

## Lambing behaviour of Merino ewes from lines subjected to divergent selection for multiple rearing ability from the same base population

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### Abstract

Timing of birth and birth site selection were investigated in two lines of grazing Merino sheep that had been divergently selected for multiple rearing ability. Time budgets in the neonatal phase were also compared between the two lines. Parturition was slightly more likely to commence during daylight hours (06:00-18:00) than at night (18:00-06:00) (0.548 vs. 0.452). Intervals between consecutive onsets of parturition in 685 ewes conformed to an exponential distribution, expected for intervals between consecutive, random occurring events. A significant excess of observed short intervals above those expected was found. This observation could either be coincidental, or indicative of an underlying mechanism that may operate as a trigger to synchronize the commencement of parturition. Recorded birth sites of 606 ewes not assisted at birth were found to differ from a random distribution in some of the 10 lambing paddocks used during the study. In four night paddocks, the frequency of birth sites in the 50% of the area situated on the boundaries was higher than in the middle portion. In the paddocks used during daytime an increased frequency of birth sites appeared to be associated with a tree on the boundary of two adjacent paddocks. In the five paddocks used at night, birth site frequencies differed when the paddocks were divided along the length in three blocks of equal size. In the paddock nearest to the base building, birth sites appeared to be concentrated along the boundary furthest from the building that served as base for the observers and the nearby floodlights. Selection line did not appear to influence the choice of a birth site. The period that ewes were observed to groom their lambs was lowly repeatable ( $0.13 \pm 0.06$ ). No line difference was observed in the period that ewes spent grooming. Ewes caring for viable multiples groomed their offspring for a longer period than those caring for singles. Mature ewes tended to groom their lambs for a longer period than primi-parous maidens. A higher proportion of High (H) line ewes groomed their progeny shortly after birth than Low (L) line ewes. Later on (90-120 min. postpartum), L line ewes were more likely than those in the H line to graze. The latter group of ewes was more likely to stand with their offspring at this stage.

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**Keywords:** Birth site selection, diurnal variation, grooming, lambing behaviour, onset of parturition, sheep, time budget

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### Introduction

Lamb mortality is regarded as a major constraint to efficient sheep production (Alexander, 1988; Haughey, 1991). A 'core' level of lamb losses remains, even if managerial inputs are optimised (Alexander, 1984). It is widely believed that human supervision and intervention will minimise maternal deaths and maximise offspring survival (Alexander *et al.*, 1993). This belief has prompted investigations into the distribution of lambings across the 24 hours of a day. Such comparisons are scarce for breeds adapted to South African environments.

The distribution of birth sites in lambing paddocks has not been studied in South African breeding flocks. Indications from elsewhere suggest that ewes prefer to lamb in higher lying areas and concentrate around the boundaries of paddocks (Alexander *et al.*, 1990). The latter observation was ascribed to attempts by ewes to seek isolation at birth. Differences in the survival of multiple lambs were recently demonstrated in South African Merino lines that were divergently selected for maternal multiple rearing ability (Cloete & Scholtz, 1998). Differences in behaviour conducive to lamb survival were also reported between the two lines, supporting the contention by Alexander (1988) that behavioural adaptations may contribute to selection responses in lamb survival.

Against this background, the diurnal variation in times of birth was studied in South African Merino ewes, as well as the synchrony of parturition within the flock. The distribution of birth sites in the lambing paddocks was also compared for Merino lines divergently selected for multiple rearing ability. The activities participated in by ewes caring for at least one viable lamb were also studied during the first 4 hours after lambing.

## Material and methods

Two lines of Merino sheep have been selected divergently from the same base population since 1986, using maternal ranking values for lambs reared per joining (Cloete & Scholtz, 1998). Ewe and ram replacements in the High (H) line were preferably the progeny of ewes rearing more than one lamb per joining (i.e. reared twins at least once). The progeny of ewes rearing fewer than one lamb per joining (i.e. barren or lost all lambs born at least once) were preferred as replacements in the Low (L) line. Depending on the average reproduction of the lines and the replacement needs, progeny of ewes that reared one lamb per joining were occasionally accepted in both lines. Selection decisions were mostly based on  $\geq 3$  maternal joinings, especially in the case of rams. Once selected, ewes normally remained in the breeding flock for five joinings. The H line was augmented by 28 ewe progeny born from an embryo transfer program during 1991 and 1992 (Cloete *et al.*, 1998). The mean performance of the ewes derived in this way was similar to that recorded in the H line, and they were treated as one group.

