THE ECONOMIC SIGNIFICANCE OF EXTRA RIBS IN PIGS

THESIS FOR THE DEGREE OF M. S.

Verne A. Freeman

1934

Swine

THE ECONOMIC SIGNIFICANCE

OF

EXTRA RIBS IN PIGS

THE ECONOMIC SIGNIFICANCE

OF

EXTRA RIBS IN PIGS

by,

Verne A. Freeman

THESIS

Submitted to the faculty of the Michigan State College in partial fulfillment of the requirements for the degree of Master of Science.

Department of Zoology
1934

ACKNOWLEDGEMENTS

The writer wishes to express his appreciation for the suggestions and constructive criticism offered by Doctor Harrison R. Hunt, Head of the Zoology Department, in planning the studies from which the data was secured and in arranging it for this thesis.

To Professor George A. Brown, Head of the Animal Husbandry Department, he is grateful for the timely suggestions and advice given throughout the study.

Acknowledgement of indebtedness is made to Professor Oren L. Snow, of the Physics Department and to Luther Lyndrup for assistance in the X-ray photography, and to Doctor Howard E. Johnson of the Anatomy Department for special assistance and instruction.

TABLE OF CONTENTS

INTRODUCTION

The evolution of hog breeding in the United States has developed several different types of hogs. The types have been changed, mainly for economic reasons, although swine type may be moulded so rapidly that there has been a tendency for some breeders to be guided by "whims and fancies" rather than adequate reasons. The early packing industry of this country demanded and paid a premium for large well-finished hogs and the leading breeders strove for great size. With the development of transportation facilities and refrigeration, the demand swung to lighter carcasses of good quality. The breeders emphasized early maturity and quality of fleshing with resulting marked deterioration of size and ruggedness. Reduced export demand for lard and domestic use of lard substitutes next developed a demand for hogs that would yield a higher per cent of lean meat cuts, and less lard. The leading breeders swung back to the big type. A decade ago you would see more advertisements of length and height of hogs than any other characteristics. While producers are still demanding size and length of body they are also asking for depth and feeding qualities and insist upon a so called "medium" or "meat type" hog and there has been a definite swing back away from the extreme large type.

The advantages claimed by breeders for length of body and large size in breeding hogs are enumerated by Vaughn (p.410).

"1. In farm herds which produce market hogs there is a tendency toward loss of size due to feeding corn too exclusively and also due in some cases to lack of proper care and management. .....

2. The cheapest gains are made during the growing period .....

3. It is true of all kinds of farm animals that the larger the breeding stock the longer the growing period

of the off-spring will be, and the more rapid will be the rate of increase in size during a given period. The pig from large parents makes more growth daily and monthly, and continues to grow for more months than does the pig from smaller stock.

4. The growthy type of pig is, therefore, "younger" at six months of age than the smaller type of pig. This is true because at six months the former has more days of growth ahead of him. As a rule the growthy pig is also younger than the smaller type pig at the same weight.

5. For these reasons the growthy pig makes his gains at somewhat lower costs, because the cheapest gains are made when animals are youngest.

6. If the breeding stock is of large size the pigs will be growthy, will gain rapidly, and will attain market weights in the shortest time.

7. Pigs marketed somewhat in advance of other pigs of the same age usually bring a better price than those marketed later at times of largest receipts.

8. The shorter the feeding period the less the risk and the less the labor cost of producing pork. The man who raises pigs of growthy type has them off to market while his neighbor who raises smaller hogs is still feeding them and still running the risk of loss from disease and other causes.

9. If the market slumps when hogs of the larger type are ready for market, they may be held on feed and will continue to make more efficient use of feed and larger gains than hogs of smaller type. ....."

Pork loins and pork bellies from choice butcher hogs are two of the most popular cuts from the American hog and are exceeded in value only by the ham. If the size of the ham can be maintained and the body lengthened without loss of depth, and the other parts of the carcass held in balance, the loin and belly would both be increased. Observations have shown that pigs do vary in their number of ribs and that extra ribs usually mean extra body vertebrae and are associated with longer bodied pigs.

A. M. Shaw (1929) reports the rib counts on a large number of

hogs of the popular breeds in America and smaller numbers of hogs from other countries. He found variation in the number of ribs in almost every breed. With some breeds the smaller number of ribs seem to predominate while with other breeds, particularly the bacon type breeds and those of longer and growthier type, the larger number of ribs occur more frequently. Wide variation frequently occurs between pigs of the same litter and is common to both sexes. The variations reported ranged from 13 to 17 pairs of ribs. He found no variation in the cervical or sacral vertebrae. The number of pairs of ribs varied with the number of thoracic vertebrae and occasionally there was variation in the lumbar vertebrae. It appears that the combined count of thoracic and lumbar vertebrae would be the factor determining the length of the body if the length of the body is affected by the number of body vertebrae.

A method of determining the variations in the vertebral column of the live pig by X-ray photograph was also described by Shaw (1930). He showed radiographs of the skeletons of pigs that would enable one to make an accurate record of the number of vertebrae in live pigs. Pictures of breeding sows were shown, one sow having 17 pairs of ribs and the other sow 14 pairs. There was a noticable difference in the length of body and type of the sows. He stated that through the use of radiographs quite large groups of pigs possessing the different vertebral variations had been selected for breeding purposes at the University of Saskatchewan farm, consisting mostly of purebred Yorkshires with some Tamworths and Berkshires.

No other literature seems to be available on this subject. The United States Department of Agriculture at Beltsville, Maryland Station, is working on variations in body vertebrae of pigs and some other stations have done some preliminary work on this subject. A communication from Dean A. M. Shaw suggested some evidence that the pigs with the larger number of

ribs and body vertebrae gain more rapidly and may make more economical use of their feed, also that breeding hogs with 16 pairs of ribs seemed to transmit more uniformity in number of ribs to their offspring than do the breeding hogs with either 15 or 14 pairs of ribs.

STUDY OF VERTEBRAL VARIATION IN THE MICHIGAN STATE COLLEGE SWINE HERD AND ON MICHIGAN FARMS

The question raised by Shaw (1929), "How Many Ribs Has A Pig?", suggests a second question, "How Many Ribs Should A Pig Have?" Plans were outlined to study the variation in the number of body vertebrae of the pigs in the Michigan State College swine herd and any economic importance that might be associated with the larger numbers. In the first part of the study skeletons were examined by dissecting all of the pigs that were still-born or that died soon after birth in the 1932 pig crop. The object was to determine the extent of variability found in the pigs of the five different breeds in the College herd. Do the variations occur any more frequently with one breed than with another, or with one sex than with the other?

