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SUMMARY

An evaluation of the relationship between several measures of semen quality and fertility of bulls mated under natural conditions has been conducted over a three-year period. Semen was collected three different times with an electro-ejaculator from bulls used in the fertility tests. Collections were made at weekly intervals. Fertility was evaluated by mating bulls to heifers starting about three days after the last collection.

Semen quality refers to the percent abnormals and the percent motility evaluated at the time of collection. Fertility was measured by the proportion of heifers that settled at natural service.

Eight bulls were mated in 1958. Fertility was lower in the two bulls having a high proportion of abnormal sperm at semen collection than in the two bulls with good quality semen at semen collection. Fertility in bulls having semen with poor motility and a few abnormal sperm and fertility in bulls with a moderate number of abnormal sperm was similar to that of bulls with good quality semen.

In 1959, fifteen bulls were used. Ten bulls had good quality semen at all three collections while five had poor quality semen. Average fertility between these two groups of bulls differed by 22% ($P < .05$). However, little or no difference in fertility between certain individual bulls having good or poor quality semen was noted.

Twenty-eight bulls were tested in 1960. Bulls with a wide range of semen quality were used. Simple correlations between semen characteristics and fertility were calculated. Typical correlations were: .40 between motility and fertility, .39 between live normal sperm and fertility, and −.35 between abnormal sperm and fertility.

Several multiple regression equations were calculated. In general, these varied from .42 to .47 while one was .83. However, there is some doubt about the reliability of this last equation because of its many

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components. These data show that the average fertility of a group of bulls could be predicted with some accuracy but the prediction of fertility of individual bulls is subject to large error. One of the principal reasons for this error is the changes that occur in semen quality.

INTRODUCTION

Bulls differ in fertility. Most of the difference appears to be the result of variation in ability of the sperm to fertilize the ovum (Kidder *et al.* (7) and Bearden *et al.* (2)). The relationship between semen quality and fertility has been investigated extensively, but most investigations have utilized bulls used for artificial insemination. As a result, the relationship between semen quality and fertility has often been studied among bulls all of which are reasonably fertile.

This bulletin reports an experiment undertaken to determine the relationship in bulls between semen evaluation before breeding and subsequent bull fertility when bulls were mated naturally. Bulls with a wide range of initial semen characteristics were utilized.

REVIEW OF LITERATURE

A recent review of the available literature on the relationship between semen quality and fertility has been made by Melrose (8). He concluded from his review of the literature that it was doubtful if more than 20% of the variation in fertility could be accounted for by variation detectable in the laboratory. He stated that published reports show that morphological examination of semen is of limited value in the assessment of fertility. However, he was of the opinion that morphological evaluation should be made since there are definite spermatozoal abnormalities associated with complete infertility.

Melrose (8) also pointed out that several authors concluded that physical activity of semen was more closely related to fertility than was metabolic activity. He concluded that the relationship between fertility and percentage of dead spermatozoa has varied between studies. Some workers found no relationship while others reported that fertility decreased when the proportion of dead spermatozoa increased. Thus, it would appear from Melrose's study that in bulls used for artificial insemination the relationship between standard measures of semen quality and fertility is low. However, it should be remembered that these bulls were highly selected for fertility.

Hulet *et al,* (5) have recently developed an index of semen quality in rams to measure the relationship between semen quality and fertility. The correlation between predicted fertility and actual fertility was 0.76 for one index and 0.73 for another index. Semen was obtained from the rams by natural ejaculation.

Predictive value of semen collected by electrical ejaculation has been shown to be much lower than that obtained by natural ejacula-

tion (Hulet *et al.* (6)). The multiple correlations between fertility and several semen characteristics were 0.45 for semen collected by electro-ejaculation and 0.74 for semen collected by natural ejaculation.

The semen of seven beef bulls was evaluated by Bartee *et al.* (1) and the bulls were then bred naturally. They reported that a higher percent calf crop was associated with higher motility scores.

