OESTRUS IN SHEEP AND BREEDING OUT OF SEASON

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Leonard H. Blakeslee.
Major professor

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OESTRUS IN SHEEP AND BREEDING OUT OF SEASON

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MOHAMAD ISHAQ SAYED

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INTRODUCTION

Domestication and breeding of sheep along with other livestock began at a more remote period than the recorded history of man himself. Sheep attracted the attention of mankind as a constant source of food and clothing.

Knowledge about the prehistoric man's association with sheep is very limited and therefore, precise information about the ancestral type of this animal is also lacking. The Old Testament makes frequent mention of the pastoral occupation of sheep herding. Thus it may be inferred that sheep were of definite value long before that period. However, primitive sheep were a very inferior stock, wool being of hairy character, thin and of various colors.

For proper development and reproduction ewes had to be protected and properly fed. With the limited number of foundation stock, their well being was all the more important in order to secure substantial increase in number which could be relied upon when needed. Mere care and haphazard breeding could not keep pace with the increasing demands of the human population, therefore, need for better and more efficient animals soon arose.

The improvement of livestock by controlling the parentage, goes beyond the time of Egyptian Prince Mehenwetre, who ruled about 21 B.C. A chamber opened in the tomb of this Prince in 1919, revealed that he owned 974 heads of sheep in addition to the other livestock. A model illustrating the difference in type between the wild and improved animals showed their understanding of the subject of breeding. Improvement of livestock according to present day conception, however, began in about 1760 in the

time of Robert Bakewell, followed by the Colling brothers in 1783, Thomas Bates and Thomas Booth.

Progressive breeders by this time began to realize a definite economic need for animals suiting different purposes which ultimately established various breeds of livestock. Continuous efforts to effect improvement in meat and wool yields brought into being Wool and Mutton breeds of sheep.

Success of any enterprise is measured in terms of return it brings as compared to its cost. In sheep enterprise, fertility is one of the factors having direct bearing upon success. To achieve this, understanding of the breeding habits of this animal is very important. It is of paramount importance, therefore, for the breeder to know of any tendency there may be in the seasonal breeding habits of a particular breed or strain of sheep under his care. A knowledge of the trend of females to come in heat and become fertilized during certain periods of the year would lead to a more rational preparation and distribution of males during such seasons and a consequent higher fertility and reproductive efficiency of the females. Also, information concerning the reproduction of a greater number of youngs during certain months of the year is advantagious as the breeder can provide adequate facilities so as to reduce the mortality to minimum when reproduction occurs during unfavorable months of the year.

PURPOSE OF STUDY

With the hope of solving some of these problems, workers in different countries have from time to time studied the occurrence of breeding season among different breeds and ages of sheep in which they were interested. Precise information on the occurrence of the phenomenon beyond the regular breeding season especially among young ewes under Michigan conditions is not available.

A flock of yearling ewes practically of similar ages but of different breeds, owned by the Michigan State College was found available to work with in January, 1951. The opportunity was considered worth spending time and energy for the purpose of obtaining exact information regarding the sexual behaviour of this flock maintained under similar dietetic and other environmental conditions through-out the period of observation, extending from January 15 to August 31, 1951.

It is further hoped that the conditions imposed upon the animals under observation being natural and thus identical with those prevailing on an average farm would furnish equally identical results which could be utilized without any further modification.

REVIEW OF LITERATURE

The breeding season is a certain period of the year when females accept the males. Onset and termination of the breeding season differs in different species of animals. Within species, it is influenced by breed, strain, heredity, age, nutrition and various environmental factors. Within breeds and strains, individual females exhibit certain differences from time to time.

Cows are generally receptive to the male at regular intervals throughout the year, although, majority breeds during Spring and late Summer.

Mares, usually exhibit signs of oestrus during Spring, while some breed regularly all the year round. Still others mate in Spring, Summer and Autumn. A similar general statement about seasonal occurrence of oestrus in sheep holds true. Breeding season in this species of livestock starts in late Summer and ends in early Winter. As in case of other livestock, one finds variations among breeds, strains and individual animals. Environmental conditions as nutrition, climate, season, etc., have a direct bearing upon the phenomenon as well. In addition to the above, age is a factor of fundamental importance. The problem being of vital importance for the industry has been a subject of study in almost all the sheep breeding countries of the world.

Henning and McKenzie (1927) while working with a group of Dorset and Grade Merino ewes found that 38% conceived in June, 48% in July and 4% in August with 8% cases of nonconception in 1924.

Next year another group of Grade Merino and Dorset x Merino ewes were observed, out of which 84% conceived in June, 8% in July, 2% in

September and October each and 4% cases of nonconception.

Valente Villegas (1929) reported his findings on a group of Indian Grade ewes. During the period of observation (1923-1928), 18.3% matings took place from January to April, 39.3% in May and June, 21.2% from July through November and 21.2% in December. This indicated two periods of marked sexual activity instead of one as is the case with other breeds.

McKenzie and Phillips (1930) found that the breeding season started in the end of August, Hampshire ewes started breeding 10 days earlier than Shropshires and Southdowns. Another group consisting of ewe lambs representing the same breeds revealed that all the Hampshires had been in first oestrus by October 19, while October 16 marked the beginning of first oestrus in Southdowns as compared with Shropshires all of which exhibited first oestrus by November 4.

Smith and Hussain (1935) observed that sheep were bred all the year round in the Punjab (India) but maximum numbers of lambs were dropped during Spring and Fall.

Smith and Singh (1938) reported that regular breeding season in the Punjab is Spring and Fall in Bikaner ewes. A study of 3 years breeding records of Bikaner and Hissar Dale flocks maintained at the Government Cattle Farm, Hissar, revealed that 82% of lambs were dropped in Spring.

Apart from the above, 2 groups of Bikaner ewes were observed from March 15 to June 15. Large majority of ewes were settled by the end of observation period (June 15), while ewes that did not settle were found coming in heat regularly up to that date.

Observations detailed above fall in line with Valente Villegas who also found that Indian Grade ewes have a tendency to breed twice a year.

McKenzie and Terril (1937) reported their observations on Hampshire, Shropshire, Southdown, High Grade Rambouillet and Grade Hampshire x Shropshire ewes from 1929 through 1936. Each year, observations started from August and terminated when all ewes had stopped coming in oestrus. They concluded that considerable variations existed in the onset and duration of breeding season in different ewes under same conditions and same ewes in different years. In spite of all these variations, breeding seasons started in late August and beginning of September and ended by the end of December or January.

Kelly and Shaw (1937, 1939, 1943) observed different strains of Australian Merino, Dorset Horned, Leicester and Merino cross bred ewes at centers 13° latitude apart. A well defined periodicity in the percentage of ewes coming in heat was observed at all centers. Decrease in the incidence of oestrus occurred in Spring months (Fall in U.S.) and rise in Summer and higher level was maintained in late Summer and Autumn throughout the period of observation. Further, breeding season started earlier in the Dorset Horned ewes while Merinos exhibited relatively longer breeding season as compared with Border Leicester ewes having a restricted season. Variations within breeds were found characteristic of strains.

Schott, Phillips and Spencer (1939) in connection with Hot House Lamb Production project conducted at Middleburry and Beltsville observed Corriedale, Dorset, Tasmanian Merino, Hampshire, Shropshire, Southdown, Karakul and various other groups of crossbred ewes. The rams were let loose in the flocks from May to the end of October each year. Ewes from different breeds were in mating throughout the period of observation but lambs tended to be dropped in two rather distinct periods around September

and January. The proportions of ewes settled in June, July and August were small. In Corriedale, Dorset and Dorset x Tasmanian Merino ewes, the proportions that settled during May were higher than in the three succeeding months. Among Tasmanian Merino ewes, none settled during July and in Dorset x Tasmanian Merino and Dorset x Delane Merino ewes, none settled during June.

Among the mature ewes in Corriedales, the first oestrus occurred during the last week of July in 1938. Among the Hampshire, Shropshire, Southdown, Karakul and Karakul crossbred ewes, the first oestrus occurred from the second to fourth week of August, yearlings tended to come in heat somewhat later than mature ewes.

Hammond (1944) reported regarding a flock of Suffolk x Border Leicester Cheviot ewes that were allowed to run with rams throughout the year from 1932 to 1939. The onset and end of the breeding season ranged from September 18 to November 5 and February 17 to April 10 respectively.

Yeats (1947) reported, that phenomenon of seasonality in breeding among sheep of British Isles is due to some stimulus of natural environments, rather than to an inherent rhythm and the idea had a support by the evidence of reversal of breeding seasons when these ewes were transfered to Southern Hemisphere. Consequently a group of ewes was subjected to varying lengths of light during 24 hours and the sexual behaviour observed. He found that seasonal variations in the length of days is the chief factor determining the onset and duration of natural breeding season, and that it can be modified and even reversed by altering the length of days artificially. A change from increasing to decreasing length of days induced reproductive activity, the breeding response occurred some

10-14 weeks after the change. On the other hand, a change from decreasing to increasing length of the day, induced an-oestrum 10-14 weeks after the change.

Gunn (1948) quoted breeding record of Australian Merinos from 1933-1938 showing that the percentage of ewes settled in October, November, December and January was lowest. From January onwards, the percentage of conceptions showed rise and reached its peak in May, June and July. From July onwards, fall in conception percentage again resulted and reached the lowest levels from about October. Onset of breeding seasons was however earlier than the breeds of British origin.

MATERIAL

Animals used in the experiment consisted of young ewes dropped by the College flock from November 1949 to May 1950. To allow proper growth and development, the ewe lambs were not bred during Fall, 1950. With the exception of a group of Rambouillet x Dorset Horned, the entire flock consisted of pure bred Dorset Horned, Hampshire, Oxford, Shropshire, Southdown and Suffolk yearling ewes. The number of females was different in different breed groups and rather small except Shropshires. This problem had no solution as no more animals were available. Deaths and other such unavoidable causes were encountered during the period of observation, that resulted in further reduction of number in different breed groups.

To start with, 47 young ewes consisting of Rambouillet x Dorset Horned 8, Dorset Horned 3, Hampshire 7, Oxford 5, Shropshire 16, Southdown 7 and Suffolk 1, were available in January 1951. The ages of these yearling ewes ranged from eight months and fifteen days to fourteen months and fourteen days (Table I).

The rams used as teasers to check oestrus belonged to regular breeding flock of Shropshire and Oxford breeds and after a trial of few days, two of them were finally found suitable for this teasing work and used throughout the period.

During Winter and early Spring, generally one of them was used for routine daily checking. From about middle of May 1951, when the atmospheric temperature started showing rise, the teasing activity of the rams was found decreased. It was therefore decided to use two instead of one to have reliable results. This scheme was then put into operation and continued throughout the rest of the period.

In addition to the material mentioned above, information was also collected from the breeding records of the College flock with the purpose of determining the onset of heat in ewe lambs. It was also considered worth-while to analyze the breeding records of adult females which might show some difference in the sexual behaviour in relation to breeds and individuals within breeds during the regular breeding season. Records of breeding dates with respect to each ewe were not kept and were calculated from the lambing dates in each case.

Housing

The entire flock of young ewes observed in this experiment along with check rams was housed in the Experimental Barn in the beginning of November 1950, when the animals returned from pasture. To provide the required housing space of 12 to 16 sq. ft. per head, the animals were confined in separate pens according to breed groups. Dorset Horned ewes were only 3 and were consequently accomodated along with Rambouillet x Dorset Horned group. Similarly a Suffolk yearling ewe, the only representative of her breed was also housed along with the Oxford group. On the whole, the flock was scattered in 5 pens, one pen for each group of Rambouillet x Dorset and Dorset Horned, Hampshire, Oxford and Suffolk, Shropshire and Southdown ewes respectively.

From May 11, 1951, the flock was put on pasture and was then moved to the Main Barn. From here, the ewes could go and come back from the grazing field at any time which was not possible from the Experimental Barn. During the pasture period all ewes were put in one flock.

Check rams were also housed in one pen by the side of ewes and were kept separate by keeping the connecting door closed.

TABLE I

AGE OF EXPERIMENTAL EWES ON JANUARY 15, 1951

Ser. No.	Breed	Ewe No.	Date of Birth	Age on January 15, 1951 Months/Days
1	Dorset Horned	846	Nov. 2/49	14/14
2	" "	849	Apr. 1/50	9/15
3	" "	869	Apr. 1/50	9/15
4	Hampshire	802	Feb.18/50	10/26
5	"	815	Mar. 3/50	10/14
6	"	816	Mar. 3/50	10/14
7	"	819	Mar. 6/50	10/11
8	"	823	Mar.16/50	10/1
9	"	831	Apr.16/50	9/0
10	"	832	May. 2/50	8/15
11	Oxford	854	Mar. 3/50	10/14
12	"	856	Mar. 4/50	10/13
13	"	857	Mar. 6/50	10/11
14	"	859	Mar. 8/50	10/9
15	"	867	Mar.18/50	9/29
16	Ramb. x	344	Jan. 50	12/15
17	Dorset Horned	345	Jan. 50	12/15
18	"	346	Jan. 50	12/15
19	"	347	Jan. 50	12/15
20	"	349	Jan.22/50	11/25
21	"	364	Jan. 50	12/15
22	"	368	Jan.22/50	11/25
23	"	386	Jan. 50	12/15
24	Shropshire	902	Feb.18/50	10/26
25	"	905	Feb.22/50	10/22
26	"	908	Feb.25/50	10/19
27	"	911	Feb.25/50	10/19
28	"	912	Feb.26/50	10/18
29	"	914	Feb.27/50	10/17
30	"	917	Feb.27/50	10/17

continued

Ser No.	Breed	Ewe No.	Date of Birth	Age on Jan. 15/51 Mo/days.
31	Shropshire	919	Mar. 1/50	10/15
32	"	923	Mar. 4/50	10/13
33	"	929	Mar.10/50	10/7
34	"	931	Mar.10/50	10/7
35	"	936	Mar.16/50	10/1
36	"	937	Mar.21/50	9/26
37	"	940	Apr.11/50	9/5
38	"	951	Apr.15/50	9/1
39	"	952	Apr.17/50	8/29
40	Southdown	963	Feb.27/50	10/17
41	"	970	Mar. 7/50	10/10
42	"	971	Mar. 7/50	10/10
43	"	972	Mar. 7/50	10/10
44	"	978	Mar.18/50	9/29
45	"	981	Mar.29/50	9/18
46	"	984	Apr.17/50	8/29
47	Suffolk	893	Feb. 8/50	11/6

Feeding and Watering

While confined in the Experimental Barn from November 1950 to May 11, 1951, ewes as well as rams were fed twice daily between 8 and 9 A.M. in the morning and 4 to 5 P.M. in the evening according to the following scale per head

Morning	
Oats and Corn (equal parts)	½#
Soyabean oil meal	1/10#
Corn silage	4#
Evening	
Oats and Corn (equal parts)	½#
Hay (mixed Alfalfa, Clover and Brome grass)	2#

Double sided feeding racks were provided, one for each pen where the feed was placed each time. The animals were found scattered all around according to their convenience and consumed their shares.

From May 11, 1951, the ewes were put on pasture consisting of 3 fields. Grazing in each field was done in rotation one after the other to provide ample young grasses. Field No. 1, 2 and 3 consisted of Ladino Clover mixed with Alfalfa and Brome grass, Ladino Clover, Alfalfa, Alsike and Brome grass and Birdfoot terfoil and Ladino Clover respectively (Fig. 1).

Throughout the period, rams had also the facility of grazing in separate field from the ewes. Wholesome and fresh water was always available in the Barn in each pen from cemented water troughs. There was no provision for water in the fields and the animals had to come to the Barn whenever they were thirsty. For so doing they had to walk about 400 yards each way.