A record of the sex and the dam of each pig examined was kept. The herd book also gives the sires. No observations were made cephalad to the first rib or caudad to the sacral arch, but the ribs and thoracic vertebrae were counted separately from the lumbar vertebrae. The examination was made by opening the pig laterally to the back-bone and exposing the skeleton sufficiently to identify the number of ribs and vertebrae. The thoracic vertebrae combined with the lumbar vertebrae are hereinafter spoken of as one group, at times, and called body vertebrae.

A total of 182 pigs were examined including 102 males and 80 females. The observations are summarized in Table I.

In the second part of the study examination of the live pig's skeleton was attempted by X-ray photographs. There were three possible objectives in this part of the study. The first one was to locate pigs of known vertebral structure to use in a feeding test. The second was to add to the information on variability of vertebral numbers in the College herd,

Table I
VARIATIONS IN BODY VERTEBRAE OF PIGS DISSECTED

Number of Vertebrae	Sex	Berkshire	Chester	Duroc	Poland	Yorkshire	Total
13 Thoracic and 6 Lumbar	M			1			1
	F						
14 Thoracic and 6 Lumbar	M		2	16		3	21
	F		1	13	1	2	17
14 Thoracic and 7 Lumbar	M				1	1	2
	F			1		1	2
15 Thoracic and 6 Lumbar	M	1	2	8	13	20	44
	F		3	7	6	20	36
15 Thoracic and 7 Lumbar	M			1	6	4	11
	F	1		1	4	1	7
16 Thoracic and 5 Lumbar	M					4	4
	F				1	4	5
16 Thoracic and 6 Lumbar	M	3	1	2	1	9	16
	F		1	2	1	8	12
16 Thoracic and 7 Lumbar	M		1		1	1	3
	F					1	1
Total		5	11	52	55	79	182

and the third was to secure stock of known rib and vertebral count for future breeding experiments.

Plans were made to use the X-ray machine in the Physics Department. Some repairs had to be made on it but this was arranged for by the Physics Department in order to make the equipment available for their laboratory use. The Department of Zoology purchased films and some added equipment essential for photographing the pigs and developing the films. Luther Lyndrup, a graduate student in Physics operated the X-ray machine and developed the films. The details of the photographic work, such as equipment used, holding the pigs, identifying the pictures, and how the machine was operated, is given on pages 33 to 35 of his thesis on "Studies in the Technique of X-ray Photography", submitted to the Michigan State College in 1932.

The pigs were given individual identification marks by the earnotch system regularly used with the College herd, and were transferred to the Physics laboratory for the X-ray. More than 200 animals were photographed although not the entire spring pig crop as had been planned, because the X-ray machine ceased functioning at the time that the pigs were at the best age. Many of the photographs were indistinct and had to be retaken. Even then some of them were discarded and an attempt was made to make use of only 172 for counting the vertebrae. When later results showed some of these observations to be inaccurate still more films that were not very distinct were discarded and the results of the counts from 137 of these pigs are shown in Table II.

These vertebra counts from the X-ray were combined with the observations from the pigs that were dissected. The combination of 15 thoracic vertebrae and 6 lumbar vertebrae occurred most often in the Chester White, Poland China, and Yorkshire breeds. The small sample of Berkshires showed a slightly larger number of pigs with 16 thoracic and 6 lumbar vertebrae

Table II
VARIATIONS IN BODY VERTEBRAE OF PIGS PHOTOGRAPHED BY X-RAY

Number of Vertebrae	Sex	Berkshire	Chester	Duroc	Poland	Yorkshire	Total
14 Thoracic and 6 Lumbar	M		1	3	1		5
	F			7		2	9
14 Thoracic and 7 Lumbar	M	1			1		2
	F		1	1	2	1	5
13 Thoracic and 5 Lumbar	M			1	1		2
	F		1				1
15 Thoracic and 6 Lumbar	M	6	10	6	11	14	47
	F	5	7	3	6	15	36
15 Thoracic and 7 Lumbar	M		1				1
	F	2		1	1		4
16 Thoracic and 5 Lumbar	M					3	3
	F			1			1
16 Thoracic and 6 Lumbar	M	6	1	1	1	4	13
	F	4			1	3	8
Total		24	22	24	25	42	137

and the Duroc Jerseys had a decidedly larger number of pigs with 14 thoracic and 6 lumbar vertebrae.

The different combinations that made the same total numbers of body vertebrae were grouped together from these studies. The occurrances of 19, 20, 21, 22 and 23 body vertebrae are shown for the different breeds and sexes in Table III. The same is shown by percentage distribution in Table IV. A graph showing the distribution by breeds is shown in Figure I, and by sexes in Figure II.

These data show a marked contrast in the frequency of 20 and 22 body vertebrae between the Duroc and Yorkshire breeds represented in the Michigan State College herd. One pig with 19 body vertebrae was found among the Durocs, 40 with 20 body vertebrae, and only 8 with 22 body vertebrae. No pigs of the Yorkshire breed were found with less than 20 body vertebrae and there were only 7 of these. There were 29 Yorkshires with 22 body vertebrae, and 2 with 23. While the Berkshire pigs showed the largest mean the number observed was small. There were 76 Durocs and 121 Yorkshires observed and the means of their number of body vertebrae show a significant difference. The Yorkshire mean was .66 larger than the Duroc with a standard error for difference of .096. There was no significant difference in the occurrance of the number of vertebrae found in the Yorkshire, Poland, and Chester pigs, nor between the two sexes.

Other variations that were observed showing intermediate conditions and suggesting a blending type of inheritance and probability of multiple factors were as follows: 1 Poland China sow with 15 pairs of ribs and thoracic vertebrae and 6 lumbar vertebrae had one short extra rib on her right side only. One Yorkshire sow with 16 thoracic vertebrae and 6 lumbar vertebrae had a similar small extra rib on the right side. One Yorkshire male with 16 thoracic vertebrae and 5 lumbar vertebrae and also one Yorkshire

Table III
DISTRIBUTION OF NUMBER OF BODY VERTEBRAE BY BREEDS
AND BY SEXES IN MICHIGAN STATE COLLEGE HERD*

Number of body vertebrae:	19	20	21	22	23	Total for breed	Mean and probable error
Berkshire			13	16		29	21.55 ± .06
Chester		5	23	4	1	33	21.03 ± .07
Duroc	1	40	27	8		76	20.55 ± .05
Poland		3	41	15	1	60	21.23 ± .05
Yorkshire		7	83	29	2	121	21.21 ± .03
Total	1	55	187	72	4	319	21.10 ± .03
Males	1	28	102	41	3	175	21.10 ± .04
Females		27	85	31	1	144	21.04 ± .04

*Data combined from pigs examined by dissection and by X-ray photograph.

