February 27, 1974

To the Graduate Council:

I am submitting herewith a thesis written by John Oliver Wallace, entitled "A Study of the Relationships Between Body Characteristics and Ovarian Activity in Hereford Heifers." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

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A STUDY OF THE RELATIONSHIPS BETWEEN BODY CHARACTERISTICS AND OVARIAN ACTIVITY IN HEREFORD HEIFERS

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

John Oliver Wallace

March 1974

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ABSTRACT

A study involving 145 Herford heifers was conducted at The University of Tennessee, Main Experiment station, Knoxville, Tennessee.

The purpose of this study was to determine the relationship between certain measurements of body characteristics and ovarian activity. Characteristics measured consisted of body fat thickness, body weight, body length, wither height, hook height, marbling score and animal age. The phrase "ovarian activity" denoted the total number of corpora lutea and corpora albicans found by cross-sectioning each ovary. The mean ovarian activity for the left ovary was 3.3 $\pm$ 1.5 and for the right ovary was 3.7 $\pm$ 1.6. The mean left ovary weight was 5.9 $\pm$ 2.4 grams and the mean right ovary weight was 6.0 $\pm$ 2.6 grams. It was noted, however, that as the right ovary weight increased the right ovary activity also increased.

The mean initial fat thickness, final fat thickness, and increase in fat thickness were 2.5 $\pm$ mm, 12.5 $\pm$ 2.7 mm and 9.9 $\pm$ 2.71 mm, respectively. However, neither left nor right ovarian activity was found to be significantly influenced by fat thickness ($P < .05$).

The mean initial body weight, mean final weight and mean weight gain were 438 $\pm$ 29.3 lbs., 990 $\pm$ 75.0 lbs. and 456 $\pm$ 70.4 lbs., respectively. As initial animal weights became higher the activity of the left ovary also increased.

Neither initial weight nor final weight exerted any influence on the weights of the left or right ovaries.

The means for body length, wither height, hook height and marbling score were 127.2 $\pm$ 4.6 cm, 64.1 $\pm$ 2.3 cm, 110.6 $\pm$ 3.3 cm and 5.6 $\pm$ 1.2, respectively. The only significant variable was marbling score ($P < .10$).

The means for initial age, final age and time on test were 261.8 $\pm$ 56.7 days, 524.8 $\pm$ 69.3 days and 263.0 $\pm$ 25.8 days, respectively. Initial age was also significantly correlated to left and right ovary weight ($P < .05$). Significant correlations were found between final age and left and right ovary weights ($P < .05$).

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CHAPTER I

INTRODUCTION

Increasing the reproductive performance in beef cattle has been the objective of many in depth studies. Early accurate selection for potentially productive beef heifers could greatly enhance the total reproductive efficiency of the beef herd and help to minimize the costly procedure of replacing low productive beef females. Likewise, early identification of sub-fertile beef females would expedite their subsequent removal from the herd.

Since no past reproductive performance records are available for virgin heifers, an alternate method of reproductive examination and evaluation must be sought. Past studies have been conducted using the body level of fatness as an indicator of reproductive efficiency. Although most commercial cattlemen do not feed heifers and cows above a moderate plane of nutrition, experimental results indicate the possibility that productivity may be impaired by levels of energy intake within limits fed by some cattlemen. Basic information on the effect of high degree of body fatness is needed. Such information, obtained by studying extreme differences in energy intake could act as an aid in the interpretation of results from research in which more "practical" differences in plane of nutrition are studied. Other studies have considered various body measurements as guides toward recognizing fertility problems in their beef females.

The purpose of this study was to determine the relationships between various body characteristics and ovarian activity in young beef heifers. The objectives of this study were as follows:

1. To establish a mean for ovarian activity.

2. To segregate the activities in the left and right ovaries.

3. To determine the relationship between body fat thickness and ovarian activity.

4. To determine the relationship between body weight and ovarian activity.

5. To determine the relationship between body and carcass measurements and ovarian activity.

6. To establish the relationship between various ages and ovarian activity.

CHAPTER II

REVIEW OF LITERATURE

I. BILATERAL OVARIAN ACTIVITY

Hamond (1927) stated that the right ovary of the bovine functions more frequently than the left and this was confirmed in another study in which Dukes (1933) concluded that the right ovary functions with slightly greater frequency than the left.

In a study involving 704 pregnant cows, Clark (1936) observed that 58 percent of the pregnancies occurred in the left uterine horn and 42 percent in the right uterine horn. He also stated that, while no authentic cases of migration of the fertilized ovum were observed, in a few cases the corpus luteum of pregnancy disappeared from one ovary and another corpus luteum formed on the opposite ovary.

In a similar study using 923 cows, Reece and Turner (1938) stated that 62.5 percent of the cows were carrying the fetus in the right horn and 37.5 percent were carrying the fetus in the left horn. They further noted that the average weight of the right ovaries was 2.71 grams and that of the left was 2.29 grams. Reece and Turner (1938) also conducted a study involving the ovaries of 98 sexually mature non-pregnant heifers. They found that the right ovary contained the corpus luteum of estrum 60.2 percent

of the time and the left ovary 39.8 percent of the time. In this same experiment the ovaries of 59 pregnant cows were also examined. Of these the corpus luteum of pregnancy was found in the right ovary 66.1 percent of the time and in the left ovary 33.9 percent of the time. It was further pointed out that in all cases the corpus luteum of pregnancy was present in the same side as was the pregnant uterine horn.

