THE EFFECT OF REARING ENVIRONMENT ON SEXUAL BEHAVIOR OF YOUNG BEEF BULLS

BY

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Introduction

Social dominance, body weight, average daily gain (Olugun et al., 1981), genotype (Chenoweth and Osborne, 1975; Chenoweth et al., 1977; Blockey et al., 1978), and bull-to-female ratio (BFR) (Rupp et al., 1977) all affect sexual behavior of bulls. However, little is known about the effect of rearing environment on libido score or serving capacity. Evidence linking various degrees of social deprivation during rearing to poor mating performance of males in such species as mice, guinea pigs (Gerall, 1963; Gerall, 1965), rhesus monkeys (Harlow, 1965; Goy et al., 1974; Mason, 1960), dogs (Beach, 1967), cats and (Rosenblatt, 1965), rats (Folman and Drori, 1965; Hemsworth et al., 1977) justifies an examination of the effects of rearing environment on bull sexual behavior. A few studies showed no effect or a slight beneficial effect on sexual behavior due to social deprivation (Beach, 1942; Bryant, 1975; Zenchak and Anderson, 1980).

In natural mating programs, a reliable technique is needed to identify beef bulls capable of impregnating large numbers of cows. Often, no selection is made for reproductive ability. The best available selection criterion is probably the breeding soundness examination (BSE), established by the Society for Theriogenology in 1976. The BSE is a valuable aid in selecting bulls for high semen quality that are free of anatomical defects. However, factors in the BSE such as semen quality and scrotal circumference are not related to libido (Chenoweth and Osborne, 1975; Blockey, 1975). Therefore, some additional criterion is needed to select bulls for mating ability. At present, the best method for evaluating mating performance is not known. Several tests have been used. Lunstra (1981) found that yearling

bulls libido tested at male:female ratios of 3:4 or 5:4 were significantly more active than those tested at a 1:1 ratio. Blockey (1975) found serving capacity tests were highly repeatable in mature bulls and Chenoweth et al. (1977) found both serving capacity and libido scores were repeatable in yearling bulls. Although considerable data are available on mating tests, studies relating libido scores and serving capacity to rearing environment are lacking in bulls.

Male-male mounting, which is commonly seen in bulls penned together, has not been evaluated as to its relationships to sex drive or serving capacity. Nelssen (1980) found that male-male sexual behavior in young boars was correlated to their adult libido score. If bull homosexual behavior is related to libido and serving capacity, it could be used to select bulls for breeding potential.

This study was undertaken to:

1. determine the effects of rearing environment and sexual experience on mating behavior in young Polled Hereford bulls;
2. compare libido and serving capacity scores in individual mating tests to scores of the same bulls in a group mating test; and
3. study the relationship between mounting activity among bulls and their subsequent sexual behavior with heifers.

Literature Review

Libido in Bulls

A relatively new term frequently associated with assessing sexual behavior in bulls is libido score. Libido score indicates the willingness and eagerness of a bull to mount and service a cow or heifer (Hültnas, 1959). Probably the earliest libido test to numerically score a bull was develped by Hültnas (1959). He scored bulls with a scale from 0 to 6 on the basis of interest, eagerness and willingness to mount and mate. He also classified a bull's natural mating technique as satisfactory, unsatisfactory due to lack of penis-vulva contact, or abnormal for some other specified reason. Osborne et al. (1971) modified Hültnas' system. This modified system used more objective observations such as mounts, attempts to mount, and services. Bulls were ranked 0 to 4, with 0 being no interest and 4 indicating one service had been completed. Chenoweth et al (1977) allowed bulls 5 minutes with a restrained heifer and scored them according to the following system:

0 = bull showed no sexual interest.

1 = sexual interest shown only once.

2 = sexual interest in female shown more than once.

3 = active persuit of female with persistent sexual interest.

4 = one mount or mounting attempt. No service.

5 = two mounts or mounting attempts. No service.

6 = more than 2 mounts or mounting attempts. No service.

7 = one service followed by no further sexual interest.

8 = one service followed by sexual interest, including mounts or mounting attempts.

9 = two services followed by no further sexual interest.

10 = two or more services followed by sexual interest, including mounts or mounting attempts.

Libido score was a repeatable value in yearling bulls tested.

It is helpful to have an idea of the general mating pattern in bulls so that deviations from this pattern can be easily detected. Mating behavior in bulls follows a characteristic pattern beginning with the proestrous female (Summer et all, 1968). Bulls use olfaction and vision to detect estrous females. They sniff the perineal region of any passing cow (Sambraus, cited by Blockey, 1975). Donovan (1967) presented evidence that bulls may be attracted by rectal secretions of estrous cows. When a number of cows are in estrous or proestrous they form a sexually active group and attract the bull primarily through visual cues (Williamson et al., 1972) such as mounting, standing to be mounted by other cows, or arching the back and raising the tail (Sambraus, cited by Blockey, 1975). Normal copulation consists of courtship, erection and protrusion of the penis, mounting, intromission, the ejaculatory thrust, ejeculation and dismounting (Hafez et all, 1969). Once an estrous female is discovered, the bull commences courtship by inducing her to stand by licking and sniffing her hindquarters (Sambraus, cited by Blockey, 1975). The bull often rests his chin on the female's back. Estrous females will stand for chinresting while a non-estrous cow responds with escape or avoidance behavior (Hafez, et all, 1969). If the bull mounts with proper orientation, clasps the hindquarters of the cow with his front legs, and has erection and protrusion of the penis, he begins seeking movements which lead to penetration (Hültnas, 1959). As the sigmoid flexure straightens, maximum intromission is achieved, the bull thrusts and ejaculation occurs (Hafez et al., 1969).

Bulls become satiated after ejaculating into an artificial vagina a number of times. However, if the stimulus animal is replaced, a previously satiated bull will resume ejaculation into the artificial vagina (Schein and Hale, 1965). There is evidence that bulls become similarly satiated with estrous females in the pasture. After several matings with one estrous cow, the bull looses interest but his libido increases upon discovery of a different cow in estrous (Sumner et al., 1968).

Libido may be heritable since Bane (1954) reported that identical twin bulls had similar mating behavior while different sets of twins showed much variation in libido. Chenoweth and Osborne (1975) libido tested Braham, Hereford, Brahman cross, Africander cross, and Shorthorn/Hereford cross bulls and reported a highly significant difference in libido score between breeds. Also, Chenoweth et al. (1977) found differences in libido among distinct lines of beef bulls. Heritability of libido at 365 days of age has been estimated to be .37 ± .45 (Warren et al., 1976).

No correlation has been found between libido and a single serum testosterone or luteinizing hormone (LH) measurement (Chenoweth et al., 1977). Berndston et al. (1979) found no effect on libido after administering 30 mg prostaglandin $F_{2\alpha}$ 2 days per week for 10 weeks to yearling beef bulls.