Table IV
PERCENTAGE DISTRIBUTION OF NUMBER OF BODY VERTEBRAE BY BREEDS AND BY SEXES IN MICHIGAN STATE COLLEGE HERD

Number of body vertebrae:	19	20	21	22	23
Berkshire			44.8	55.2	
Chester		15.2	69.7	12.1	3.0
Duroc	1.3	52.6	35.5	10.5	
Poland		5.0	68.3	25.0	1.7
Yorkshire		5.8	68.6	24.0	1.6
Males	.6	16.0	58.3	23.4	1.7
Females		16.8	59.0	21.5	.7

Figure I
DISTRIBUTION OF NUMBER OF BODY VERTEBRA BY BREEDS
IN MICHIGAN STATE COLLEGE SWINE HERD

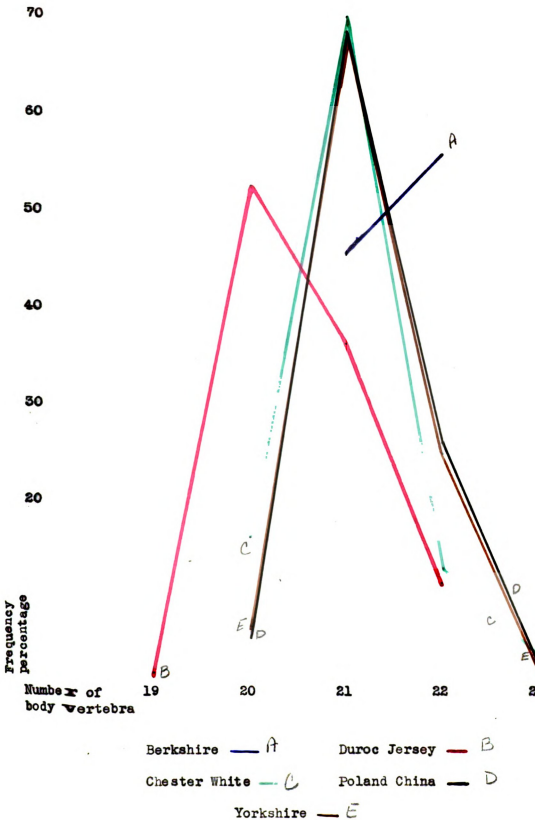
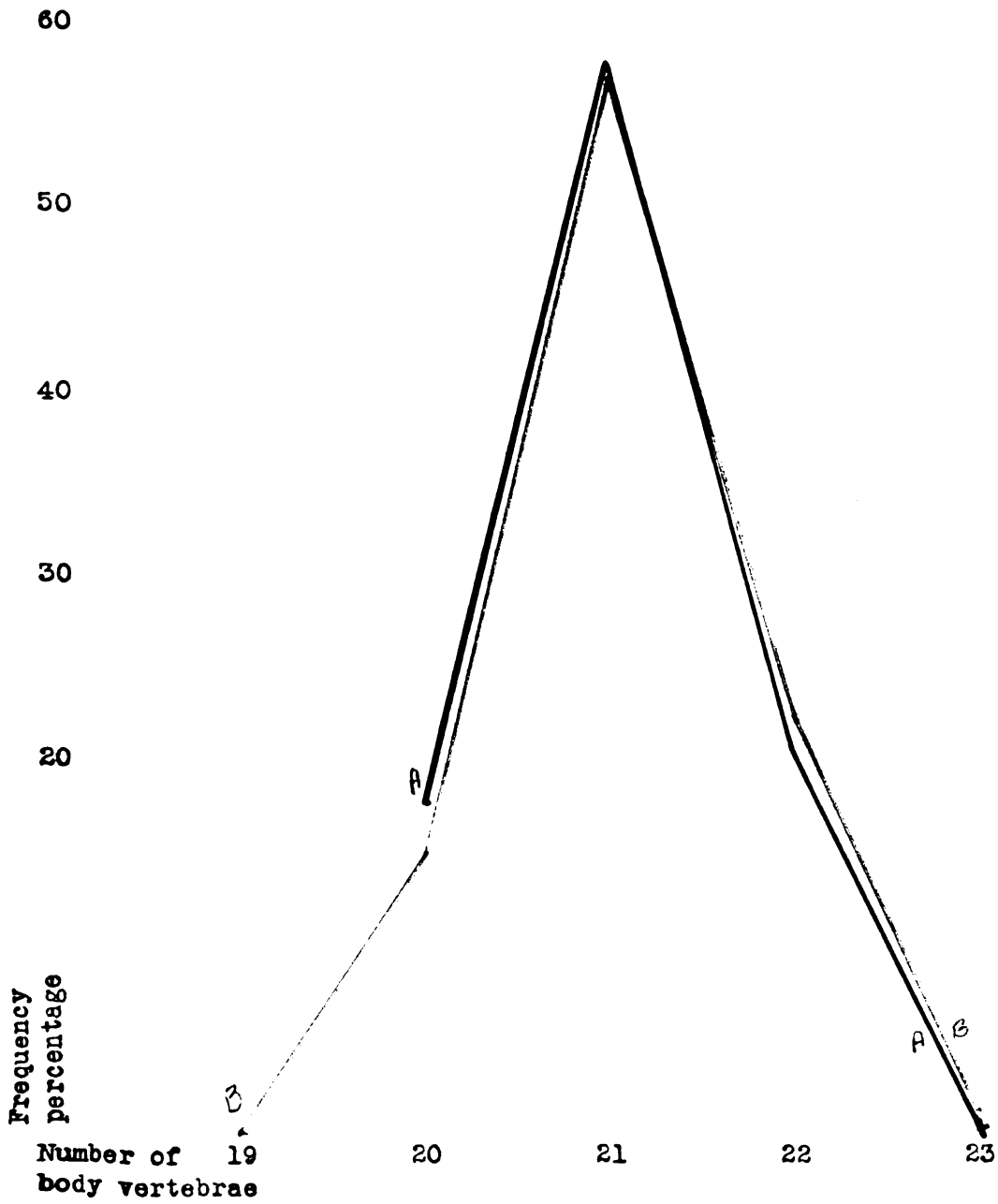
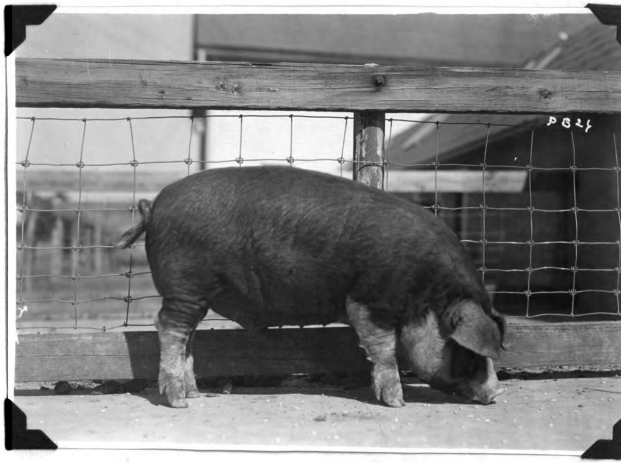
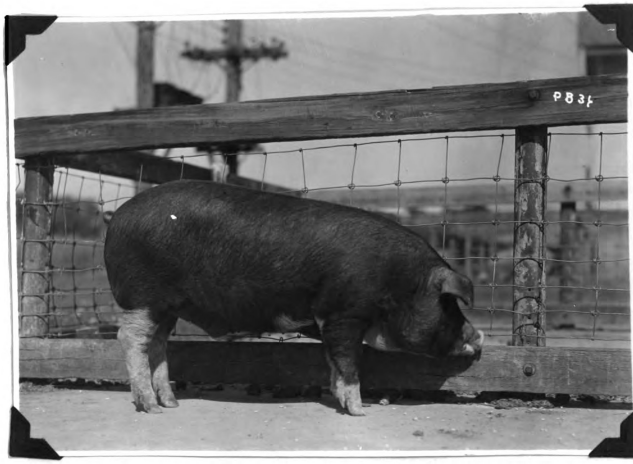


