



**Behaviour of Young Dairy Bulls under
Group Housing Conditions and Mature
Dairy Bulls during Semen Collection**

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Master of Science Programme in Veterinary Medicine
for International Students
Faculty of Veterinary Medicine and Animal Science
Swedish University of Agricultural Sciences

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The present thesis is a partial fulfilment of the requirements for a Master of Science Degree in Veterinary Medicine for International Students at the Swedish University of Agricultural Sciences (SLU), in the field of Ethology

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Dedication

**To my father who spent his whole life and energy to make me
grown up and educated
To my mother who bore all kinds of hardships to bring up
seven children
To my sisters who always pray for me
To my brothers who helped and encouraged me in all aspects of
my life
To my country 'Pakistan' which gave me my own identity in the
world**

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Abstract

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This thesis consists of two studies carried out at a semen collection centre (Svensk Avel) in the South-West part of Sweden.

The first aim was to observe the behaviour of young dairy bulls under group housing conditions and difference in the aggressive and other social interactions between the bulls. Behaviour of 163 bulls of Swedish Holstein (SH) and Swedish Red and White Breed (SRB), from 1.5 to 4 years, was observed. The bulls were housed in groups of 7-12/pen in 16 different pens in two half open buildings. The bulls were divided into three age groups (2, 3 and 4 year). Statistical analysis was done to test the difference of age, breed and observer on the general behaviours, and the effect of age, breed and breed*age on the social interactions. A significantly higher percentage of lying in the 2 year age groups, ruminating standing in the 3 year age groups and rubbing walls in the 4 year age groups was found. Aggressive behaviour was the major social interaction among the bulls of all age groups. Mounting was significantly higher for the 2 year age groups and lower in 4 year age groups. It was concluded that the bulls living under group housing conditions spent most of their time standing, eating and lying ruminating (during our observation period). The bulls showed a quite high level of aggressive behaviours, but that did not seem to cause harm to their health. There were no differences in the aggressive behaviours between breeds and age groups.

The second purpose was to observe the behaviour and the reaction time (RT) of mature dairy bulls during semen collection and the effect of handling staff (3 persons at a time) and other factors during semen collection. Effect of delayed RT on semen quantity, semen quality and total sperm collected (TSC) per ejaculate was also investigated. Behaviour of 18 bulls (13 SRB and 5 SH) was recorded. The bulls were divided into four age groups (5, 6, 7 and 8 year). Statistical analysis was done to investigate the effect of day (once or twice a week), order (of the bulls 1-9, during semen collection), age group, handler A, B and collector (seven people handling bulls on different days) on RT, behaviours, semen quantity, semen quality and TSC. The RT to first mount, first semen collection and second semen collection was 253.84 s, 91.08 s and 110.02 s respectively. A significant effect of handler B and day on RT to first ejaculation was found. Walking, sniff teaser and vocalize tended to be affected by handler A. A significant negative correlation between RT and semen quality, RT and TSC in the first semen ejaculates was found. A higher number of sperms per ejaculate were collected from the bulls being collected once a week. It was concluded that RT and some behaviours of the bulls was affected by the presence of different handling persons in the semen collection hall. Moreover long RT caused a decreased TSC with low quality.

Keywords: dairy bulls; group housing; behaviour; aggression; social interactions; reaction time; semen quantity; semen quality; total sperm collected

Introduction

Swedish Red (SR) and Swedish Holstein (SH) are the most common dairy breeds in Sweden. Bulls used for semen collection have traditionally been kept on individual tie stalls while waiting for the evaluation of their progeny testing. Since cattle are highly social domestic animals (Bouissou *et al.*, 2001) a new way of keeping bulls in groups was introduced by Svensk Avel, Sweden in 1987. Group housing of cattle is a much discussed topic in Europe and group housing is compulsory in the European Union for calves over eight weeks of age (Council Directive 97/2/EC, 1997). There is no such regulation for keeping older bulls in group housing system. The group size of bulls, at Svensk Avel, is near to the natural feral group sizes. Bulls from one and a half to four years of age are kept in groups of 7-12 bulls per pen which is similar to the numbers previously reported in feral groups (Bouissou *et al.*, 2001). Outside the mating period, three to four year old males have been reported to live either solitary or in male groups of two to ten individuals (Bouissou *et al.*, 2001).