Ologun et al. (1981), testing bulls individually, reported a low, but significant correlation between dominance and libido in yearling bulls. Corah et al. (1979) found in herds using two yearling bulls, one of the two will usually sire significantly more calves. In one heard, observed two consecutive years, the dominant bull remained dominant as a 2-year-old. However, the social dominance order in yearlings is not well established. Post-weaning management can affect libido. Bulls reared

in a large bull herd (usually around 400 animals of various ages) exhibited lower libido than bulls kept in groups of five (Macfarlane, 1974). Disease and injury (Bane, 1954; Hafez, 1969), periods of psychological stress and extreme climatic conditions (Hafez, 1969), and poor nutrition (Hafez, 1969; Meachem et al., 1963) all adversely affect bull libido.

Lindsay et al. (1976) reported that sexual behavior of dominant rams was not affected by an audience of submissive rams. However, submissive rams mounted and ejaculated less when observed by dominant rams.

Serving Capacity in Bulls

Serving capacity refers to the number of services a bull achieves during a specified mating period (Blockey, 1975). The serving capacity score is a valuable measure since it has been shown to influence pregnancy rates (Blockey, 1978a). Chenoweth et al. (1977) found serving capacity to be a repeatable measure in yearling bulls and as good an indication of sex drive as libido score.

Another method used to describe mating activity is reaction time or the time it takes a bull to first breed the heifer in a mating test. Reaction time has not proved to be a repeatable value in yearling beef bulls (Chenoweth and Brinks, 1978) or a good indicator of mating performance (Farin, 1980).

Blockey (1978b) found bulls that rated high or medium in serving capacity were highly efficient (96.2% to 100%) at detecting estrus when used at a BFR of 3:114. Under range conditions, multiple-sire pastures were discovered to be inefficient because 70% or more of the heifers were bred by more than one bull during a single estrus (Rupp et al., 1977),

since they found single-sire mating resulted in comparable pregnancy rates. Breeding ratios of 1:44 and 1:60 were preferred over a BFR of 1:25 because they were more efficient. They concluded that bulls could be used at these higher, more efficient breeding ratios so long as adequate care was taken to identify and eliminate bulls unable to serve large groups of heifers adequately. Rupp et al. (1977) reported that bulls used at BFR's of 1:25, 1:44, and 1:60 were equally efficient at estrus detection.

Social rank significantly influences the sexual activity of bulls in mixed age groups but does not influence the activity of 2-year-old bulls when the social dominance order is unstable (Blockey, 1975). Seniority in the herd, and to a lesser extent age, maintains rank in mixed-age groups (Blockey, 1979). There is a low, but negative correlation between serving capacity and social dominance in yearling beef bulls ($r = -.30$; $P < .05$) (Ologun et at., 1981). The mating test used tested bulls singly.

Chenoweth et al. (1977) found differences in serving capacity among distinct lines of beef bulls. Heritability of serving capacity on a within breed basis has been estimated to be .59 ± .16 for beef bulls (Blockey et al., 1978).

Blockey (1975) reported that 3 to 7 g/ml of circulating testosterone was necessary for castrated bulls to maintain servi capacity at levels similar to their identical twin brothers. He concluded that differences in serving capacity were due to different degrees of responsiveness to a threshold level of testosterone.

Correlations between average daily gain and serving capacity and between weight and serving capacity are reported by Ologun et al. (1981) to be negative and highly significant.

Breeding Soundness Examination

The most common criterion for the selection of bulls for natural breeding is the breeding soundness examination (BSE) established by the Society for Theriogenology in 1976. The BSE utilizes an evaluation of genital condition, a scrotal circumference measurement and a semen evaluation (with emphasis on spermatozoal motility and morphology) to classify bulls according to breeding potential. The scoring system for the BSE is presented in Table 1. The discretionary level between satisfactory and questionable scores is 60. Bulls scoring lower than 30 are considered unsatisfactory. Concentration, percent motile sperm, percent live sperm, volume, pH, color, and presence of other cell types in semen, should be used as aids in interpretation of results.

Many of the evaluations made in the BSE are correlated to sperm output and semen quality, but it does not evaluate libido or serving capacity. Scrotal circumference is highly repeatable, easy to obtain and is correlated with tested weight (Hahn et al., 1969). Coulter et al. (1975) found that scrotal circumference measurements taken between 1 and 2 years of age were good indicators of mature sperm output. Age at first estrus in heifers is significantly correlated ($r = -.71$) with the scrotal circumference of their half brothers (Coulter, 1980). In the same study, scrotal circumference was found to have a relatively high correlation with fertility ($r = .58$).

Almquist et al. (1976) reported a 32% increase in scrotal circumference and width in Charolais bulls from puberty to 2 years of age. Slightly greater than 75% of that increase occurred between puberty and 65 weeks of age. Testicular growth decreases as bulls mature and testicle size declines slightly in aged bulls (Coulter et al., 1975). Coulter

Table 1. BREEDING SOUNDNESS EXAMINATION SCORING SYSTEM (SOCIETY FOR THERIOGENOLOGY, 1976)

Classification	Score	Age mos.) 12 - 14	15 - 20	21 - 30	over 30
Scrotal Circumference (cm):					
Good	40	over 34	over 36	over 38	over 39
Fair	24	30 -34	31 - 36	32 - 38	34 - 39
Poor	10	under 30	under 31	under 32	under 34
		% Primary Abnormalities		% Total Abnormalities	
Percent abnormal sperm:					
Very good	40	less than 10		less than 25	
Good	25	10 - 19		26 - 39	
Fair	10	20 - 29		40 - 59	
Poor	3	more than 29		more than 59	
		Gross Motility		Individual	
Motility:					
Very good	20	rapid swirling movement		rapid linear	
Good	12	slower swirling movement		moderately fast	
Fair	10	shakey movement		slow-linear to erratic	
Poor	3	flickers		very slow, often erratic	

and Foote (1976) reported that season of year had an effect on testicular growth in Holstein bulls.

Body weight is positively correlated to scrotal circumference. Coulter and Foote (1977) reported a partial correlation coefficient of .58 in Holstein bulls when age was held constant. Scrotal circumference was highly correlated with final weight, age, ejaculate volume and sperm output of beef bulls coming off a 140-day performance test (Underwood et al., 1978).

While it is best to select for scrotal circumference within the same age group, bull stud, year and season (Coulter and Foote, 1976), some general recommendations have been made. Coulter (1980) suggests that 6 to 7, 12, and 18-month-old bulls with scrotal circumferences less than 20, 32, and 33.5 cm respectively, be disqualified. Similarly, Elmore et al. (1976) suggested that Polled Hereford bulls of breeding ages and weights should have at least a 32 cm scrotal circumference to be classified as sastisfactory breeders.

