ONSET OF THE BREEDING SEASON
IN THE CORRIEDALE EWE

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CHAPTER I

INTRODUCTION

Any sheep husbandry programme aiming at an improvement of lamb production must rely on known information about ewe and ram reproductive physiology. Of primary importance in the case of the ewe is a knowledge of the breeding season and in particular its onset, since, as this has been demonstrated to vary between breeds and regions, it must be determined for each particular case.

The Corriedale breed is known to have its onset earlier than Romneys and later than Merinos and because of its dual purpose nature is particularly suitable for early lamb production; besides that, Canterbury province, because of its high density of Corriedale sheep, can play a major role on the above mentioned early lamb production.

Information about Corriedale's onset of the breeding season is scarce throughout the world in comparison with the large amount of data about the Merino and other breeds.

In order to get an earlier and concentrated lambing, synchronisation methods have been devised, but these necessitate an accurate knowledge of the breeding season and in particular of its onset. This applies especially for the case of synchronisation by the ram introduction technique, which at the present is the only practicable method for general farm use.

The onset of the breeding season for Corriedales in Canterbury has not been precisely determined; the present experiment was planned to provide information on this aspect of the reproductive process.

Several methods can be utilized for determinations of the breeding season of ewes. The possibility of obtaining information from a number of flocks belonging to different properties and the large number of animals involved decided the utilization of the examination of reproductive organs of slaughtered ewes technique.

By means of this method information of the presentation of heats and thus approximate date of ovulation cannot be obtained; on the other hand it permits the consideration of a large number of animals. Date of ovulation can be determined with a relative precision from examination of the ovaries.

The presence of the ram can alter the onset of the breeding season (see Chapter II, page 7) thus for a determination of the natural onset all ewes to be slaughtered were kept away from rams.

It was intended to continue the observations throughout the breeding season, but, due to problems in the availability of animals, this was not done and only the onset was able to be determined.

CHAPTER II

REVIEW OF LITERATURE

A) ONSET OF THE BREEDING SEASON

The physiological mechanisms governing the onset of the breeding season in ewes are believed to be understood. However, variations between and within breeds do exist and need special consideration.

Ovulations without heat are of common occurrence at the beginning of the breeding season, which, if not considered, can bias any interpretation of results.

Other than normal factors can, under some circumstances, alter the normal onset of the breeding season. Amongst these "stress" caused by transportation is relevant to this review.

1) Physiology

Most of the commercial type of sheep breeds are known as polyoestrus seasonal breeders (Marshall, 1922), experiencing a restricted breeding season which in general extends over the Autumn or early Winter (Yeates, 1949). This statement is only partially true for fine wool breeds which tend to be polyoestrus all the year round (Asdell, 1946). This pattern has been demonstrated to be largely governed by environmental factors (Yeates, 1949; Hart, 1950; Hafez, 1952; Dutt and Bush, 1955; Smith, 1962; Riches and Watson, 1954).

Environment encompasses the full range of conditions to which an organism is exposed, and is a complex of climatic, nutritional and biotic factors (Radford, 1966).

a) Climatic factors

i) Light - Light/dark ratio plays the major role in determining the breeding season in sheep and in other mammals (Yeates, 1949; Hart, 1950; Hammond, 1954; Ortavant et al, 1964), at least at high latitudes, because under tropical conditions there are reports that do not support this view (Symington and Oliver, 1966; Smith, 1967 and others). In sheep, at least, light seems to govern the macroperiodicity only (Nalbandov , 1964).

Sheep are known to be "short-day" breeding animals, meaning that they are sensitive to short hours of light per day, this being more important than the gradual decrease in hours of light (Hart, 1950). Yeates (1949), Hart (1950), and Hafez (1952) provided evidence that in many English breeds of sheep the breeding season starts after a change from increasing to decreasing hours of day light, and Yeates (1956) demonstrated similar photosensitivity in Merino ewes. Subsequently Radford (1961) demonstrated that continuous light did inhibit but not completely suppress the development of normal sexual activity in Merino ewes and that the response of mature Merinos to equatorial light was variable, some ewes exhibiting continuous sexual activity, others remaining seasonal. Smith (1967) concluded that the mechanism in Merinos seemed to be different from that of British breeds.

The neuro-humoral mechanism by means of which light-stimulus operates is known to involve the optic receptors, the hypothalamus, the hypophysis, and the release by this gland of gonadotrophins, which in turn stimulate the ovary. An extensive review of these mechanisms lies out of the scope of this work.

ii) Temperature - The evidence of a regulatory effect of temperature in the breeding season is not clear. McKenzie and Phillips (1933), found no significant effect on the initiation of oestrus by subjection of ewes to temperatures of 44° to 48° F. Dutt and Bush (1955) involved temperature as a modulator of reproductive function in sheep when they showed that a lowered environmental temperature (40° - 45° F.) induced oestrus some 50 days earlier than in controls at a temperature of approximately 90° F. Williams et al (1956) found a higher incidence of oestrus in ewes treated with low temperatures (70° to 60° F.) than in control ewes exposed to ambient temperatures. Godley, Kennedy and Hurst (1966) reported similar findings, although no significant differences in average birth date were demonstrated for the different treatments (namely, light and temperature), and concluded that sexual activity as indicated by oestrus in sheep is influenced by light, temperature or a combination of both. Lees (1966) suggested that high ambiental temperatures for a short period shortly before the onset of the breeding season delayed the onset; he also suggested that the importance of the delay was related to the temperature.

b) Nutritional factors

"Flushing" does not speed up the onset of the breeding season (Kelley, 1937; Underwood and Shier, 1941). Malnutrition, on the other hand, delays the onset of the breeding season (Quinlan and Mare, 1931; Roux, 1936). Under-feeding and over-feeding, however, were reported to have no effect on sexual activity of sheep (Voss, 1950). Hafez (1952) studied the effects of submaintenance upon the breeding season and concluded that a submaintenance diet started before the onset did not delay the breeding season, but did decrease the percentage of possible silent heats from 56% to 36% as compared with another group in which submaintenance was started after the breeding season was commenced.

The somewhat conflicting data are interpreted by Hafez (1952) as being the result of different latitudes where the experiments had been carried out.

Recent reports, in turn, show a more definitive regulatory effect of nutrition upon the breeding season of sheep. Suijendorp (1959) has noted an association between occurrence of oestrus and feed availability in Merino ewes in Western Australia. Hunter (1961) too, has shown an effect of nutrition upon occurrence of oestrus in ewes, and Smith (1962, 1966) has demonstrated that both current and previous nutritional status have an influence upon occurrence of oestrus in Merino ewes.

Ahmed et al. (1955) proposed that the effect of feeding level may be exerted through the growth of the reproductive tract and the activity of the ovaries in producing ova (both quantitatively and qualitatively). According to Bellows (1962) a high level of nutrition may operate, in activating ovarian activity, by increasing pituitary weight and therefore total FSH and LH production.

An increase in glucose availability provided by high nutritional levels has been suggested as the reason for an increased hormonal output by the pituitary gland (Howland et al., 1966).

c) Biotic factors

The best known of them is the presence of the ram,that can modify markedly reproductive activity of ewes. Evidence has been adduced by Underwood, Shier and Davenport (1944), Thompson and Schinkel (1952), Riches and Watson (1954), and Schinkel (1954) that the introduction of rams among Merino ewes in the late Spring has a stimulating influence in the occurrence of oestrus, and Schinkel (1954) has found that under such circumstances, there is an immediate stimulation of ovulation in the majority of ewes which are not already exhibiting oestrus cycles. Radford and Watson (1957) and Edgar (1962), confirmed these previous reports with the Merino in Spring and the Romney in early Autumn respectively.

For Corriedales, reports sustain the existence of a ram effect (Lyle and Hunter, 1965; Coop and Clark, 1968), though it may be variable in nature, for Coop and Clark (1968) reported a variable response in synchronisation attempts (see below) and also indirect evidences were suggested by Coop (pers. comm.) since, when examining lambing records for Corriedales, he found lambing peaks for the beginning of the season and corresponding to the introduction of rams - in some years but not in others for the same property. The ram effect of altering the onset of the breeding season is believed to operate shortly prior to, or at the beginning of, the breeding season; on the other hand, there is evidence indicating that the ram effect might not exist later in the breeding season (Lishman and Hunter, 1966).

The presence of the ram and its subsequent effect has been utilized as a means of synchronising oestrus cycles. Miller (cited by Lamond, 1964) obtained highly successful synchronisation in Merinos in Australia. Edgar and Bilkey (1963) working with Romney ewes and Southdown rams reported that the onset of the breeding season was successfully advanced whem rams were introduced at the beginning of February (shortly before the onset, Averill, 1964). Synchronisation was successful in both young and mature ewes and entire rams were more effective than vasectomized ones. Coop and Clark (1968) reported successful synchronisation with South Island Romneys. The same workers reported variable results for Corriedale ewes. True synchronisation was obtained in some years but not in others and also for the same year results varied between flocks. It was suggested that this could be due to a more widely spread onset of the breeding season as compared, for instance, with the Romney.

2) <u>Breed differences</u>

Two types of breed differences are to be considered, those between breeds and those within the same breed. Particular reference is going to be made of Corriedale breed.

a) Between breeds

It is well known the fact that breeds of sheep can differ markedly in the date and intensity of response to the light stimulus at the onset of the breeding season.

Hafez (1952), in an extensive study over several breeds of sheep, found that, although all breeds observed had their mid-breeding season around the shortest day of the year, there were large variations in the onset due, probably, to differences in the length of the ovulatory period, these differences due to genetic properties were suggested to be related to the different origins of the breeds considered, involving, therefore, different latitudes (Hafez, 1950). Several further reports with particular reference to each breed give support to this view (Asdell, 1946; McMeekan, 1959; Hart, 1961).

b) Within breeds

i) Age - In general ewe lambs come into oestrus later than two tooth ewes which in turn are later than mature ewes (Hafez, 1952; Smith, 1966).

Between ewes of the same age there are differences as well, though these may be small for Averill (1964), in a survey with New Zealand Romneys, concluded that all the ewes he examined came into ovulatory phase within 20 days, which would indicate no large within breed differences for Romney breed.

ii) Strain - In the other hand, Lamond (1964) reported strain differences in the onset and intensity of ovulatory activity for Merinos in Australia. Strain differences were suggested to be brought about by selection (Hafez, 1952).

iii) Individual - Between year variations for the same breed have also been reported. Underwood, Shier and Davenport (1944) reported a variation from year to year with the same type of sheep in the same locality. In New Zealand Romney Marsh stud flock the percentage of ewes coming in season within the first five weeks varied with the year, and ranged from 69 to 99% (Goot, 1949). Hafez (1952) reported no significant differences between years in the breeds considered, although individuals did not show constancy in the time of onset between years.

c) Onset in the Corriedale

World literature is very scanty in reports about breeding season of the Corriedale breed.

Schott, Phillips and Spencer (1939) in the United States of North America studying the breeding season of several local sheep (44º latitude North) reported that the onset of oestrus in Corriedales was, for mature ewes between August 29 and September 4, and for yearlings between September 5 and September 11. McMeekan (1959) gives the end of March as the date of the onset for Corriedales of the South Island of New Zealand, determined for a non stated number of ewes, with vasectomized rams. Hart (1961) reported data of recovery of ova from the 31st of January until the 19th of June for Corriedales of the South Island of New Zealand (44º latitude, South). Averill (1964) reported that the breeding season in Corriedales in Otago was thought to be 2-3 weeks earlier than for Romneys, for which, in turn, the ovulatory activity was determined as starting at the end of February. In Brasil, Velloso (cited by Spedding, 1965, p.70) reported that the onset of the breeding season for Corriedales (30º latitude South) was at the end of February. For Uruguay (32º-35º latitude South) Duran del Campo A. (pers. comm.) reported the end of January as the mean date for the onset on ewes running with vasectomized rams.

3) <u>Silent heat</u>

Ovulation without oestrus (silent heat) takes place before the onset and after the end of the breeding season as revealed by slaughterhouse material (Grant, 1933; Robinson, 1950; and others) and by the vaginal smear technique (Cole and Miller, 1945; McDonald and Raeside, 1956). There is no universal agreement as to the degree of ovulation without oestrus before the onset of the breeding season.

Under natural conditions ovulations without oestrus were reported to occur in 6% of the cases (McKenzie et al., 1933). However, Grant (1933, 1934) stated that ovulations without heat occur normally at the beginning of the season. The same was reported by Hammond Jr. (1944) Robinson (1950) and others.

Many references give no information as to the nutritional status of the animals at the time of determination of silent heats incidence and as to how silent heats have been observed and recorded. Evaluation of these reports is therefore very difficult.

Considering previous observations,Schinkel (1954) stated that all ewes which at slaughter had not a previous corpus luteum did not show oestrus in this particular ovulation. This is due to a lack of progesterone from a previous corpus luteum, called "waning" corpus luteum. Robinson (1959) proposed that the mechanism was that of insufficient production of oestrogens owing to ineffective release of pituitary gonadotrophins. Reardon and Robinson (1961) suggested that to these two explanations it must be added in some cases a relative refractoriness to oestrogens in the late Winter and early Spring months, possibly as a result of "stress" induced by adverse environmental factors.

a) Breed differences

There seems to be breed differences in the incidence of silent heats (Kelley, 1937; Hafez, 1952; and others). Hafez (1952) reported percentages of silent heat up to 28 per cent for mature Blackface M. ewes and 7 per cent for Dorset Horns. Hutchinson et al. (1964) reported 13.6 per cent of silent heats in Welsh Mountain ewes. Goot (1949) found that less than 2 per cent of silent heats occurred in New Zealand Romneys, though under stud conditions.

b) Management differences

Management differences in the incidence of silent heat seem to be evident since Riches and Watson (1954) found with Merino ewes that the incidence of silent heats was much higher among ewes continuously running with vasectomised rams than among ewes kept away from rams and before the start of the season joined to them. Radford and Watson (1957) found no evidences of silent heats in Merino ewes joined to rams just prior to the breeding season. The effect of nutrition has already been discussed.

4) "Stress" and onset

Other factors than the normally described can affect the time of onset of the breeding season, at least in some breeds of sheep. One of them is the "stress" factor.

In laboratory animals it has been observed alterations in the normal reproductive behaviour brought about by "stress".

Arvay, Kertesz and Lampe (1959) reported that severe nervous stimulation can bring about changes in ovarian activity of sexually active rats. These changes were of increased cycles followed by a lasting state of dioestrus. It has also been reported that some of the changes in function were accompanied by morphological changes. Also Arvay and Nagy (1958) showed that juvenile albino rats can reach the stage of sexual maturity significantly earlier when severe nervous stimulation is applied at the appropriate time and in the correct way. These authors conclude that the adenohypophysis responds to a nervous stimulation with an increased hormonal function, producing increased amounts not only of ACTH, as it has been shown to happen in "stress" (Seyle, 1947) but also of gonadotrophic hormones. Herbert and Zuckermann (1957) working with ferrets observed that "stress" caused by operations brought about unexpected synchronized ovulations.

In domestic animals a few reports of modified ovarian activity due to "stress" have been made.

Shorthorn heifers moved by road ovulated soon after the journey as reported by Lamond (1962). Hafez and Sugie (1963) have reported the frequent occurrence of ovulation unaccompanied by oestrus in beef heifers transported long distances. Sows under the same circumstances were reported to ovulate more than non-transported counterparts (Nalbandov, 1964).

In sheep, Braden et al. (1964) noted a high proportion of recently formed corpora lutea in removed ovaries from anoestrus Merino ewes. There was not any association of these ewes with rams that would affect ovarian activity as reviewed (see p.7). The ewes had been subjected to the severe "stress" of a 24 hours rail journey a few days prior to ovariectomy. Braden and Moule (1964) following the unexpected findings of the previous experiment (above), carried out a study to determine the cause of those synchronized ovulations, in Merino ewes. It was concluded that in anoestrous ewes, ovulation unaccompanied by oestrus was often induced by severe "stress". Morphological changes were reported, consisting of large cavities in the body of corpora lutea, being these morphological changes associated with "stress". A more extense review of these findings is presented in page 22. Lang (1964) observed the effects of transportation on ovarian changes in Merino ewes during a six months period (July to February) when the induced ovulations varied from 85 per cent to 0 per cent in different flocks and times. He concludes that the use of abattoir material for assessment of sexual activity of ewes may be misleading unless allowance is made for ovulations induced by transportation and proposed that some of the variability in the incidence of induced ovulations may possibly be explained by differing susceptibility according to the stage of the anoestrus period.

It seems to be that there are variations between breeds in response to "stress". For instance, Averill (1964), in an extensive trial recording ovulatory activity from Romney ewes of different localities of the South and North Islands of New Zealand, by means of reproductive tracts collected at several Freezing Works, did not observe any situation likely to be attributed to "stress".

B) REPRODUCTIVE TRACT CHANGES

Reproductive tract organs normally undergo cyclic changes throughout the breeding season. For slaughterhouse material these changes can be observed in the uterus, ovaries, and ovum migration after ovulation has occurred.

1) Vagina

Histological changes in the vagina were reported to occur (Lada, 1961, 1962; Sitarska and Mazurczak, 1963). This topic is not going to be further reviewed since it is not relevant to the present experiment.