Aggressive behaviour is commonly observed among bulls at pasture (Kilgour & Campin, 1973), in feedlots (Gonyou & Stricklin, 1984), in paddock (Hunter & Edwards, 1964) and in natural feral cattle (Schloeth, 1958, 1961; Hall, 1989). Agonistic behaviour as a major behavioural response in bulls was also recorded by Jago *et al.* (1997). At Svensk Avel most of the fighting problems have been observed among bulls which are either 1.5 or 4 years old. Bulls often start fighting just after being placed into new groups at Svensk Avel at the age of 1.5 year. These bulls, before coming to Svensk Avel, had been kept in groups at Falkenberg bull station. Then bulls remain almost in the same groups up to the four year of age. The fights stop after a period of time, but bulls start fighting again just before four years of age. This is probably age of bulls when they become dominant, because in feral cattle middle-aged males (3-5 years) tend to become dominant (Bouissou *et al.*, 2001). May be, there are only one or two bulls in each group who disturb the equilibrium of the whole group at Svensk Avel. Either these bulls have become bullied (always fight with other bulls) or they are high ranked (dominant) bulls in that group. When bulls at Svensk Avel reach the age of four years it is not possible to keep them in groups any more because of the hard fighting among the bulls. So, bulls have to move to individual pens. According to the knowledge of the author there is no behavioural study that has been done in the past on young bulls kept in this kind of group housing system. Behaviour is a sensitive measure of animal welfare, probably more sensitive than animal health or production because it is elastic and easily modified in stressful conditions (Raussi, 2005). Welfare is defined as the quality of life experienced by an animal (Bracke, Metz & Spruijt, 2001). Behaviour of feral cattle can give us some clue about the natural behaviour of bulls (Bouissou *et al.* 2001). In this study we have observed the behaviour of bulls kept under farm condition and tried to compare with behaviour of bulls in feed lots, paddocks, pasture and the natural feral cattle.

At Svensk Avel variations in reaction times have been observed in the mature bulls when the semen was collected. Some times a normal healthy bull takes a longer time for semen collection than normal and some times even it refuses to

give semen. The entire procedure of semen collection mentioned by Collins, Bratton & Henderson (1951) was followed at Svensk Avel. Usually semen is collected from a bull within one ejaculatory thrust and that might take a few seconds. The period of time during which the bull approaches the mount prior to copulation has been termed the reaction time (RT) (Mercier, Bratton & Salisbury, 1949; Kerruish, 1955). The factors affecting RT of bulls like; attendants and nearby structures (Kerruish, 1955) as well as psychological and other factors (Fraser, 1960) has been discussed in detail. Better quality semen have been obtained from bulls restrained for a while just before semen collection (Collins, Bratton & Henderson, 1951) and some other studies have also reported the same results (Amann & Almquist, 1976; Hale & Almquist, 1960; Hafs, Knisely & Desjardins, 1962; Foster, Almquist & Martig, 1970; Hafs, 1972; Almquist, 1973). Restraining a bull for a while near the mount animal before semen collection was termed as *sexual preparation* (Amann & Almquist, 1976). Moreover they have discussed the methods to decrease RT. According to the knowledge of the author the factors affecting RT in the semen collection room and the effect of delayed RT on semen collection has not been studied in detail before.

It should be noted that most of the literature on the sexual behaviour of the cattle is between 20 and 50 years old, and much is descriptive in nature. There appears to be a need for the conduct of some rigorous hypothesis testing in this subject area (Petherick, 2005). The first purpose of this study was to observe general and social behaviour of young dairy bulls under group housing conditions and to investigate the difference in the aggressive and other social interactions. Moreover, if there was any homosexual, bullee or dominant bull in the groups. The assumption was that there was a big difference in the aggressive behaviour of the bulls in different age groups and that the youngest and the oldest bulls would fight the most. The second purpose of this study was to observe behaviour, RT, factors affecting RT and effect of long RT on semen volume, semen concentration and total sperms collected (TSC) per ejaculate in mature dairy bulls during semen collection. It was supposed that there was no effect of RT on semen volume, semen concentration and total sperm produced per ejaculate. To start with a detailed literature review is provided in this thesis.

Aims of the investigation

The general aim of this study was to observe the normal behaviour of the two most prevalent breeds of Swedish dairy bulls when they were kept under group housing conditions (from 1.5 to 4 years of age) and during semen collection. The research has been split up into two studies.

More specifically the aims of the first study were to investigate;

- 1) The difference in general behaviour between different breeds and age groups
- 2) The difference in the social behaviours, especially aggressive behaviours, between breeds and age groups.
- 3) Whether there was any kind of affiliation developing among the bulls reared in groups; as for example if there was any type of sexual relation (homosexuality), any sub-grouping within the main groups, any dominant, bullee, rider or buller bull in a group?