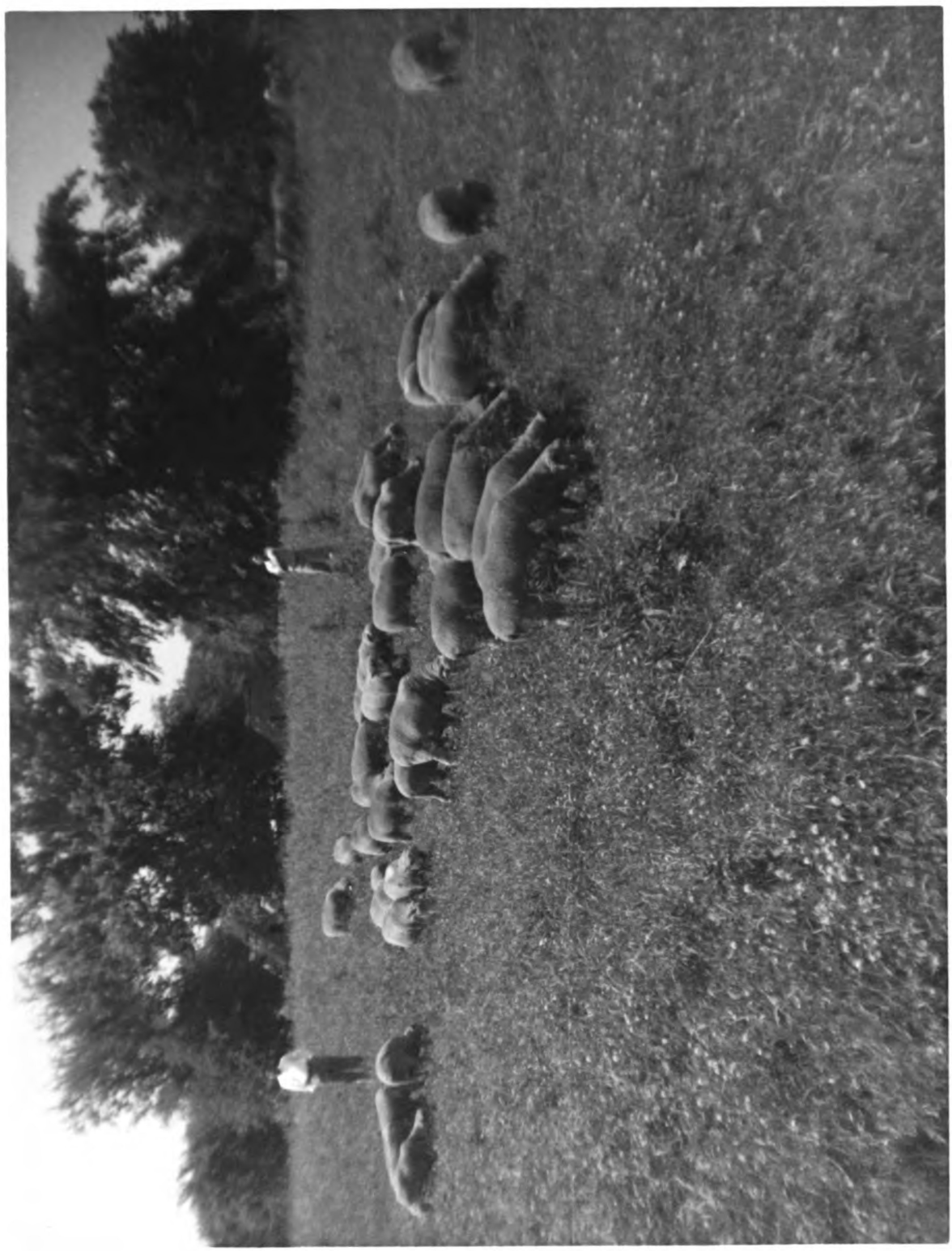

Figure 1. Experimental Ewes on Pasture.

METHOD OF OBSERVATION

Workers on similar projects have, from time to time used different methods for detecting heat in ewes. Rams were allowed to run with ewe flock all the time by some and breeding dates calculated from dates of lambing. Others, used rams with painted breasts and ewes bearing color mark on rumps on the following day were assumed to be in heat. In either case, rams had to be withdrawn after some time for rest and replaced by a fresh group. Similarly, painting of breasts required constant attention and frequent changes of colors to have correct readings. At every change of color, clipping of rumps was essential to remove the previous stains.

Method No. I, described above seemed to provide no information about the occurrence of oestrus in the same ewe in successive months which formed main feature of the present investigation. Method No. II, on the other hand seemed not very reliable, as a vigorous ram would mark atleast some ewes even when they were not in heat.

For the purpose of obtaining reliable information etc., it was decided to use aproned rams for checking the flock. The rams were kept separate and only turned with flock at the time of checking. It was therefore, possible to continue using the same rams without replacements. Moreover every ewe was under direct supervision at the checking time each day , thus giving a true picture of the behaviour of different breeds and individual females constituting the flock.

From the very start of the experiment, it was decided that the flock should be contented and satisfied when checked in order to have satisfactory readings. Mornings and evenings both, being feeding times were unsuitable as the ewes were always found restless and bleating. Under the cir-

cumstances checking in the afternoons was considered more suitable. This plan was adhered to as closely as possible between 1 and 2 P. M. every day so long as the flock was confined in the Barn previous to May 11, 1951.

Everyday usually one ram was taken out from his pen with an apron fitted around his neck in front passing between forelegs and under the belly, finally tied around flanks in the rear.. For the purpose of imposing the least feeling of restraint on ram, the apron was never fitted very tight and thus the ram could easily mount the ewes in heat. The ram was then led to one pen and allowed to check each ewe. Except Rambouillet x Dorset Horned and Shropshire groups, ewes in any single pen did not exceed 8 in number and the ram, therefore, had no limitation in contacting each ewe. Regarding groups containing more ewes, the animals were either taken out in the adjacent yard or moved every now and then to facilitate contact of both sexes. (Fig. II.)

As the work progressed, it was observed that the ram after surveying a pen from one side to the other, stood disinterested in case no ewe happened to be in heat. On the other hand, any ewe in heat was almost immediately detected and was removed from the pen to induce the ram to attend the rest. In this way, after checking all the pens one after the other, the ram was separated and confined in his own pen till the next day.

From May 11, 1951, the ewes were pastured and shifted to the Main Barn. All the time the ewes were given free access to and from the pasture fields at will. Due to the onset of summer season, decrease in the teasing activities of rams was noticed especially during hot parts of the day. This necessitated a change in checking time as well as increase in number of teasing rams to obtain reliable results. Consequently, two rams

instead of one were now used early morning instead of afternoon.

Ewes were generally found grazing and were driven back to the Barn every day. They were then divided into 3 lots of approximately equal sizes. One out of the three lots was confined at a time in a pen and rams allowed to mix as before. Every ewe was identified from her ear tag number painted in bold letters on her back. Date as well as time of onset and end of heat was recorded in each case in order to collect complete information of the sexual behaviour of individual ewes besides the flock as a whole during the period under review.

Behaviour of Ram

Rams exhibited great variations in behaviour toward ewes. The same ram behaved differently with the same ewes on different days, showing more interest on one day and less on the other. However, no association of such a varied behaviour could be established with the sexual activity of ewes. On the other hand, disinterestedness of a ram after surveying the whole lot of ewes was found to be a fairly reliable index of no ewe being in heat in that lot. Ewes attended least on the previous day were in heat the following day while ewes in whom ram showed continued interest for many days did not come in heat for months after. Thus the rams were never found consistant in giving more or less attention to females for a considerable length of time.

Broadly speaking, ram would go round practically every ewe in the pen giving more attention to some and less to others till any ewe that happened to be in heat was detected, otherwise he stood disinterested. Immediately after contacting a ewe, the ram sniffed her vulva, elevated his head with curled upper lip and sniffed air. The head was then low-

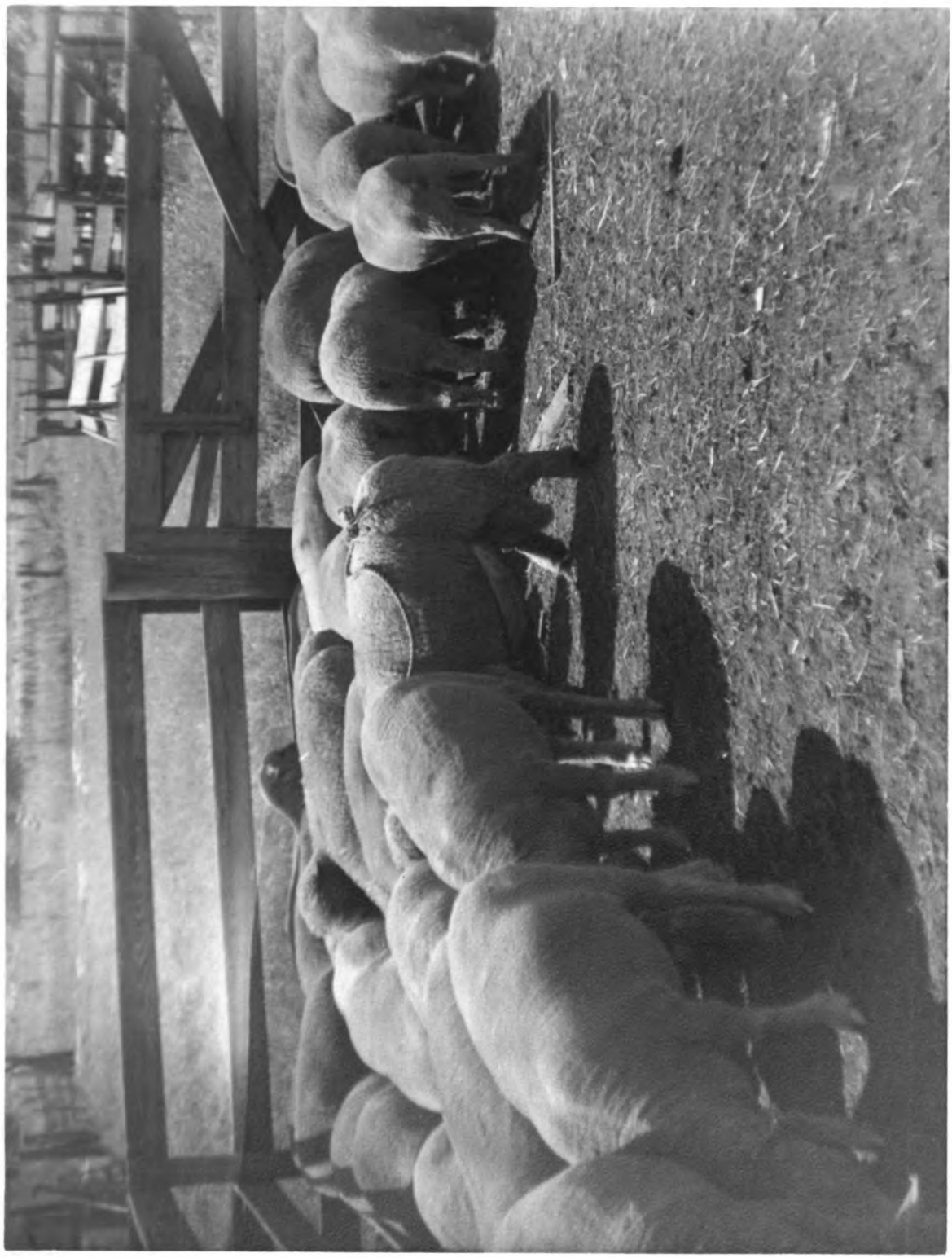

Figure 2. Group of Ewes with the Ram equipped at the checking time.

ered and same action repeated with the same ewe. In others, after sniffing vulva once, he walked to a second ewe without taking any further notice. In still others, after having sniffed once or twice, regular teasing started which consisted of a variety of actions. Neck was stretched and head moved up and down being in close contact with one side of ewe more often with flank. At this stage it appeared as if the ram is going to butt the ewe. Along with head movements, tongue was also moved in and out of mouth kept generally open. A typical murmuring sound was emitted at this stage of action, sometime very low and often so loud that it could be heard from a distance. Along with the actions mentioned above, ram would always strike his fore leg against the belly or hind leg of the ewe while teasing. A vigorous ram after sniffing the vulva would straight away jump without going through any of the above formalities. Such a behaviour was common with young rams especially yearlings. On the other hand, aged rams did not attempt to mount till they felt sure that the ewe would not move. Affinity for certain ewes and antagonism against others was not observed among rams used in this experiment.

Besides the characteristic behaviour of a ewe in heat, it seemed probable that certain odoriferous substances were secreted during this period that help the ram in locating such a ewe. To establish this, vagina of Dorset Horned ewe No. 846 was swabed on August 2, 1951 with cotton when she was in heat. The cotton swab was then rubbed around perinium of Southdown ewe No. 936 who was not in heat. The Southdown ewe thus treated was then turned with another ram along with 4 other ewes. The ram went around, sniffed vulva of each one of them and finally started teasing the Southdown ewe whose perinium had been smeared. The ewe did

not stand to teasing but in-spite of that, the ram attempted to mount her several times.

It is further possible that such substances are secreted in varying quantities and concentrations by individual ewes during heat. That these substances persist for some time depending upon quantitiy and concentrations secreted, which seems to be a suitable explanation as to why rams persistently follow only certain females for some-time after heat, when such ewes do not stand to teasing.

Behaviour of Ewes.

Like rams, ewes too exhibited quite a variety of behaviours when approached by rams. When in heat, they stood to teasing action of ram and allowed mounting. At this stage it was very easy to catch the ewe for identification of ear tag number which otherwise required considerable effort.

Almost all whether in heat or not, stood to sniffing of vulva and moved away when teasing started. Others allowed teasing for some-time and finally moved away. Still others jumped immediately when teased, then turned back and started butting the ram. Most of the ewes that stood to teasing urinated, wiggled their tails and moved away if teased any more. A few individuals stood to teasing for any length of time but moved and even jumped away when the ram attempted mounting. As in the case of rams, individual ewes were found very inconsistent in their day to day behaviour and it was thus impossible to assign a set routine response to a certain female.

Signs of Oestrus

A female is said to be in heat when she receives the male. Behaviour at this stage is very typical and can be detected easily even by those who are not very well aware of it. They are restless, nervous and wander in search of male if free to do so. Appetite is decreased, congestion and even swelling of vulva is present with mucous discharge in some. Bellowing and neighing is seen in cows and mares respectively and the tail is kept high. Frequent urination is very common but each time only a small quantity of urine is passed. The writer has seen in young heifers of Dhanni breed discharging actual blood when not mated. Ewes behave somewhat differently than females of other species of livestock mentioned above.

During this experiment, it was not usually possible in the absence of ram to predict with a reasonable certainty that such and such ewe was in heat. Congestion of vulva was observed in some cases while in others it was not noticed. On the other hand in some ewes, vulva was found congested in dioestrus and anoestrus periods. Similarly mucous discharge was not detected in any case. This might have been either absent or in so slight a quantity that it passed unnoticed. Growth of wool around vulva and checking the flock only once a day might have been the other responsible causes. Likewise nervousness, restlessness and bleating was not seen in any ewe except one of Dorset Horned group No. 969 in one heat only. On this occasion, she was found standing apart from other mates and bleated occasionally. When turned with ram she immediately walked towards him and stood for mounting.

Symptoms of heat in the presence of ram may be summed up as follows. As expected, the ram approached and sniffed vulva. Some of the ewes urinated while others did not. Majority of them stretched their bodies and

brought rumps in close contact with the breast of ram. Most of these turned their heads towards ram every now and then and finally stood firm when mounted.

Individuals were also observed who did not always exhibit the characteristic signs described above. They kept on moving this or that way while being teased and did neither stretch their bodies nor came in close contact of the ram. When mounted they did not stand firm like the others . Dorset Horned ewe No. 846 on one occasion on April 14, 1951 behaved this way but stood firm like others next time.

A third group of ewes however, did not behave like either extremes but took the middle course. To sum up, the ewes were extremely variable with respect to the signs of oestrus. Even the same ewe was not always found consistant in behaviour on successive occasions.

VISUAL OBSERVATIONS OF OESTRUS IN THE EXPERIMENTAL EWES FROM JANUARY 15 TO AUGUST 31

A total of 47 young ewes were observed daily from the start of the experiment. During the course of this work that terminated on August 31, few ewes died, some were removed and in two cases three were added to the already existing number. In each breed group, dates of death, removal or addition have been shown against the individuals so involved.

On account of shortage of pasture in August, it was decided to discontinue observing the ewes that had been in heat during August. Consequently a total of 15 such ewes (Dorset Horned 3, Hampshire 5, Oxford 1 and Ramb. x Dorset Horned 6) was removed from the flock. The ewes thus removed have been indicated in their respective breed groups.

In order to present an overall picture of the sexual behaviour of each ewe, a separate table for each breed has been prepared wherein the record of each ewe presented for the entire period. Date of onset and end of oestrus with respect to each ewe has been shown along with the dioestrus period and duration of heat.

Apart from such an individual treatment, a complete picture of each breed group has been presented in Table II and Figure 3, showing the number of ewes observed and average percentages that came in heat in a certain month. In calculating these percentages, the number of ewes that died, were sold, added or replaced, was counted in case they remained in the flock for more than 15 days in that month, otherwise not.