2) Uterus

Cyclic changes in the uterus of breeding ewes have been described (Marshall, 1903; Casida and McKenzie, 1932; Grant, 1934; Cole and Miller, 1935; McKenzie and Terrill, 1937). Hammond (1944) reported that the uterus tended to be more turgid about the time of ovulation. Histological changes within a cycle of the uterus were summarized by Eickstein and Zuckermann (1956) as follows: "During anoestrus the organ is in a state of quiescence. During proestrus and oestrus the stromal cells show mitotic activity, being also marked oedema and vascular congestion of the mucosa". Also, increasing growth and coiling of the endometrial glands, with an increase in the height of the epithelium in the fundus of the glands, occur during the luteal part of the cycle.

Hammond, Hammond and Parkes (1942) concluded that the weight of the uterus varied markedly between animals and therefore it was not possible to relate uterus weight to any other reproductive characteristic.

Roux (1936) concluded that low level rations inhibit the development of the uteri of young sheep, and besides that nutrition appeared to affect the weight of the uteri of mature sheep.

Furthermore he found no relationship between weight of the uterus and sexual activity.

Changes in the cervical mucus have been described (Restall, 1961, 1962) but they are of little value for post-mortem examinations.

3) <u>Ovaries</u>

Changes in the ovaries are by far the most important and are reviewed as changes in the actual ovary tissue, in the Graafian follicles, and after ovulation as changes in the corpus luteum.

a) Ovary size

Grant (1934) in a detailed work over more than 90 genitalia at various stages of the cycle stated that changes in ovary size and weight occur during the oestrus period,but due mainly to the size of largest follicles and of corpora lutea, and not to cyclical changes of the ovarian tissues themselves. There seem to be large variations between ovaries,and the only trend seems to be an increase with age, due to an increase in the amount of fibrous tissue.

McKenzie and Terrill (1937) found no significant trend in the changes of size of ovaries during the breeding seasons. They found more often an increase than a decrease in size of the ovaries as the season progressed,but the majority showed no definitive change.

Hutchinson and Robertson (1966) found a significant correlation between ovarian weight and the total follicular plus corpora lutea volume, this further supports Grant's view that changes in ovarian tissue do not occur throughout the season.

There are no clear reports on the possible effect of nutrition on ovary size.

b) Right and left ovaries activity

Clark (1934), McKenzie and Terrill (1937) and Henning (1939) reported that the right ovary in sheep produces more corpora lutea than the left ovary. Casida et al., (1966) found that ewes with single ovulations had 61.8% corpora lutea in the right ovary, and that ewes with more than one corpora lutea had 55.5% corpora lutea in the right ovary.

c) Graafian follicles

The development of Graafian follicles throughout the year follows the same pattern, or, better, it indicates the degree of activity of ovaries. There are marked differences between breeds, some of them showing a continuous growth throughout the year, and other showing a period of relative quiescence (Roux, 1936; Hammond Jr., 1944; Warwick, 1946; Watson, 1952; Lammond, Wells and Miller, 1963).

Merino ewes, for instance (Watson, 1952) showed follicular growth and ovulation all the year round, while other breeds have in turn a period of relative quiescence following the breeding season. However, Hutchinson (1966) does not agree with the term "quiescence", suggesting that follicular growth always occurs even though ovulation stage is not reached.

According to Quinlan and Mare (1931), rapid enlargement of the follicles destined to rupture at the next oestrus occurs shortly after ovulation, these follicles continuing to grow, but very slowly, during the remainder of the cycle. However, follicular development within a cycle was described as steady throughout the oestrus cycle followed by a rapid growth a few hours before the ovulation occurs (Grant, 1934). On the other hand, Hutchinson and Robertson (1966) claim that there is an intense follicular growth immediately after ovulation, due possibly to high levels of oestrogens and of LH/FSH ratio. They conclude that most of the final follicle size is reached within the first few days of the oestrus cycle.

Since many workers are now favouring a steady rate of FSH secretion, this would tend to support the view of a steady growth of Graafian follicles throughout the cycle.

d) Corpus luteum

Soon after ovulation the cavity of the follicle is filled by the proliferation of follicle wall cells, this new gland, the corpus luteum, normally grows and declines within an oestrus cycle, undergoing macroscopic changes in size, shape and colour.

Growth and decline of the corpus luteum have been described by a number of authors, Marshall (1904), Quinlan and Mare (1931), Grant (1934), Warbritton (1934), and others. These authors have shown that in the non-pregnant ewe, the corpus luteum follows a regular growth and decline pattern, maximum size being reached between the sixth and ninth day after ovulation.

Dun, Ahmed and Morrant (1960) combined the published measurements of corpora lutea size made by Quinlan and Mare (1931), Kelley (1937) and McKenzie and Terrill (1937), and composed a graph that, according to them, could be used to predict corpora lutea age, since corpus luteum size was plotted against days after ovulation. Restall (1964) argues that the above mentioned graph is not accurate, due to the fact that the two works on which the graph was based were reported as two different measurements. He carried out an experiment including 35 Merino ewes of mixed age slaughtered at different times after ovulation. Corpora lutea diameter was measured and then plotted against known time after oestrus, and two curvilinear regressions were calculated, one for growth period (i.e., 1 to 10 days) and other for the decline period (i.e., 14 to 25 days). He stated that research workers intending to use large amounts of slaughter house material can make use of the regressions calculated.

Changes in shape of corpus luteum after ovulation are described by Quinlan and Mare (1931). After ovulation the walls of the cavity collapse, but retaining some fluid; after 30 hours the cavity is filled by luteal tissue and the corpus luteum starts to project above the surface of the ovary as a "rosette-shaped" dark reddish prominence. This projection may reach a height of 0.3 cm. and a diameter of 0.6 cm. The corpus luteum is always sphere-shaped or slightly oval. Occasionally there is a prism-shaped tendency. After mid term of the inter-oestrus period the rosette-shaped part gradually begins to disappear and the corpus sinks into the ovarian tissue, remaining the same shape until it becames a brown speck only.

Grant (1934) gave a description in agreement with this of Quinlan and Mare (1931).

Changes in colour of the luteal tissue were reported to occur. Quinlan and Mare (1931) described these changes as being from reddish-pink coloured corpora lutea at the beginning, gradually showing slight changes to become paler, but remaining pale reddish-pink coloured throughout the inter-oestrous period. Just prior to the next oestrus they described a slight tinge of yellow developing. After next ovulation a rapid decline is described and changes in colour towards yellow. Older corpora lutea are described by these authors as brown specks under the ovary surface. Grant (1934) reported a more detailed description of changes in colour of the corpus luteum. The very young corpus is represented on the surface by a minute red spot. Then the rosette-shaped prominence has at about two days a deep red colour. Colour is deeper at the prominence because of extravasation of blood. There are no further changes until 24-36 hours before the onset of a new heat period, when the corpus rapidly losses its red colour, and the regressing body is represented superficially by a hard white or slightly yellow area of the ovary, becoming deeper gradually to orange or brown, a last trace remaining distinguishable as a minute brown or chocolate coloured patch for several months and perhaps permanently. Dun, Ahmed and Morrant (1960) working with Merinos also gave a scale of colours following standard shades of the British Colour Council. This scale was of seven colours or shades: Madder Carmine, Terra Cotta, Burnt

Sienna, Brown Ochre, Law Sienna, Middle Chrome, and Gold, reported to occur at $2\frac{1}{2}$, 6, 10, 15, 17, 21 and 31 days after ovulation. Restall (1964) reported, for corpora lutea of known age, the following colours: red, 1 to 8 days, pink, about 11 days, fading pink to yellowish, 14-18 days, and yellow, 18-25 days after ovulation.

The existence of two types of normal mature corpora lutea, one with a cavity occupying the central part (i.e., hollow) and a second type without such a cavity (i.e., solid), have been described in genitalia of ewes collected at abbatoirs (Grant, 1934; Arthur, 1956; Enriquez de Salamanca, 1957), but generally attracted little attention. Braden and Moule (1964) concluded that the presence of a large cavity in the corpus luteum often seemed to have been induced by transportation "stress", but the amount of luteal tissue and its microscopic appearance did not usually appear much different from solid corpora lutea.

4) Ovum

In mature ewes, within a few hours after the ovulation, the ovum passes to the junction of the ampulla and isthmus of the Fallopian tube, and then spends about 72 hours moving along the tube before entering the uterus (Edgar, 1962).

Both in young ewes and in induced-to-ovulate females this time was shorter (Edgar and Asdell, 1960).

Recovery of ova techniques and a criterion to differentiate between normal and abnormal ova have been developed by Hart (1956).

In the same paper it was reported, also a criterion to differentiate between fertilized and unfertilized ova, working on the basis of the presence or absence of spermatozoa at the zona pellucida. Most workers followed later the same principles.

C) OVULATION RATE

Ovulation rate is given by the number of ova shed per ewe in one single ovulatory period.

Ovulation rate within the breeding season is believed to be governed by environmental factors. However, breed differences have been reported to occur.

1) Environmental factors

a) Light

Light/dark ratio is believed to be responsible for the rise and fall in ovulation rate within the breeding season. There is no universal agreement on when the "peak" of ovulation rate occurs. Part of this disagreement could be due to the use of different breeds and techniques, for its determination.

There is a within-season rise and fall in the mean numbers of ovulations per ewe (McKenzie and Terrill, 1937; Hammond, 1944; Watson, 1952; Averill 1955, 1959; McDonald, 1958, 1961 and others).

Ovulation rate measured by the number of corpora lutea of laparotomized ewes increases from the first to the third ovulation (McDonald and Ch'ang, 1966) and first to second (Allison, 1968).

The incidence of abnormal ova was demonstrated to vary throughout the breeding season (Brambell, 1948; Hart, 1961), therefore an interpretation of ovulation rate records measured by the number of corpora lutea must take into account the above mentioned fluctuation.

Multiple births taken as a measure of ova shed, were considered by Marshall (1922) and Hammond (1944) to postulate that the number of ovulations per ewe is higher at the early parts of the seasonal matings. On the other hand Johansson and Hanson (1943), Averill (1955) and Allden (1956) favour the middle of the season as the moment when more ovulations per ewe occur.

b) Nutrition

Clark (1934) indicated an increase in ovulation rate of mature ewes due to "flushing" for a period as short as approximately 3 weeks in one of two trials. McKenzie and Terrill (1937) and El-Shiekh et al. (1955) have demonstrated consistent increases in ovulation rate from higher levels of feeding over an extended period of time. Ahmed et al. (1955) reported, as well as higher ovulation rate, larger follicles and higher density of small follicles, with a high level of nutrition. Foote et al. (1959) reported differences averaging 30 per cent in ovulation rate when comparing two different levels of nutrition, in favour of the high level. They concluded that the only factor that fully explains these differences was body-weight. Coop (1962) reported a significant increase in twinning rate with increasing body weight. Killeen (1967) showed that both size and condition are important in Border Leicester x Merino ewes. He reported that the higher the body weight of ewes at mating the higher the ovulation rate, and that an increase in condition by high levels of nutrition prior to mating increased ovulation rate, being this effect independent of the effect of body weight at mating. Lax and Brown (1968) reported results in agreement with Coop (1962), Smith (1964) and Killeen (1967).

c) Differences between environments

Differences between environments were found to influence ovulation rates even if body weights did not change (McDonald and Ch'ang, 1966).

d) Other factors

Factors such as temperature and the presence of the ram have not been reported as to affect ovulation rate.

2) Breed differences

a) Between breeds - Characteristic breed differences exist and are reflected in fecundity, as tabulated by Asdell (1946).

b) Within breeds - There seem to be differences within the same breed, for Averill (1964) found differences in ovulation rate for New Zealand Romneys, ewes of the Southern regions showed much higher ovulation rates than those of the Northern ones. Differences in latitude are believed to cause these variations.

c) In Corriedales - Reports of the "peak" ovulation rate for Corriedale breed are variable. Terrill and Stoehr (1939) gave a figure of 118.0 per cent for Corriedales in the United States. Rasmussen (1941) differentiating between Canadian Corriedales and Corriedales in Canada, reported an ovulation rate of 146.0 per cent and 114.0 per cent respectively. Hart (1961) gave a value of 132 per cent for Corriedales in New Zealand. Coop (1962) reported 40 per cent of twinning rate for New Zealand Corriedales.

CHAPTER III

MATERIAL AND METHODS

A) FARMS SOURCE OF ANIMALS

The reproductive tracts collected were from 1147 Corriedale ewes coming from seven different properties situated in Canterbury (43 to 44º latitude South) as shown in Figure 1 (p.32).

A brief description of each farm and of each group of ewes slaughtered, follows.

1) Ashley Dene

It is one of the Lincoln College's commercial farms, situated at Ellesmere, about 17 miles south of Christchurch and about 18-19 miles from the place of slaughter. It comprises 878 acres of light land.

The fertility records of the Corriedale flock indicate a lambing percentage of 110-115 per cent. There is a fertility selection policy, based on the selection of twin rams and ewes. The usual time of mating has been about the end of March or beginning of April.

The 71 ewes slaughtered in two groups, from which reproductive tracts were collected, were mainly cast-for-age and were bred on the property. The feeding level of these two groups of animals prior to slaughter was reported to be minimal, and the body condition variable, due to the age of the animals.

The two groups were mustered, yarded and trucked within a few hours and were slaughtered the following day, on the 22-1-68 and 13-2-68. The collection of reproductive tracts was made, therefore, within 48 hours after mustering.

The average carcass weights of the two groups are given in Table 3 (Chapter IV, p.49).

2) Bowenvale

Private farm situated on the hills of Banks Peninsula with an area of 873 acres of hill country land, located about 12 miles from the place of slaughter.

The lambing percentage of the last few years has been about 93 to 95 per cent with no shepherding at all. There was at the time no selection for fertility. The usual time of mating is around the 11th of March.

The 192 ewes slaughtered, from which reproductive tracts were collected, in four groups, were cast-for-age and culled for poor teeth. These animals were bought in from North Canterbury as four and five year old ewes. Before slaughter the ewes were grazing improved tussock hill country pasture.

All groups slaughtered were mustered at 6 a.m. on a Sunday, trucked on the afternoon and slaughtered in the morning of the following day. The collection of reproductive tracts was, therefore, made within 36 hours after mustering.

The average carcass weights of the four groups are given in Table 3 (Chapter IV, p.49).

3) <u>Hollymount</u>

Private farm situated at Springston, about 14 miles south of Christchurch and about 26 miles from the place of slaughter. This property has 448 acres of light land, carrying a total of 1800 sheep.

Lambing percentages of 110 per cent have been recorded for the last few years. There is no knowledge of any selection for fertility. The usual time of mating is the 1st of March.

The 280 reproductive tracts collected were from Corriedale ewes (originated in North Canterbury) slaughtered in two groups. The animals were cast-for-age ewes or culled because of udder or lambing troubles. The feeding before slaughter consisted of spring-summer pasture with a very little second-growth rape. The body condition of the animals was reported as poorish.

All ewes were mustered, yarded and trucked within a few hours on the day previous to slaughter. The collection of reproductive tracts was, therefore, made within 36 hours after mustering.

The average carcass weights of the two groups slaughtered are given in Table 3 (Chapter IV, p.49).

4) <u>College Arable Farm</u>

Another of the Lincoln College's farms, situated close to the College at Lincoln. Located at about 13 miles south of Christchurch and about 25 miles from the place of slaughter.

The 84 reproductive tracts collected were from Corriedale ewes bought in as cast-for-age from a North Canterbury hill country replacement flock. These animals were kept on the farm for two years for export lamb production.

The two groups of ewes slaughtered were kept, before slaughter, on short dry feed. The animals were yarded and trucked in the same day of slaughter. Therefore collection of reproductive tracts was made within 24 hours after mustering.

The average carcass weights of the two groups slaughtered are given in Table 3 (Chapter IV, p.49).

5) <u>Paparua Prison</u>

This farm run on a commercial basis is situated in Templeton area at about 6 miles from the place of slaughter. It comprises 2000 to 3000 acres of light land.

There is a selection for fertility, though not very intense, partly because of increasing stock numbers. Ewes are bred on the farm and mated to rams bred on the property from a selected flock. The usual time of mating is around the 15th of March. It is noted that the mating period is quite long. The lambing percentage records indicate 105 to 115 per cent for the last few years.

The reproductive tracts collected were from 315 Corriedale ewes cast-for-age as four to five years old. Before slaughter the feeding level was unusually high and it was reported to be difficult to avoid overfatness at slaughter.

The five groups slaughtered were culled in December and run as one mob until the space of the Freezing Works permited some animals to be slaughtered. Each time the whole mob was yarded late on Sunday afternoon, the number required drafted off and trucked on Sunday evening to be slaughtered early on Monday morning.

The average carcass weights of the five groups slaughtered are given in Table 3 (Chapter IV, p.49).