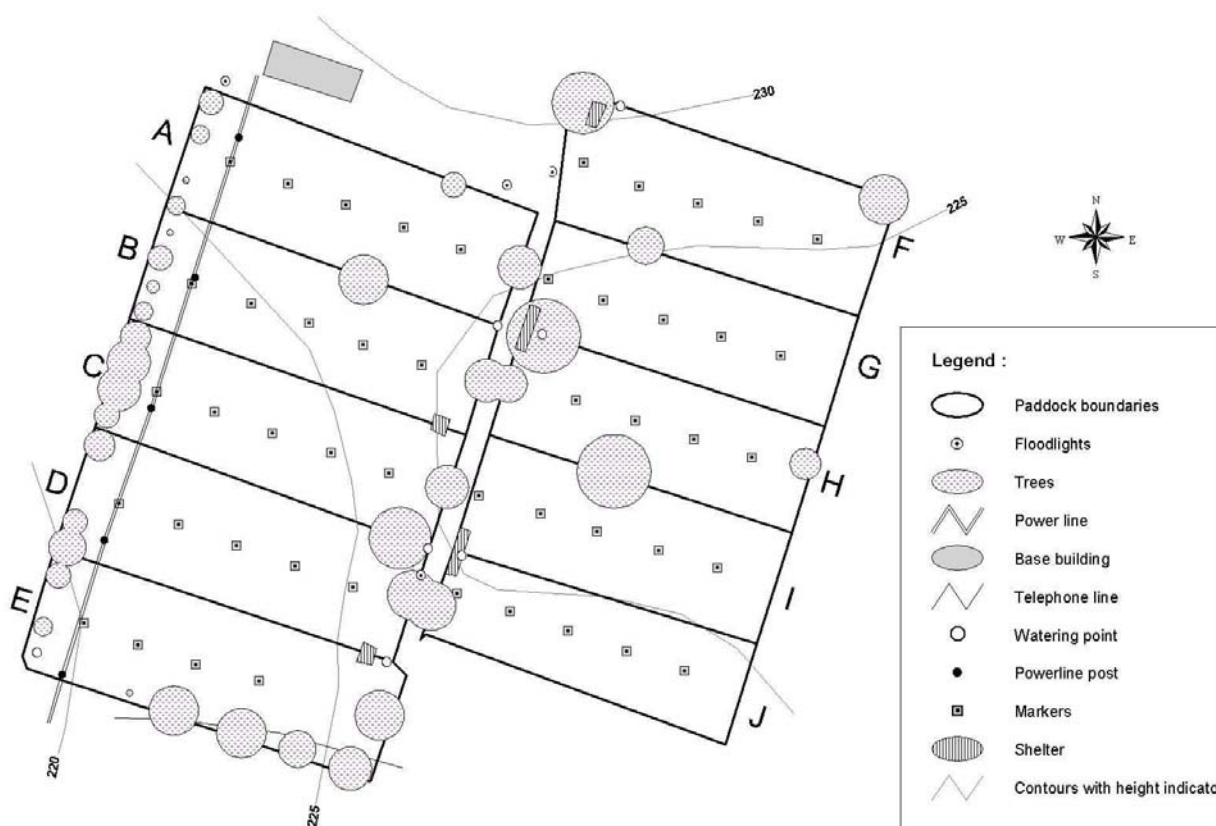
For the duration of the experiment, the two lines were maintained as a single flock, except during joining over a 6-week period in single sire groups to 4-5 rams during January-February each year. For the duration of the present study, the lines were maintained on the Elsenburg experimental farm near Stellenbosch. Cloete & Scholtz (1998) detailed the locality and the management practices implemented, as well as the recording of behavioural data in the flock. The study was conducted over a 5-year period (1993-97). Lambing took place on 10 Kikuyu paddocks, which were generally rested for at least two months prior to the commencement of lambing. Ample feed was generally available. Ewes were side-branded with stock-marker spray to facilitate identification with minimal disturbance. Age (maiden or mature), number of viable lambs given birth (single or multiple) and selection line (H or L) were recorded for individual ewes.