It may be noted that the months during which none of the ewes was observed in heat, have been omitted from the respective table.

Dorset Horned Ewes

Only three ewes of this breed were available for observations throughout the period (Table III). Out of these 3, two (Nos. 969 and N49) were twins. None from the group came in heat during January, February, March, May and June. The number that was observed in heat during April, July and August was 2, 2, and 3 respectively.

Ewe. No. 846 was in heat on April 14, for the first time and on July 16 and August 2 for the second and third times respectively.

Ewe No. 969 one of the twins, came in heat for the first time on April 9 and on July 6 and 22 for the second and third times respectively. Fourth heat in this ewe was observed on August 8 when she was bred.

The last of this group was ewe No. N49 which came in heat on August 10 for the first time when she was also bred. These three ewes were removed from the flock on August 13. It may be noted how different was the behaviour of twin born ewes (No. 969 and N49) maintained under identical environmental conditions.

Hampshire Ewes.

The number of ewes in this group was 7. Out of these, ewe No. 815 died on May 8 and No. 802 was slaughtered on February 22. Neither of the two was observed in heat. From the remaining 5, ewe No. 819 was removed from the flock on May 12 and brought back again on July 21. Another ewe No. 834 born on March 3, 1950 had still birth and was put in the flock on May 12 (Table IV). However none of the ewes under observation, came in heat during January, February, March, May and June. The number of ewes found in heat during April, July and August was 1, 1 and 5 respectively.

Ewe No. 832 was the first to come in heat on April 29. For the second time she was in heat on August 6.

First heat shown by ewe No. 816 was on July 24 and second on August 8.

Ewes No. 819, 823 and 834 were in heat on August 7, 3 and 4 respectively for the first time. The only ewe of this group that did not show heat up to August 13 was No. 831. With the exception of this, all others were removed from the flock on August 13. The remaining ewe of this group (No. 831) was observed up to August 31 and was not found in heat till then.

Oxford Ewes.

Five ewes were available in this group to start with. Out of these, ewe No. 856 died on May 22 (Table V) without coming in heat till death. From the remaining 4, no one was observed in heat during January, February, May, June and July. The number of ewes that came in heat in March, April and August was 2, 1 and 1 respectively.

Ewe No. 857 was in heat for the first time on March 2 but after that she was not found in heat till August 31.

Ewe No. 867 was in heat on March 4 for the first time, on April 9 for the second time. For the third time, she was in heat on August 8 and was removed from the flock on August 13.

Out of the remaining three ewes (Nos. 854, 857 and 859), that were observed up to August 31, not one was found in heat till then. The ewes of this group that did not show even one heat during the entire period of observation were Nos. 854 and 859.

Ramb. x Dorset Horned Ewes.

The number of ewes (8) in this group remained constant throughout the period of observation. None came in heat during January, March and April.

The number that came in heat during February, May, June, July and August was 1, 1, 2, 5 and 4 respectively (Table VI).

Ewe No. 346 was the first of her group that came in heat on February 25. The second heat observed in this ewe was on June 27 when she was bred but she did not settle and was found in heat on July 14 and 31 for the third and fourth times.

The second earliest heat from the group was shown by ewe No. 986 on May 26 when she was also bred. Since then, she did not repeat and was therefore, assumed to have been settled.

In addition to ewe No. 346 mentioned above, ewe No. 349 was second to come in heat on June 9 for the first time and was likewise bred. She too, did not come in heat after that and was therefore taken as settled.

Ewe No. 345 came in first heat on July 17 and again on August 4 for the second time. Similarly first heat in ewe No. 347 was observed on July 30.

First heat in ewes No. 364 and 368 was found on July 4 and 2 respectively but neither of the two was seen in heat again till August 31.

Ewe No. 344 was the last to come in heat on August 4 for the first time.

With the exception of ewes No. 364 and 368, all others were in heat by August 13. From this date (August 13) onwards, ewes No. 364 and 368 were observed till August 31 and all the rest were removed from the flock.

Shropshire Ewes.

The number of ewes in this group was 16 at the onset. Out of these, ewes Nos. 914, 917, and 937 died on July 22, July 2 and June 21 respectively. From the remaining 13, ewe No. 908 and 936 were sold on August 8

(Table VII). None of these 5 ewes had been observed in heat by the time of death or sale respectively. Out of the rest 11 ewes, no one came in heat during January, February, March, May, June and July.

Ewe No. 929 was observed in heat on April 13 for the first time. Up to August 31 she was not observed in heat for the second time.

Ewes Nos. 905, 923, 911 & 951 were found in heat for the first time on August 19, 17, 17, and 16 reapectively. None of these ewes were seen in heat again up to August 31. The ewes that did not come in heat even once till August 31 were Nos. 902, 912, 919, 931, 940 and 952.

Southdown Ewes.

This group consisted of 7 ewes to start with. Out of these, ewe No. 963 was removed on April 8 without showing any heat till this date (Table VIII). Out of the remaining 6 of the group, none came in heat up to July 31.

The first heat in this group, was shown by ewe No. 970 on August 23 with ewe No. 971 following on August 30. It is worth-while to state, that these two ewes (No. 970 and 971) were separated from the rest of the flock, in the end of June and fed on concentrates and hay in order to be ready for the show. The remaining 4 ewes of this group were on pasture alone along with the rest of the flock and did not come in heat during the entire period of observation even once.

Suffolk Ewes.

Only one ewe of this group was available to start with. On July 21, two more yearling ewes of this breed were available and were consequently added to the flock (Table IX). Up to July 31, none of the 3 was observed in heat.

On August 19, ewe No. 932 was observed in heat while 891 and 893 did not come in oestrus till August 31.

DURATION OF OESTRUS

The flock was checked once every day up to August 12, when twice a day checking was decided with the idea, that some ewes might have been in heat that passed u noticed on account of exceptionally short duration. So in addition to the morning, evening checking was also started from that date.

Duration of oestrus was calculated from the time, when a ewe was first observed in heat to the time when she was first found to be out of heat at the checking time. A ewe was considered in heat when she stood to mounting by the ram, and out of heat when the ram was not allowed to mount. Calculated this way, the duration of heat that exceeded 24 or 48 hours has been shown with + sign, and in case of less than 24 with - sign up to August 11. From August 12 onwards, it was possible to split the -24 hour's duration into -12 and +12 hours. & likewise the +24 hour's duration into -36 and +36 hours.

Out of the observed oestrus periods between August 12 and 31, the writer did not find any individual with -12 and +48 hour's duration. It may be noted, that the data recorded in connection with the duration of oestrus, does not furnish the required accuracy. It is possible, that a ewe found to be in heat at 8 A.M. on a certain day, might have been in heat from the last 23 hours. On the other hand, it is equally possible, that a ewe might have been in heat just a short while before the checking time. A similar discrepancy, might have been operating regarding the end of oestrus. As such, in the analysis of this data it was assumed, that the onset as well as end of oestrus was according to the checking times.

Duration of Oestrus in the Different Breed Groups

In all, 38 oestrual periods were observed among the different breed groups (Dorset Horned 8, Hampshire 7, Oxford 4, Ramb. x Dorset Horned 12, Shropshire 5, Southdown 1 and Suffolk 1) which ranged from ⁄12 to ⁄48 hours in duration. Out of these, 9 or 23.68% were found to be of -24, 26 or 68.42% of ⁄24 and 3 or 7.89% of ⁄48 hour's duration (Table X).

From the 9 oestrual periods of -24 hour's duration, 3 were observed in the Shropshire, 2 and 2 among the Dorset Horned and Hampshire and 1 and 1 among the Oxford and Ramb. x Dorset Horned groups respectively. It may be noted that the largest number of -24 hours duration occurred in the Shropshire ewes.

On the other hand, out of the 3 periods of ⁄48 hours length, 2 were seen among the Hampshire ewes and one among the Ramb. x Dorset Horned ewes.

Further analysis of the data revealed that even the individual ewes were not consistent regarding the duration of heat at different times. Ewe No. 816 of the Hampshire group (Table IV) had ⁄24 hours duration on the first oestrus in July and ⁄48 hours on the second in August. Similarly ewe No. 832 of this group had ⁄24 hour's duration on the first oesturs in April and -24 hour's duration on the second in August.

The only oestrus of ⁄48 hours duration in the Ramb. x Dorset Horned group was seen in ewe No. 346 (Table VI) on the first oestrus in February. During the remaining three oestrual periods seen in this ewe, the duration was ⁄24 hours in each case.

Likewise, two ewes No. 846 and 969 of the Dorset Horned group (Table III) had -24 hours duration in April when heat was observed in them for the first time. Later in July and August, 2 oestrual periods were observed in

ewe No. 846 and 3 in ewe No. 969 which were of /24 hour's duration.

The duration of oestrual periods, most frequently met with among all the groups and individual ewes, was /24 hours with the exception of the Shropshire group, in which only 2 out of 5 such periods were of /24 hours. The fact that only one heat period was observed in each ewe of the Shropshire group might not have given the true picture especially when inconsistency in the individual ewes occurring so frequently was taken into consideration.

Only 3 oestrual periods of / 24 hours duration, were observed after August 12, which could be splitted into -36 and /36 hours. One cut of these 3, was of -36 hours duration seen in Shropshire ewe No. 911 and the other two were of /36 hours duration, one in Southdown ewe No. 970 and the other in Suffolk ewe No. 892 (Table VII, VIII and IX). However, it seemed reasonable to conclude that, the duration of oestrus in these ewes was /24 in the great majority of cases irrespective of individual as well as breed differences.

DIOESTRUS PERIOD

Dioestrus period may be defined as a period of sexual quiescence between heat periods.

Length of the dioestrus period was counted from the day when a ewe did not allow the ram to mount immediately after oestrus to the day when she stood for mounting again, both days exclusive. A total of 13 such periods was observed which ranged from 118 to 12 days (Table XI).

Dorset Horned ewes No. 846 and 869 were observed in heat for the first time on April 14 and 9 respectively. For the second time, these ewes were found in heat on July 16 and 6 after a long period of sexual inactivity of 91 and 86 days respectively. Third heat in these ewes was observed on August 2 and July 22 after a dioestrus period of 14 and 13 days in each case. Ewe No. 969 was again found in heat on August 8 after 14 days interval. It was thus evident that ewes of this breed, underwent a period of sexual rest after showing only one oestrus in April to about the end of first week of July, when they started coming in heat regularly (Table III).

Hampshire ewes No. 816 and 832 were found in heat for the first time on July 24 and April 29 respectively. For the second time, ewe No. 816 was found in heat on August 8, after a dioestrus period of 12 days. On the other hand ewe No. 832, went through a period of long rest of 96 days and was in heat for the second time on August 6. Out of the remaining 4 ewes of this group, 3 came in heat in August for the first time. As all of these ewes were removed from the flock on August 13, it was therefore, not possible to note their future sexual behaviour. (Table IV).

Two dioestrus periods observed in the Oxford group were in ewe No. 867. She was first observed in heat on March 4 and again on April 9 after

33 days. For the third time, she was found in heat on August 8, after observing one of the longest periods of sexual inactivity of 118 days (Table V).

Four dioestrus periods observed in the Ramb. Dorset Horned group, were in 2 ewes No. 345 and 346. First oestrus in ewe No. 345 was seen on July 17 and second on August 4 after a dioestrus period of 15 days. Ewe No. 346 was the first to come in heat on February 25 and again on June 27 after a dioestrus period of 118 days, the second longest duration. Third and fourth heats in this ewe were found on July 14 and 31 respectively, with a dioestrus period of 14 days in each case. Like Dorset Horned ewes , this group too (Ramb. x Dorset Horned), went through a period of sexual inactivity up to about the end of May (Table VI).

Leaving the long periods of sexual inactivity aside, the longest and shortest durations observed were 15 and 12 days respectively. Out of the 7 such periods, the duration was 15 days in one case, 14 days in 4 and 13 and 12 in one case each respectively with a mean of 13.71 and standard deviation of $\pm$0.7 days.

Within the breed groups, the duration was 14 days in 2 cases and 13 days in 1 case in the Dorset Horned group, 12 days in the Hampshire and 15 days in 1 and 14 days in 2 cases in the Ramb. x Dorset Horned group. Thus the longest duration was observed in the Ramb. x Dorset Horned group and shortest in the Hampshire group.

OESTRUS CYCLE

Oestrus cycle may be defined as the interval between the onset of the preceding and succeeding oestrus. This was counted from the day a ewe was observed in heat to the day when she was again found in heat, including the former and excluding the latter.

Out of a total of 13 such cycles observed, the duration ranged from 122 to 15 days (Table XII). In seasonally polyoestrus females as ewes, an unusual cycle length of 122, 99, 93 and 88 days is an indication of sexual quiescence during that period. Leaving such durations aside the interval was 18 to 15 days. The two extremes of interval were observed in the Ramb. x Dorset Horned ewe No. 345 and Hampshire ewe No. 816 respectively. A majority of the oestrual cycles, a total of 4 out of 7, were of 17 days duration with a mean of 16.71 and standard deviation of ±0.7 days.

In case of the Oxford ewe No. 867, the interval between the first and second oestrus cycle was 36 days. This showed that this ewe missed one cycle which falls within the mean cycle length. It is equally possible that she might have exhibited an exceptionally short oestrual period this time that passed unnoticed in once a day checking that was being followed at that time.

ONSET OF THE BREEDING SEASON

The number of ewes of each breed group that was observed and the percentages that came in heat every month from the different groups have been shown in Table II and Figure 3. Breeding season in sheep, is the period when majority of the ewes accept the males, and in case they are not mated, or those who do not settle after mating, keep on coming in heat throughout that period with a reasonable regularity. However, variations in oestrual cycle length, as early or late oestrus or missing of one heat etc. are met with even in the regular breeding season. Such variations are due to hereditary, breed and environmental differences, some of which are difficult to control and evaluate. The data given in Table II and from Tables III to IX are being interpreted in this light in the discussion that follows.

The Dorset Horned ewes underwent a period of sexual quiescence from January up to the end of March. In April, 2 out of a total of 3 observed or 66.66% were found in heat. Both these ewes after showing only one oestrus each, again observed a period of sexual rest up to the end of June. In July, the same two ewes (No. 969 and 846) came in heat and from then onwards, both kept on coming in heat after a dioestrus period of 13 to 14 days up to August 13. The remaining ewe of the group (No. N49), was also found in heat in August, thus giving a percentage of 66.66 and 100.00 in July and August respectively. It was therefore, concluded that the breeding season in the Dorset Horned ewes started in the first week of July, and by the first week of August, all of them were in heat.

The Hampshire ewes similarly went through a period of sexual inactivity, from January through March. In April, 1 (No. 832) out of the 6 or

16.66% of the total was found in heat. During May and June, none was found in heat but in July, 1 (No. 816) out of the 5 or 20% of the ewes observed, was found in heat. In August, 6 ewes of this group were observed of which 5 or 83.33% were found in heat. Ewe No. 816 which was found in heat on July 24 was one of the 5 ewes that came in heat in August, after a dioestrus period of 12 days. None of the ewes, that were in heat during August, could be observed for the second oestrus on account of their removal from the flock on August 13. In view of the fact, that 5 out of the 6 observed came in heat during August and the one found in heat during July repeated after a normal dioestrus period, it was inferred that the breeding season in this group began, between the last week of July and the first week of August. Comparing this group with the Dorset Horned, the onset of the breeding season was delayed for about 3 weeks.

The 5 ewes of Oxford group remained sexually quiescent during January and February. In March, 2 of them (No. 857 and 867) or 40% of the total were found in heat. In April, ewe No. 867 was again found in heat after a dioestrus period of 33 days. During May, June and July, none was observed in heat but in August, 1 (No. 867) out of a total of 4 or 25.0% was seen in heat, after a dioestrus period of 118 days. This ewe was removed from the flock on August 13, and as such, it was not possible to observe her future sexual behaviour. The rest 3 of the group were observed till August 31, but none was found in heat. In view of the absence of further observations on the only ewe that came in heat in August, and the sexually quiet behaviour of the rest, the only conclusion that could be drawn was, that the breeding season in this breed did not set in until the end of August.

Out of the 8 ewes of Ramb. x Dorset Horned group, none came in heat during January. In February, 1 (No. 346) or 12.5% of the total was found in heat. In March and April, no heat was observed in this group but in May, again 1 (No. 986) or 12.5% of the total was found in heat. This ewe was bred. In June, 2 out of the remaining 7 (No. 346 and 349), or a total of 28.57% was found in heat. Both these ewes were also bred but ewe No. 346 did not settle and started coming in heat regularly thereafter, observing a dioestrus period of 14 days each time.