II. NUTRITION AND OVARIAN ACTIVITY

In an experiment by Hill et al. (1970) the effects of short term undernutrition were examined as a possible cause of low ovarian function. Their study involved beef heifers: 20 undernourished and 20 control. They reported that undernutrition reduced the plasma levels of progesterone within five days, temporarily reduced the number of medium-sized ovarian follicles, and reduced the proportion of heifers with normal fertilized ova. Weights of corpora lutea formed in undernourished heifers were 70 percent lighter than those formed in the control heifers.

Bellows et al. (1963) in a study with ewes found that increased nutrition at certain times in the estrous cycle increased the action of the ovaries. Grain feeding increased the follicular fluid weight and thus increased the ovarian weight. They postulated that flushing in ewes is associated with increased rate of protein synthesis.

Howland et al. (1966) studied 96 mature ewes to determine the effect of long-term feeding of a high-energy ration on ovarian and pituitary activity. Ewes fed the high-energy ration, when compared with ewes fed the low-energy ration, had a higher ovulation rate, greater follicular fluid weight and a greater number of large follicles. They also noted that the volume of follicular fluid in the largest follicle was greatest at Day-1 of the estrous cycle. Furthermore, ewes on the high-energy ration averaged 1.71 corpora lutea at slaughter compared with 1.42 for the ewes on the low-energy ration. They explained that rumen action on the high-energy ration leads to an abundance of propionic acid which through gluconeogenesis results in elevated plasma glucose levels. They concluded that persistently elevated plasma glucose levels, via hypothalamic stimulation, lead to greater gonadotropin production and subsequent greater ovarian activity.

In an experiment involving Holstein heifers, Sorensen et al. (1959) noted a marked increase in ovarian weights with an increase in level of feeding. They also reported that mature follicles developed earlier, and the onset of estrus and ovulation occurred earlier in life in heifers on the high level of feeding. However, ovarian function after the first estrus seemed to be little affected by the feeding level.

Arnett et al. (1971) conducted a study using 12 sets of twin beef heifers with one twin from each set being

fed to obesity and the other being fed normally. They reported that the average weight of the ovaries from the normal twins was 16.9 grams and that of the obese twins was 14.2 grams. These workers did not report ovarian activity in this study.

Morris (1958) reported that a daily supplement of one pound of crushed sorghum grain fed to a group of heifers increased ovarian activity as compared to that of heifers on an otherwise similar ration.

Hammond (1927) stated that in times of poor nutrition or heavy milk production the follicles are actually starved into a state of atrophy. The needs of other tissues such as young follicles and corpora lutea are satisfied first, thus causing maintenance to come before production.

In a study using puberal gilts Edey et al. (1972) examined the ovarian response to fasting following both high and low planes of nutrition. They found that the high plane gilts had a mean of 2.5 more corpora lutea than low plane gilts but the effects of fasting on the number of corpora lutea were negligible. They further reported that the numbers of follicles were not changed significantly by the fasting plane of nutrition. They therefore concluded that folliculogenesis and ovulation in the puberal gilt are insensitive to short-term fasting.

Lamond et al. (1973), in a study using Rambouillet ewes examined the influence of nutrition on ovulation and

562 lbs. (s.d. 53.0). The average gain from weaning to puberty was 158 lbs. (s.d. 50.0). They also established that the correlation between weaning weight and age at puberty was -.23, and between gain from weaning to puberty was 0.77.

Turman et al. (1963), from a study at Fort Reno, Oklahoma, concluded that heifers to be bred to calve at two years of age they must have reached puberty by 15 months of age. They further stated that the single most important factor in the reproductive performance of heifers after puberty is the nutritional level on which those heifers are maintained from weaning until puberty. Joubert (1954) showed the onset of puberty to be hastened by feeding beef heifers supplementary feed during the previous winter.

Thurman et al.(1963) also reported that heifers placed on three different levels of nutrition reached puberty at different ages. The three levels of feeding were characterized as: high, 1.0 lb daily gain; moderate, 0.5 lb. daily gain; and low, no gain or loss in weight. The average ages at which first estrus occurred in heifers of the various levels were high, 353 days; moderate, 373 days; and low, 386 days. They further stated that all of the heifers on the high level had reached puberty by 15 months of age compared to 90 percent on the moderate level and 70 percent on the low level. Wiltbank et al. (1965) reported that heifers which were fed varied levels of

protein and energy in combination tended to show puberty first in the groups receiving higher energy levels. They acknowledged, however, that not all heifers on high-energy rations came in heat, and that puberty seemed to be more closely related to amount of feed consumed than to energy level of the ration fed.

Smithson et al. (1963) stated that low levels of nutrition as a calf are very critical because of the retarding effect on body and skeletal development. In a later study, Smithson et al. (1964) reported that the first winter's feed level evidently set the pace at which the heifers matured sexually and that nutrition as a yearling was of less importance.

