SEMEN MEASUREMENTS, SEXUAL BEHAVIOR, AND FERTILITY COMPARISONS FOR TWELVE STRAINS OF CHICKENS

by

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TABLE OF CONTENTS

INTRODUCTION

Obtaining a high percentage of fertile eggs is a problem of major importance to poultry-breeder flock owners and hatcherymen. Incubated infertile eggs represent an appreciable economic loss in that they have little or no value as food and require additional incubator space and labor.

Results of considerable research concerning male fertility have been published but many aspects remain untouched or require further investigation. This particular study was designed to measure and observe the semen characteristics, mating behavior, and fertility of random samples of twelve strains of chickens representing six popular commercial breeds. Previous studies have normally been limited somewhat in terms of number of individual males, number of strains and breeds involved, and measurements of the individual male's reproductive capabilities at different seasons of the year.

During the past few years the hatching of baby chicks has been extended beyond the conventional late winter, spring, and early summer months. Today, hatcheries are operating the entire year to provide chicks for the broiler producer and the egg producer who desire replacement pullets for continuous production.

During the late summer and fall months relatively large percentages of infertile eggs are often produced from matings in which yearling or older cocks are used. Taylor (1949), suggested the possibility of using cockerels from early spring hatches as breeders. It is desirable therefore to have additional knowledge on the development of fertility in late winter or early spring hatched cockerels.

All males utilized in this study were hatched February 15, 1956. The development of sexual maturity and the measurement of semen characteristics, sexual aggressiveness and fertility was accomplished for the following summer months, during the following spring, and again during the late summer and early fall when males were 19 months old. Measurements and observations accomplished for the three respective periods were semen volume, motility of spermatozoa, concentration of spermatozoa, and mating behavior of sexual aggressiveness. Another objective of this study was to estimate the association between social status of the individual male and his semen characteristics and mating behavior.

REVIEW OF LITERATURE

The anatomy of the male reproductive system has been described by Bradley (1915) and Burrows and Quinn (1937). The reproductive system of the male chicken consists of two testes with epididymis, the vas deferens, and the copulatory apparatus. The two testes are bean-shaped and lie on either side of the vertebral column in the abdominal cavity.

Sampson and Warren (1939) obtained semen capable of fertilization from White Leghorn cockerels as early as 9 and 10 weeks of age. Spermatozoa were observed by Parker et al. (1942a) in testicular tissues of White Leghorn and New Hampshire cockerels at 12 weeks of age. Parker and his co-workers further found when placing males with females that fertility was unsatisfactory until the males were 24 weeks old. Hogue and Schnetzler (1937) working with Barred Rock males reported fertile eggs at 21 weeks of age but did not advise putting males with the breeding flock until they were at least 26 weeks of age. Males of a high fecundity strain attained sexual maturity at an earlier age than a low fecundity strain as shown by development of spermatogenesis and by a significantly greater volume of semen produced at 12 weeks of age, Jones and Lamoreux (1942). These workers reported that the average volume of semen from 316 to 365 days for the high fecundity strain was .40 cc and for the low fecundity strain was .28 cc. The average weight of the testes did not differ significantly. Jones and Lamoreux concluded that semen production in the male chicken and egg production in female chicken were expressions of comparable genotypes for high and low fecundity.

Maximum sperm production was not obtained from Barred Rock males until eight to nine months of age according to Parker and McSpadden (1942). Williams and McGibbon (1954) measured the yields of semen among inbred lines and crosses of Single Comb White Leghorns and found highly significant differences among males within the inbred lines. The correlation between body weight of a male and the average yield of semen was found to be highly significant.

Seasonal variation in semen production of Barred Rock males was observed by Wheeler and Andrews (1943). Maximum volumes of semen were obtained between November and March. Penquite et al. (1930) observed that White Leghorn cockerels in the fall of their first year produced semen that was less dense and contained a smaller percentage of live sperm than semen produced the following spring. During the second breeding season these males were less productive than during the first. A decline in semen production during late spring and summer months is associated with the normal drop in egg production during this period according to Parker and McSpadden (1943). It is believed this seasonal slump in sperm production is responsible for the decline in fertility normally experienced. Wheeler and Andrews (1943) found an average temperature of 83.5°F had no harmful effect on sperm production and therefore concluded that length of day is the determining factor in semen production.

Motility of chicken sperm has been observed by a number of workers, Payne (1914), Burrows and Quinn (1939), and Shaffner et al. (1941). Parker et al. (1942b) found a correlation of .246 between motility and fertility.

Utilizing a competitive scoring system, Allen and Champion

(1955) found a correlation of .72 between motility and fertility. This work has been further substantiated by Cooper and Rowell (1957) who reported poorer fertility with lower motility. Shaffner and Andrews (1947) found a positive correlation (.42) between fertility and the initial motility of sperm.

With the number of sperm per cubic millimeter of semen varying between 825,000 and 7,000,000, Hutt (1929) found no correlation between sperm concentrations and male fertility in Brown Leghorns in natural matings. Sperm counts per cubic millimeter varied from 0 to 10 million for New Hampshire males tested by Parker et al. (1942b). Munro (1938) showed that 100,000,000 sperm must be inseminated for optimum fertility and that the concentration of semen from Brown Leghorn males varied from 1.9 to 10.2 million sperm per cubic millimeter. Parker et al. (1942b) also indicated that if 100,000,000 sperm are inseminated the sperm concentration of the semen has little influence on fertility.

Investigations of the sexual drive of libido of the male fowl has indicated considerable variation among individual males. Results reported show considerable variation and are limited in scope and number. This aspect of male fertility appears to offer a fertile field for further study. Heuser (1916) found that the number of copulations per male per day in White Leghorns ranged from 0 to 32. Also in observations of White Leghorn males, Penquite et al. (1930) reported the number of matings per day varied from 6 to 28. Preferented mating, Upp (1928), receptivity of the females and the number of females in the pen were found to influence the libido of the male fowl, Guhl, et al. (1945); Martin and Anderson (1918). Heuser (1916) and Parker et al. (1940) observed that males were more active sexually during the late afternoon than at other times of the day. Another factor found to influence male sexual activity and fertility considerably is social status or the "Peck order" which has been known since Schjelderup- Ebbe's (1922) investigations. The report by Guhl et al. (1945), showed that hens with high social positions do not mate as often with males as do hens with lower social positions. Guhl and Warren (1946) observed that dominant males mated more often and fertilized more eggs than males which were dominated or lower in the "peck order". Results of investigations by Long and Godfrey (1952) are in agreement with those reported by Guhl and Warren (1946).

