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BEHAVIOURAL INTERACTIONS OF DAIRY COWS WITH THEIR NEWBORN CALVES AND THE EFFECTS OF PARITY

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Abstract. Continuous observations of 82 individually penned Friesian cows and their calves were made during the first 6 h post partum. The behaviour observed was similar to that described for wild ungulates of the 'hider' type. Cows showed a marked decrease in calf-directed activities with time after parturition. This was more pronounced in older animals, which recommenced ingestive behaviour sooner. The incidence of licking and other maternal behaviour depends upon the characteristics of the calf and upon the state of the mother. Close proximity between cow and calf was maintained, in small calving pens, by the mother at the first three calvings but by the calf after these. The eating of the afterbirth is considered to be anti-predator behaviour. Calves of primiparous dams spent more time suckling and suckled from more quarters than did calves of older cows. Primiparous dams showed a higher incidence of abnormal maternal behaviour.

Detailed studies of maternal behaviour in species with precocial young are far outnumbered by those concerning altricial young, especially rodents and lagomorphs (Richards 1967), cats (Schneirla et al. 1963) and primates (Hinde 1974). Such studies are difficult to carry out on wild animals since close observation is generally impossible without causing disturbance. Detailed behavioural observations are difficult to make from a distance, since parturition frequently takes place in an area concealed by vegetation or within a group of conspecifics. These problems are minimized when studying domestic animals. Conditions on a farm are more standardized than in the wild, although the precise environmental control exercised in laboratory studies cannot be achieved. The animals are accustomed to the close proximity of humans and are thus less likely to be disturbed by an observer.

Domestication of cattle probably began 6000–8000 years ago (Zeuner 1963). In more recent times direct selection for either meat or milk production has resulted in divergent evolution into distinct beef and dairy breeds. In dairy cattle man has selected against some aspects of maternal behaviour, since the cow must let down milk in the absence of her calf and must be amenable to early handling of the calf and separation from it. Calves are generally removed from their dam at or soon after birth, and reared artificially. Hence the deleterious effects on the calf of poor maternal behaviour will be brief. It is thus of interest to compare the maternal behaviour of dairy cattle with that recorded for wild ungulates which have not been subjected to human selection on farms.

The first few hours following parturition are especially important in ungulates. There appears to be a critical period during which specific mother–infant ties are established and after which all unrecognized infants are rejected (Herscher et al. 1963; Le Neindre & Garel 1976; Hudson & Mullord 1977). In addition, the latency to first suckling determines the level of passive immunity achieved by the neonate and hence its subsequent likelihood of contracting infectious diseases (Selman et al. 1970c).

Walker (1950) published an account of the behaviour of three calves during the first 4 days of life. A more extensive study was carried out by Selman et al. (1970a, 1970b), who observed 30 cows and their calves during the first 8 h post partum. However the 20 dairy animals in this study were admitted to the research location only within the last few days of gestation and little information on their background was available. Broom & Leaver (1977) reported on the behaviour of dairy heifers and their calves, but based their results on relatively short observation periods at some time during the first 10 h post partum.

In the present study the behaviour of both cow and calf during the first 6 h post partum is described in detail. A large number of animals were observed under the same management conditions on a commercial farm.

Methods

Following a pilot study on cows calving in a field, 82 Friesian cows and their calves were ob-

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served in the autumn and winter at Sonning Farm, University of Reading. Prior to calving, the animals were moved into one of a row of individual calving pens, 3.0 × 3.8 m, which were separated by metal gates. Hay and water were available at all times. The parity of the cows was considered by grouping data as follows: first calvers (heifers), second calvers, third calvers, and fourth-plus calvers.

A continuous record of the behaviour of both cow and calf was made commencing at calving and continuing uninterrupted for the following 6 h. Observations were made from a position in full view of the subjects. The animals were accustomed to the close proximity of humans and appeared to pay little attention to a visible observer who remained still and quiet.

The measures of behaviour used in this paper are listed below. The terminology is largely that proposed by Cowie et al. (1951). The terms 'suckle' and 'suck' require additional comment. In colloquial and scientific usage, 'suckle' refers to the coming together of mother and young mammal so that the young obtains milk from the mother. Where the mother is active in initiating this occurrence it is often said that she suckles her young, but where the young are active in finding the teat, as in young ungulates, they are said to suckle. In this study the young are said to suckle when they take a teat in the mouth and make intermittent sucking movements. Suckling is directed exclusively to teats whereas individuals may suck a variety of objects. Whilst on the teat, the young animal can sometimes be seen to make sucking movements, which are attempts to draw milk into the mouth, but suckling includes the periods between sucks when the teat is still held in the mouth.

