Some factors affecting the behavioural manifestation of oestrus in cattle: a review

Agustín Orihuela*

Facultad de Ciencias Agropecuarias, Universidad Autónoma de Edo de Morelos,
Apartado Postal 5-78 Cuernavaca, Mor., 62051 Mexico

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Abstract

The development of more efficient and cost-effective oestrous detection techniques for cattle depends on a thorough understanding of the changes in behaviour and physiology of the female during its oestrous cycle. Variability in the expression of oestrous behaviours both between individuals and over successive oestrous cycles complicates this process. This review considers many of the biological and environmental factors that influence the intensity and duration of oestrous behaviours in domestic cattle. Topics discussed include dominant–subordinate relationships, social facilitation, animal density, oestrous synchronisation, nutritional status, age and physiological state, presence of the bull and breed differences. Facility design, cattle management and various techniques used to detect oestrus (e.g. frequency, duration and timing of observations) directly influence the efficiency of oestrous detection programs. Environmental phenomena such as weather, day length, photoperiod and ambient temperature also affect the expression of oestrous behaviours. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Standing immobile when mounted by a bull or female herd-mate is the primary and most dependable sign of oestrus and the best indicator that a cow or heifer is in a pre-ovulatory state and sexually receptive (Hafez et al., 1969; Baker and Seidel, 1985). Standing immobile for mounting defines ‘true oestrus’ (Phillips and Schofield, 1989). Pro-oestrus precedes and meta-oestrus follows true oestrus (Hurnik et al., 1975).

The intensity and duration of oestrous behaviours during the oestrous cycle is highly variable among individuals. Mounts initiated and received in female–female encounters...
during true oestrus may range from 1 to 150 (Esslemont and Bryant, 1976) and the duration of true oestrus may range from 2 to 48 h (Plasse et al., 1970; Esslemont and Bryant, 1976; Walker et al., 1996), including means of 6.7 h (Plasse et al., 1970) and 9.5 h (Walker et al., 1996). Cows may receive over 20 successful matings (services) during this period when exposed to bulls. Social interactions, housing and management factors, the physical environment impinging on the animal, nutritional status age and physiological state, genetic factors and presence of the bull can influence the behavioural manifestation of oestrus in cattle. The objective of this report is to present some of the more salient points relevant to these topics.

2. Social interactions

Social interactions including social dominance may play an important role in the manifestation of oestrous behaviours (Hafez and Lindsay, 1965; Galina et al., 1996). Some, but not all the animals in a group of heifers mount oestrous females (Hafez and Bouissou, 1975). Orihuela et al. (1988) found that 60% of the time female–female mounting was initiated by larger, heavier cows than those being mounted. If larger, dominant cows may inhibit the mounting activity of smaller, subordinate animals (Orihuela and Polanco, 1980; Allrich, 1993). In contrast, other research (Morrel et al., 1991; Orihuela and Galina, 1997) has reported no correlation between dominance rank and the frequency of mounts given versus received.

Social rank can influence the timing of reproductive behaviours in the herd and possibly underlying physiological mechanisms. Castellanos et al. (1997) found that in oestrus synchronised cattle, the behavioural manifestations of oestrus in the socially dominant members of the herd had a strong influence on the number of cows in oestrus at any given time. Social dominance can also influence the duration of oestrus (Chicoteau et al., 1989).

When oestrous cycles are synchronised, a sexually active group (SAG) of females is often formed (Williamson et al., 1972). SAGs are highly mobile and undergo frequent changes in membership (Chenoweth, 1981). One report (Blockey, 1978) indicated that oestrous heifers spent 97% of their time in a SAG. A single SAG was present 90% of the time.