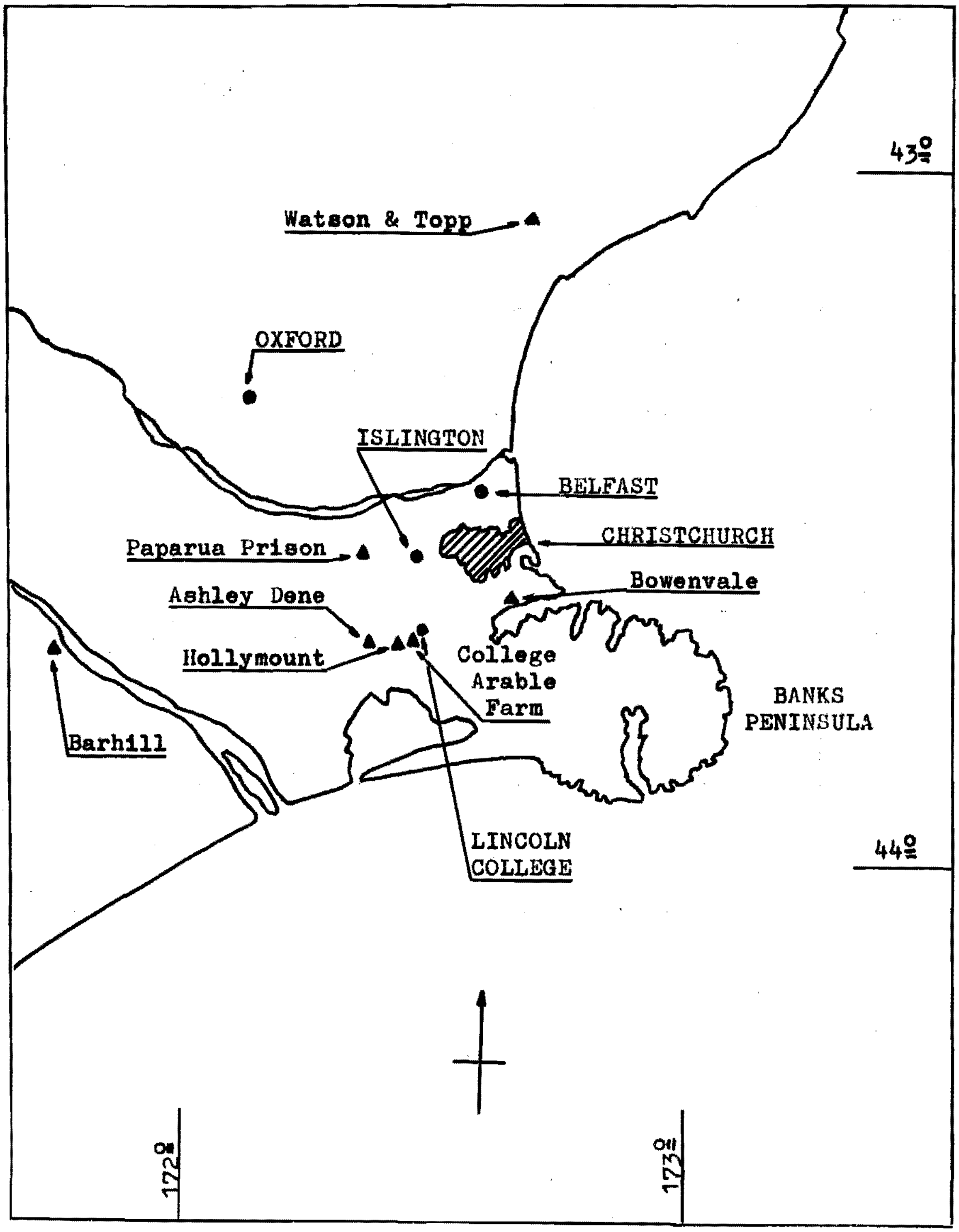
6) Watson and Topp, and Barhill

A single collection of ovaries was made from one group of ewes of each property. The date of collection was very early and likely to be out of the normal breeding season for Corriedales, therefore no further data were recorded from these farms.

Carcass weights of the two groups of animals are given in Table 3 (Chapter IV, p.49).

Figure 1

Location of Farms and Freezing Works



B) COLLECTION OF REPRODUCTIVE TRACTS

Slaughtering of animals was made at three Freezing Works near Christchurch. Ewes from Ashley Dene and College Arable Farm to Canterbury Frozen Meat Company at Belfast, those from Hollymount and Paparua Prison to New Zealand Refrigerating Company at Islington, and those from Bowenvale to Borthwicks at Belfast, respectively. Slaughter procedure followed the usual pattern in each Freezing Works, there being no real differences between the three.

First collection of material was done on the 19th of December, 1967, and the last on the 4th of April, 1968. Number of groups slaughtered and intervals between slaughters are shown, for each farm, in Figure 2 (p.34).

Collection of organs was made at the point on the chain after the evisceration operation when abdominal contents are put on individual mechanically moving trays. From the beginning of the experiment until the 30th of January, 1968, only ovaries were collected, and after a primary classification done on the place between ovaries with corpora lutea (one cycle old)* and ovaries without corpora lutea, the two groups were put in separate plastic bags. From the 6th of

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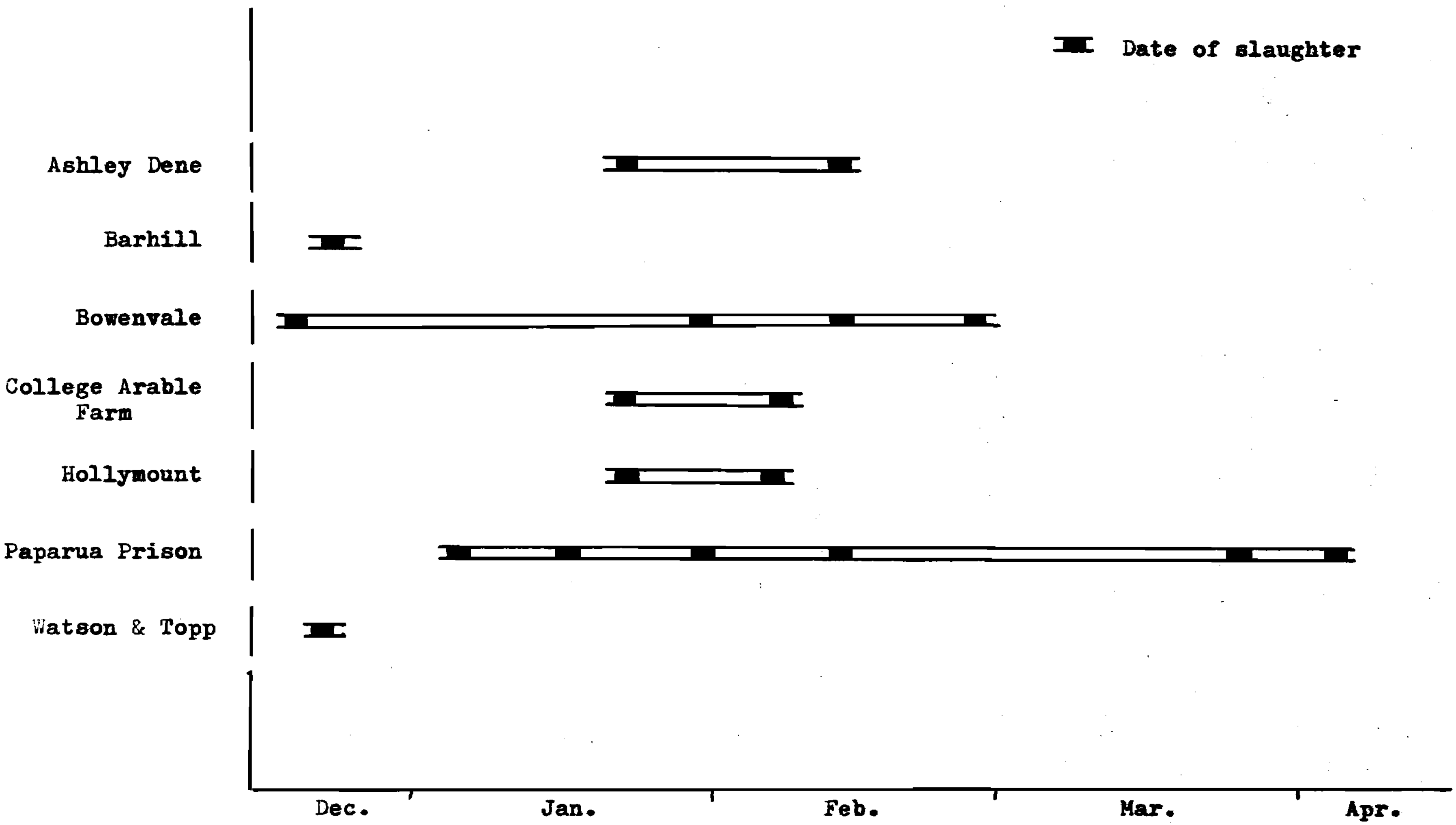
* In the text the term corpus luteum is used for corpora of less than 17 days and the term corpus albicans for older ones.

Figure 2

Pattern and frequency of slaughter



February onwards whole reproductive tracts, excluding vagina and vulva were removed, and placed in order of collection on trays.

Carcass weights of each flock were recorded at the end of the chain in most of the cases. Due to problems in obtaining the corresponding carcass weights to collected uteri, mainly because of carcasses rejected or side-chained for closer inspection, and the impossibility of removing each reproductive tract, only flock average carcass weights were recorded in the last few collections.

In each occasion either ovaries or reproductive tracts were transported to the College and then placed on cold rooms within 5 hours after collection. The ovaries from the first four groups were actually kept on freezing rooms until examination.

Reproductive tracts were removed either by Lincoln College personnel or by meat inspectors.

In the evisceration process some reproductive tracts were damaged and then incomplete organs were obtained. The criteria applied when examining these organs is described elsewhere.

C) EXAMINATION OF THE MATERIAL

The actual examination of the material was started on the 12th of January. Four groups of ovaries had been kept under deep freeze. From the 12th onwards the examination was done as soon as possible after collection. When overnight storage had to be done (cold room at 36-40° F.) soaked cloths were placed over the reproductive tracts in order to avoid the drying up of organs.

The examination of the material was carried out in the following way.

While only ovaries were removed, each one was carefully examined for the presence of large follicles and then measured from pole to pole to the nearest millimetre. Those containing corpora lutea were sectioned and the corpus luteum measured to the nearest millimetre as explained below.

When whole reproductive tracts were removed the procedure for each individual genitalia was as follows:

Any fat or excess tissue was trimmed, keeping only a half length of the cervix, the entire uterus, the Fallopian tubes, the ovaries and corresponding ligaments.

Ovary size was measured from pole to pole to the nearest millimetre. Ovaries, Fallopian tubes, and ligaments were removed and the remainder was weighed to the nearest gram and recorded as uterus weight.

Ovaries were further examined for density and size of Graafian follicles, being classified by eye surface examination only, into four groups:

1) Quiescent ovary, no follicles apparent at the ovary surface.

2) Poorly active ovary, very few small follicles apparent.

3) Quite active ovary, many small follicles apparent.

4) Fully active ovary, some large follicles - of more than 4mm., and many small ones.

When corpora lutea were present, ovaries containing them were classified into the fourth group.

Where Graafian follicles were present a further subclassification was made as follows:

1) Less than 4mm.

2) Between 4 and 8mm.

3) More than 8mm.

The exact number of apparent follicles was recorded for the last two groups, in the case of the first group only density, as none, few or many, was recorded.

Corpora lutea, when present, were examined in the following way:

Firstly number and location (right or left ovaries) were recorded, secondly a section following a plane on the main diameter was made with a scalpel, then measurements to the nearest millimetre of the two main diameters were taken.

The presence of a cavity at least as large as the thickness of the two walls, in the body of the corpus luteum, was recorded as hollow following Braden and Moule (1964).

The classification of corpora lutea into days after ovulation was done considering several items at the same time, namely:

1) Colour of the body of the corpus luteum after sectioning.

2) Colour and shape of the formation protruding on the ovarian surface (named rosette-shaped).

3) Consistency of luteal tissue.

4) Presence in either or both ovaries of large Graafian follicles.

5) Number of corpora lutea present in both ovaries.

6) Size of the corpus luteum given by the two main diameters.

This criterion was developed following initial training under the guidance of Dr. Hart at the beginning of the experiment and completed by means of some reproductive tracts removed from a group of ewes of known date of coming into oestrus, slaughtered at the College's butchery. A complete description of this side trial is given in the Appendix (p.101).

Recovery of ova from either the Fallopian tubes or the uterine horns was attempted in many cases to ensure a correct classification of corpora lutea. The criterion followed was that reported by Edgar (1962).

The technique utilised was described by Hart (1956) consisting of the washing out of ova from either the Fallopian tube or the uterine horn with a saline solution with the help of an hypodermic syringe and an hypodermic needle. A detailed description of this technique was presented by Allison (1967). The searching of ova was carried out using a binocular dissection microscope with a zoom lens.

More than one cycle old corpora, when present at the same time as corpora lutea, were considered as corpora albicantia. Location size and number were recorded in the same way as described for corpora lutea. This was possible with one cycle old corpora albicantia only, because older ones, often present, appear as little brown specks undistinguishable from others, probably belonging to the previous season, or to out-of-season ovulations.

An example of the recording paper sheet utilized is shown in Figure 3 with theoretical possibilities for each column. Some measurements are given as well, these were taken at random.

Figure 3

Recording sheet

Farm:			Freezing Works:											Date:	
No.	Ovary size		Graafian follicles left			Graafian follicles right			Corpus luteum age		Corpus luteum size			Corpus albicans	Uterus weight
	l	r	-4	4-8	8+	-4	4-8	8+	l	r	l	r			
1	1.4	1.5	M	0	0	M	2	0	5d	5d	9x7	8x7		1 L 3x3	46
2	1.7	1.2	M	1	1	F	0	0	1d	-	5x4 4x4	-		0	53
3	1.4	1.6	Vf	0	0	0	0	0	-	-	-	-		0	32
4	1.9	2.1	M	2	1	M	3	1	14d	14d	7x6	7x5 6x5		2 R 3x3 4x3	71

D) ANALYSIS OF DATA

No data was included from tracts which could be classified as follows:

1) Incomplete reproductive tracts, ovaries or uterine horns missing (damaged at the evisceration process).
2) Atretic genitalia, following Averill (1964) uteri weighing less than 25gm. and hypoplasic ovaries, subjectively appraised.
3) Follicular abnormalities, namely cystic follicles (referred to as luteinized follicles by some authors).

Ovaries having corpora lutea of less than 17 days of age were considered to belong to the last oestrus cycle before the slaughtering, for each particular flock. 17 days were taken as an approximate figure of interval between two ovulations within the breeding season as reported by several workers (McKenzie and Terrill, 1937; and many others).

Genitalia rejected for reasons given before were not included in the total number of ewes given for each observation.

Average carcass weights were obtained for all slaughter groups.

Results obtained were statistically analyzed as follows,

a) X^2 test was used to test the significance of:

i) the effect of carcass weight on the onset of the ovulatory season.

ii) differences in activity of right and left ovaries;

iii) differences in density of Graafian follicles;

iv) differences in incidence of hollow corpora lutea;

v) differences in size of corpora lutea between single and twin ovulations;

vi) differences from expected values of some 0-3 day ovulations. In this case, expected values were considered as being 17.5 per cent of the total number of ovulations for each observation. These values were compared with the actual number of 0-3 day ovulations recorded for each corresponding observation.

b) A linear regression equation was used to express the relationship between individual carcass and uterus weights.

c) Two curvilinear equations were calculated in an attempt to express the growth and decline of corpus luteum and corpus albicans up to the 32nd day after ovulation.

E) CLIMATIC CONDITIONS

In order to give a more complete picture of the general conditions under which the present experiment has been carried out, monthly averages of rainfall, temperatures and hours of sunshine are given, for the period between December 1967 and April 1968, in Figures 4, 5 and 6, respectively. These figures are shown in page 42. Mean values of 25 years of observations are given as well and are referred to as Station means.