Cow behaviour. Stand — weight supported only by feet; lick calf — tongue applied to any part of calf (which part noted); sniff calf — nose within 2 cm of calf; nudge calf — pressure applied to calf with bridge of nose; approach calf — any whole body movement reducing the cow–calf distance; leave calf — any whole body movement increasing the cow–calf distance; eat — jaw movements while hay or complete diet in mouth; butt calf — pressure applied to calf with forehead; kick calf — strike calf with foot; vocalization — any vocalization of cow; rumination — rhythmical jaw movements, swallowing and regurgitation; cow–calf distance — distance between head of cow and nearest point on calf; cow–calf orientation — facing towards or away from calf.

Calf behaviour. Stand — weight supported only by feet; approach dam — any whole body movement reducing the calf–cow distance; leave dam — any whole body movement increasing the calf–cow distance; approach udder — any whole body movement reducing the distance between the calf's head and the udder to less than 0.5 m; nuzzle part of cow or object — contact between nose of calf and specified part of cow or object; vocalization — any vocalization of the calf; calf–cow distance — distance between head of calf and nearest point on cow; calf–cow orientation — facing towards or away from dam.

Measures of distance and orientation were recorded at 1-min intervals but all other recording was continuous.

The data were not normally distributed, so the Mann–Whitney *U* test was used for all comparisons between age classes, and for all changes with time each animal was matched with itself in a Wilcoxon matched-pairs test.

Results

At a late stage of pregnancy, whilst the cow was still in a field with other cows, it sometimes showed behavioural signs of the imminence of parturition. Some cows withdrew temporarily from the herd and stood apart for some minutes or hours. Others approached and attempted to sniff or lick alien calves. Both of these sorts of behaviour were very variable in their time of onset and many animals failed to exhibit either of them. The animals in this study were removed from the field to calving pens before parturition, but in a pilot study some cows moved away from the herd and calved in isolation whereas others calved in the midst of the herd.

Standing by Cow and Calf

Cows were always recumbent when calving unless there was human assistance. After calving, some cows vocalized a lot whilst others were largely silent. The delay before the cow stood up after calving decreased according to the parity of the cow (Table I).

The time spent standing by the cow decreased with time after parturition (Fig. 1). Heifers spent less time standing during the first hour post partum ($P < 0.01$). Unlike older animals, they increased their standing time from the first to the second hour ($P < 0.01$), before following the general decreasing trend over the rest of the 6-h period ($P < 0.01$ for all animals).

The time spent standing by the calf increased from the first hour, when many calves had not

Table I. The Behaviour of Dairy Cows and their Calves during the First 6 h Post Partum in Relation to Cow Parity

Measure of behaviour	Parity 1	2	3	4+
Median delay before cow first stands (min)	26.2	3.3	1.3	0.5
Median time standing by cow in 6 h (min)	218.6	237.4	282.9	226.9
Median time standing by calf in 6 h (min)	104.8	131.0	131.8	129.7
Median time lying by cow whilst calf standing (min)	6.5	13.2	14.4	27.9
Median time licking calf in 6 h (min)	54.3	64.1	56.4	50.6
Median duration of licking bout (s)	20.1	23.3	21.6	27.8
Median time facing away from calf by cow (min)	201	186	187	217
Median time facing away from cow by calf (min)	232	188	205	177
Median delay before eating hay by cow (min)	183.2	51.0	85.5	24.6
Median time eating hay by cow in 6 h (min)	16.1	23.6	20.1	39.3
Median % of time available that cow ate placenta	58.4	78.6	19.3	17.4
Median % of teat-seeking directed to body of cow	39.0	47.0	35.2	72.9
Median time suckling by calf in 6 h (min)	13.9	12.1	0	8.4
Median frequency of interruptions by cow of suckling and nuzzling udder by calf (min^{-1})	0.60	0.48	0.24	0.12
% of cows butting calf	26	16	12	0
% of cows kicking calf	39	10	12	12

yet stood for the first time, to the second ($P < 0.001$, Fig. 1). It then decreased from a peak during the second or third hour after birth, except for calves of fourth-plus calvers, in which the time spent active remained constant. Calves of heifers spent less time standing than calves of older mothers during the 6 h post partum ($P < 0.01$), principally as a result of the lower values during the first hour. There was no significant correlation between the total time a calf spent standing and the total amount of licking it received from its dam. ($r_s = 0.134$, $N = 81$, $P = 0.233$).

Occasions on which a cow remained lying while its calf was active were infrequent, occupying on average only 5.4 % of the total observation time. Since, on average, the cow was lying for 36.3 % and the calf standing for 33.2 % of the observation time, these events should have coincided over 12.1 % of the time if they were independent of each other. Therefore it appeared that the activity bouts of the cow and calf were synchronized, and the degree of synchronization decreased with parity: first calvings (1) versus fourth or later calvings (4+), $P < 0.001$; Table I. This synchrony could not be attributed solely to the behaviour of the cow or calf, since both initiated and terminated bouts of cow-lying–calf-standing. Bouts initiated by the calf rising were more frequently terminated by the calf lying again in fourth-plus calvers (58.8%). Younger cows more frequently terminated such bouts by rising also, so calves terminated only 40.8%.