MATERIALS AND METHODS

Males representing 12 pure strains of chickens were used for this study. Breeds used and strains representing each are designated and referred to as follows:

White Leghorn Strain 1	= Leg_1
White Leghorn Strain 2	= Leg_2
White Leghorn Strain 3	= Leg_3
White Leghorn Strain 4	= Leg_4
Rhode Island Red Strain 1	= RIR_1
Rhode Island Red Strain 2	= RIR_2
Rhode Island Red Strain 3	= RIR_3
Rhode Island Red Strain 4	= RIR_4
White Rock Strain 1	= WR_1
Barred Rock Strain 1	= BR_1
Black Australop Strain 1	= A_1
New Hampshire Strain 1	= NH_1

All strains with the exception of the Kansas State College White Rock Strain were hatched from eggs obtained from prominent commercial breeders with presumably closed flocks.

Cockerels utilized in this study were hatched and sexed February 15, 1956. All birds were battery reared for three weeks and then reared in brooder pens for seven weeks. Birds were vaccinated for Newcastle Disease at four and eight weeks of age.

Period One

Dubbing, removal of combs, was performed at 10 weeks of age. Also at 10 weeks of age, eight males of each strain were selected at random from healthy individuals to be used for natural mating and artificial ejaculation tests. These eight males per strain were randomly divided into two groups of four each, one group being designated for natural mating and the second group as the artificial ejaculation group. These groups were placed in battery pens until birds were 12 weeks of age at which time the groups of four each were again randomly divided into pairs and the pairs randomly assigned to exhibition type cages. This assignment by pairs was not changed until birds were 29 weeks of age at which time the first test period was terminated. At 20 weeks of age each individual male of these pairs was classified as either an Alpha or Beta bird. Alpha designating the male dominant over his cage mate and Beta referring to the subordinate or submissive male dominated by the Alpha male. Classification of males as either Alpha or Beta was accomplished by three different observers making individual observations. Unanimous agreement on all pairs was revealed upon comparison of observer's classifications.

The four males of each strain designated as artificial ejaculation birds received artificial stimulations twice weekly, starting at 10 weeks of age. Recordings of the male's age at first semen production were not made until after a two week conditioning period had been completed. Following the conditioning period, semen volume measurements in cubic centimeters were made twice weekly and sperm per cubic millimeter measurements were estimated once weekly.

Motility scores, used by Herman and Swanson (1941) to designate motility of bull semen, were utilized to designate motility of semen at 20, 22, 24, 26, and 28 weeks of age.

Motility scoring system utilized:

Motility Score	Definition
1	No motility
2	Less than 50% in motion
3	Approximately 50% of sperm motile; no waves or eddies
4	Approximately 50% to 85% of sperm motile; vigorous waves and eddies moving slowly
5	At least 90% of sperm in motion; rapid waves and eddies
6	100% of sperm motile; extremely rapid waves and eddies

The date of first ejaculate with 100,000,000 sperm for each male was determined by computing total sperm per cubic centimeter and taking this figure times total volume of semen which gave total sperm per ejaculate for that respective age of the bird. After producing 100,000,000 sperm, the number of sperm reported by Munro (1938) required to adequately fertilize a female, an attempt was made to determine the male's fertilizing capabilities. The quantity of semen in cubic centimeters containing 100,000,000 sperm was computed for each male and this amount inseminated into virgin hens. Insemination of females was accomplished on a bi-weekly basis with the quantity of inseminated semen determined from recordings of the previous collection date. Eggs laid by females were incubated for 72 hours and then broken to determine fertility.

Four randomly selected unstimulated males of each strain were sacrificed at 14 weeks of age to determine if artificial stimulation was an influencing factor in the production of sperm. Microscopic examination of slides prepared from testes smears and vas deferens fluids was made for each male. Each male was rated according to the number of sperm observed by the following scoring system:

Sexual Development Score	Definition
1	No sperm observed in testes and vas deferens
2	Immature sperm in testes, few in vas deferens
3	Considerable sperm found in vas deferens
4	High concentration of sperm in vas deferens

At 11 weeks of age, each male of the artificial ejaculation and natural mating groups was introduced individually to pens of White Rock females and Rhode Island Red females for periods of 10 minutes. After a two weeks conditioning period, the introduction of the natural mating group of males was continued through 28 weeks of age. Each male of the natural mating group was placed in a pen of females for 10 minutes twice weekly. Rotation of males through four pens each containing 10 White Rock females and four pens of 10 Rhode Island Red females was accomplished by placing each male in a pen of each breed of females weekly. All observations were completed between 3:00 PM and 5:30 PM. According to work reported by Parker, et al. (1940), males are more active sexually during the late afternoon than at other times of the day. During each observation period for a male, the numbers of attempted matings and successful matings were recorded and the male received an aggressiveness score according to the following system of rating:

Aggresive score	Definition
1	Timid, bird runs for corners, afraid of females, definitely subordinate.
2	Male is not timid but fails to display interest in females. Male appears to be adjusted to environment.
3	Male displays interest in females but in attempts to dominate females is unsuccessful.
4	Male displays definite male behavior such as courting. Male is quite aggressive and dominates females; however he does not mate.
5	Male is definitely dominant. Male attempts to mate but is unsuccessful.
6	Male is definitely dominant and in attempts to mate is successful.

Following the termination of the first test period at 28 weeks of age all males were housed in one pen of a slatted floor shelter house. Due to high mortality resulting from excessive fighting among the males, the birds were removed from this pen at 35 weeks of age and placed in individual cages designed for caged layers. Males were housed in individual cages of this type until termination of the experiment except for short periods when they were placed with females for natural mating studies.

Period Two

Prior to conditioning for the second test period, Rhode Island Red strain four and New Hampshire strain one were removed from the experiment because of mortality. For the 10 remaining strains, four males of those strains, having four or more birds surviving, were selected to represent their respective strain. Artificial ejaculation males surviving were retained and supplemented by natural mating males. Attention was given to maintaining Alpha and Beta bird pairs when replacements were chosen at random from surviving Alpha and Beta birds of the natural mating group.

The males, tested during the Spring of 1957, i.e. period two, were first conditioned for two weeks in preparation for measurements of semen volume, motility, and concentration which were recorded twice weekly for the following two weeks. Volume, motility, and concentration recordings were made according to the procedures and standards followed during period one of the previous summer.