Figure II
DISTRIBUTION OF NUMBER OF BODY VERTEBRA BY SEXES
IN MICHIGAN STATE COLLEGE SWINE HERD

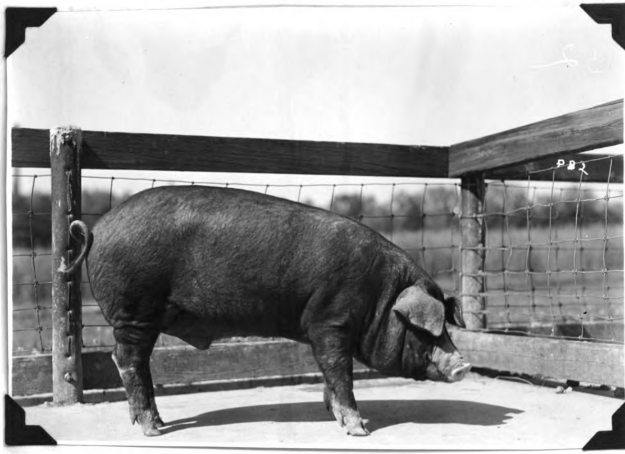




Poland barrow No.26 has fourteen thoracic vertebrae and six lumbar vertebrae.



Poland barrow No.36 is a litter mate to Poland barrow No.26 and has fifteen thoracic vertebrae and six lumbar vertebrae.



Poland barrow No.2 has fifteen thoracic vertebrae and seven lumbar vertebrae.

male with 16 thoracic and 6 lumbar vertebrae each had a short last rib on the right side and a normal full length rib on the left side. Four Yorkshire pigs, including two males and two females, and one Poland male had a last pair of ribs shorter than usual estimated at about one-half the average length, both ribs being about equal. One Yorkshire male pig had a last pair of ribs that were estimated at about three-fourths the usual length. No attempt was made to measure these ribs because the pigs varied in size from very slightly over one pound at birth to nearly four pounds at the time they were examined.

Marked variation was shown by pigs within the same litter as shown in Table V. The three litters represent the wider variations found and are one each of purebred Duroc Jersey, Poland China, and Chester White. A heterozygous condition of the parents of these litters is indicated, especially in the parents of the litter from Chester sow number 33.

A third part of the study of variations was made by counting the vertebrae in pork carcasses at the Rose-Vail Packing Company, located at Dewitt. Practically all of these hogs were purchased from farmers within 30 miles of the plant and excluding those counted which came from the College herd, it is believed that they represent a good random sample of the hogs that are being produced on central Michigan farms.

The object was to determine the extent of variation and to locate, if possible, some carcasses that would be suitable for measuring and making cutting records to supplement the data from the feeding and slaughtering studies. The plant was visited on the days that they made their larger kills, or the following day, so that a considerable number of carcasses could be observed in a few trips.

Counts were made on a total of 342 carcasses, including 107 coming from the Michigan State College herd. No attempt was made to classify

Table V
VARIATION IN VERTEBRAE OF PIGS FROM SAME LITTER

Number of Vertebrae	Sex	Litter of Duroc sow No.1	Litter of Poland sow No. 5	Litter of Chester sow No. 33
14 Thoracic) and 6 Lumbar)	M	5		2
	F	4	1	1
14 Thoracic) and 7 Lumbar)	M			
	F		1	
15 Thoracic) and 6 Lumbar)	M	2	5	2
	F	2		1
15 Thoracic) and 7 Lumbar)	M	1	2	1
	F		1	
16 Thoracic) and 6 Lumbar)	M		2	2
	F			1
17 Thoracic) and 7 Lumbar)	M			1
	F			
Total		14	12	11

these carcasses by sex or breed, and only the total number of body vertebrae were counted. The results of the counts are shown in Table VI.

Only carcasses showing 20, 21, or 22 body vertebrae were found. There was a significant difference in the number of carcasses with 20 and 22 body vertebrae found among the carcasses from farms and those from the College herd. Thirty-four per cent of the farmer's hog carcasses had 20 body vertebrae as compared with only 7½ per cent of the carcasses from the Michigan State College. Less than nine per cent of the farm carcasses had 22 body vertebrae as compared with 27 per cent of the College carcasses. There was a significant difference of .445 in the mean number of vertebrae of the two groups with a standard error of difference of only .066. Expressed in terms of probable error the difference in the means is .445 ± .045. The difference is nearly 10 times its probable error and the mathematical odds that a real difference exists are almost 65,000,000,000 to 1.