Sorenson et al. (1959) reported that heifers on high levels of feeding average 37.4 ± 7.1 weeks (262 days) of age at first estrus; medium feeding level averaged 49.1 ± 6.3 weeks (343 days); and low feeding level averaged 72 weeks (504 days). They also reported that the average weight of heifers at first estrus varied less among feeding levels than age at first estrus, but within each feeding level considerable variation was found. They further reported that there was more of a tendency for heifers to come in estrus for the first time at a given stage of skeletal growth. They found that the average height at withers at first estrus for the heifers on high feeding level was 42.7 inches, for those on the medium level it

was 44.3 inches and for those on the low level it was 44.2 inches. They also pointed out that the average body lengths at puberty were 48.5, 50.0, and 48.3 inches for the high-, medium-, and low-fed groups, respectively.

Reid et al. (1964) in a study involving heifers on three different nutritional planes found that the average ages at the onset of puberty were: low-plane, 88 weeks (616 days), medium-plane, 49 weeks (343 days); and high-plane, 40 weeks (290 days). They further reported that despite the differences in age, the body size of the heifers at the time of the first heat was about the same regardless of the feeding level on which they had been reared. Their report confirmed the study by Sorenson et al. (1959) which stated that there was more of a tendency for heifers to come in estrus for the first time at a given stage of skeletal growth.

De Lange (1950), in an experiment using 25 beef heifers on high and low levels of nutrition, reported that the average age at sexual maturity was 534 days in the high level group and 481 days in the low level group.

Hammond (1927) stated that the age of puberty for all breeds under normal conditions of feeding is about nine months (283 days), but may vary from 5 to 15 months (150 to 450 days). Stoss (1928), quoted by Quinlan et al. (1939), likewise observed that heifers reached sexual maturity at nine months (283 days); Craig (1930) reported 12 to 18 months; and Williams (1943) reported 6 to 8 months.

Williams also concluded that age at sexual maturity depended largely on feeding and environment.

IV. FATNESS

Totusek et al. (1960), in a study using 13 sets of twin heifers fed low and high levels of nutrition, reported that breeding efficiency was not affected by the high degree of body fat induced in the twin fed on the high nutritional level. In a later experiment conducted similarly, Totusek et al. (1961) confirmed their earlier findings and stated that high level of body fatness had little influence on breeding efficiency.

Arnett et al. (1971), in an experiment using 12 sets of twin beef females, reported conflicting results. Their study showed that obesity induced during the period of growth and development has a detrimental effect.

CHAPTER III

EXPERIMENTAL PROCEDURE

Data for this study were collected between October 20, 1972 and August 4, 1973, from an experiment conducted at The University of Tennessee Main Experiment Station, Knoxville, Tennessee.

I. EXPERIMENTAL ANIMALS

One hundred and eighty feeder heifers, ranging in weight from 375 to 500 lbs. and in age from 150 to 396 days, were purchased through graded feeder calf sales in East Tennessee and used in this experiment. One hundred and forty-five heifers completed the experiment; 35 were removed due to one of the following reasons:

Received diethylstilbestrol (DES)
Pregnancy
No established initial age
Breed difference
Anatomical maladies

Originally, the breeds represented were 174 Herefords, 4 Hereford-Shorthorn crossbred and 2 Shorthorns.

II. MANAGEMENT AND FEEDING

A short period was allowed before going on test for the heifers to adjust to the environment and recover from the stress of weaning and transportation. After the adjustment period, the heifers were weighed, sonorayed for fat

thickness and measured for body length, wither height and hook height. Heifers were also mouthed for age and palpated *per rectum* to determine pregnancy. Pregnant heifers were then aborted with intramuscular injections of 100 mg diethylstilbestrol (DES).

Six heifers were then assigned to each of 30 pens according to their predicted outcome and body measurements.

Their feeding period consisted of two phases: (1) a 140-day roughage phase during which the heifers were fed corn silage *ad libitum* plus 6.0 lbs. of concentrate per head per day and (2) a full-fed phase in which the heifers were given a full feed of concentrate of corn-cotton seed meal in an 8 to 1 ratio plus 4.0 lbs. of hay per head per day.

III. COLLECTION OF DATA

During the first phase of the study the heifers were weighed, sonorayed and measured at 14-day intervals until the pen reached an average of 10 mm of fatness, then at 7-day intervals until sent to slaughter at 12 mm. Height at withers was measured as the perpendicular distance from the ground to the crest of the scapular cartilage while the animal was standing in a normal erect position. Hook height was measured as the perpendicular distance from the ground to the crest of the hip. Body length was measured from the point of the shoulder to the point of the pin bone (lateral tuberosity to the posterior point of the tuber ischii) while

the animal was standing in a normal, erect position. Large animal calipers were used for these measurements.

The reproductive tracts were removed after slaughter and identified for later analysis. In the laboratory both ovaries were removed from the reproductive tracts and weighed separately. After weighing, each ovary was cross-sectioned until all corpora lutea and corpora albicans were exposed for counting.

Each carcass, after a 48-hour chilling period, was assigned a marbling score by a United States Department of Agriculture (USDA) meat grader.

IV. METHOD OF ANALYSIS

The seven independent variables involved in this study were body weight, fat thickness, age, hook height, wither height, length and marbling score of carcass. The relationships between these variables and ovarian activity were determined by simple correlation coefficients.

CHAPTER IV

RESULTS AND DISCUSSION

The results of this study will be presented in the following order: bilateral ovarian activity, fat thickness, body weight, body dimensions, and animal age. The overall means and standard deviations for selected variables are illustrated in Table I.