Following the completion of the artificial ejaculation phase, the males were conditioned for natural mating studies by introducing each male to a particular pen of females consisting of five White Leghorn females and five Rhode Island Red females for a period of 10 minutes on six different occasions. At the termination of this conditioning period, each male was tested for 10 minutes, twice weekly for two weeks in the pen of females in which he had been conditioned. Attempted matings, successful matings, and aggressive scores were recorded for each male according to the procedure followed during period one.

Fertility studies of each individual male were accomplished differently than in period one. Following the completion of the natural mating studies, each male was assigned and placed at random in a pen of 10 females. After the male had resided in the pen of females for five days, eggs were saved for a 10 day period. These eggs were incubated for 72 hours, then broken to determine fertility.

Period Three

Males tested during the spring months were again tested during the late summer and early fall months designed as period three. Conditioning and completion of the artificial ejaculation phase was accomplished in the same manner as in period two. For the natural mating phase, the males were introduced to the females in a different manner and the conditioning period was shortened. Males were placed individually in partitioned exhibition cages which were located in pens of 30 White Leghorn females. Males and females were able to see each other. After being in these cages for 48 hours, the males were released individually for 10 minutes with the females during the late afternoon of four succeeding days. Attempted matings and successful matings were observed and recorded. Aggressive scores were assigned from the scoring system utilized in periods one and two.

Upon completion of the natural mating phase of study, five females per male were artificially inseminated with each female receiving five hundredths of a cubic centimeter of semen from an assigned male each time inseminated. Each female was inseminated on a Monday afternoon and again on the following Wednesday afternoon. This double insemination was performed to reduce the percentage of improper inseminations due to faulty technique. After waiting a period of two days, eggs were saved for a 10 day period. These eggs were candled on the day 18 of incubation and any questionable eggs were broken to determine fertility.

Statistical Analysis

Analyses of variance (ANOVA) were designed and computed as outlined by Henderson (1955) and Snedecor (1956). The procedure followed for computing sums of squares for analyses of variance are found in Appendix Tables 32 and 33. Strains used in this study were considered a random sample of all possible strains. Position was considered fixed in that only two positions were being considered (Alpha and Beta). With this established, the analysis was considered a mixed model and the "F" tests were computed as outlined in this diagram of the mixed model.

Source	E (M.S.)	Test for "F" with:
Strains	$\sigma_w^2 + K_3 \sigma_s^2$	Within
Position	$\sigma_w^2 + K_1 \sigma_{ps}^2 + K_2 \sigma_p^2$	P x S
P x S	$\sigma_w^2 + K_1 \sigma_{ps}^2$	Within
Within	σ_w^2	

Breed of hen found in analysis of variance for aggressive scores at 18 through 28 weeks of age was considered random. This was considered a measure or indication of the influence which breed of hen has on the mating behavior of the male and not the mating behavior exhibited by the males toward these two particular breeds of hens. The "F" test for position in this mixed model of analysis was performed as outlined by Cochran (1951). All other "F" tests were accomplished as shown in this diagram of the analysis.

Source	E (M.S.)	Test for "F" with:
Breed of hen (H)	$\sigma_w^2 + 4\sigma_{hs}^2 + 48\sigma_h^2$	H x S
Strain of cock (S)	$\sigma_w^2 + 4\sigma_{hs}^2 + 8\sigma_s^2$	H x S
Position (P)	$\sigma_w^2 + 2\sigma_{hsp}^2 + 4\sigma_{sp}^2 + 24\sigma_{hp}^2 + 48\sigma_p^2$	See Cochran (1951)
S x P	$\sigma_w^2 + 2\sigma_{hsp}^2 + 4\sigma_{sp}^2$	P x H x S
H x S	$\sigma_w^2 + 4\sigma_{hs}^2$	P x H x S
H x P	$\sigma_w^2 + 2\sigma_{hsp}^2 + 24\sigma_{hp}^2$	P x H x S
P x H x S	$\sigma_w^2 + 2\sigma_{hsp}^2$	Within
Within	σ_w^2	

Duncan's new multiple range test at the five percent level, illustrated by Federer (1955) was used to find significant mean differences between different strains after the completion of the "F" tests. For groups with even numbers the five percent "Studentized" ranges computed by Duncan (1955) were used in computations of measuring sticks or ranges for means of those groups. The significant ranges of strain means with unequal numbers of replications were accomplished as described by Kramer (1956). Duncan's test was used to test for significant mean differences between strains where the "F" test for strain differences was non-significant. The use of the Duncan's test in this capacity is justified as discussed by Federer (1955). The probability of rejecting the null hypothesis when it is false is much greater; therefore, the test is generally considered a more powerful test than the "F" test.

Correlation coefficients for period two between fertility and volume, motility, sperm counts, and aggressive scores were calculated on a within strain basis. The method of chi-square described by Snedecor (1956) was used to test the hypothesis that the correlations for the different strains were not alike. The average "z" value was used in determining an average correlation, where heterogeneity was not found.

Due to mortality in certain strains, which left the strains with too few numbers to be used in a "z" Transformation Table, the other correlation coefficients shown in correlation tables were obtained by pooling. The cross products and sums of squares for each strain were added together and the resulting totals utilized in computing the desired correlation coefficient. Each strain contributed n-2 degrees of freedom.

RESULTS

Measurements of Male Sexual Maturity

Table 2 shows that WR_1 produced semen significantly earlier than RIR_4 when stimulated artificially. For all other strains tested, the dates of first semen production by artificial stimulation did not differ significantly. For the birds killed at 14 weeks of age, significant strain differences were found when scoring the number of sperm found in the vas deferens and testes of birds, Tables 3 and 4. Significant differences were found to exist between the Leghorn strains whereas the heavy breed strains did not differ significantly except for A_1. A fair amount of correspondence between dates of first semen production by artificial ejaculation and the degree of development of sperm production in autopsied males is found when comparisons are made of the means of each strain in Tables 2 and 4. In Table 4, strains with the lower numerical scores were less advanced in the development of sperm production than those strains with the higher scores.

Table 1. ANOVA for date of first semen by artificial stimulation.

Source of variation	d. f.	Mean square	F
Strain of cock	11	29.469	1.42
Position	1	33.333	3.49
P x S	11	9.561	.46
Within	24	20.792	

Table 2. Duncan's test for date of first semen by artificial stimulation.

