NUMBER OF OOCYTES PRESENT AT BIRTH IN THE OVARIES OF PURE AND FINNISH LANDRACE CROSS BLACKFACE AND WELSH SHEEP

R. B. LAND

A.R.C., Animal Breeding Research Organisation, Edinburgh 9

(Received 1st March 1969)

Summary. Pure-bred Blackface and Welsh sheep were found to have significantly more oocytes at birth (20 and 16×10^4 respectively) than had their Finnish Landrace (Finn) crosses (11 and 15×10^4 respectively). The proportion of oocytes in large follicles with an antrum was, however, significantly greater in Finn cross than in the pure-bred animals (0.58 and 0.18% respectively).

As both pure and cross-bred offspring had pure-bred mothers, it was concluded that the higher proportion of developing oocytes in the Finn crosses was due to an increased level of foetal follicular sensitivity or stimulation rather than maternal gonadotrophic activity.

INTRODUCTION

The Finnish Landrace (Finn) sheep has been shown to have a noticeably high litter size, particularly in comparison to native British breeds. Their mean litter size has been reported as 2.5 in Finland (Majjala, 1966) and 3.4 in Scotland (Donald & Read, 1967), whereas Scottish Blackface and Welsh Mountain sheep kept under similar conditions in Scotland were found to produce litters of 1.9 and 1.5 respectively (Wiener, 1967). Furthermore, the litter sizes of crosses between Finn and native British breeds of sheep have been found to be approximately midway between the parental breeds (Donald, Read & Russell, 1968; unpublished Animal Breeding Research Organization data).

The relative contributions of ovulation rate and embryonic viability to the high fertility of the Finn and its crosses have not been established but preliminary results in this laboratory indicate that their ovulation rate is higher than that of their indigenous British counterparts. The factors which affect ovulation rate are complex but the number of oocytes present at birth, their subsequent rate of atresia and the endocrinological environment of the ovary at the time of ovulation are clearly of importance. The purpose of this present communication is to report an investigation of the number of oocytes in newly born lambs of two British breeds and their Finn crosses.

MATERIAL AND METHODS

Animals

Twenty Blackface and twenty Welsh ewes were kept at the Animal Breeding Research Organisation Field Laboratory, Roslin, Midlothian. Half the ewes of each breed were mated in the autumn of 1967 to rams of the same breed, and half to Finn rams. All the female lambs born to these matings were killed between 4 and 16 hr after birth and both ovaries removed.

Histology

The ovaries were dissected free of adjoining tissues and fixed in acetic-formol-alcohol. One ovary of each pair was taken at random and serially sectioned at 8 μ . The sections were stained with Weigert's iron haematoxylin and chromotrop 2R. All preparations were coded to ensure that the breed or cross was unknown at the time of examination.

Quantitative observations

A small proportion of the nuclei in the oocytes of the ovaries of newborn lambs were found to have more than one nucleolus. Consequently, the nucleus rather than the nucleolus was used as a marker (as used by Mauléon, personal communication). The number of oocytes with a nucleus was counted in every tenth section of the first fifty sections at each end of the ovary, and in every fortieth section in between. The total count for that ovary was obtained as the sum of the products of the number per section and the range of sections it represented.

The nuclear diameter was measured in five oocytes taken at random from every sixth section counted. The mean nuclear diameter for oocytes in an ovary was used to correct the overall count for that ovary, as described by Mandl & Zuckerman (1951).

Oocytes were classified according to their stage of development into: (1) those with no more than one layer of follicular cells, (2) those with more than one layer of cells but lacking an antrum, and (3) those with an antrum. These classes correspond to the types 1 to 3b, 4 to 5b and 6 to 8, respectively, of Pedersen & Peters (1968).

RESULTS

The mean numbers of each class of oocytes per ovary for Blackface, Welsh, Finn $\times$ Blackface and Finn $\times$ Welsh lambs are given in Table 1, together with the number with an antrum expressed as a percentage of the total number. A summary of the cross classification analysis of variance of unweighted cell means is also given for each parameter. The residual sums of squares were obtained from the sums of squares within groups divided by the harmonic mean of the number of animals per group.

The ovaries of Finn crosses were found to have fewer oocytes at birth than had the pure breeds ($P < 0.05$). Ovaries from the Welsh and Welsh-cross lambs

TABLE 1
THE MEAN NUMBER OF OOCYTES IN FOLLICLES WITH A MAXIMUM OF ONE LAYER OF CELLS, MORE THAN ONE LAYER OF CELLS AND WITH AN ANTRUM PRESENT AT BIRTH IN ONE OF THE OVARIES OF PURE-BRED AND FINN-CROSS, BLACKFACE AND WELSH LAMBS, TOGETHER WITH THE MEAN SQUARES (MS) AND VARIANCE RATIOS (VR) FROM THE ANALYSES OF VARIANCE

Breed or cross	No. of lambs	No. of oocytes					% with antrum
		< one layer	> one layer	With antrum	Total		
Blackface	6	98,472	988	241	99,701	0.23	
Welsh	7	79,667	1,363	113	81,142	0.13	
Finn x Blackface	5	52,165	857	494	53,515	0.67	
Finn x Welsh	6	72,265	1,239	355	73,858	0.48	
Source of variation	d.f.	MS	MS	MS	MS	MS	
Between breeds	1	418,611	143,198	17,826	795,557	0.020	
Between pure- and cross-bred	1	721,167,393	16,209	61,244	714,728,143	0.154	
Interaction	1	378,397,422	13	25	378,341,401	5.3*	
Residual	20	154,162,368	56,407	24,957	157,774,694	0.002	
		VR	VR	VR	VR	VR	
		<1	2.5	<1	<1	<1	
		4.7*	<1	2.5	4.5*	5.5*	
		2.5	<1	<1	2.4	<1	