Licking the Calf

Licking the newborn calf was the predominant behaviour shown by the cow immediately after calving, occupying 30% to 50% of the first hour post partum (Fig. 2). Licking the calf decreased markedly with time after calving. A very large drop of more than 50% occurred from the first to the second hour post partum ($P < 0.001$) and a smaller, but significant ($P < 0.05$), decrease was observed in every successive hour with the exception of the last hour. There was a positive correlation between time spent licking in the first hour after calving and total time spent licking during the 6-h period ($r_s = 0.65$, $P < 0.001$).

Over the 6-h period, heifers and fourth-plus calvers spent less time licking their calves than did second and third calvers ($P < 0.05$; Table I). In the case of the heifers this was attributed to the smaller amount of time spent licking during the first hour after calving ($P < 0.01$). This lower initial licking time was partially compensated for during the second hour after calving, when heifers licked their calves more than did older dams ($P < 0.05$; Fig. 2).

Licking bout-length showed a marked decrease from a median of 35 s to a median of 20 s ($P < 0.001$) between the first and second hour after calving, but then remained constant for the remainder of the observation period. There was no difference between parities during the first hour after calving, but over the 6-h period fourth-plus calvers showed longer bout lengths due to higher values during the last 3 h (1 versus 4+: $P < 0.05$).

Three heifers (8%) failed to lick their calf at any time during the 6 h after calving, whereas none of the 44 older mothers observed failed to do so.

Maintenance of Proximity

The mean distance between the cow's head and the nearest point on the calf increased markedly for cows of all parities ($P < 0.001$) except heifers, between the first and second hour, and then continued to increase steadily with time after calving for all parities ($P < 0.001$; Fig 3). Over the 6-h period this distance was greater for heifers than for older animals ($P < 0.05$). The distance between heifer and calf at five and six hours post partum (1.0 m) was very similar to the 1.25-m median value for heifers and calves of approximately this age which were observed in fields during the pilot study.

The proportion of time the cow spent facing away from her calf also increased with time after calving, from 19% in the first hour to 31% in the second hour ($P < 0.001$). After the first 3 h all cows spent about 40% of the time facing away. The oldest and the youngest mothers faced away most (Table I: 2 and 3 versus 4+, $P < 0.05$). There were no trends over the observation period in the proportion of time calves spent facing away from their dam. The overall value for the 6-h period was greater for heifers' calves than for calves of older animals ($P < 0.05$; Table I).

There was no change over time in the proportion of the cow's movements which decreased the cow–calf distance (Fig. 4). Fourth-plus calvers approached their calves less than younger cows ($P < 0.001$). Over the first 3 h, and especially during the second hour, heifers approached their calves more than older cows did ($P < 0.001$). No differences related to the parity of the dam were observed, over the 6-h period, in the proportion of the calf's movements which decreased the calf–cow distance, although calves of fourth-plus calvers approached their dams more during the first hour post partum ($P < 0.05$).

The relative roles played by the cow and calf in maintaining proximity are shown in Fig. 5. The difference between the percentage of approaches and the percentage of leavings due to the calf was positive for fourth-plus calvers, indicating that the calf played the greater role in maintaining proximity. In all younger cows the value was negative, indicating that maintenance of proximity was primarily attributable to the cow (4+ versus the rest, $P < 0.001$).

Eating Hay and Placenta

The time between calving and recommencement of eating hay by the cow decreased with parity (Table I). The amount of time spent eating increased with time after calving from 2 min in

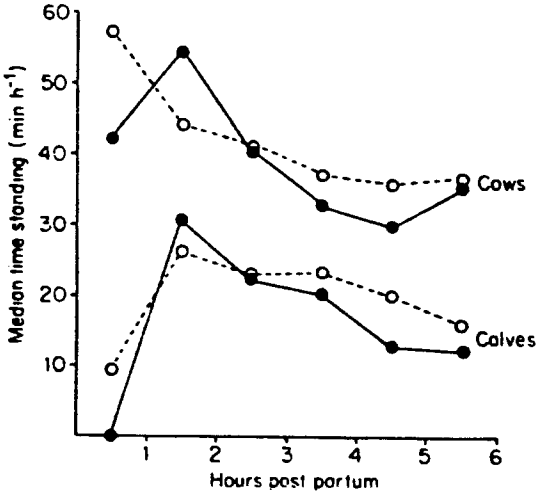

Fig. 1. The median time spent standing by dairy cows and their calves during the first 6 h post partum. Filled circles: heifers. Open circles: second-plus calvers.