I. BILATERAL OVARIAN ACTIVITY

As seen in Table I, the mean ovarian activity for the left ovary was 3.3 $\pm$ 1.5 and for the right ovary was 3.7 $\pm$ 1.6. The term "ovarian activity" denotes the total number of corpora lutea and corpora albicans found upon cross-sectioning the ovaries. The mean weight for the left ovary was 5.9 $\pm$ 7.4 grams and for the right ovary was 6.0 $\pm$ 2.6 grams. This agrees with the reports of Hammond (1927) and Dukes (1933) which suggested that the right ovary of the bovine functions more frequently than the left.

In figures 1 and 2, heifers are grouped according to ovarian activity. It was observed that with the left ovary the greatest number of heifers (36) had an ovarian activity of four, and for the right the greatest number (40) was also four.

Coefficients of correlations, presented in Table II, among left and right ovarian activities indicated that heavier

TABLE I

OVERALL MEANS AND STANDARD DEVIATIONS FOR SELECTED VARIABLES

Variable	Mean	Standard Deviation
Number of Animals	145	
Initial observations		
Weight, lbs.	439	29.3
Fat thickness, mm.	2.6	1.1
Age, days	261.7	56.7
Performance measurements		
Final weight, lbs.	986	75.0
Weight gain, lbs.	456	70.0
Final fat thickness, mm.	12.5	2.7
Fat gain thickness, mm.	9.9	2.7
Final age, days	525	69.3
Time on test, days	263	25.8
Left ovarian weight, gm.	5.9	2.4
Right ovarian weight, gm.	6.0	2.6
Left ovarian activity[a]	3.3	1.5
Right ovarian activity[a]	3.7	1.6
Body length, cm.	127.2	4.6
Wither height, cm.	64.1	2.3
Hook height, cm.	110.6	3.3
Marbling score, units	5.6	1.2

[a]Ovarian activity: total number of corpora lutea and corpora albicans.

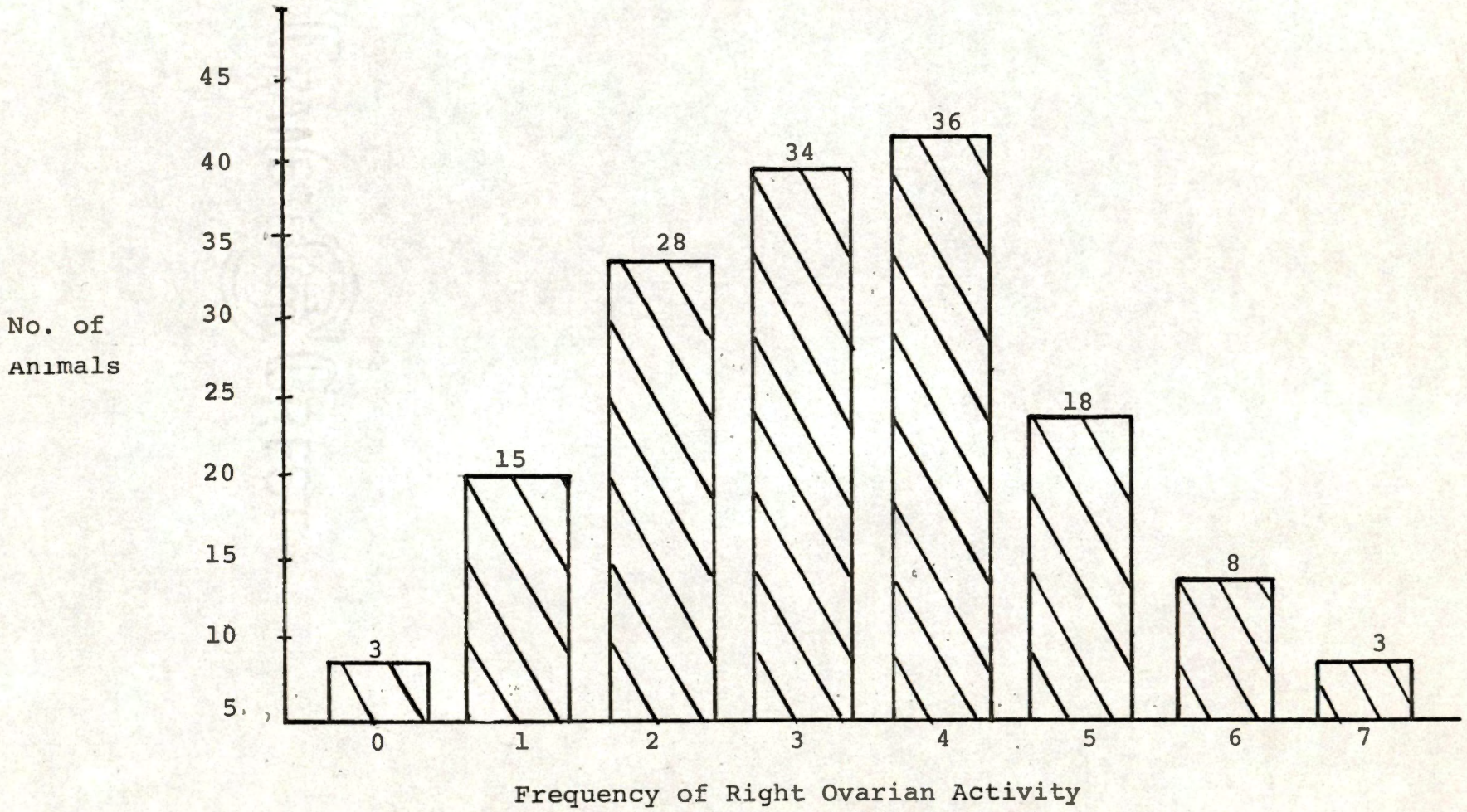

Figure 1. Relationship of number of animals to frequency of left ovarian activity.