The number and familiarity of animals in the SAG can also affect the manifestation of oestrous behaviours (Kilgour et al., 1977; Alexander et al., 1984; Helmer and Britt, 1985). With only one animal in oestrus, mounting activity and the duration of oestrus are minimal (Esslemont and Bryant, 1976; Helmer and Britt, 1985; Hurnik and King, 1987). In some cases, these single oestrous cows only attempt to mount others and are not mounted themselves (Hurnik and King, 1987). Hurnik et al. (1975) found that the number of mounts initiated increased from a mean of 11 with one animal in oestrus, to 36 with two and 53 with three cows in oestrus at the same time. The greater accessibility of sexual partners when several cows are in oestrus and the sexual stimulation provided by the SAG may explain this effect. The sexual performance (serving capacity) of bulls is improved if they are given the opportunity to observe mounting behaviour prior to being placed with females (Blockey, 1981).
Hurnik et al. (1975) found that 90% of mounted cows were in oestrus but only 71% of those mounting. In Zebu type cattle, mounting behaviour occurs almost exclusively between cows in oestrus (Galina and Arthur, 1990).

Mounts by cattle are typically brief, generally 5–7 s (Hurnik, 1987). If two cows are in oestrus, duration of mounting averages longer than if only one cow is in oestrus (7 versus 4 s, respectively).

Kilgour et al. (1977) concluded that when oestrus is synchronised in a herd, a higher proportion of animals will participate in the SAG because of the effects of social facilitation and sexual stimulation. Weston and Ulberg (1976) observed that the timing of oestrus in non-synchronised cows was similar to their progestagen-synchronised herdmates when both were run together. In a similar study, Orihuela et al. (1983) reported that about 80% of the non-synchronised cattle displayed oestrus within the same time period as their synchronised herd mates. In a more recent study (Medrano et al., 1995) in which cows were treated to exhibit oestrus one after the other at daily intervals, the cows tended to cluster their oestrous responses rather than exhibiting oestrous behaviours at the scheduled daily intervals. In addition, Porras et al. (1993) observed at least 60% of cows in oestrus in several Zebu-type herds treated simultaneously with Synchromate B (Ceva Laboratories, Mexico), while Medrano et al. (1995) found that a modest 40% of the cows displayed oestrus when the same treatment was given to individual cows at 1 day intervals. In the latter study, only 60% of the cows that responded showed sexual activity within the expected range of 34–57 h following implant withdrawal. The remaining 40% clustered their sexual activity with other members of the herd, again suggesting that cows tend to manifest synergistic behaviour.

‘Natural’ oestrus synchronisation has also been observed in the field (Lamonthe et al., 1995) and is believed to be more common among younger animals (Hurnik et al., 1975). This may explain why younger cows show fewer silent or undetected ovulations than older cows. Natural oestrous synchronisation suggests a certain effect of oestrous animals over the behaviour of their herdmates. Gutiérrez et al. (1993) proposed that some cows may imitate the oestrous behaviours of other cows.

Although temporal clustering of oestrous behaviour is most obvious between animals in the same pasture or pen it may also occur among animals in neighbouring pens, albeit to a lesser extent, especially if partitions permit sensory contact (Kilgour et al., 1977; Hurnik, 1987; Mohammed et al., 1991; Medrano et al., 1995).

Natural synchronisation of oestrus indicates that social influences, mediated through sensory stimulation can influence the activity of neuro-hormonal mechanisms controlling female sexual behaviour. Larson and Kiracofe (1995) have shown that some ovariectomised cows will display behavioural oestrus following progestagen-oestrogen treatment if accompanied by other cows displaying sexual activity.

Some cows appear to have preferred sexual partners in sexually-active female groups, a tendency which seems to be greater in mature animals (Castellanos et al., 1997). Some cows are highly attractive to all other cows in sexual interactions but seldom initiate approach and mounting during oestrus. Other cows exhibit the reverse relationship (Horrell and Kilgour, 1985). Some cows are more sexually active than others (Fraser, 1980; Orihuela and Galina, 1997).
3. Management factors

Oestrus detection is one of the more important concerns of cattle breeders using artificial insemination. The accuracy and efficiency of direct observation as an oestrus detection technique are affected by the frequency, duration and timing of the observation periods (Williamson et al., 1972; Hurnik et al., 1975; Orihuela et al., 1983).