In July, out of a total of 6 ewes observed, 5 or 83.33% were found in heat. On August 13, 6 ewes of this group were removed from the flock which consisted of 2 ewes that had settled and 4 that came in heat during August. The remaining 2 ewes (No. 364 and 368) were observed till August 31, but they did not come in heat till then. Thus out of a total of 6 ewes observed during August, 4 or 66.66% were found in heat. Leaving the 2 ewes that were bred and settled during the end of May and beginning of June, the first oestrus that was followed by the regularly recurring heat periods in that very ewe and in majority of the rest was observed on June 27. Based upon the evidence of these data, the breeding season in this group started between the last week of June and first week of July, falling in line with the Dorset Horned ewes and about a month earlier than the Hampshire group. The Shropshire ewes remained sexually inactive from January through March. In April, 1 (No. 929) out of the 16 ewes or a total of 6.25% was found in heat. This ewe was not found in heat again up to August 31. From May through July, the group was again sexually silent. Four of the 11 ewes observed or a total of 36.36% were found in heat on August 16, 17, 17 and 19. None of these ewes was found in heat up to August 31, which was

natural with a mean dioestrus period of 13.71 days observed in the entire flock. The data so compiled showed, that the breeding season in this group, started after the middle of August, a month and a half later than the Dorset Horned and Ramb. x Dorset Horned groups and about two weeks later than the Hampshire group.

The group of Southdown ewes was one of the two that observed the longest period of sexual quiescence from January through July. Two ewes (No. 970 and 971) out of the 6 observed in August, or a total of 33.33% was found in heat in the last week. The rest 4 did not come in heat up to the end of this month. As already mentioned, these 2 ewes were being fed on concentrates and hay from the end of June as compared with the remaining 4 which were on pasture. As such, these two ewes were in a much better bodily condition than the others. Better feeding might possibly have been the cause of early heat in them alone. However, assuming that the other ewes of this group would have been found in heat after a reasonable interval in case observations had continued after August 31, the breeding season in that case started in the last week of August, about 7 weeks later than the Dorset Horned and Ramb. x Dorset Horned groups, 3 weeks later than the Hampshire and one week later than the Shropshire group.

In the Suffolk group only one ewe was under observation till July 21, when 2 more were available. Up to July 31, no oestrus was recorded in this group which constituted the other longest period of sexual inactivity in the second group.

In August, 1 out of the 3 ewes, or a total of 33.33% was found in heat. The other 2 remained sexually quiet till August 31. With such a meager data at hand no definite conclusion could be drawn regarding the on-

set of the breeding season in this group. However, assuming that from August 31 onwards, the group would start coming in heat regularly, the breeding season in that case started 7 weeks later than the Dorset Horned and Ramb. x Dorset Horned groups, 3 weeks after the Hampshire and one week after the Shropshire group.

TABLE II

NUMBER AND PERCENTAGE OF EWES IN HEAT

Breed	Jan.			Feb.			Mar.			April			May			June			July			August		
	No. Observed	No. in Heat	% in Heat	No. Observed	No. in Heat	% in Heat	No. Observed	No. in Heat	% in Heat	No. Observed	No. in Heat	% in Heat	No. Observed	No. in Heat	% in Heat	No. Observed	No. in Heat	% in Heat	No. Observed	No. in Heat	% in Heat	No. Observed	No. in Heat	% in Heat
Dorset Horned	3	-	-	3	-	-	3	-	-	3	2	66.66	3	-	-	3	-	-	3	2	66.66	3	3	100.00
Hampshire	7	-	-	7	-	-	6	-	-	6	1	16.66	5	-	-	5	-	-	5	1	20.00	6	5	83.33
Oxford	5	-	-	5	-	-	5	2	40.00	5	1	20.00	5	-	-	4	-	-	4	-	-	4	1	25.00
Rambouillet x Dorset Horned	8	-	-	8	1	12.5	8	-	-	8	-	-	8	1	12.5	7	2	28.57	6	5	83.33	6	4	66.66
Shropshire	16	-	-	16	-	-	16	-	-	16	1	6.25	16	-	-	16	-	-	14	-	-	11	4	36.36
Southdown	7	-	-	7	-	-	7	-	-	6	-	-	6	-	-	6	-	-	6	-	-	6	2	33.33
Suffolk	1	-	-	1	-	-	1	-	-	1	-	-	1	-	-	1	-	-	1	-	-	3	1	33.33

TABLE III

OCCURRENCE OF OESTRUS IN DORSET HORNED EWES FROM JANUARY 15 TO AUGUST 31.

Serial No.	Ewe No.	April				July				August				Total Oestrual Periods
		Onset (date)	End (date	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	
1	846	14	15	-24	-	16	18	∤24	91	2	4	∤24	14	3
2	N49	-	-	-	-	-	-	-	-	10	12	∤24	-	1
3	969	9	10	-24	-	6 22	8 24	∤24 ∤24	86 13	8	10	∤24	14	4

TABLE IV

OCCURRENCE OF OESTRUS IN HAMPSHIRE EWES FROM JANUARY 15 TO AUGUST 31.

Serial No.	Ewe No.	April				July				August				Total Oestrual Periods	
		Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)		
1	802	-	-	-	-	-	-	-	-	-	-	-	-	-	Slaughtered February 22
2	815	-	-	-	-	-	-	-	-	-	-	-	-	-	Died May 8
3	816	-	-	-	-	24	26	∠24	-	8	11	∠48	12	2	
4	819	-	-	-	-	-	-	-	-	7	10	∠48	-	1	Removed 5/12. Replaced 7/21
5	823	-	-	-	-	-	-	-	-	3	5	∠24	-	1	
6	831	-	-	-	-	-	-	-	-	-	-	-	-	-	
7	832	29	5/1	∠24	-	-	-	-	-	6	7	-24	96	2	
8	834	-	-	-	-	-	-	-	-	4	5	-24	-	1	Placed May 12

TABLE V

OCCURRENCE OF OESTRUS IN OXFORD EWES FROM JANUARY 15 TO AUGUST 31.

Serial No.	Ewe No.	March				April				August				Total Oestrual Periods	
		Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)		
1	854	-	-	-	-	-	-	-	-	-	-	-	-	-	
2	856	-	-	-	-	-	-	-	-	-	-	-	-	-	Died May 22
3	857	2	4	∠24	-	-	-	-	-	-	-	-	-	1	
4	859	-	-	-	-	-	-	-	-	-	-	-	-	-	
5	867	4	6	∠24	-	9	11	∠24	33	8	9	-24	118	3	

TABLE VI

OCCURRENCE OF OESTRUS IN RAMBOUILLET X DORSET HORNED EWES FROM JANUARY 15 TO AUGUST 31.

Serial No.	Ewe No.	February				May				June				July				August				Total Oestrual Periods
		Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	
1	344	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	-24	-	1
2	345	-	-	-	-	-	-	-	-	-	-	-	-	17	19	∠24	-	4	6	∠24	15	2
3	346	25	28	∠48	-	-	-	-	-	27	29	∠24	118	14 31	16 8/2	∠24 ∠24	14 14	-	-	-	-	4
4	347	-	-	-	-	-	-	-	-	-	-	-	-	30	8/1	∠24	-	-	-	-	-	1
5	349	-	-	-	-	-	-	-	-	9	11	∠24	-	-	-	-		-	-	-	-	1 bred
6	364	-	-	-	-	-	-	-	-	-	-	-	-	4	6	∠24	-	-	-	-	-	1
7	368	-	-	-	-	-	-	-	-	-	-	-	-	2	4	∠24	-	-	-	-	-	1
8	986	-	-	-	-	26	28	∠24	-	-	-	-		-	-	-	-	-	-	-	-	1 bred

TABLE VII

OCCURRENCE OF OESTRUS IN SHROPSHIRE EWES FROM JANUARY 15 TO AUGUST 31

Serial No.	Ewe No.	April				August				Total Oestrual Periods	
		Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)			
1	902	-	-	-	-	-	-	-	-	-	
2	905	-	-	-	-	19	20	∠12	-	1	
3	908	-	-	-	-	-	-	-	-	-	Sold Aug. 8
4	911	-	-	-	-	17	19	-36	-	1	
5	912	-	-	-	-	-	-	-	-	-	
6	914	-	-	-	-	-	-	-	-	-	Died July 22
7	917	-	-	-	-	-	-	-	-	-	Died July 2
8	919	-	-	-	-	-	-	-	-	-	
9	923	-	-	-	-	17	18	∠12	-	1	
10	929	13	15	∠24	-	-	-	-	-	1	
11	931	-	-	-	-	-	-	-	-	-	
12	936	-	-	-	-	-	-	-	-	-	Sold Aug. 8
13	937	-	-	-	-	-	-	-	-	-	Died June 21
14	940	-	-	-	-	-	-	-	-	-	
15	951	-	-	-	-	16	17	∠12	-	1	
16	952	-	-	-	-	-	-	-	-	-	

TABLE VIII

OCCURRENCE OF OESTRUS IN SOUTHDOWN EWES FROM JANUARY 15 TO AUGUST 31.

Serial No.	Ewe No.	January				August				Total Oestrual Periods	
		Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)	Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)		
1	963	-	-	-	-	-	-	-	-	-	Removed April 8
2	970	-	-	-	-	23	25	36	-	1	
3	971	-	-	-	-	30	-	-	-	1	Removed Aug. 30
4	972	-	-	-	-	-	-	-	-	-	
5	978	-	-	-	-	-	-	-	-	-	
6	981	-	-	-	-	-	-	-	-	-	
7	984	-	-	-	-	-	-	-	-	-	

TABLE IX

OCCURRENCE OF OESTRUS IN SUFFOLK EWES FROM JANUARY 15 TO AUGUST 31.

Serial No.	Ewe No.	August				Total Oestrual Periods	
		Onset (date)	End (date)	Duration (hours)	Dioestrus Period (days)		
1	891	-	-	-	-	-	Placed July 21
2	892	19	21	∠36	-	1	Placed July 21
3	893	-	-	-	-	-	

TABLE X

OBSERVED DURATION OF OESTRUS IN DIFFERENT BREEDS

Breed	Duration (hours)			Total
	12.....-24	24.....-48	48.....-72	
Dorset Horned	2	6	-	8
Hampshire	2	3	2	7
Oxford	1	3	-	4
Ramb. x Dorset Horned	1	10	1	12
Shropshire	3	2	-	5
Southdown	-	1	-	1
Suffolk	-	1	-	1

TABLE XI

DURATION OF DIOESTRUS PERIOD IN DIFFERENT BREEDS

Breed	Ewe No.	Interval (days)			Total
		Between 1st and 2nd. Oestrus	Between 2nd and 3rd. Oestrus	Between 3rd and 4th Oestrus	
Dorset Horned	846	91	14	-	2
Dorset Horned	969	86	13	14	3
Hampshire	816	12	-	-	1
Hampshire	832	96	-	-	1
Oxford	867	33	118	-	2
Ramb. x Dorset Horned	345	15	-	-	1
Ramb. x Dorset Horned	346	118	14	14	3

TABLE XII

DURATION OF OESTRUS CYCLE IN DIFFERENT BREEDS

Breed	Ewe No.	Onset of I Oestrus	Onset of II Oestrus	Interval (days)	Onset of II Oestrus	Onset of III Oestrus	Interval (days)	Onset of III Oestrus	Onset of IV Oestrus	Interval (days)	Total
Dorset Horned	846	4/14	7/16	93	7/16	8/2	17	-	-	-	2
Dorset Horned	969	4/9	7/6	88	7/6	7/22	16	7/22	8/8	17	3
Hampshire	816	7/24	8/8	15	-	-	-	-	-	-	1
Hampshire	832	4/29	8/6	99	-	-	-	-	-	-	1
Oxford	867	3/4	4/9	36	4/9	8/8	121	-	-	-	2
Ramb. x Dorset Horned	345	7/17	8/4	18	-	-	-	-	-	-	1
Ramb. x Dorset Horned	346	2/25	6/27	122	6/27	7/14	17	7/14	7/31	17	3

OESTRUS IN EWE LAMBS

Like other phases of sheep industry, occurrence of first oestrus with respect to age in ewe lambs have been studied by workers from time to time.

McKenzie and Phillips (1930), found that out of seven Hampshire ewe lambs born between February 7 and March 21, 1930, all had been in oestrus by October 19, 1930, at an av. age of 213 days (range 187 - 250 days). Out of another group of 13 Shropshires, eight came in heat by November 4, 1930. These were born in February and early March of the same year. The remaining five born on March 2, 10, 17 22 and 31 did not come in heat by November 4. He concluded that puberty in early ewe lambs is reached in the Fall months; later lambs may fail to come in oestrus until the following year.

Cole and Miller (1935) found that in eight ewe lambs the first oestrus was expressed at eight to 10 months age. They further stated that the first oestrus of the breeding season appeared later in ewe lambs than in mature ewes.

Roux (1936) found that first oestrus in Merino ewe lambs occurred when they were 16 to 20 months of age.

By January 15, 1951, when this experiment was started, the breeding season had already passed and it was therefore not possible to subject the ewe lambs to direct observations for this specific phase of study. The fact that ewes had never been bred at the College until about 1½ years of age, made it more difficult to obtain precise information as no data were available for the previous years. It was however, noticed in the breeding records that some ewe lambs of Hampshire, Oxford and Shropshire breeds lambed in 1948 and 1951 lambing seasons. These ewe lambs were bred per

chance while on pasture by some rams who gained access somehow, inspite of the existing arrangements for keeping them separate. Lambing records of 22 such ewes were available regarding whom the data are presented in Table XIII. Breeding dates of these individuals were calculated from their respective lambing dates with an average gestation period of 147 days. Records of the dates of birth of these ewes were available which enabled calculation of the breeding ages respectively. It is probable as well that some of these ewes might have been in heat on one or more occasions before they were bred. However, the data falls in close comparison with the findings of other workers refered to above.

In this case, the average age of the onset of oestrus in Hampshire group was 257 days ranging between 235 to 268 days. In Oxford group, 255 days was the average age and ranged between 240 to 272 days. Lastly in Shropshire ewe lambs, the observed range was from 231 to 297 with an average of 257 days. Considering the three groups together, the average age was 256 days ranging between 231 and 297 days.

Comparison between ages at the breeding time among Hampshire ewe lambs in this case and at first oestrus of those reported by McKenzie and Phillips in 1930 showed that the oestrus appeared 44 days later in the ewe lambs at this station. In the absence of direct observations it appears safe to assume that this delay might have been due to the absence of observations rather than climatic, nutritional or strain differences. On the other hand average age of oestrus among all groups observed here was almost the same, 257, 255 and 257 days in Hampshire, Oxford and Shropshire breeds respectively.

It may thus be concluded that ewe lambs of the above three breeds can be bred at an average age of 255 days.

TABLE XIII

AGE OF EWE LAMBS AT THE BREEDING TIME

Serial No	Ewe No.	Breed	Date of Birth	Date of Breeding (Calculated)	Date of Lambing	Age at Breeding No./days
1	303	Hampshire	Mar. 9/47	Dec. 1/47	Apr. 26/48	8/21
2	311	"	Mar. 15/47	Dec. 2/47	Apr. 27/48	8/17
3	313	"	Mar. 16/47	Nov. 25/47	Apr. 20/48	8/9
4	322	"	Mar. 29/47	Dec. 22/47	May. 17/48	8/23
5	809	"	Feb. 23/50	Nov. 18/50	Apr. 13/51	8/26
6	810	"	Feb. 24/50	Nov. 21/50	Apr. 16/51	8/28
7	834	"	Mar. 19/50	Nov. 13/50	Apr. 8/51	7/25
8	354	Oxford	Mar. 29/47	Dec. 30/47	May. 26/48	9/2
9	362	"	Apr. 3/47	Dec. 3/47	Apr. 28/48	8/0
10	372	"	Apr. 12/47	Dec. 26/47	May. 21/48	8/14
11	861	"	Mar. 9/50	Nov. 30/50	Apr. 25/51	8/21
12	862	"	Mar. 9/50	Nov. 15/50	Apr. 10/51	8/6
13	202	Shropshire	Mar. 3/47	Dec. 4/47	Apr. 29/48	9/1
14	206	"	Mar. 8/47	Jan. 4/48	May. 30/48	9/27
15	215	"	Mar. 18/47	Nov. 28/47	Apr. 23/48	8/10
16	223	"	Mar. 3/47	Dec. 4/47	Apr. 29/48	9/1
17	232	"	Apr. 5/47	Nov. 26/47	Apr. 21/48	7/21
18	250	"	May. 3/47	Dec. 25/47	May. 20/48	7/22
19	903	"	Feb. 18/50	Nov. 10/50	Apr. 5/51	8/23
20	916	"	Mar. 9/50	Nov. 30/50	Apr. 25/51	8/22
21	924	"	Mar. 5/50	Nov. 11/50	Apr. 6/51	8/6
22	927	"	Mar. 7/50	Nov. 13/50	Apr. 8/51	8/6

SEXUAL BEHAVIOUR IN THE BREEDING SEASON

According to their sexual behaviours, females of different species of livestock have been classified as monooestrus, seasonally polyoestrus and polyoestrus.