Cupps *et al.* (3) evaluated the semen of 460 young beef bulls. They found that about 8% had semen quality that would indicate poor reproductive efficiency. However, the semen quality had improved in about half of these bulls which were re-tested in a 6 to 18-month period. Changes in semen quality were also observed in older bulls which were re-tested. Twelve bulls were bred either naturally or artificially. From those breedings regression lines were calculated. The authors concluded that if a conception rate of 30% or less was considered impaired breeding efficiency; then an impairment of breeding efficiency was present when less than 43% of sperm were living, less than 37% were motile, or more than 35% were abnormal.

The semen from a large number of bulls has been evaluated at Colorado State University. Hill (4) reported that 6% of 2,760 bulls tested were classified as unsatisfactory and 7% were classified as questionable. Bulls were not re-tested and no information was presented on the relationship between the classification given and fertility.

There is a general practice of evaluating semen which has been collected by an electrical ejaculator in beef bulls. This evaluation is used as an indication of future fertility under normal mating conditions. The relationship between semen evaluation and subsequent fertility has not been clearly established. Therefore, it is important to investigate more thoroughly the relationship between methods of semen evaluation and subsequent fertility in beef bulls.

MATERIALS AND METHODS

This study was conducted over a three-year period. With the exception of two 30-month-old animals, all bulls were about 18 months old at the time of the first semen evaluation. In most instances, the bulls had completed a record of performance test immediately before initial semen evaluation. Semen was collected from 31 Hereford and 17 Angus bulls the first year; 63 Hereford, 13 Angus, and 7 Shorthorn bulls the second year; and 94 Hereford, 2 Angus, and 5 Shorthorn bulls the third year (Table 1).

The treatment of bulls from weaning to time of semen collection was about the same in all three years. Bulls were placed in dry lot at weaning time and fed alfalfa hay *ad libitum* plus approximately two pounds of a concentrate mixture (Table 2). The daily level of concentrate was increased ½ pound biweekly until the bulls were about 1 year old. The amount of concentrate mixture then was increased over the next two weeks until bulls were on full feed. Bulls

Table 1. Number of bulls of each breed in this study.

	1958	1959	1960
Hereford	31	63	94
Angus	17	13	2
Shorthorn	0	7	5
Total	48	83	101

were then placed on pasture and had access to self feeders until about 18 months old. Initial semen collection was made at this time.

Semen was collected using an electrical ejaculator. The first year three semen collections were made on all bulls at intervals of one week. In the second and third years, a single collection was taken from all bulls. Certain bulls were then selected for two additional collections. These additional collections were made at weekly intervals. Thus, all bulls used in the fertility test were collected three times before the start of the test.

An attempt was made to procure a good ejaculate at each collection. In instances where ejaculates of low concentration and poor vigor were obtained, a second ejaculate was taken after the bull had rested 10 to 15 minutes.

Bulls were restrained in a squeeze chute while the collections were made. Collections were made either outdoors or in an unheated building. A tube containing warm water was placed around the collection vial to lessen the possibility of cold shock. Semen was evaluated in a warm room. Evaluation started within five minutes of collection.

During the first two years motility was scored as percent motile. The third year motility was given a score from zero (no motility) to five (high motility). Motility was scored on the basis of: (1) the motility in an undiluted drop on a warm slide and (2) the motility in a drop diluted with sodium citrate under a cover slip. Concentration was scored from 0 to 5 by observing the semen in the collection tube and the density of the sperm in an undiluted drop under a low power microscope.

Semen smears were stained with a nigrosin eosin stain and the percent live and abnormal sperm estimated from counts of one hundred cells.

Bulls to be used in subsequent fertility tests were selected on (1) the quality of semen and (2) the consistency of semen quality. Since only a small percentage of the bulls could be mated for fertility tests,

Table 2. Concentrate mixture fed to bulls.