Oestrus synchronisation has been used to increase the efficiency of oestrus detection and thus improve conception rates. Most reports on oestrus synchronisation have dealt with the influence of hormone treatments on interval to onset of oestrus, oestrus duration and conception rate (Fukui et al., 1985; Morbeck et al., 1991; Morrel et al., 1991). Walker et al. (1996) found the frequency and duration of oestrous behaviours highly variable with no differences between those induced by PGF$_{2\alpha}$ and those occurring spontaneously. Slenning and Farver (1990) reported that prostaglandin use decreased the accuracy of oestrus detection and increased the proportion of false negative detections by 61% over controls.

When comparing oestrus duration occurring naturally versus induced by PGF$_{2\alpha}$ (oestrus synchronisation), Vaca et al. (1985) reported mean duration of 15.3 and 13.3 h, respectively. Jaume et al. (1980) also found the average duration of oestrus in Zebu heifers slightly greater for natural oestrus (21.7 h) than when induced in an oestrus synchronisation program (19.8 h).

Lokhande et al. (1983) compared the efficiency of oestrus detection when using a progesterone releasing intra-uterine device (PRID), a progestagen implant and prostaglandin. Approximately, 70% of the cows were detected in oestrus using the PRID and the implant, whereas oestrus was observed in only 44% of the prostaglandin-treated cows. Similar findings were obtained in Indo-Brazilian cattle in Mexico, when comparing the accuracy of oestrus detection and subsequent fertility, using a progestagen or a prostaglandin (Orihuela et al., 1989).

In modern cattle breeding, hormone treatments have become common place not only for oestrous synchronisation but also for super-ovulation. However, relatively large amounts of exogenous FSH had no effect on the frequency of mounts initiated and received during oestrus (Jezierski, 1993). Furthermore, Coe and Allrich (1989) found no effect on the duration of oestrus under different serum concentrations of estradiol 17β.

The management of hormone treated animals may affect when oestrus is exhibited. Vaca et al. (1985) enclosed Zebu type cattle raised under field conditions in a pen for oestrus detection. Fifty percent of the herd injected with PGF$_{2\alpha}$ did not exhibit oestrous behaviour until about 110 h following injection and after being returned to the field, in contrast to the more typical 48 h delay commonly reported (Galina and Arthur, 1990). Conversely, the introduction of unfamiliar cattle into the herd may accelerate oestrous activity (Alexander et al., 1984).

Studies with European cattle have found that increasing stocking density will increase the frequency of oestrous cows meeting and interacting sexually. Barn-housed cattle exhibited more mounts per hour during oestrus than cattle housed on pasture (De Silva et al., 1981). Cattle maintained on pasture spend more time feeding (grazing) than animals confined in barns or corrals (Phillips and Leaver, 1986) and thus have less time to engage in oestrous behaviours.
The substrate on which cattle are housed can affect the frequencies of oestrous behaviours. Floors with good traction are preferred over slippery surfaces (Pennington et al., 1985). Mounting by oestrous cows is more frequent on slatted floors than in straw yards (Beneke et al., 1983), particularly by older cows (Hurnik et al., 1975), or cement floors compared to dirt footing (Rodtian et al., 1996). Several authors (Britt et al., 1986; Dozier and Britt, 1990; Vailes and Britt, 1990) reported that concrete surfaces greatly reduce the frequency of mounting and the duration of oestrus compared with dirt surfaces. The preference for a dirt surface is greater when foot problems are prevalent in a herd (Britt, 1982).

Other housing and management factors that may inhibit mounting activity are loud noises (particularly if unusual or irregular), low ceilings (Hurnik et al., 1975; Allrich, 1993), deep mud and the conditioned expectation of milking (Michalkiewicz et al., 1984; Hurnik, 1987) and feeding (Allrich, 1993).

