

AN ABSTRACT OF THE THESIS OF

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TITLE: SCROTAL CIRCUMFERENCE MEASUREMENTS AS AN INDICATOR  
OF GROWTH IN THE MALE BEEF ANIMAL

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Testes size as an indicator of future growth was examined in a total of 45 bull calves from spring calves born in 1978 and 1979. Scrotal circumference measurements were used as the physical indicator of testicle size in the live animal. Growth traits studied were preweaning average daily gain, weaning weight, feedlot gain, market weight and weight per day of age. Scrotal circumference measurements, and body weights were taken at birth, midpoint of the nursing period, and immediately before castration. Regression coefficients were calculated using preweaning growth traits as dependent on scrotal circumference.

Birth scrotal circumference was significantly related only to mid-nursing weight ( $P < .05$ ). Mid-nursing scrotal circumference significantly predicted ( $P < .01$ ) mid-nursing to weaning growth rate, and weaning weight. Correlation coefficients calculated for mid-nursing circumference and growth traits were high and positive. Adjusting mid-nursing scrotal circumference for body weight decreased the corre-

lation coefficients. Correlation coefficients calculated for the relationship of body weight and growth were high and positive as expected, and similar to values between scrotal circumference and growth.

Twenty-three of the castrated animals were utilized in a postweaning feeding trial in order to examine the relationship of preweaning scrotal circumference to postweaning growth. Relationships between preweaning testes size and feedlot gains were nonsignificant. Measurements of scrotal circumference taken at mid-nursing and castration were both significantly correlated ( $P < .01$ ) with market weight and weight per day of age, and so could be used as indicators of final weight.

Birth testes size was a poor predictor of market traits as correlations were low. As expected, midpoint weight and weaning weight were highly correlated ( $P < .01$ ) with end of feedlot trial weight.

Early measurements such as at birth are not as valuable in making growth predictions as are later measurements. Findings indicate that measurements are best used to obtain a ranking of the animals on a within year basis. Finally, results suggest that scrotal circumference or body weight are of equal value in predicting future performance in male beef cattle and can be used as a management tool or practice.

SCROTAL CIRCUMFERENCE MEASUREMENTS AS AN INDICATOR  
OF GROWTH IN THE MALE BEEF ANIMAL

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# SCROTAL CIRCUMFERENCE MEASUREMENTS AS AN INDICATOR OF GROWTH IN THE MALE BEEF ANIMAL

## INTRODUCTION

Current trends in the beef cattle industry, including higher production costs and rapid market fluctuations, are forcing cattlemen to make every effort to produce as efficiently as possible. Feed costs are considerably higher, and the current economic situation has caused beef consumption to decrease for the third consecutive year (Western Livestock Roundup, 1979). These conditions are causing many producers to consider major revisions in their farming or ranching operation, and in the type of cattle being produced or fed.

Cattle which gain rapidly and efficiently are highly desired in the beef production industry. The cow-calf producer is attempting to produce calves which gain rapidly from birth and then display desirable weaning weights. The cattle feeder needs to have a source of beef animals which have high average daily gains in the feedlot in order to maximize profit and take advantage of market fluctuations.

Male beef animals have long been desired by producers for meat production because they can be raised as either steers, or faster gaining intact bulls. However, selecting male beef animals for preweaning or postweaning growth traits is difficult to do at an early age. If selection of efficiently growing beef animals is to be successful,

information related to the potential growth of the individual animal must be available.

It would be desirable to be able to predict the growth of male beef cattle by some factor at birth or during early stages of growth. In order to do this, selection techniques need to be developed which would enable a cattleman to accomplish this task.

Testicular measurement in the male has been one of the fields of increasing interest in the area of beef cattle research. Scrotal circumference, a testicular measurement, has been studied as an indicator of performance in the male beef animal and has been correlated with many aspects of growth and reproduction. It is well known that androgens such as testosterone are important in protein metabolism. They induce nitrogen retention and are commonly used as anabolic agents. This is seen in vivo as bulls have higher rates of gain and leaner carcasses. It would be interesting to find a correlation between the size of the testes and the growth potential of the animal.

Since bulls exhibit few easily measurable traits, scrotal circumference may be a factor which would be useful in growth rate examinations. If measuring scrotal circumference proved to be an effective way to predict subsequent growth rate, this would enable the beef producer to have one more tool available to increase his confidence in selection.

Scrotal circumference has rarely been examined in

young males and little, if any, work has been done concerning the effects of pre-weaning testicle size on pre- and postweaning performance.

This study was designed to examine the relationship between scrotal circumference and animal performance. Economic traits studied were preweaning average daily gain, weaning weight, postweaning average daily gain, feedlot gain and weight per day of age. Measurements of scrotal circumference were made at birth, mid-birth to weaning, and at weaning time. Some of the animals were castrated and later used in a feedlot trial to analyze postweaning performance. Weights were recorded periodically and gains computed. Testes weights and yearly variation were also examined to verify the accuracy of the scrotal measurement.

## LITERATURE

The relationship of testicle measurements to aspects of growth and reproduction has been examined in various studies. It is well known that the testis of the male animal is an extremely complex organ and is the site of many hormonal and physiological interrelationships (Johnson et al., 1970). The role of the testis in the development and growth of an animal, and the potential use of physical measurements as indicators of performance is an area of increasing interest. It would be convenient at this point to review the development and function of the testes and scrotum in order to establish an understanding of the complexity of this organ.

Testicle development begins prenatally in the gonadal ridge, which lies medial to the embryonic kidney or mesonephros (Hafez, 1974). Primordial germ cells are responsible for initiating the formation of the gonadal ridge, which subsequently develops into testes in the male (Johnson et al., 1970). The gonadal ridge in the bovine embryo is first visible at approximately day 28 of the gestation period (Johnson et al., 1979). The original gonadal ridge then increases rapidly in diameter and is a globular gland by day 38. Differentiation of the fetal testes and development of the male reproductive tract are caused by androgen and Mullerian suppression hormone, respectively (Hafez, 1974). Both are produced by the fetal gonad (Hafez, 1974) and causes the indifferent gonad to become testicles by day 41

of the gestation period (Johnson et al., 1970).

Descent of testicles involves abdominal migration to the internal inguinal ring, inguinal migration through the canal, and finally migration within the scrotum (Hafez, 1974). Testicular descent in the bull occurs approximately at the midpoint of fetal life (Hafez, 1974).

A cross-section of the scrotum and testes would show that the testes are covered by several sheaths, comprised of connective tissue, muscle, epithelium, and vascular components. The scrotal wall is composed of several layers of muscle, dermis and connective tissue.

Seminiferous tubules make up most of the testes proper with intertubular or interstitial tissue surrounding the tubules (Johnson et al., 1970). The distinctive components of the intertubular tissue are Leydig cells which are believed to be one of the primary sources of the male hormone, testosterone (Hafez, 1974).

At birth the testes of the bovine weigh between three and eight grams. Testicular development progresses until the animal reaches full maturity (Van Demark, 1956). At one month of age, a few Leydig cells are present along with evidence of gonocytes in the tubules (Johnson et al., 1970). Primary spermatocytes appear at two months of age, and by five months of age Leydig cells have increased in number and size (Johnson et al., 1970). By six months of age, spermatozoa, Sertoli cells and numerous mature Leydig cells are present.

Rawlings et al., (1972) examined the development of the testis in Holstein bulls from birth to one year of age. Testicular concentrations of testosterone were found to be high at five months, decreasing slightly at six months, then generally increasing until 11 months of age. Plasma testosterone erratically increased from birth to 11 months of age, but overall correlations with testicular concentrations were significant ( $P < .01$ ). Schanbacher (1979) reported a similar increase in serum testosterone in bull calves from birth to 11 months, however the increase was less erratic. Androstenedione, also a testicular steroid, decreased in concentration from birth to one year of age in both the testes and plasma (Rawlings et al., 1972). The low correlations between the testicular and plasma concentrations of this steroid suggest a source other than the testes (Rawlings et al., 1972).