Figure 4

Monthly rainfall

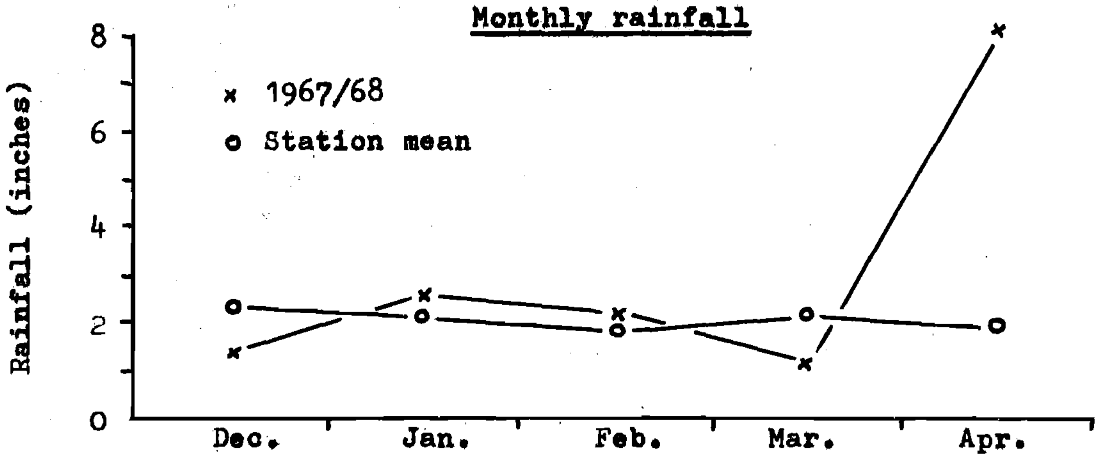


Figure 5

Monthly temperatures

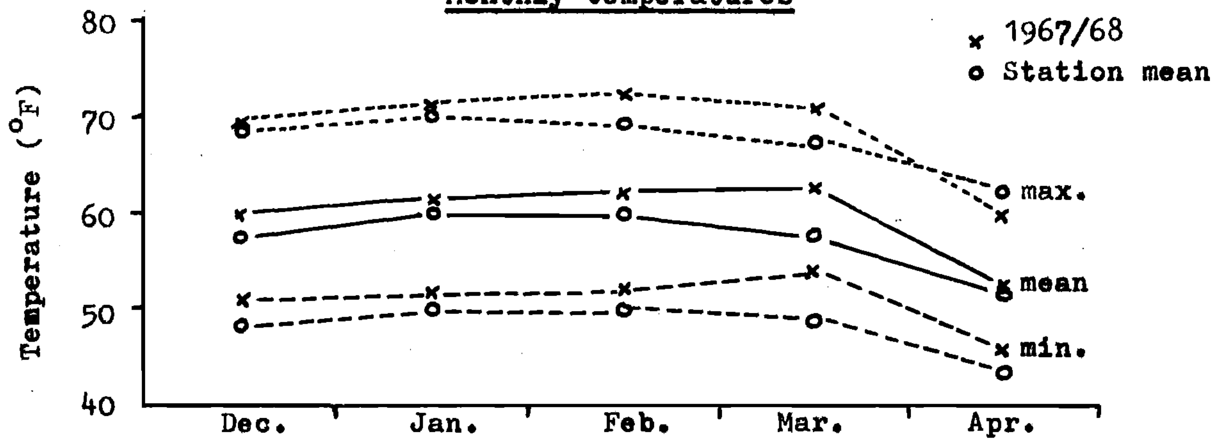
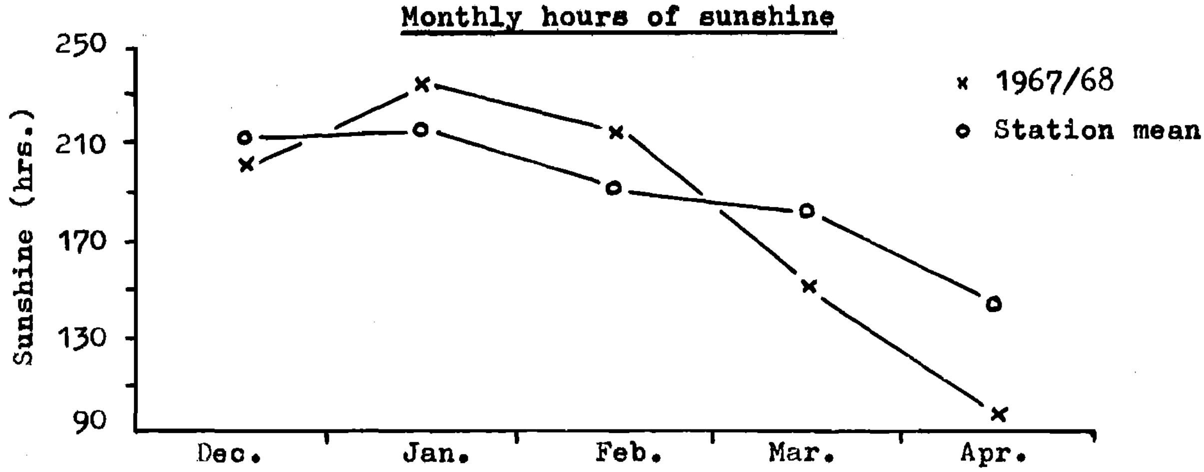


Figure 6

Monthly hours of sunshine



These observations were made by the Lincoln College Meteorological Station.

Pasture growth measurements were not included as indication of pasture availability, since particular descriptions for each farm are given in Section A of this Chapter.

CHAPTER IV

RESULTS

A) ONSET OF THE OVULATORY SEASON

1) Onset experimentally determined

Percentages of reproductive tracts whose ovaries had corpora lutea less than one cycle old, over the total number of reproductive tracts considered for each observation,are shown in Table 1 (p.45). These figures can be regarded as percentage of ewes ovulating over the total number of ewes considered. Total number of ewes slaughtered were not considered,due to failure in collecting all genitalia and to rejection of some reproductive organs as described in Chapter III (p.40). These values were plotted against time in Figure 7 (p.46).

Generally speaking it can be seen that there is a trend, following the expectancies of a sigmoid curve, normal for the beginning of the breeding season of sheep.

There were some abnormal factors affecting these percentages, especially in the case of Bowenvale where against expected values the second percentage of ewes ovulating was lower than the first, despite

Table 1

Ewes ovulating throughout the experiment

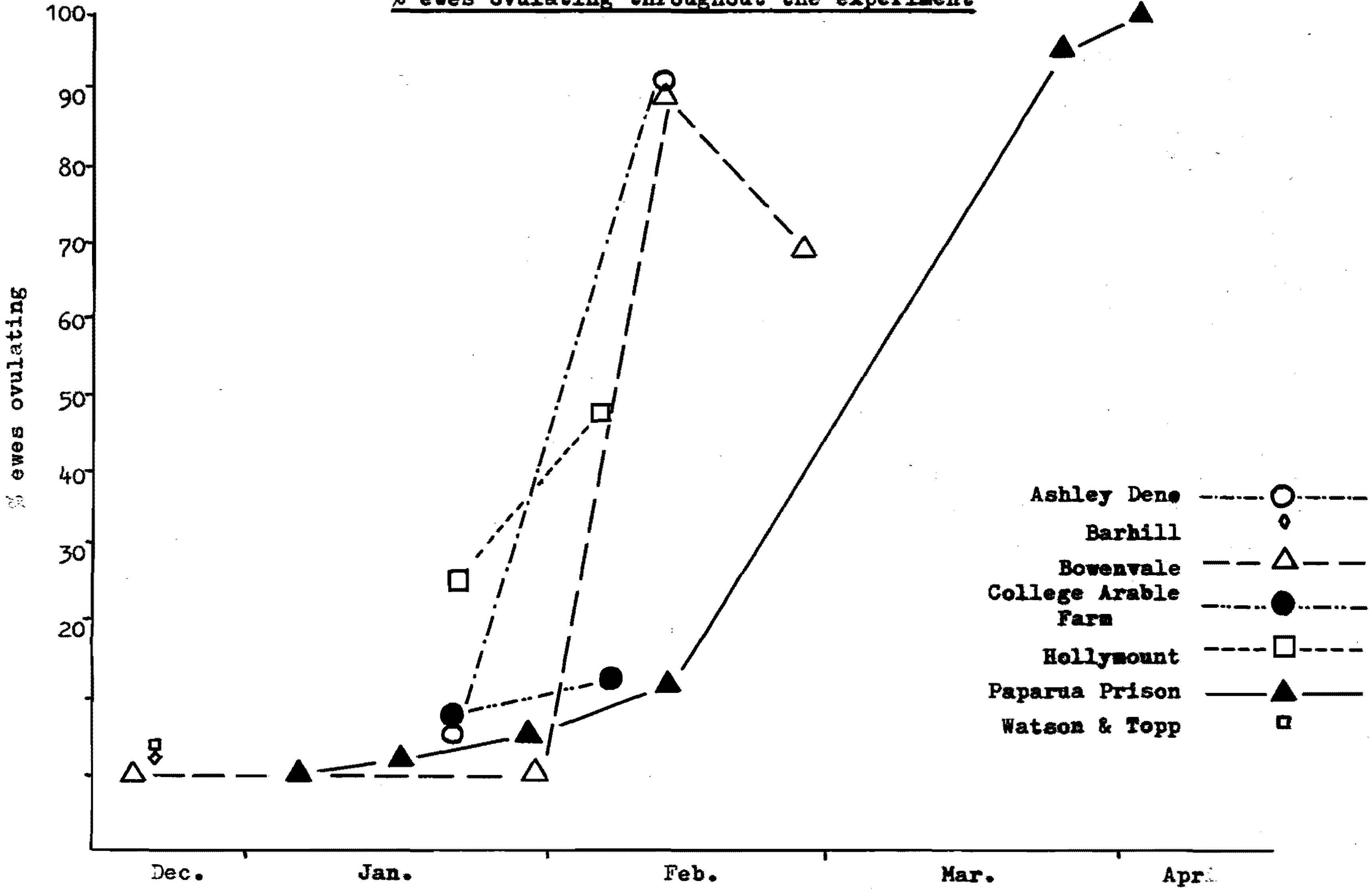
Farms	Date	No. ewes	No. ewes ovulating	% ewes ovulating
Bowenvale	19-12-67	31	0	0
Watson and Topp	22-12-67	100	3	3.0
Barhill	22-12-67	100	2	2.0
Paparua Prison	5- 1-68	100	0	0
Paparua Prison	16- 1-68	48	1	2.1
Ashley Dene	22- 1-68	39	2	5.1
College Arable Farm	22- 1-68	36	2	5.5
Hollymount	22- 1-68	74	19	25.7
Bowenvale	30- 1-68	30	0	0
Paparua Prison	30- 1-68	50	3	6.0
Hollymount	6- 2-68	212	102	48.1
College Arable Farm	7- 2-68	48	6	12.5
Bowenvale	13- 2-68	31	28	90.3
Paparua Prison	13- 2-68	34	4	11.8
Ashley Dene	13- 2-68	32	29	90.6
Bowenvale	27- 2-68	100	69	69.0
Paparua Prison	25- 3-68	32	31	96.8
Paparua Prison	4- 4-68	51	51	100.0
Total		1147	352	

of being later in the season. Reasons for this are discussed in Chapter V (p.71).

First ovulations within the experiment were observed as early as the 22nd of December when percentages of 3.0 and 2.0% were

Figure 7

% ewes ovulating throughout the experiment



recorded for Watson and Topp, and Barhill, respectively. No further observations were made on flocks belonging to these two farms. Therefore it is not possible to decide whether to take these percentages as beginning of the breeding season or out of the season ovulations.

In the casesof Ashley Dene, College Arable Farm and Hollymount first observations yielded 5.1, 5.5 and 25.7 per cent of ewes ovulating respectively, being therefore the ovulatory period already commenced when the observations started, on the other hand in the case of Bowenvale and Paparua Prison, when the first observations were made no ovulations were recorded.

Two observations of animals from Ashley Dene, College Arable Farm and Hollymount were made only. On the other hand animals from Bowenvale and Paparua Prison were followed quite well throughout the experiment; however there are some undesirable gaps between observations.

2) "Stress" and onset

Corpora lutea classification according to age gives further information on the distribution of ovulations within the oestrus cycle previous to slaughter. In Table 2 (p.48) the incidence of corpora lutea aged less than 3 days at time of slaughter, as a percentage of total ovulations, is given for observations in which sufficient data were available to allow comparisons to be made. Any "stress" factor due to trucking or yarding could possibly operate within the 0-3 day period only. Some percentages of 0-3 day ovulations over the total number of ovulations for each observation showed significant differences from the expected values. In the case of Paparua Prison, however, percentages lie within the expected values.

Although only in the case of Paparua Prison, percentage of ovulations was followed until it reached 100 per cent value, it can be seen that this value would be reached earlier in the case of all other farms (Figure 7, p.46). These differences can not be tested for significance because of lack of data but a between-flock variation can be considered to occur.

3) Carcass weights

Average carcass weights compared with the percentage of ovulations did not show any between-flocks significance in favour of earlier onset of ovulation from heavier animals, as it has been suggested, and in fact the heaviest average carcass belonged to Paparua Prison, the latest to start the cyclic ovulatory period.

Table 2

Corpora lutea aged less than 3 days at time of slaughter (as possible index of "stress" effect)

Farms	Date	No. ewes	No. ovulations	0-3 day ovulations	0-3 day as a % of total
Hollymount	22-1-68	74	19	18	94.7**
Hollymount	6-2-68	212	102	64	62.7*
Bowenvale	13-2-68	31	28	28	100.0**
Ashley Dene	13-2-68	32	29	19	65.5*
Bowenvale	27-2-68	100	69	27	39.1
Paparua Prison	25-3-68	32	31	4	12.9
Paparua Prison	4-4-68	51	51	4	7.8

* ($p < 0.05$)
** ($p < 0.01$)

Carcass weights recorded are given in Table 3.

Table 3

Carcass weights averages

Farms	Date	No. carcasses	Average carcass weight (lb)	Range (lb)
Bowenvale	19-12-67	31	43.19	-
Paparua Prison	5- 1-68	100	60	
Paparua Prison	16- 1-68	50	62.9	44-84
Ashley Dene	22- 1-68	40	46.9	-
College Arable Farm	22- 1-68	36	53.8	-
Hollymount	22- 1-68	74	51.7	-
Bowenvale	30- 1-68	30	42.39	-
Paparua Prison	30- 1-68	50	60.3	47-69
Hollymount	6- 2-68	230	49.1	28-53
College Arable Farm	7- 2-68	50	49.4	25-72
Bowenvale	13- 2-68	31	45.9	39-64
Paparua Prison	13- 2-68	52	66.5	52-90
Ashley Dene	13- 2-68	32	45.1	34-55
Bowenvale	27- 2-68	129	36.8	24-57
Paparua Prison	25- 3-68	32	60	-
Paparua Prison	4- 4-68	55	60	-

A within-flock comparison was not possible, due to the fact that carcass weights could not be related to the corresponding reproductive tracts as described in Chapter III (p.35). In the three observations where this record was obtained there were no significant differences between the flock average carcass weights and the ovulating animals carcass weights as shown in Table 4 (p.50).

Table 4

Average carcass weights of ovulating ewes

Farms	Date	Flock average carcass weights	No. ewes ovulating	% ewes ovulating	Ovulating animals average carcass weights
College Arable Farm	7-2-68	49.4	6	12.5	48.8
Bowenvale	13-2-68	45.9	28	90.3	44.4
Ashley Dene	13-2-68	45.1	29	90.6	45.7

B) REPRODUCTIVE TRACTS CHANGES

1) Weight of the uterus

Average and range of uterus weights recorded are given in Table 5 (p.52). No further analysis were made, reasons are given in Chapter V (p.80).

In one case, where only a few ovulations were recorded and corresponding carcass and uterus weights were obtained, a regression line was calculated of uterus weights on carcass weights, considering the ones that had not ovulated only. The regression line is shown in Figure 8. The value of the regression coefficient gives a significant positive correlation ($p < 0.05$) between these two variables for this particular observation.

Analysis of variance of the regression gave significance at 5% level.

Figure 8

Regression of uterus weight on carcass weight

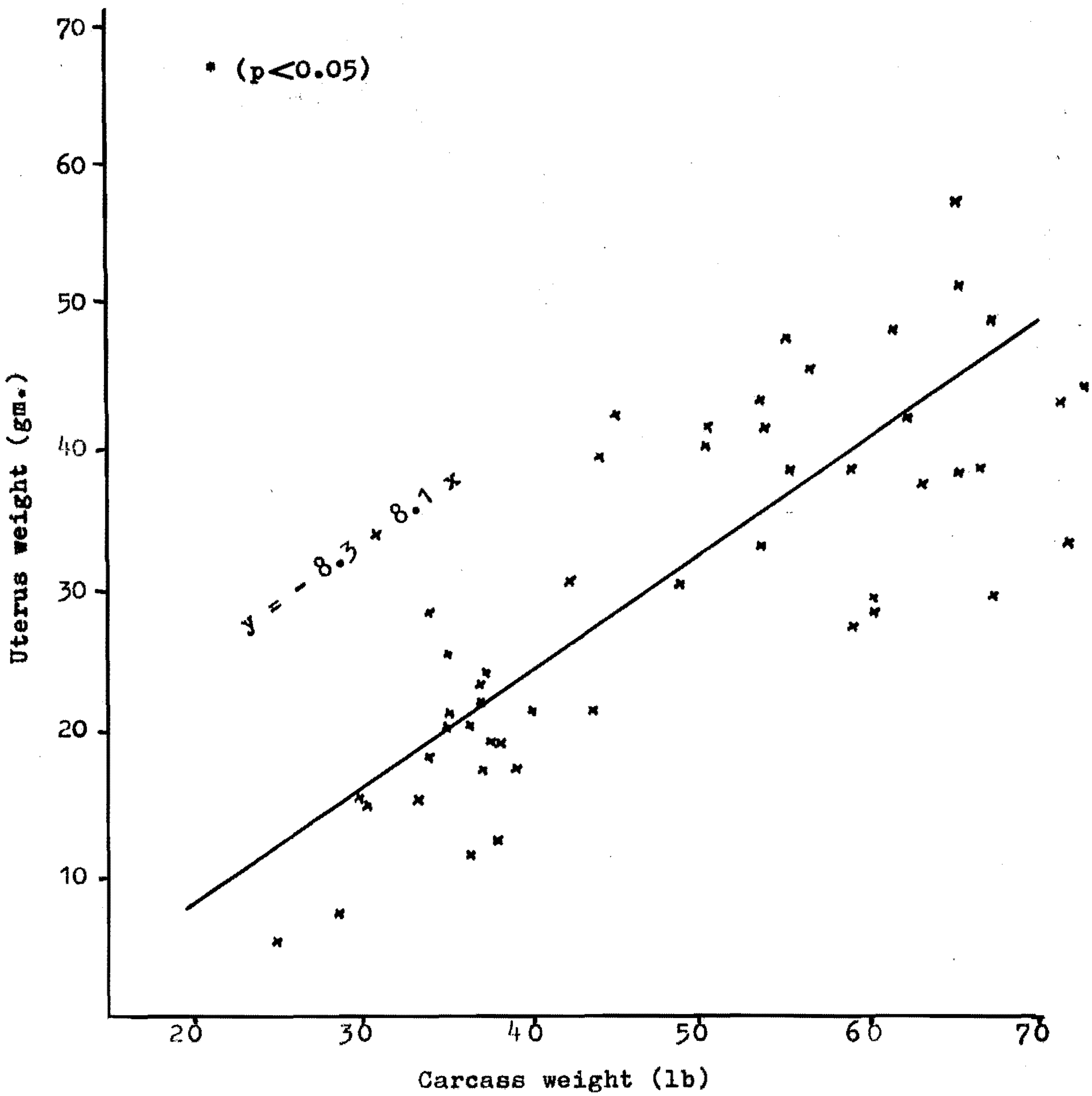


Table 5

Average weights of the uterus

Farms	Date	No. reproductive tracts	Uterus weight (gm.) average	Uterus weight (gm.) range
Hollymount	6-2-68	212	53.3	32-102
College Arable Farm	7-2-68	48	35.7	25-80
Ashley Dene	13-2-68	32	58.9	30-104
Paparua Prison	13-2-68	34	44.5	30-75
Bowenvale	13-2-68	31	47.8	32-69
Bowenvale	27-2-68	100	48.9	26-71
Paparua Prison	25-3-68	32	62.7	40-97
Paparua Prison	4-4-68	51	64.6	32-93
Total		540	52.1	25-104

2) Ovary

a) Ovary size

Average and range for each observation are given in Table 6 (p.53). These values are of measurements from pole to pole of each ovary and no allowances were made for large follicles or corpora lutea, thus the presence of any of these altered, to a major or minor extent, the true value of ovary size, depending upon on their situation in the body of the ovary.