4. Environmental factors

Environmental factors related to the season (Galina and Arthur, 1990), such as weather (Williamson et al., 1972), day length (Phillips and Schofield, 1990), ambient temperature (Zakari et al., 1981; Tucker, 1982; Pennington et al., 1985) and photoperiod (Hansen and Hauser, 1984) can influence the sexual receptivity and reproductive efficiency of cattle. Even the lunar phase (particularly full moon) can influence oestrous activity (Roy et al., 1980). Management systems which reduce or eliminate fluctuations in food availability, temperature and photoperiod, together with intensive genetic selection, can minimise or eliminate reproductive seasonality in cattle (Hurnik et al., 1975).

Sambraus (1978) has reported that the intensity of oestrous behaviour in cows is reduced in late fall and early winter relative to the summer months. Thibault et al. (1966) and Hauser (1984) found erratic oestrous cycles and long periods of ‘days-open’ more common during winter months. More recently, Wolfenson et al. (1988) and Gwazdauskas et al. (1990) reported that mounting activity (mounts per hour) of oestrous females was lowest during very cold weather, increased up to a maximum at about 30°C and then decreased again above this temperature. Gupta and Mishra (1980) found that oestrus duration of Brown Swiss × Sahiwal cattle in India averaged 12.6 h in the summer versus 18.9, 18.4 and 21.2 h in autumn, winter and spring, respectively. Zakari et al. (1981) in Nigeria also found seasonal differences in the duration of true oestrus, from 3.9 h in the dry season to 4.7 h in the wet season.

An extended period of high ambient temperature shortens the duration of oestrus and reduces the intensity of oestrous behaviour in dairy cows (Gangwar et al., 1965; Thatcher and Collier, 1986; Chicoteau et al., 1989). Arthur and Rahim (1984) found that heat stress in Holstein cows greatly reduced oestrus duration (5.3 h in the summer versus 10.2 h in the winter), particularly in older females (Hurnik, 1987). Verma et al. (1985) showed that Hariana × Brown Swiss and Hariana × Jersey cattle were better adapted to thermal stress than Hariana × Holstein, as evidenced by observing proportionately more animals in oestrus from the first two crosses in the hot summer months.

Shorter oestrous periods have also been reported when European cattle are moved to the subtropics or tropics possibly due to changes in nutrition, parasites and climate on
reproductive physiology (Hall et al., 1959; Rodtian et al., 1996). In general, *Bos indicus* cattle exhibit oestrous behaviours more readily in the hot summer months (Kumar, 1978; Pursey and Sane, 1978; Zakari et al., 1981) whereas in European cattle, cold weather, if not excessive, appears less inhibitory than hot weather (De Silva et al., 1981; Solano et al., 1982; Arthur and Rahim, 1984). Plasse et al. (1970), working with Brahman cattle, reported an association between low winter temperatures and long oestrous cycles plus a relatively high frequency of silent ovulations. Wolfenson et al. (1988) found that during the summer months, oestrous behaviour lasted longer for cooled (16 h) than in moderately-cooled (11.5 h) Holstein cows with low (2.6) body condition scores.

Some studies (Solano et al., 1982; Amyot and Hurnik, 1987; Gwazdauskas et al., 1990) have reported that the onset of oestrus occurs at dawn and during daylight hours whereas others suggest that mounting occurs more frequently during the evening or at night (Hall et al., 1959; Orihuela et al., 1983; Mattoni et al., 1988). Still other studies have found no difference in the incidence of sexual receptivity during day versus night (Esslemont et al., 1980; De Silva et al., 1981; Alexander et al., 1984). Most of the published information on Zebu-type animals indicates that oestrous behaviours are more likely to occur during the hours of darkness (Orihuela et al., 1983) or in the early morning hours (Galina and Arthur, 1990).

The intensity of oestrous behaviours may be associated with the time of day in which oestrus commenced. De Silva et al. (1981) found that animals in oestrus during the morning (a.m.) displayed more oestrous activity than those first seen in oestrus in the evening (11.4 versus 7.6 mounts per hour, respectively).

