

CATTLE REPRODUCTIVE BEHAVIOR

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Abstract

Knowledge of cattle reproductive behavior is important for optimal management, economics and welfare. Evolutionary behavioural traits of cattle which facilitated domestication included tractability, nutritional adaptability, large, hierarchal patriarchal groupings, promiscuous mating and early bonding of young. Females form sexually active groups, with bulls being attracted by observation of mounting behavior. Pheromonal recognition of oestrus requires close physical proximity. Social hierarchy in females can influence oestrous signs, with breed differences occurring. Female immobility is the major stimulus for bulls to attempt service. Females newly in oestrus are most attractive to bulls, with optimal fertility requiring multiple breeding. Bulls compete for eligible females, with dominant males achieving greatest female access. Bull dominance is associated with age and/or seniority. Although breed, body size, and presence of horns may influence social dominance, sex-drive and seminal traits apparently do not. Bull sex-drive, a genetically controlled trait, is associated with breeding success. It is not, however, directly linked with breeding soundness traits (semen traits and testicular size), body size, growth rate or overt aggression. Estimates of bull sex-drive include reaction time, libido score, serving capacity score and indirect hormonal assessments. Over-nutrition in young bulls can depress sex-drive. In general, single-sire breeding is more efficient than multi-sire, which works best with younger (<3.5 yrs), homogenous bull groups. The male effect ("biostimulation") does occur in cattle, with both intact bulls and androgenised females being shown to influence female puberty and post-partum cyclicity. At calving, cattle tend to be a "lying-out" species although considerable behavioural plasticity occurs. Beef breeds may show more intensive maternal behavior than dairy breeds.

Key words: reproductive behaviour, sex-drive, oestrus, dominance

Introduction

Species survival is ensured by the regular production of viable offspring. This, in turn, depends upon the successful execution of a number of behavioral processes. These processes include mating and the subsequent successful delivery and raising of the young. Positive genetic associations occur between a number of reproductive, behavioural and production traits. Thus, knowledge of evolutionary behavioural patterns allows best coordination of production, management, behavior and welfare. Domestication imposes new demands upon animals beyond those for which they have adapted over millenia of living in the wild. Domestication presupposes some degree of assimilation or adaptation of evolutionary behaviors. That this process is not easily

assumed is evident by the realization that only approximately 6% of current species of ungulates are domesticated (Tennessee and Hudson, 1981). Why are there so relatively few domesticated livestock species? Logic suggests that certain evolutionary behavioral traits should be more conducive to domestication than others. Such favorable traits include the following (after Hale 1962; Tennessee and Hudson 1981; Price 1984, 1985), many of which are evident in cattle;

- * *social structure which favors the formation of large, hierarchal groups,*
- * *association of males with females (at least on a seasonal basis),*
- * *male dominance,*
- * *promiscuous mating behavior,*
- * *sexual signaling by movement and/or postural cues,*
- * *early bonding of young,*
- * *relatively large adult size,*
- * *relative lack of territoriality,*
- * *tractability,*
- * *nutritional adaptability.*

Comparative Aspects of Sexual Behavior in Livestock.

Most food animal species are polygynous, which allows individual males to inseminate relatively large numbers of females (Price 1987). Male reproductive success in such a system is dependent upon adequate sex-drive (or libido), sperm production and semen quality (Chenoweth 1994a), as well as social rank. Modern production systems, by greatly reducing male to female breeding ratios (Lindsay 1996), place an even greater premium on many of these factors than required in the wild.

Reproductive Behavior of Cattle (*Bos taurus* and *Bos indicus*).

Cattle are not generally considered to be seasonal breeders, although seasonal effects on reproductive functions are reported. For example, females of *Bos indicus* breeds show a preference for long-day breeding with lowered cyclicity, and perhaps fertility, being evident during the late fall and winter months, even in subtropical and tropical environments (Randel 1984; Chenoweth 1994b).