No measurements were taken of ovaries of ewes from Bowenvale at the 19-12-67 and 30-1-68 observations.

No further analyses were followed on this particular data.

Table 6

Ovary size

Farms	Date	No.ovaries (pairs)	Average ovary size	
			left ovary	right ovary
Watson and Topp	22-12-67	100	average 1.54	
Barhill	22-12-67	100	average 1.54	
Paparua Prison	5- 1-68	100	1.50	1.51
Paparua Prison	16- 1-68	48	1.53	1.53
Ashley Dene	22- 1-68	39	1.46	1.47
College Arable Farm	22- 1-68	36	1.42	1.46
Hollymount	22- 1-68	74	1.49	1.52
Paparua Prison	30- 1-68	50	1.58	1.57
Hollymount	6- 2-68	212	1.52	1.53
College Arable Farm	7- 2-68	48	1.41	1.39
Bowenvale	13- 2-68	31	1.61	1.58
Paparua Prison	13- 2-68	34	1.49	1.50
Ashley Dene	13- 1-68	32	1.44	1.43
Bowenvale	27- 2-68	100	1.54	1.59
Paparua Prison	25- 3-68	32	1.61	1.58
Paparua Prison	4- 4-68	51	1.61	1.62
T o t a l		1086	1.51	1.52

b) Activity of right and left ovaries

Differences in activity between right and left ovaries are given in Table 7 (p.54), as measured by incidence of ovulations in each, and the incidence of twin ovulations in each ovary is shown in Table 8 (p.54). None of these differences were significant at 5% level.

Table 7

Activity of right and left ovaries

Farms	Date	No. pairs with C.L.	Ovulations at the right ovary	Ovulations at the left ovary
Ashley Dene	13-2-68	29	19	18
Bowenvale	13-2-68	28	19	20
Bowenvale	27-2-68	69	35	46
Hollymount	6-2-68	102	74	45
Paparua Prison	13-2-68	4	3	3
Paparua Prison	4-4-68	51	35	48
College Arable Farm	7-2-68	6	2	4
Paparua Prison	25-3-68	32	27	28
Total		321	215	206

Table 8

Twin ovulations in each or both ovaries

Farms	Date	Left ovary	Right ovary	Both ovaries	Total
Hollymount	6-2-68	4	3	10	17
Ashley Dene	13-2-68	3	2	3	8
Bowenvale	13-2-68	4	2	5*	10
Paparua Prison	13-2-68	2	0	0	2
Bowenvale	27-2-68	6	2	4	12
Paparua Prison	25-3-68	5	4	10	19
Paparua Prison	4-4-68	8	10	14	32
Total		32	23	46	100

* One triplet

c) Graafian follicles

According to corpora lutea age the data was divided into three groups representing the length of one oestrus cycle, namely 0 to 5 days, 6 to 10 days and 12 to 17 days. For each group the number of follicles between 4mm. and 8mm. and more than 8mm. in size were recorded.

Number of pairsof ovaries (presenting corpora lutea) with at least one follicle in any of the two groups, and therefore bigger than 4mm. and the total number of pairs of ovaries considered, are shown in Table 9.

Table 9

Number of follicles bigger than 4mm. within an oestrus cycle

Period of the oestrus cycle	Pair of ovaries with follicles between 4 and 8mm.		Pair of ovaries with follicles more than 8mm.		Total examined
	No.	%	No.	%	
0-5 days	51	25.6	3	1.4	203
6-10 days	93	60.3	76	49.4	154
11-17 days	56	90.3	56	90.3	62

There are significant differences ($P<0.05$) between all figures demonstrating a trend of higher density of large follicles towards the end of the cycle.

The percentage of relatively quiescent ovaries, namely ovaries that did not have apparent follicles at their surface, decreased as the experiment progressed, as it can be seen in

Table 10 where the percentage of active ovaries is shown, over the total number of ovaries. The first two observations for Bowenvale are not included.

Table 10
Percent of active ovaries

Farms	Date	No. of ovaries (pairs)	% active ovaries	
			one ovary	both ovaries
Watson and Topp	22-12-67	100	51.6	
Barhill	22-12-67	100	30.2	
Paparua Prison	5- 1-68	100	55.8	
Paparua Prison	16- 1-68	48	61.6	
Ashley Dene	22- 1-68	39	72.1	
College Arable Farm	22- 1-68	36	87.3	
Hollymount	22- 1-68	74	92.6	
Paparua Prison	30- 1-68	50	79.4	
Hollymount	6- 2-68	212	100	93.7
College Arable Farm	7- 2-68	29	100	97.2
Bowenvale	13- 2-68	31	100	94.3
Paparua Prison	13- 2-68	34	100	100
Ashley Dene	13- 2-68	32	100	97.1
Bowenvale	27- 2-68	100	98.2	92.4
Paparua Prison	25- 3-68	32	100	100
Paparua Prison	4- 4-68	51	100	100

These determinations were made subjectively and therefore errors are likely to be present.

The incidence of cystic follicles was not constant and did not follow any pattern throughout the experiment. 0.8 per cent of cystic follicles were observed for Hollymount on the 6-2-1968, 0.9 per cent at 27-2-1968 in Bowenvale, and 1.9 per cent on the 4-4-1968 for Paparua Prison.

d) Corpus luteum

i) Growth and decline

Means of the two main diameters of corpora lutea and of corpora albicantia on a daily basis and for each farm, are given in Table 11 (p.58). Between brackets are the number of corpora lutea considered.

Individual sizes of all corpora lutea and albicantia examined were plotted against time and two curvilinear regressions were calculated, one considering sizes from day 1 to day 15 and the other considering sizes from day 18 to day 32.

The reason for using these two equations was given by several attempts of fitting statistical regression curves, most of which gave erroneous results, due, probably, to the variability in sizes - especially during the first 15 days - and the existence of a gap between day 15 and day 18.

The two calculated equations,

$$y = 3.32 + 1.52\,x - 0.097\,x^2 \pm 1.47 \qquad (1)$$
$$y = 13.5 - 0.714\,x + 0.012\,x^2 \pm 0.71 \qquad (2)$$

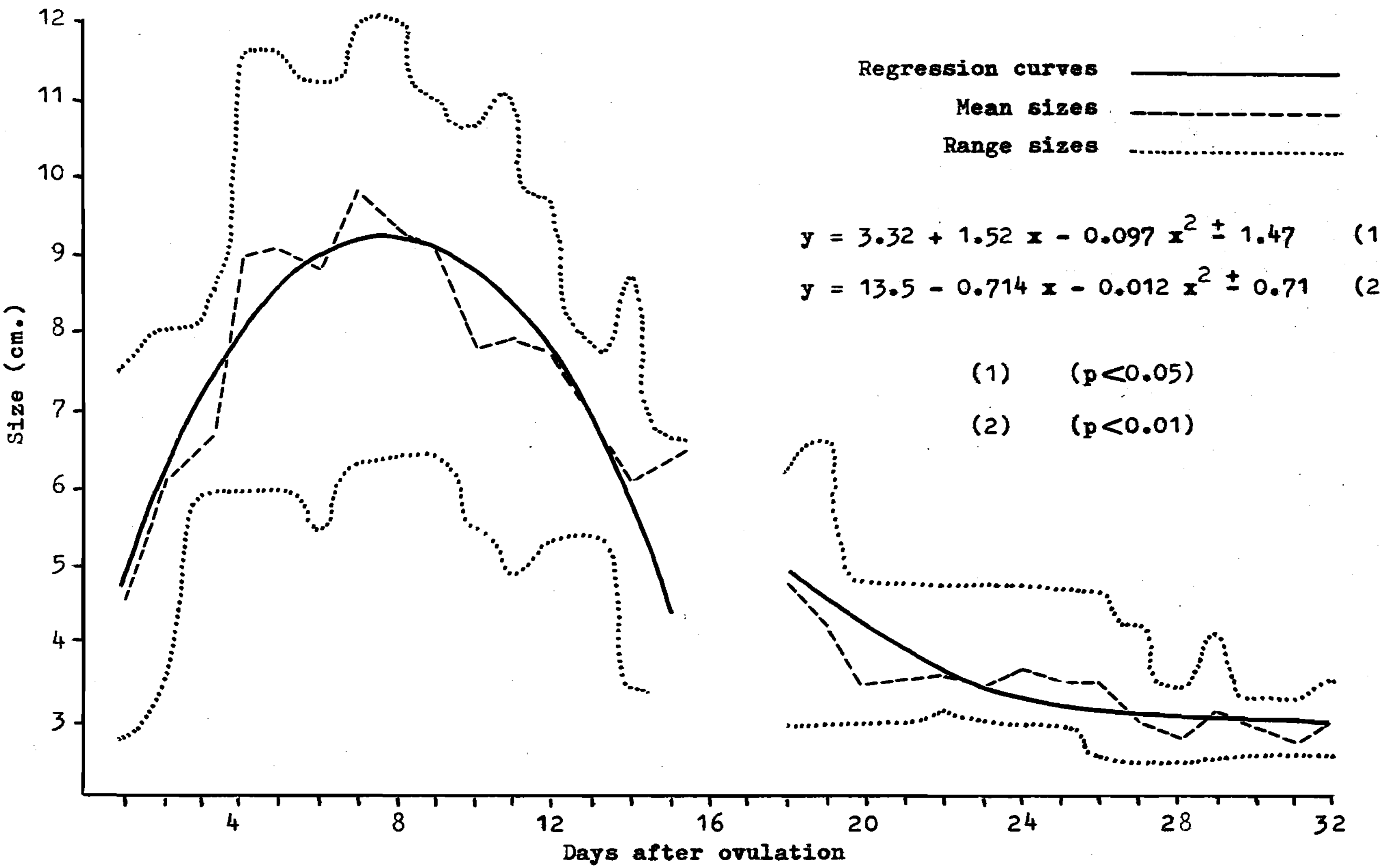
gave significance at 5% level with an F test. However it can be seen that the S.D. of equation (1) is quite large, reflection of the variability in size of corpora lutea of the same given age.

Table 11 Corpus luteum size

Days after ovulation	Farms				
	Ashley Dene	Bowenvale	Hollymount	Paparua P.	College A.F.
1	4.6 (19)	3.9 (64)	5.1 (35)	4.1 (6)	4.0 (1)
2	5.0 (4)	5.8 (6)	6.4 (10)	5.8 (2)	-
3	6.2 (4)	7.0 (2)	6.5 (1)	-	-
4	9.8 (2)	8.6 (6)	8.0 (4)	6.2 (6)	-
5	8.7 (5)	9.4 (11)	8.0 (4)	9.2 (11)	-
6	8.1 (4)	9.3 (8)	7.5 (8)	8.8 (13)	8.0 (1)
7	-	9.6 (10)	10.0 (12)	10.0 (18)	10.5 (1)
8	-	7.6 (3)	9.9 (8)	9.7 (18)	-
9	-	8.5 (2)	7.2 (3)	9.6 (11)	-
10	6.0 (1)	5.5 (1)	6.9 (10)	8.6 (20)	7.0 (1)
11	-	-	6.7 (5)	8.2 (10)	8.0 (1)
12	-	7.5 (1)	7.9 (6)	7.3 (14)	-
13	-	5.2 (2)	6.1 (7)	7.2 (5)	-
14	-	-	6.2 (6)	6.5 (3)	6.2 (1)
15	-	-	-	6.3 (3)	-
16	-	-	-	-	-
17	-	-	-	-	-
18	4.7 (3)	4.9 (6)	5.5 (14)	5.0 (4)	4.5 (1)
19	4.0 (1)	4.2 (3)	5.1 (2)	4.5 (4)	-
20	3.2 (1)	-	3.7 (1)	-	-
21	3.4 (2)	3.7 (2)	3.4 (1)	3.7 (4)	-
22	-	3.8 (2)	-	3.5 (10)	-
23	-	3.5 (3)	-	3.6 (14)	-
24	-	3.4 (5)	-	3.2 (6)	3.2 (1)
25	-	3.2 (1)	-	3.0 (5)	-
26	-	3.5 (1)	-	3.4 (4)	-
27	-	-	-	3.1 (7)	-
28	-	-	-	3.2 (2)	3.0 (1)
29	-	-	-	3.0 (2)	-
30	-	-	-	2.7 (2)	-
31	-	-	-	-	-
32	-	-	-	2.7 (1)	-

Figure 9

Corpus luteum growth and decline



In Figure 9 (p.59) the two regression curves calculated and the mean size value for each day are shown. It can be seen that corpus luteum grows rapidly from 4.5cms. at the first day after ovulation to 9.2cms. at 7 days after ovulation when maximum size is reached. After the 9th day corpus luteum size starts to decrease quite markedly being at the end of the oestrual cycle of 6.5 cm. When next ovulation occurs further decrease in size is observed until the end of the second cycle when it is 3.2cms. in size. After next ovulation the old corpus luteum is known as corpus albicans.

Variations in size of corpora lutea of the same given age are quite large, due in some cases, to the presence of a cavity in the body of corpus luteum (hollow corpus luteum) and in others, to the situation of twin adjacent corpora lutea in the same ovary.

Average size of twin corpora lutea, in the same or in the two ovaries, and of single corpora lutea, are given in Table 12 (p.61).

It can be seen that although there are not significant differences between groups, the bigger corpora lutea are the single ones, followed by separate twins; hollow corpora lutea did not differ significantly in size from solid corpora lutea (see Table 13, p.62) and therefore were not likely to influence these results.

ii) Changes in colour

Variations in colour between corpora lutea of the same size and same ovulation were large and in some cases two corpora lutea in the same ovary showed marked differences in colour as if one of them was older than the other although within the same oestrus cycle.

Table 12 Size of single and twin corpora lutea

Day	Single	Together twins	Separate twins
1	4.8	4.4	3.9
2	6.0	5.4	5.3
3	6.6	-	6.0
4	9.1	8.3	8.3
5	9.3	8.7	8.5
6	8.9	8.9	8.4
7	10.1	9.8	9.7
8	8.9	8.1	-
9	9.7	9.5	9.4
10	7.9	7.4	7.0
11	8.0	-	7.4
12	7.5	7.6	7.3
13	6.0	6.5	-
14	6.4	6.3	5.9
15	6.3	-	6.3
16	-	-	-
17	-	-	-
18	5.2	4.8	5.0
19	4.7	4.4	4.7
20	3.5	-	-
21	3.8	3.2	3.3
22	3.6	-	3.4
23	3.7	3.3	3.4
24	3.5	3.1	-
25	3.1	3.0	3.0
26	3.5	3.2	-
27	3.1	-	-
28	3.0	3.2	-
29	-	-	3.0
30	2.7	-	-
31	-	-	-
32	2.7	-	-

iii) Hollow and solid corpora lutea

The incidence of hollow corpora lutea for each observation of the experiment is shown in Table 13 as a percent of the total corpora lutea considered. Observations with a large percentage of ovulations were considered only.

Table 13
Incidence of Hollow corpora lutea

Farms	Date	No. corpora lutea	No. Hollow	%
Hollymount	22-1-68	20	4	20.0
Hollymount	6-2-68	119	41	34.4
Ashley Dene	13-2-68	37	5	13.5
Bowenvale	13-2-68	81	43	53.1
Paparua Prison	25-3-68	50	16	32.0
Paparua Prison	4-4-68	83	12	14.4
Total		390	121	31.0

Highly significant differences were obtained in the case of Bowenvale only, when compared with the other farms. The other observations do not differ significantly.

Hollow corpora lutea are more numerous within twin ovulations. One hollow and one solid is the commonest situation, as it can be seen in Table 14, (p.63).

Table 14

Distribution of hollow corpora lutea

Farms	Date	No. hollow	Single	Twins: Both hollow	Twins: One solid one hollow
Ashley Dene	13-2-68	5	1	-	1
Bowenvale	13-2-68	27	8	6	13
Hollymount	6-2-68	14	4	2	8
Paparua Prison	4-4-68	10	4	1	5
Paparua Prison	25-3-68	15	7	3	5

Hollow corpora lutea do not differ significantly ($p<0.05$) in size from solid corpora lutea, as it was seen when the average size of both types were tested by means of a X^2 test.

Other characteristics, such as colour and consistency, do not, usually, differ between solid and hollow corpora lutea.