The lambing flock was observed continuously by one to two trained observers for a period of approximately three weeks during peak lambing in June-July. The ewes adapted to human presence within a short period, and could be approached closely (<10 m) without disturbance. Five lambing paddocks were used during daylight hours, while the other five were floodlit for use at night (Cloete & Scholtz, 1998). Ewes were moved from day paddocks to the following night paddock at approximately 18:00, and from night paddocks to the following day paddock at approximately 07:00. Inclusive of the twilight time of dusk and dawn, detailed observations without supplementary lighting were possible from approximately 06:45 to 18:00. For the assessment of these data it was assumed that it would be feasible to observe ewes for the provision of assistance (when needed) from 06:00 to 18:00 (subsequently termed as daytime). The time of onset of lambing was recorded individually for 690 ewes during the experiment. Since the ewes were under continuous observation, it was possible to calculate the interval between onsets of parturition within the flock and to determine synchrony of parturition within production years. A total of 685 intervals between onsets of parturition was calculated for the duration of the experiment.

The sites of 647 births were recorded during the experiment. Estimation of distances was aided by a grid system consisting of iron poles and fluorescent markers placed on the paddock fences at 20 m intervals. Individual lambing sites were transferred to a map of the area, using a Geographic Information System. A detailed map of the area, indicating the major topographical features, is presented in Figure 1. The size of individual paddocks ranged from 0.33 to 0.47 ha. Two blocks of five paddocks were used either for observations during daytime (situated on the eastern side of the map) or at night (on the western side). The floodlights used for illumination at night were situated on the northern side of the night paddocks. All paddocks were roughly rectangular, approximately 110 m in length (in a general east-west direction) and approximately 40 m in width (in a general north-south direction). The corridor between the paddocks was situated roughly along a ridge. Height contours indicated that altitude decreased from a north-westerly and south-westerly direction in the day paddocks. The lowest parts of these paddocks were thus on the eastern end of the centre day paddock. The night paddocks sloped gently in a south-westerly direction. Small to very large trees were scattered along the boundaries of individual paddocks.

Lambs were identified with stock marker spray according to the order of birth within a litter after being groomed by their mother for at least 15 min. The birth site was simultaneously marked with a peg. The behaviour of ewes and their lambs was recorded at 30-min intervals during the first four hours postpartum. Behaviour patterns recorded in ewes included standing, lying, grooming or grazing. Ewes were observed for a period of approximately 30 seconds, and the activity engaged in for the majority of time was recorded. The time that individual ewes spent grooming their progeny was derived from these recordings. Grooming was assumed to have stopped for an individual ewe if this activity was not recorded for three consecutive 30-min intervals, i.e. for 1.5 h.

Differences in proportions or frequencies were assessed for statistical significance by Chi<sup>2</sup> procedures (Siegel, 1956). Seeing that the data for the time that ewes spent grooming their lambs were unbalanced, least-squares procedures (Harvey, 1990) were used. The data were positively skewed and leptocurtic. A standard square root transformation was required to normalise these data. The interpretation of results was complicated by the fact that repeat observations were made on several ewes in different years. Since these observations could be correlated, the assumptions for analysis of variance were not necessarily satisfied. This limitation was overcome by including the random effect of ewes within selection lines (H or L) in these analyses. This approach enabled us to calculate repeatability coefficients for these traits using the between ewe and error variance components (Turner & Young, 1969). Other fixed effects included in these analyses were lambing year (1993-97), age (maiden or mature) and number of live lambs cared for (single or multiple). Two-way interactions between main effects were relatively unimportant ( $P > 0.1$ ) in the analyses, and are thus not presented. Lambing year means are similarly not presented, as they were not significantly different.