Assessing sexual behavior in bulls provides a method of identifying poor breeders that would not be identified without a mating test. Blockey (1975) examined 548 bulls for breeding soundness by examining the genitals and evaluating the semen microscopically. Bulls were then tested for serving capacity. Of 118 bulls determined to be unsound for breeding, 48 (42.5%) would not have been culled on the basis of the BSE alone. The BSE as an exclusive criterion for selecting breeding bulls seems even more inadequate when we consider there is little or no relationship between semen quality and libido (Chenoweth and Osborne, 1975; Chenoweth et al., 1977). The BSE in conjunction with some type of mating test would be a more appropriate aid in the selection of breeding bulls.

Social Restriction

The degree of social restriction that affects mating behavior varies among species. Guinea pigs separated by a solid partition showed poor mating dexterity (Gerall, 1963). Orientation, clasping, and mounting were adversely affected, but sexual behaviors such as growling, circling, and abortive mounts were not affected. No adverse effects were seen if the guinea pigs were raised individually but separated by a mesh screen, allowing visual contact. Rhesus monkeys separated from their mothers at birth and raised in hardware-cloth cages or with various kinds of inanimate surrogate mothers had almost totally inadequate sexual posturing (Harlow, 1965). These males showed a high incidence of inadequate and disoriented mounts. However, there was no indication of a lack of sexual drive. These results are not unusual since the degree of isolation in this study was quite severe. However, even when rhesus monkeys are subjected to less severe restriction their sexual behavior is still adversely affected. When allowed to live with their mothers during the first month of life and later housed in individual cages allowing visual and auditory contact with other young monkeys but preventing physical contact betwen them, rhesus monkeys did not perform as well sexually as feral monkeys (Mason, 1960). In addition, the restricted monkeys had a few brief periods of intraspecies social contact during the first year of life. The individually reared monkeys did not orient themselves correctly to the female and had difficulty clasping her when mounting. Apparently, rhesus monkeys are more sensitive to social restriction than are guinea pigs. Limited peer peer contact (but not complete isolation) is restriction enough to cause abnormal sexual behavior such as disoriented mounting in dogs (Beach, 1967) and rhesus monkeys (Goy, et al., 1974), but does not affect rams (Bryant, 1975).

Boars appear to be severely affected by social restriction. Hemsworth et. al. (1977) reported that boars reared in all-male groups performed better than those reared without physical or visual contact with other hogs. There was no improvement in the isolates up to 13 months of age. Group-reared boars were more sexually aggressive than boars raised singly (Thomas et al., 1979). In contrast to the reaction of boars to social restriction, rams reared with no physical contact with other rams performed better sexually than contact-permitted rams (Zenchak and Anderson, 1980). Apparantly rams reared with other rams preferred rams to ewes and therefore did not do well in a mating test (Zenchak, et. al., 1981). This variation among species in the reaction to social restriction necessitates a study of bulls housed individually. Data on the behavior of bulls reared in various housing schemes is lacking. Since different species have shown various reactions to rearing environment deprivation, it would be faulty to attempt to predict the behavior of socially limited bulls based on the behavior of other species. In addition, description of housing in social restriction studies is sometimes not very detailed, making it difficult to compare various studies.

Rats reared after weaning with no visual or tactile contact with other rats were more sexually active than those reared with males and females (cohabitation) (Beach, 1942). The cohabitation group was more active than those rats raised with males only. He concluded that isolated males performed better due to the excitement of contacting another animal and to the fact that this group had gained more weight than others. Gerall et al. (1967) had very different results. Twenty-six of 30 rats (87%) reared in various degrees of restriction exhibited abnormal mating behavior. Only 7.5% of restricted rats completed a

mating in five mating test, while 83% of rats reared with males mated and 87% of those reared with females and males mated.

Hemsworth et al. (1977) reported that boars reared in all-male and mixed-sex groups performed better than those reared without physical or visual contact with other hogs. There was no difference between the all-male and mixed-sex groups. Thomas et al. (1979) found that boars reared in all-male groups attained a higher libido score than boars reared with prepubertal gilts. Allowing young boars fenceline contact with mature females does not affect libido score (Nelssen, 1980).

These studies show that clear, consistent data has not been obtained on the effects of exposing males to females during rearing. Data is lacking on the effect of exposing young bulls to heifers or cows.

Materials and Methods

Rearing Environment and Sequence of Testing

Fifty-eight Polled Hereford bulls were used in this study. All were born between February 19 and May 10 and nursed cows on pasture until weaned October 5 at an average age of 196 days. Beginning at weaning they were penned individually in 1.5m x 7.0m pens. The only contact with other cattle after weaning occurred at weighing on November 2, November 29, December 27, January 25, and February 21. Contact during weighing lasted about 1 hour and was between bulls of approximately the same age. Individually-penned bulls were able to see, hear, and smell one another. They were separated by partitions consisting of six horizontal steel bars, each 5 cm wide, which were 25 cm apart. The partitions were 1.5m high (Figure 1). Fencing allowed limited contact with bulls in adjacent pens. Bulls were put on a 140-day, individually-fed performance test using the ration given in table 2.

Six months after weaning, bulls were allotted by sire, age, and weight to one of four rearing-environment treatments for 10 weeks. The week after allotment was designated week 0. Twenty bulls remained in individual pens while 38 bulls were group reared in a 30 m x 63 m drylot. One half of the individually-penned and one half of the group-penned, drylot bulls were exposed to an ovariectomized heifer in estrus for libido and serving capacity evaluation (one bull with one heifer) on weeks 0, 2, 4, 6 and 8 (tests 1 to 5). The four rearing treatments produced a 2 x 2 factoral design as follows:

Figure 1. Bulls in individual pens.

TABLE 2. RATION FED DURING THE 140-DAY PERFORMANCE TEST

Ingredient	%
Prarie hay	25.0
Dehy alfalfa	15.0
Corn	43.0
Soybean meal	12.5
Molasses	4.0
Salt	0.5

(1) individually penned with no heifer contact;

(2) individually penned with heifer contact once every 2 weeks;

(3) group penned with no heifer contact; and

(4) group penned with heifer contact once every 2 weeks.

During week 10 all bulls were given an individual sexual behavior test (test 6A) and during week 12 all bulls were group tested (5 bulls with 4 heifers; test 6B). All 58 bulls were penned together from week 12 to 30, ie. when bulls averaged 452 to 604 days old. During week 20 and 28 all bulls were given another individual test (tests 7A and 8A), and during weeks 22 and 30 all were given another group test (tests 7B and 8B). The 11 mating tests were conducted when the bulls' average age was 368, 383, 396, 410, 424, 438, 452, 519, 533, 590 and 604 days.