#### Relationship of Androgen and Gain

It has been well established that intact males, in general, have increased protein metabolism and increased muscling (Sitarz et al., 1977). Bulls gain faster and reach market weight at an earlier age than herd mate steers (Martin et al., 1966). These characteristics have been ascribed mainly to the effects of testosterone and androstenedione (Ellis and Beeliner, 1965). Gortsema et al., (1974) reported that plasma levels of testosterone were significantly higher ( $P < .05$ ) in intact males than steers. This is in agreement with the work done by Kellaway et al., (1971).

Gortsema cites numerous workers (Turton, 1962; Field et al., 1964; Nichols et al., 1964; Bailey et al., 1966) that have found greater ( $P < .05$ ) average daily gains and higher feed efficiencies in bulls over steers. In a study of male Angus-Hereford calves from weaning to slaughter, Gortsema et al., (1974) reported that intact males gained weight more rapidly ( $P < .05$ ) and more efficiently than castrated males. This study also found a high negative correlation ( $r = - 0.94$ ) between overall average daily gain and overall feed efficiency (units of feed per unit gain), indicating that animals which exhibited better feed efficiencies gained weight more rapidly.

Recently Sitarz et al., (1977) studied growth rates in Angus bulls greater than 120 days of age. It was found that bulls exhibiting higher average daily gains (within crude protein treatments) had higher average levels of plasma testosterone. Lund-Larson et al., (1977) reported a negative correlation ( $r = - 0.52$ ,  $P < .05$ ) between average testosterone concentrations of "Red Danish" bulls 6 to 10 months of age, and feed utilization. However, Lund-Larson et al., (1977) also reported a low correlation between plasma testosterone and average daily gain, which is in conflict with work previously cited. Gortsema et al., (1974) suggests that the increased gain, and feed efficiency seen in bulls is related to higher levels of endogenous testosterone. The effect of exogenous testosterone in promoting deposition of muscle protein and establishing a

positive nitrogen balance (Hale and Oliver, 1973) is well known and supportive of the effects of endogenous testosterone.

#### Relationship of Androgen and Growth Measurements

Researchers have investigated the relationship of levels of androgen to characteristics of growth. Recently, Lunstra et al., (1978) found significant correlations ( $P < .01$ ) between serum levels of testosterone and body weight of bulls. This is in conflict with earlier work. Sitarz et al., (1977) reported that in Angus bulls from 120 to 383 days of age, correlations of plasma testosterone with variables of growth (body weight, weaning weight) were not significant. Lund-Larson et al., (1974) examined the relationship between anatomical measurements (muscle area measured at 11 months of age; chest girth and height measured at 12 months of age) and plasma levels of testosterone in bulls. No significant relationship was found between the testosterone and the measurements. Hence, it is clear that this issue remains unsettled. Lund-Larson et al., (1974) suggest that limited sampling in the study may not have been sufficient to fully examine the relationship.

#### Androgen and Testis Measurements

Workers have attempted to investigate the relationship between levels of hormone and measurements of testes. Lunstra et al., (1978) studied testicular development in Hereford, Angus, Red Poll, Brown Swiss and Angus-Hereford



bulls from seven through 13 months of age. It was reported that across all breeds of bulls, scrotal circumference was positively and significantly ( $P < .01$ ) correlated with levels of serum testosterone. Serum testosterone concentrations were found to increase with advancing age of the bull. This supports the work previously reported by Rawlings et al., (1972) for younger bulls. Bulls which reached a scrotal circumference of  $27.9 \pm 0.2$  cm were found to be sexually mature, regardless of breed. Lunstra et al., (1978) also noted that bulls with higher levels of testosterone reached puberty at a younger age.

Schanbacher (1979) examined the relationships of androgen and testes development in the immature bovine male. As previously stated, serum testosterone steadily increased from birth to 11 months of age, however the greatest increases were from six to 11 months. Schanbacher (1979) found that serum concentrations of testosterone in bulls six to 12 months of age were significantly ( $r = 0.95$ ,  $P < .01$ ) correlated with paired testes weights (calculated from mean values).

### Testes Measurements

It is well known that anatomical measurements of the testes are highly correlated with each other. Hahn et al., (1969) examined testicular characteristics in Holstein bulls, seven months of age to 15 years. Various measurements of the removed testis were highly correlated ( $P < .05$ ) with each other e.g. scrotal circumference, left and right testis

depth, right and left testis length. Weisgold and Almquist (1979) examined the testis and found no differences between the right and left testis weights.

Actual measurements of the testes on an animal are difficult to obtain unless it is castrated or slaughtered. Since this is not highly desirable in most cases, various workers have investigated relationships between the weight of the testis, and external measurements such as scrotal circumference, and diameter. Hahn et al., (1969) reported a correlation of 0.92 between testis weight and scrotal circumference in mature Holstein bulls. This is in agreement with the values of 0.92 to 0.95 reported by Van Demark (1956), Boyd and Van Demark (1957), Willett and Ohms (1957) and Seidal (1968). Memon et al., (1971) reported a significantly positive correlation between scrotal circumference and testes weight in mice. Land and Carr (1975) reported a 0.94 correlation between testis diameter and testis weight in Blackface, Finn and Merino ram lambs at 12 or 16 months of age. Boyd and Van Demark (1957) found no significant difference between in situ measurements of the scrotum and measurements of the excised testes. Therefore, on the basis of this evidence, physical measurements of the testes i.e. scrotal circumference or diameter, are accurate indications of testis size.

#### Testes Measurements and Reproduction

In recent years, researchers have found interesting relationships between the size of the testes and scrotum,

and aspects of reproduction. In most cases, testis measurements are used as indicators of reproductive performance. Hahn et al., (1969) reported correlations between scrotal circumference, and sperm output per week for young Holstein bulls. The values were  $r = 0.81, 0.72, 0.64, 0.40, 0.22$ , with correlations decreasing as age increased from 17 to 150 months. This is in agreement with the work of Almquist and Amann (1961) who report a correlation of 0.62 ( $P < .01$ ) between testicular weight and daily sperm production in Holstein bulls. Ortavant (1958) found a correlation of 0.84 ( $P < .01$ ) between the number of spermatids and testis weight in Ile-de-France rams. Boyd and Van Demark (1957) reported a correlation of 0.80 between testis-epididymal weight and sperm concentration of semen in one and one-half to four year old Holstein bulls. Swierstra (1966) reported a correlation of 0.83 between testes weight and daily sperm production in Shorthorn bulls. Coulter and Foote (1976) reported large variations of testicular weights in Holstein bulls of similar ages. They suggest measuring the scrotal circumference and selecting young bulls with larger testes as these bulls will have superior spermatozoal producing capabilities.

Buffalo bulls were studied by Verma et al., (1965) and the correlation between testis weight and the number of spermatids in testicular homogenate was 0.54. In New Zealand White rabbits, Kirton et al., (1967) reported a correlation of 0.66, similar to the value of Orgebin-Crist (1968) of

0.61 for the relationship of testis weight and sperm concentration. Land (1973) reported a correlation of 0.97 between testis weight in males and ovulation rate in related female mice. Islam and Hill., (1976) also reported a significant relationship between male testis weight and primiparous ovulation in related females ( $0.50 \pm 0.18$ ). The partial correlation was 0.82 when testis weight was adjusted for differences in body weight (Land, 1973).

### Testicle Measurements and Growth

Growth of the testis in males is indicative of not only the reproductive performance of an animal, but also the growth of an animal. Testicle size is related to the age of an animal as one would expect. Hahn et al., (1969) found the relationship between the age of the bull and its scrotal circumference to be 0.87 in Holstein bulls seven months to 15 years of age. This is in agreement with the value of 0.88 reported by Lunstra et al., (1978) for beef bulls from seven to 13 months of age.