* $P < 0.05$.

had a greater, but not significantly greater, number of oocytes with more than one layer of follicle cells than had the ovaries of their Blackface counterparts. In contrast to the number of oocytes with a maximum of one layer of follicle cells, the ovaries from Finn-cross lambs had more oocytes with an antrum than had the ovaries from pure-bred lambs but this difference was not significant ($P < 0.05$). The ovaries from Finn crosses were, however, found to possess a significantly greater proportion of oocytes with an antrum ($P < 0.05$) than the ovaries from pure-bred lambs.

DISCUSSION

The number of eggs shed by a mammal is a function of the total number of oocytes available and the proportion of these oocytes which develop into mature follicles and ovulate. The results of this study indicate that the high fecundity of Finn and Finn-cross sheep is not related to a higher complement of oocytes at birth and, consequently, that a greater proportion must be ovulated. The observation of a greater proportion of oocytes with an antrum in the ovaries of Finn-cross compared with pure-bred lambs at birth not only supports this conclusion but also shows that the circulating level of gonadotrophic activity, or the ovarian sensitivity to gonadotrophins, must be higher in the Finn-cross lambs. The fact that both the cross- and the pure-bred lambs were carried by the same type of pure-bred female, and therefore subjected to the same uterine environment, indicates that the increased oocyte development was the result of foetal rather than maternal activity.

Further work is obviously necessary to determine whether the smaller number of oocytes in the ovaries of Finn-cross lambs at birth is the result of greater atresia during embryonic development or of a lower initial complement. However, the observation that in the absence of follicular stimulation, i.e. after hypophysectomy, the rate of oocyte atresia in the rat is lower than normal (Ingram, 1953), together with the present evidence for greater follicular response in the newborn Finn-cross lambs, indicate that the lower number of oocytes at birth is, at least in part, due to a greater rate of pre-natal atresia.

The relationship between ovarian sensitivity to exogenous gonadotrophins and the number of oocytes present in the ovaries of the cow and rat was examined by Mauléon & Rao (1963) and Mauléon (1966), respectively. In both cases, the two variables were found to be positively correlated. Although these observations appear to be incompatible with the present results, the difficulty of relating natural fertility to ovarian sensitivity towards exogenous gonadotrophins (Land & Falconer, 1969) reduces the contrast. Furthermore, a negative correlation between the total oocyte population at birth and subsequent fecundity is not limited to the present data. Jones & Krohn (1961) stated in their study of the number of oocytes in different strains of mice that "CBA females with an endowment of oocytes no more than two thirds of that possessed by A and RIII females have larger litters on average than either of these two strains". It is possible, therefore, that the more fertile strains have a higher rate of pre-natal atresia and consequently a lower oocyte count at birth than less fertile strains.

ACKNOWLEDGMENTS

I am pleased to acknowledge the advice of Dr T. G. Baker during the planning of the experiment and the preparation of the manuscript; the technical assistance of Mrs M. N. S. MacMillan and Mrs C. A. Thomson; and the tolerance and care devoted to this experiment by Mr A. D. MacGregor and the farm staff at Roslin.

REFERENCES

- DONALD, H. P. & READ, J. L. (1967) The performance of Finnish Landrace sheep in Britain. *Anim. Prod.* **9**, 471.
- DONALD, H. P., READ, J. L. & RUSSELL, W. S. (1968) A comparative trial of crossbred ewes by Finnish Landrace and other sires. *Anim. Prod.* **10**, 413.
- INGRAM, D. L. (1953) The effect of hypophysectomy on the number of oocytes in the adult albino rat. *J. Endocr.* **9**, 307.
- JONES, E. C. & KROHN, P. L. (1961) The relationships between age, numbers of oocytes and fertility in virgin and nulliparous mice. *J. Endocr.* **21**, 469.
- LAND, R. B. & FALCONER, D. S. (1969) Genetic studies of ovulation rate in the mouse. *Genet. Res.* **13**, 25.
- MAIJALA, K. (1966) Causes of variation in litter size of Finn-sheep ewes. *9th int. Congr. Anim. Prod. Edinburgh*, Abstracts, p. 29.
- MANDL, A. M. & ZUCKERMAN, S. (1951) The relation of age to number of oocytes. *J. Endocr.* **7**, 190.
- MAULÉON, P. (1966) Use of gonadotrophins for raising the fertility of domestic mammals. *Proc. Vth Congr. Fert. Steril., Stockholm. Excerpta med. int. Congr.* **133**, 35.
- MAULÉON, P. & RAO, H. (1963) Variations génétique des populations folliculaires dans les ovaires de ratte impubères. *Annls Biol. anim. Biochim. Biophys.* **3**, 21.
- PEDERSEN, T. & PETERS, H. (1968) Proposal for a classification of oocytes and follicles in the mouse ovary. *J. Reprod. Fert.* **17**, 555.
- WIENER, G. (1967) A comparison of the body size, fleece weight and maternal performance of five breeds of sheep kept in one environment. *Anim. Prod.* **9**, 177.