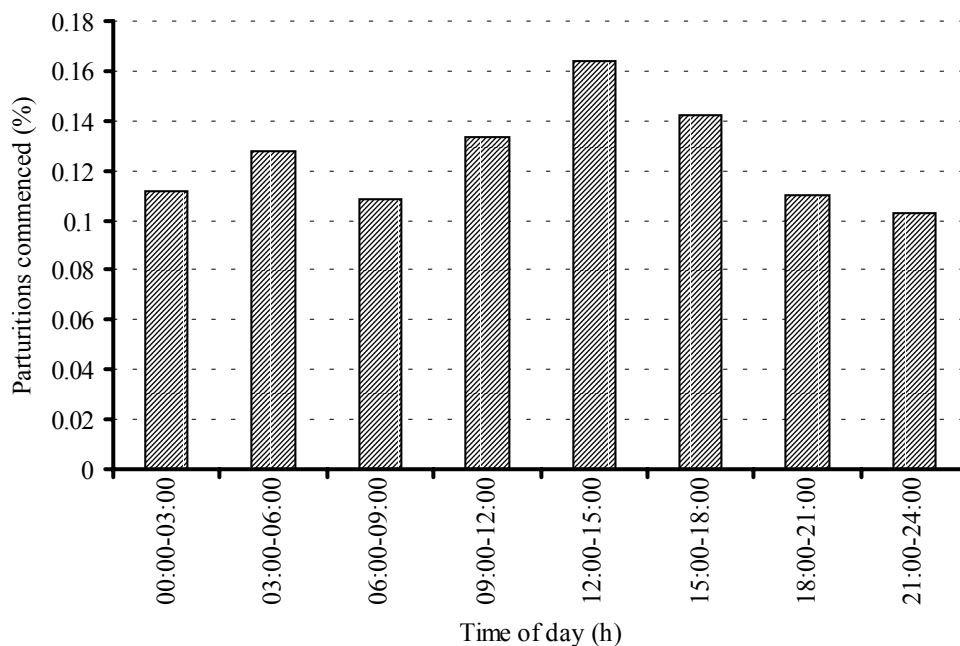
**Figure 1** Map of the trial location with the dominant topographical features depicted on it

## Results

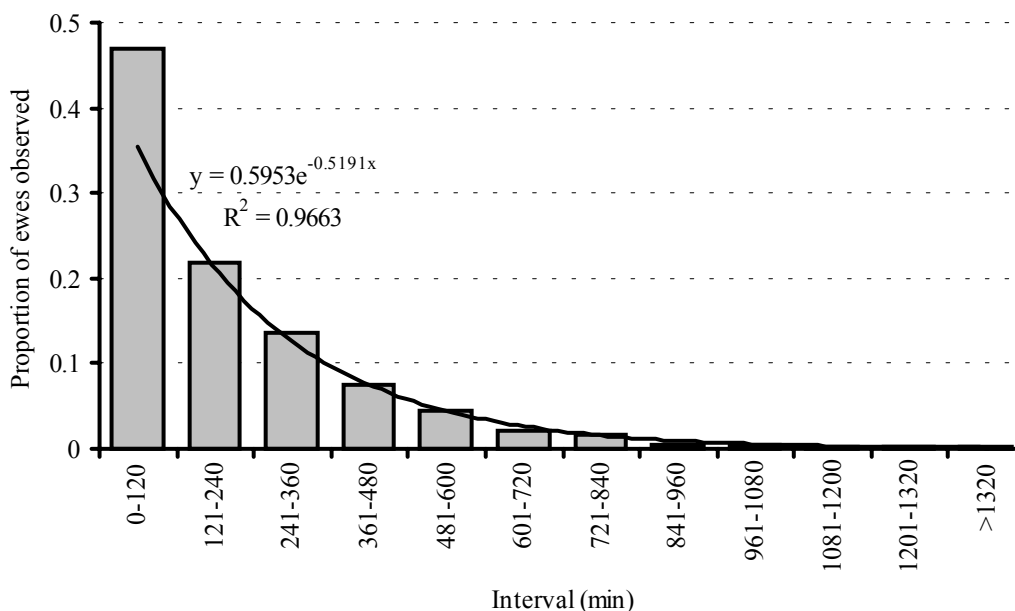
If the frequency of onset of parturition that was recorded during eight 3-hour periods was independent of the time of the day, these proportions would be equal at 0.125. The observed proportions differed from a hypothetical equal distribution ( $\text{Chi}^2 = 16.7$ ; degrees of freedom = 7;  $P < 0.05$ ), showing a peak around noon (Figure 2). Respective frequencies of onset of parturition for the periods from 06:00 to 09:00 and from 18:00 to 21:00 (the times of the morning and afternoon drifts) were 0.109 and 0.110. Onset of parturition of 378 ewes was observed between 06:00 and 18:00 (during daytime), while 312 ewes started lambing during the night (between 18:00 and 06:00). Expressed as deviations from equal frequencies, more ewes started to lamb during daylight hours ( $\text{Chi}^2 = 6.3$ ; degrees of freedom = 1;  $P < 0.05$ ). However, this difference was small, with 54.8% of the ewes commenced lambing during the day and 45.2% at night.