Strain	WR_1	RIR_3	BR_1 RIR_1	NH_1 RIR_2	Leg_3	Leg_1 Leg_2	Leg_4	A_1	RIR_4
$\bar{X}$ Weeks	13.25	13.75	14.50	14.75	15.25	16.00	17.50	19.25	21.00

Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 3. ANOVA for development of sperm production in birds killed at 14 weeks of age.

Source of variation	d. f.	Mean square	F
Strain of cock	11	2.294	2.19*
Within	36	1.049	

* Significant at the .05 level.

Table 4. Duncan's test for development of sperm production in birds killed at 14 weeks of age.

Strain	A_1 Leg_4	Leg_1	BIR_4 BR_1	RIR_2 Leg_3	RIR_1 NH_1	WR_1 RIR_3	Leg_2
$\bar{X}$ Score	1.50	2.00	2.25	2.75	3.00	3.50	3.75
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Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Tables 5 and 6 indicate that the strains did not differ significantly for date of first ejaculate with 100,000,000 sperm. The lack of significance with a range of 7.5 weeks between average dates of the two earliest strains and the last strain to reach this figure may be attributed to small samples and large individual variations. WR_1 and RIR_4 held the same respective positions in age at first semen and age at 100,000,000 sperm, Tables 2 and 6. Significant strain differences were found for interval between date of first ejaculate of 100,000,000 sperm and first fertile egg, Table 8. Comparisons of Tables 6 and 8 indicated that males which produce 100,000,000 sperm at an earlier date also tend to fertilize eggs earlier. This was not true for A_1 males which reached the 100,000,000 sperm count later than most strains but were among those strains with the shorter interval until first fertile egg.

Table 5. ANOVA for date of first ejaculate with 100,000,000 sperm.

Source of variation	d.f.	Mean square	F
Strain of cock	11	22.95	1.08
Position	1	18.75	3.36
P x S	11	5.52	.26
Within	24	21.25	

Table 6. Duncan's test for date of first ejaculate with 100,000,000 sperm.

Strains	RIR_1 WR_1	Leg_2	RIR_3	RIR_2	Leg_1	Leg_4 BR_1	NH_1	Leg_3	A_1	RIR_4
$\bar{X}$ Weeks	16.25	17.00	17.25	17.50	18.50	18.75	19.00	19.50	23.00	23.75

Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 7. ANOVA for interval between date of first ejaculate with 100,000,000 sperm and first fertile egg measured in weeks.

Source of variation	d.f.	Mean square	F
Strain of cock	11	8.917	1.69
Position	1	.348	.06
P x S	11	5.621	1.06
Within	20	5.282	

Table 8. Duncan's test for interval between 100,000,000 sperm and first fertile egg.

Strains	RIR_3	RIR_1	A_1	WR_1	Leg_2	Leg_3	BR_1	RIR_2	NH_1	Leg_4	Leg_1	RIR_4
$\bar{X}$ Weeks	2.00	2.50	2.67	2.75	3.00	3.50	3.75	4.50	5.50	5.66	6.00	7.00
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Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

The dates of first successful natural matings with females were found to be highly significantly different for the strains tested, Tables 9 and 10. Considerable individual variation within strains was also observed. To those males not mating successfully by the end of the test period at 28 weeks of age, a maturity age of 35 weeks was assigned. As shown in Table 10, all males representing Leg_2 failed to mate successfully during the testing period. Males of strains representing the heavy breeds, with the exception of RIR_4, mated at earlier ages than the males of the Leghorn strains. Tables 4 and 6 indicate that some Leghorn strains develop sperm at ages as early or earlier than heavy breeds but as shown in Table 10 did not have the drive or desire to mate until later ages, at least with older hens (See Discussion).

Tables 1, 5, and 9 indicate no significant effect of social position between males on sexual maturity as measured by dates of first semen production and of 100,000,000 sperm or date of first successful natural mating. All "F" values for position are larger than three and might have been significant with larger sample numbers. The significant position effect found in analysis of aggressiveness scores, Table 11, tends to substantiate the possibility that these fairly high "F" values may indicate that position effect has some influence on sexual maturity.

Table 9. Date of first successful natural matings measured in weeks.

Source of variation	d.f.	Mean square	F
Strain of cock	11	76.936	3.25**
Position	1	121.920	3.02
P x S	11	40.423	1.93
Within	24	20.911	

** Significant at the .01 level.

Table 10. Duncan's test for date of first successful natural matings.

Strains	WR_1	RIR_3	RIR_2	A_1 BR_1	RIR_1	NH_1	Leg_1	Leg_4	Leg_3	RIR_4	Leg_2
$\bar{X}$ in weeks	18.25	22.88	25.00	26.00	26.38	27.88	28.38	28.75	29.00	30.63	35.00

Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Measurements of Male Sexual Aggressiveness at Three Ages

ANOVA and Duncan's test, Tables 11 and 12, respectively, show highly significant strain differences for sexual aggressiveness. Mean scores in Table 12 indicate that males of Leghorn strains were less aggressive than strains representing the heavy breeds. This was also indicated in Table 10 with RIR_4 being the exception in both observations. The interaction (P x S), Table 11, was found to be highly significant. This suggests that although Alpha males were generally more sexually aggressive than Beta males as indicated by the significant position effect, they were not consistently more aggressive. Mean aggressive scores for Alpha males of all strains was 3.62 and for the Beta males was 2.77.

The non-significant breed of hen effect indicates that the breed of the female did not influence the degree of sexual aggressiveness expressed by the male.

Table 11. ANOVA for mean aggressive scores assigned 18 through 28 weeks of age.

Source of variation	d.f.	Mean square	F
Breed of hen (H)	1	11.344	.48
Strain of cock (S)	11	686.162	29.34**
Position (P)	1	2118.761	6.79*
P x S	11	259.306	17.17**
H x S	11	23.389	1.55
H x P	1	55.510	3.01
H x P x S	11	15.101	.17
Within	48	90.323	

* Significant at the .05 level.
** Significant at the .01 level.

Table 12. Duncan's test for mean aggressive scores assigned 18 through 28 weeks of age.

Strains	Leg_2	RIR_4	Leg_4	Leg_1	Leg_3	RIR_1	BR_1	NH_1	RIR_3	RIR_2	A_1	WR_1
$\bar{X}$ scores	2.10	2.20	2.56	2.64	2.89	3.07	3.30	3.38	3.47	3.57	4.05	5.15
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Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

At 60 weeks of age, highly significant strain differences for sexual aggressiveness were still present, Table 13. The position effect and the (P x S) interaction concerning eight strains were found to be non-significant. This would suggest that by placing males in individual cages the submissive males became equally as aggressive during period two as the males determined to be Alpha or dominant during period one. Table 14 shows that Leghorn strains with the exception of Leg_3 were still less aggressive than the heavy breed strains. Leg_3 was the most aggressive strain tested during period two, Table 14, but dropped to one of the least aggressive strains during period three. Mean aggressive scores assigned to the males at three different ages were consistently lower for the Leghorn strains on the average than for the heavy breed strains. Leg_2 was the least aggressive strain during all three test periods.