Cows come in heat at usually regular intervals of about three weeks all the year round and are therefore classed as polyoestrus.

Mares and ewes, on the other hand come in heat after every three weeks and 16 to 18 days respectively in certain seasons of the year and are classed as seasonally polyoestrus.

Commencement of the breeding season is marked when a reasonably representative number of females of a certain species start coming in heat regularly. Similarly breeding season is said to have passed when majority of the females of that species quit coming in heat. In some species of animals as deer, the males also go through a period of sexual inactivity for some part of the year.

With the object of knowing the frequency with which ewes of the same, as well as different breeds mated in the different years at the Michigan State College, the data were obtained from the records of the College breeding flock from 1948 to 1951.

In seasonally polyoestrus females as sheep, the choice of early or late breeding lies with the flock owner. Consequently some breeders prefer breeding their flocks earlier than others. At this station the rams were turned in on September 20 in 1948 and 1949 and September 29 and October 2 in 1950. They were allowed to run with ewes till January 31 each year and separated thereafter as detailed in Table XIV.

TABLE XIV

DATES OF TURNING IN AND TAKING OUT OF RAMS

Breed	1948		1949		1950	
	In	Out	In	Out	In	Out
Hampshire	Sept. 20	Jan. 31	Sept. 20	Jan. 31	Oct. 2	Jan.31
Oxford	"	"	"	"	Sept.29	"
Shropshire	"	"	"	"	"	"
Southdown	"	"	"	"	"	"
Suffolk	"	"	"	"	"	"

Breeding dates of individual ewes were calculated from the lambing dates with a gestation period of 147 days in each case.

Obviously it was difficult to determine the precise dates for the onset of the breeding season in different breeds beyond the dates of turning in the rams. It was equally difficult to know for sure whether the late breeding ewes were habitual late breeders or not for the above reason. Partial or complete infertility of some rams in the early season might have been one of the most important factors, at-least in some ewes that bred late in those seasons. In order to eliminate this factor, further investigations regarding fertility of rams at the time they were turned in revealed, that Shropshire ram No. 575 (ROTTER) pruchased in Summer 1949 and used as ram lamb in the following Fall was not completely fertile for at least sometime in the beginning. Similarly another Shropshire ram 404 (CCC) was also infertile in the start of the breeding season of 1948. Likewise semen of Hampshire ram No. 4-50 (BUCKY) was of poor quality in 1950 breeding season.

Number and Percentages of Ewes Settled

The data were further arranged in Tables XV to XIX according to number and percentages of ewes of the same breed that settled in different months. Besides this, Figures 4 to 10 inclusive present graphs showing the percentage of ewes of the same as well as different breeds that settled in different months of the same as well as different breeding seasons.

A careful study of the tables as well as graphs revealed that out of Hampshire ewes, 34.78, 69.56 and 81.48 per cent settled in October 1950, 1949 and 1948 respectively. During 1950 breeding season, 52.17 per cent of the ewes, the peak figure were settled in November. Hampshire ram lamb No. 4-50 (SMOKY) used this year was only partially fertile in the early season and thus some out of 23 ewes in mating did not settle during October (Table XV).

The percentages of Oxford ewes that settled during October 1950, 1949 and 1948 was 73.33, 78.6 and 94.44 respectively. During 1950 and 1949, 13.33 and 14.28 per cent settled in September but none during 1948. This year 5.55 per cent settled in November (Table XVI). It seemed that either the breeding season started later in 1948 or the ewes that came in heat during September were in dioestrus periods between September 20 when the ram was turned in and October 8 when the first ewe of the group (No. 425) settled. With a dioestrus period of 15 days it was evident that ewe No. 425 alone might have been in heat just before the ram was turned in as all others fell beyond the normal dioestrus period. It therefore appeared reasonable to assume that onset of the breeding season was late in 1948. Nutritional and physical factors might have been responsible but to evalu-

ate these was impossible for practical purposes.

The Shropshire group also showed height of breeding activity during October when 78.05, 75.75 and 71.74 per cent of the ewes settled in 1950, 1949 and 1948 respectively. During 1950 and 1949, 4.88 and 15.15 per cent of the ewes settled in September but none in 1948. Absence of any settled in September was most probably due to ram No. 404 (CSC) who was partially infertile in the early season of 1948. As such late breeding in this case might have been due to infertility of the ram (Table XVII).

Likewise, height of conception rate among Southdown ewes also occurred in October reaching 70.4, 64,7 and 50.0 per cent in 1950, 1949 and 1948 respectively. It was rather interesting to note that in 1950 and 1949 none settled in September, December and January. In 1948 however, 25 per cent settled in September while 8.33 per cent in December and January each. Out of the three ewes that settled in September, two (No. 87-40 and 331) did not appear in the flock during the following years but the third (No. 63) that settled in January 1948 was settled in November and October during 1949 and 1950. Nutritional and other such causes seemed operating in this case and resulted in late breeding (Table XVIII).

Regarding Suffolk ewes, the data were available only for 1950 and 1949 breeding seasons. Moreover, the total number of ewes in the flock was only four each year. However, in 1950 all of them settled in October but in 1949, 75 per cent settled in September and 25 per cent in October. The four ewes that appeared in 1949 were purchased from outside and were already bred. Breeding records for 1950 revealed that these ewes settled from October 2 to 8. Probably these ewes might have been in heat during

September and would have settled in case the ram was available earlier (Table XIX).

From the above discussion it appeared that partial infertility of some rams, breed and individual variations among the ewes and finally nutritional and other such environmental differences were responsible for variations among the percentages of ewes settling in different months during the period under review. In spite of the above factors which were hard to evaluate and control, the percentage of settled ewes was low in September and highest in October, going down in November and December each year. January marked the close of breeding season every year when a very low percentage of ewes was found settled.