Assessment of Sexual Behavior

The individual test consisted of observing the behavior of one bull with one estrus heifer. Generally six tests were run simultaneously (Figure 2). Individually-penned bulls were kept separated from other bulls prior to and following each test.

The group test was run with 5 or 6 bulls having access to 4 or 5 heifers, respectively. Heifers were stanchioned approximately 2 m apart. The number of each bull was painted on his shoulders (Figure 3).

Heifers were restrained by a halter and stanchioned for all mating tests. All heifers were ovariectomized for at least 6 months prior to the experiment. Estrus was induced in all test heifers by intramuscularly injecting .5 mg of 17β estradiol and 25 mg progesterone in 3 cc corn oil

Figure 2. Individual mating tests.

Figure 3. Group mating test.

on 3 consecutive days. Two days later an intramuscular injection of 6 mg of 17β estradiol in 3 cc of corn oil was administered. Twenty-four hours after the last injection, most heifers showed behavioral signs of estrus. Only heifers standing for mounting were used. Heifers were used within a given test as long as they accepted mounting without attempting to escape. When a heifer resisted mounting she was replaced by a different heifer.

Sexual activity in individual and group tests was recorded for 30 minutes. Bulls were tested in random order within their treatment groups. The following behaviors and the minute after exposure to the heifer(s) in which each occurred were recorded:

1. sniffs and licks of the vulvular area;
2. attempted mounts - raising both front feet off the ground but failing to position them on the heifer;
3. mounts - raising both fron feet and positioning them on the heifer;
4. disorientation - any mount or attempt to mount of the heifer's head or side; and
5. service - intromission accompanied by an ejaculatory thrust.

Bulls were given a libido score using a modified system of Chenoweth et al., (1977):

0 = no interest.

1 = sexual interest shown once.

2 = sexual interest shown more than once.

3 = one mount or attempted mount without a service.

4 = two mounts or attempted mounts without a service.

5 = more than 2 mounts or attempted mounts without a service.

6 = one or more services.

Serving capacity was considered to be the number of services achieved by a bull during each 30 minute test (Blockey, 1975).

Semen Evaluation and Physical Measurements

Semen was collected by electroejeculation 3 weeks after the seventh mating test when the average age of the bulls was 473 days. Volume was measured and a microscopic estimate of motility was made. A subsample was diluted and concentration was determined using a hemocytometer (Sorenson, 1971). A sample of semen was stained with Fast Green and Eosin Bluish stains and dried on mircoscopic slides as described by Sorenson (1971). The percentage of live or dead and normal or abnormal sperm cells wad determined microscopically.

The following physical measurements were taken at 2 month intervals on all bulls beginning February 21: weight, height at withers, height at hips, and testis-scrotal circumference.

Bull Homosexual Behavior

Immediately after completion of the mating tests on weeks 4, 6, 8, 10 and 12, all group penned bulls (rearing treatment groups 3 and 4) were penned together and observed for 30 minutes. Each bull had his identification number painted on his shoulder. The number of times each bull mounted another bull or was mounted by another bull was recorded.

Statistical Analysis

Treatment differences were analyzed by two-way analysis of variance, (Snedecor and Cochran, 1967). Group and individual mating tests were

compared using the paired-t test (Snedecor and Cochran, 1967). All correlations were Spearman correlations and regression analysis was used to determine whether the bulls' performances changed as the number of mating tests they were exposed to increased (Draper and Smith, 1966).

Results and Discussion

Rearing Environment

Results of the first five mating test which provided heifer exposure and sexual experience for bulls in rearing treatments 2 and 4 are shown in table 3. The average serving capacity of bulls housed in individual pens (treatment 2) was slightly lower in tests 1 and 2, but greater in tests 3, 4 and 5. However, there was no significant difference in average serving capacity, libido score, serving efficiency, or disorientation between these bulls and group-penned bulls (treatment 4). The average number of mounts was significantly higher for bulls penned individually for the first four tests. Increased activity of restricted males is similar to the results reported by Beach (1942) in rats. Like the isolated rats in that study, the individually-penned bulls were heavier than the group-reared bulls (table 4). However, body weight was not significantly correlated to mating test performance in any of the four treatments (table 5). Height/weight ratio, an indication of body condition, was not significantly correlated to libido or serving capacity (table 6). It seems likely the increased activity of the individually penned bulls was due to the excitement of being out of the pen and contacting other cattle and not due to weight differences.

Results of the individual (6A, 7A and 8A) and group (6B, 7B and 8B) mating tests for all bulls are shown in tables 7 and 8. Rearing treatment did not significantly affect performance in the individual test. Bulls in individual pens had a greater serving capacity ($P < .01$) and were more efficient at service ($P < .01$) than were group-penned bulls the first time the bulls were given a group mating test.

TABLE 3. AVERAGE MATING PERFORMANCE OF BULLS DURING THE FIRST FIVE MATING TESTS[a]

Test no.	Treatment	Item: No. of bulls	Serving capacity	Libido score	Mounts	Serving efficiency[d]	Disorientation[e]
1	2[b]	10	.89±2.77	5.40± .52	33.40±11.80**	.06±.08	.50±1.08
	4[c]	19	1.90±1.57	5.11±1.37	19.33± 9.42	.06±.11	.06± .24
2	2	10	1.50±1.65	5.60± .52	30.80± 9.48**	.06±.07	.10± .32
	4	17	1.17±1.71	5.29±1.49	15.18±11.29	.15±.17	.12± .49
3	2	10	3.30±2.91	5.80± .42	20.20±11.15*	.19±.18	.30± .95
	4	19	1.84±2.14	5.42±1.43	11.32± 9.89	.20±.25	.16± .50
4	2	10	3.00±2.36	5.80± .42	23.00±12.91*	.17±.16	0±0
	4	18	2.33±2.38	5.72± .46	13.72± 8.17	.16±.18	.17± .71
5	2	10	3.90±3.51	5.70± .48	16.00± 9.90	.25±.23	.10± .32
	4	18	1.89±1.94	5.78± .43	13.94± 6.29	.12±.12	.17± .57

[a]All tests were conducted with a single bull exposed to a stanchioned estrus heifer for 30 minutes.

[b]Individually-penned bulls.

[c]Group-penned bulls.

[d]Serving efficiency = $\frac{\text{No. of services}}{\text{No. of mounts + No. of services}}$

[e]Number of disoriented mounts or disoriented mounting attempts during test.

*Different from treatment 4 mean ($P < .05$).