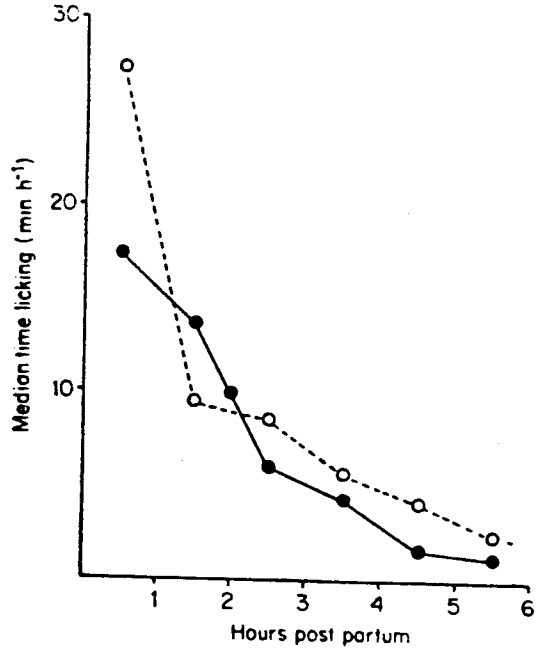

Fig. 2. The median time spent licking their calves by dairy cows during the first 6 h post partum. Filled circles: heifers. Open circles: second-plus calvers.

the first hour to 7 min in the sixth ($P < 0.001$). Fourth-plus calvers spent more time eating during the observation period than did younger cows ($P < 0.001$).

Expulsion of the placenta usually occurred between 2 and 6 h after the calf was born, and 89% of mothers ate the placenta. The percentage of time spent eating the placenta during the time that it was available is shown in Table I. This value was lower for third-plus calvers than for younger cows ($P < 0.01$). There was no overall correlation between the percentage of time spent eating the placenta and the amount of time spent licking the calf. All three heifers which failed to lick their calves also failed to eat the placenta, but two other heifers which did not eat their placenta licked their calves well and one licked its calf a little. All four older cows which failed to eat the placenta showed normal licking of their calves.

Teat-seeking and Suckling

A calf will often spend some time nuzzling a part of its dam's body other than the udder (Fig. 6). The amount of such unsuccessful teat-seeking by calves of fourth-plus calvers was much greater than that by calves of younger animals ($P < 0.001$). However there were no differences related to the parity of the dam in the time spent nuzzling at the udder. As these results indicate, the proportion of teat-seeking directed to parts of the dam other than the udder was greatest in fourth-plus calvers (Table I; $P < 0.001$). In all groups except fourth-plus calvers there was a marked decline in this value over the first 4 h. An increase in the percentage of teat-seeking directed at the udder corresponded to the peak times of suckling for each group.

The total time spent suckling during the first 6 h post partum is shown in Table I. The mean time spent suckling was greater for heifers' calves (Table I: 1 versus 2+, $P < 0.05$), but there was much individual variation. The majority of calves of third-parity cows failed to suckle within the 6-h observation period.

In all parity groups more calves suckled first from a front teat (72%, $\chi^2 = 10.96$, $P < 0.001$), and during the whole 6 h, a bias towards a front teat was observed in all parity groups (86%, $\chi^2 = 29.4$, $P < 0.001$). The mean number of different teats suckled from during the first 6 h post partum was 3.1 for heifers' calves and 2.6 for calves of older animals. Heifers' calves directed a smaller percentage of total suckling to the favoured teat (62%) and changed teats more frequently during a bout of suckling (mean of 8.7 times) than did calves of older cows (76%, $P < 0.01$ and mean of 2.9 times, $P < 0.001$).

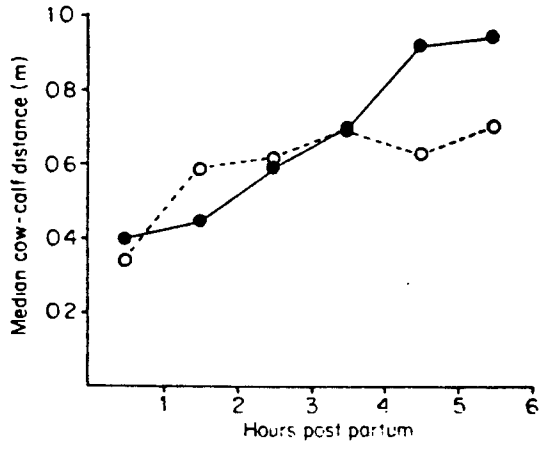

Fig. 4. The median % of dairy cows' movements which decreased the cow–calf distance during the first 6 h post partum. Filled circles: heifers. Open circles: second and third calvers. Squares: fourth-plus calvers.