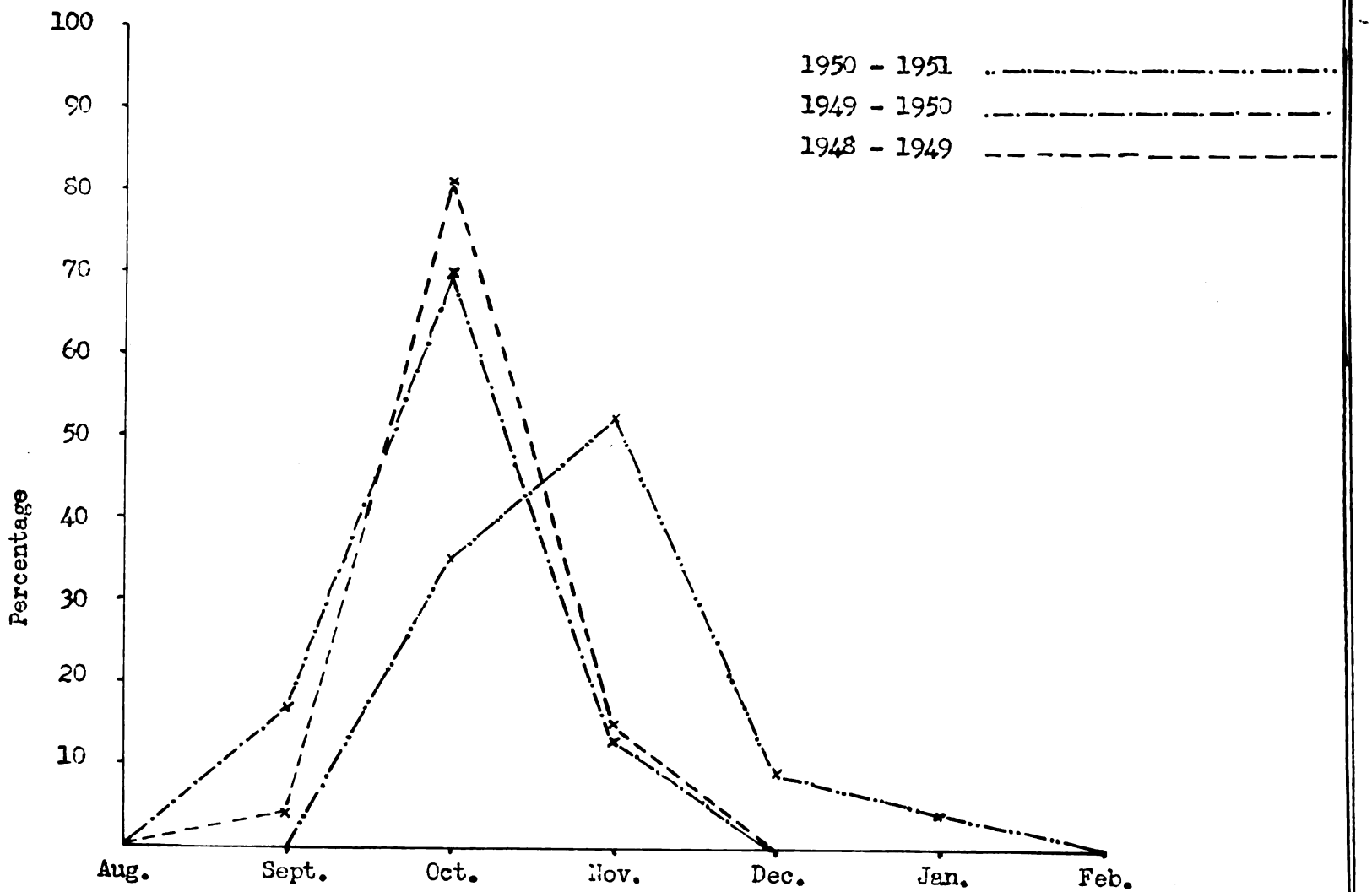

Figure 4 Average percentage of Hampshire ewes settled each month

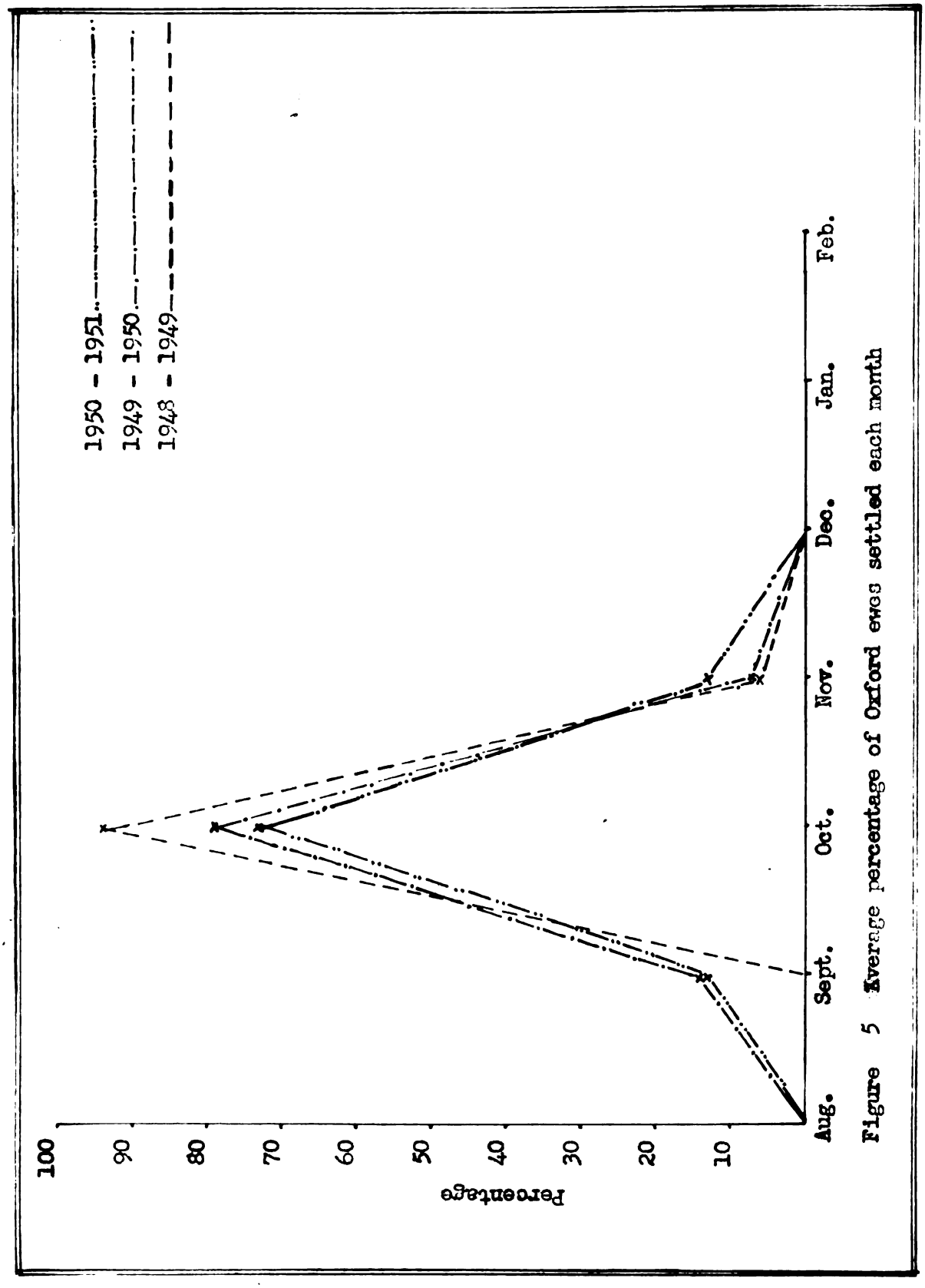

Figure 5 Average percentage of Oxford ewes settled each month

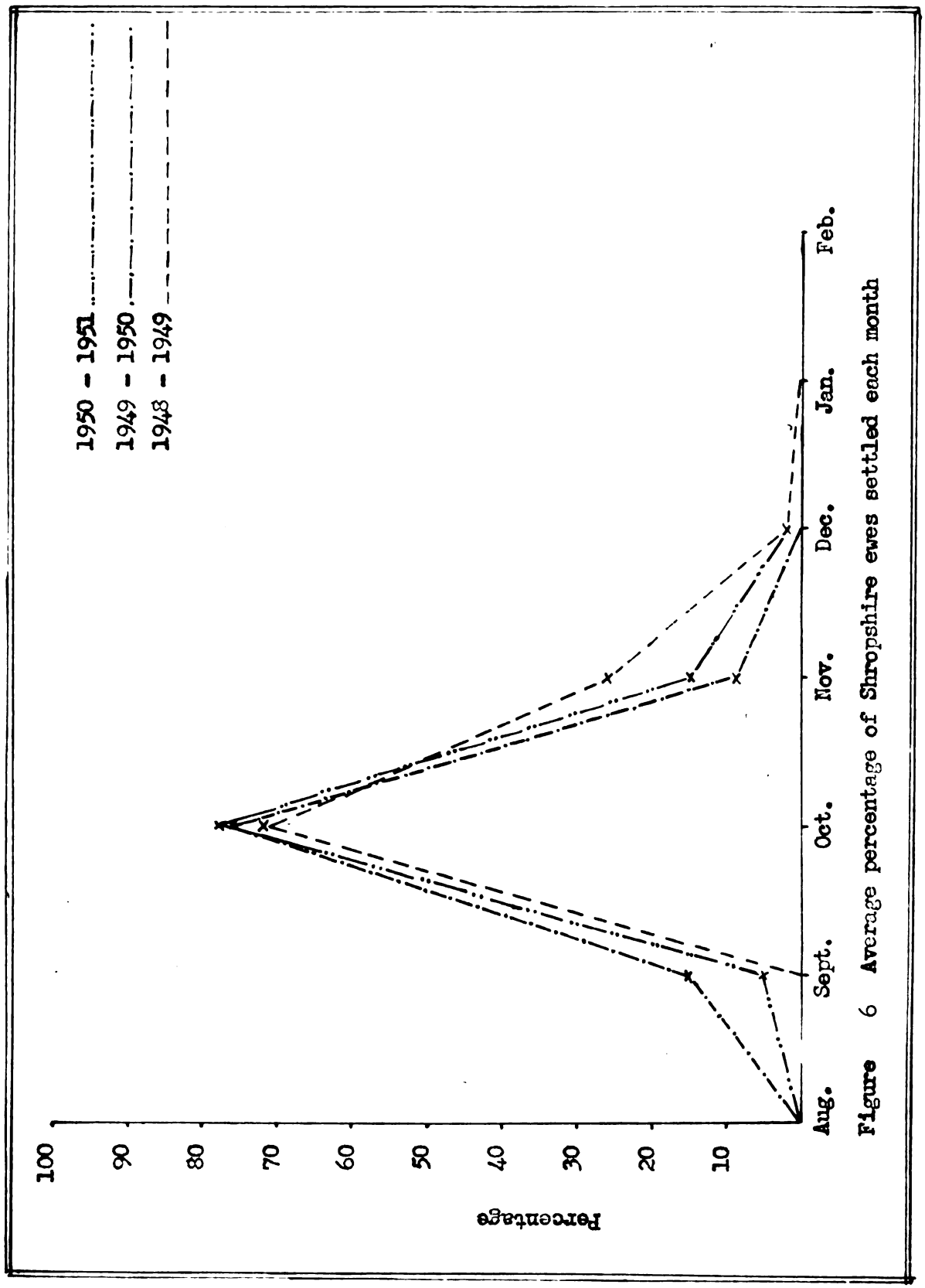

Figure 6 Average percentage of Shropshire ewes settled each month

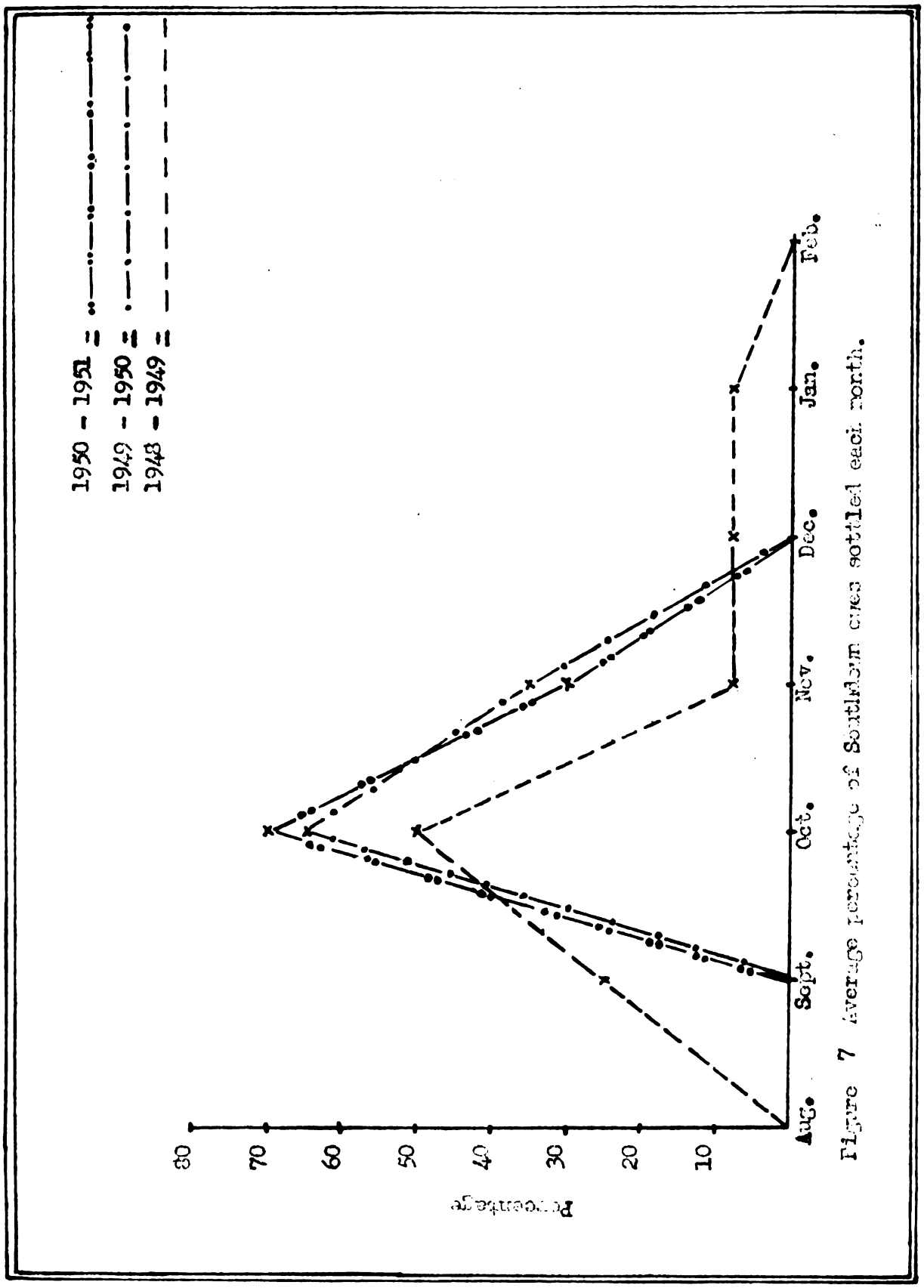

Figure 7 Average percentage of Southern Cree settled each month.

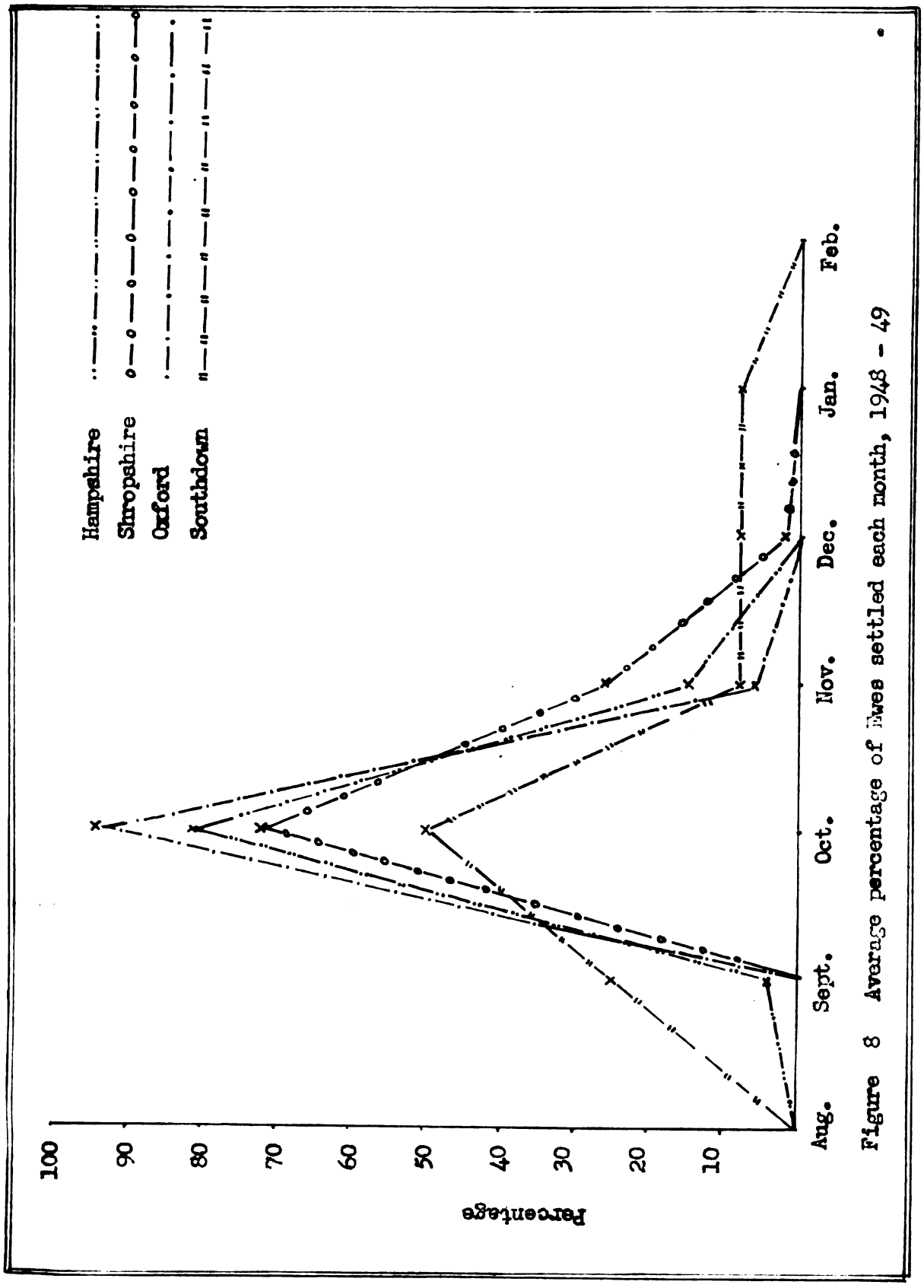

Figure 8 Average percentage of Ewes settled each month, 1948 - 49

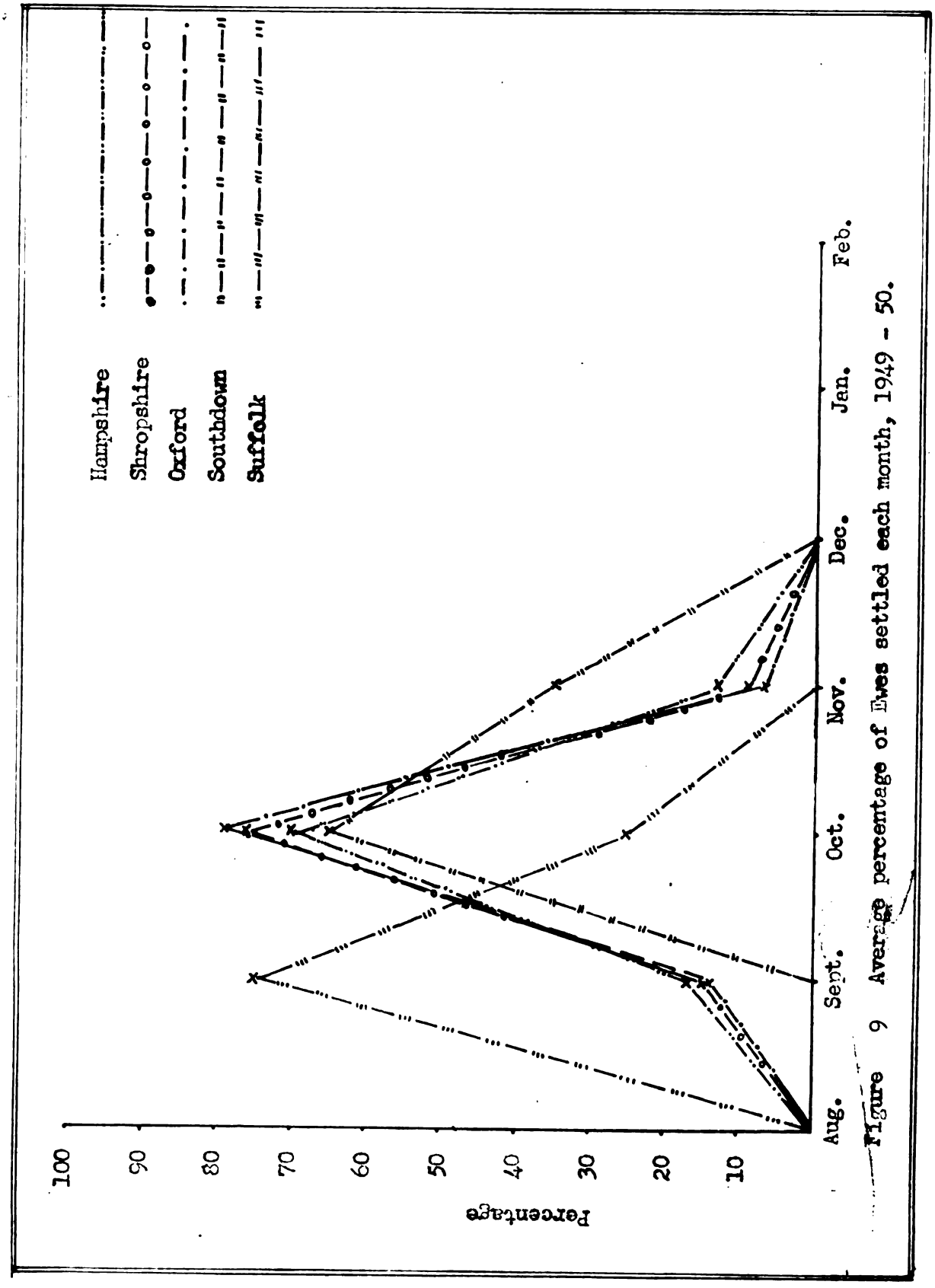

Figure 9 Average percentage of Ewes settled each month, 1949 - 50.

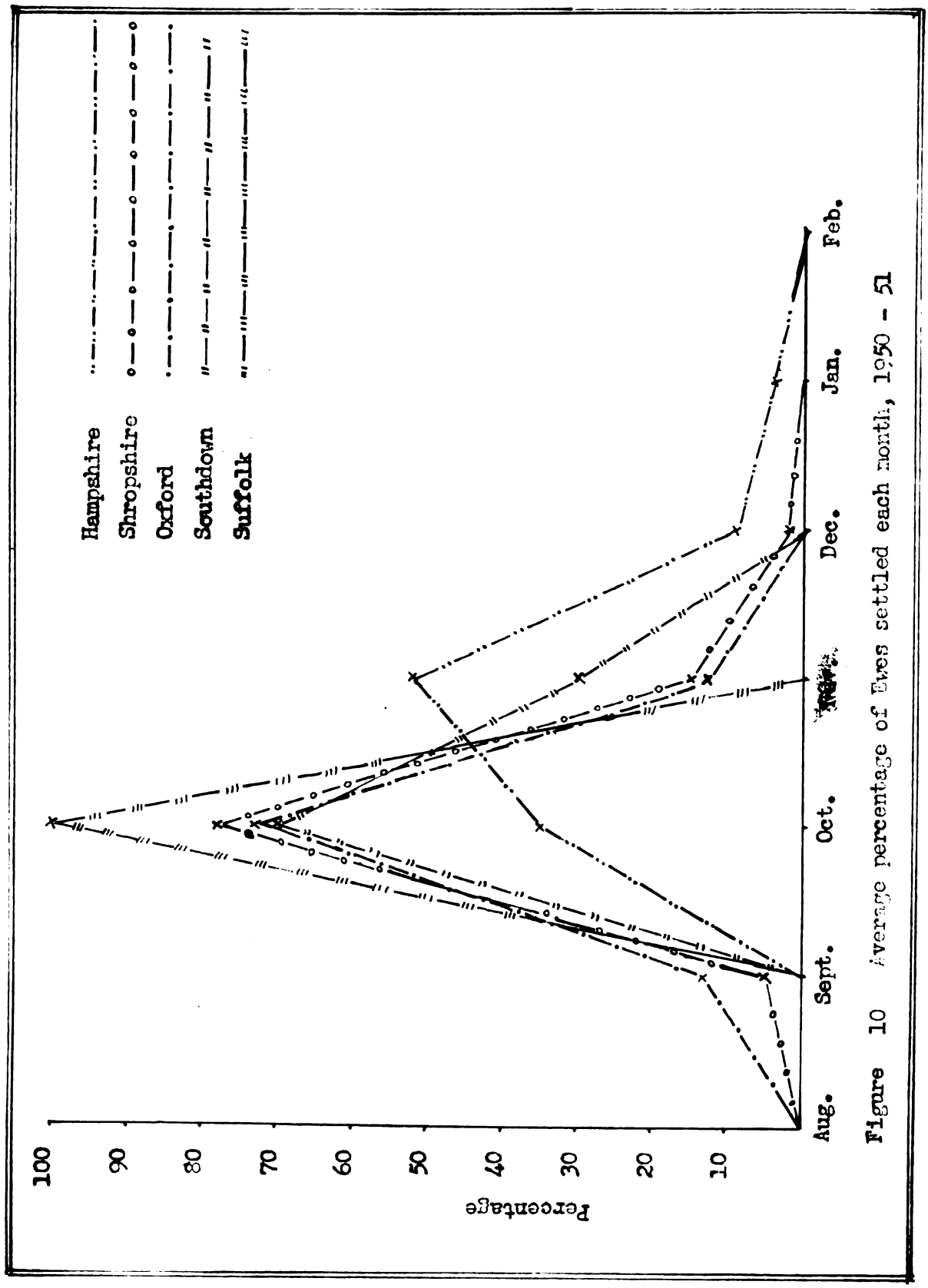

Figure 10 Average percentage of Ewes settled each month, 1950 - 51

TABLE XV

NUMBER AND PERCENTAGE OF HAMPSHIRE EWES SETTLED

Year	September		October		November		December		January		Total
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	
1950	-	-	8	34.78	12	52.17	2	8.7	1	4.35	23
1949	4	17.4	16	69.56	3	13.04	-	-	-	-	23
1948	1	3.7	22	81.48	4	14.81	-	-	-	-	27