Oestrus Behavior

Cattle are a seasonally polyoestrous species. Classical descriptions of oestrous behaviour include the onset of restlessness, mobility, vocalisation, mounting behaviour and standing to be mounted. Differences in estrous behavior have been noted between *Bos indicus* and *Bos taurus* breeds of cattle. Although some studies indicate that estrous cycle length is similar in both groups (Holroyd 1986; Mukasa-Mugerwa 1989; Galina and Arthur 1990), one study suggested that increased Brahman content in crossbred heifers was associated with increased cycle length (Holroyd et al 1993). There is, however, general consensus that observable oestrus is usually of shorter duration in *Bos indicus* females, and the external signs are less intense than those observed in *Bos taurus* cattle (Mukasa-Mugerwa 1989; Randel 1994; Chenoweth

1994b; Galina et al 1996). Part of this difference may be explained by greater difficulties in detecting oestrous in *Bos indicus* females, and their tendency to display behavioral estrus more commonly during evening hours (Chenoweth 1994b) and for oestrous females to engage in both mounting and standing behavior (Chenoweth 1994b). This last observation contrasts with those for *Bos taurus* cattle, where the mounted animal is likely to be in estrus, particularly if she exhibits immobility (Baker and Seidel 1985). Females of higher social rank within *Bos indicus* female groups are reluctant to allow themselves to be ridden by a lower ranked female (Orihuela et al 1988; Mukasa-Mugerwa 1989). Also, some high ranking *Bos indicus* females appear to not participate in mounting behavior, either actively or passively, differing again from observations with *Bos taurus* cattle indicating that cows higher in the social order are usually the ones which initiate mounting activity (Mylrae and Beilharz 1964).

Dairy breed females are reputed to mount more often during oestrus than beef females (Baker and Seidel 1985), possibly because of greater selection for this trait, especially in systems where males are largely or completely absent. Widespread use of AI in dairy cattle has probably caused indirect selection for overt oestrous behavior (Hohenboken 1987), even though high milk production in dairy cows has been associated with weak or irregular oestrus (Weber 1911; Morrow 1966). In turn, oestrous intensity, a trait that has been shown to be genetically influenced in dairy cattle (Gwazdauskas et al 1983), has been positively associated with conception rates in both *Bos taurus* and *Bos indicus* cattle (Bonfert 1955; Hall et al 1959) (Morales et al 1983). An heritability of 0.21 has been recorded for estrous intensity by Rottensten and Touchberry (1957), who also obtained a within-year repeatability for oestrous behavior score of 0.29.

Male Sexual Behavior

In breeding herds, males are attracted to females primarily by the sight of female mounting, or more particularly, females standing to receive mounting. It has been shown that bulls are primarily attracted to the inverted U shape which resembles the rear end of the female. Where this exists, the presence or lack of oestrus is largely irrelevant in eliciting a mounting response from the bull, as shown by routine use of steers as mount animals in semen collection centers (Chenoweth 1981). Pheromones also play a role in helping bulls to detect receptive females, even though the appropriate bovine pheromone(s) has yet to be isolated. However, evidence suggests that pheromonal activation requires close physical contact for implementation in cattle (Jacobs et al 1980) and that it generally represents a secondary oestrus detection tool. Vision is the primary tool that bulls use to detect oestrous females (Hale 1966; Geary and Reeves 1992). This process is facilitated by the tendency of females in both late pro-oestrus and oestrus to form a sexually active group (SAG). This group is very mobile and yet usually stays within visual contact of the bull or bull group (Williamson et al 1972; Chenoweth 1981). Females in heat generally become more active and vocal than they do at other phases of the oestrous cycle. Bulls tend to be most attracted to females who are newly in oestrus, and provision of a new stimulus female can restore

sexual interest in satiated males (Almquist and Hale 1956).

Bulls are polygynous, tend to be hierarchal and compete for eligible females, with successful males generally being those higher in social rank. Competition can increase bull sexual response, as can prestimulation (Mader and Price 1984). Social dominance can directly influence reproductive success as males of high status have greater access to females than more lowly males. This may be advantageous if dominance is associated with other favorable reproduction and production traits. Unfortunately, however, social dominance in male livestock is not synonymous with bull libido or other fertility traits (Ologun et al 1981), leading to the possibility that dominant, infertile males may cause depressed herd fertility when multi-sire breeding is employed. Social hierarchies are rapidly established in bull groups, with highest status often being associated with age and seniority within the herd. However, breed effects also occur, as well as those associated with physical size and presence of horns.