The second purpose of this study was to investigate;

- 1) Why some bulls show long 'RT to first mount' and long 'RT to first and second ejaculate' and which factors cause the difference in time and what the ultimate effect of that delayed RT has on semen volume, semen concentration and total sperms collected per ejaculate.
- 2) If the bulls behave differently towards the different handlers.
- 3) Whether bulls need less time for preparation, semen collection and produce a higher volume, better concentration of semen and higher TSC with some handlers.

Review of Literature

Dairy breeds in Sweden

Swedish Red (SR) and Swedish Holstein (SH) are the most common dairy breeds in Sweden.

Swedish Red (SR) cattle history

The local name for SR is *Svensk Röd och Vit Boskap* in Swedish, and synonyms for this is Swedish Red and white Breed (SRB) in English. The total population of SR animals in Sweden is 486,638 (Swedish register of bovine animals CDB, 2005) and the range of use is *milk production*. The breed originates from Red Pied Swedish and Swedish Ayrshire, which merged to form the Swedish Red and White Breed (SRB) in 1927. The Ayrshire breed was a result of earlier import from Scotland. These two breeds were approximately equal in size and yield. After turning both breeds into one, the attention was directed towards the conformation and milk production traits. The breeding objective was pure breeding of high-yielding dairy cattle (<http://neurocad.lva.lt/Breeds/SwedishBreeds.htm> 4 Nov. 2005).

The breed has had influence from other breeds only for a short time. As early as in the late 1950s a lot of Ayrshire bulls were used in Sweden, and in the 1960s many bulls of Finnish Ayrshire were imported. From the 1970s there has been an interchange of semen with Norway and Finland, which means that there has been a large influence from Norwegian and Finnish red and white dairy cattle breeds. As a result, the red and white dairy cattle in these countries in fact belong to one large Nordic population of about 700,000 cows. In Sweden, however, the term Swedish Red (SR) is used instead of Swedish Red and White Breed (SRB) (Håård, pers. comm.). Even though there has been quite some exchange of semen there are still differences between the countries due to differences in the breeding goals.

The SR animals are red with small white markings. They are spread all over the country, but are mainly found in the south and central regions of Sweden, with the exception of the southern provinces of Skåne and parts of Halland, where mostly Swedish Holstein is held. The SRB has for a long time been one of the breeds with the highest milk yield in the world. The breed is also known for high fertility, easy deliveries and a good temperament. These days there is a big demand for semen of SR bulls in USA and other big markets in the world. In short the reasons for the success are that there is no Holstein blood in SRB, they combine production and proofs for health traits (<http://neurocad.lva.lt/Breeds/SwedishBreeds.htm> 4 Nov. 2005).

Swedish Holstein (SH) cattle history

The local name for Swedish Holstein is *Svensk Låglandsboskap (SLB)*. The total population in Sweden is 596.634 (Swedish register of bovine animals CDB, 2005) and range of use is milk production. The Swedish Friesian cattle breed was established in Sweden around 120 years ago. The first SLB cow in Sweden was

imported from the Netherlands and from different German regions, most of them from the old Friesland. During hard work to increase the average milk yield of the Swedish cows in the 1870s, a large number of Holstein-Friesian animals were imported. They were established as specialised breeding herds, and thereafter the breed spread to other herds, resulting in Holstein-Friesian gradually becoming the most common breed in the southern part of the country. Further imports have been done in the 1930s and 1950s. The first imports of Holstein were cows of a pronounced dairy type. In Sweden, and particularly in the province of Skåne, the breeding efforts during the 1940s and 1950s have resulted in the individuals with shorter legs and a wider body than the original Holstein-Friesian. During the 1960s, when the number of dairy cows decreased very much, the SH breed spread into the rest of Sweden and is now common all over the country. Holstein-Friesian cattle were also exported to North America, and since the 1970s, semen from Holstein Friesian has been imported into Sweden from the USA. The typical American Holstein was then a taller and heavier cow with an excellent udder shape and a very strong skeleton. These imports have improved the Swedish SLB especially regarding milk yield and udder characteristics. The extensive import and use of North American Holstein bulls is the reason why there are now very few pure-bred Swedish Friesian cows in the country. The breed is characterised by high milk yield (<http://neurocad.lva.lt/Breeds/SwedishBreeds.htm> 4 Nov. 2005).

