lb for the "Terrace" and the "Tuapaka" ewes, respectively.

D. P. SINCLAIR: *What are the major differences between the two farms?*

DR MCDONALD: Differences exist in factors such as the climate, physical environment and day to day management between the two farms. However, the annual farming calendar marked by events such as duration of mating and lambing, and date of shearing and weaning, is essentially the same on the two farms.

I. J. INKSTER: *The results on ovulatory activity were obtained under the conditions of the "Terrace" farm. Was similar work also carried out under the conditions of the "Tuapaka" farm?*

DR MCDONALD: No. However, it is agreed that a reciprocal transfer of ewes between the two farms would be desirable if the objective was to evaluate the specific effects of some prior treatment given to the ewes of each farm.