**Different from treatment 4 mean ($P < .01$).

TABLE 4. LINEAR MEASUREMENTS OF BULLS

Measurement period[a]	Item	Item: Pens: Individual[b]	Item: Pens: Group[c]	Item: Heifer Contact: Yes[d]	Item: Heifer Contact: No[e]
1	No. of bulls	20	38	29	29
	Shoulder height, cm	105.06	104.24	104.31	104.99
	Hip height, cm	109.86	109.60	110.71	108.75
	Weight, kg	336.97	328.40	338.27	327.11
	Scrotal circumference, cm	32.35	33.19	32.87	32.67
	Hip height/weight	.330	.337	.336	.330
2	No. of bulls	20	35	29	26
	Shoulder height, cm	107.63	107.40	106.89	108.14
	Hip height, cm	112.59[g]	111.87[h]	111.63	112.83
	Weight, kg	396.08[g]	349.94[h]	363.03	382.99
	Scrotal circumference, cm	35.31[k]	34.01[l]	134.70	34.62
	Hip height/weight	.287[g]	.322[h]	.311	.298
3[f]	No. of bulls	20	38	29	26
	Shoulder height, cm	111.32	110.01	110.04	111.29
	Hip height, cm	116.33[i]	115.61[j]	115.27	116.67
	Weight, kg	465.48[i]	434.21[j]	443.05	456.64
	Scrotal circumference, cm	36.86[i]	36.66[j]	37.01	36.51
	Hip height/weight	.251[i]	.268[j]	.262	.257
4	No. of bulls	15	33	24	24
	Shoulder height, cm	114.92	114.62	114.24	115.30
	Hip height, cm	119.13[k]	119.02[l]	118.60	119.55
	Weight, kg	483.18[k]	514.30[l]	496.99	500.49
	Scrotal circumference, cm	33.48[g,i]	36.84[h,j]	35.41	34.91
	Hip height/weight	.249[i]	.232[j]	.240	.241
5	No. of bulls	15	33	24	24
	Shoulder height, cm	117.57	116.86	117.30	117.12
	Hip height, cm	120.98[k]	121.13[l]	120.59	121.52
	Weight, kg	505.17[k]	540.28[l]	520.56	524.90
	Scrotal circumference	32.14[k]	33.46[l]	32.73	32.87
	Hip height/weight	.241[i]	.225[j]	.233	.234

[a]Measurements taken at 2-month intervals beginning February 21.

[b]Treatments (1) individually penned, no heifer contact and (2) individually penned, heifer contact every 2 weeks.

[c]Treatments (3) group penned, no heifer contact and (4) group penned, heifer contact every 2 weeks.

TABLE 4. LINEAR MEASUREMENTS OF BULLS (continued)

[d]Treatments (2) individually penned, heifer contact every 2 weeks and (4) group penned, heifer contact every 2 weeks.

[e]Treatment (1) individually penned, no heifer contact and (3) group penned, no heifer contact.

[f]All bulls were penned together after the third measurement period.

[g,h]Means in a row with different super scripts differ ($P < .001$).

[i,j]Means in a row with different super scripts differ ($P < .01$).

[k,l]Means in a row with different super scripts differ ($P < .05$).

TABLE 5. SPEARMAN CORRELATIONS BETWEEN WEIGHT AND MATING TEST PERFORMANCE

Item	Treatment[a]	Measurement Period[b] 1	2	3	4	5
Serving capacity	1			.44	.36	-.22
	2	-.32	.15	.41	.00	.18
	3			.17	.04	-.24
	4	-.27	.15	-.21	.36	.32
Libido score	1			-.34	.43	-.22
	2	-.32	-.26	.41	.00	-.39
	3			.05	-.03	-.06
	4	-.39	.08	-.11	.10	.30

[a]Treatment: (1) bulls individually penned, no heifer contact; (2) bulls individually penned, heifer contact every 2 weeks; (3) group penned, no heifer contact; (4) group penned, heifer contact every 2 weeks.

[b]Measurements taken every 2 months beginning February 21.

TABLE 6. SPEARMAN CORRELATIONS BETWEEN HIP HEIGHT/WEIGHT AND MATING PERFORMANCE

Item	Treatment[a]	Measurement Period[b] 1	2	3	4	5
Serving capacity	1			.08	-.36	.30
	2	.23	-.05	-.55	.00	.09
	3			-.02	.04	.29
	4	.20	-.16	.20	-.16	-.26
Libido	1			.19	-.43	.30
	2	.21	.26	-.52	.00	.65
	3			-.07	-.03	.22
	4	.35	-.17	.07	.05	-.26

[a]Treatment: (1) bulls individually penned, no heifer contact; (2) bulls individually penned, heifer contact every 2 weeks; (3) bulls group penned, no heifer contact; (4) bulls group penned, heifer contact every 2 weeks.

[b]Measurements taken every 2 months beginning February 21.

TABLE 7. AVERAGE MATING PERFORMANCE IN INDIVIDUAL MATING TESTS[a]

Test no.[b]	Item	Item: Pens: Individual[d]	Item: Pens: Group[e]	Item: Heifer Contact: Yes[f]	Item: Heifer Contact: No[g]
6A[c]	No. of bulls	20	37	28	29
	Serving capacity	3.2	1.8	2.5	2.4
	Libido score	5.7	5.6	5.7	5.6
	Mounts	19.1	20.3	18.7	20.8
	Serving efficiency	.18	.10	.15	.14
	Disorientation	1.00	0	.30	.70
7A	No. of bulls	15	37	24	28
	Serving capacity	2.3	1.9	1.7	2.5
	Libido score	5.4	5.7	5.4	5.7
	Mounts	14.9	13.6	12.6	15.9
	Serving efficiency	.16	.19	.16	.18
	Disorientation	.17	.13	.22	.08
8A	No. of bulls	16	36	24	28
	Serving capacity	1.75	1.75	1.7	1.8
	Libido score	5.5	5.7	5.6	5.6
	Mounts	15.5	11.9	14.4	13.1
	Serving efficiency	.11	.17	.14	.14
	Disorientation	.05	.18	.11	.16

[a]Mating tests were conducted with a single bull exposed to a stanchioned, estrous heifer for 30 minutes.

[b]Tests 6A, 7A and 8A were conducted when bulls averaged 438, 519 and 590 days of age, respectively.

[c]All bulls were penned together after test 6A when bulls averaged 438 days of age.

[d]Treatments (1) individually penned, no heifer contact and (2) individually penned, heifer contact every 2 weeks.

[e]Treatments (3) group penned, no heifer contact and (4) group penned, heifer contact every 2 weeks.

[f]Treatments (2) and (4).

[g]Treatments (1) and (3).