TABLE XVI

NUMBER AND PERCENTAGE OF OXFORD EWES SETTLED

Year	September		October		November		December		January		Total
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	
1950	2	13.33	11	73.33	2	13.33	-	-	-	-	15
1949	2	14.28	11	78.6	1	7.14	-	-	-	-	14
1948	-	-	17	94.44	1	5.55	-	-	-	-	18

TABLE XVII

NUMBER AND PERCENTAGE OF SHROPSHIRE EWES SETTLED

Year	September		October		November		December		January		Total
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	
1950	2	4.88	32	78.05	6	14.63	1	2.44	-	-	41
1949	5	15.15	25	75.75	3	9.09	-	-	-	-	33
1948	-	-	33	71.74	12	26.08	1	2.17	-	-	46

TABLE XVIII

NUMBER AND PERCENTAGE OF SOUTHDOWN EWES SETTLED

Year	September		October		November		December		January		Total
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	
1950	-	-	19	70.4	8	29.6	-	-	-	-	27
1949	-	-	11	64.7	6	35.3	-	-	-	-	17
1948	3	25.0	6	50.0	1	8.33	1	8.33	1	8.33	12

TABLE XIX

NUMBER AND PERCENTAGE OF SUFFOLK EWES SETTLED

Year	September		October		November		December		January		Total
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	
1950	-	-	4	100.00	-	-	-	-	-	-	4
1949	3	75.0	1	25.0	-	-	-	-	-	-	4

DISCUSSION

Duration of Oestrus

In the entire flock of ewes under observation, 38 oestrual periods were observed up to August 31. In 9 such periods, the duration was found to be -24, while it was ⁄24 and ⁄48 hours in 26 and 3 out of the ramaining 29 periods. It was thus evident, that the duration of ⁄24 hours was most frequent in the whole flock.

In each breed group, the duration of ⁄24 hours was again more frequent except in the Shropshire group, in which, out of a total of 8 oestrual periods, 6 were of -24 hour's duration.

It may be noted that Table X shows only 3 oestrual periods of -24 hour's duration instead of 6. The writer continued observing the flock even after August 31, with the idea to collect if possible, some additional information that might help in a more efficient interpretation of the results. Out of the 6 periods of -24 hour's duration, 3 were observed in ewes No. 951, 919 and 902 between September 1 and 2. Ewe No. 951 on a previous heat on August 16 had also -24 hour's duration. It was thus evident that the duration of heat was shorter in the Shropshire ewes as compared with the rest.

Only 3 periods of ⁄48 hours were observed, 2 in the Hampshire and 1 in Ramb. x Dorset Horned ewes. The duration of ⁄48 was observed on one oestrus only in each case.

Similar work reported by McKenzie and Phillips (1930) showed that out of 247 oestrual periods, 74% were of 18 - 36 and 3% less than 9 or more than 48 hours in length. They further observed that the mean duration in the Hampshire, Shropshire and Southdown breeds was 30.7, 26.7 and 24.0

hours respectively, the Hampshire ewes therefore, had longer oestrus than the other two breeds.

Terril (1935) observed 884 heat periods that ranged from 5 - 72 hours in length. He found the mean duration of 30.7 in the Hampshire ewes as compared with 26 hours in the Shropshire and Southdown groups. In this case too, the duration of heat was longer in the Hampshire ewes.

McKenzie and Terril (1937) presented data on 1235 oestrual periods of Hampshire, Shropshire, Southdown, High Grade Rambouillet and Grade Hampshire and Shropshire ewes. The duration in this case ranged between 3 and 73 hours with a mean of 29.33. Periods of less than 24 hour's duration were met with in every group, 18.2% fell below 21 hours and 15.5% above 39. About 7.5% of the periods were less than 15 and 7% above 45 hours in duration. In the two groups of Southdown ewes, the mean duration was 23 and 26.4 hours and in 2 of the Shropshires, it was 24.2 and 28.2 hours respectively. In 3 groups of Hampshire ewes, the mean duration ranged from 28.6 to 31.3 hours. The longest mean duration was observed in Grade Hampshire x Shropshire ewes and shortest in the Grade Rambouillet ewes.

Kelly and Shaw (1939) reported, that out of 1 group of Dorset Horned and 2 of Merino ewes, the duration of oestrus was longer in the former than the latter. Moreover +24 hour's lengths were more common in the Dorset Horned ewes as compared with the Merinos, whose majority had -24 hour's length.

Comparing the results of the present investigation with that of other workers, 23.68% of the oestrual periods were of -24, 68.42% of +24 and 7.89% of +48 hour's length. As the durations of such periods were grouped by

every worker in a different way, it was therefore difficult to make a fair comparison. McKenzie and Phillips (1930) observed 74% of the periods between 18 - 36 hours in duration which was a close comparison with 68.42% grouped under ⁄24 hours in the present experiment. They had only 3% cases, in which the observed length was -9 or ⁄48 hours. In this case 7.89% fell in ⁄48 hour's duration, while no comparison was available for -9 hour's length.

Regarding the length of oestrus in different breeds, the above workers found that the Hampshire ewes had longer durations than the Shropshire, Southdown and Grade Rambouillet ewes. The same results were secured in this experiment, when out of the 3 periods of ⁄48 hour's duration, 2 were found in the Hampshire group as compared to only one in the rest of the ewes of all groups. In the Dorset Horned ewes likewise, more durations of ⁄24 hours were seen than -24 hours as reported by Kelly and Shaw (1939).

To summarize, the duration of oestrus ranged from ⁄12 to ⁄48 hours but in the majority of ewes except Shropshires, it was ⁄24 hours. Length of oestrus in the individual ewes varied in some cases at different heat periods, being less in some and more in the other than the preceeding or succeeding oestrus and vice versa. Such variations might have been the result of experimental error, environmental differences or physiological state of the ewes.

Oestrus Cycle

Out of 116 cycles observed by McKenzie and Phillips (1930), 92 were 14, 15 and 16 days in duration. The over all average was 16.6 with a range of 8 to 49 days. The average cycle length in ewe lambs was 15.9 days.

Terril (1935) found, that the duration of oestrus cycle varied from 14 to 19 days in 590 cycles. The mean cycle length in this case was 16.5 days.

From a total of 1038 cycles observed by McKenzie and Terril (1937), 938 were found within a range of 14 to 19 days with a mean of 16.72 days.

Kelly and Shaw (1937) reported, that in the majority of oestrus cycles, the observed length was 15 to 19 days and from these cycles, the duration of 16 - 18 days was the commonest.

Similarly, Smith and Singh (1937) found, that in Bikaner ewes, the cycle length was 15 to 19 days.

The writer, during the conduct of this work observed an interval of 15 - 18 days with a mean of 16.71 days which was almost equal to the interval as well as mean lengths observed by the above workers. It was interesting that in the Indian ewes, the same cycle length was observed as in case of ewes of the European origin. However the Indian ewes were breeding twice a year.

Onset of the Breeding Season

The data collected from the observations in this experiment showed, that 66.66% of the Dorset-Horned, 16.66 of Hampshire and 6.25% of the Shropshire ewes were in heat during April. From the Ramb. x Dorset Horned ewes 12.5% were in heat during February, while 40 and 20% of the Oxford ewes were in heat during March and April respectively. Second heat after a normal dioestrus period was not found in any of the ewes from the above groups. This showed that ewes of all breeds represented in this flock were undergoing a period of anoestrum during Spring and early Summer months. Such a sporadic occurrence of heat as was observed in February, March

and April could hardly be called a heat of the breeding season.

The earliest oestrus that was followed by regularly recurring heat periods was observed on June 27 in the Rumb. x Dorset Horned group and by the end of July, 83.33% of the ewes were in heat.

This group was followed by the Dorset Horned ewes in which July 6, marked the first heat of the breeding season and by August 10, the whole group was in heat at-least once.

The Hampshire ewes came next in which the first oestrus of the breeding season was observed on July 24 and by the end of August, 83.33% of them were in heat. The last heat covering the entire group was seen on September 2.

In the Shropshire group the first oestrus that was followed by others in regular succession, was seen on August 16, and by the end of this month, 36.36% of the ewes had been in heat. By September 2, 54.59% of the ewes were in heat at-least once.

In the Southdown and Suffolk groups, the first heat recorded was on August 23 and 19 respectively. In the Southdown ewes, the second oestrus was seen on August 30 but no Suffolk ewe was found in heat till August 31.

Regarding the Oxford group, only one oestrus was seen on August 9 and no more until August 31.

The breeding season therefore, started in the last week of June and the first week of July in the Dorset Horned and Rumb. Dorset Horned groups, in the last week of July in the Hampshire, third week of August in the Shropshire and in the last week of August in the Southdown and Suffolk groups. As the second oestrus was not recorded in the Oxford group within an interval of 3 weeks that marked the close of observations, therefore

it was concluded, that the breeding season did not set in until August 31 in this group.

In view of the fact, that all the ewes that comprised this flock, were practically of similar ages and were subjected to the same environmental conditions through-out the experiment, the logical conclusion that followed was, that ewes of different breeds had different sexual behaviour under similar conditions and that these differences were hereditary in nature.

Henning and McKenzie (1927) reported, that out of the two groups of Grade Merino and Dorset x Merino F_1 ewes, the rate of conception in the first year was 38%, 48% and 4% during June, July and August. Next year the conception rate was 84% in June, 8% in July and 2% in September and October each.

Comparing the above results with the present, 28.57% of the ewes of Ramb. x Dorset Horned group were in heat in June against 38 and 84% found by the above workers. In July, 83.33 and 66.66% of the ewes of Ramb. x Dorset Horned and Dorset Horned groups were in heat as compared with 48 and 8% in the same months reported by those workers. In August the percentage of conception was 4 as compared to 66.66 and 100.00% in this experiment. Such a variation was but natural as the ewes were not bred in this case, while all in heat were bred by those workers, and the ewes that came in heat next month were either in first heat or those that did not settle or both. With this in view, the results were similar in both cases except that the breeding season started in June which was a few days earlier than in this case. This departure was not an unexpected one, keeping in view the breed and environmental differences in the two cases.

McKenzie and Phillips (1930) observed, that in 1929 and 1930, the breeding season started in the last week of August, but the Hampshire ewes started breeding 10 days earlier than the other two groups of Shropshire and Southdown ewes.

The breeding season in the Hampshire ewes observed in this case, started between the last week of July and first week of August and in the third and fourth week of August in the Shropshire and Southdown ewes respectively. The results were thus very similar with the above workers in the similar breeds.

McKenzie and Terril(1937) found, that the breeding season started in the middle and last week of August in Hampshire ewes in 1930, 1934 and 1935. In the Shropshire and Southdown ewes observed in 1929 and 1930, the breeding season began in the first and second week of September. In this case too, the results were practically similar except that the Shropshire and Southdown ewes started coming in heat a few days later than in the present case.

Schott, Phillips and Spencer (1939) found in connection with a hot-house lamb project, that each month from May through October, the percentage of the Dorset ewes that settled was 35.44, 5.00, 2.74, 10.52, 44.11 and 57.14 respectively. In the Dorset Horned group observed at the Michigan Station, 66.66% of the ewes were in heat during April and July and 100.00% in August while no oestrus was recorded in May and June. With such a large number of ewes observed by Schott et al. (79, 60, 73, 57, 34 and 7 each month), it should not be surprising to find such variations when only 3 ewes were observed in this case.

Kelly and Shaw (1943) reported, that among the Dorset Horned ewes in

Australia, the percentage of oestrus was from 94 to 100 from February to July, 35 and 41 in January and August respectively, and zero from September through December in 1938. In 1939, 100 to 67% of the ewes were in heat from February through July and 33 and 11% in January and August. From September through December, the frequency of oestrus was again zero (Spring in Australia and Fall in U. S. are similar). Similarly in the four different strains of Australian Merinos observed from 1936 to 1941, these workers found that the frequency of oestrus in the Spring and early Summer months (September to December) was almost zero, a gradual increase was observed in the late Summer and the peak figures were reached in the Autumn months. It may be noted that the sexual behaviour of ewes reported by these workers was on the whole, similar in flocks located at stations 13° of latitude apart. The results of the present work were again comparable with the above so far as the seasonal breeding habits of the ewes were concerned in the same as well as different breeds.

Hammond (1944) observed, that in the Suffolk x Border Leicester Cheviot ewes, the earliest and latest dates of the onset of breeding season, were September 18 and November 5 respectively from 1932 to 1939 in Great Britain. In view of the breed, strain and environmental differences, the onset of the breeding season was not very different.

So far as the sexual behaviour of the breeds of British or more truly of European origin is concerned, the common conclusion drawn by workers at the different times is, that ewes irrespective of the breed, individual and environmental variations, observe the phenomanon of seasonality in breeding only once a year. The breeding season starts in late Summer, the peak figures are reached in Fall and the end of Winter marks the closing

phase of the breeding season, and that they observe the same cycle even when transfered from Northern to Southern Hemisphere (Yeats 1949). The findings of the present work also support the above results.

The breeding habits of the Indian breeds of sheep were found somewhat different when the literature was reviewed in this connection.

Villegas (1929) reported, that a group of Indian blood ewes in which 33 matings were recorded in Phillipine, observed two breeding seasons, one in May and June when 39.3% of the ewes mated, and the other in December when 21.2% of the matings were observed. In the rest of the months, the matings ranged from zero to 9.1% of the total.

Smith and Hussain (1935) showed, that during 1927 - 28, 1928 - 29 and 1929 - 30, out of a total of 507, 490 and 548 ewes of Hissar Dale and Bikaner breeds, 77, 86.5 and 81.4% lambed from Fall matings (September to November). On the other hand in 1930 - 31, 1931 - 32 and 1932 - 33, out of a total of 441, 574 and 689 ewes, 86.1, 81.9 and 77% lambed from Spring matings (March to June). These figures showed that the breeding chances in the Fall and Spring were practically similar.

It may be pointed out that the Hissar Dale breed was developed at the Government Cattle Farm, Hissar maintained by the Punjab Government in the United India. The two breeds used for crossing were Bikaner and Merino. The ewes that were in mating during Falls and Springs consisted of both Hissar Dale and Bikaner breeds with the former predominating. In view of the fact, that the Merino ewes experience only one breeding season a year (late Summer and Fall) and their progeny experienced two, it follows that the character of breeding twice a year was transmitted by the Bikaner parent.

This view was further substantiated by the findings of Smith and Singh (1937) at the same Farm. They found that Bikaner ewes came in heat regularly from March to June by subjecting two groups of these ewes to daily observations during the above period. This shows that Indian breeds of sheep (Bikaner and Hissar Dale) have different breeding habits than European ewes and they likewise observe them when taken into other countries (Phillipine). How far the different breeds in Pakistan resemble the either variety is a matter to be explored and proven on basis of the experimental evidence.

Modification of the Natural Breeding Season

Length of Light Allowed

Sykes and Cole (1944) reported, that out of 8 ewes (1 Southdown, 1 Hampshire, 2 Rambouillet and 4 Crossbred), 5 were bred in the Spring of 1943 from April 16 to June 6 when they were subjected to the effect of the decreasing day light length. By the end of March, 3 hours of day light were added to the normal day so that the ewes were getting about 15½ hours light, almost equal to mid June day. The light was then decreased by one hour each week, so that by the middle of May, the ewes had only 9½ hours light, almost equal to the day length in the end of November (Fig. 11). Four out of the 8 ewes came in heat between April 16 and 21. At this stage, the ewes were having 12½ hours daily light equal to about mid September day when normally the breeding season starts almost in every breed.