The frequency distribution of intervals between consecutive onsets of parturition over the 5-year period showed a higher frequency of shorter intervals (Figure 3). The frequency distribution shows a decline for longer intervals between births. The theoretical and observed frequencies were closely related, as

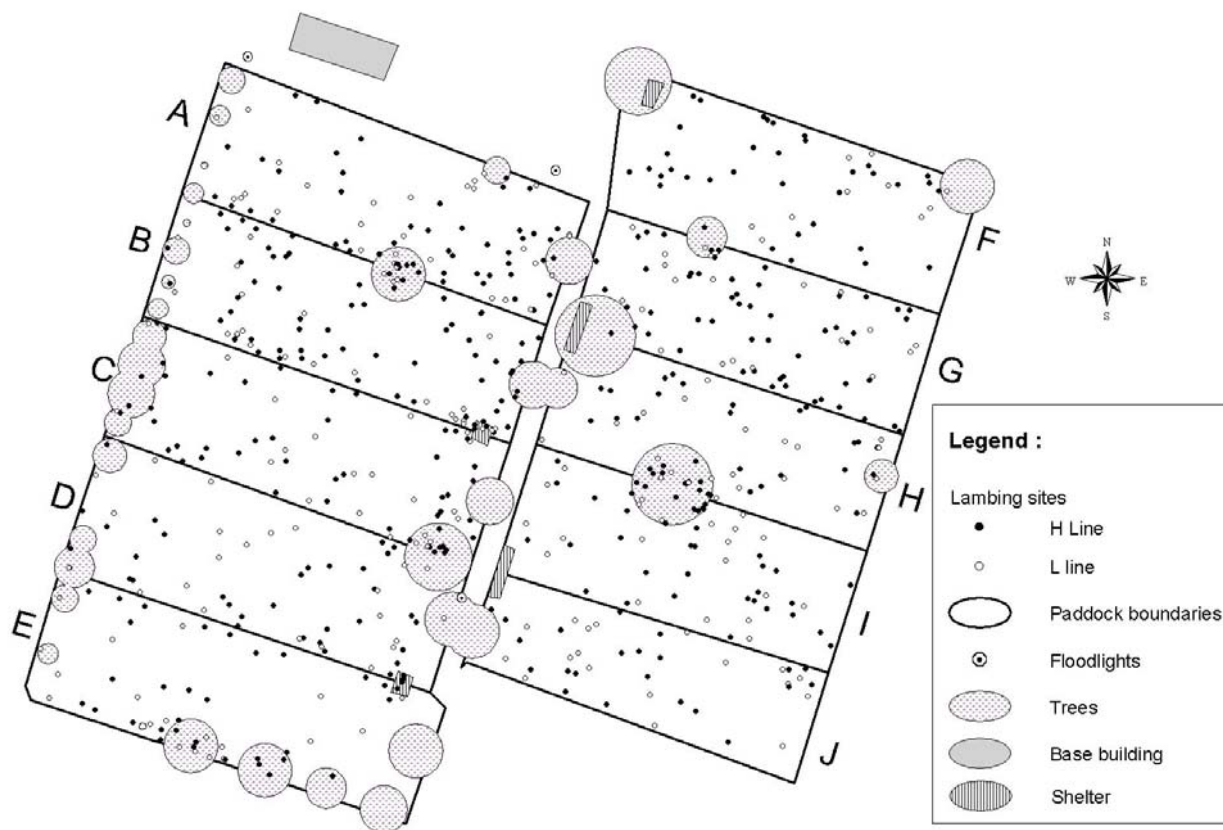
reflected by a  $R^2$ -value of 0.966. There was, however, evidence of an excess of observed small intervals. The observed frequency for the interval of 0-120 minutes between onsets of parturition was 0.470, compared to an expected frequency of 0.355 from the regression ( $\text{Chi}^2 = 17.07$ ; degrees of freedom=1;  $P < 0.01$ ).



**Figure 2** Overall diurnal distribution of lambings for the period 1993 to 1997. If the occurrence of births was independent of time of the day, a proportion of 0.125 of the lambings would have been recorded for all intervals.



**Figure 3** Histogram depicting the proportion of onsets of parturition ( $n = 685$  ewes) associated with time intervals between parturitions (1993 to 1997). A trendline depicting the theoretical exponential distribution for events occurring randomly is also included.