TABLE 8. AVERAGE MATING PERFORMANCE IN GROUP MATING TESTS[a]

Test no.[b]	Item	Item: Pens: Individual[d]	Item: Pens: Group[e]	Item: Heifer Contact: Yes[f]	Item: Heifer Contact: No[g]
6B[c]	No. of bulls	20	37	29	28
	Serving capacity	3.2[h]	1.4[i]	2.5	2.2
	Libido score	5.8	5.5	5.7	5.6
	Mounts	17.8	16.8	15.2	19.4
	Serving efficiency	.19[h]	.08[i]	.15	.12
	Disorientation	.35	.13	.16	.33
7B	No. of bulls	13	35	22	26
	Serving capacity	1.3	1.3	.9	1.7
	Libido score	5.6	5.6	5.6	5.6
	Mounts	18.4	14.3	17.3	15.5
	Serving efficiency	.08	.09	.06	.11
	Disorientation	0	.23	.18	.06
8B	No. of bulls	16	36	24	28
	Serving capacity	1.6	1.4	1.3	1.7
	Libido score	5.7	5.6	5.6	5.6
	Mounts	13.7	13.1	12.9	13.9
	Serving efficiency	.11	.11	.10	.12
	Disorientation	.33	.39	.28	.44

[a]Mating test were conducted with five or six bulls exposed to four or five stanchioned, estrous heifers, respectively, for 30 minutes.

[b]Tests 6B, 7B and 8B were conducted when bulls averaged 452, 533 and 604 days of age, respectively.

[c]All bulls were penned together after test 6B when they averaged 438 days of age.

[d]Treatments (1) individually penned no heifer contact and (2) individually penned, heifer contact every 2 weeks.

[e]Treatments (3) group penned, no heifer contact and (4) group penned, heifer contact every 2 weeks.

[f]Treatments 2 and 4.

[g]Treatments 1 and 3.

[h,i]Means in a row with different super scripts differ ($P < .01$).

However, these differences did not persist once all bulls were penned together. Although the degree of social restriction was not severe, it is similar to conditions that might be imposed on young bulls during feeding trials or commercial bull-testing programs. The degree of social restriction used in this experiment was apparently not detrimental to the bulls' sexual development. Being together on pasture from birth until weaning, in contact with one another for approximately one hour on five occasions while being weighed, and having visual, auditory and olfactory exposure to one another was enough social interaction to allow normal sexual expression by 14 months of age. Stanchioned heifers used in the mating tests may have helped orient bulls for mounting, thus reducing the disorientation noted in other studies.

There were significant differences among groups for weight and height/weight ratios (table 4). Bulls in treatments 1 and 2 (reared in individual pens), were heavier and had smaller height/weight ratios at the second and third measurement periods. At the last two measurement periods, when all bulls were penned together, treatments 3 and 4 (group-penned bulls) were heavier and had smaller height/weight ratios. Bulls penned individually gained more. However, when mixed with the group-penned bulls their weight advantage did not persist. Blockey and Lade (1974) showed that dominance relationships among young bulls could influence weight gain. Bulls in treatments 3 and 4, who were accustomed to the group pen and group feeding, may have dominated bulls in treatments 1 and 2 when they were introduced into the pen.

The fourth and fifth scrotal circumference measurements were larger for the group-penned bulls. This is most likely related to the heavier body weight of these bulls. Correlations between weight and scrotal

circumference were generally positive (table 9). Coulter and Foote (1977) reported a partial correlation coefficient between body weight and scrotal circumference of .58 ($P < .01$) when age was held constant in Holstein bulls.

Rearing environment did not significantly affect most semen measurements (table 10). Semen from bulls in treatment 2 (group-penned with heifer contact) was more concentrated (table 11) than in the other treatments. Since semen was only collected on one occassion and the group size was small in this treatment ($N = 5$) it is possible that this concentration difference is due to chance. More frequent semen collections would be needed to determine if this effect is real. Semen traits were not highly correlated to scrotal circumference or sexual behavior (table 12). Large scrotal circumference measurements are associated with fertility and sperm output of mature bulls (Coulter, 1980; Coulter et al., 1975); while semen quality has been shown to be unrelated to sexual behavior (Chenoweth and Osborne, 1975; Blockey, 1975). Table 13 shows that serving capacity, libido score and mounting activity are not highly correlated to scrotal circumference which is in agreement with Chenoweth and Osborne (1975) and Blockey (1975).

Sexual experience, in the form of exposure to an estrous heifer every 2 weeks (treatments 2 and 4), did not affect libido score or the amount of disorientation shown (table 14). The number of mounts decreased steadily until the last test, then increased slightly in bulls individually penned. The number of mounts in bulls group-penned (treatment 4) did not change over time. Individually-penned bulls (treatment 2) mounted more frequently during the first four tests than did group-penned bulls. The serving efficiency of individually-pennd bulls improved during the first five individual tests but declined during the last three tests when they

TABLE 9. SPEARMAN CORRELATIONS BETWEEN BODY WEIGHT AND SCROTAL CIRCUMFERENCE

Treatment[b]	Measurement Period[a]				
	1	2	3	4	5
1	.75*	.44	.10	.72*	.39
2	.75*	.54	.07	.60	.38
3	.40	.55*	.34	.76*	.74**
4	.28	.29	-.11	.21	.36

[a]Measurements taken every 2 months beginning February 21.

[b]Treatments: (1) bulls penned individually, no heifer contact; bulls penned individually, heifer contact every 2 weeks; bulls group penned, no heifer contact; (4) bulls group penned, heifer contact every 2 weeks.

*($P < .05$).

**($P < .01$).

TABLE 10. SEMEN EVALUATION ON BULLS ELECTROEJACULATED AT AN AVERAGE OF 473 DAYS

	Item			
	Pens		Heifer Contact	
Item	Individual[a]	Group[b]	Yes[c]	No[d]
No. of bulls[e]	13	30	19	24
% motile	17.88	25.53	24.65	18.75
% abnormal	37.38	26.59	34.50	29.47
% live	57.75	63.57	57.32	64.00
Volume	1.31	1.56	1.44	1.43

[a]Treatment (1) individually penned, no heifer contact and (2) individually penned, heifer contact every 2 weeks.

[b]Treatments (3) group penned, no heifer contact and (4) group penned, heifer contact every 2 weeks.

[c]Treatment (2) individually penned, heifer contact every 2 weeks and (4) group penned, heifer contact, every 2 weeks.

[d]Treatments (1) individually penned, no heifer contact and (3) group penned, no heifer contact.

[e]Evaluations could not be made due to lack of sperm quantity in one bull in treatment 1, 2 bulls in treatment 2, 3 bulls in treatment 3 and 4 bulls in treatment 4.

TABLE 11. CONCENTRATION/ML (X107) ON SEMEN FROM BULLS ELECTROEJACULATED AT AN AVERAGE AGE OF 473 DAYS

	Pens		
Heifer contact	Individual[a]	Group[b]	Heifer contact mean
Yes[e]	38.90[e]	13.46[f]	26.18
No[d]	12.31[f]	15.72[f]	14.06
Pen Mean	15.60	14.59	17.05[g]

[a]Treatment (1) individaully penned, no heifer contact and (2) individually penned, heifer contact every 2 weeks.

[b]Treatments (3) group penned, no heifer contact and (4) group penned, heifer contact every 2 weeks.