Ingredients	Percent by weight
Corn	30
Oats	20
Bran	15
Soybean meal	10
Beet pulp	25

attempts were made to test those having wide variations in semen quality. In general, the bulls selected for fertility tests had consistently produced semen of the same apparent quality during three collections. Fertility tests commenced within three days after the last semen evaluation in all three years. Success or failure of breeding was determined by diagnosis of pregnancy between 35 and 42 days after breeding.

Bulls to be tested for fertility the first year were each placed in a feed lot with about 50 heifers for about 2 hours in the morning and 2 hours in the evening. The bulls were painted on the brisket with a multi-purpose grease containing a green pigment. All heifers having grease on the tail or rump were presumed to have been bred. The same bull was placed in a lot each day until he had bred 20 to 25 heifers. Only first services were used for evaluation of fertility.

Fertility tests were conducted under hand mating conditions the second and third years. Bulls were placed in a small lot with the heifer to be mated. Close surveillance was maintained to be certain that actual mating occurred in each case. In most cases, bulls were allowed to mate a heifer only one time. The heifers mated to each bull were chosen at random. Heifers which showed a second heat, at a normal interval, were re-randomized and bred a second time. Since there was no significant difference in conception rate between first and second service ($P < .05$), the data from first and second services have been combined for evaluation of fertility.

RESULTS AND DISCUSSION

Relationship Between Semen Quality and Fertility

Fertility of eight bulls was evaluated in 1958. The bulls were grouped into four groups according to semen quality. These were: good quality semen (motility 90%, abnormal sperm 11%); semen with poor motility (motility 44%, abnormal sperm 14%); semen with moderate abnormal sperm (motility 72%, abnormal sperm 32%); and semen with a large proportion of abnormal sperm (motility 56%, abnormal sperm 54%). Fertility in the four groups varied from 28 to 58% ($P > .05$) (Table 3).

Only the bulls which had produced semen with a large proportion of abnormal sperm showed a marked decrease in fertility when compared to bulls which had produced good quality semen. The variation found between bulls which had produced the same quality semen at the time of semen evaluation was large. One bull with a high percentage of abnormal sperm (7151) had much lower fertility level as compared to bulls with good quality semen. Fertility in the other bull with a large number of abnormal sperm (7029) is only slightly lower than one bull (7052) with good quality semen. Marked variation can also be seen in the other groups. Undoubtedly, part of

Table 3. Relationship between fertility, abnormal sperm and motility of sperm (1958).

Selection criteria	Bull no.	Semen characteristics (av. 3 collections before breeding)		No. heifers bred in fertility test	Pregnant
		Abnormal sperm	Motility		
		%	%		%
Good quality semen	7052	11	87	18	41
	7093	11	93	26	58
	Average	11	90	22	50
Poor motility	7039	6	36	23	52
	7135	21	53	22	64
	Average	14	44	22	58
Moderate percentage of abnormals	7078	27	62	21	52
	7108	37	83	22	41
	Average	32	72	22	46
High percentage of abnormals	7029	53	68	23	35
	7151	54	45	23	22
	Average	54	56	23	28

the variation in fertility is the result of the small number of heifers each bull bred.

In 1959 fifteen bulls were tested for fertility. Ten of these bulls had good quality semen at all three collections. The proportion of abnormal sperm did not exceed 15% on any of the three collections. Motility in most cases was 85% or better (three exceptions are shown in Table 4). Concentration of sperm in all bulls was high. However, no attempt was made to measure this quantitatively. The number of dead sperm in most cases did not exceed 26% (five exceptions, Table 4).

The other five bulls to be bred in the fertility test had consistently produced semen with the highest proportion of abnormal cells and the lowest motility of the 83 bulls from which semen was evaluated. In most instances the semen had 40% or more abnormal sperm. One bull (8157) had only 19% abnormal sperm in the first collection. However, there were 55 and 81% abnormal sperm in the next two collections. Another bull (8086) had 38% abnormal sperm in the first collection and 57 and 41% in the second and third collections. Motility varied a great deal from bull to bull but generally was lower in bulls with poor semen quality than that found in bulls with good semen quality. The percentage of sperm which was dead also showed variation between bulls. However, it was not as marked as the variation noted in motility.