Sadowski (1965) studied Black Pied Lowland bulls between nine and 78 months of age and found the correlation between body weight and testes weight to be 0.85. Attal and Courot (1963) in examining Normande bulls, reported a value of 0.95 ( $P < .01$ ) for the relationship between body weight and the logarithm of testis weight from 12 to 36 months of age.

Sitarz et al., (1977) reported a significant relationship ( $r = 0.60$ ,  $P < .01$ ) between the body weight and scrotal circumference of Angus bulls at 375 days of age. Schanbacher

(1979) also reported a high correlation in his study and this is in agreement with work previously cited. Workers at the U. S. Meat Animal Research Center (Lunstra et al., 1978) reported a correlation of 0.80 between the weight of the bull and the scrotal circumference across breeds, between seven and 13 months of age.

Examined by Hahn et al., (1969) was the relationship of scrotal circumference to anatomical measurements of growth. Withers height, as a measure of growthiness, was significantly correlated to scrotal circumference ( $r = 0.80$ ,  $P < .01$ ) when examined over all the ages of the bulls. Correlations of testicular measurements with withers height on a with-in age basis were positive, but low ( $r = 0$  to  $0.39$ ). The exception to this were a group of selected A. I. bulls over six years old in which the correlation between withers height and scrotal circumference was  $0.68$  ( $P < .01$ ). This indicated that the larger bulls had larger testicles. Sitarz et al., (1977) reported a correlation ( $r = 0.36$ ,  $P < .05$ ) between weaning weight and scrotal circumference of bulls at 375 days of age.

## MATERIALS AND METHODS

Forty-five bull calves were studied over a period of 15 months for testicular characteristics and growth rates. The calves were obtained from the University's beef cattle herd at Soap Creek Ranch, located approximately ten miles north of the Oregon State University campus. The herd is composed of approximately 170 cows of predominantly Hereford breeding with some Hereford-Angus crosses.

In 1978, 26 bull calves were used in this experiment. Calving began in mid-March; however, the calves used in the study were selected from those born from the mid-point of the calving season and later. As soon as a calf was born, it was placed into an individual pen with its dam. A device for measuring the scrotal circumference (figure 2) was constructed for use in this experiment. The device was used to obtain the greatest diameter of the testes and scrotum (figure 1) as described by Foote (1969).

Measurements were taken within two to four days of birth by separating the individual calves from their dams and then measuring scrotal circumference. The calves were also weighed at the time of measurement. The most accurate measurements were taken with the animals lying on their side, (figure 3), henceforth all measurements were taken in a similar manner.

The second measurement of the bull calves occurred at the midpoint of the nursing period. This was calculated as the date halfway between the average birth dates of the

study animals and the projected castration date. The same device was used to take all scrotal measurements, and the same personnel performed each task. Scrotal thickness was taken at this time with a set of outside calipers. The testicles were pushed up and then the measurement was taken near the distal portion of the scrotum. The thickness of the scrotum was estimated by dividing the measurement by two. The calves were also weighed at the time of this midpoint measurement.

During the birth to castration period, management was similar for all calves. The cows and calves were allowed to graze on improved pasture throughout the nursing period.

The final scrotal measurement was taken immediately before castration. Scrotal circumference and calf weights were obtained at this time. After the castration of an animal, the testicles were weighed on a balance arm scale to obtain paired testes weights (Hahn et al., 1969). The testicles were then placed in plastic bags with the individual calf number recorded on each bag. The next day, the testicles were weighed on a laboratory Metler balance to verify field weights. Two of the study animals were not castrated as they were selected for potential herd sires. The average daily gain for the two periods, birth to midpoint and midpoint to castration, was calculated for each animal in the study.

The calves were weaned several days later. Twenty-three steers were transported to the campus beef facility immediately after weaning to begin the feeding trial (figure

4). Three rations were fed during the entire feeding period. Ration I, an adjustment ration, was fed to the steers for 56 days (table 1). Ration II, a finishing ration, was fed for the following 154 days. This ration was formulated using requirements as indicated in Nutrient Requirements for Beef Cattle (N. R. C., 1976) for steers with expected average daily gains of 1.3 kilograms. The animals were fed both hay and concentrate twice daily. The concentrate was increased to a maximum of 8.29 kg per head per day plus 2.96 kg hay. Samples were taken of the hay periodically and analyzed to insure that there were satisfactory levels of protein. The 23 steers were weighed bi-weekly and the average daily gain calculated for the entire feeding period.

Ration III, a high energy finishing ration (table 3), was fed for the final feeding period of 34 to 54 days. The concentrate was increased to a maximum of 8.6 kg per head in addition to 2.36 kg of hay per head per day. Three-tenths of an inch of backfat, measured between the 12th and 13th ribs, was used as an endpoint to determine the time to slaughter the animals. Preliminary measurements (figure 5) on a random sample of five steers by ultrasonic probe, on day 25 of the final feeding period, showed that the animals were nearing the endpoint. A measurement of all test animals on day 34 showed 16 steers with greater than or equal to three-tenths of an inch of backfat. The 16 steers were then sold to a slaughter plant. Eleven of the steer carcasses were evaluated at the slaughter plant to verify the live animal backfat measurements.



Table 1. Ration I

	CP%	TDN%	ME MCAL/Kg	% of ration
Cracked corn (4-02-931) <sup>a</sup>	4.5	40.95	1.48	45.0
Rolled Oats (4-07-999)	3.96	30.8	1.08	40.0
Molasses (4-00-668)	.44	4.45	.16	5.0
Beet pulp (4-00-669)	.45	3.24	.12	4.5
Alfalfa hay (1-00-063)	.86	2.75	.10	5.0
Trace mineralized salt	---	----	----	.5
Total in ration	10.21	82.19	2.94	100.00

<sup>a</sup>NRC Feed Reference No.

Table 2. Ration II

	CP%	TDN%	ME MCAL/Kg	% of ration
Cracked corn (4-02-931)	4.2	38.22	1.38	42.00
Cottonseed meal (5-01-621)	2.69	4.51	.16	6.01
Beet pulp (4-00-669)	1.00	7.2	.26	10.0
Grass hay (1-01-912)	3.62	18.9	.68	35.0
Molasses (4-00-668)	.87	5.79	.21	6.5
Trace mineralized salt	----	----	----	.26
Limestone	----	----	----	----
Total in ration	12.09	74.62	2.69	100.0

Table 3. Ration III

	CP%	TDN%	ME MCAL/Kg	% of ration
Cracked corn (4-02-931)	5.67	51.55	1.86	56.65
Cottonseed meal (5-01-621)	1.94	3.26	.12	4.34
Beet pulp (4-00-669)	.54	3.90	.14	5.43
Grass hay (1-01-912)	2.90	14.91	.54	27.61
Molasses (4-00-668)	.47	4.83	.17	5.43
Trace mineralized salt	----	----	----	.25
Limestone	----	----	----	.29
Total in ration	11.52	78.45	2.83	100.00

Backfat measurements were made on the remaining seven steers on day 54. Six steers were observed with three-tenths and one steer with 0.25 inches of backfat. The steers were then sold and the trial concluded.

The steers were weighed prior to shipment. Average daily gains were calculated for each feeding period and weight per day of age was also calculated.

In 1979, nineteen bull calves of similar breeding were measured at birth and again at an average age of 95 days. Procedures for obtaining scrotal measurements and body weights were the same as those utilized for the 1978 calves. Management of all calves was the same during the study period.

Regression equations were calculated for the various growth traits using scrotal circumference as an independent variable. Correlation coefficients between scrotal circumference, paired testes weight and growth traits were also calculated. Residual tests (Neter and Wasserman, 1974) were used to test for appropriateness of linear regression models. Relationships between animals were examined on a within year basis.