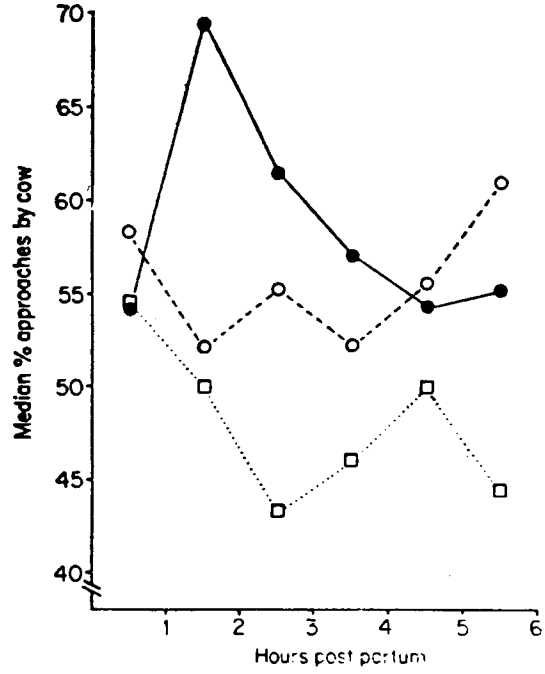

Fig. 3. The median distance between dairy cows and their calves during the first 6 h post partum. Filled circles: heifers. Open circles: second-plus calvers.

Maternal Interruption of Suckling, and Maternal Aggression

Older cows moved and thus interrupted suckling less frequently than did heifers (1 versus 2+, $P < 0.05$). Parity differences were even more pronounced when all breaking of the calf's contact with the udder, whether suckling or nuzzling, was considered (Table I; 1 versus 2+, $P < 0.001$).

Butting the calf and kicking it as it approached and nuzzled the udder were common in heifers, but were seen less often with increasing parity of the dam (Table I; both $P < 0.01$). Not only did the proportion of animals showing aggression decrease with the parity of the cow, but the frequency of aggressive acts was also much greater in heifers. No third or fourth-plus calvers butted or kicked their calves more than 10 times, but amongst heifers, 13% showed this amount of butting and 16% showed this amount of kicking. Butting occurred only when the calf was on its feet and was most commonly observed in response to an approach by the calf.

One cow, a fifth calver, killed her calf 80 min after calving by lying on its head and refusing to rise. The calf suffocated before it could be released. The behaviour of the cow had appeared normal prior to this event and she subsequently showed no signs of ill health.

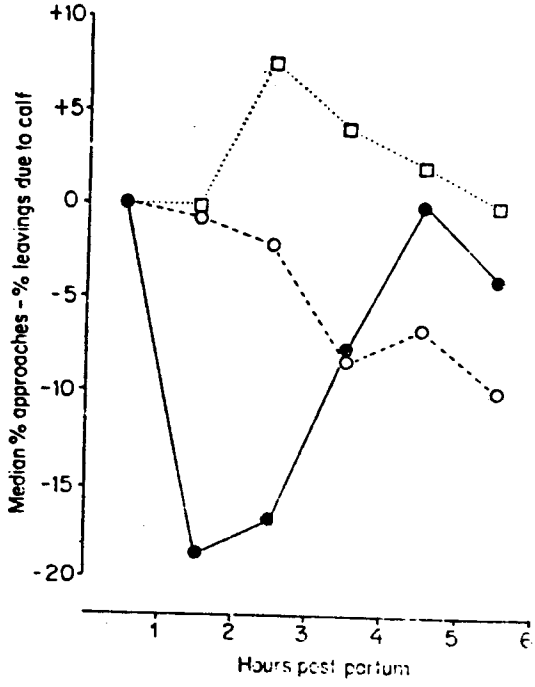

Fig. 5. The median difference between the % of approaches and % of leavings due to the calf during the first 6 h post partum. Filled circles: heifers. Open circles: second and third calvers. Squares: fourth-plus calvers.

Discussion

The major results of this study are the description of the interactions between 82 cows and their calves, during the first 6 h after parturition, and the clear differences in behaviour of mother and calf according to the parity of the mother. There are anatomical differences between heifers and older animals, e.g. in udder size and shape (Selman et al. 1970b; Edwards, in preparation), but some of the differences in behaviour with parity must be a consequence of the experience of the cow during previous calvings.

All unassisted calvings occurred while the cow was recumbent. This was also observed by Arthur (1961) and appears to be general in ungulates, since it has been reported for the majority of sheep (Arnold & Morgan 1975), horses (Rossdale 1968), and wild ungulates (e.g. Jarman 1976; Estes & Estes 1979). Selman et al. (1970a) observed that in two-thirds of births, calves were born to the hips while the dam was recumbent but parturition was completed when the dam stood. This was not observed to occur in the present study.