No attempt had been made to select breeding stock in the College herd with a larger number of body vertebrae, as there were no records of the number of vertebrae in the breeding herd. However, it appears that the College herd may have been more carefully selected for the present day approved type and that the selection for relatively long growthy hogs had resulted in a line of breeding showing a tendency toward the larger number of body vertebrae. Some evidence that the form is modified by the number of body vertebrae is shown by the pictures on pages 14 to 16. These pictures were taken a few days before slaughter. The vertebrae were counted in their carcasses.

Table VI
BODY VERTEBRAE IN CARCASSES EXAMINED AT DEWITT

Number of body vertebrae	20	21	22	Total	Mean and probable error
Carcasses from farms	80	134	21	235	20.749 ± .027
Percentage distribution	34.04	57.02	8.94		
Carcasses from Michigan State College	8	70	29	107	21.196 ± .036
Percentage distribution	7.48	65.42	27.1		
Difference of means					.447 ± .045

FEEDING EXPERIMENT

The object of the feeding experiment was to determine whether longer bodied pigs or pigs with extra ribs and body vertebrae would grow faster or more economically than ordinary pigs. The pigs used in the feeding test could be dressed at uniform weights and used for a carcass study.

Two lots were selected so that they would represent as much variation in number of ribs and number of body vertebrae as it was possible to secure from the pigs photographed by X-ray. These pigs were selected by pairs with both pigs of the pair having similar breeding, but one of the pair having one or more body vertebrae more than the other. The pairs of pigs were selected as near equal as possible for thrift. There were three males and five females in Lot 1 and four of each sex in Lot 2. The pigs starting Lot 1 averaged 76 days old compared with 71 days for Lot 2. The Lot 1 pigs averaged 42.6 pounds at the start compared with 44.4 for Lot 2.

A good ration similar to what the pigs had been receiving was fed both lots. Self-feeders were used so as to give the pigs every opportunity to feed heavily and gain at their full capacity.

The pigs were selected from a total of 172 with fairly good X-ray photographs. They were produced in the breeding herd at the Michigan State College. Every effort was made to raise them under sanitary conditions so that treatment for round-worms would be unnecessary. They were immunized from Hog Cholera by double treatment while they were still nursing their mothers. They appeared healthy and thrifty at the beginning of the experiment. Eight pairs were selected for the two lots. Ten of the pigs were started on feed June 7, and two other pairs were started June 21, soon after weaning. The youngest pair started July 5. One of the later pigs became unthrifty and died July 30. The pig that was paired against him was

taken out of the experiment August 2, which was the next weigh-day for the lot. A third pig became unthrifty and was removed from Lot 1 September 13. The remaining 13 pigs were carried through the feeding test.

The animals were weighed individually three days in succession at the beginning of the experiment and the average of these was taken as the initial weight. The pigs were started on feed the second day they were weighed. They were weighed as a lot at intervals of 14 days. Individual weights were taken every 28 days. When they approached 200 pounds they were weighed individually for three days in succession and the average was used as the final weight.. They were taken out of the lot the second day of their final weight, but were kept on the same ration thus giving them a uniform "fill" as compared with the other days. Weights were taken about the middle of the forenoon.

The pigs were given a uniform daily allowance of buttermilk. The other feeds used were weighed when placed in the feeder and a record kept of all feed added. An estimate of the feed left in the feeder was made each 28 days and any time that a pig was removed from a lot the feed was weighed back to give a basis for estimating the feed consumed by the pig taken out. At the close of the experiment the feed left in the feeder was weighed out. The feed consumed by each lot was computed for any desired period between weighing dates by deducting the feed left at the end of the period from the total amount added and in the feeder at the beginning.

Both lots were fed in adjacent rape pastures. Artifical shade was provided and the pigs had a portable cot to sleep in when they chose. Water was provided in self-waterers and both lots were fed at the same type of self-feeders. A mineral mixture of equal parts of steamed-feeding bone meal, fine ground limestone, and salt was kept before both lots. The amounts of mineral consumed by either lot was so small that it could not

be accurately weighed. More of the mineral was thrown out from becoming wet and dirty than was consumed by the pigs. Shelled corn and tankage were fed in separate compartments throughout the experiment. A small amount of ground wheat was fed in a separate compartment at the beginning. The wheat was used to avoid a violent change in the ration because the pigs had been receiving wheat in their feed mixture before weaning. Buttermilk was trough-fed at the rate of 8 pounds per pig daily.

It was necessary to estimate the feed that had been consumed by pigs taken out of the experiment so as to deduct it from the total feed consumed by each lot. The same method was used that the Michigan Experiment Station has been using in recent years for estimating the feed consumed by pigs removed from an experiment. The total feed consumed by the lot for the period, which had included the pig, was divided by the number of pigs and 40 per cent of this amount deducted for the maintenance of the pig. The total amounts of feed consumed by the lot were then divided by the number of pounds of gain made by the whole lot during the period. Sixty per cent of this amount was considered the amount of feed more than the estimated maintenance used for each pound of gain. In the case of a pig which had weighed more at the last individual weighing than he did at the time he was removed from the experiment, the feed required for gain was based on the heaviest weight that was recorded for him. These estimates of feed for the maintenance and gain for any pig removed from the experiment are added together and deducted from the total feed charged to the entire lot.

The method is illustrated by the corn deducted for Chester barrow 12 removed from Lot 2. During the period which he was fed with the lot of 8 pigs they consumed 560 pounds of corn and gained 321.7 pounds. Chester barrow 12 gained only 21.7 pounds.

560 divided by 8 equals 70 pounds (an average pig's share).

70 multiplied by 40 per cent equals 28 pounds (corn estimated for maintenance of one pig)

560 pounds divided by 321.7 equals 1.74 pounds (average corn consumed per pound of gain)

1.74 multiplied by 60 per cent equals 1.046 pounds (estimated corn above maintenance for each pound of gain)

1.046 multiplied by 21.7 (gain of C.B.12) equals 22.7 pounds (estimated corn consumed by C.B.12 for gain)

28 plus 22.7 equals 50.7 pounds (total corn estimated that C.B.12 consumed).

When a lot of pigs are fed together there is no method by which the exact amount of feed consumed by any one pig may be accurately estimated. In some cases where limited rations have been fed in comparison with full feeding at the Michigan Experiment Station, it appeared that approximately 40 per cent of the full fed ration was used for maintenance. While the accuracy of this method is open to question it is more nearly correct than to deduct an average pig's share of the total feed if the pig removed has been unthrifty and failed to gain long enough to justify his removal from the experiment. The feed deducted for the pigs taken out of the experiment is shown in Table VII.