One calf died during the study, and all information of this animal was eliminated from the analysis. Two steers were removed from the analysis as it was evident that they were implanted with Zeranol at birth. Their growth and testicular characteristics were similar to implanted calves as reported by Ralston (1978) and Riesan et al., (1977). The remaining 23 calves from the 1978 calf crop were studied

from birth to weaning. Two more calves that were not castrated because they were selected as potential herd sires were only used in birth to weaning comparisons. The remaining 21 calves were used in examining birth to market relationships.

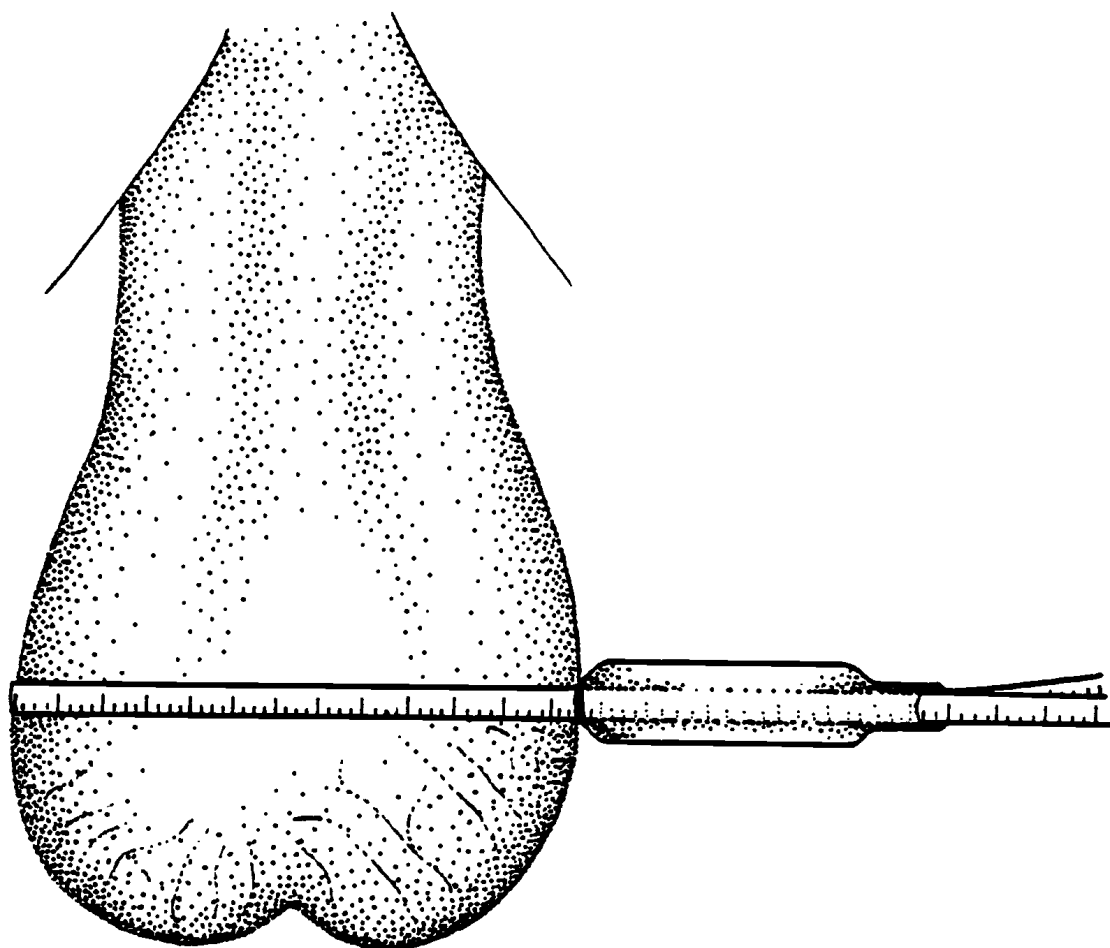


Figure 1. Representation of scrotal circumference measurement.

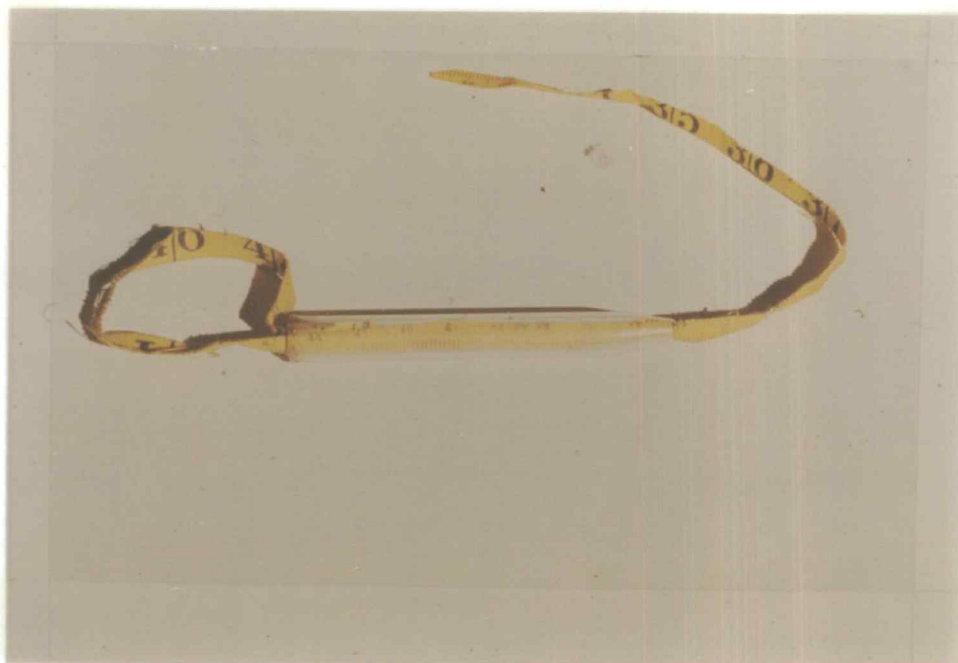


Fig. 2. Scrotal circumference measuring device.



Fig. 3. Use of the measuring device on a bull prior to castration.



Fig. 4. View showing the uniformity of the steers on the weaning to market trial.



Fig. 5. Use of the Scanoprobe to determine live animal backfat thickness.



## RESULTS AND DISCUSSION

Means and standard deviations for all traits are presented in tables 4 and 5 for 1978 and 1979 calves respectively. Calves born in 1978 had larger average scrotal circumference at birth ( $P < .01$ ) than 1979 calves (11.92 vs 11.02 cm).

Analysis of the relationship between paired testes weight and scrotal circumference (SC) of the 21 castrated animals showed it to be significant ( $r = 0.73$ ,  $P < .01$ ). The regression equation calculated for paired testes weight dependent on SC is illustrated in figure 6. The correlation value and regression equation were calculated using the testes weights obtained in the field. However, verification of field weights on a laboratory balance showed the field and lab weights to be very similar ( $r = 0.99$ ,  $P < .01$ ). Since all relationships were high and positive, SC was used as a confident indicator of testis size.

### Relation of SC to Growth Through Weaning

The coefficients of correlation of SC and growth traits from birth to weaning for 1978 calves are presented in table 8. Correlation coefficients and regression equations for traits in 1979 calves are presented in tables 6 and 7 respectively.

Birth SC and birth weight were positively correlated for 1978 calves ( $r = 0.64$ ,  $P < .01$ ) and 1979 calves ( $r = 0.59$ ,

$P < .01$ ). Thus, SC was an indicator of present body size.

Scrotal circumference at birth, and birth SC adjusted for differences in birth weight (table 9), were used in regression analysis in an attempt to predict later performance. In both cases, regression coefficients in which birth to weaning growth traits were dependent variables were mostly nonsignificant. Exceptions were the regression (table 10) of midpoint body weight ( $P < .01$ ) and weaning weight ( $P < .05$ ) on unadjusted birth SC. Birth SC accounted for 17% of the total variation in weaning weight. However, the correlation of birth weight with weaning weight was also high and positive ( $r = 0.51$ ), accounting for 25% of the variation in weaning weight. This indicated that birth SC and birth weight were of similar value in predicting end of nursing performance.