The latency to standing by the cow, after unassisted calving, decreased progressively with

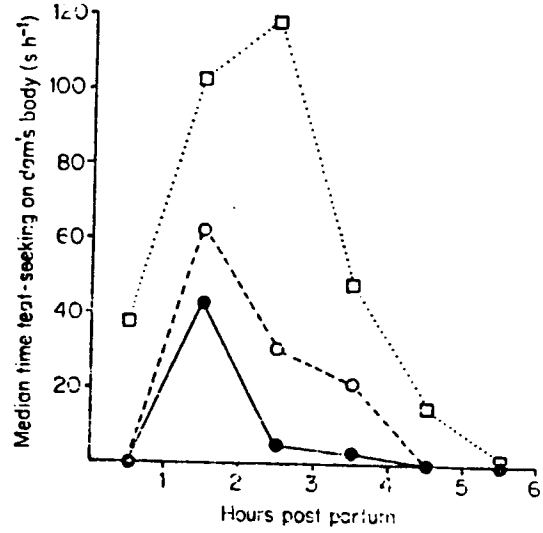

Fig. 6. The median time spent teat-seeking on parts of the dam's body other than the udder during the first 6 h post partum. Filled circles: heifers. Open circles: second and third calvers. Squares: fourth-plus calvers.

parity. Many heifers appeared initially exhausted by their exertions during calving. An association between difficult parturition and delayed standing of the dam has frequently been noted. One dairy heifer observed by Selman et al. (1970a) remained lying for 70 min after a difficult calving, whereas all other animals stood within 10 min, and most within 1 min, of the birth of the calf. Delayed standing by ewes is more frequently observed in those which have experienced a long labour (Shelley 1970; Leclerc & Lecrivain 1978). In one study it was reported that the percentage of ewes experiencing longer-than-average labour increased progressively, from 35% of animals standing within 1 min, to 100% of animals taking more than 10 min to stand (Arnold & Morgan 1975). Heifers requiring assistance at calving, if not standing at calving or forced to stand immediately afterwards, took even longer to stand after parturition. However, it was farm practice in such cases to drag the newborn calf to the head of the cow so that licking could take place without the cow standing. The prolonged lying could thus be attributed either to greater exhaustion after calving or the absence of the necessity to stand in order to reach the calf.

The licking of the neonate is a behaviour pattern common to the majority of mammalian species, the reported exceptions being in the Camelidae (Pilters 1956), Suidae (Fradrich 1974) and Phocidae (Le Boeuf et al. 1972). The widespread occurrence of this behaviour pattern amongst species occupying very different ecological niches indicates that such licking enhances the survival prospects of the neonate. Suggested functions of licking of the neonate include removal of the foetal membranes (Hediger 1955), drying of the coat and associated reduction of heat loss (Moore, in Blauvelt 1955), stimulation of activity in the infant (Barron, in Blauvelt 1955; Townsend and Bailey 1975), stimulation of breathing (Barron, in Blauvelt 1955; Arthur 1966), stimulation of the circulation (Moore 1968) and stimulation of urination and defaecation (Hediger 1955). Licking also serves to improve general nest and body surface hygiene, reducing the risk of both infection and predation (Sambraus 1973; Townsend & Bailey 1975). In species with precocial young, rapid formation of a specific mother–infant bond is essential, and licking of the neonate has been shown to play a very important role in this process. Performance of licking provides the dam with much olfactory and gustatory imput, and leads to what has been described as 'olfactory imprinting' of the infant on its dam (Klopfer et al. 1964). Ungulates prevented from licking their newborn offspring show a high probability of subsequently rejecting them, although a short period of neonatal licking is sufficient for formation of a specific bond which will survive subsequent separation (Klopfer et al. 1964; Hudson & Mullord 1977).

The intensity of licking was observed to be greatest immediately post partum and to decrease rapidly with time. Thus the period of maximum licking corresponded to the time at which the formation of a mother–infant bond was occurring. The decline in time spent licking after parturition has also been measured quantitatively for sheep (Bareham 1976). At this time there must be changes in the motivational state of the dam and in the stimulus characteristics of the infant. Immediately after parturition the coat of the neonate is saturated with amniotic fluid, which is progressively removed by licking. Parturient females are strongly attracted to birth fluids and will lick soiled objects and bedding (Rossdale 1968; Selman et al. 1970a; Lent 1974), sometimes to the neglect of their offspring (Tyler 1972; Jarman 1976). Licking of older alien calves can be induced by wetting their coat with amniotic fluid (Hudson 1977). Such results suggest that the decline in licking intensity is partly attributable to the progressive desaturation of the neonatal coat as amniotic fluid is removed. However, the positive correlation between licking during the first hour and the first 6 h post partum suggests that other factors are involved, since cows do not appear totally to compensate for delayed onset of licking. Furthermore Collias (1956) reported that washing of a newborn kid with strong detergent does not eliminate licking by its dam, and cows shortly before and after parturition may lick older, alien calves with dry coats (Edwards, in preparation). Thus the hormonal state of the dam is also important in determining licking intensity.