Other environmental factors that tend to suppress oestrous-related motor activities are heavy rain, strong wind and high humidity (Hurnik et al., 1975; Kilgour et al., 1977; Allrich, 1993).

5. Nutrition

It is often stated that malnutrition or specific nutrient deficiencies may interfere with or inhibit oestrous behaviours. Nutritional factors can promote or inhibit cyclic ovarian function (Rutter and Randel, 1984) but in general, nutritional factors do not influence the expression of oestrus as long as cyclic ovarian function is proceeding normally (Allrich, 1993). Overfed or severely undernourished beef cows show delayed postpartum oestrus compared with properly fed cows in moderate to good condition (Hurnik, 1987). Severe protein deficiency interferes with reproductive processes in dairy cows. Excessively high protein consumption, however, delays the onset of puberty and causes an increase in days open after parturition. Vitamin A deficiency postpones the onset of puberty (Hurnik, 1987). It is clear, however, that nutrition (and in many cases energy balance) has a large influence on the timing of the postpartum return to cyclic ovarian function (Canfield et al., 1990; Canfield and Butler, 1991; Allrich, 1993). A negative energy balance in the early postpartum period will prolong postpartum anestrus (Weaver, 1987; Bulter and Smith, 1989; Ferguson, 1991).

Negative energy balance or fat body condition in nulliparous heifers did not reduce the duration of oestrous behaviour (Villa-Godoy et al., 1990). In addition, nulliparous heifers
fed 80, 100 and 120% of National Research Council requirements for energy and protein did not differ in the duration of oestrus or in mounting activity (Knutson and Allrich, 1988).

Mineral deficiencies may also affect reproduction. It is known that phosphorus deficiency delays postpartum oestrus (Hurnik, 1987). However, in studies feeding 73, 138 and 246% of the National Research Council requirements for phosphorus in the diets of dairy heifers, no differences were found in the duration of oestrus or the frequency of mounting behaviour (Hurley et al., 1982). Insufficient cobalt in the diet causes irregular oestrous cycles, and inadequate manganese levels prolongs postpartum return to oestrus and if severe, may cause anestrus (Hurnik, 1987). This last author also reported that the intensity of oestrous is reduced as a consequence of β-carotene deficiency.

6. Age and physiological status

It has been stated that oestrus duration is shorter in heifers than cows (Fraser, 1980; De Silva et al., 1981). However, Esslemont and Bryant (1976) reported that the average duration of oestrus in 11 heifers and 22 cows was very similar (14.6±5.5 versus 15.1±4.4 h, respectively).

Gwazdauskas et al. (1980) found that the intensity of oestrous behaviour increased with parity, from 5.5 mounts per hour in oestrous maiden heifers, to 6.3 in first calf heifers to 7.9 in older cows. De Silva et al. (1981) reported that at the beginning of oestrus older cows exhibited more mounting activity than younger animals.

The number of mounts received by oestrous heifers and cows is highly variable. One study using lactating oestrous cows (Esslemont and Bryant, 1976) noted a range of 3–140 mounts received during oestrus, whereas another study using nulliparous heifers (Coe and Allrich, 1989) noted a range of 3–225 mounts received.

The tendency for oestrous cattle to form SAGs weakens with age (Hurnik and King, 1987). The composition of SAGs of heifers and cows may be different. Castellanos et al. (1997) found that heifers form fewer SAGs with more members per group than cows. Kilgour et al. (1977) found that SAGs with more than six participants were unstable. Castellanos et al. (1997) found that the individuals comprising SAGs of cows had a higher repeatability than those in heifer groups over successive induced oestrous periods.

Sharma and Lukute (1983) found that by 90 days postpartum, 15% of a herd composed of crossbred of Holstein, Brown Swiss and Jersey with Harianas still had not exhibited oestrus. The incidence of anestrus by 90 days postpartum was higher in primiparous females (25%) than in cows that had calved five times.