**Figure 4** Distribution of the lambing sites of ewes in the H and L lines across the lambing paddocks used in the investigation for the period 1993 to 1997. Paddock identification details are provided.

A map of the experimental location is given in Figure 4, with individual lambing sites of 606 unassisted H and L line ewes depicted on it. The sites of 41 assisted births were excluded. It was decided to test three hypotheses: The first of these was a concentration of birth sites along the boundaries of individual paddocks. Individual paddocks were divided in equal parts, with one part positioned along the boundaries and the other part in the centre of the paddock. A higher ( $P < 0.05$ ) frequency of birth sites was found along the boundaries of paddocks A, B, C and E. No significant differences were found for the paddocks used during daytime. Overall, similar proportions of 400 H line ewes and 206 L line ewes gave birth in the portion of paddocks that was situated nearest to the boundaries (0.610 and 0.655 respectively;  $\text{Chi}^2 = 1.01$ ; degrees of freedom = 1;  $P > 0.05$ ). The hypothesis that the increased frequency of births along the boundaries of the paddocks was related to the seeking of shelter by ewes was subsequently tested. The half of the respective paddocks along the boundaries was divided into the part under trees and the remainder. Respective areas were computed and expected frequencies were related to the observed number of births, to assess if a disproportionately large frequency of births occurred in areas underneath trees and shelters in the paddocks, relative to the area occupied. This was found to be the case in paddock A ( $\text{Chi}^2 = 7.94$ ; degrees of freedom = 1;  $P < 0.01$ ), paddock C ( $\text{Chi}^2 = 10.33$ ; degrees of freedom = 1;  $P < 0.01$ ) and paddock H ( $\text{Chi}^2 = 10.46$ ; degrees of freedom = 1;  $P < 0.01$ ).

Thirdly, frequencies for columns (across the width of paddocks, in a general north-south direction) and rows (along the length of paddocks, in a general east-west direction) in individual paddocks were assessed for deviations from a random distribution. Frequencies for columns deviated from a random distribution in paddocks A and H (Figure 4). In paddock A, a higher frequency of birth sites was found in the eastern, higher part of the paddock ( $\text{Chi}^2 = 12.07$ ; degrees of freedom = 2;  $P < 0.05$ ). Birth sites were more likely to occur in the middle column of paddock H, apparently in association with a tree on the boundary between paddocks H and I. When rows were compared for individual paddocks, significant ( $P < 0.05$ ) deviations from a random distribution were found for seven paddocks (A, B, C, D, E, H and I; Figure 4). In the floodlit paddocks used at night (A to E), birth sites were generally concentrated in the southern part of the paddock (furthest from the floodlights). In absolute terms, fewer births were occasionally found

in the centre row of individual paddocks, although significant differences were not found. Birth sites in paddocks H and I were centred along the boundary between the two paddocks and appeared to be associated with the tree previously mentioned. Again, no significant association of selection line with specific birth site preference could be demonstrated.

The between ewe variance component for the time ewes spent grooming was significant ( $P < 0.05$ ), but the repeatability ( $\pm$ s.e.) between years of the trait was fairly low at  $0.13 \pm 0.06$ . Time spent grooming was independent of selection line, although absolute means favoured the H line (Table 1). Mature ewes tended to spend longer ( $P < 0.10$ ) periods grooming their offspring than primi-parous maidens. Ewes caring for more than one viable lamb spent longer ( $P < 0.01$ ) periods grooming both lambs than ewes caring for singles.

**Table 1** Least squares means for the square root transformed period spent grooming by individual ewes, as affected by selection line, age, and number of viable lambs cared for

Effect	Number of Observations	Stay on birth site (min)	
		Mean $\pm$ s.e	(Mean) <sup>2</sup>
Overall mean	654	6.30 $\pm$ 0.17	39.7
Selection line		n.s.	
High line	428	6.44 $\pm$ 0.19	41.5
Low line	226	6.15 $\pm$ 0.27	37.8
Lambing year		n.s.	
Age		0.08	
Maiden	154	5.87 $\pm$ 0.33	34.5
Mature	500	6.73 $\pm$ 0.26	45.2
Number of lambs		**	
Single	350	5.66 $\pm$ 0.24	32.0
Multiple	304	6.94 $\pm$ 0.25	48.2