[c]Treatment (2) individually penned, heifer contact every 2 weeks and (4) group penned, heifer contact every 2 weeks.

[d]Treatments (1) individually penned, no heifer contact and (3) group penned, no heifer contact.

[e,f]Means with different super script differ ($P < .05$).

[g]Mean concentration for all bulls.

TABLE 12. SPEARMAN CORRELATIONS BETWEEN SEMEN TRAITS AND SCROTAL CIRCUMFERENCE, SERVING CAPACITY AND LIBIDO SCORE BY TREATMENT GROUPS

Item	% abnormal	% live	concentration	scrotal circumference	serving capacity	libido score
Treatment 1 (N=8)						
% motility	.20	.88**	.45	.30	-.75*	-.40
% abnormal		.34	.26	.34	-.70	-.70
% live			.61	.24	-.78*	.06
concentration/ml ($X10^7$)				-.42	-.37	.06
Treatment 2 (N=5)						
% motility	.74	-.32	.45	.92*	-.45	.00
% abnormal		.40	-.40	.74	-.80	.00
% live			-.10***	-.32	-.80	.00
concentration/ml ($X10^7$)				.15	-.10	.00
Treatment 3 (N=16)						
% motility	-.22	.21	.40	-.21	-.13	-.06
% abnormal		-.74**	-.09	.30	.12	.14
% live			.10	.03	-.01	.04
concentration/ml ($X10^7$)				-.50	.55*	.39
Treatment 4 (N=14)						
% motility	-.05	-.09	.29	-.12	.12	.25
% abnormal		-.12	-.52	.32	-.51	-.42
% live			-.08	.04	.09	.23
concentration/ml ($X10^7$)				-.28	.06	.13

[a]Treatment groups (1) individually penned; (2) individually penned, heifer contact every 2 weeks; (3) group penned; (4) group penned, heifer contact every 2 weeks.

*P < .05.

**P < .01.

***P < .001.

TABLE 13. CORRELATIONS BETWEEN SCROTAL CIRCUMFERENCE AND SERVING CAPACITY, LIBIDO SCORE, AND MOUNTING ACTIVITY

Item	Treatment	Measurement period[a] 1	2	3	4	5
Serving capacity	1			-.63	-.31	-.52
	2	-.21	.06	-.32	-.16	.00
	3			-.04	-.09	-.39
	4	-.33	-.07	-.30	-.31	.28
Libido score	1			-.72*	.87*	-.52
	2	-.21	-.17	.17	.00	-.27
	3			.15	-.07	-.22
	4	-.06	-.06	-.24	-.41	-.52
Mounts	1			.21	.00	-.33
	2	-.15	-.05	.04	.60	.23
	3			-.23	-.36	.16
	4	-.33	.27	.17	-.49*	-.24

[a]Measurements taken at 2-month intervals beginning February 21.

[b]Treatments: (1) individual penned; (2) individually penned, heifer contact every 2 weeks; (3) group penned; (4) group penned, heifer contact every 2 weeks.

*$P < .05$.

TABLE 14. REGRESSION COEFFICIENTS FOR MATING VARIABLES MEASURED IN MATING TESTS 1, 2, 3, 4, 5, 6A, 7A AND 8A TREATMENTS 2 AND 4[a]

	Treatment							
	2				4			
Item	α[b]	β_1[c]	β_2[d]	Comment	α	β_1	β_2	Comment
Serving capacity	2.79	-.029	-.0001*	Quadratic	1.39	.011	-5.40*	Quadratic
Libido score	5.67	-.0001	.....	No change	5.42	.002	.....	No change
Mounts	32.66	-.315	.0011**	Quadratic	16.18	-.022	.....	No change
Serving efficiency	.066	.003	-1.3850**	Quadratic	.12	.0003	.....	No change
Disorientation	.302	-.001	.....	No change	.10	.0003	.....	No change

[a]Treatment 2 consisted of those bulls penned individually during rearing and exposed to heifers every 2 weeks. Treatment 4 consisted of those bulls group penned and exposed to heifers every 2 weeks.

[b]Intercept.

[c]Linear regression coefficient.

[d]Quadratic regression coefficient.

*P < .05.

**P < .01.

were group penned. There was no change in efficiency in the group penned bulls. Serving capacity fit a curvilinear regression in both treatments 2 and 4, increasing in the early tests and decreasing in the later tests. Since a number of different heifers were used and bulls always had at least 2 weeks rest between tests, the decrease would not appear to be due to satiety. Perhaps the bulls reached a natural plateau. Mating tests at later dates would give more insight into this rise and fall in serving capacity.

Table 15 gives the correlations between serving capacity, libido score, mounting activity during the mating test, and disorientation. Results were very similar for all treatments. Serving capacity and libido score were highly correlated ($r = .80$ to $.89$; $P < .001$). Number of mounts was negatively correlated with serving capacity ($r = -.24$ to $-.52$; $P < .05$). Disorientation was not significantly correlated with serving capacity, libido score, or mounting activity.

Homosexual Behavior

Correlations between homosexual and heterosexual behavior of bulls showed no significant relationship between behavior with bulls and subsequent sexual behavior with heifers (table 16). There was a significant, but low correlation ($r = .22$; $P < .05$) between mounting other bulls and mounting heifers in treatment 4 (group penned bulls with no heifer contact during rearing).

TABLE 15. SPEARMAN CORRELATIONS BETWEEN BEHAVIORAL TRAITS DURING THE MATING TESTS

Item	Libido score	Mounts	Disorientation
Treatment 1[a]			
Serving capacity	.89***	-.31*	-.03
Libido score		-.18	-.03
Mounts			.10
Treatment 2[b]			
Serving capacity	.80***	-.52***	-.17
Libido score		-.37***	-.23
Mounts			-.01
Treatment 3[c]			
Serving capacity	.84***	-.40***	-.06
Libido score		-.28***	-.06
Mounts			-.15
Treatment 4[d]			
Serving capacity	.85***	-.24***	-.08
Libido score		-.14	-.05
Mounts			.11

[a]Individually penned.

[b]Individually penned, heifer contact every 2 weeks.

[c]Group penned.

[d]Group penned, heifer contact every 2 weeks.

*P < .05.

**P < .01.

***P < .001.

TABLE 15. SPEARMAN CORRELATIONS BETWEEN BULL-BULL MOUNTING[a] AND BEHAVIOR DURING MATING TESTS 3, 4, 5, 6A and 6B

		Item		
Treatment	Item	MEE	Mounts	Serving capacity
2	MEE[b]	.04	.25	-.19
	MER[c]		-.03	.05
4	MEE	-.13	.05	.02
	MER		.22*	.03

[a]Mounting behavior of group-penned bulls was observed for 30 minutes on the day of the mating tests.