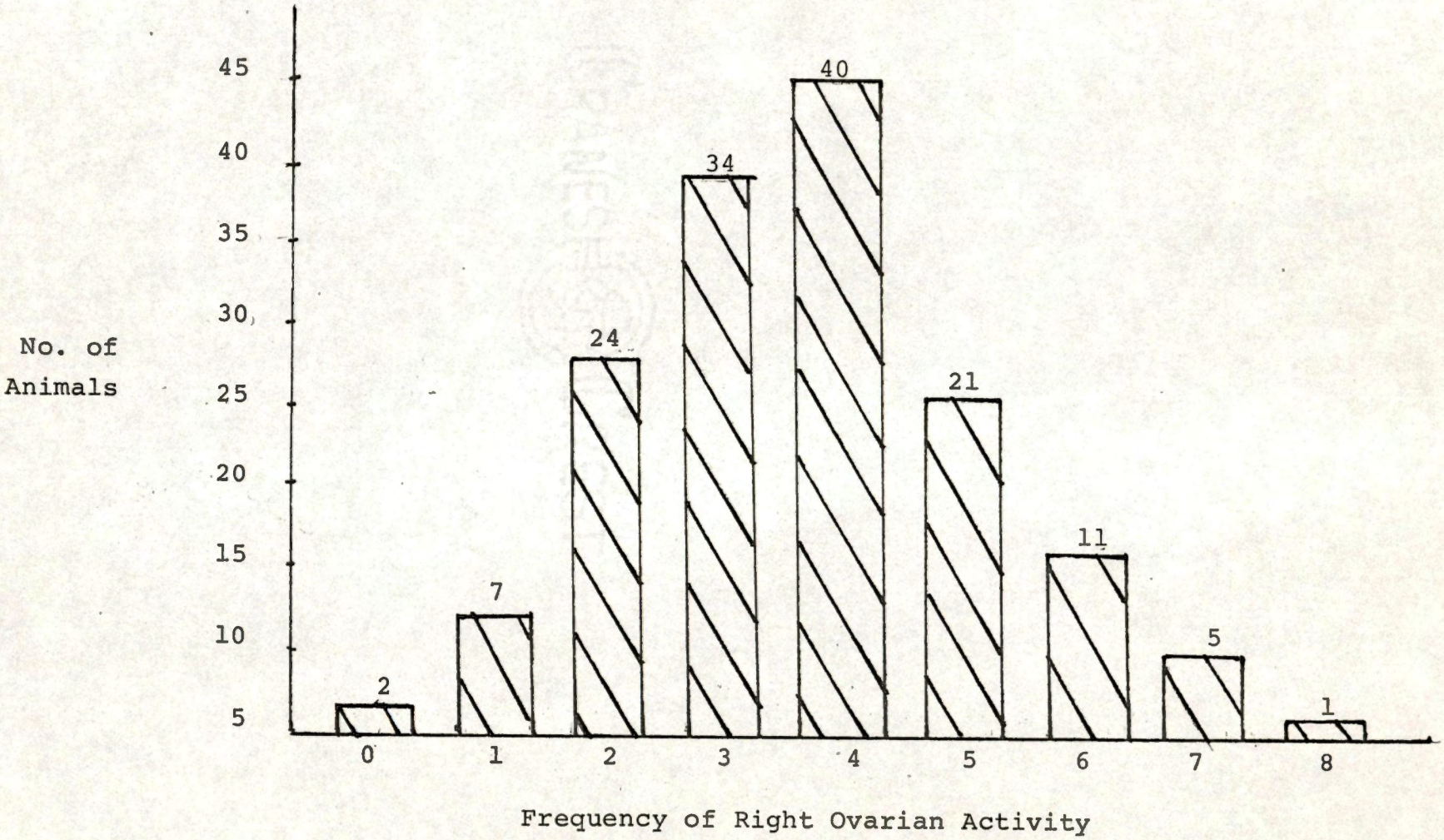

Figure 2. Relationship of number of animals to frequency of right ovarian activity.

TABLE II

SIMPLE CORRELATION COEFFICIENTS BETWEEN
LEFT AND RIGHT OVARIAN ACTIVITY

		(1)	(2)	(3)	(4)	(5)
(1)	Left ovary weight	1.000				
(2)	Right ovary weight	-.294*	1.000			
(3)	Left ovarian activity	-.034	-.001	1.000		
(4)	Right ovarian activity	-.046	.198**	.064	1.000	
(5)	Total activity	-.055	.136	.723**	.736**	1.000

*Significant (P <.05)
**Highly significant (P <.01)

right ovaries were also more active and an increase in right ovarian activity resulted in increased right ovary weight. The small and nonsignificant ($P < .05$) relationship of left ovary weight to left ovarian activity indicated that increased left ovary weight did not result in increased ovarian activity.