\*\*  $P < 0.01$ ; n.s. - not significant

Neo-natal activity was monitored in 428 H and 226 L line ewes during 1993-1997. At the first postpartum observation, H line ewes were more ( $P < 0.05$ ) likely to be engaged in the grooming of their offspring than L line contemporaries (0.804 vs. 0.730 respectively;  $\text{Chi}^2 = 4.32$ ; degrees of freedom = 1). A similar observation was made at the second observation, 30 minutes later (0.598 vs. 0.518;  $\text{Chi}^2 = 7.58$ ;  $P < 0.01$ ). Grooming behaviour subsequently declined rapidly, and no further line differences were found. Ewes in the L line were more likely to graze than H line contemporaries at 90 minutes (0.341 vs. 0.203;  $\text{Chi}^2 = 14.15$ ;  $P < 0.01$ ) and 120 minutes (0.310 vs. 0.224;  $\text{Chi}^2 = 5.26$ ;  $P < 0.05$ ) after lambing. A similar tendency ( $P < 0.10$ ) was found 210 minutes after lambing (0.270 vs. 0.201;  $\text{Chi}^2 = 3.65$ ). Ewes belonging to the H line were more ( $P < 0.05$ ) likely to stand with their progeny than L line contemporaries at 90 minutes (0.638 vs. 0.531;  $\text{Chi}^2 = 6.61$ ) and 180 minutes (0.640 vs. 0.535;  $\text{Chi}^2 = 6.36$ ) postpartum. No line differences were observed with regard to the proportion of ewes lying.

## Discussion

Substantial proportions of births were recorded in each of the eight 3-hour intervals throughout the day (Figure 2), although slightly more ( $P < 0.05$ ) births were recorded during daylight. Supervision of lambing to improve lamb survival would thus be only partly effective if restricted to daylight hours. Other authors reporting on paddock-lambing ewes came largely to the same conclusions (George, 1969; Arnold & Morgan, 1975; Alexander *et al.*, 1993). The work of Jilek *et al.* (1985) suggested that 42% of births occurred during the 12-hour period from 18:00 to 06:00, which is in good agreement with the present results. The present results also accorded with those reported by Alexander *et al.* (1993) for Merinos under comparable conditions. In contrast, George (1969) found only 37% of births in the period from 08:00 to 18:00 in Merino ewes. Research on ewes that lambed in barns suggested that parturitions could be synchronised to an extent by manipulating feeding schedules and that feeding in the mornings, resulted in a relatively low proportion of late-night births, and more daytime births (Lindahl, 1964; Holmes, 1976;

Gonyou & Cobb, 1986; Field *et al.*, 1998). In grazing animals, like those in the present investigation, varying feeding regimes is an unlikely option for managers.

Only the paper by Alexander *et al.* (1993) was available for comparison with the present results on the interval between consecutive lambings. Their results were very similar to those reported in the present paper, with the intervals between the onset of births found to conform to a theoretical exponential distribution. They also found that the observed distribution deviated significantly from the expected distribution for small intervals between consecutive lambings. They argued that small departures from the expected distribution could become significant if the observed sample is large (their study included roughly 1900 births). On the other hand, they contended that such a deviation could be biologically real. The endocrinological and physiological mechanisms involved in the commencement of parturition are known (Rice *et al.*, 1984). Yet, it may be possible that the parturition process in near-term ewes could be stimulated by pheromones or vision, facilitating the commencement of other births when one ewe has started lambing (Alexander *et al.*, 1993). The latter authors argued that such factors could be turned into an advantage from an animal husbandry perspective if it could be properly understood. The present knowledge only allows speculation in this regard, and further research is indicated.