The number of heifers bred per bull varied from 4 to 8 for the bulls with good quality semen and from 11 to 14 for bulls with poor quality semen. Sixty-seven percent of the heifers bred to bulls with

Table 4. Details on semen quality for bulls bred in 1959.

Bull no.	1st collection			2nd collection			3rd collection		
	motility %	abnormal %	dead %	motility %	abnormal %	dead %	motility %	abnormal %	dead %
Good semen bulls									
8057	100	6	18	100	6	12	100	11	16
8117	100	4	18	95	8	16	95	13	14
8180	90	12	100	100	10	16	100	7	10
8300	100	12	24	100	13	20	100	11	16
8094	100	5	22	100	11	24	100	10	38
8278	85	5	24	90	7	20	100	4	22
8349	100	14	24	100	5	10	no observation	15	no observation
8055	60	12	50	95	15	44	100	10	22
8986	100	8	10	100	9	18	5	10	32
8065	90	14	26	75	13	26	95	11	26
Poor semen bulls									
8023	95	68	38	100	56	32	85	43	26
8086	100	38	14	50	57	16	50	41	20
8244	40	40	46	70	40	34	50	55	24
8157	90	19	24	100	55	36	15	81	30
8240	95	66	20	95	51	28	45	50	26

Table 5. Relationship between semen quality and bull fertility in bulls with good and poor semen (1959).

	Bull no.	Semen characteristics (av. 3 collections before breeding)			No. heifers bred in fertility test	Pregnant
		Abnormal sperm	Motility	Dead		
		%	%	%		%
Good semen bulls	8278	5	92	22	8	50
	8057	8	100	15	5	80
	8986	9	68	20	4	100
	8094	9	100	28	8	62
	8117	9	97	15	7	86
	8180	10	97	42	6	83
	8349	11	100	17	7	57
	8300	12	100	20	7	43
	8055	12	85	39	7	57
	8065	13	87	26	4	50
	Average	10	93	24	6	67
Poor semen bulls	8244	45	53	35	12	67
	8086	45	67	17	13	31
	8157	52	68	30	14	36
	8240	56	78	25	11	36
	8023	56	90	32	14	57
	Average	51	71	28	13	45

good quality semen were diagnosed pregnant compared to 45% bred to bulls with poor quality semen (Table 5). This difference of 22% was statistically significant ($P < .05$). Although the average fertility differed markedly between the groups with different semen quality, there were individual bulls having good or poor quality semen in which little or no difference in fertility was noted. One bull (8244) with poor quality semen had the same fertility as the average of the bulls with good semen and exceeded the fertility of six of the bulls with good quality semen. One other bull (8023) with poor semen exceeded the fertility of three bulls with good quality semen and had the same fertility as two other bulls. Thus, it is possible to predict the average fertility of a group of bulls with some reliability, while prediction of an individual bull's fertility is less reliable.

More details concerning the type of abnormal sperm present in bulls with poor semen is presented in Table 6. These data are based on a single collection taken immediately before the bulls were bred. The type of abnormality present in one bull which subsequently had good fertility (8023) differs somewhat from the other bulls. One other bull (8244) with good fertility, however, shows essentially the same type semen as the three bulls with poor fertility. Thus, it would appear difficult to characterize the semen of individual bulls with poor fertility.

Twenty-eight bulls were tested for fertility in 1960. The number of heifers bred to each bull varied from 13 to 16. Bulls were selected

Table 6. Type of sperm abnormalities in bulls with poor quality semen.