II. FAT THICKNESS

As shown in Table I, the mean initial fat thickness for the 145 heifers was 2.6 $\pm$ 1.7 mm. The means for final fat thickness and fat thickness gain were 12.5 $\pm$ 2.7 and 9.9 $\pm$ 2.7, respectively.

In Table III initial fat thickness, final fat thickness and fat gain were examined with relationship to ovarian activity. Neither left nor right ovarian activity was found to be significantly ($P < .05$) influenced by fat thickness. When final fat thickness was evaluated in relationship to mean ovarian activity in Figure 3, a definite pattern was established. As the heifers approached a high degree of fat thickness ovarian activity was inversely affected. This agrees with the report by Arnett *et al.* (1971), which suggested that obesity caused a reduction in ovarian weight.

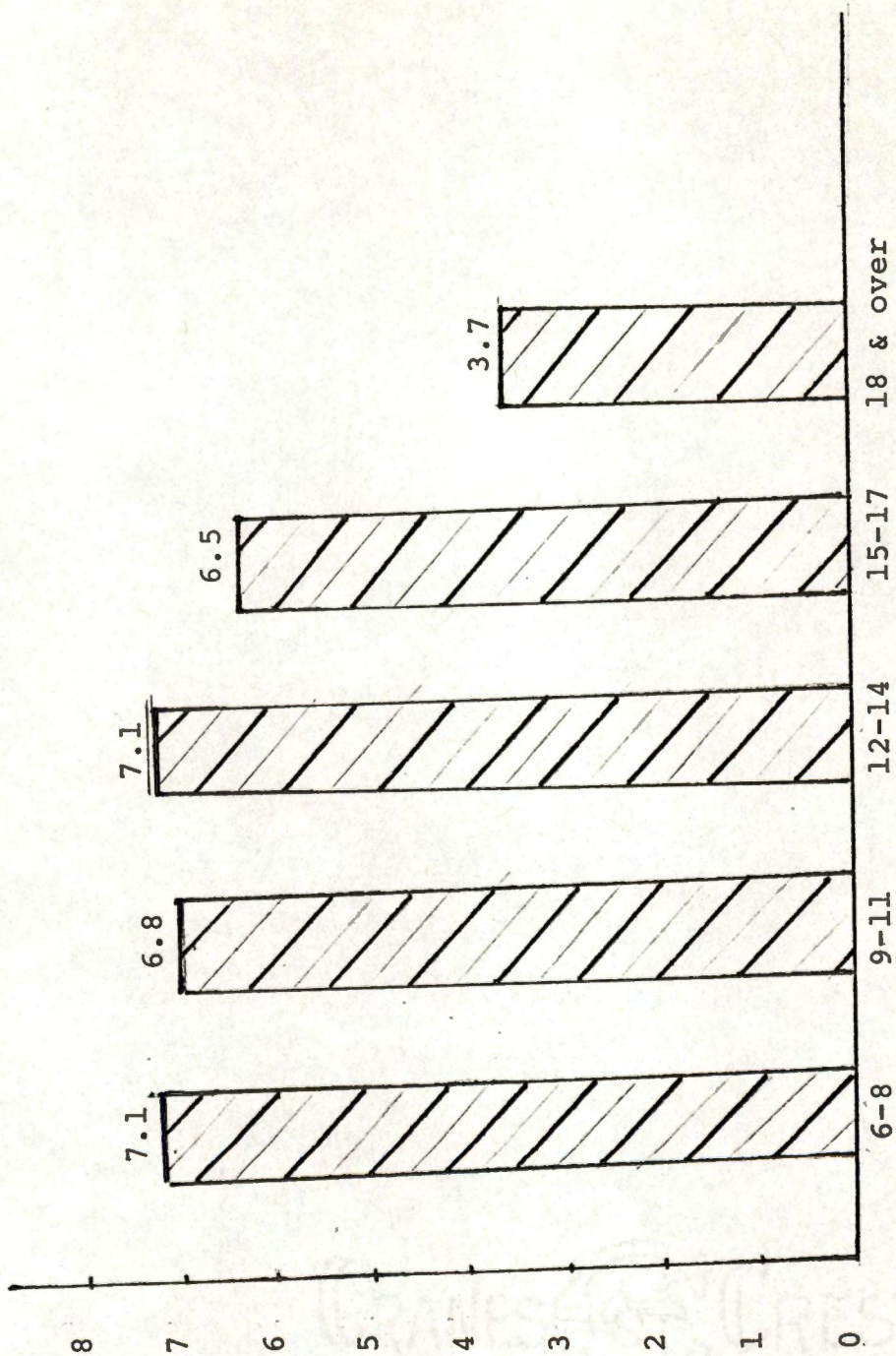

Figure 3. Relationship of mean ovarian activity to final fat thickness.

III. BODY WEIGHT

The mean initial weight for the 145 heifers was 439 ± 29.3 lbs. and the mean final weight and mean weight gain were 896 ± 75 lbs. and 456 ± 70.4 lbs., respectively.

Coefficients of correlations (Table III) between body weights and ovarian activity indicated that as initial weights became higher the activity of the left ovary also increased, and that the relationship between weight gain and left ovary weight was significant ($P < .10$). Neither initial weight nor final weight had any influence on the left or right ovary weights.