The regression of average daily gain (ADG) from birth to midpoint on birth SC (table 7) was significant for 1979 calves ( $P < .05$ ) but not for 1978 animals. Slight differences in management of the 1979 calves for several weeks plus measuring at a younger age could account for the difference.

Midpoint SC (MSC) was significantly and positively correlated with midpoint body weight (tables 6 and 8) for calves in 1978 ( $r = 0.87$ ,  $P < .01$ ) and 1979 ( $r = 0.91$ ,  $P < .01$ ). Correlation coefficients (table 8) of MSC with growth traits were generally high and positive, suggesting MSC was an indicator of animal performance. Regressions (table 11) of weaning weight, ADG from birth to castration and ADG from midpoint to castration on MSC were significant

( $P < .01$ ).

Midpoint body weight was also significantly related to the growth traits. Body weight and MSC each accounted for similar values of 76 and 74 percent respectively, of the variation in weaning weight and 37 and 35 percent, respectively, of the variation in ADG from midpoint to castration.

Adjusting MSC for body weight decreased the correlation coefficients (table 8). This may be interpreted to mean that SC is a function of the size and growth of the animal and has the same value as body weight in indicating present or future performance.

Castration SC was related to weaning weight ( $P < .01$ ) and earlier growth traits ( $P < .01$ ) except birth weight. Regressions of ADG from birth to weaning and midpoint to weaning on castration SC were significant ( $P < .01$ ), suggesting a relationship between SC and past performance of the animal. As was previously stated, SC was correlated to paired testes weight. Regression equations for castration SC are presented in table 12.

#### Relation of SC to Market Traits

The 1978 steers were on the feeding trial for an average of 194 days. Most differences between animals were due to body weight as variations in body height were small.

The correlations between SC and postweaning traits are presented in table 13. Relationships between preweaning

SC measurements and feedlot performance were found to be small and nonsignificant. Correlation coefficients of market traits and adjusted birth SC (table 13) were also low and nonsignificant.

MSC was positively related ( $P < .01$ ) to market weight, weight per day of age, and ADG from birth to market. Adjusting the MSC for body weight slightly decreased the correlation coefficients (table 13). Regression equations are presented in table 14 and 15 for unadjusted and adjusted MSC respectively.

Regression coefficients (table 16) of market weight, weight per day of age and ADG from birth to market on castration SC were also significant ( $P < .01$ ). The correlation between SC and market weight, weight per day of age and ADG from birth to market were 0.63, 0.71 and 0.73 respectively. Adjusting castration SC for body weight generally decreased the correlation coefficients with market traits.

None of the SC measurements were accurate predictors of feedlot gain. The correlation between market characteristics (e.g. weight per day of age) and actual SC were found to increase from birth to castration. Weaning weight was also significantly related ( $P < .01$ ) to market traits.

## CONCLUSION

Body measurements have been proven as indicators of performance in beef cattle. Brown (1973) examined the relationship of growth traits (e.g. average daily gain) with body measurements such as body weight, length and height at the withers. It was reported that such body measurements, in the absence of performance data, may be helpful in identifying bulls that have a potential for high average daily gain. Studies by Brown et al., (1979) support the earlier findings.

In the present study, significant relationships were found between SC measurements, preweaning average daily gain and weaning weight. Scrotal circumference measurements were also related to market weight and weight per day of age. Thus, this type of physical measurement may be useful in making predictions about the growth of an animal. Scrotal measurements taken at the midpoint between birth and weaning were more valuable in assessing the later performance of the animals than was birth SC. This suggests that calves should be allowed an initial development period before predictions about future performance are made.

It was also found that body weights were positively related to SC, preweaning traits and market characteristics. Therefore, it was apparent in this study that either SC or body weight, except at birth, could be used as indicators of growth and in the selection of desirable beef cattle. Where management practices are such that weights cannot

be obtained, SC can provide information in order that a ranking may be applied to the animals. One should not disregard the use of performance test data in the selection of efficient beef cattle. However, this type of information is not always available on young animals, so SC measurements can provide additional information on the relationship of present size to future performance.

It must be realized that taking these measurements may not always be practical. Cattle producers with many thousands of head are not able to individually measure a large number of calves. On the other hand, it might be useful in attempting to select young breeding bulls for a large range operation.

Scrotal circumference measurements may have valid application in smaller operations, especially where scales are not available. In smaller herds, selection of steers or replacement bulls is especially critical for economic reasons. Scrotal measurements can help to increase confidence in selection.

These findings may possibly be most valuable as a research aid. Further studies on prediction of growth may need to utilize all available selection methods when high performance animals are desired.

However applied, SC measurements are best utilized on a within year basis. Coulter and Foote (1976) report that selection of bulls for testicular traits can best be made within the same age group and year-season. Once information

is collected, calves can be ranked for later performance, whether raised as castrated or intact animals.

Scrotal circumference can provide useful information to the progressive beef producer. The goals set in the individual selection program can only be accomplished by good management and incorporation of all available selection tools. Measuring the SC of male animals is one more tool available to the beef producer to aid in the selection and production of highly efficient beef cattle.

Table 4. Means and standard deviations for traits in 1978 animals.

<u>Trait</u>	<u>Mean</u>	<u>Standard Deviation</u>
Birth weight (kg)	36.1	4.49
Birth SC (cm)	11.92	0.79
Midpoint weight (kg)	133.7	22.56
Midpoint SC (cm)	16.51	1.35
Scrotal thickness (cm)	.228	.0378
Castration SC (cm)	22.22	1.71
Weaning weight (kg)	204.58	30.47
Paired testes weight (g)	125.233	35.95
Birth to midpoint ADG (kg)	.92	.207
Birth to castration ADG (kg)	.85	.151
Midpoint to castration ADG (kg)	.77	.122
Birth to market ADG (kg)	.94	.058
154 day trial ADG (kg)	1.28	.132
Midpoint to market ADG (kg)	.96	.066
Weaning to market ADG (kg)	1.27	.300
Market weight (kg)	457.9	25.32
Age at market (days)	447.3	11.89
Weight per day of age (kg)	1.02	.063



Table 5. Means and Standard Deviations for Traits in 1979 animals.

<u>Trait</u>	<u>Mean</u>	<u>Standard Deviation</u>
Birth weight (kg)	35.6	4.31
Birth SC (cm)	11.02	1.263
Midpoint SC (cm)	14.77	2.39
Birth to midpoint ADG (kg)	.82	.256
Midpoint weight (kg)	111.3	30.17

Table 6. Correlation coefficients between growth traits and testicular measurements for 1979 calves.

<u>Trait</u>	<u>Birth SC</u>	<u>Midpoint SC</u>	<u>Adjusted Birth SC</u>
Birth weight	0.59**	0.73**	---
Midpoint weight	0.69**	0.91**	0.41
ADG, birth to midpoint	0.55*	0.88**	0.31

\* P<.05    \*\* P<.01

Table 7. Regression equations relating scrotal circumference (cm) to growth traits (kg) for 1979 calves.

Birth scrotal circumference (Y) on birth weight (X)

$$Y = 4.92465 + .171117 X$$

ADG from birth to midpoint (Y) on birth scrotal circumference (X)

$$Y = -.6457 + .08551 X$$

Midpoint body weight (Y) on birth scrotal circumference (X)

$$Y = -100.862 + 12.3974 X$$

Midpoint scrotal circumference (Y) on midpoint body weight (X)

$$Y = 7.12133 + .068677 X$$

Table 8. Correlations between growth traits and testicular measurements from birth to weaning (1978).