Bull no.	Semen characteristics (single collection immediately prior to breeding)										Pregnant
	Twisted tails	Abnormal head	Deformed midpiece	Proximal protoplasmic droplet	Mid-protoplasmic droplet	Tailless	Bent tail	Short tail	Total abnormals	Motility	
	%	%	%	%	%	%	%	%	%	%	%
8244	36	3	3	5	3	2	1	2	55	50	67
8086	24	2	2	4	2	3	1	3	41	50	31
8157	41	6	3	6	14	6	0	0	76	15	36
8240	12	3	5	25	2	8	1	0	56	45	36
8023	5	3	2	18	2	29	0	0	59	85	57

Table 7. Fertility and semen evaluations in bulls of varying semen quality before breeding.

Bull no.	Semen characteristics (average 3 collections prior to breeding)											No. heifers bred in fertility test	Pregnant
	Total abnormalities	Abnor. heads	Abnor. midpiece	Coiled tails	Prox. drops	Bent tails	Tailless	Medium protoplasmic drops	Motility	Conc.	Live normal		
	%	%	%	%	%	%	%	%	%	%	%		%
1	7	1	1	1	0	0	3	1	3	4	56	14	71
2	9	2	0	3	2	0	1	1	5	5	74	13	62
3	14	3	1	3	3	0	3	1	5	2	29	13	77
4	13	4	2	3	1	0	3	0	4	5	67	13	38
5	14	2	1	5	1	0	2	3	3	4	41	14	14
6	15	3	1	8	0	1	1	1	3	2	72	15	67
7	19	5	1	7	1	0	4	1	4	4	43	14	50
8	20	4	2	5	0	0	3	6	3	3	45	13	54
9	21	3	1	5	2	0	4	6	5	4	51	14	21
10	22	3	2	5	2	0	6	4	4	4	59	13	85
11	23	1	1	11	1	4	4	1	4	4	34	14	43
12	23	3	0	8	0	0	12	0	3	5	47	13	46
13	27	1	1	8	0	0	16	1	4	4	59	14	71
14	27	5	1	8	0	0	13	0	3	3	36	13	54
15	29	1	3	15	1	7	1	1	4	4	56	14	57
16	32	2	2	17	3	1	6	1	3	5	42	15	60
17	34	2	2	18	1	0	7	4	4	5	34	13	62
18	44	1	1	23	3	4	1	11	4	4	45	13	62
19	52	9	0	18	0	0	25	0	0	1	3	13	31
20	71	28	14	6	4	0	19	0	1	1	5	13	62
21	75	3	2	49	1	1	18	1	1	2	4	16	38
22	70	18	15	16	3	3	15	0	2	3	5	13	69
23	61	1	2	16	11	8	18	5	2	1	16	13	38
24	81	4	3	23	6	12	32	1	2	2	13	13	62
25	77	16	3	21	3	7	26	1	2	3	9	14	0
26	86	20	4	21	14	1	22	4	1	1	8	14	7
27	Aspermia											15	0
28	Aspermia											15	0

so that a wide range of semen quality was represented. The principal characteristics of the semen for the three collections before breeding are shown in Table 7.

Simple correlations between semen characteristics and between each semen characteristic evaluated and fertility were calculated (Table 8). In general, the relationship between any one measure of semen quality and fertility was low. Motility showed the highest correlation (.40) with fertility. However, the relationship between fertility and certain other characteristics; i.e., live normal (.39), total abnormals (—.35), secondary abnormalities (—.34) was nearly as high.

Several semen characteristics were studied by multiple regression to determine their combined or joint relationship to subsequent bull fertility. The standard partial regressions and the multiple correlations were calculated for six combinations of semen characteristics (Table 9). The predictive values of five of these six combinations were only slightly better than using motility or live normal alone. The predictive value of the other combination of semen characteristics appears to be quite high. There are several points, however, that are questionable regarding the reliability of the multiple correlation for this combination of semen characteristics and fertility. The number of bulls on which the multiple regression equation is based is small and thus the standard error is large. The number of traits involved is large and with the large error involved, a multiple correlation of this magnitude could occur by chance. The magnitude of the error involved is further demonstrated when predicted values are compared to actual values (Table 10). The predicted values and the actual values differ markedly. In bulls predicted to have between 50 and 59% of their cows pregnant, the average percent pregnant was 52. The range in the actual values was from 21 to 71%. Other groups show similar variation. Again the average fertility of a group of bulls was predicted quite accurately but the fertility of individual bulls in many instances was not.