Changes in sexual activity may occur as oestrus progresses. Mounting (initiated and/or received) is greatest during the first hour of true oestrus, then gradually declines (De Silva et al., 1981; Hurnik and King, 1987).

After parturition, nursing or the mere presence of the calf will delay the onset of oestrous cycling and inhibit the display of sexual behaviour (Peters, 1984). Milked dairy breeds usually return to cyclic ovarian function sooner after calving than suckled beef breeds (Harrison et al., 1990; Azzam et al., 1991; Masilo et al., 1992). The average number of mounts (initiated and/or received) per cow per oestrus increases with each successive postpartum oestrus during the first 3 months after parturition (Hurnik et al., 1975; Kilgour
et al., 1977; Esslemont et al., 1980). Hurnik et al. (1975) found that in 98% of all mount interactions, at least one of the cows was in oestrus; 71% of the time, both were in oestrus. Phillips and Schofield (1990) were unable to induce mounting activity by an oestrous cow on a non-oestrous cow. Orihuela et al. (1983) working with Indo-Brazil cattle, found that 85% of the mounts were initiated by oestrous cows. Kilgour et al. (1977) found that diestrous cows would often initiate mounts when the SAG came nearby.

In European cattle, 6% of pregnant cows have been reported to participate in mounting oestrous penmates (Erb and Morrison, 1958). In Zebu-type cattle, less than 2% of pregnant animals become involved in mounting (Singal et al., 1978; Patil et al., 1982; Kaikini and Fasihuddin, 1984). Mounting by pregnant females generally occurs during the first 100 days of gestation, when oestrogen concentrations are usually low (Galina and Arthur, 1990).

During pro-oestrus and meta-oestrus, *Bos taurus* cattle are often observed only as mounters (Kilgour et al., 1977). However, in Brahman cattle, both mounters and mounted individuals have been observed prior to and following true oestrus (Orihuela and Galina, 1997).

Stress can shorten or inhibit oestrus (Allrich, 1993). Transporting field-raised Zebu cattle to a new pasture or enclosing them in a pen can suppress oestrous activity (Vaca et al., 1985). Tropical storms can have the same effect (Hurnik, 1987).

Because it is sometimes difficult to administer studies that directly induce stress on cattle, adrenocorticotropic hormone (ACTH) and/or cortisol are often administered in place of stressors. Intramuscular (IM) injections of 320 IU of ACTH during pro-oestrus delayed the onset and shortened the duration of oestrus in heifers (Hein and Allrich, 1992). Infusion of cortisol for 90 h to pro-oestrus heifers completely blocked the LH surge and oestrous behaviour without altering plasma estradiol concentrations (Stoebel and Moberg, 1982). When a one time injection of cortisol (0, 50, 100, or 200 mg) was given to estradiol-treated ovariectomised heifers, oestrous traits were not altered (Cook et al., 1987). When one injection of 4 mg of dexamethasone (a synthetic glucocorticoid) was given to estradiol-treated ovariectomised heifers, however, the percentage of heifers in oestrus decreased, but the behaviour of those heifers displaying oestrus was not altered (Cook et al., 1987; Allrich et al., 1989).

Rising oestrogen titters are thought to cause the LH surge associated with oestrus and ovulation (Chenault et al., 1975). Glencross et al. (1977) reported no direct relationship of either estradiol 17β or progesterone levels on the intensity of oestrous behaviour. However, De Silva et al. (1981) found that decreasing levels of progesterone and increasing levels of estradiol appear to exert a stimulatory effect on late oestrous activity.

Duchens et al. (1995) modified progesterone levels during the oestrous cycle of heifers using implants containing progesterone in different dosages between days 8 and 25 of the cycle (ovulation designated day 0). As dosages of progesterone increased, true oestrus became less evident and oestrous behaviours were weaker in intensity.