Bulls tend to be first attracted to individual females in late pro-oestrus, with the ultimate cue for attempted copulation being immobility, or standing behavior of the female. Bull courtship behavior aims to elicit or detect standing behavior in the female, and may include real or sham mounting attempts, chin resting, nudging, licking and sniffing around the perineal region of the female (Chenoweth 1997). In turn, females play a major role in mate selection and can greatly influence the timing of mating and the male(s) involved (Chenoweth and Landaeta 1998). Pre-stimulation of males increases sexual response (Chenoweth 1997). For young bulls, a learning process is often necessary before competent and confident mating ability is achieved, and for full expression of sex drive (Landaeta et al 2000). Bulls possess a fibro-elastic penis, which increases much in turgidity during copulation, but not in size. Copulation is rapid with ejaculation usually being completed within 1-2 seconds. Many bulls display a corkscrew action of the penis during ejaculation (Seidel and Foote 1969). Bulls are capable of short bursts of great reproductive activity, dependent upon their inherent sex drive, opportunity and stimulus pressure (Chenoweth 1997).

Fertility in the natural breeding bull is influenced by a number of factors including sperm production and semen quality, sex-drive and social interactions among animals in the breeding herd (Chenoweth 1994). That bull sex-drive is able to be measured in a repeatable manner, and that it plays an important role in this equation, has been demonstrated in a number of studies (Chenoweth 1997). It is also evident, however, that some learning or maturing component is involved in the full development of competent bull mating ability (Landaeta et al 2000). This can lead to inaccurate results when young bulls are subjected to sex-drive assessment procedures.

Breed differences in bull sex-drive have long been reported. Several reports indicate that dairy breeds may be more sexually active than beef breeds (Amann 1976). Reference has been made to a "sexual sluggishness" exhibited by zebu bulls, at least when they were subjected either to semen collection or a pen test to assess sex-drive .

In tropical Australia, Brahman and Brahman crossbred bulls obtained the lowest scores in libido tests, Africander-type bulls achieved the highest, whereas European bred bulls were intermediate (Perry et al 1991). In US studies, higher sex-drive assessment scores were also obtained from *Bos taurus* bulls than from *Bos indicus* bulls (Chenoweth et al 1996). Current testing procedures may disadvantage *Bos indicus* bulls which may have earned an unfair reputation for low libido. When bulls were bred with oestrous synchronized females, *Bos indicus* derived bulls were as efficient in detecting, serving and impregnating estrous females as were *Bos taurus* bulls, even though their service rate was apparently lower (Chenoweth 1994a). This discrepancy may occur because *Bos indicus* bulls tend to be selective and shy breeders, and generally do not perform well in pen testing of sex-drive, even though they can be very active and efficient detectors of oestrus in the pasture. Zebu bulls have also been reported to be reluctant to breed with females of other breeds, particularly when a choice is available or when they are faced with competition from bulls of other breeds (Chenoweth 1997). However, selectivity in breeding partners has also been reported among *Bos taurus* breeds of bulls. Although such studies have generally implicated the bull as being the partner which initiates and controls sexual contact, increasing evidence suggests that female choice might play a major role in such outcomes.

The evidence for genetic influences on bull sex-drive is strong. In Scandinavia, pairs of monozygous twin bulls raised on differing nutritional regimes showed greater similarity within pairs in mating behavior and temperament than between pairs, suggesting strong genetic influences upon these traits (Bane 1954). Paternal half-sibs of Swedish bulls differed significantly in libido and variations were greater between sire-son groups than within them (Hultnas 1959). Studies showing that cross-bred bulls generally exhibited higher sex-drive in pen-tests than did their parental pure breeds show that heterosis also influences bull sex-drive (Chenoweth and Osborne 1975; Perry et al 1991). In Colorado, line of breeding (inbred lines or crosses among inbred lines) was an important source of variation in bull sex-drive (Chenoweth et al 1977). Similarly, breeding lines and sires-within-lines differed for libido scores in young bulls of British breeds (Ologun et al 1981). Here, high sex-drive was not synonymous with either superior production traits (average daily gain or final test weight) or high social ranking. Sire strongly influenced serving capacity in young Angus bulls (Boyd et al 1988). A number of studies have indicated that measures of traditional breeding soundness criteria, such as scrotal circumference and semen traits, are not significantly correlated with sex-drive estimates in bulls (see Chenoweth 1997), indicating that they should be regarded as separate traits, at least for assessment purposes. An heritability estimate of 0.59 ± 0.16 serving capacity in a study of 157 paternal half-sib bulls in Australia.