Certain components of the multiple correlations do not appear valid biologically. Concentration in every case is negatively correlated with fertility. In several cases, different types of abnormal sperm are positively correlated with fertility. It is thought this is a result of small numbers and consequently large experimental error in the sample used.

Changes in Semen Quality

One of the potential sources of error in using semen quality as a tool to predict future fertility is the variation occurring in semen quality from collection to collection and from collection to breeding. In an attempt to measure these changes, indexes 1 and 5 have been employed and data from 1960 have been used. These were utilized to predict a bull's fertility from semen collections taken at various times

Table 8. Relationship between semen characteristics and fertility.

		Abnormals												
	1 Motility	2 Total	3 Primary	4 Secondary	5 Head	6 Mid piece	7 Coiled tail	8 Prox. drops	9 Bent tails	10 Tailless	11 Mid drops	12 Live normal	13 Conc.	14 Percent pregnant
1														
2	−.79													
3	−.77	.95												
4	−.65	.87	.68											
5	−.66	.65	.73	.38										
6	−.48	.54	.66	.25	.80									
7	−.52	.71	.71	.58	.09	.08								
8	−.40	.63	.59	.56	.42	.27	.25							
9	−.22	.53	.35	.70	−.00	.10	.41	.42						
10	−.76	.84	.68	.91	.52	.31	.51	.45	.45					
11	.25	.00	−.01	.04	−.20	−.18	.10	.23	.09	−.26				
12	.84	−.88	−.84	−.78	−.66	−.53	−.57	−.52	−.37	−.81	.08			
13	.72	−.58	−.55	−.50	−.53	−.30	−.27	−.50	−.16	−.58	.16	.69		
14	.40	−.35	−.31	−.34	−.25	.12	−.27	−.33	−.13	−.32	−.11	.39	.20	

Table 9. Standard partial regressions and predictive value of multiple regression equations.

	Combination					
	1	2	3	4	5	6
Motility	.43	.39	.30	.29	.26	.58
Percent abnormal sperm						
Total		.14			.07	
Primary	.22			.17		
Head			.14			−1.00
Midpiece						1.27
Coiled tails						.07
Proximal drops			−.23			−.16
Secondary	−.07			−.09		
Bent tails			.09			−.22
Tailless						.59
Mid drops						.03
Percent live normal	.34	.36	.15	.22	.24	.67
Concentration	−.25	−.24				−.58
Multiple correlation	.47	.45	.46	.43	.42	.83

(Table 11). In a 3-week period, large changes were noted in many instances in the predicted fertility. Twenty-two percent of the bulls showed a change of 20% or more in predicted fertility when index 1 was used and 7% showed a change of 20% or more when index 5 was used.

Changes in predictive values were also measured over a 9-week period. These changes were more marked than those seen in the 3-week period (Table 12). It should be remembered that the group of bulls used for measuring changes over the 9-week period were a selected sample. Only bulls which had shown little or no change in semen quality during the 3-week collection period were available for study. The bulls were being used in test matings for 6 weeks of the 9 weeks studied. Of the 27 bulls used, 13 showed changes of at least 10% in predicted fertility and 8 showed changes of 20% or more in predicted fertility during the 9-week period. When an average of the first 3 collections is used as a base, 15 bulls showed changes of 10% or more while 7 showed changes of 20% or more.

Table 10. Predictive value of fertility using index No. 6 compared to actual fertility.