SR sexual development

In Sweden bulls are generally selected at an age between 11 and 12 months of age and by the age of 14 months AI organisations like to see that the majority of bulls have their semen distributed for progeny testing (Håård, pers. comm...). It is known that many bulls at that age have reached a stage of development characterized by considerable growth and manifestation of secondary sexual characteristics. Bulls of the SRB, however, reach the age of puberty much earlier than this age as revealed by microscopical examination of testicular tissue (Lagerlöf, 1934; Knudsen, 1954; Abdel-Raouf, 1960, 1961).

Viable spermatozoa have also been obtained from other breeds in ages earlier than 15 months (Van Demark *et al.*, 1956; Baker, Van Demark & Salisbury, 1955; Flipse *et al.*, 1953; Davies *et al.*, 1957). Hooker (1944) stated that calves exhibited sexual behaviour as early as at 5 ½ months of age. Flipse *et al.* (1953) obtained the first ejaculate from low level fed Holstein bulls at 57 weeks of age and from high level fed ones at 41 weeks. Baker, Van Demark & Salisbury (1955) and Van Demark *et al.* (1956) obtained the first ejaculate from Holstein bulls at the age of 38 weeks. Using electro-ejaculation, Davies *et al.* (1957) obtained sperm from high level fed Shorthorn bulls at the age of 9 ½ months and from low level fed brothers at 10 ½ months. According to Abdel-Raouf (1965) healthy SRB-bulls normally attain puberty at 40 weeks of age.

Housing systems

In the European Commission (SNCO.C.2/AH/R22/2000) it is reported that Swedish Legislation requires a minimum surface of 4.5 m² per head of cattle in excess of 400 kg in loose deep litter housing (Jordbruksinformation 2-1998).

However, they have not mentioned the space required for bulls when they are kept in groups. Permanent tethering of fattening cattle in tie-stalls is common in small units in Scandinavia and part of Germany (SNCO.C.2/AH/R22/2000).

Behaviour of bull calves aged 3-16 months in two different housing systems has been investigated (Lidfors, 1992). Changes of the housing environment often result in abnormal behaviours, some of which is stereotyped, such as tongue-rolling, but also excessive licking and grooming which develops rapidly in intensively housed cattle with inadequate space and diet (Phillips, 2002). No effect on eating behaviour but an increase in weight gain by increasing space was observed in beef bulls (Andersen *et al.*, 1997). The bulls waiting for progeny testing are kept in paddocks in North Australia (Fordyce *et al.*, 2002), in feed lots in America (Klemm *et al.*, 1983/84) and on pasture in America (Blackshaw, Blackshaw and McGlone, 1997).

A survey on the bull housing systems in European countries has recently been presented by Ruigh (2005). She reported that most of the bulls (while waiting for their progeny testing) are housed in closed barns in individual housing systems, some are in half open group housing systems, some are in open groups housing system and very few are on pasture/grazing.

Behaviour of bulls in natural feral cattle

Behaviour of feral cattle can give us some clue to the behaviour of bulls in natural environments. Behaviour of Chillingham cattle kept in a closed park, in the northern England, for more than 700 years with minimum human interference was observed by Hall (1986, 1989). Feral cattle has also been studied on Amsterdam, an island southwest of Madagascar (Daycard, 1990), the Maremma cattle in Italy (Lucifero, Janella & Secchiari, 1977), a population of 140 animals running in the south of Spain (Lazo, 1994) and a herd in the Orkney islands (Hall & Moore, 1986). Also observations have been done of domestic cattle that are free-ranging as for example the Camargue cattle (Schloeth, 1961), a herd in Utah (Howery *et al.*, 1996) and a small mixed herd on the Isle of Rhum (Clutton-Brock, Greenwood & Powell, 1976).

Groups of two to ten bulls of 3-4 years were observed in different studies about the natural feral cattle (Bouissou *et al.*, 2001). Individual bulls or small groups of 2-4 bulls, and rarely more than four bulls remained in specific domain all the time after feeding (Hunter & Edwards, 1964). Solitary bulls were observed in Donana feral cattle (Lazo, 1994).

Behaviour of bulls in groups under farm conditions

Abdel-Raouf (1965) reported that the bulls kept with heifers or in male groups become mature earlier than the bulls kept separately. Social behaviour among bulls can roughly be divided into agonistic and non-agonistic encounters. Agonistic interactions include aggressive acts and responses to aggression, mainly avoidance or flight. Non-agonistic interactions include social licking and sexual

behaviour (Bouissou *et al.*, 2001). Anogenital and rump lickings, as well as licking of the penis in bulls, are more associated with sexual behaviour. Lickings in young bulls are often preceded by a solicitation to be licked, including the adoption of a special posture with the head and neck lowered and often with slight bunts under the neck or chest (Bouissou, 1985; Sato & Maeda, 1991).