Table 13. Analyses of variance for aggressive scores at two ages.

	60 weeks			80 weeks		
Source of variation	df	Mean square	F	df	Mean square	F
Strain of cock	9	5.550	7.64**	9	1.584	1.69
Position	non-significant for 8 strains					
P x S	non-significant for 8 strains					
Within	30	.727		23	.94	

** Significant at the .01 level.

Table 14. Duncan's test for aggressive scores assigned at 60 weeks of age.

Strains	Leg_2	Leg_1	Leg_4	RIR_3	RIR_2	RIR_1	A_1	WR_1	BR_1	Leg_3
$\bar{X}$ scores	1.38	1.81	2.00	2.25	2.38	3.00	3.13	3.38	4.38	4.75

Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 15. Duncan's test for aggressive scores assigned at 80 weeks of age.

Strains	Leg_2	Leg_3	Leg_4	RIR_2	Leg_1	RIR_3	A_1	WR_1	RIR_1	BR_1
$\bar{X}$	2.08	3.00	3.06	3.13	3.44	3.50	3.94	4.08	4.33	4.42
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		———	———	———	———	———	———	———	———	
		———	———	———	———	———	———	———		
		———	———	———	———	———	———			
	———	———	———	———	———	———				

Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

The correlation coefficient for 60 week aggressive scores and fertility from natural matings approaches significance at the five percent level, Table 16. Fertility for all males in all strains tested during this period was only 22 percent. This almost significant correlation with such poor general fertility obtained by natural mating suggests a possible relationship between male sexual aggressiveness and fertility.

Table 16. Pooled within-strain correlations of aggressive scores and fertility.

Description of correlation	d.f.	Correlation
60 week scores with 80 week scores	9	.32
60 week scores with fertility by natural mating at 62 weeks	20	.34*

* Approaches significance at the .05 level, correlation of .42 needed for significance.

Measurements of Semen Volume for Males at Three Ages

The variation in semen volume was found to be highly significant for strains tested during period one and period two, Table 17. In Table 18, the average total volume for males in each strain is given for the entire period. The average total volume was used instead of the average volume per ejaculate to better illustrate the semen volume production ability of males at this age. The average age at which males of the respective strains started producing semen is given in Table 2. It can easily be seen that total volume for the period 12 through 28 weeks of age is in part associated with age at first semen as expected. Volumes shown in Tables 19 and 20 are expressed as cubic centimeters per ejaculate. Leg_2 produced the least semen of all strains in both periods two and three. Significant strain differences were detected at the three different ages as shown in Tables 18, 19, and 20. However, strains representing the heavy breeds and the Leghorn breed, respectively, were neither high nor low in semen volume as a group for any one of the periods in which measurements were taken.

Table 17. Analyses of variance for semen volume measurements at three ages.

	ANOVA for volume at 12 through 28 weeks of age			ANOVA for volume at 56 weeks of age			ANOVA for volume at 78 weeks of age		
Source of variation	df	Mean square	F	df	Mean square	F	df	Mean square	F
Strain of cock	11	14.616	3.44**	9	.576	4.20**	9	.236	2.12
Position	1	1.216	.36	non-significant for 8 strains			non-significant for 8 strains		
P x S	11	3.392	.80	non-significant for 8 strains			non-significant for 8 strains		
Within	24	4.249		30	.137		26	.111	

** Significant at the .01 level.

Table 18. Duncan's test for semen volume at 12 through 28 weeks of age.

Strains	RIR_4	Leg_1	Leg_3	A_1	NH_1	Leg_2	BR_1	RIR_2	Leg_4	RIR_3	RIR_1	WR_1
$\bar{X}$ cc	1.37	1.41	1.46	2.21	2.29	2.77	3.82	3.95	4.66	5.28	5.52	7.32

Note: 1) Means represent average volume per male per strain for entire period during which measurements were taken.

2) Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 19. Duncan's test for semen volume per ejaculate at 56 weeks of age.

Strains	Leg_2	RIR_2	BR_1	Leg_3	Leg_1	A_1	RIR_3	WR_1	Leg_4	RIR_1
$\bar{X}$ cc	.24	.37	.39	.40	.42	.58	.76	.97	1.09	1.39
								x	x	x
						x	x	x	x	
		x	x	x	x	x	x	x		
	x	x	x	x	x	x	x			

Note: 1) Means represent average volume per ejaculate.

2) Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 20. Duncan's test for semen volume per ejaculate at 78 weeks of age.

Strains	Leg_2	BR_1	Leg_1	Leg_3	WR_1	RIR_2	Leg_4	A_1	RIR_1	RIR_3
$\bar{X}_{cc}$	.27	.35	.36	.48	.64	.65	.78	.80	.95	1.00
				—	—	—	—	—	—	—
		—	—	—	—	—	—	—	—	
	—	—	—	—	—	—	—	—		

Note: 1) Means represent average volume per ejaculate.

2) Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Significant correlations for volume between periods were obtained when within-strain correlations were pooled, Table 21. These correlations suggest that males were consistent in their ability to produce a certain volume of semen from period to period. This would suggest that males high in semen volume at an early age would be high in volume when older. Period one volume readings used to compute correlations were limited to those taken at 21 through 24 weeks of age which was considered to be the optimum time for the pretesting of young males, as volume per ejaculate showed a tendency to level off during this period.

Table 21. Pooled within-strain correlations of semen volume and other traits.

Description of correlation	d.f.	Correlation
21-24 week volume with 56 week volume	10	.64*
21-24 week volume with 78 week volume	10	.53
56 week volume with 78 week volume	10	.63*
56 week volume with 62 week fertility by natural mating	20	.18
78 week volume with 82 week fertility by artificial insemination	11	-.15
78 week volume with 78 week motility	11	-.02
78 week volume with 78 week sperm count	11	.32

* Significant at the .05 level.