3) Recovery of ova

Although it was not done as a normal practise a number of ova were recovered in both the Fallopian tubes and uterine horns. 86 recoveries were attempted, 51 in the tubes and 35 in the uterine horns. Success was obtained in 48 and 22 cases respectively. Only 2 apparently abnormal ova were recorded, although the type of microscope used did not allow an accurate judgement, and therefore some others could be classified as abnormal in more refined analyses.

C) OVULATION RATE

Ovulation rate as indicated by the number of ovulations (measured by the number of corpora lutea) expressed as a percentage of the number of ewes considered, is shown - for each observation - in Table 15 (p.65), and also is plotted against time in Figure 10 (p.66).

Ovulation rate increased from 100% at the beginning of the experiment to 162.7% at the last observation. There are wide variations between farms in the same date, although factors such as too few ovulations and the "stress" problem could be responsible for most of these variations. Figure 10 must be also taken with care. It must be remembered that the experiment ended before many flocks reached the "peak" of ovulation and only the Paparua Prison data can be considered sufficiently complete to draw a curve of ovulation rate.

The effect of carcass weight on ovulation rate can be drawn from Table 16 (p.67), where the corresponding carcass weights and ovulation rates are given for each flock slaughtered.

Table 15

Ovulation rate

Farms	Date	No. of ewes ovulating	No. ovulations	Ovulation rate %
Bowenvale	19-12-67	0	0	-
Watson and Topp	22-12-67	3	3	100
Barhill	22-12-67	2	2	100
Paparua Prison	5- 1-68	0	0	-
Paparua Prison	16- 1-68	1	1	100
Ashley Dene	22- 1-68	4	6	150
College Arable Farm	22- 1-68	2	2	100
Hollymount	22- 1-68	19	20	105.3
Bowenvale	30- 1-68	0	0	-
Paparua Prison	30- 1-68	3	3	100
Hollymount	6- 2-68	102	119	116.7
College Arable Farm	7- 2-68	6	6	100.0
Paparua Prison	13- 2-68	4	6	150.0
Bowenvale	13- 2-68	28	39	129.3
Ashley Dene	13- 2-68	29	37	127.6
Bowenvale	27- 2-68	69	81	117.4
Paparua Prison	25- 3-68	31	50	161.3
Paparua Prison	4- 4-68	51	83	162.7
Total		351	455	-

Figure 10

Ovulation rate throughout the experiment

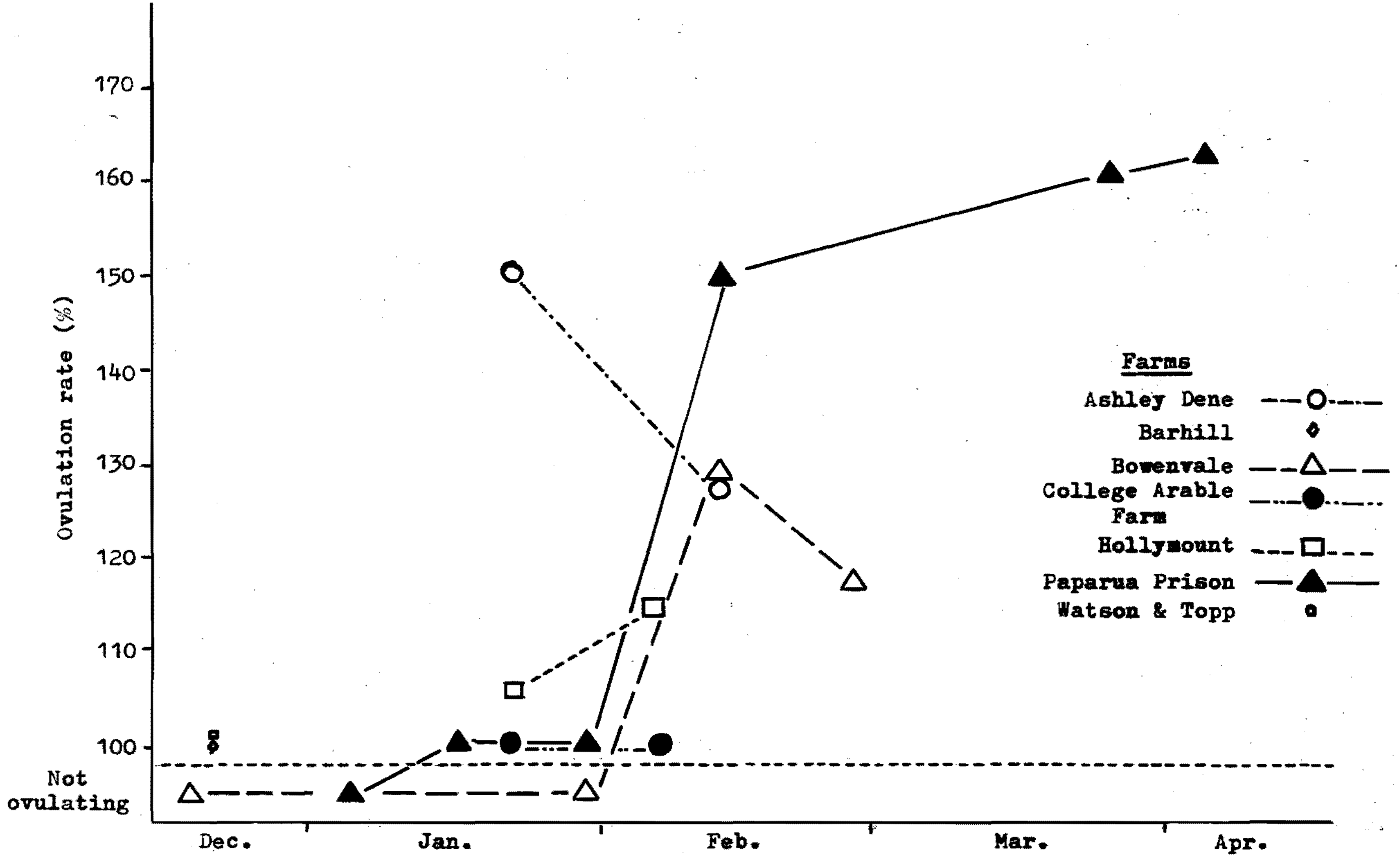


Table 16

Average carcass weights and ovulation rates

Farms	Date	No. carcasses	mean weight	No. reprod. tracts consid.	Ovulation rate
Paparua Prison	5-1-68	100		100	-
Paparua Prison	16-1-68	50	62.9	48	100.0
Ashley Dene	22-1-68	40	46.9	39	150.0
College Arable Farm	22-1-68	36	53.8	36	100.0
Hollymount	22-1-68	74		74	105.3
Paparua Prison	30-1-68	50	60.3	50	100.0
Hollymount	6-2-68	230	49.1	212	116.6
College Arable Farm	7-2-68	50	49.4	48	100.0
Bowenvale	13-2-68	31	45.9	31	139.2
Paparua Prison	13-2-68	52	66.5	34	150.0
Ashley Dene	13-2-68	32	45.1	32	127.6
Bowenvale	27-2-68	113	36.8	100	117.4
Paparua Prison	25-3-68	37		32	161.3
Paparua Prison	4-4-68	54		51	162.7
Total		949		887	

Not enough data is available to draw any conclusive result. The only case where comparisons may be made is on the 13-2-68 where the heavier flock had 150% ovulation rate, while the other two flocks 10lb lighter had 139% and 127% respectively, but they belong to different properties and therefore other factors can be operating.

CHAPTER V

DISCUSSION

The term "breeding season" was defined by Heape (1899) as being the period of time when the female accepts the male and fertile mating is rendered possible.

It has been postulated by most workers that the first ovulation can occur unaccompanied by oestrus (see Chapter II, p.11) this ovulation being called "silent heat". However, there is some disagreement as to the percentage of ewes that undergo silent heats.

In this trial the incidence of silent heats could not be determined as no rams were run with the ewes slaughtered prior to the commencement of the trial; thus whilst evidence of corpora albicantia appeared in some cases (see p.76), that may or may not have been from silent heats.

Determination of ovulation was made in the present experiment by means of presence of corpora lutea; therefore, considering what was said about silent heats, the onset of the breeding season, as defined by Heape (above), was not determined. What has been determined is the onset of the ovulatory period, which, for want of a better term is referred to as "ovulatory season, which,in most cases, will be 17 days earlier than the breeding season defined by Heape.

Since the time of ovulation was determined and not the moment when the animal was showing heat, there is likely to be a further discrepancy with Heape's definition.

A) ONSET OF THE OVULATORY SEASON

The onset of the ovulatory season has been determined for some flocks of Canterbury Corriedales.

Alterations of the date of onset determined were likely to be brought about by "stress" factors, incidence of silent heats, management differences, presence of the ram and climatic conditions.

1) Onset experimentally determined

At the beginning of the experiment 3.0 per cent of Watson and Topp, and 2.0 per cent of Barhill, ewes were observed to be ovulating. No further observations were made on animals from these farms, therefore it cannot be determined whether they represent ovulations within the breeding season of this particular group, or were out of season ovulations. The last possibility is known to occur (Warwick, 1946; Watson, 1952) and due to the small percentages this interpretation is favoured.

To obtain accurate information about any characteristic of the breeding season of sheep, observations have to be made on less than 17 day intervals for the required period of time. This requirement could not be fullfilled in the present experiment for reasons given in Chapter I, however, bearing in mind within-breed variations (Hafez, 1952) the combined data of all observations can give a fairly accurate overall information.

Determination of the onset of the ovulatory season for each farm in particular can be made for Bowenvale and Paparua Prison only, since in all the other cases ovulatory activity had already started when first observations were made. In the case of Bowenvale, however, "stress" seemed likely to operate by modifying the percentages of ewes ovulating.

Present results indicating the second half of January as the date of onset of the ovulatory season, are in agreement with previous data on the onset of the breeding season in Corriedale breed, if it is taken into consideration that silent heats were not determined and the ram effect did not operate.

For the same region and latitude, Hart (1961) with the recovery of ova technique, reported that ovulatory period started at the end of January. Coop (pers. communication) reported some ewes as being in heat at the end of January in synchronisation trials, meaning an earlier onset of ovulatory activity, at least in one farm, because in one trial done at Ashley Dene (in 1965) first ovulations were recorded at the end of January and beginning of February. This is in agreement with the present data. Reports from other parts of the world are also in agreement if corrections for latitude are made (Yeates, 1949; Hafez, 1952). Schott et al. (1939) reported a date which converted to the Southern hemisphere gives the end of January as the date for the onset in the United States of America at 44º latitude North. In Brazil, Velloso (cited by Spedding, 1965, p.70) reported a later date for 30º latitude South, although no altitude was stated. This date seems to be too late when compared with data from Uruguay at about the same latitude, Duran del Campo A. (pers. comm.).

2) Stress and the onset determined

Percentages shown in Table 1 (p.45) were somewhat biased by unexpected synchronisation of ovulations within the last 3 days previous to slaughter as shown in Table 2 (p.48), where, in some observations, significantly different percentages from expected were recorded. This is in agreement with observed synchronised ovulations of animals subjected to the "stress" of transport for long distances (Branden and Moule, 1964; Lang, 1964) in Merino ewes and yarding for short periods (Coop, pers. comm.) in Corriedale ewes.

No special provision was made to study the "stress" problem since it arose at about the middle of the experiment and became incidental to the trial.

Handling of animals did not differ from usual management in each farm. No differences in management which could in turn cause "stress" to operate to a greater extent in some cases than in others were investigated.

The length of the transported journey reported by Lang (1964) as being of importance in determining the intensity of response to "stress", was not observed as being likely to have any participation, since differences in journeys duration, though small, were not related to the intensity of the response to "stress"; for instance, the longest journey was that of Paparua Prison groups, where no ovulations significantly different from expected values were observed (see Chapter IV, p.48).

Bearing in mind all these previous considerations it can be seen that results follow Lang's (1964) conclusions of a higher incidence of "stress" - induced ovulations at the beginning of the season, although comparisons within farms were not possible in many cases and therefore it seems to be unwise to draw definitive conclusions. Between farm comparisons on the incidence of "stress" - induced ovulations can be made and it can be seen that there are marked differences, Bowenvale and Paparua Prison being the extremes. These differences could be explained by management differences but they seem to be too wide to be accounted for only by this reason. Since within-breed differences in intensity of oestrus have been reported (Hafez, 1952) these seem to indicate a higher or lower degree of hormonal activity, which may account for some of the variations in response to "stress", leading then to the conclusion that strain differences should be included when explaining the behaviour of ewes before "stress" situation.

Sensitivity to stress seems to be a breed characteristic, Averill (1964) did not observe any situation likely to be explained by "stress" in New Zealand Romneys. Braden and Moule (1964) and

Lang (1964) observed a high incidence of "stress"-induced ovulations in Merinos, and Coop (pers.comm.) and the present results favour a variable incidence of "stress"-induced ovulations in Corriedales.

Although synchronisation by means of rams lies out of the scope of this experiment, it is tempting to associate this to the present results in reference to "stress". Some reports about synchronisation with the presence of rams attempted an explanation of the mechanism that would operate. For instance, Lamond, Wells and Miller (1963) suggested that the ram effect would operate, affecting the neurohumoral mechanisms controlling oestrus and ovulation. It seems interesting to note that the mechanism might be similar to that reported for "stress" (Arvay and Nagy, 1958), namely the nervous stimulations of the hypothalamus and thence by the neuro-secretory system to the hypophysis, resulting in an increased hormonal secretion from this gland, determining a higher ovarian activity.

The 6 days given as the period of time between the introduction of rams and the first induced ovulation (usually without heat), as reported by Schinkel (1954), and the nearly immediate ovulation after a severe "yarding-trucking" stress can be explained if different levels of gonadotrophins produced are assumed to be related to the intensity of "stress". The ram effect is thought to be less intense.

Variable response to synchronisation obtained by Coop (pers. comm.) could then be explained by strain differences within

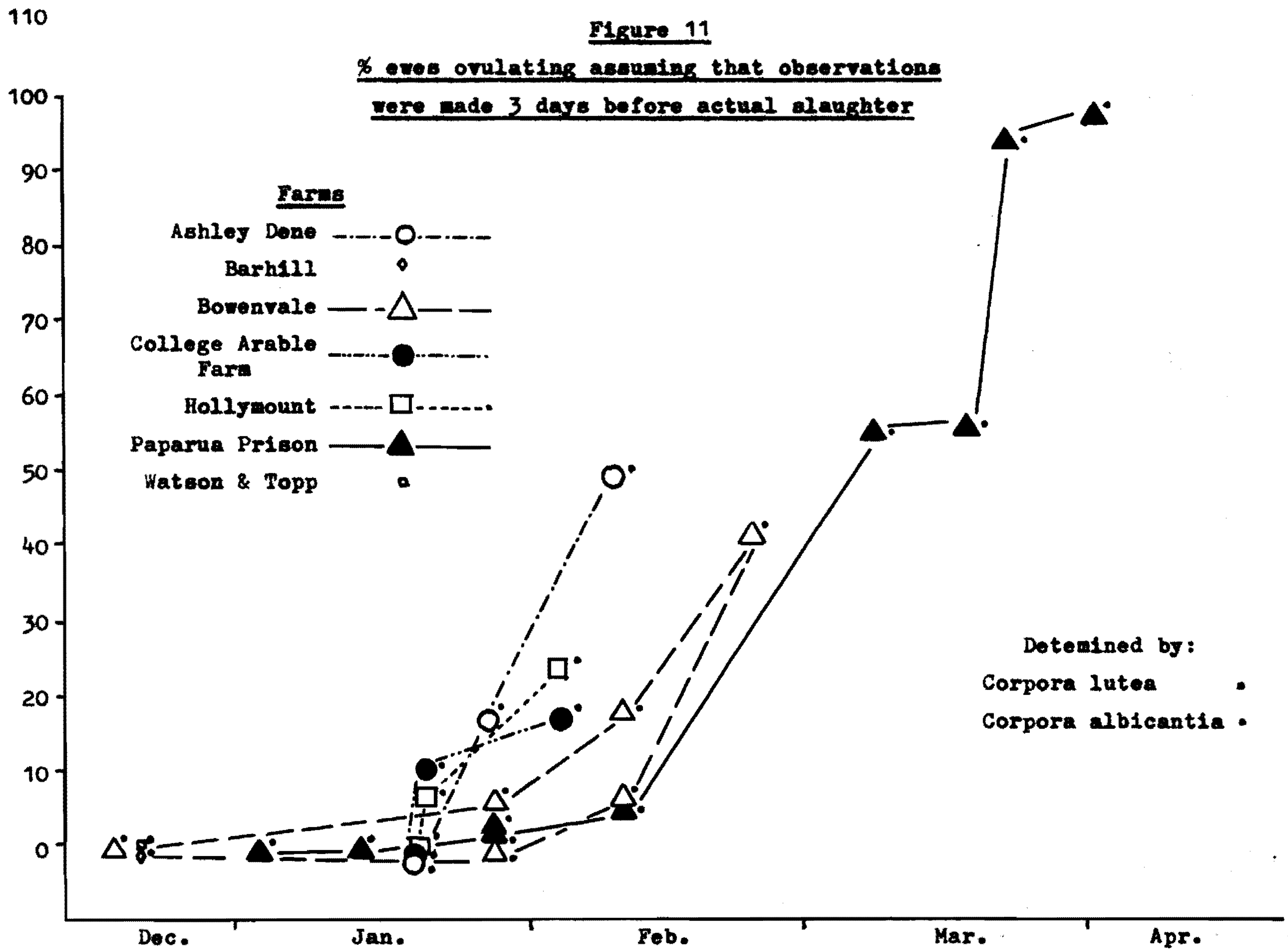
Corriedales, in response to the presence of the ram. Another explanation could be that the onset of the breeding season is more spread over time than for Romneys (Averill, 1959) where better results were obtained, but this does not explain fairly good results obtained with Merinos (Miller, cited by Lamond, 1964). There is no doubt that more evidence is needed to favour one argument or another.