The results of the feeding experiment are given in Table VIII. The pigs with 20 body vertebrae of Lot 1 made an average daily gain of 1.29 pounds as compared with 1.35 pounds for Lot 2, the pigs with the larger number of body vertebrae. While this difference of .06 of a pound was in favor of the pigs with the extra vertebrae, the difference is too small and the number of pigs not large enough to indicate any significant superiority for the pigs with extra vertebrae.

There was no indication from the feed consumed per hundredweight

Table VII
FEED DEDUCTED FOR PIGS REMOVED FROM FEEDING TEST

Lot I

B. B. 13	Corn	Wheat	Tankage	Buttermilk
Maintenance (July 5,1932 to Sept. 13,1932)	86.1	2.0	.8	224.0
Grain of 30 lbs.	47.2	1.3	.4	125.1
C. S. 22				
Maintenance (June 21,1932 to Aug. 2,1932)	27.0	6.6	.3	131.2
Grain of 32.7 lbs.	34.7	7.9	.4	165.[illegible]
Total for Lot I	195.0	17.8	1.9	645.8

Lot II

C. B. 12				
Maintenance (June 21,1932 to July 30,1932)	28.0	6.4	.2	121.6
Grain of 21.7 lbs.	22.7	5.1	.2	98.4
Total for Lot II	50.7	11.5	.4	220.0

The method of estimating the above feed is given on page 23.

Table VIII
RESULTS OF FEEDING TEST

Twenty Body Vertebrae vs Twenty-One
(June 7, 1932 to November 28, 1932)

	Lot I*	Lot II**
Number of pigs	6	7
Total pig days	746	822
Average initial weight	42.55	44.43
Average final weight	203.5	203.24
Average daily gain	1.29	1.35
Total feed consumed:		
Shelled corn	2470.	2940.
Ground wheat	133.	135.
Tankage	32.	28.
Buttermilk	6101.	6552.
Average daily ration:		
Shelled corn	3.31	3.58
Ground wheat	.18	.16
Tankage	.043	.034
Buttermilk	8.18	7.97
Feed consumed per cwt. gain:		
Shelled corn	255.8	264.5
Ground wheat	13.8	12.1
Tankage	3.3	2.5
Buttermilk (4 by 7)	90.3	84.2
Total	363.2	363.3

* Lot 1 included: four pigs with 20 body vertebrae,
one pig with 21 body vertebrae,
one pig with 22 body vertebrae,

** Lot 2 included: four pigs with 21 body vertebrae,
three pigs with 22 body vertebrae.

gain that either lot was more efficient. On account of the pigs taken out of the experiment and the consequent deduction of feed, there was a slight difference in the proportion of buttermilk fed the two lots. If instead of adding in the total amount of milk, the pounds of milk fed each lot is divided by 7 to reduce it to the probable equivalent of concentrates that it might replace, the total feed consumed would amount to 363.2 pounds for Lot 1, and 363.3 for Lot 2. The pigs in Lot 2 ate a slightly larger average daily ration and gained slightly faster but it is not probable that two check lots on the same ration would have been closer together in feeding results obtained. These results are in accord with the findings of Carroll (p.364) that "type in swine is not a controlling factor in either rate or economy of gain."

SLAUGHTER STUDY

The object of the slaughter test was to determine, if possible, any difference in the size of the vital organs or the yield of the wholesale cuts of pork attributable to the difference in the number of ribs and body vertebrae. These slaughter tests gave an opportunity to check the accuracy of the observations of the number of ribs and body vertebrae made through the X-ray photographs. Some of these photographs were not very distinct, but were believed to be reasonably accurate. Six of the observations did not prove to be correct.

As fast as the individuals of either lot in the feeding experiment reached an approximate weight of 200 pounds they were removed from the experiment and slaughtered in groups of one to three. The hogs were given their usual feed up until 5:30 of the night previous to slaughtering. They were killed the following forenoon, and weighed before bleeding, after bleeding, and after scraping. Also the hot dressed carcasses and the cold dressed carcasses were weighed. These weights are shown in Table IX.

An attempt was made to note any possible difference in the anatomy between the two lots, such as the location of the diaphragm. Each internal organ was weighed to the nearest gram. The stomach, small intestine, and large intestine were weighed both before and after cleaning. The volume of each organ was measured by water displacement through the use of a ten gallon can having an outlet so that the surplus water could be caught and measured. The can was filled to the outlet before immersing the organ and the water that ran off after immersion was measured to give the volume.

Weights and measurements of organs were taken for all 13 of the hogs slaughtered. After finding there were only five pairs in the two lots that actually had a difference within the pair for number of vertebrae,

Table IX
SLAUGHTER DATA
(pounds)

Lot I

Pig Identification	Live weight	Weight after bleeding	Weight after scraping	Hot dressed weight*	Cold dressed weight*	Dressing percentage (cold)
D.S.41	197	190	187.5	154	148	75.13
D.S.17	197.5	191	189	158	154.5	78.23
D.S.11	197	189.5	187.5	159	155.5	78.93
D.B. 4	194	187	185.5	152	147	75.77
P.S.12	196	189	185.5	155	148	75.51
B.S.22	194	187	185	155	146	75.26
Average	195.9				149.8	76.48

Lot II

D.B.16	198	192	190	159.5	152	76.77
B.B.37	184	177	175	147	144	78.26
B.S.36	202	195	193	163	156	77.23
B.B. 7	197	191	188.5	157	151	76.65
P.S. 3	191	184	181.5	156.5	151	79.06
B.S.12	198.5	189	187	157.5	152.5	76.85
B.S. 3	195.5	188.5	187	156	153	78.26
Average	195.1				151.4	77.56

*Dressed shipper style but leaf fat and kidney removed.

only the data from these five for each lot are included in the tables. The data from the pigs out of Lot 1 included four Durocs having 20 vertebrae each and one Poland with 21. From Lot 2 it included four Durocs with 21 body vertebrae each and one Poland with 22.

The weights of the organs are shown in Table X and the volume in Table XI. Great variation was observed between individuals of the same lot compared with the small difference between the averages of the two lots. For instance, in Lot 2 the liver from D.B.7 weighed only 1344 grams compared with 1734 grams for D.B.16. In Lot 1 Duroc barrow number 4 had the smallest heart, weighing only 292 grams, but he also had the largest lungs, weighing 1027 grams. Duroc sow number 41 had next to the largest heart in this lot weighing 327 grams, but the smallest lungs, weighing only 514 grams, or just half as much as the lungs from Duroc barrow number 4. Whether the larger heart was due to the small lungs, and the necessity for it to produce greater blood pressure that the smaller lungs might do their work can only be guessed. Most of the internal organs were smaller in the hogs of Lot 2, both in weight and volume as measured by the water displacement, but the differences in the means were not large. Due to the small number of animals in the slaughter study no conclusions could be drawn from the results.