<u>Growth Traits</u>	<u>Birth SC<sup>a</sup></u>	<u>Adjusted birth SC</u>	<u>Midpoint SC</u>	<u>Adjusted midpoint SC</u>	<u>Castration SC</u>
Birth weight	.64**	---	.44*	-.22	.14
ADG, birth to midpoint	.33	.11	.87**	.15	.65**
Midpoint weight	.54**	.19	.87**	---	.62**
Weaning weight	.41*	.10	.86**	.06	.66**
ADG, birth to castration	.24	-.03	.84**	.15	.66**
ADG, midpoint to castration	.03	-.13	.59**	.17	.56**

\*  $P < .05$

\*\*  $P < .01$

<sup>a</sup>Scrotal circumference

Table 9. Regression equation relating birth scrotal circumference (cm) to birth weight (kg) in 1978.

Birth scrotal circumference (Y) on Birth weight (X)

$$Y = 7.86365 + .112295 X$$

$$(r = .64)$$

Table 10. Regression equation relating birth scrotal circumference (cm) to birth weaning traits (kg) (1978).

Midpoint body weight (Y) on birth scrotal circumference (X)

$$Y = -52.075 + 15.5858 X$$

Table 11. Regression equations relating midpoint scrotal circumference (cm) to birth to weaning traits (kg) (1978).

Scrotal circumference (Y) on Midpoint body weight (X)

$$Y = 9.51962 + .052317 X$$

ADG from birth to Castration (Y) on scrotal circumference (X)

$$Y = -.6899 + .0933226 X$$

ADG from Midpoint to Castration (Y) on scrotal circumference (X)

$$Y = -.111530 + .05342 X$$

Weaning weight (Y) on scrotal circumference (X)

$$Y = -116.772 + 19.4603 X$$

Castration scrotal circumference (Y) on Midpoint scrotal circumference (X)

$$Y = 7.16199 + .911991 X$$

Table 12. Regression equations relating castration  
scrotal circumference to birth to weaning  
traits (1978).

Weaning weight (Y) (kg) on scrotal circumference (X) (cm)

$$Y = -124.863 + 25.8968 X$$

ADG from midpoint to castration (Y) (kg) on scrotal  
circumference (X)

$$Y = -.110713 + .039661 X$$

ADG from birth to castration (Y) (kg) on scrotal  
circumference (X) (cm)

$$Y = -.446882 + .0584128 X$$

Paired testes weight (Y) (g) on scrotal circumference  
(X) (cm)

$$Y = -205.06 + 14.9325 X$$

Table 13. Correlations between growth traits and testicular measurements from birth to market (1978).

<u>Growth Traits</u>	<u>Adjusted birth SC<sup>a</sup></u>	<u>Midpoint SC</u>	<u>Adjusted Midpoint SC</u>	<u>Castration SC</u>	<u>Adjusted castration SC</u>
ADG, 154 day feed trial	.42	0	-.02	0	.14
ADG, high energy feed trial	-.38	0	.14	.17	.15
Market weight	.15	.55**	.49*	.63**	.31
Weight per day of age	.17	.68**	.65**	.71**	.33
ADG, birth to market	.17	.65**	.64**	.73**	.39
ADG castration to market	-.41	-.33	-.03	0	.04
ADG, midpoint to market	-.08	-.05	-.04	.24	.42

\* P<.05

\*\* P<.01

<sup>a</sup>Scrotal circumference



Table 14. Regression equations relating midpoint scrotal circumference (cm) to birth to market traits (kg)

Market weight (Y) on scrotal circumference (X)

$$Y = 284.884 + 10.5782 X$$

Weight per day of age (Y) on scrotal circumference (X)

$$Y = .489871 + .0326599 X$$

ADG from birth to market (Y) on scrotal circumference (X)

$$Y = .476508 + .028567 X$$

Table 15. Regression equations relating midpoint adjusted scrotal circumference (cm) to birth to market traits (kg) for 1978.

Market weight (Y) on scrotal circumference (X)

$$Y = 241.083 + 10.1943 X$$

Weight per day of age (Y) on scrotal circumference (X)

$$Y = .318304 + .03183 X$$

ADG from birth to market (Y) on scrotal circumference (X)

$$Y = .304121 + .03009 X$$

Table 16. Regression equations relating castration scrotal circumference (cm) to market traits (kg) for 1978.

Market weight (Y) on scrotal circumference (X)

$$Y = 256.159 + 9.12129 X$$

Weight per day of age (Y) on scrotal circumference (X)

$$Y = .461528 + .0254336 X$$

ADG birth to market (Y) on scrotal circumference (X)

$$Y = .413395 + .0239933 X$$

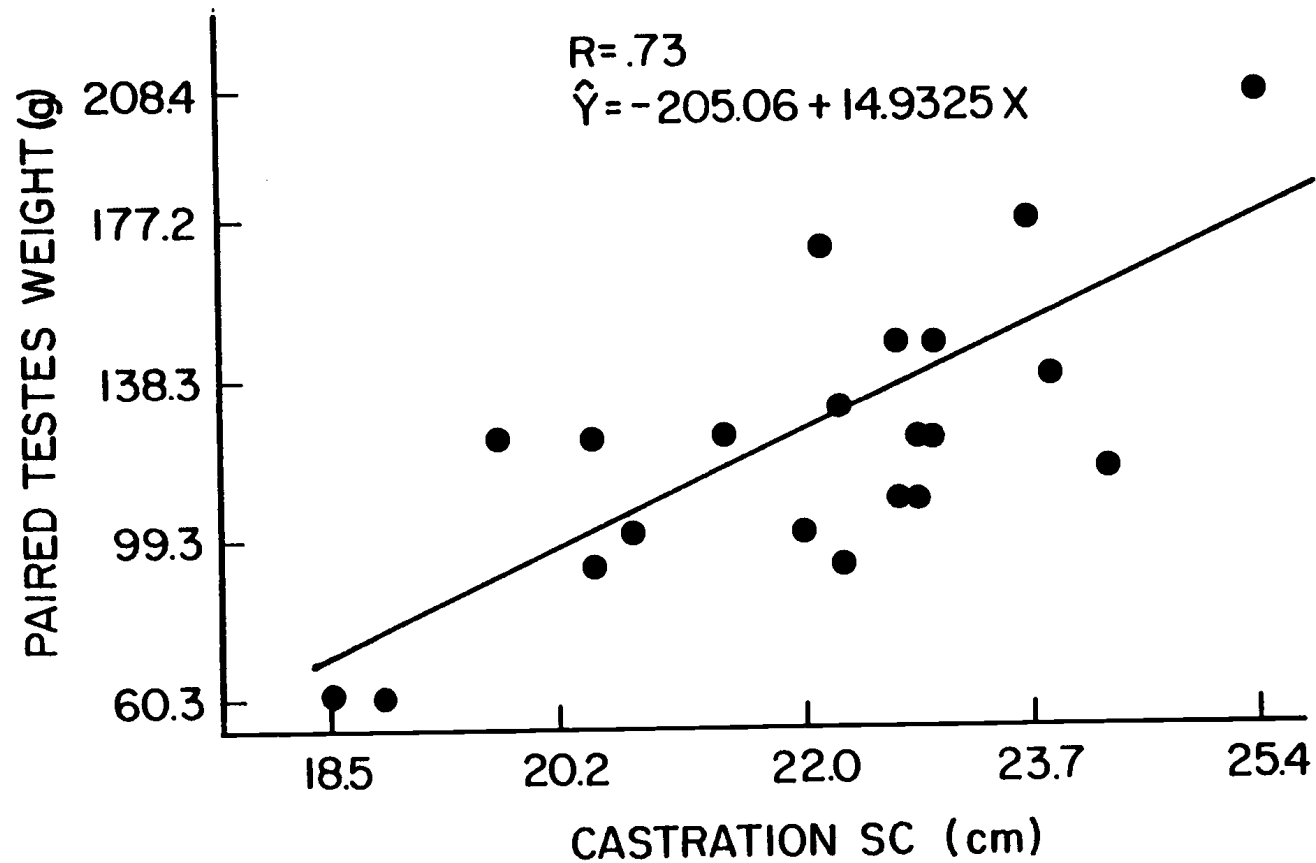


Figure 6. Regression of paired testes weight on castration SC.