Motility Scores for Males at Three Ages

Variation between strains for motility scores was found to be highly significant at 20 through 28 weeks of age and was significant at the five percent level for scores assigned at 78 weeks of age, Table 22. Significant strain variations were not observed at 56 weeks of age, (Table 22). During period one, the position effect was not significant but the (S x P) interaction was highly significant. This would indicate that in certain strains the Alpha or dominant birds had higher scores than their subordinate partners. Tables 23, 24, and 25 show that certain strains, such as RIR_2 had consistently low scores for the three periods and Leg_4 had consistently high scores for the three periods. Mean scores for heavy breed strains and light breed strains were intermingled when ranked from lowest to highest.

Table 22. Analyses of variance for motility scores at three ages.

Source of variation	20 through 28 weeks			56 weeks			78 weeks		
	df	Mean square	F	df	Mean square	F	df	Mean square	F
Strain of cock	11	2.686	6.37**	9	1.811	1.36	9	2.268	2.87*
Position	1	1.220	.67	non-significant for 8 strains			non-significant for 8 strains		
P x S	11	1.829	4.33**	non-significant for 8 strains			non-significant for 8 strains		
Within	22	.421		29	1.332		26	.791	

* Significant at the .05 level.

** Significant at the .01 level.

Table 23. Duncan's test for motility scores at 20 through 28 weeks.

Strains	RIR_2	RIR_3	Leg_1	RIR_1	Leg_2	WR_1	Leg_3	NH_1	A_1	Leg_4	RIR_4	BR_1
$\bar{X}$ scores	1.87	2.90	3.04	3.24	3.61	3.66	3.73	3.75	4.11	4.45	4.77	5.10

Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 24. Duncan's test for motility scores at 56 weeks.

Strains	RIR_2	Leg_1	RIR_1	Leg_2	RIR_3	A_1	Leg_3	BR_1 WR_1	Leg_4
$\bar{X}$ scores	2.50	3.13	3.25	3.38	3.50	3.75	3.88	4.38	4.88

Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 25. Duncan's test for motility scores at 78 weeks.

Strains	RIR_2	A_1	WR_1	RIR_1	Leg_3 Leg_2	Leg_1	RIR_3	BR_1	Leg_4
$\bar{X}$ scores	1.88	2.75	2.83	3.00	3.17	3.25	3.50	4.13	4.63

Note: Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Pooled within-strain motility score correlations for different ages of the males were found non-significant; however the correlation between period one scores and period two scores is moderately high, Table 26. Correlations computed with period three scores are low which may indicate a possible late summer decline in sperm motility due to environmental conditions at that time of year. This decreased motility of the sperm may possibly be due to the increased age of the birds.

Table 26. Pooled within-strain correlations of motility scores and other traits.

Description of correlation	df	Correlation
20-28 week scores with 56 week scores	10	.42
20-28 week scores with 78 week scores	10	.02
56 week scores with 78 week scores	10	.23
56 week scores with 62 week fertility by natural mating	20	.15
78 week scores with 82 week fertility by artificial insemination	11	.01
78 week scores with 78 week volume	11	-.02
78 week scores with 78 week sperm count	11	.09

Sperm Counts for Males at Three Ages

Table 27 shows that significant sperm count differences were found between strains during periods one and three.

During period two, RIR_2 males, Table 29, were found significantly lower in sperm concentration than six of the 10 strains compared. This particular strain, RIR_2, was found consistently lower in concentration than most other strains in each test period; whereas Leg_4 strain was found consistently higher than all other strains in each test period. All strains were fairly consistent in sperm counts as may be seen in Tables 28, 29, and 30. Pooled within-strain correlations for sperm counts between periods, Table 31, were not significant but the correlation of period two and period three counts did approach significance at the five percent level. With an increase in the number of degrees of freedom, these correlations might well add additional support to indications of consistency of concentrations of sperm shown in Tables 28, 29, and 30. Sperm count correlations with fertility for periods two and three were not significant but were of sufficient magnitude to suggest a definite relationship between concentration and fertility.

Table 27. Analyses of variance for sperm counts at three ages.

Source of variation	28 weeks			56 weeks			78 weeks		
	df	Mean square	F	df	Mean square	F	df	Mean square	F
Strains of cock	11	9,676.98	2.52*	9	16,649.25	1.83	9	14,668.08	2.97*
Position	1	49.65	.01	non-significant for 8 strains			non-significant for 5 strains		
P x S	11	5,205.60	1.36	non-significant for 8 strains			non-significant for 5 strains		
Within	24	3,839.04		30	9,097.64		26	4,935.32	

* Significant at the .05 level.

Table 28. Duncan's test for sperm counts at 12 through 28 weeks of age.

Strains:	RIR_4	A_1	RIR_1	NH_1	RIR_2	Leg_1	BR_1	Leg_3	WR_1	RIR_3	Leg_2	Leg_4
$\bar{X}$ in millions	1.603	1.616	1.678	1.777	1.805	1.959	2.138	2.360	2.386	2.620	2.694	3.121
							—	—	—	—	—	—
			—	—	—	—	—	—	—	—	—	
		—	—	—	—	—	—	—	—	—		

Note: 1) Means are expressed in millions of sperm per cu. mm.

2) Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 29. Duncan's test for sperm counts at 56 weeks of age.

Strains	RIR_2	RIR_1	RIR_3	Leg_2	A_1	Leg_1	BR_1	WR_1	Leg_3	Leg_4
$\bar{X}$ in millions	1.550	2.396	2.479	2.675	2.943	2.973	3.186	3.503	3.509	3.688

Note: 1) Means are expressed in millions of sperm per cu. mm.

2) Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 30. Duncan's test for sperm counts at 78 weeks of age.

Strains	RIR_2	A_1	RIR_1	Leg_2	Leg_1	Leg_3	RIR_3	BR_1	WR_1	Leg_4
$\bar{X}$ in millions	1.781	1.928	2.038	2.385	2.424	2.548	2.673	2.900	3.312	3.785
							—	—	—	—
			—	—	—	—	—	—	—	
	—	—	—	—	—	—	—	—		

Note: 1) Means are expressed in millions of sperm per cu. mm.

2) Two means not underscored by the same line are significantly different and any two means underscored by the same line are not significantly different.

Table 31. Pooled within-strain correlations of sperm counts and other traits.

Description of correlation	df	Correlation
12-28 week counts with 56 week counts	10	.00
12-28 week counts with 78 week counts	10	.29
56 week counts with 78 week counts	10	.54*
56 week counts with 62 week fertility by natural mating	20	.24
78 week counts with 82 week fertility by artificial insemination	11	.46
78 week counts with 78 week volume	11	.32
78 week counts with 78 week motility scores	11	.09

* Approaches significance at the .05 level, .576 needed for significance.