[b]Number of times bull was mounted by another bull in five 30 minutes observation periods.

[c]Number of times bulls mounted another bull in five 30 minute observation periods.

*P < .05.

Test Evaluation

Data comparing the individual and group test are shown in table 17. Bulls were generally more sexually aggressive in the individual tests. Average serving capacity was higher ($P < .05$) when bulls were tested individually than when they were tested in a group and individually-tested bulls wasted fewer mounts while attempting to breed the heifer. These results are contrary to those of Lunstra (1981). There are two factors which may have contributed to these conflicting results. Heifers were stanchioned closer together and there were generally six bulls tested together in the group test in the present study, while Lunstra used three or five bulls in a group test. The larger number of bulls and the closer proximity of the heifers seemed to encourage bull-bull interactions such as interference and fighting, thereby disrupting breeding behavior. Secondly, our individual test tested six bulls simultaneously in adjacent pens (figure 2) but Lunstra individually tested one bull at a time. Therefore, bulls in his individual test did not have the opportunity to observe other bulls mate during their test. Our individually tested bulls could observe each other breeding heifers. Observing the mating behavior of other bulls is believed to stimulate sexual activity in bulls (Blockey, 1975). Although bulls were more active in the individual test, both tests seemed to adequately stimulate sexual activity in yearling bulls. The results suggest that heifers should be spaced further than 2 m apart in group tests.

Interference and being interferred with were not highly correlated with test performance (table 18). The correlations were significant, however, in treatments 3 and 4 where bulls were penned together. Serving capacity and being interferred with were significantly negatively correlated

TABLE 17. A COMPARISON OF MATING BEHAVIOR OF BULLS IN INDIVIDUAL AND GROUP MATING TESTS

Item	Item	
	Individual (6A, 7A, 8A)	Group (6B, 7B, 8B)
Serving capcity	1.96[a]	1.64[b]
Mounts	15.78	15.27
Libido score	5.65	5.60
Serving efficiency	.15[c]	.09[d]
Disorientation	.22	.26

[a,b]Means on the same line with different super scripts are significantly different ($P < .05$).

[c,d]Means on the same line with different super scripts are significantly different ($P < .01$).

TABLE 18. SPEARMAN CORRELATIONS BETWEEN INTERFERENCE DATA AND MATING TEST RESULTS

Item	Interferred with	Serving capacity	Libido score	Mounts	Disorientation	Serving capacity
Treatment 1						
Interference[a]	-.05	0	.04	.55**	-.01	-.10
Interferred with[b]		.01	.07	.45*	-.01	-.11
Treatment 2						
Interference	.12	-.15	-.18	-.10	.11	-.08
Interferred with		-.15	-.26	-.23	-.01	-.11
Treatment 3						
Interference	.32*	-.27	-.10	.16	0	-.27*
Interferred with		-.39**	-.30*	.20	-.19	-.40**
Treatment 4						
Interference	.27*	.21	.25	.20	.01	.18
Interferred with		.02	.06	.47**	-.18	-.16

[a]Number of times a bull interferred with another bull's attempt to mount a heifer in the group mating test.

[b]Number of times a bull was interferred with as he attempted to mount a heifer in the group mating test.

*($P < .05$).
**($P < .01$).

($r = -.39$; $P < .01$) in treatment 3. Likewise, libido score and being interferred with were significantly negatively correlated in treatment 3 ($r = -.30$; $P < .05$). Interference activity was generally positively correlated to mounting activity. Most likely active bulls mount and interfer frequently and are therefore also likely to be interferred with. Disorientation was not related to interference. Serving efficiency was not significantly correlated to interferring activity but the correlations were generally negative, suggesting that more efficient bulls spent less time fighting with other bulls.

It was generally noted that bulls did not distribute their attention equally to all heifers available in the group tests. They usually mounted two or three of the five heifers more frequently. However, it did not appear that any one heifer was particularly attractive to all bulls, nor were any heifers ignored by all bulls. While one bull may have been mounting heifers 1, 2 and 3, another bull may have been mounting heifers 4 and 5, another mounting heifers 2, 3 and 4, and so on.

Summary

There were generally no significant differences among the four rearing groups in sexual performance. The first time all bulls were group tested (test 6B) individually-penned bulls had significantly larger ($P < .05$) serving capacity and serving efficiency scores than group-penned bulls. These differences did not persist once all bulls were penned together. The degree of social restriction was not severe and restraining the heifers in stanchions may have reduced the amount of disorientation that would have occured otherwise.

Bulls penned individually were heavier while penned individually, but when all bulls were group penned, group-reared bulls out-weighed individually-reared bulls. Average scrotal circumference was higher during the last two measurement periods for bulls penned in groups than those penned individually. Rearing environment generally did not affect semen quality.

Libido score did not change significantly after the first mating test. Serving capacity fit a curvilinear regression, increasing throughout the early tests and decreasing in the later tests.

Serving capacity and libido score were highly correlated ($r = .80$ to $.89$; $P < .001$). Mounting activity was negatively correlated with serving capacity ($r = -.24$ to $-.52$; $P < .05$). Disorientation was not significantly correlated with serving capacity, libido score or mounting activity.

Homosexual behavior between bulls was not significantly correlated with their sexual behavior toward heifers.

Serving capacity was higher ($P < .05$) when bulls were tested individually than when they were tested in a group, and individually tested bulls had fewer mounts per service ($P < .01$) than group tested bulls.

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THE EFFECT OF REARING ENVIRONMENT ON SEXUAL BEHAVIOR OF YOUNG BEEF BULLS

by

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Fifty-eight Polled Hereford bulls were weaned after nursing cows on parture for an average of 196 days. They were penned individually at weaning but were able to see, hear and smell one another. Physical contact between bulls was limited to fenceline exposure to bulls in adjacent pens.

Six months after weaning, bulls were allotted to one of the following 10-week rearing treatments: (1) individually penned with no heifer contact; (2) individually penned with heifer contact every 2 weeks; (3) group penned with no heifer contact; (4) group penned with heifer contact every 2 weeks.

All 58 bulls were penned together after week 12. Mating test were 30 minutes long. All bulls were given an individual mating test (one bull with one stanchioned, estrus-induced heifer) during weeks 10, 20 and 28, and all bulls were group-tested (generally six bulls with five stanchioned, estrus-induced heifers) during weeks 12, 22 and 30.

During weeks 4, 6, 8, 10 and 12, all group-penned bulls were observed for 30 minutes. The number of times each bull mounted another bull or was mounted by another bull was recorded.

Sexual behavior was not different between bulls in the rearing environments used in this study. Serving capacity was higher in the individual tests than in the group tests ($P < .05$), but both types of mating tests adequately stimulated sexual activity in yearling bulls. Bull homosexual behavior was not correlated to sexual behavior in a mating test with a heifer.