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## APPENDIX



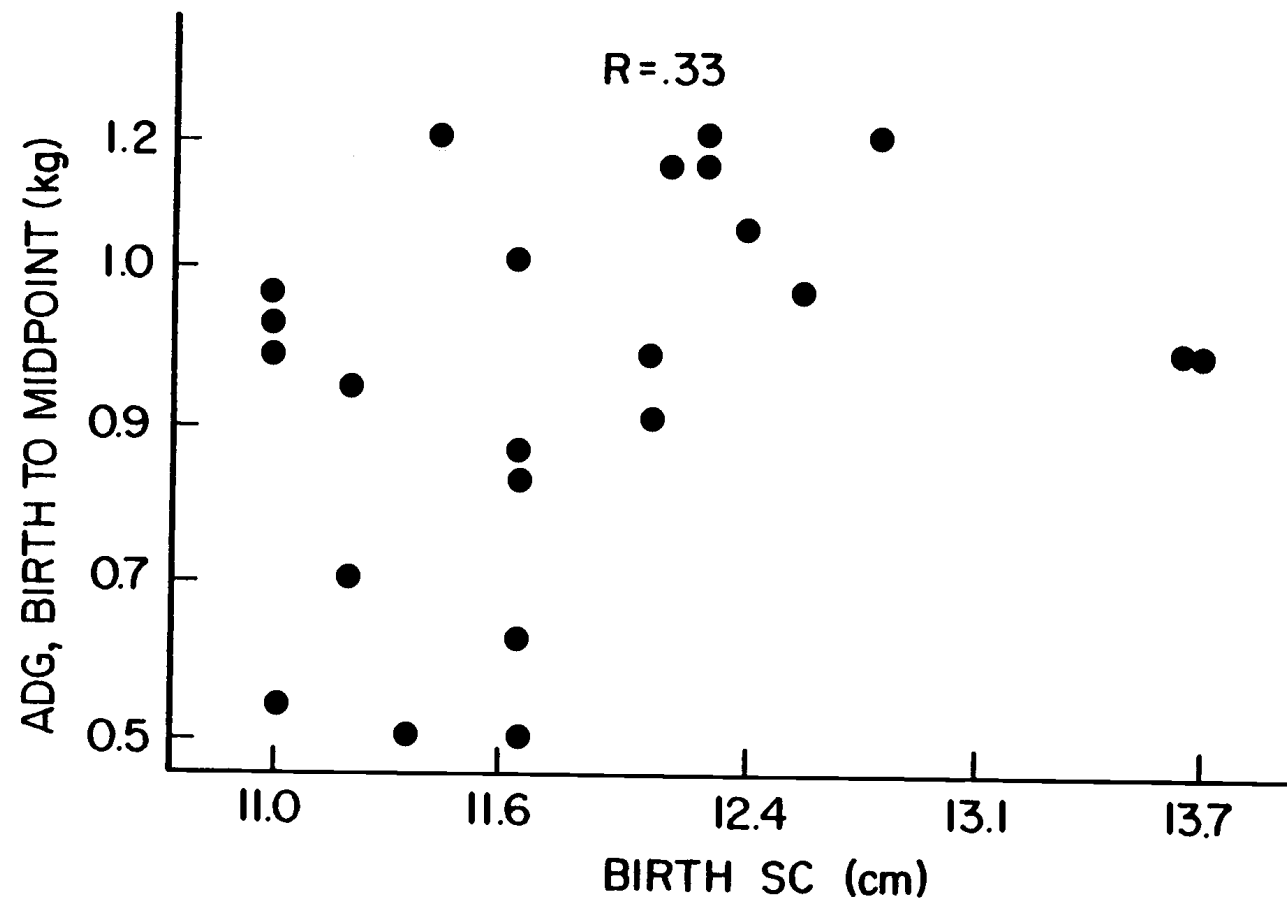


Figure 7. Regression of ADG from birth to midpoint on birth SC.

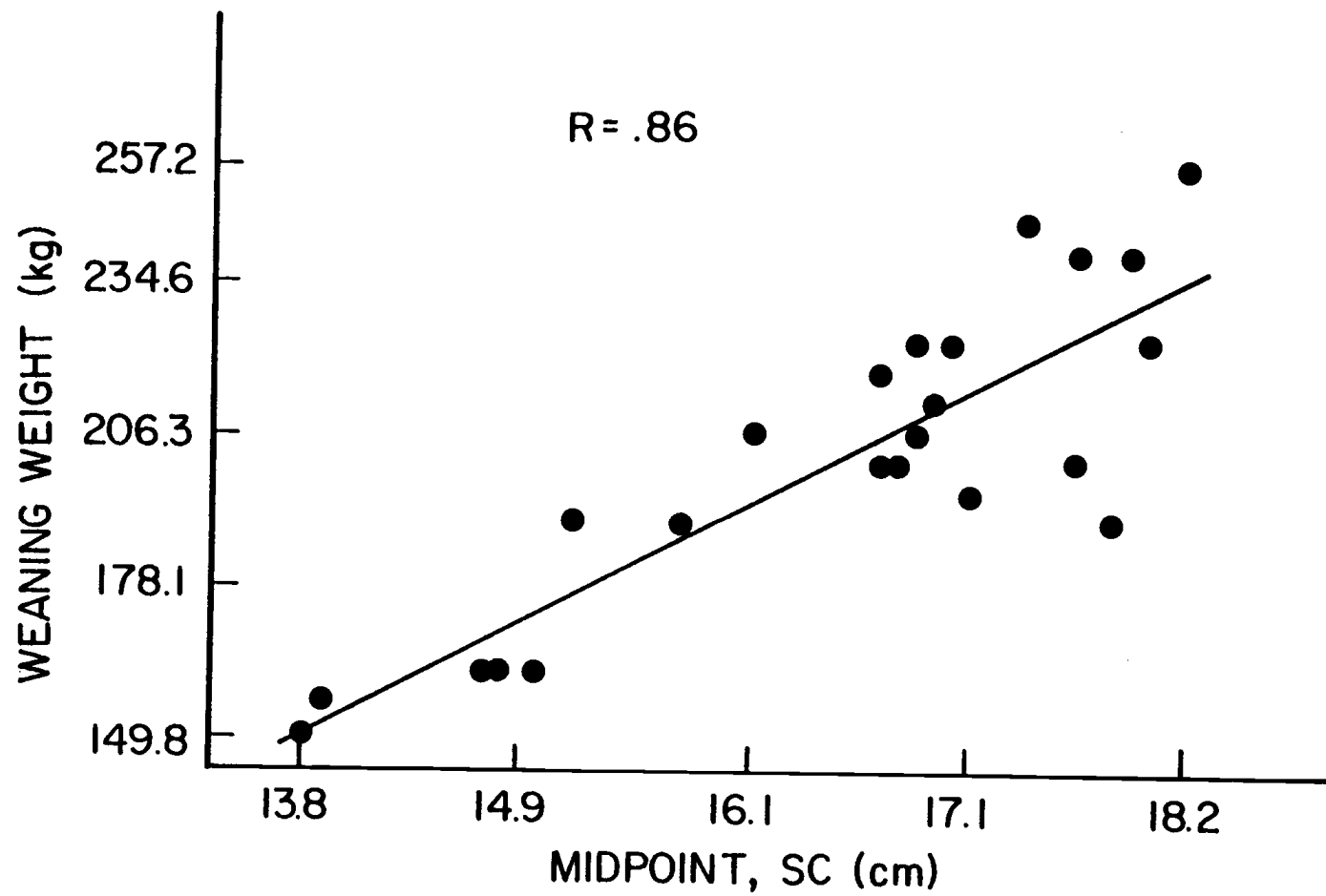


Figure 8. Regression of weaning weight on midpoint SC.