Total failure to lick the calf was observed only in heifers. This was also the case in the study by Selman et al. (1970a). Desertion was not possible in the housing conditions in which these observations were carried out, but may well have occurred had the opportunity existed. The incidence of desertion has also been found to be higher in primiparous than in multiparous ewes (Shelley 1970). The higher incidence of aggression directed towards the calf which was observed amongst heifers may have been a result of enforced proximity to the calf in animals which would have deserted had space been available.

Casual observations on heifers which had failed to lick their first calf showed that all licked their second calf adequately, as was also noted in the study by Donaldson et al. (1971).

Over the first 6 h post partum, heifers and fourth-plus calvers spent less time licking their calves than did dams of intermediate parity. In the case of heifers, this was attributable to the higher incidence of animals rejecting their calf and to the delayed onset of licking observed in the many animals which were slow to stand after calving. If the lower level of licking observed in heifers resulted from their greater sensitivity to external disturbance, it would be predicted that licking bout lengths would be shorter, as a result of more frequent alerting by the dam. This was found not to be the case. Selman et al. (1970a) observed that the duration of the initial intense period of licking was shorter in heifers than in older cows. Differences in the quality of licking between primiparae and multiparae have also been reported for deer (Bubenik 1965), and it was frequently observed in the present study that licking was initially more tentative in heifers. The lower level of licking observed in fourth-plus calvers may have been a consequence of the prevalence of hypocalcaemia, which principally affected older cows, during the observation seasons.

As intense interest in the neonate, as indicated by licking, decreased, cows spent more time lying and orientated less towards their calves, and the cow–calf distance progressively increased. Heifers appeared excited by the presence of the calf for a longer period, and took longer after calving to exhibit unrelated behaviour patterns such as eating. Older cows had their attention drawn away from the calf more quickly by other environmental stimuli such as food, so that fourth-plus calvers started eating again sooner, and spent more time eating over the 6-h observation period. Activity of the calf served to renew interest in it, as was described by Selman et al. (1970a). Cows seldom remained lying while their calves were active and frequently followed them when they walked away, as reflected by the negative value for the difference between the percentage of approaches and leavings due to the calf. While the calf was still wet and unsteady on its feet it was a source of great attraction to the cow. Heifers turned towards their calves more frequently than did older cows, keeping the calf in front of their head. This behaviour could be motivated by intense interest in the calf and desire to lick it, or by fear of the calf and desire to keep it in full view and in a position from which it could be fended off with the head. Since licking was not more intense in heifers the latter explanation is more probable, and it is supported by the frequent observations of heifers meeting with lowered head an approach by their calf. Greater fear of the calf, whose birth and presence comprise a novel situation for primiparae, may be the cause of the higher frequency of aggression and desertion seen in young dams (Duncan 1974). It has been suggested that the first parturition serves merely to give the animal experience in preparation for subsequent parturitions, and has no direct reproductive function (Hediger 1955). However this is unlikely, in view of the costs to the dam involved in gestation and parturition.

The apparently greater role played by the dam in the maintenance of proximity is also partly attributable to the large number of movements away from the dam shown by the calf. These occur especially towards the end of calf activity bouts. Cattle have been classified as a 'hider' species, since the calf lies away from its dam. In such species the neonate walks away from its dam at the end of an activity bout and selects its own bedding site (Lent 1974). This site was generally at the perimeter of the pen in this study, but in a pilot study it was often near or in tall vegetation such as maize (*Zea mays*). It has frequently been noted that infant ungulates bed down near vertical objects rather than in the open (Lent 1974; Scheurmann 1974).

Calf activity rose to a peak during the second or third hour post partum, before declining. Calves exhibited the greatest activity soon after first standing, and subsequent standing bouts were generally shorter, especially when early suckling occurred. Although licking by the dam often appeared to initiate or prolong a standing bout, there was no overall correlation between total licking received and total time spent standing. The time course of calf activity, with an early peak followed by a decline, cannot be attributed solely to decreased licking by the dam or to reduced teat-seeking activity after successfully suckling, since it occurs in calves isolated from birth (Scheurmann 1974). However it has been observed that calves spend less time lying and more time walking during the first day of life when their dam is present (Pytloun et al. 1974).

In this study, a high degree of synchronization of activity bouts of the cow and calf was observed. A similar observation was made by

Selman et al. (1970a), who attributed this principally to the reluctance of the cow to remain lying while her calf was active. However occasions on which the cow was lying while her calf was standing were found in the present study to be initiated and terminated equally by both partners. The lower level of synchronization of activity bouts observed in older cows may be attributed to the greater reactivity of heifers towards their calves, and to the higher incidence of clinical, and possibly also sub-clinical, hypocalcaemia in older animals.