A further reason for formulating no conclusions from these results was the small difference in the number of ribs and body vertebrae between the two lots. This was due to incorrect observations from the X-ray photographs when selecting the pigs for the feeding experiment. One of the pigs in Lot 1, Berkshire sow number 22, was supposed to have 16 thoracic vertebrae and 5 lumbar vertebrae, but proved to have 6 lumbar vertebrae. Either one of the Berkshires in Lot 2 could have been paired against her. Berkshire sow number 12 was supposed to have 16 thoracic vertebrae and 7 lumbar. She proved to have the 7 lumbar vertebrae, but had only 15 thoracic

Table X
WEIGHT OF ORGANS
(grams)
Lot I - Twenty and Twenty-one Vertebrae

	D.S.41	D.S.17	D.S.11	D.B. 4	P.S.12 *	Total	Mean
Heart	327	310	380	292	300	1609	321.8
Lungs	514	679	789	1027	690	3699	739.8
Liver	1495	1648	1823	2052	1572	8590	1718
Pancreas	176	126	150	148	133	733	146.6
Right kidney	124	156	138	125	119	662	132.4
Left kidney	135	144	181	119	126	705	141
Stomach (before cleaning)	1080	849	767	986	975	4657	931.4
Stomach (after cleaning)	679	659	706	654	670	3348	669.6
Small intestines (before cleaning)	2026	1943	1761	2300	1972	10002	2000.4
Small intestines (after cleaning)	1422	1412	1278	1216	1066	6394	1278.8
Large intestines (before cleaning)	4067	2842	2622	3148	3507	16186	3237.2
Large intestines (after cleaning)	1647	1711	1565	1696	1233	7852	1570.4
Spleen	156	153	123	117	169	718	143.6
Tongue	260	204	333	221	256	1274	254.8
Mesentery and intestinal fat	2552	1427	1344	1606	1093	8022	1604.4
Gall bladder	48	71	85	broken	18	222	55.5

* Had twentyone vertebrae.

Table X Continued
WEIGHT OF ORGANS
(grams)
Lot II - Twenty-one and Twenty-two Vertebrae

	P.B.16	D.B.37	D.S.36	D.B. 7	P.S. 3*	Total	Mean
Heart	309	389	348	294	275	1555	311
Lungs	652	818	713	964	602	3749	749.8
Liver	1734	1367	1446	1344	1669	7560	1512
Pancreas	213	116	190	177	168	864	172.8
Right Kidney	136	147	122	120	119	644	128.8
Left Kidney	139	177	114	118	113	661	132.2
Stomach (before cleaning)	847	893	865	825	662	4090	818
Stomach (after cleaning)	674	584	598	587	563	3006	601.2
Small intestines (before cleaning)	2095	1681	1777	1576	1762	8891	1778.2
Small intestines (after cleaning)	1502	1279	1282	1267	1137	6467	1293.4
Large intestines (before cleaning)	3718	2545	2913	3090	2745	14811	2962.2
Large intestines (after cleaning)	1772	1488	1486	1601	1402	7749	1549.8
Spleen	113	167	123	213	152	768	153.6
Tongue	253	191	194	292	236	1166	233.2
Mesentery and intestinal fat	1505	1085	1424	1811	1010	6775	1355
Gall bladder	62	76	out	54	27	219	54.8

*Had twenty-two vertebrae.

Table XI
VOLUME OF INTERNAL ORGANS*

Lot I - Twenty and Twenty-one Vertebrae

	D.S.41	D.S.17	D.S.11	D.B. 4	P.S.12**	Total	Mean
Heart	310	295	348	284	289	1526	305.2
Lungs	1282	1400	1695	1993	1436	7746	1549.2
Liver	1380	1565	1534	1922	1464	7865	1573
Pancreas	176	140	148	144	132	740	148
Right kidney	122	150	136	125	112	645	128.6
Left kidney	133	134	174	117	117	675	135
Stomach (before cleaning)	1694	1246	1870	1684	2824	9268	1853.6
Stomach (after cleaning)	658	670	686	614	678	3306	661.2
Small intestines (before cleaning)	2650	2130	2052	2787	2200	11759	2351.8
Small intestines (after cleaning)	1556	1390	1210	1165	1006	6127	1225.4
Large intestines (before cleaning)	4495	4552	4145	3979	3755	20726	4145.2
Large intestines (after cleaning)	1596	1690	1540	1666	1214	7706	1541.2
Spleen	147	148	120	136	149	700	140
Tongue	254	185	326	217	241	1223	244.6
Gall bladder	48	68	82	broken	17	215	53.8

*Volume was measured in cubic centimeters by water displacement.

** Had Twenty-one vertebrae.

Table XI Continued
VOLUME OF INTERNAL ORGANS*

Lot II - Twenty-one and Twenty-two Vertebrae

	D.B.16	D.B.37	D.S.36	D.B. 7	P.S. 3**	Total	Mean
Heart	294	308	337	269	258	1366	273.2
Lungs	1440	1256	1623	1536	1600	7455	1491
Liver	1565	1296	1358	1267	1570	7056	1411.2
Pancreas	211	120	190	182	172	875	175
Right kidney	151	142	116	107	116.	612	122.4
Left kidney	125	157	111	108	112	613	122.6
Stomach (before cleaning)	1398	1244	2457	2312	1220	8631	1726.2
Stomach (after cleaning)	630	555	576	576	582	2919	583.8
Small intestines (before cleaning)	2742	1780	2032	1812	2096	10462	2092.4
Small intestines (after cleaning)	1455	1260	1287	1220	1072	6234	1246.8
Large intestines (before cleaning)	4955	3150	3395	4175	4054	19707	3941.4
Large intestines (after cleaning)	1760	1490	1472	1565	1337	7624	1524.8
Spleen	126	146	113	201	131	717	143.4
Tongue	240	180	181	281	255	1117	223.4
Gall bladder	60	68	(cut)	52	27	207	51.8

*Volume was measured in cubic centimeters by water displacement.
**Had twenty-two vertebrae.

vertebrae. Berkshire sow number 3 was supposed to have 16 thoracic vertebrae and 7 lumbar, she had the 16 thoracic vertebrae, but only 6 lumbar. Poland sow number 3 of Lot 2 was supposed to have 16 thoracic vertebrae and 7 lumbar vertebrae but proved to have only 6 lumbar vertebrae. Duroc barrow number 16 was supposed to have 16 thoracic vertebrae and 6 lumbar, but proved to have 15 thoracic vertebrae. Duroc sow number 36 was supposed to have 15 thoracic vertebrae and 7 lumbar, but proved to have only 14 thoracic vertebrae. This left only 7 pigs on which no errors had been made, but left 5 pairs with a difference of one vertebra between the 2 pigs of each pair.