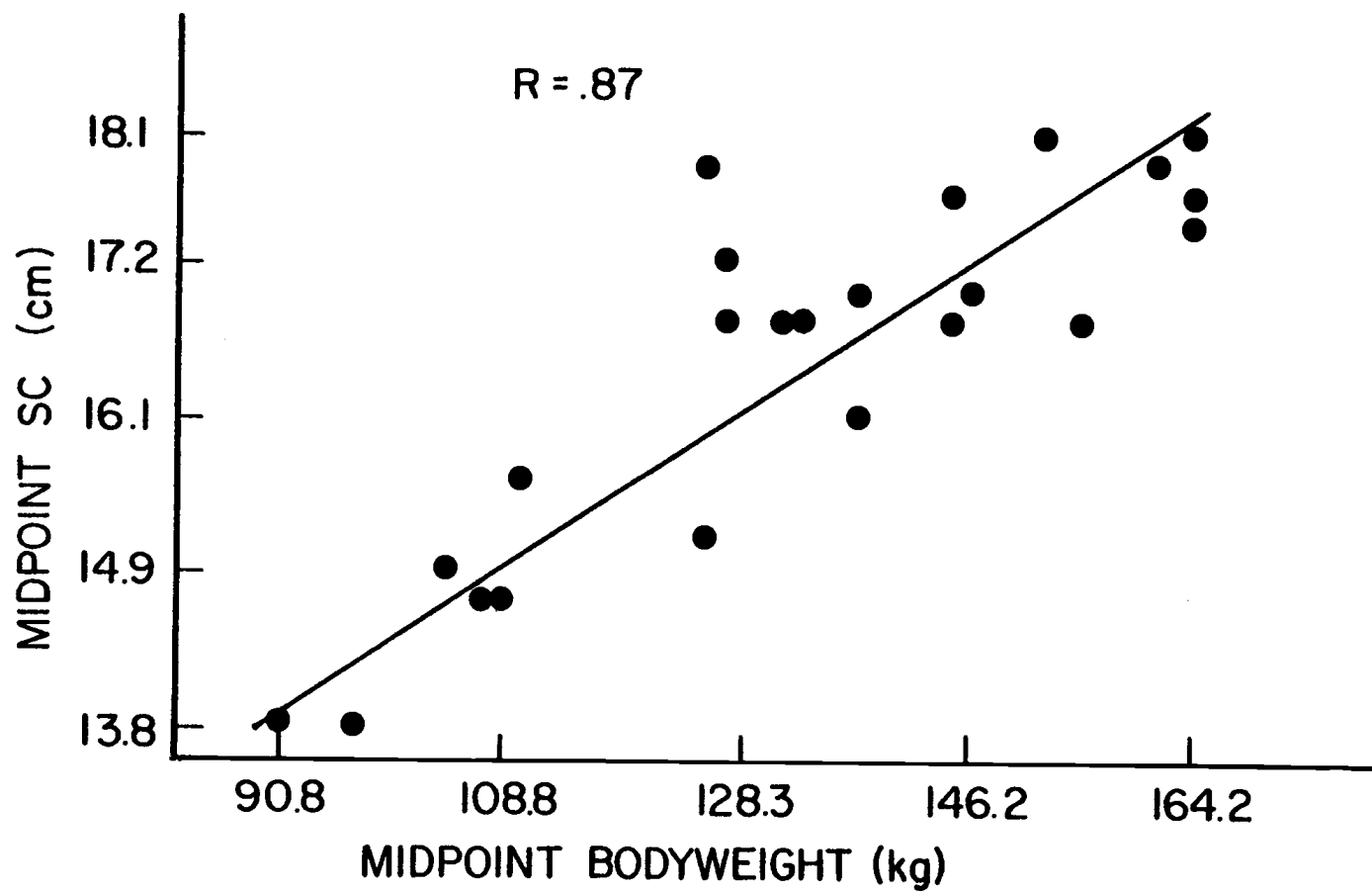


Figure 9. Regression of midpoint SC on midpoint body weight.

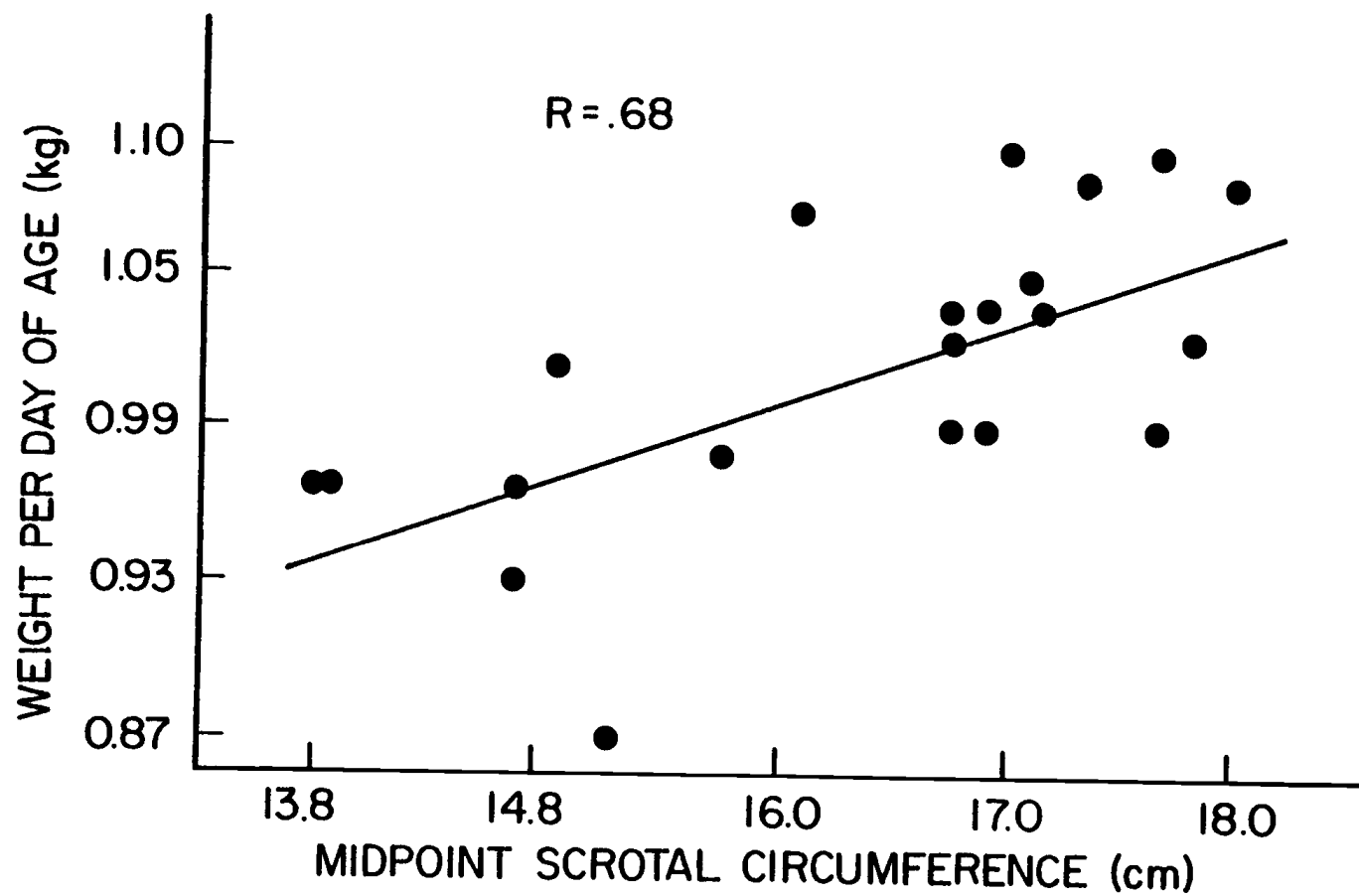


Figure 10. Regression of weight per day of age on midpoint SC.