DISCUSSION

Significant differences between strains as to the age of first production of sperm were detected by artificial stimulation and microscopic examination of vas deferens fluid and testicular tissue. The age at which males of the various strains produced sperm and fertilized eggs is in fair agreement with results obtained by such workers as Sampson and Warren (1939), Parker et al. (1942a) and Jones and Lamoreux (1942). Results for all strains definitely show that the ability to produce sperm in sufficient numbers to adequately fertilize females is reached at an earlier age than the ability to successfully mate with older females. These results support the findings and recommendations of Hogue and Schnetzler (1937).

Differences in the expression of male sexual aggressiveness for different strains as measured by aggressiveness scores were found to be highly significant. This expression was found to be influenced by the social status of the male with other males but was not of the same magnitude in all strains. This confirms earlier investigations by Guhl and Warren (1946) who found that dominant males mated more often and fertilized more eggs. By isolating males and testing mating behavior at later periods, it was found that the earlier social status of the male did not influence the male's sexual aggressiveness during the later test periods. This would suggest that males may forget or overcome a psychological advantage or disadvantage they once displayed which was established through associations with members of their own sex. Early associations with dominating females may not be as easily forgotten by the males. In testing to determine at what age the males would successfully mate with the matured females, it was found the females did not accept or respect the younger males. During many of the early introductions, the younger males would have been severely injured had they not been removed from the pens of females. Explanation of this inability of the males to socially dominate the females may be due to the insufficient size of the males. As the males grew older and larger the females refrained more and more from attacks on the males, but most males continued to avoid or appeared psychologically subordinate to the females. Fourteen of the 48 males tested failed to mate successfully by the conclusion of the first test period. During the test periods at 58 and 60 weeks of age most males still avoided or were inactive sexually with females of their own age. Fertility resulting from natural matings at 62 weeks of age averaged only 22 percent for all males. With the use of artificial insemination at 82 weeks of age, the average fertility for all males was 66 percent. During the summer and fall months, a decline in fertility is normally experiences, Taylor (1949). This increase in fertility, contrary to normally experienced results, would suggest that the males possessed the potential to fertilize eggs at 60 weeks of age but were incapable of successful matings due to their psychological condition.

Significant strain differences were found to exist for volume measurements, motility scores, and sperm counts. Strains within breeds showed large differences for all these traits so that strains of different breeds were intermingled in their rankings. The social status of the male was not found to be associated with any of these semen characteristics. Significant correlations found for volume between periods suggests that early measurements may indicate the semen volume potential of the male at an older age. Motility scores and sperm counts were not significantly correlated between periods.

Correlations between motility scores and fertility from natural and artificial matings were contrary to results reported by Parker et al. (1942b), Shaffner and Andrews (1947), and Allen and Champion (1955). The correlation of .15 for period two motility scores with fertility probably has sexual aggressiveness confounded with motility as indicated by the low fertility and observations of sex drive. The period three correlation of .01, for motility scores with fertility, may be based on too few degrees of freedom to be taken seriously; however, it does not agree with other work or with unpublished data from other experiments conducted at Kansas State College.

Sperm count correlations with fertility from natural and artificial matings were of sufficient size to indicate a possible relationship between the concentration of the sperm and fertility. Through artificial insemination, the positive correlation between concentration and fertility of .46 approaches significance. This correlation is not in agreement with the work of Hutt (1929) who found no correlation between sperm concentration and fertility by natural mating. Inseminations during the test with five hundredths of a cubic centimeter of semen from some males with sperm counts of less than two million sperm per cubic millimeter for a total of less than 100,000,000 sperm may not have provided sufficient sperm for maximum fertility. Parker et al. (1942b) reported that as long as 100,000,000 sperm are inseminated the sperm concentration of the inseminated fluid has little influence on fertility.

SUMMARY AND CONCLUSIONS

Significant differences between strains within and between breeds were found for semen volume, motility scores and sperm counts at 12 through 28, 58, and 78 weeks of age. Volume measurements were found to be significantly correlated between ages whereas motility scores and sperm counts were not.

The social status of the male with other males did not influence semen volume, motility scores or sperm counts. Alpha males, which dominated Beta males, mated more frequently and had higher sexual aggressiveness scores. The magnitude of this difference was not consistent for all strains. Results of this study indicate that the difference in sexual aggressiveness of Alpha and Beta males was reduced or lost when males were confined individually for the five months between the first and second observation periods.

Age of sexual maturity for young males determined by the date of first semen by artificial stimulation, presence of sperm in males killed at 14 weeks of age and date of first ejaculate with 100,000,000 sperm was found to be considerably earlier than the age of first successful natural mating. The results show that males of most strains possessed the ability to fertilize eggs at ages earlier than they were capable of mating successfully with old hens. Young males placed with older females were in many cases socially dominated by the females and appeared to be suppressed in their display of sexual aggressiveness. This psychological castration may never be overcome for certain males as was indicated by the low sexual aggressiveness scores recorded and the high percentage of males who failed to complete successful matings even when tested for natural mating ability with hens of their own age at 58 and 80 weeks of age.

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APPENDIX

Table 32. Use of Henderson's (1955) "rule of thumb" method for computing sums of squares.

Source of variation	d.f.	SS
Strain of cock (S)	n_s-1	$(n_s/N)s-I$
Position (P)	n_p-1	$(n_s\ n_p/N)\ p-I$
Position x strain	$(n_s-1)(n_p-1)$	$(n_s\ n_p/N)ps-s'-p'-I$
Within	$n_s\ n_p(n_w-1)$	total - ps

Notation for S.S.

I = correction term = $(\text{total})^2/N$
N = total number of individuals in test
s = uncorrected strain SS = $(S_1)^2+(S_2)^2+\ldots+(S_{12})^2$
p = uncorrected position SS = $(\text{Sum } P_A)^2+(\text{Sum } P_B)^2$
ps = uncorrected status: strain SS = $(P_{11})^2+(P_{21})^2+\ldots+(P_{1,12})^2+(P_{2,12})^2$
s' = corrected sum of squares for strains and is a modification of Henderson's method.
p' = corrected sum of squares for position and is a modification of Henderson's method.