Figure 4 illustrates what seems to be an optimum weight range where ovarian activity is greatest, and that as body weight passes this range ovarian activity begins to decrease.

IV. BODY DIMENSIONS

The body measurements analyzed in this study were body length, wither height, hook height and marbling scores, and the means for these were 127.2 ± 4.6 cm, 64.1 ± 2.3 cm, 110.6 ± 3.3 cm, and 5.6 ± 1.2, respectively.

An inverse correlation ($P < .10$) between right ovary weight and marbling score was found and is illustrated in Table IV. This means that marbling has an inverse effect on right ovary weight. Other variables such as body length, wither height and hook height had no significant ($P < .10$)

TABLE III

SIMPLE CORRELATION COEFFICIENTS BETWEEN FAT THICKNESS, BODY WEIGHT AND OVARIAN MEASUREMENTS

	Ovarian measurements				
	Weight		Activity		Total Activity
	Left	Right	Left	Right	
Fat thickness					
Initial	-.076	-.043	.129	-.006	.083
Final	.047	.007	-.004	-.028	-.022
Gain	.077	.024	-.055	-.026	-.055
Body weight					
Initial	.074	.094	.132	-.040	.061
Final	.153	.070	-.010	-.072	-.057
Gain	.139	.034	-.065	-.062	-.087

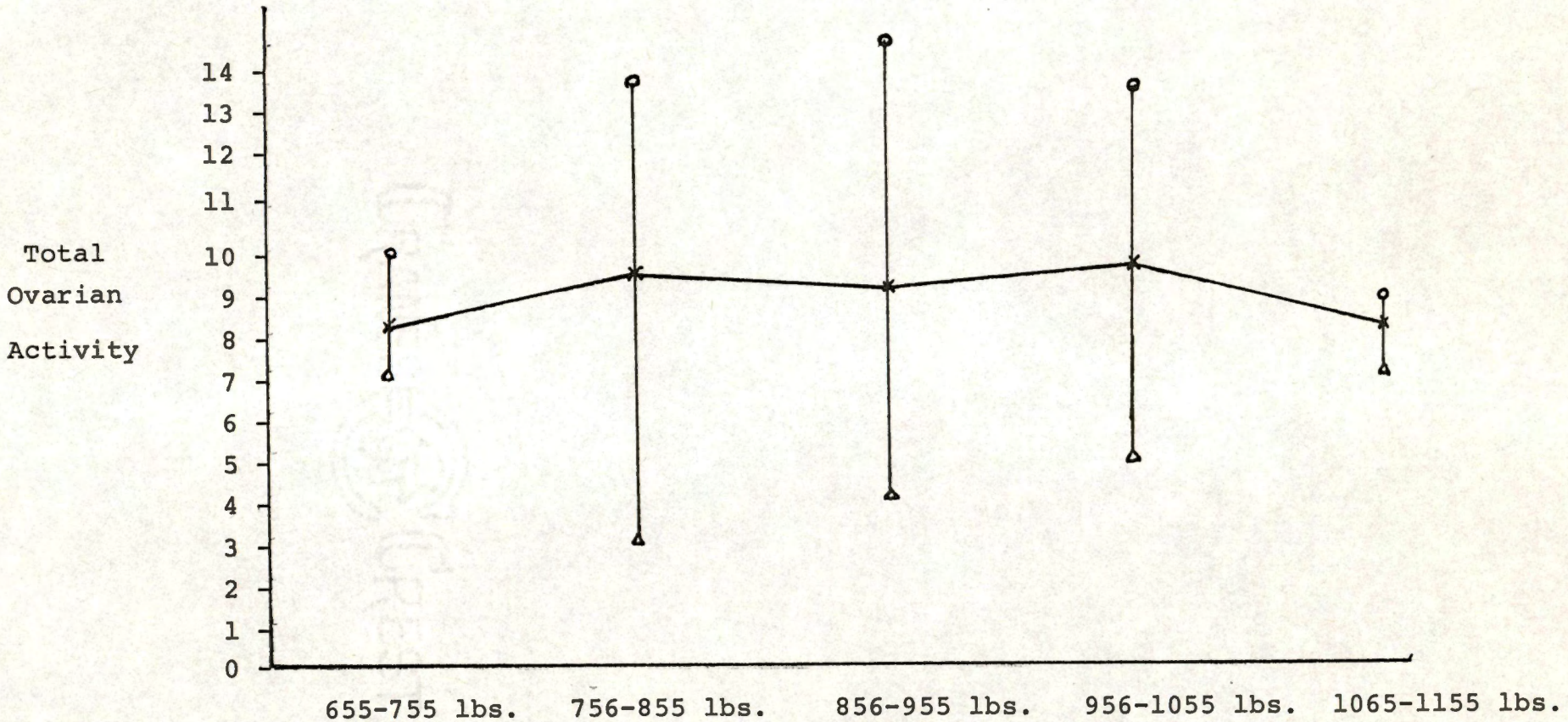

Figure 4. Relationship of total ovarian activity and body weight.

TABLE IV

SIMPLE CORRELATION COEFFICIENTS BETWEEN BODY DIMENSIONS AND OVARIAN MEASUREMENTS

	Ovarian measurements				
	Weight		Activity		Total
	Left	Right	Left	Right	Activity
Body length	.059	.022	.063	-.054	.005
Wither height	.110	.090	-.007	-.046	-.037
Hook height	-.019	.092	-.090	-.050	-.097
Marbling score	.092	-.135	.075	-.009	.044

influence on ovarian activity. This disagrees somewhat with the study by Sorenson et al. (1959) which reported that age at puberty is influenced by skeletal growth.