Biostimulation.

This discussion of the reproductive behavior of cattle would be incomplete without reference to biostimulation, or the "male effect" (Chenoweth and Spitzer 1995). Male animals can trigger neuroendocrine reflexes in conspecific females which can influence

their hypothalamic-pituitary-ovarian functions (Signoret 1980). This effect has been observed in sheep (reviewed by Lindsay 1996), goats (Shelton 1960; Chemineau 1983); red deer (Iason and Guinness 1985), wild pigs (Delcroix and Mauget 1990) and cattle (reviewed by Chenoweth and Spitzer 1995). In domestic animals, biostimulatory effects are most evident in sheep and swine, where management techniques are commonly employed to exploit them. These include the sudden introduction of rams to ewes during transitional periods from the "non-breeding" to the "breeding" season to initiate group cyclic activity, and the exposure of peripuberal gilts to boars to advance and stimulate puberty. Important prerequisites for the "success" of biostimulation appear to include prior female isolation, the sudden introduction of rams and physiological "readiness" of the females (Signoret et al 1984). In cattle, there is considerable evidence for a biostimulatory effect on post-partum return to oestrus, and equivocal evidence for such an effect on the onset of female puberty (Chenoweth and Spitzer 1995).

Maternal Behavior

Cows in free-ranging herds are reported to leave the herd for calving although this is possibly less common for cattle on more intensive pasture systems. Cattle appear to show a considerable degree of behavioral plasticity in calving behavior, with this being influenced by factors such as availability of nutrition, type of terrain, threat of predation and the need for bonding with the calf (Chenoweth and Landaeta 1998). Important criteria for selection of a birthing site apparently include dry, soft bedding with provision of cover. The time of day at which most births occur has varied in different studies, with strategic feeding being shown to influence this (Gonyou and Stookey 1987). Females bond with their newborn very early in the postpartum period, probably while they are still wet with birth fluids (Gonyou and Stookey 1987). Cattle have been described as a "hider" species as there is a preference for seclusion of the young away from the main herd for at least several days after birth, during which time the mother grazes within earshot and returns regularly to the calf. Older calves may be left under the watchful eye of a "nanny" cow under extensive conditions, with this trait being particularly observed with *Bos indicus* breeds.

Large individual differences have been observed to occur in calving behavior. However, breed differences were reported in a study by Le Neindre (1989) in which maternal behavior exhibited by a beef breed (Salers) was more intense than that shown by a dairy breed (Friesian). This, together with the observation that beef females tend to leave the herd at calving more readily than dairy females ((Lidfors et al 1994), could suggest that dairy cattle have been strongly selected for less intense maternal behavior in comparison with beef breeds in which strong maternal behavior is still prized (Le Neindre 1989). Females of *Bos indicus* breeds are generally regarded as being strongly protective mothers, an observation apparently supported by Williams et al (1991) with evidence that the direct additive genetic influence of the Brahman was positive for weaning rate of calves. Temperament score at calving, a putative indicator

of maternal ability, was shown to differ among beef breeds in New Zealand, although heritabilities for behavioral traits were generally low (Morris et al 1994). Lastly, an important contributor to calf losses in *Bos indicus* females in Australia is considered to be abnormal development of oversized or "bottle" teats in dams, which can become too large or unwieldy for effective suckling (Frisch 1982; Holroyd 1987). Survival of *Bos indicus* neonates has also been identified as a problem in the Gulf States of the U.S., particularly during colder weather, although here the primary problem appears to be one of either obtaining or utilising adequate energy sources (Chenoweth 1994b).

References.