Strain 1 = Alpha = $(X_{11}+X_{12}) = P_{11}$; Beta = $(X_{11}+X_{12}) = P_{21}$; $= S_1$

Strain 2 = Alpha = $(X_{11}+X_{12}) = P_{12}$; Beta = $(X_{11}+X_{12}) = P_{22}$; $= S_2$

⋮

Strain 12 = Alpha = $(X_{11}+X_{12}) = P_{1,12}$; Beta = $(X_{11}+X_{12}) = P_{2,12}$; $= S_{12}$

Note: X_{11} = measurement on individual one of strain (i), Alpha or Beta as indicated.
X_{12} = Measurement of individual two of strain (i), Alpha or Beta as indicated.

Table 33. Use of Henderson's (1955) "rule of thumb" method for computing sums of squares for aggressiveness scores at 18 through 28 weeks of age.

Source of variation		
Breed of hen (H)	n_h-1	$(n_h/N)h-I$
Strain of cock (S)	n_s-1	$(n_s/N)s-I$
Position (P)	n_p-1	$(n_s n_p/N)p-I$
Position x Strain (PxS)	$(n_s-1)(n_p-1)$	$(n_s n_p/N)ps-s'-p'-I$
Hen x Strain (H x S)	$(n_h-1)(n_s-1)$	$(n_h n_s/N)hs-h'-s'-I$
Hen x Position (H x P)	$(n_h-1)(n_p-1)$	$(n_h n_p/N)hp-h'-p'-I$
Hen x Position x Strain (HxPxS)	$(n_h-1)(n_p-1)(n_s-1)$	$(n_h n_s n_p/N)hps-h'-p'-s'-I$
Within	$(n_w-1)n_h\ n_s\ n_p$	total - hps

Notation for SS

I = correction factor = $(\text{total})^2/N$

N = total number of individuals in test

h = uncorrected hen SS = $(\text{total of breed of hen \#1})^2 + (\text{total of breed of hen \#2})^2$

s = uncorrected strain SS = $(S_1)^2\ (S_2)^2 \ldots\ldots (S_{12})^2$

p = uncorrected position SS = $(\text{Sum } P_A)^2 + (\text{Sum } P_B)^2$

ps = uncorrected position by strain SS = $(P_{11})^2 + (P_{21})^2 + \ldots\ldots + (P_{2,13})^2$

hs = uncorrected hen by strain SS = $(HS_{11})^2 + (HS_{21})^2 + \ldots\ldots + (HS_{2,12})^2$

hp = uncorrected hen by position SS = $(\text{Sum all } HP_{11})^2 + (\text{Sum all } HP_{12})^2 + (\text{Sum all } HP_{21})^2 + (\text{Sum all } HP_{22})^2$

hps = uncorrected hen by position:strain = $(HP_{111})^2 + (HP_{211})^2 + \ldots\ldots + (HP_{2,2,12})^2$

s' = corrected sum of squares for strains and is a modification of Henderson's method

p' = corrected sum of squares for position and is a modification of Henderson's method

h' = corrected sum of squares for hens and is a modification of Henderson's method

Table 33 (concl.)

Strain of male	Breed of Hen One		: Breed of Hen Two			
Strain 1 =	$X_{11}+X_{12} = HP_{111}$	$=HS_{11}$	$X_{11}+X_{12} = HP_{211}$	$=HS_{21}$	$= P_{11}$	$=S_1$
	$X_{11}+X_{12} = HP_{121}$		$X_{11}+X_{12} = HP_{221}$		$= P_{21}$	
Strain 2						$=S_2$
.						
.						
.						
.						
.						
.						
Strain 12			$X_{11}+X_{12}= HP_{2,1,12}$	$=HS_{2,12}$	$=P_{1,12}$	$=S_{12}$
			$X_{11}+X_{12}= HP_{2,2,12}$		$=P_{2,12}$	
	total H_1		total H_2			

Note: X_{i1} = measurement on individual one of strain (i), Alpha or Beta as indicated.

X_{i2} = measurement on individual two of strain (i), Alpha or Beta as indicated.

SEMEN MEASUREMENTS, SEXUAL BEHAVIOR, AND FERTILITY COMPARISONS FOR TWELVE STRAINS OF CHICKENS

by

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Males of 12 strains of chickens representing six different breeds were selected to study the development of sexual maturity and the expression of semen characteristics, sexual aggressiveness, and fertility at three different ages. Eight males of each strain, picked at random from healthy individuals, were used for artificial ejaculation and natural mating tests when males were 12 through 28 weeks of age. By observation at 20 weeks of age, the social status, whether Alpha or Beta, was determined for each male.

Four males of each strain were stimulated twice weekly to determine earliness of sperm production and the age when 100,000,000 sperm were first obtained. The ability to fertilize eggs by each male was determined by fertility of eggs from two virgin hens inseminated with a quantity of semen containing an estimated 100,000,000 sperm. Semen volume measurements, assignment of motility scores and sperm counts were accomplished.

The four males of each strain used for natural mating tests were placed for 10 minutes once weekly in pens containing 10 White Rock females and once weekly in pens containing 10 Rhode Island Red females. The frequencies of attempted and successful matings were recorded and each male was given a sexual aggressiveness score.

At 14 weeks of age, four males of each strain were killed and a score was assigned for amount of sperm in the fluid of the vas deferens and the testicles. This was done to determine if artificial stimulation had any effect on the time at which sperm were first found.

Due to mortality, only four of the original eight males of each strain and fewer than the original 12 strains were used for both artificial ejaculation tests and natural mating tests conducted when males were 54 through 62 weeks of age and again when 76 through 82 weeks of age. Fertility by natural mating was obtained at 60 weeks of age. Artificial insemination was used to obtain fertility at 82 weeks of age.

Significant differences between strains within and between breeds were found for semen volume, motility scores, and sperm counts at 12 through 28, 58, and 78 weeks of age. Volume measurements were found to be significantly correlated between ages whereas motility scores and sperm counts were not.

The social status of the male with other males did not influence semen volume, motility scores, or sperm counts. It was found however that Alpha males generally mated more frequently and had higher sexual aggressiveness scores than the Beta males. Results of this study indicate that the difference in sexual aggressiveness of dominant and subordinate males was reduced or lost when males were confined individually for the five months between the first and second observation periods.

The age of sexual maturity for young males determined by the date of first semen by artificial stimulation, presence of sperm in autopsy males, and date of first ejaculate with 100,000,000 sperm was found to be considerably earlier than the age of first successful natural matings. It was found that males of most strains possess the ability to fertilize eggs at ages earlier than they were capable of mating successfully with old hens. Young males placed with older females were in many cases dominated by the females and never overcame this psychological castration.