V. ANIMAL AGE

As seen in Table I and Table VI, the mean initial age of the heifers was 261.7 ± 56.7 days. The mean final age was 524.8 ± 69.3 days and the mean time on test was 263.0 ± 25.8 days.

Table V shows that significant correlations were found between age and ovarian measurements. One to be noted first is the significant correlation between final age and weight of left and right ovary ($P < .05$). Initial age was also significantly correlated to left and right ovary weight ($P < .05$).

Other indications from this analysis showed that time on test was inversely correlated to right ovarian activity.

TABLE V

SIMPLE CORRELATION COEFFICIENTS BETWEEN
AGE AND OVARIAN MEASUREMENTS

	Ovarian measurements				
	Weight		Activity		Total
	Left	Right	Left	Right	Activity
Initial age	.145	.209	.019	.051	.048
Final age	.180*	.168*	-.001	-.016	-.011
Time on test	.145	-.036	-.043	-.157*	-.138

*Significant (P <.05)

CHAPTER V

SUMMARY

The purpose of this study was to determine the relationships between various body characteristics and ovarian activity. The data were collected from 145 Hereford heifers at The University of Tennessee Main Experiment Station, Knoxville, Tennessee. Body characteristics consisted of body fat thickness, body weight, body length, wither height, hook height, marbling score and animal age. The term "ovarian activity" denoted the total number of corpora lutea and corpora albicans found by cross-sectioning the ovaries. The mean ovarian activity for the left ovary was 3.3 $\pm$ 1.5 and for the right ovary, 317 $\pm$ 1.6; and the mean left ovary weight was 5.9 $\pm$ 2.5 grams and the mean right ovary weight was 6.0 $\pm$ 2.6 grams. It was noted, however, that as the right ovary increased in weight the right ovarian activity also increased.

The mean initial fat thickness, final fat thickness, and increase in fat thickness were 2.6 $\pm$ 1.1 mm, 12.5 $\pm$ 2.7 mm and 9.9 $\pm$ 2.7 mm, respectively. However, neither left nor right ovarian activity was found to be significantly influenced by fat thickness ($P < .05$).

The mean initial body weight, mean final weight and mean weight gain were 439 $\pm$ 29.3 lbs, 890 $\pm$ 75 lbs. and 456 $\pm$ 70.4 lbs., respectively. It was found that as initial weights became higher the activity of the left ovary also increased.

Neither initial weight nor final weight exerted any influence on the weights of the left or right ovaries.

The means for body length, wither heights, hook height and marbling score were 127.2 $\pm$ 4.6 cm, 64.1 $\pm$ 2.3 cm, 110.6 $\pm$ 3.3 cm and 5.6 $\pm$ 1.2, respectively. The only significant variable was marbling score ($P < .10$).

The means for initial age, final age and time on test were 261.7 $\pm$ 56.7 days, 524.8 $\pm$ 69.3 days and 263.0 $\pm$ 25.8 days, respectively. Initial age was also significantly correlated to left and right ovary weight ($P < .05$). Significant correlations were found between final age and left and right ovary weights ($P < .05$).

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APPENDIX

TABLE VI

OVERALL MEANS, MINIMUM VALUES, MAXIMUM VALUES, AND STANDARD DEVIATIONS FOR SELECTED VARIABLES

	Mean	Minimum value	Maximum value	Standard deviation
Initial weight, lb.	439	375.	500	29.3
Final weight, lb.	896	700	1155	75.0
Weight gain, lb.	456	275	665	70.4
Initial fat, mm.	2.6	1.0	7.0	1.1
Final fat, mm.	12.5	6.0	20.0	2.7
Fat gain, mm.	9.9	3.0	16.0	2.7
Initial age, days	261.7	135.0	396.0	59.7
Final age, days	524.8	360.0	667.0	69.3
Days on test	263.0	197.0	292.0	25.8
Left ovary weight, gm.	5.9	2.2	16.1	2.4
Right ovary weight, gm.	6.0	1.5	14.5	2.6
Left ovarian activity[a]	3.3	0.0	7.0	1.5
Right ovarian activity[a]	3.7	0.0	8.0	1.6
Total activity[b]	7.0	1.0	13.0	2.2
Body length, cm.	127.2	114.5	138.6	4.6
Wither height, cm.	64.1	57.8	68.2	2.3
Hook height, cm.	110.6	103.1	121.2	3.3
Marbling score	5.6	3.7	9.0	1.2

[a]Ovarian activity: total number of corpora lutea and corpora albicans.

[b]Total activity: total number of corpora lutea and corpora albicans on left and right ovaries.

VITA

John Oliver Wallace was born in Jamestown, Tennessee, on August 31, 1946. He attended Allardt Elementary School at Allardt, Tennessee, and high school at Alvin C. York Agricultural Institute at Jamestown, Tennessee, from which he graduated in 1964. The following June, he entered Middle Tennessee State University at Murfreesboro. In September 1966 he transferred to The University of Tennessee at Knoxville, from which he was graduated with a Bachelor of Science degree in Agriculture in August 1968.

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