Percent pregnant predicted	No. bulls	Percent pregnant actual (av.)	Percent pregnant range
Over 60	5	75	69–85
50–59	9	52	21–71
40–49	8	52	38–62
30–39	1	14	
20–29	1	31	
10–19	0	....	
< 10	2	4	0–7

Table 11. Variation in predicted fertility during a three-week period.

Predicted fertility at first collection	No. of bulls	Changes occurring in predicted fertility 3 weeks after first collection						
		Changes of less than 10%	showing decrease in fertility			showing increase in fertility		
			10–15%	16–20%	over 20%	10–15%	16–20%	over 20%
		no.	no.	no.	no.	no.	no.	no.
using multiple *regression 1*								
66–85	9	4	0	1	4	0	0	0
56–65	14	10	2	0	2	0	0	0
46–55	15	7	0	1	2	3	1	1
36–45	6	3	1	0	0	1	1	0
26–35	2	1	0	0	0	1	0	0
0–25	5	3	0	0	0	0	0	2
using multiple *regression 5*								
66–75	4	1	0	2	1	0	0	0
56–65	19	14	1	1	3	0	0	0
46–55	15	11	2	0	0	1	1	0
36–45	12	9	0	1	0	0	2	0
26–35	6	5	0	0	0	1	0	0

Table 12. Variation in predicted fertility during a nine-week period.

Predicted fertility at first collection	No. of bulls	Changes occurring in predicted fertility by 9 weeks after initial collection						
		Changes of less than 10%	showing decrease in fertility			showing increase in fertility		
			10–15%	16–20%	over 20%	10–15%	16–20%	over 20%
		no.	no.	no.	no.	no.	no.	no.
using multiple *regression 1*								
76–85	1	0	0	0	1	0	0	0
66–75	3	0	0	2	1	0	0	0
56–65	5	3	0	0	2	0	0	0
46–55	9	6	0	0	1	1	0	1
36–45	7	6	1	0	0	0	0	0
6–35	0	..	..	..	..	..	..	..
0–5	2	0	0	0	0	0	0	2
Predicted fertility using an average of *3 collections*								
56–65	8	4	2	0	2	0	0	0
46–55	9	3	0	0	2	3	1	0
36–45	6	3	2	0	0	0	0	1
26–35	2	2	0	0	0	0	0	0
6–25	0	..	..	..	..	..	..	..
0–5	2	0	0	0	0	0	0	2

Table 13. Semen changes in bulls bred in 1960.

Bull no.	Average of 3 collections						Collection after 21 days of breeding						Collection after 42 days of breeding				
	Prim. abnor.	Sec. abnor.	Live norm.	Motil.	Conc.	% preg. 1st serv.	Prim. abnor.	Sec. abnor.	Live norm.	Motil.	Conc.	% preg. 2nd serv.	Prim. abnor.	Sec. abnor.	Live norm.	Motil.	Conc.
	%	%	%				%	%	%				%	%	%		
1	3	4	56	3	4	80	8	6		5	5	50	9	6	50	3	4
2	6	2	74	5	5	67	9	1		5	4	50	7	1	48	3	5
3	9	4	43	5	2	78	6	2		3	2	75	36	14	38	2	3
4	10	4	67	3	5	22	4	11		4	4	75	5	3	84	3	5
5	9	5	41	3	4	20	8	0		5	5	0	45	11	18	1	5
6	12	2	72	3	2	60	5	4		0	5	80	3	0	70	1	2
7	13	5	43	4	4	67	10	1		2	5	20	6	12	28	2	5
8	11	9	45	3	3	56	11	10		5	4	50	9	7	4	1	5
9	11	11	51	5	4	20	6	3		4	4	25	4	16	0	2	5
10	12	10	59	4	4	78	11	5		5	5	100	17	0	70	2	1
11	13	9	55	4	4	50	6	12		5	5	25	6	2	66	5	5
12	11	12	47	3	5	56	15	5		5	5	25	16	10	48	2	5
13	10	17	59	4	4	67	15	15		5	5	80	16	5	66	5	5
14	15	13	36	3	3	56	21	18		2	5	50	19	3	76	5	5
15	20	9	56	4	4	60	22	13		3	4	50	14	5	66	3	4
16	24	8	42	3	5	80	21	3		2	5	20	13	12	48	3	3
17	23	11	51	4	5	78	31	11		1	5	25	48	8	54	4	5
18	28	16	45	4	4	56	11	30		3	5	75	25	5	46	3	4
19	27	25	8	0.3	1	22	20	16		4	5	50	18	2	42	2	5
20	53	19	7	0.7	1	56	25	24		4	4	75	7	6	78	5	5
21	55	20	12	1	2	36	30	10		2	4	40	64	3	22	1	5
22	52	18	5	2	3	67	25	15		2	4	75	28	41	26	2	3
23	31	31	16	2	2	33	27	14		0	3	50	47	17	....	1	1
24	36	45	13	2	3	67	36	57		2	5	50	56	8	18	2	5
25	43	34	9	2	3	0	63	13		1	2	0	65	20	4	1	3
26	60	27	8	1	1	10	44	35		3	3	0	36	20	18	2	5
27	Aspermia					0	Aspermia					0	55	17	20	1	1
28	Aspermia					0	Aspermia					0	36	38	26	1	3