The dominant bull will butt its opponent in the side or rump if the threatened animal is too slow to submit or fails to notice the threat. In a well-established hierarchy, the threatened animal will spontaneously retreat and take a submissive posture, with its head held low and directed away from the opponent (Bouissou *et al.*, 2001). Before dominance relationships are established, fights may occur. Fighting is displayed by head-to-head, followed by head to neck combat (Bouissou, 1985). Most of the fights are short, 80 % last less than one minute, but the duration can vary from a few seconds to one hour (Bouissou, 1974). Buller-steer syndrome in beef bulls was observed by Blackshaw, Blackshaw and McGlone (1997) and Lott (1984). In this syndrome bulls always mount on the same bulls until the mounted bull become injured and loose weight. Homosexual behaviour in the bulls was studied by Klemm *et al.* (1983/84) and Jezierski *et al.* (1989).

Management of bulls waiting for evaluation of their progeny testing have been discussed by Hunter and Edwards (1964). Bulls awaiting results from progeny testing represent the future of an artificial breeding organization. The adage “out of sight, out of mind” should never apply to such a bull (Amann & Almquist, 1976). Even if semen is not banked, two successive ejaculates should be collected every 4 weeks from each bull in the stud to observe semen quality and testicular examination (Amann & Almquist, 1976). Unimpaired effect of sexual rest for 3 ½/4 years in dairy bulls was observed (Hunter & Edwards 1964).

Effect of remixing and re-grouping on welfare of bulls

Mixing is a stressor for cattle based on animal behaviour, stress physiology and production. Mixing-induced stress might vary for animals depending on their age (Raussi, 2005). Council of Europe (1988) recommends that ‘bulls should not be added to a group already formed.’ Mixing of bulls before slaughter causes behavioural interactions that lower the glycogen content of muscles, resulting in a higher ultimate carcass pH (Warriss, *et al.*, 1984). Placing one new bull in the already established group of bulls was a problem (Hunter & Edwards, 1964). Attempts to create familiarity through the use of common odours applied to pigs prior to regrouping have not reduced the level of aggression (Friend, Knabe & Tanksley, 1983; Gonyou, 1997). Altogether negative effects of mixing on animal welfare and production are considered so great that regrouping should, when possible, be completely avoided (Hasegawa *et al.*, 1997). A method of mixing a new bull in a group was introduced by Hunter & Edwards (1964) but pre-requisite for that was a sexual rest of that bull for at least four weeks, but preferably 8 weeks before they were turned loose together.

Mixing can also cause problems in other animals; like in pigs, fighting and stress responses following mixing, especially during the embryo implantation period,

can affect reproduction (for review: Arey & Edwards, 1998). So, the pig Welfare Advisory Group (DEFRA, Development for Environment, food and Rural Affairs, UK) advised avoidance of mixing sows.

Sexual Stimulation

Sexual stimulation is the presentation of a stimulus situation adequate to illicit mounting and ejaculation (Amann and Almquist, 1976). Sexual stimulation should not be confused with Sexual preparation. *Sexual preparation* is prolonging stimulation of the bull beyond that needed to induce mounting and ejaculation; this result in more or enhanced contractions of the muscles involved in emission and ejaculation of semen (Amann and Almquist, 1976). Sexual preparation will increase the number of sperm ejaculated (Amann, 1990). At A.I. Organizations and to some extent on farms where a rigid routine of controlled mating is practiced, adequate sexual stimulation prior to ejaculation is not provided. Compared to natural pasture mating, the preliminary courtship and displays of masculinity and libido are absent. Sex drive is consequently reduced as well as the vigor of the ejaculatory reflex. With lowered sex drive relaxation is prolonged and longer periods of sexual continence are required between collections (Kerruish, 1955). Kerruish (1955) found a significant improvement in sexual behaviour and an 8.7% rise in conception rate when ten bulls were placed for five months on regimes of intensive sexual stimulation prior to semen collection. Five months prior to intensive sexual stimulation, the ten bulls had been on a sexual regime of inadequate sexual stimulation.