Yeats (1947 and 1949) showed, that the seasonal changes in the length of day determined the time of the year at which the Grade Suffolk ewes experience their breeding season under natural conditions in Cambridge, and that it may be modified or even reversed by the alteration of daily light allowed. The ewes were subjected to such controlled conditions of lighting, that in actual Summer they had the Winter day length and vice versa. By such modification of the daily light allowance, he found that the ewes started coming in heat after 10 - 14 weeks of the change from increasing to the decreasing light. On the other hand, breeding activities ended after 10 - 14 weeks, when the change was made from the decreasing to increasing light of the day. The change in light allowance in this case was very gradual, equal to about 4 minutes a day.

A similar work was done by Terry(1951) at the Michigan State College ,

who found that in a period of 69 days of observation (June 22 to August 29), out of the 3 groups of 8 ewes each (control, constant light and constant darkness), one ewe lambed earlier in the constant darkness group, 4 from the constant light group, while in the control group no ewe lambed earlier. These results were apparantly contrary to the hypothesis offered by Yeats, that the breeding activities came to stand-still under the increased effect of light.

Applying the decreasing day light hypothesis to the results obtained in this experiment, the breeding season started in about the second week of the decreasing light of the day in the Dorset Horned and Ramb. x Dorset Horned groups, 4 weeks after in the Hampshire, 7 weeks in the Shropshire and 8 weeks in the Southdown and Suffolk groups under natural conditions.

Temperature

A common belief exists among the breeders, that the onset of cool nights in Fall is somehow related to the breeding season in sheep. Figure 12 and 13 show the average monthly minimum and maximum temperatures from March through August and such daily temperatures for July and August that prevailed at East Lansing in 1951. It may be noted that the breeding season started in July in 3 breed groups under observation (Dorset Horned, Ramb. x Dorset Horned and Hampshire) when the average minimum temperature was highest (59.3°). On the other hand, in March, April and May, when the average minimum temperature was 26.2°, 35.5° and 47.4°F, no breeding activity of the nature of a breeding season was noticed. This showed that the onset of cool nights alone was not the determining factor. This view was further supported by the findings of McKenzie (1939) who observed no

change in the onset of breeding season among ewes that were subjected for 12 - 24 hours each day to a temperature of 44 - 48°F. in cooled rooms when the atmospheric temperature ranged from 70 to 95°F. The work was repeated next year with the same results.

To sum up the hypothesis that the decreasing length of the day, acted as a stimulus in bringing the ewes to heat has sounder experimental evidence behind than the assumption of cool nights. On the other hand, cool night might have an additive effect to the decreasing and antagonistic to the increasing length of the day. An experiment designed, to evaluate the relation between the two factors (decreasing light and cool nights) will certainly add a useful information to the present conception.

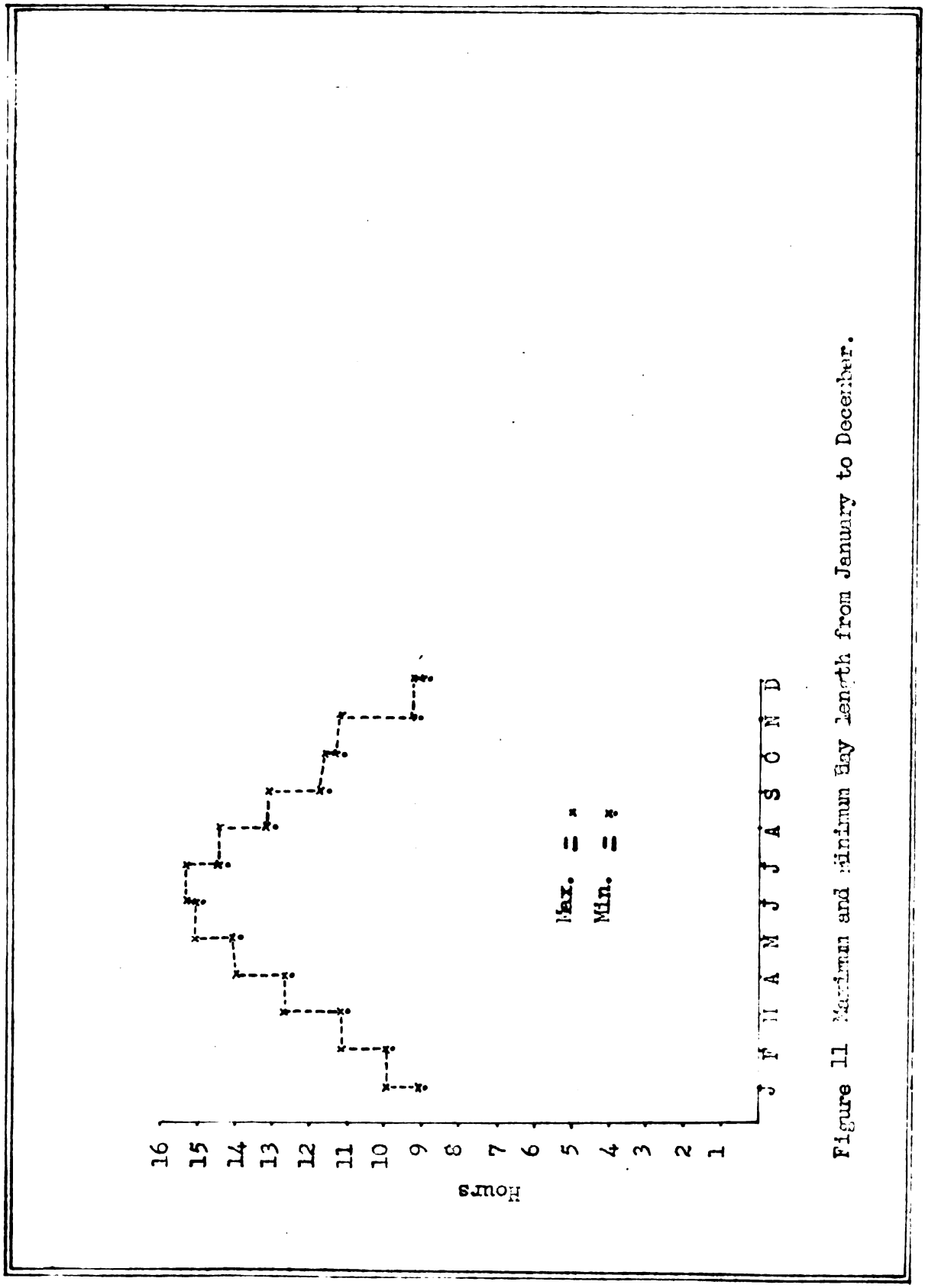

Figure 11 Maximum and minimum day length from January to December.

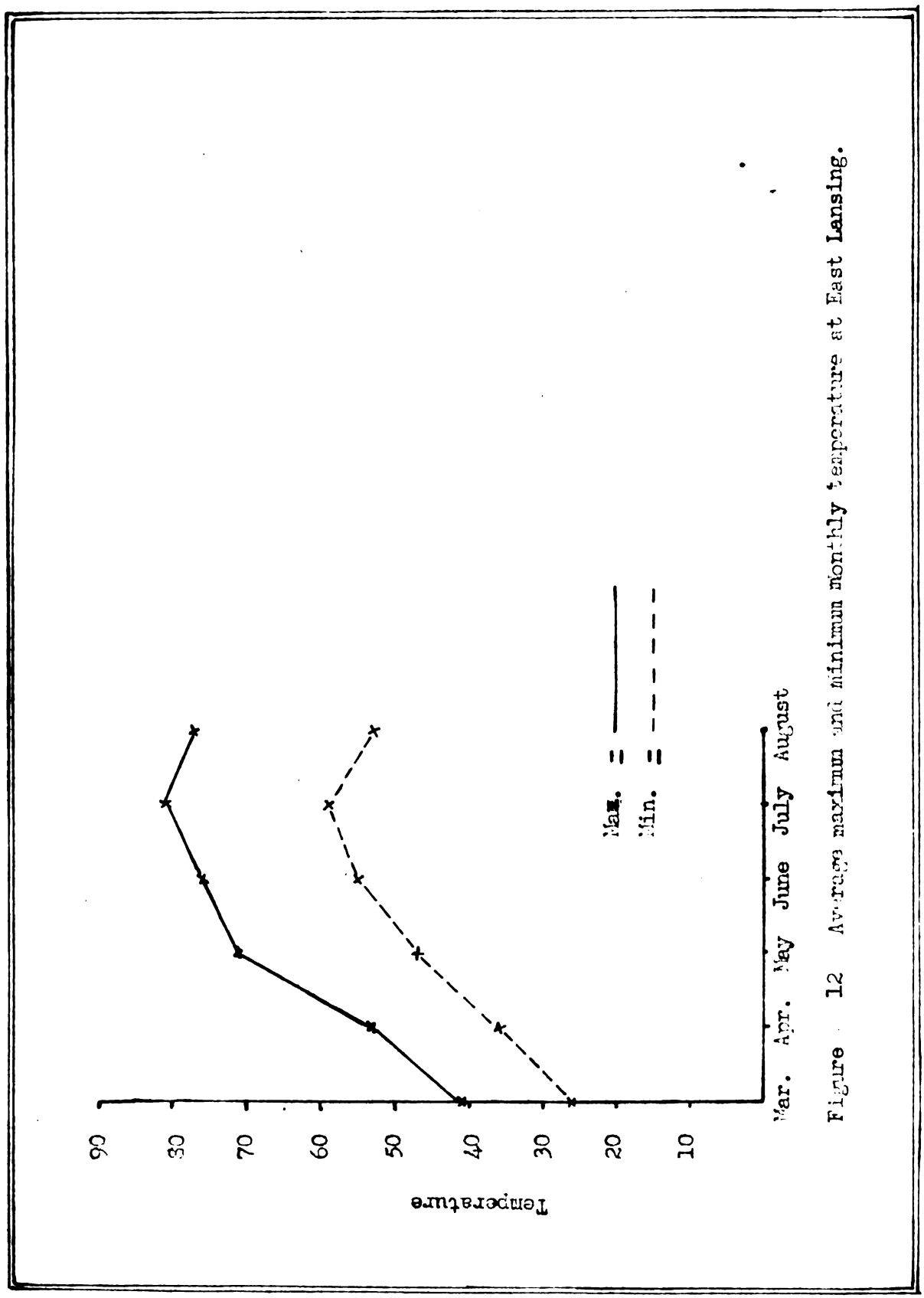

Figure 12 Average maximum and minimum monthly temperature at East Lansing.

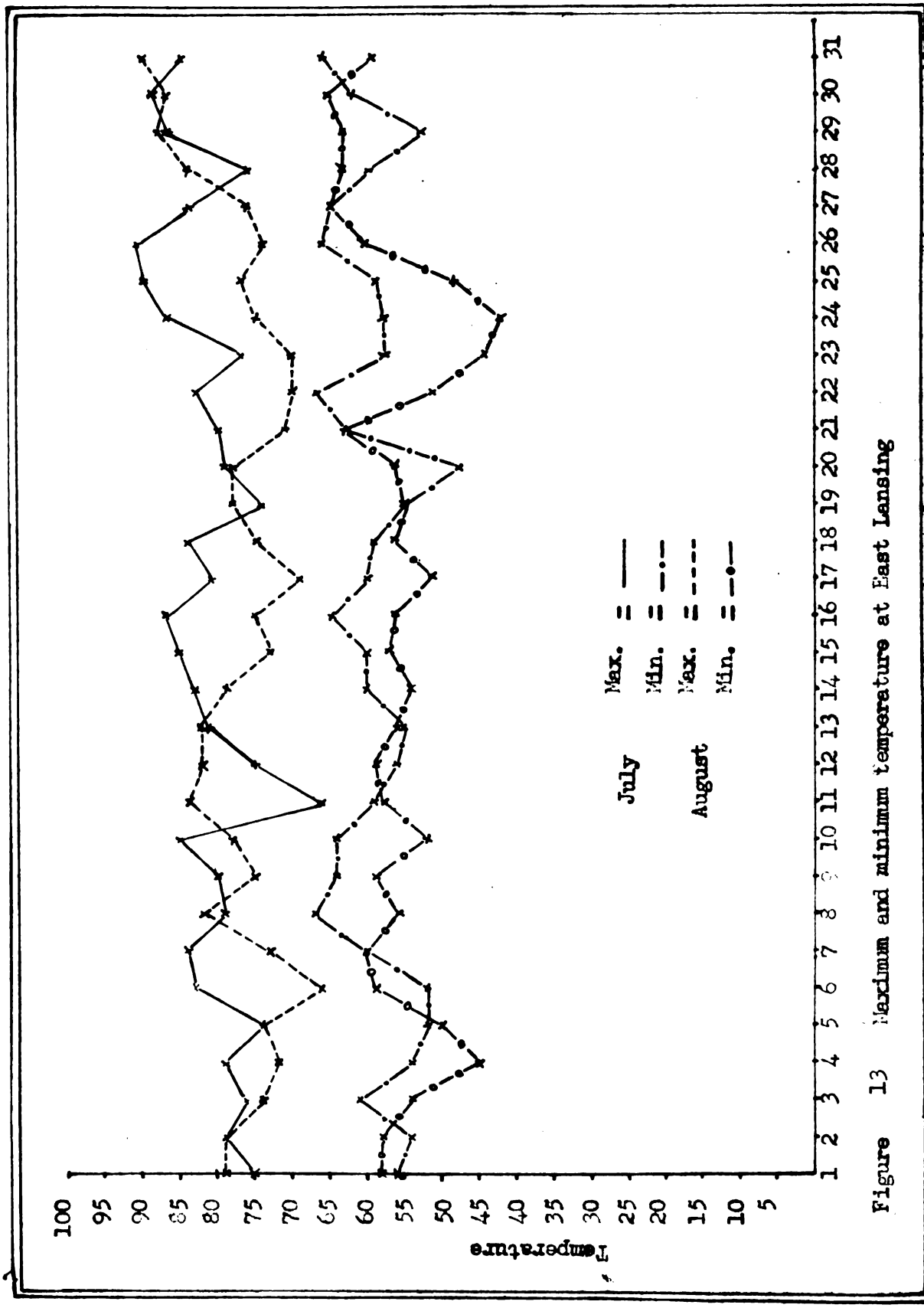

Figure 13 Maximum and minimum temperature at East Lansing

SUMMARY

1. The sexual behaviour of 47 yearling ewes of the Dorset Horned, Ramb. x Dorset Horned, Hampshire, Oxford, Shropshire, Southdown and Suffolk breeds was studied from January 15, to August 31, 1951.

2. The flock was checked once a day up to August 12 and twice a day thereafter.

3. Oestrus lengths of -24, ∠24 and ∠48 hours were observed in ewes of different breeds, but no oestrus of less than 12 or equal to 72 hours was noticed. Majority of the periods of -24 hours duration were observed in the Shropshire ewes but in the Hampshire group, the durations of ∠48 hours were more frequent. In the entire flock however, the commonest duration was ∠24 hours.

4. Dioestrus periods ranged from 118 to 12 but durations of 12 to 15 days were considered normal with a mean of 13.71 and standard deviation of ± 0.7 days.

5. Oestrus cycles varied from 122 to 15 days in length but range of 18 to 15 was considered normal with a mean of 16.71 and standard deviation of ± 0.7 days.

6. The data indicated that some ewes of the Dorset Horned, Hampshire, Oxford, Shropshire, and Ramb. x Dorset Horned groups came in heat during Spring, but second oestrus was not found in any of these ewes. On the other hand, the earliest heat that was followed by regularly recurring ones, was observed on June 27. The ewes of all breeds therefore, went through a period of sexual quiescence in Spring and early Summer except for sporadic occurrence of oestrus.

7. The breeding season began in the last week of June and first week of

July in the Dorset Horned and Romb. x Dorset Horned groups, end of July in Hampshire, third week of August in Shropshire and in the last week of August in the Suffolk and Southdown groups.

8. The breeding season started in July in two breed groups when the average minimum temperature was higher than any month from March to August.

9. Onset of oestrus in 22 ewe lambs as calculated from the lambing dates, occurred at an average age of 257 in the Hampshire, 255 in Oxford and 257 days in the Shropshire breeds. The mean age of all groups was found to be 256 days.

10. Analysis of the breeding records of the College breeding flock from 1948 through 1951 revealed, that the majority of ewes irrespective of the individual and breed variations settled in October. It may be noted that late dates of conception in certain cases were due to infertile rams in the early breeding season.

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