In order to obtain a more reliable information about the onset, because of the possible error involved within the 0-3 days period (only period in which "stress" factors could operate), it was thought to be better to assume that the observations were made 3 days before the actual date of slaughter and then eliminate this biased period. Ovulations from 4 days old onwards were considered, only. Furthermore, by means of corpora albicantia records, it was possible to determine the percent of ewes of the same group ovulating 17 days before, if errors involved in assuming this figure are allowed.

With these two procedures it was possible to draw Figure 11. It can be seen that errors are present, such as having two different percentages for the same farm and the same date, though two different groups were involved. Differences between farms, though less marked, do exist and it can be predicted that some flocks would reach the 100 per cent of ewes ovulating some 40 days before the others. All farms considered seem to have the start of the ovulatory period in the later part of January, date that agrees with previous reports if silent heats and the absence of ram effect are considered.

Figure 11

% ewes ovulating assuming that observations were made 3 days before actual slaughter



3) Incidence of silent heats

For a precise determination of silent heats the ewes slaughtered should have been run with rams for at least one oestrous cycle, prior to slaughter. This was not done since, as stated in Chapter I, it was planned to keep all ewes to be slaughtered away from rams.

However, following Schinkel (1954) it can be assumed that all ewes whose ovaries had corpora lutea but not corpora albicantia, had ovulations unaccompanied by oestrus. Under this assumption the incidence of silent heats throughout the experiment can be calculated.

The probable incidence of silent heats expressed as a percentage of the number of ewes ovulating is shown in Table 17.

Table 17
Probable incidence of silent heats

Farms	Date	No. ewes ovulating	No. ewes ovulating without previous C.L.	Probable % of silent heats
Hollymount	6-2-68	102	84	82.3
College Arable Farm	7-2-68	6	3	50.0
Ashley Dene	13-2-68	29	23	79.3
Paparua Prison	13-2-68	4	3	75.0
Bowenvale	13-2-68	28	26	92.8
Bowenvale	27-2-68	69	50	72.4
Paparua Prison	25-3-68	31	18	58.1
Paparua Prison	4-4-68	51	22	43.1
Total		320	229	71.5

Full records were available for the last eight observations, only (see Chapter III, p.33).

All these observations were done after the onset of the ovulatory period and not many conclusions can be drawn, except as expected, a within farm decrease in the percentage of probable silent heats as the season advances.

Number of animals is too small to allow any further comment.

4) Management

Within management factors, nutrition and selection are relevant to this discussion.

a) Nutrition

From the information given in Chapter II, Section A it can be seen that all groups slaughtered were not likely to be either flushed or underfed. Except ewes from Paparua Prison which were reported to be slightly overfat, but no "flushing" was likely to be present. Therefore, for the present experiment, nutrition was not likely to affect to a great extent the onset of the ovulatory season, although the extent to which undernutrition may alter the onset of the ovulatory season could be different from the effect on presentation of oestrus.

Carcass weights recorded are to some extent an expression of the nutritional status prior to slaughter. No relationship was found between average carcass weights and onset of the ovulatory period, although as said before (Chapter IV, p.49) the present results and the fact that only average carcass weights were recorded do not allow to draw any conclusions. However, no relationship was to be expected (Kelley, 1937 and Underwood and Shier, 1944).

b) Selection

Strain differences in the Corriedale breed have been suggested to occur, therefore any selection policy for early or late breeders is likely to bring about differences in the time of onset of the ovulatory season. Unfortunately only two farms can be compared, Ashley Dene and Paparua Prison, since the animals from Hollymount, Bowenvale and College Arable Farm were bought in from North Canterbury and no records of these animals are available.

In Figure 11 (p.75) it seems to be clear that all ewes from Ashley Dene would enter ovulatory season earlier than those from Paparua Prison, which would indicate a strain difference between the two flocks.

Looking at the usual dates of mating for each farm (Chapter III, p.27) it can be seen that there are no real differences in the dates of introduction of rams. However, although it was not mentioned in Chapter III, it is known that the tupping period is longer in Paparua Prison than in Ashley Dene.

The difference in the period of tupping between the two farms can probably account for a fraction of the proposed strain differences, but, although data from Ashley Dene is incomplete this management difference is not believed to be responsible for the whole difference in onset of the ovulatory season between the two farms.

5) <u>Presence of the ram</u>

All ewes to be slaughtered were kept away from rams, therefore the date of onset of the ovulatory season, determined in the present experiment, is likely to differ from that under normal farm conditions.

Assuming that the majority of Corriedale ewes respond to the stimulus of the presence of the ram, the onset of the ovulatory season should be earlier than the present determination. However, it is questioned the occurrence of a massive response in Corriedale ewes (see p. 73).

6) <u>Climatic conditions</u>

The effects of climatic conditions on the onset of the ovulatory season can be direct or indirect.

Of the three variables recorded, temperature is the only one likely to have a direct effect as reviewed in Chapter II (p. 5). However, the temperatures for this season did not differ markedly from the Station mean, especially during the early parts of the experiment.

Indirect effects can be exerted through pasture growth. But, it is believed that for the animals slaughtered, kept in store condition, characteristics of pasture growth are of little importance.

B) REPRODUCTIVE TRACT CHANGES

1) <u>Uterus weight</u>

Since uterus weight was demonstrated to vary throughout the oestrus cycle by histological changes (Eckstein and Zuckermann, 1956) any comparison of uterus weights of ovulating animals is not possible. Any comparison, then, must be made before ovulatory period. This was done in one case only, since when uterus weights recording was started (6th of February) the percentage of ewes ovulating was already relatively high in all but one observation (College Arable Farm, 7-2-68). The regression equation calculated and the regression line gave a significant relationship between carcass and uterus weights. This is in disagreement with the conclusions reported by Hammond, Hammond and Parkes (1944).

2) <u>Ovary</u>

a) Ovary size

As it was stated before (see Chapter II, p.17) ovary size remains fairly constant throughout the season and changes are brought about mainly by large follicles and corpora lutea, therefore it is not possible to discuss any further the present results. Furthermore, only length from pole to pole was taken and this measure is not an accurate expression of ovary size.

b) Right and left ovaries activity

Although not significant, present data shows greater activity of left ovaries as compared with right ovaries. This is in opposition to previous findings (Clark, 1934; McKenzie and Terrill, 1937; Hennings, 1939; Casida et al., 1966).

It is believed that ovulations taking place in either of the two ovaries is a matter of chance. Therefore, when enough data are obtained, the number of ovulations in the left ovary should equal the number of ovulations in the right ovary.

c) Graafian follicles

Results reported in this experiment of ovarian activity as measured by the presence or absence of visible (on the surface), Graafian follicles are likely to be biased, since not all ovaries were sectioned, but this bias would be simply an underestimation of the number of follicles present and probably not influence the relative percentages. As expected, the number increased after the onset of the ovulatory season, although fairly high percentages of active ovaries were recorded before the ovulatory season started, favouring the theory of a steady build up of activity before the breeding season starts.

Data shown in Table 9 (p.55) favour a steady growth of Graafian follicles throughout the oestrus cycle as reported by Grant (1934) and therefore disagree with Hutchinson and Robertson (1966) who claimed a rapid follicular growth at the beginning of the season.

As the present data was subjectively determined no further interpretations of data obtained were attempted.

d) Corpus luteum

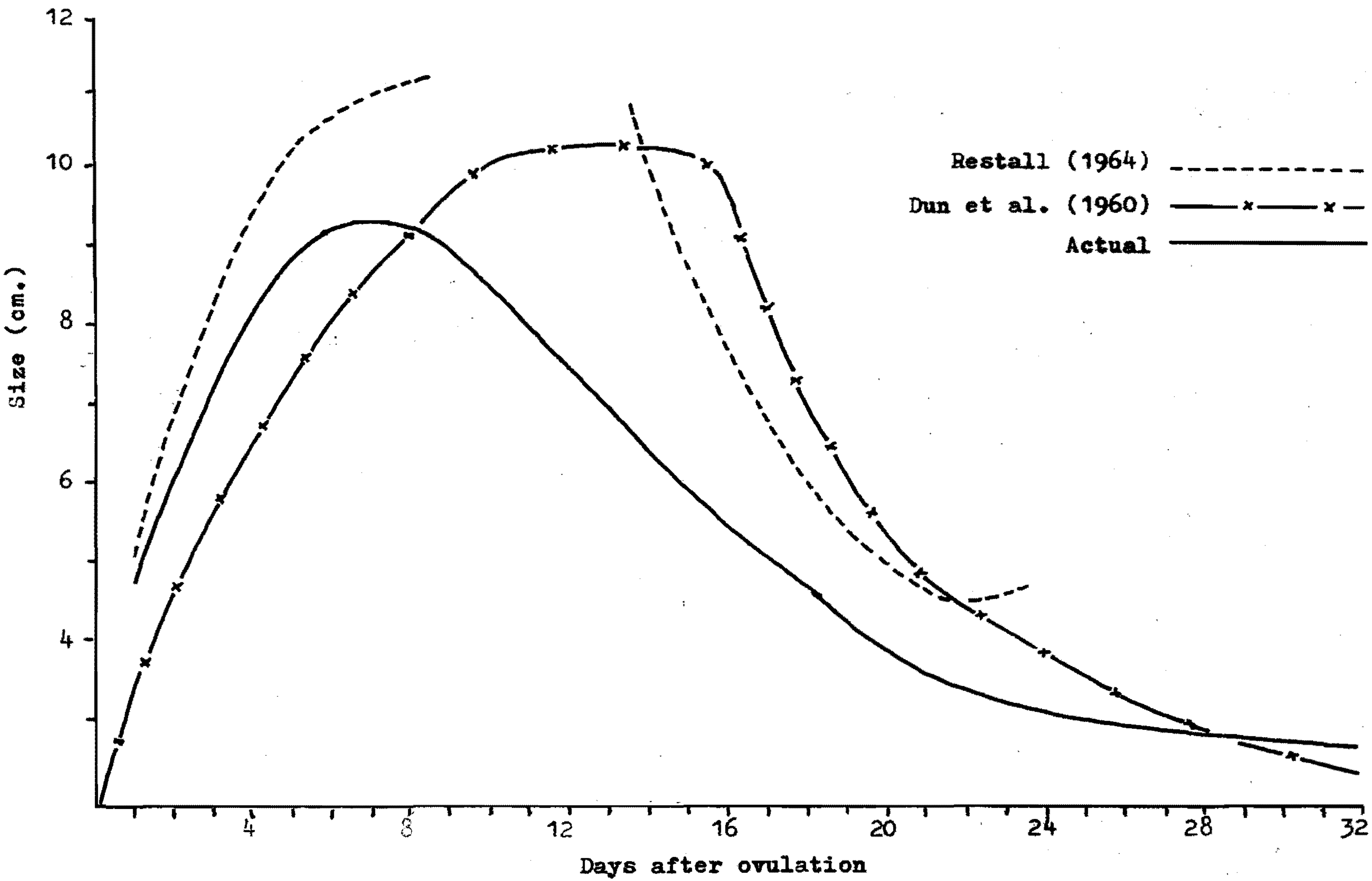
As the two curvilinear regressions do not give a fully satisfactory picture of corpus luteum growth and decline, another curve was drawn was thought to be the curve of best fit for the present data. It is shown in Figure 12 (p. 83).

As a means of comparison the curves reported by Restall (1964) and Dun, Ahmed and Morrant (1960) were drawn in the same Figure.

Corpus luteum growth as shown in Figure 12 followed the same pattern as reported before (Quinlan and Mare, 1931; Grant, 1934; Warbritton, 1934; Restall, 1964; and others). Decline, on the other hand, seems to have occurred earlier than as previously reported, since, by 14th day a size of 6.2cm. is given against much higher values reported by other workers. Considering that the method of ageing corpora lutea was subjective this could explain the difference if earlier-than-time given dates are assumed to be recorded. This indicates that the actual Figure is not realiable guide for other workers intending to work on the basis of ageing corpora lutea. In fact, it is believed that the method used in this experience is not reliable when accuracy is needed, since wide variations in size between corpora lutea of similar given age were observed. For instance, corpora lutea of the same size showed in many cases different colours, which might mislead the classification in a few days. Furthermore, in the side trial carried out (see Appendix) it was observed that corpora lutea of similar known age varied markedly in size, shape and colour.

Figure 12

Corpus luteum growth and decline



The existence, in the data, of a gap between the 15th and the 18th day, further supports the view of a biased technique.

None of the previous reports was considered to give an accurate method for day by day corpora lutea classification. Allowances for single and twin corpora lutea have to be made since it was observed that this factor can influence both size and colour of corpora lutea.

Examination of corpora lutea should be made soon after slaughter, since decoloration advanced with advancing age or time after collection, in the present experiment when immediate examination was not made.

Corpora lutea probably belonging to the same oestrus cycle having different characteristics as if consecutive ovulations happened within a few days, were observed in a few cases. The same was reported by Averill (1959).

Hollow corpora lutea seems to be a common situation since a fair number of them were always recorded (Table 13, p.62). Braden and Moule (1964) concluded that hollow corpora lutea were brought about by "stress" of transportation. A "stress" problem was observed in the present experiment, as discussed elsewhere and it was observed that where the response to "stress" was higher (Bowenvale) the highest percentage of hollow corpora lutea was recorded as well. With the technique used and data available it can not be determined whether ewes slaughtered were under some "stress" condition within

3 to 17 days before slaughter, since all data of Table 13 were taken from corpora lutea 4 days old onwards.

If it is accepted that there are strain differences in susceptibility to "stress", then the higher and significant incidence of hollow corpora lutea in Bowenvale as compared with Paparua Prison, can be explained by the fact that it was in flocks of Bowenvale where the highest response to "stress" was obtained. It is reasonable to expect the highest percentage of hollow corpora lutea within the same flocks but, on the other hand, if differences in response to "stress" are explained by differences in management between farms then the differences in incidence of hollow corpora lutea between all farms and furthermore the high percentages recorded can not be explained by a strain effect.

A definitive answer to this problem can not be obtained from this experiment considering the present knowledge on the matter.

Hollow corpora lutea were more common among twin ovulations (Table 14, p. 63) but no reasons for this were found.

Hollow corpora lutea are somewhat bigger than solid ones. This is another complicating factor considering corpus luteum size as a guide for classification of this gland according to age.

It is concluded that with the method of classification used in this experiment, any worker, not having plenty of experience in the matter, should not go beyond the following general classification of corpora lutea age:

i) Very recent ovulation - less than 24 hours of age.

ii) Period of growth - from 1st to 6th day.

iii) Period of plateau or slow growth and decline - from 7th to 12th day.

iv) Period of fast decline - from 13th to next ovulation.

The decline after ovulation followed the same pattern as described by other authors and in very few cases, corpora albicantia of less than 3mm. in diameter were recorded. This is in agreement with Radford and Watson (1957). It seems that older corpora are embeded in ovarian tissues and are not seen by a surface examination of the ovary.

3) Recovery of ova

As explained elsewhere recovery of ova was incorporated in the trial simply as a means of helping the determination of corpora lutea age according to the position of the ova along the reproductive tract. Abnormal ova were recorded only when gross abnormalities were apparent, therefore the number recorded is likely to underestimate the true value. This is quite apparent when comparing present percentage of abnormal ova with that reported by Averill (1955) and Hart (1961).

The method itself could be biased when taking 72 hours as the period of time in which the ovum remains in the Fallopian tube, if the conclusions of Edgar and Asdell (1960) are taken into account, namely synchronised ewes showed a faster rate of passage of the ovum along the Fallopian tube. This applies especially to determination made between 3rd and 4th day after ovulation. However, nearly all "stress" synchronised ovulations were recorded as being one or two days old, and in nearly all cases attempted tubal ova were recovered.

C) OVULATION RATE

Ovulation rate is an expression of the number of ova shed. As the number of monovular twins is very low (Morley, 1948; Barton, 1949) the number of corpora lutea or corpora albicantia on the ovary are representative of the number of ova shed (Allison, 1967).

The ovulation rate determined experimentally could be influenced by "stress" or by management differences.

1) Ovulation rate experimentally determined

Only in the case of Paparua Prison ovulation rate was followed up to quite high values. In the majority of the other cases too few ovulations were recorded (see Table 15, p.65, and Figure 10, p.66). Therefore, not enough data is available in order to draw any conclusions.

However, it is possible to point out that,

i) ovulation rate increased from the first ovulation up to the second (Bowenvale) and to the third (Paparua Prison). This agrees with previous reports (Marshall, 1922); Hammond, 1944; McDonald and Ch'ang, 1966 and others); and,

ii) the "peak" of ovulation rate is likely to be about the end of March for most of the farms considered. Hart (1961) reported a "peak" of 165 per cent, measured by the number of ova shed, around mid-March for New Zealand Corriedales. However, the 162.7 per cent recorded for ewes from Paparua Prison on the fourth of April seems to indicate a later date for ewes of this farm. Coop (1962), also for New Zealand Corriedales reported a maximum "peak" of twinning rate of 40 per cent at the end of March. The present results are in close agreement with this report, if percentages of abnormal ova are considered (Hart 1961).

2) "Stress" and the ovulation rate determined

"Stress" factors have not been reported to affect ovulation rate.