A comparison of spermatological characteristics and fertility rates from semen collected after different lengths of sexual preparation time was performed by Kommissrud and Berg (1996). Semen volume was found to be significantly higher in the 12 Norwegian bulls used when sexual preparation time was less than 15 minutes compared to longer preparation. Several studies have confirmed that the sexual performance of bulls was enhanced by allowing them to view their cohorts engaged in copulatory behaviour (Blockey, 1981). A study by Mader and Price (1984) also demonstrated that in the context of controlled mating, sexual performance is slightly improved by a bull being restrained in close proximity to a stimulus female, and by being watched by another male while engaged in sexual interactions.

Two trials were conducted by Almquist (1973) using Angus and Hereford bulls to determine the effects of sexual preparation by false mounting on sperm output, semen trials and sexual activity. The data were compared with data for Holstein bulls collected twice in succession on one day per week after three false mounts or one false mount. In this study it required nearly 10 times longer time to stimulate beef than dairy bulls, to first mount, and about three times longer to collect two successive ejaculates with three false mounts from beef than dairy bulls. However, giving 3 false mounts rather than no false mounts before semen collection had increased sperm output by about 50% in the first ejaculates for both beef and dairy bulls. Almquist (1973) found that changes of stimulus animal and semen collection location were commonly required to stimulate many of the beef bulls and to maintain their sexual interest during sexual preparation.

Reaction Time (RT)

The period of time during which the bull approaches the mount prior to copulation has been termed the reaction time (Mercier *et al.*, 1949; Kerruish, 1955; Kushwaha, Mukherjee & Bhattacharya, 1955). According to Hale & Almquist (1959) 'The interval between presentation of the bull to the stimulus animal and his initial mount is termed reaction time'. In a semen collection environment, this time should be kept to a minimum for efficiency. Various researchers have recorded many factors influencing reaction time in past years. Kushwaha, Mukherjee & Bhattacharya (1955) have observed that season may be a factor. These researchers reported significant differences between seasons in India for reaction time in bulls. Certain breeds are believed to have a long reaction time as a general rule. Couttie & Hunter (1956) claimed that fat bulls, particularly the Aberdeen Angus breed, have a lack of libido and are slow to serve. Lagerlöf (1954) has shown that breed type has an influence on the willingness of the animal to copulate. Almquist and Hale (1956) have observed that the frequency of copulation will ultimately increase the reaction time of a bull.

A number of extraneous factors such as attendants and nearby structures can affect the bull's reaction time (Kerruish, 1955). Several authors have reported that some hormones can have such an influence in bulls and other mammals (Petersen *et al.*, 1941; Beach, 1957; Lagerlöf, 1954; Asdell, 1955). Frequency of copulation will ultimately increase the reaction time of the bull. This was observed by Baker, Van Demark & Salsbury (1955). With the objective of seeking further information on reaction times, Fraser (1960) observed bulls at service over a period of 4 years. The breeds observed were Holstein, Ayrshire, Jersey, Shorthorn, Brahman, Hereford and Aberdeen Angus. The average reaction time found for all the breeds was 12.5 minutes. Fifty per cent of the bulls commenced copulation or a mounting attempt within two minutes of encountering the teaser animal. Fraser (1960) found that for bulls 4 years of age and over, the reaction time of beef breeds was significantly greater than that of dairy breeds. The interval between the presentations of the bull to the stimulus animals until ejaculation is called the *reaction time to ejaculation (RET)* (Amann & Almquist, 1976).

Collection Interval

The number of days between the semen collections can have an effect on the reaction time and sperm output. A higher number of sperm was obtained from the bulls collected after eight days as compared to bulls collected after four days (Bratton, Foote & Henderson, 1954). Shorter intervals between collection days caused ejaculate volumes to decrease slightly, sperm concentration to decrease markedly, and sperm output per unit of time to increase considerably (Hafs, Hoyt and Bratton, 1959; Hale & Almquist, 1960; Seidel and Foote, 1969). Similar trends were observed by other researchers (Amann, 1990; Bratton, Foote & Hensteron, 1954) when successive ejaculates were collected on the same day, especially when sexual preparation was intense for each ejaculate.

Amann & Almquist (1976) reported that 3.5 times more motile spermatozoa could be collected from 1 to 2 year old Holstein bulls when six ejaculates per week were collected as compared with one ejaculate per week. However, 40% more time was required to obtain an ejaculate on the six ejaculates per week schedule with one ejaculate collected daily. With appropriate sexual preparation, these authors concluded that similar spermatozoa harvests could be achieved by collecting two to three ejaculates every 3 to 4 days. As short as 15 minutes was the time within which high libido dairy bulls may perform two ejaculates (Mader & Price, 1984).

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