Although they are normally herbivorous, most cows ate the placenta when given the opportunity. This has previously been reported for cows (Arthur 1961; Selman et al. 1970a; Broom & Leaver 1977) and sheep (Hafez et al. 1969). Among domestic animals both 'hider' and 'follower' species may thus eat the placenta. Such reports on wild ungulates generally came from 'hider' species (e.g. Townsend & Bailey 1975; Jarman 1976). In one 'follower' species observed, the wildebeeste (*Connochaetes taurinus*), the placenta is usually consumed by scavengers but there are indications that it is rarely eaten by the parturient female even if the opportunity exists (Estes & Estes 1979). Similarly, placentophagia is absent in Equidae, both domestic (Tyler 1972; Waring et al. 1975) and wild species (Klingel 1969). Because ungulate dentition is adapted to a herbivorous diet the placenta is poorly, if at all, cut up before ingestion (Arthur 1961). As a result of this, clinical problems may arise from choking and rumen malfunction (Galholtra & Gautam 1971). There are a number of reasons why eating the placenta may be adaptive despite such disadvantages (Galholtra & Gautam 1971). The behaviour is more common in altricial species and 'hider' species than in 'follower' species. Where the young remain at or near the birth site it is important for purposes of hygiene that the placenta is removed; and its presence would, in addition, attract predators to the vicinity of the neonate. The placenta also constitutes a very good source of minerals at a time when deficiency could occur in the dam (Keindorf 1974). Eating of the placenta may have arisen secondarily from a strong attraction to birth fluids and have evolved concurrently with licking of the neonate. An association between failure to lick the neonate and failure to eat the placenta was noted in the present study and in previous studies (Selman et al. 1970a). Species where the neonate is not licked generally also fail to show placentophagia, as in the Suidae (Fradrich 1974) and Phocidae (Le Boeuf et al. 1972).

Teat seeking by the calf was most intense soon after it first stood up. Calves of younger dams directed a progressively higher proportion of their teat seeking towards the udder with time post partum. Attention to the correct area appeared to be reinforced by successful suckling, as previously suggested (Fraser 1976). The higher proportion of misdirected teat-seeking shown by calves of older dams may well be a reflection of the poor conformation of these animals. Pendulous udders do not provide the correct stimulus characteristics to focus teat-seeking and they delay the reinforcement of correctly-directed teat-seeking from suckling (Edwards, in preparation).

The total time spent suckling during the first 6 h post partum decreased with cow parity, principally owing to a greater latency to first suckling and higher incidence of failure to suckle during the observation period seen in older cows (Edwards & Broom 1979). It was commoner for suckling to occur first from a front teat, as was observed by Selman et al. (1970b). Heifers' calves frequently suckled from all four quarters at some time during the observation period, whereas calves of older cows seldom suckled from more than two teats. This could reflect differences in milk supply or teat accessibility. Heifers' calves frequently changed teat within a bout of suckling and distributed suckling more evenly among the quarters. This could be because the supply of milk available from a single quarter was insufficient to satisfy the appetite of the calf. Older cows have more milk available in each quarter and it may therefore be unnecessary for the calf to suckle from more than one teat. However the difference in the number of teats suckled could also result from the poorer udder conformation of older cows. Heifers generally had small udders, with all teats accessible to the calf from one side of its dam. Older cows tended to have more pendulous udders and larger teats, which made access to, and gripping of, some teats difficult. It is noticeable in relation to this that all calves of third-plus calvers suckled most from a front teat. Once suckled, a teat became less swollen and easier to grip, a further factor acting in favour of continued suckling from the same teat in calves of older dams. Another factor which would tend to increase the frequency of teat changes by heifers' calves is the higher incidence of interruption of suckling by the dam. More frequent interruption of suckling by

primiparous dams has also been noted in sheep (Shelly 1970), and could arise from a number of factors. As discussed previously, primiparae seem more afraid of their offspring and more reluctant to allow them near the vulnerable abdominal region. They often appear to have more sensitive udders, flinching when contacted (Barty 1974; personal observation). Butting of the udder by the calf was more frequent for heifers, probably as a result of the more restricted milk supply and less ready let-down. Such behaviour, if too vigorous, is likely to cause movement by the dam. Older cows, on the other hand, have experienced a long period of machine milking, where failure to stand still during milk removal is subject to negative reinforcement.

Thus, despite selection by man for many generations, maternal behaviour in dairy cattle still differs little from that seen in wild ungulates. However, selection for larger body size and increased milk yield has indirectly affected behaviour by increasing the frequency of difficult parturitions and of dams with poor udder configuration. Parity differences are considerable and may be exaggerated by these factors, as well as by clinical conditions made more frequent by the metabolic pressures to which older cows are subjected.

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