The changes in semen characteristics of individual bulls are shown in Table 13. The changes in semen characteristics of bulls number 5, 19, 20, 27, and 28 should be especially noted. Some of the deviations from expected fertility that were noted were associated with changes occurring in semen characteristics.

Bull number 19 had semen with a high proportion of abnormal cells, low motility, and low concentration the first three collections and low fertility on services during the first three weeks of test matings. There was a drop in abnormal sperm and a marked improvement in motility and concentration at the collection taken after the first 21 days of breeding. Fertility improved at test matings made during the second 21-day period. The sample of semen collected at the end of the breeding period was of fairly good quality. Bull number 20 shows the same kind of changes. The changes in the semen of bull number 5 are almost as marked as those for number 20 except that deterioration of semen quality and lower fertility were noted before changes in semen quality were detected. Therefore, subtle changes in the semen must have taken place at least by the time collection was taken 21 days after breeding. Marked changes in semen quality were noted after termination of the experiment in the two bulls showing aspermia. Bull number 28 was bred about three weeks after the last collection shown in Table 13. He was bred to four heifers and three conceived. Bull number 27 was used in a breeding herd three to four months after the last collection and settled 16 cows out of 19 bred.

LITERATURE CITED

1. Bartee, J., Brown, C. J., and Peterson, H. P.
   1961. Determining the fertility of beef bulls. Arkansas Farm Research. X:4.
2. Bearden, H. J., Hansel, Wm. and Bratton, R. W.
   1956. Fertilization and embryonic mortality rates of bulls with histories of either low or high fertility in artificial breeding. J. Dairy Sci. 39:312-318.
3. Cupps, P. T., McGowan, B., and Rahlmann, D. R.
   1959. Semen quality in beef bulls. California Agriculture 13:5.
4. Hill, H. J.
   1958. Breeding soundness of bulls. Veterinary Medicine 53:189.
5. Hulet, C. V. and Ercanbrack, S. K.
   1962. A fertility index for rams. J. Animal Sci. 21:489-493.
6. Hulet, C. V., Foote, W. C., and Blackwell, R. L.
   1963. Effects of electroejaculation and semen sampling on fertility prediction in rams. J. Animal Sci. 22:861 (Abstr.).
7. Kidder, H. E., Black, W. G., Wiltbank, J. N., Ulberg, L. C., and Casida, L. E.
   1954. Fertilization rates and embryonic death rates in cows bred to bulls of different levels of fertility. J. Dairy Sci. 37:691:697.
8. Melrose, D. R.
   1962. Artificial insemination in cattle. The Semen of Animals and Artificial Insemination. Edited by J. P. Maule. Technical Communication No. 15 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburg. Page 2-181.