De Silva et al. (1981) noted that cows with longer oestrous periods had higher conception rates. Gwazdauskas et al. (1983) found no effect of the intensity of oestrous behaviour (mounts per hour) on conception. However, Thatcher and Wilcox (1973) reported a 12% increase in conception associated with increased postpartum oestrous activity.
7. Genetic factors

Species and breed differences exist with respect to oestrus duration (Anderson, 1944) and the intensity of oestrous behaviours (Lagerlof, 1951). The duration of sexual receptivity in *B. taurus* females varied from 4 to 48 h with means reported between 13.6 and 19.3 h, while in *B. indicus* cows the mean duration of oestrus was 6.7±0.8 (S.D.) h with two-thirds of 53 heifers between 2 and 7.5 h (Plasse et al., 1970). Johnson and Gambo (1979) and Johnson and Oni (1986) showed that the period of sexual receptivity of White Fulani heifers was significantly shorter than for White Fulani crossbred heifers sired by Holstein bulls (3.6 versus 8.2 h).

Differences in oestrous intensity between *B. taurus* and *B. indicus* cattle have also been reported (Phillips, 1993). Galina et al. (1982) reported that Brahman cattle averaged one mount (initiated and received) per hour during oestrus, whereas Charolais cows averaged 2.8 mounts (initiated and received) during a similar time period. Furthermore, Brahman cattle rarely mounted Charolais cows in oestrus, whereas almost 40% of the mounts received by the Brahman cows were initiated by Charolais females. Brakel et al. (1952) observed that Brown Swiss cows exhibited less intense oestrous behaviour than other breeds and suggested that, in general, dark-coloured breeds show more intense oestrous behaviour than cows with white or red hair colouration. Koppel et al. (1984) in Mexico, failed to detect differences in oestrous duration when comparing Zebu with Holstein cows and Zebu×Holstein crossbred females. The average duration of true oestrus for the three groups (combined) was about 13 h.

In general, oestrous behaviour has been reported to be less intense in tropical cattle (Plasse et al., 1970). Vale Filho et al. (1985) and Singh and Kharche (1985) reported that intense signs of oestrus could be observed in only 20–30% of the herd. Furthermore, Llewlyn et al. (1987) reported that only 27% of the *B. indicus* cows in their herd were detected in oestrus by mounting behaviour.

Rottenstein and Touchberry (1957) found a low heritability (0.21) for oestrous intensity (mounts per hour). This may explain, in part, the differences in oestrous intensity shown among cows from the same sire.

8. Influence of the bull

In heterosexual groups, Sambraus (1971) established that bulls become more sexually active in the hours of sunrise and at that time oestrous cows may be sexually receptive for longer periods. Orihuela et al. (1988) exposed the same herd of cows to different bulls in subsequent synchronised oestrous periods and found that different sexual activity patterns of the males elicited a different distribution of mounts received by cows within a 24 h period.

 Whereas the presence of a teaser bull may improve the percentage of cows detected in natural oestrus (Blockey, 1978), this advantage does not appear to exist when oestrus is induced and synchronised under pasture conditions. In Mexico, Wild et al. (1972), Orihuela et al. (1983) and Landivar et al. (1985) compared oestrous behaviours in groups of cows synchronised with PGF$_2$α with and without a bull present. No differences were
found in the percentage of cows detected in oestrus. When comparing the same group of synchronised females in consecutive oestrous cycles with the bull present or absent, Orihuela et al. (1988) found that peaks of mounting behaviour were more intense at night, when the bull was not present, confirming previous observations that the distribution of mounts is affected by the presence of the bull (Orihuela et al., 1983). It is not known if this difference is socially-induced and/or has a physiological basis. Fertility in both groups appeared to be similar (Wild et al., 1972; Landivar et al., 1985).

Teaser bulls used for oestrous detection in synchronised cattle often mount some females very frequently while others are ignored (Orihuela et al., 1988; Chicoteau et al., 1989). In one experiment, Kilgour et al. (1977) reported a cow that was ignored by the bull, but was mounted by other cows 17 times over 11 h. Plasse et al. (1970) also noted a bull who mated vigorously with certain females but who failed to show an interest in an oestrous heifer that was readily mated by other bulls. In some instances, heifers stood to be mounted by other females when they would not stand for the bull.