The interpretation of data on birth sites is affected by a variety of interacting factors, complicating interpretation (Alexander *et al.*, 1990). The latter study found that Merino ewes would generally lamb on the high ground of a paddock. Very little evidence of such a trend was found in the present study, with the possible exception of paddock A, where more birth sites were found in the higher eastern part of the paddock. Alexander *et al.* (1990) also found that birth sites tended to be concentrated around the boundaries of paddocks in breeds other than the Merino. This finding was related to an attempt of ewes to seek isolation prior to birth (Alexander, 1988). In four night paddocks higher proportions of ewes were found to lamb in the half of the paddock nearest to the boundaries, but no such tendency was found in the day paddocks. This trend could have been associated with the preference of ewes for the southern parts of the night paddocks, furthest from the floodlights and the building used as base for the observers. This preference was particularly strong in paddock A, where respectively 16, 25 and 40 ewes lambed in the top third (the northernmost part of the paddock), middle third and bottom third. In most of the other paddocks, equal or higher (in absolute terms) numbers of ewes were seen to lamb in the top third when compared to the middle third. There was evidence that birth sites near to trees along the boundaries of paddocks A and C was associated with the preference ewes showed for the outer half of these paddocks. The significance of this finding is not clear, since these paddocks were used at night, when shelter from the sun would not be regarded as important. Results from the present study thus neither supported nor refuted the contention of Alexander *et al.* (1990) that Merino ewes did not prefer birth sites along the boundary fences. The distribution of birth sites in our day paddocks would support such a contention, but not those in the night paddocks. The only outstanding feature of the paddocks that could be related to a concentration of birth sites was trees on the boundaries of paddocks A, C and H, as was stated previously. In the study of Alexander *et al.* (1990), Merino ewes were generally not attracted to birth sites that were characterised by logs, rock piles, individual trees, clumps of trees or contrived shelters. The distribution of birth sites in our study was much closer to random compared to the results of Alexander *et al.* (1990). This difference probably results from much smaller paddocks used (averaging approximately 0.4 ha), compared to 8 - 9 ha in the latter study. In general, patterns with regard to birth site preference were not associated with selection line.

Alexander (1988) reported that grooming is usually intense at first, but that it becomes spasmodic within approximately half an hour of birth. Bouts of grooming can be interspersed with grazing or eating hay (Edwards & Broom, 1982). A similar pattern can be discerned in this study (Table 2). Literature results indicated that single lambs were groomed more intensively than individual twins (O'Connor & Lawrence, 1992). When the total amount of grooming was considered, it was clear that an increased litter size was associated with an increase in overall grooming behaviour by the ewe. When the time-budget of ewes for the first 4 hours after lambing was considered, it was clear that a higher proportion of H line ewes groomed their lambs at first than L line contemporaries (Table 2). No conclusive line difference could be discerned about an hour after the first recording. It has previously been demonstrated that mild sedation of lambs led to less activity shortly after birth (Murphy & Lindsay, 1996). Ewes caring for these lambs spent less ( $P < 0.05$ ) time grooming their progeny, and longer periods separated from them. Although the effect of sedation was only temporary, the survival of sedated lambs to nine weeks was lower ( $P < 0.05$ ) relative to their contemporaries. Murphy & Lindsay (1996) contended that the poor vigour induced by sedation disrupted the formation of a strong dam-offspring bond, thus compromising subsequent lamb survival. Maternal and

neonatal behaviour of superfine wool lambs born as part of an embryo transfer program to either superfine or medium wool ewes was considered in a later study (Kuchel & Lindsay, 1999). Medium wool ewes spent more time grooming and less time separated from their superfine progeny than superfine ewes. Neonatal progress in the progeny of superfine ewes was slower, as reflected by fewer standing attempts, a longer interval to progress from birth to suckling and shorter periods that were spent standing or suckling. Lamb survival was correspondingly compromised in the superfine progeny of superfine ewes. Progeny from the H line that was assessed in the present study were quicker to suckle than contemporaries in the L line, and also had a higher survival to weaning (Cloete & Scholtz, 1998). This led the latter authors to hypothesise that higher levels of lamb vigour in the H line possibly stimulated maternal interest, thus enhancing the probability of survival. The greater initial interest of H line ewes in their lambs supports this line of reasoning, although it cannot be proved beyond doubt.

There was evidence that L line ewes were more likely to resume grazing shorter after birth than their H line contemporaries. The latter ewes appeared to be more content just to stand with their offspring at this stage. These results could possibly be related to the longer period that ewes caring for sedated offspring spent apart from their progeny, as reported in the study of Murphy & Lindsay (1996).

## Conclusions

If the supervision of Merino ewes in South Africa was to be confined to daylight hours in intensive systems, a substantial proportion of births would not be supervised. If further research substantiates the contention that births trigger each other under certain conditions, it would be of benefit to identify the mechanism involved. This knowledge could facilitate the synchronisation of natural births in pasture lambing flocks, where it is impractical to alter the distribution of births by nutrition. Although relatively few line differences were found in the present study compared to earlier work on other behavioural characteristics (Cloete & Scholtz, 1998), it could be mentioned that behavioural adaptations in the H line would generally facilitate lamb survival, as was found previously.

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