It is not possible to determine, in the present experiment, the extent to which 0-3 day ovulations were caused by "stress". However, merely as a point of interest, ovulation rate of 0-3 day ovulations were compared with that of 4-17 day ones. This is shown in Table 18 for observations which allowed comparisons to be made.

Table 18

Ovulation rate of 0-3 day and 4-17 day periods (as possible index of stress effect)

Farms	Date	Ovulation rate	0-3 day ovulations		4-17 day ovulations	
			No.	ov.rate	No.	ov.rate
Hollymount	6-2-68	116.7	64	115.7	38	118.4
Ashley Dene	13-2-68	127.6	19	133.3	10	120.0
Bowenvale	27-2-68	117.4	27	114.8	42	119.0

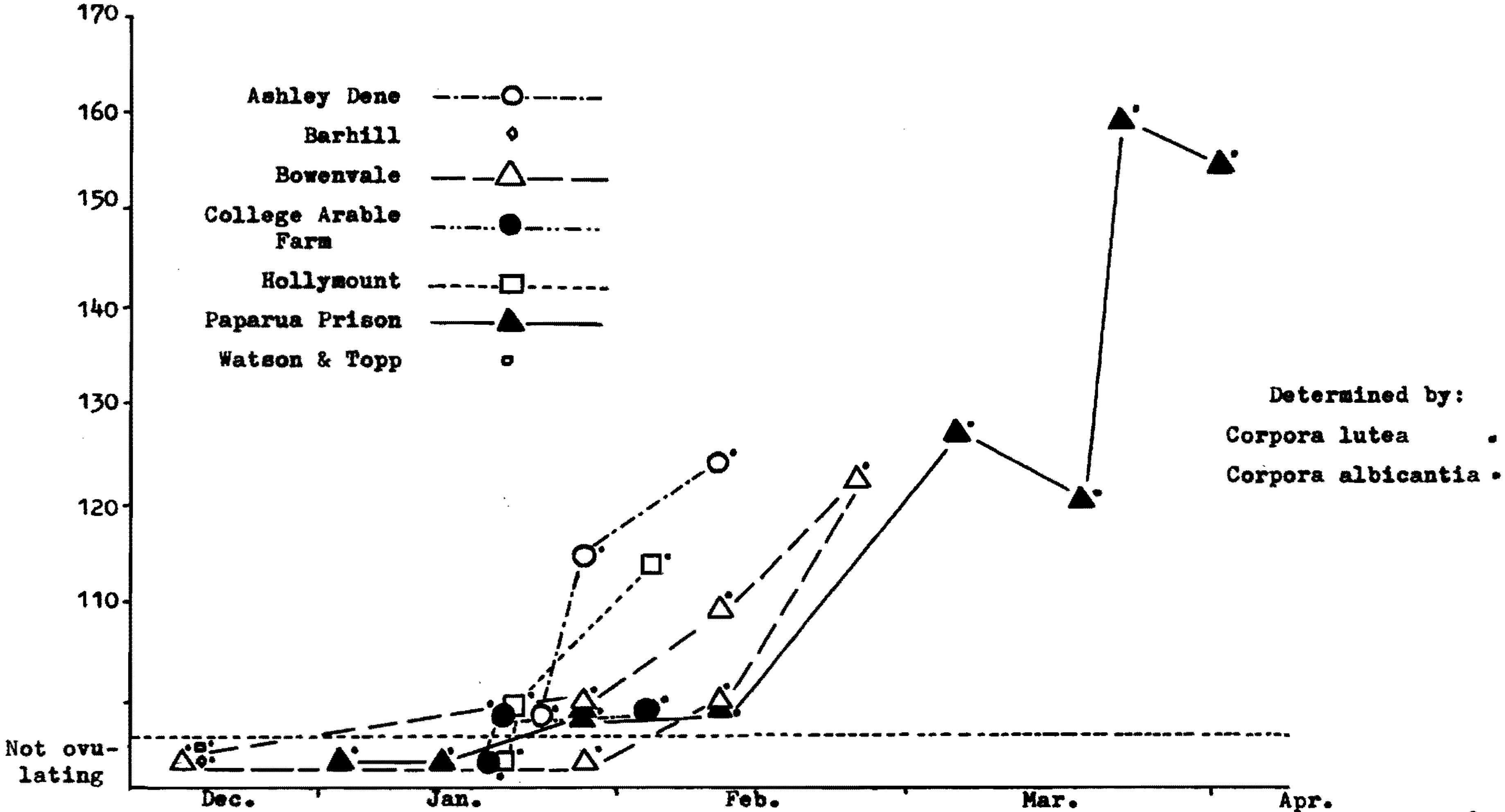
With a procedure similar to that explained in page 74, Figure 13 (p.90) was obtained. A more realistic situation is believed to be achieved and although not enough data is available it seems probable that the "peak" of ovulation rate would have occurred at the end of March for most flocks.

3) Management differences

With only one determination likely to be close to the "peak" of ovulation rate and no records of individual carcass weights it seems unwise to discuss between-and within-farm differences in ovulation rate which could in turn be brought about by differences in nutrition or selection.

Figure 13

Ovulation rate assuming that observations were made 3 days before actual slaughter



SUMMARY

In order to determine the onset of the breeding season of Corriedale ewes in Canterbury, a trial was carried out, at Lincoln College between December 1967 and April 1968.

1147 reproductive tracts were collected from Corriedale ewes coming from seven different properties (43-44º latitude, South), slaughtered at three Freezing Works near Christchurch. All ewes slaughtered were kept away from rams.

Average carcass weights were recorded for all groups slaughtered.

The first collection of material was made on the 19th of December, 1967 and the last on the 4th of April 1968. At the beginning of the experiment, only ovaries were removed, from the 6th of February onwards, whole reproductive tracts were removed.

The material collected was examined as follows.

i) Size and number of Graafian follicles were recorded.

ii) Size of the ovaries was measured.

iii) Size, number, location (either ovary) and age of corpus luteum were recorded (the last, subjectively).

iv) Weights of the uterus were recorded.

v) The recovery of ova technique was used as a help in the ageing of corpora lutea.

The results and conclusions obtained, follow.

1) The second half of January is suggested to be the date of onset of the ovulatory season for Corriedale ewes kept away from rams; at 43-44° latitude South.

2) Between and within farm differences in the onset of the breeding season are believed to exist. It is suggested that these differences can be brought about by strain differences within the Corriedale breed.

3) "Stress" - induced ovulations were likely to occur in some of the groups slaughtered. The "stress" situation seemed to be caused by yarding and transportation. Variable response of Corriedale ewes to "stress" is suggested to occur.

Possible alterations to the date of onset, caused by "stress" and other factors are discussed.

4) Corpora lutea were used as a means of determining ovulations. A further classification of the age of corpora lutea, on a daily basis, was subjectively made. The reliability of the method used and of the results obtained is discussed on the light of existent evidences.

5) Data obtained on: uterus weight, ovary size, right and left ovaries activity, density of Graafian follicles, hollow and solid corpora lutea, and others, are discussed.

6) Determination of ovulation rates were made. Most of the flocks considered did not reach the probable "seasonal peak" of ovulation rate, within the experiment.

7) A complementary trial was carried out in order to obtain a more precise information on the morphological changes which take place in the corpus luteum throughout the oestrous cycle. 16 ewes were slaughtered after being run, for a short period, with a raddled ram, providing corpora lutea of known age after heat. Detailed description of the reproductive tracts removed are given.

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APPENDIX

COMPLEMENTARY TRIAL

30 4-tooth Corriedale ewes, culled for poor body condition, were run with an entire raddled ram from the 14th of February (9 a.m.) to the 6th of March on the College Arable Farm at Lincoln College. A vasectomized ram was not available.

Ewes were checked twice daily (9 a.m. - 4 p.m.) for marked ones. These were drafted, tagged and date and number recorded.

On the 7th of March (9-12 a.m.) the 16 ewes marked by the ram were slaughtered at Lincoln College's butchery. Reproductive tracts were removed and identified. No carcass weights were recorded.

Poor body condition may account for the relatively small percentage of ewes marked by the ram despite of the advanced of the season. Also the fact that probably the "lag and peak" situation did not start yet.

The purpose of this trial was to obtain a range of corpora lutea of known age after oestrus and, thus, approximate age after ovulation.

The reproductive tracts were examined immediately after slaughter, as follows.

a) The uterus was weighed to the nearest gram.

b) The ovary size was obtained measuring the two main diameters (length and width) to the nearest millimetre.

c) Graafian follicles were classified according to the diameter, measured to the nearest millimetre into three groups, as follows,

i) Less than 4mm.

ii) Between 4 and 8mm.

iii) More than 8mm.

d) Recovery of ova from both the Fallopian tubes and/or the uterine horns were attempted in most of the cases.

A detailed description of individual reproductive tracts with corresponding dates of heat and probable time after ovulation, follows.

<u>Ewe No. 151 (pregnant)</u>

Marked by the ram on the period between 9 a.m. and 4 p.m. on the 16th of February.

Uterus weight, 54gm. (embryos included)

Right ovary

size, 1.4 x 0.8cm.

follicles, very few small ones

Left ovary

size, 1.8 x 1.2cm.
follicles, few small ones
corpus luteum, two corpora lutea of 10 x 10 and 10 x 9mm. In section, dark flesh colour, even darker than corpora lutea of non-pregnant ewes. Approximate age 19-20 days.

Ewe No. 152 (empty)

Marked by the ram on the period between 9 a.m. and 4 p.m. on the 16th of February.

Uterus weight, 60gm.

Right ovary

size, 1.5 x 1.3cm.
follicles, two between 4 and 8mm. and many small ones.
corpus albicans, two corpora albicantia of 6 x 5 and 5 x 5mm. protruding on the surface.

Left ovary

size, 1.6 x 1.4cm.
follicles, few small ones.
corpus luteum, two corpora lutea rosette-shaped and flesh-coloured in section, 9 x 8 and 10 x 9. Approximate age 3-4 days.
recovery of ova, one unfertilized egg was recovered from the left uterine horn.

Ewe No. 153 (pregnant)

Marked by the ram between 4 p.m. on the 17th of February and 9 a.m. on the 18th of February.

Uterus weight, 62gm. (embryos included)

Right ovary

size, 2.3 x 1.9cm.
follicles, few small ones.
corpus luteum, one C.L. deep red in colour, 12 x 10mm. in size, markedly protruding on the surface of the ovary.

Left ovary

size, 1.4 x 1.3cm.
follicles, few small ones.

Ewe No. 154 (empty)

Marked by the ram on the period between 9 a.m. and 4 p.m. on the 26th of February,

Uterus weight, 51gm.

Right ovary

size, 1.4 x 1.0.
follicles, many small ones.
corpus luteum, a still protruding 7 x 7mm. corpus luteum ochre-yellowish coloured. Approximate age 9 to 10 days.

Left ovary

size, 1.8 x 1.1cm.
follicles, very few small ones.
recovery of ova, no ova were recovered.

<u>Ewe No. 155 (empty)</u>

Marked by the ram between 4 p.m. on the 26th and 9 a.m. on the 27th of February.

Uterus weight, 79gm.

Right ovary

size, 1.7 x 1.3cm.
follicles, many small and two between 4 and 8mm.
corpus albicans, two corpora of 2 x 2 and 3 x 2mm.

Left ovary

size, 1.6 x 1.4cm.
follicles, few small follicles.
corpus luteum, two corpora of 11 x 8 and 10 x 10mm. hollow and solid, respectively. The hollow ochre-coloured and the solid pale flesh-coloured. Approximate age 9 days.
recovery of ova, no ova could be recovered.

<u>Ewe No. 156 (empty)</u>

Marked by the ram between 9 a.m. and 4 p.m. on the 29th of February.

Uterus weight, 52gm.

Right ovary

size, 1.3 x 0.8cm.
follicles, few small ones.

Left ovary

size, 1.5 x 1.3cm.
follicles, one of more than 8mm. and many small ones
corpus luteum, one C.L. rosette shaped, pale flesh coloured, 12 x 9mm. Some blood vessels visible on the surface. Approximate age 7 days.
corpus albicans, one C.A. 4 x 2mm.
recovery of ova, no ova were recovered.

<u>Ewe No. 157 (empty)</u>

Marked by the ram between 9 a.m. and 4 p.m. on the 29th of February.

Uterus weight, 50gm.

Right ovary

size, 1.6 x 1.3cm.
follicles, many small ones.
corpus luteum, one C.L., 12 x 9mm., rosette-shaped markedly protruding pale flesh-coloured in section, with some blood vessels on the surface. Approximate age 7 days.

Left ovary

size, 1.4 x 1.2cm.
follicles, one of more than 8mm. and a few small ones.
corpus albicans, one C.A. 5 x 2 of yellowish colour.
recovery of ova, no ova were recovered.

Ewe No. 158 (empty)

Marked by the ram between 4 a.m. on the 29th of February and 9 a.m. on the 1st of March.

Uterus weight, 47gm.

Right ovary

Size, 1.9 x 1.4cm.
follicles, very few small ones.
corpus luteum, one C.L. flesh-coloured, 13 x 11mm. nearly completely sank into the ovary and with a small rosette shaped formation. In section, flesh coloured. Approximate age, 6 to 7 days.

Left ovary

size, 1.6 x 1.5cm.
follicles, one between 4 and 8mm. and many small ones.

Ewe No. 159 (pregnant)

Marked by the ram between 9 a.m. and 4 p.m. on the 4th of March.

Uterus weight, 42gm.

Right ovary

size, 1.4 x 0.9cm.
follicles, few small ones.

Left ovary

size, 1.9 x 1.8cm.
follicles, few small ones.

corpus luteum, two very deep flesh-coloured C.L. of 8 x 6 and 6 x 6mm. Approximate age 3 days.
corpus albicans, one 4 x 3 gold coloured.
recovery of ova, one fertilized ova in the left oviduct.

Ewe No. 160 (empty)

Marked by the ram between 9 a.m. and 4 p.m. on the 4th of March.

Uterus weight, 36gm.

Right ovary

size, 1.3 x 1.1cm.
follicles, few small ones.
corpus albicans, one C.A. of 5 x 3mm. in section yellow-coloured with accumulation of brown pigment.

Left ovary

size, 1.6 x 1.3cm.
follicles, few small ones.
corpus luteum, one C.L. dark flesh-coloured, rosette-shaped formation, and an uncompletely filled cavity in the body of the corpus. 9 x 6mm. in size. Approximate age 3 days.
recovery of ova, one unfertilized ova was recovered from the left oviduct.

Ewe No. 161 (empty)

Marked by the ram between 4 p.m. on the 4th of March and 9 a.m. on the 5th of March.

Uterus weight, 66gm.

Right ovary

size, 1.7 x 1.6cm.
follicles, many small ones.
corpus luteum, one C.L., by external examination a small red ring appeared, in section flesh coloured folded walls surrounding a not completely filled cavity 7 x 5mm. in size. Approximate age 2 days.

Left ovary

size, 1.4 x 1.2cm.
follicles, many small ones.
recovery of ova, one unfertilized ova recovered from the right oviduct.

Ewe No. 162 (empty)

Marked by the ram between 9 a.m. and 4 p.m. on the 5th of March.

Uterus weight, 53gm.

Right ovary

size, 1.5 x 1.2cm.
follicles, few small ones.

Left ovary

size, 1.6 x 1.3cm.
follicles, many small ones.
corpus luteum, one C.L. on external examination, not very well organized, in section unevenly pale flesh-coloured cavity filled with a gelatine like fluid. Approximate age 1 day.
corpus albicans, two C.A. still protruding on the surface, in section yellow-coloured, 5 x 5 and 4 x 4mm. in size.

Ewe No. 163 (empty)

Marked by the ram between 9 a.m. and 4 p.m. on the 6th of March.

Uterus weight, 47gm.

Right ovary

size, 1.6 x 1.2cm.
follicles, two of more than 8mm. and a few small ones
corpus luteum, one C.L. hardly protruding on the surface, in section ochre colour, 7 x 6mm. in size. Approximate age 16 days.

Left ovary

size, 1.8 x 1.0cm.
follicles, one of more than 8mm. looking like about to ovulate, (less internal pressure than the others).

Ewe No. 164 (empty)

Marked by the ram between 4 p.m. on the 22nd and the 23rd of February.

Uterus weight, 43gm.

Right ovary

size, 0.8 x 0.6cm.
follicles, none at all.

Left ovary

size, 1.2 x 1.0cm.
follicles, one of more than 8mm. two between 4 and 8mm. and a few small ones.

corpus luteum, one C.L. sank into the ovary, in section red brownish coloured with paler edges, 7 x 7mm. in size. Approximate age 12 days.

recovery of ova, no recovery was attempted.

Ewe No. 165 (empty)

Not marked by the ram.

Uterus weight, 51gm.

Right ovary

size 1.7 x 1.0cm.

follicles, two of more than 8mm. and many small ones.

Left ovary

size 1.4 x 1.2cm.

follicles, many small ones.

corpus luteum, one C.L. with a small rosette-shapted formation protuding on the surface of the ovary, in section pale flesh-coloured. 7 x 5mm.

Note: This ewe presumably had a silent heat

Ewe No. 166 (empty)

Marked by the ram between 9 a.m. and 4 p.m. on the 6th of March.

Uterus weight, 48gm.

Right ovary

size 1.3 x 0.9cm.

follicles, many small ones.

Left ovary

size, 1.7 x 1.1cm.

follicles, few small ones.

Note: This ewe was possibly not in heat, although it was marked.