The timing of the first postpartum ovulation can also be influenced by bull exposure (Azzam et al., 1991; Burns and Spitzer, 1992). The presence of a bull stimulates the onset of oestrous behaviour in postpartum cows (Fraser, 1980; Zalesky et al., 1984).

Female–female mounting declines in the presence of a bull (Kilgour et al., 1977; Orihuela et al., 1988). In addition, SAGs may become fragmented (Kilgour et al., 1977). Differences in the sexual behaviours of bulls may affect their usefulness in oestrous detection (Rodrı́guez et al., 1993). Orihuela et al. (1988) reported that whereas one bull detected 30% of the oestrus cows by 50 h after PGF$_2$α injection, another male in a different group spent 60 h merely searching for cows in oestrus before his first mount was recorded.

Oestrus duration is shortened when cows are naturally mated (serviced) by the bull or artificially inseminated (De Alba et al., 1961; Price, 1985). Hardin et al. (1980) reported a reduction in the duration of oestrous behaviours in a group of cows treated with a uterine catheter 72 h after prostaglandin injection. Stimulation of the cervix by the penis of the bull or during artificial insemination may trigger physiological responses (e.g. release of oxytocin) that shorten the period of true oestrus (De Alba et al., 1961).

9. Atypical oestrus patterns

Hurley et al. (1982) looked at individual oestrous behaviours of heifers over two successive oestrous cycles and reported that repeatabilities were low for number of hours to the onset of oestrus following PGF$_2$α treatment ($r_1$=0.07), number of mounts received ($r_1$=0.24) and oestrous duration ($r_1$=0.02). Other studies (Rottenstein and Touchberry, 1957; Horrell and Kilgour, 1983) reported higher repeatability levels for oestrous behaviours (0.26 to 0.29).

Nelsen et al. (1985) and Rutter and Randel (1986) reported that young heifers may exhibit a behavioural oestrus not followed by ovulation and subsequent formation of a corpus luteum (non-puberal oestrus). This condition may characterise the first oestrus of up to 60% of heifers (Allrich et al., 1989).

In cattle, the first postpartum ovulation often is not associated with oestrous behaviour (silent ovulation). King et al. (1976) reported that only 50% of the first postpartum
Ovulations of dairy cows were accompanied by behavioural oestrus, 94% of the second and 100% of the third. A similar pattern was reported by Kyle et al. (1992).

Failure to exhibit behavioural oestrus during the first postpartum ovulation may be explained by high concentrations of estradiol at the end of pregnancy. Progesterone released during the first luteal phase following parturition removes the refractory state so that the second ovulation is more likely accompanied by oestrous behaviours (Kyle et al., 1992). Silent ovulations are more common during the warmer months of the year (Rodtian et al., 1996) and in dairy cows with higher levels of milk production (Stoebel and Moberg, 1982).

Johnson and Gambo (1979) working with White Fulani heifers in Nigeria, reported that only 3 of 32 heifers (9%) showed four consecutive periods of behavioural oestrus during 112 days of continuous observation, suggesting that silent ovulations are not that uncommon in heifers of this breed.

Cystic ovaries can be defined by the presence of enlarged follicles, 2.5 cm in diameter, that persist for 10 days (Emanuelson and Bendixen, 1991). These follicular structures develop but ovulation fails to occur (Ashmawy et al., 1992). Cystic ovaries are a frequent cause of atypical oestrous behaviour (Resende et al., 1972; Mohammed et al., 1991) and may affect up to 30% of European cattle (Youngquist, 1986). In general, cows with cystic ovaries mount other cows more frequently than they are mounted by peers. Cows with cystic ovaries in an advanced stage may show a tendency to develop masculine body conformation (Hurnik and King, 1987).

References