A second examination of the X-ray films was made to see if it were possible to determine why these errors were made. One of them was due to an indistinct film. Another was due, apparently, to the pig having moved during the X-ray exposure. The others were due to photographing too late for getting the whole pig on one film, and attempting to picture part of the body at a time. In these cases the vertebraewere counted from the front rib to the last rib on one film, and from the last rib to the last lumbar vertebra on another. Sometimes the outlines of the ribs were indistinct and there was danger of the last rib not showing on the film for the caudad part of the body. In this case the last thoracic vertebra was accidentally counted with the lumbar vertebrae. The best results were obtained when the pigs were two to three weeks old.

In measuring the length of the thoracic cavity as shown by the dorsal and ventral attachments of the diaphragm, it was observed that the attachment at the breast was always adjacent to the ventral end of the sixth rib. The dorsal attachment varied slightly with the pigs of different numbers of ribs. In the case of the pigs with 14 pairs of ribs the diaphragm was attached at the base of the last rib. In pigs with 15 and 16

Table XII
MEASUREMENTS OF ABDOMINAL CAVITIES
(millimeters)

Lot I - Twenty and Twenty-one Vertebrae

	D.S.41	D.S.17	D.S.11	D.B. 4	P.S.12*	Mean
Length of thoracic vertebra	414	448	442	423	403	426
Length of lumbar vertebra	234	240	239	230	260	240.6
Length:**						
at back	415	427	430	406	387	413
at breast	205	210	220	208	214	211.4
Length:‡**						
at back	338	415	365	358	372	369.6
at breast	573	625	597	552	545	578.4

Lot II - Twenty-one and Twenty-two Vertebrae

	D.B.16	D.B.37	D.B. 7	D.S.36	P.S. 3‡‡	Mean
Length of thoracic vertebra	469	454	470	423	466	456.4
Length of lumbar vertebra	236	220	234	269	222	236.2
Length:**						
at back	412	422	424	406	390	410.8
at breast	210	210	222	217	220	215.8
Length:‡**						
at back	388	350	383	380	381	376.4
at breast	626	548	585	585	590	586.8

* Had twenty-one vertebrae.

** Measurement was taken from the anterior edge of first rib to the anterior side of the end of the diaphragm.

‡** Measurement was taken from the aitch bone to anterior side of the end of the diaphragm. The aitch bone is the ischio-pubic symphysis.

‡‡ Had twenty-two vertebrae.

pairs of ribs it was sometimes attached between the 14th and 15th ribs and sometimes at the level of the base of the 15th rib. But in no case with any of this group was it attached caudad to the 15th rib. The measurements for these cavities are shown in Table XII. The length of the thoracic cavities as measured from the anterior margin of the first rib to either dorsal or ventral attachment of the diaphragm was strikingly similar in the two lots. The same was true of their abdominal cavities. There was less variation between the two lots in these respects than in the length of the thoracic and lumbar vertebral columns.

CARCASS STUDIES

The object of the carcass studies was to determine whether there was any difference in the value of carcasses of pigs with varying numbers of body vertebrae as shown by a system of carcass measurements, or by actual cutting record of the carcasses into wholesale cuts. The carcass measurements used were worked out by the United States Department of Agriculture, Bureau of Animal Industry, and published on a mimeographed sheet entitled "Method For Measuring Hog Carcasses". The directions are as follows:-

"No.1 - Length of head - from the snout (between nostrils) to the tip of the Atlas joint (occipito-atloid articulation) (Use calipers).

No.2 - Length of neck - from the base of the Atlas joint to the anterior aspect of the first thoracic vertebra.

No.3 - Length of carcass - from the anterior edge of the first rib to the lowest point (as the carcass hangs on the hook) of the aitch bone.

No.4 - Length of leg - from the lowest point of aitch bone to the coronary band of the hind foot.

Depth of Carcass

No.5 - At the seventh thoracic vertebra measure the thickness of the back fat (exclusive of the skin).

No.6 - At the seventh thoracic vertebra measure the distance from the lower margin of the back fat to the upper edge of the spinal canal.

No.7 - At the seventh thoracic vertebra measure the distance from the upper edge of the spinal canal to the lower edge of the split breast bone.

Thickness of Back Fat (exclusive of skin)

No.8 - At the first thoracic vertebra.

No.9 - Count from the last lumbar vertebra to a point 7 vertebra lower as the carcass hangs (include last lumbar vertebra in count). At this point measure the thickness of back fat.

No.10 - Count from last lumbar vertebra to a point 3½ vertebra lower as the carcass hangs (include last lumbar vertebra in count). At this point measure the thickness of back fat.

No.11 - At the last lumbar vertebra measure the thickness of back fat.

No.12 - Measure the circumference of the right front leg at the point of least circumference between knee and pastern joints.

No.13 - Width through shoulders. From inside of carcass at first thoracic vertebra to outside of shoulder on a line parallel with the floor. Measure both sides of carcass. (Use calipers).

No.14 - Width through hams. From the top point of the aitch bone to the outside of the ham on a line parallel to the floor. Measure both sides of carcass. (Use calipers).

No.15 - Measure from the lowest point of the aitch bone to the center of the inside of the hock joint. The point of the hock joint to which this measurement should be taken is at a bony projection which may be felt under the skin of the leg.

No.16 - Plumpness of ham. Using one-half of measurement No. 15 locate 3 or 4 points on ham equidistant from plane through center of hock joint. It is best to mark these points with sharp skewers. Measure circumference of ham, encircling with steel tape immediately below skewers.

All measurements are taken in millimeters and with carcass hanging from hook in normal position. "

The measurements for the 13 carcasses from the feeding experiment are grouped according to the number of body vertebrae and are shown in Table XIII. The means for each measurement were computed for each group, but standard deviation and probable error were not computed on account of the numbers being so small. Most of the measurements are very similar for the different groups. The length of the carcass did show an increase for the

Table XIII
CARCASS MEASUREMENTS*

Twenty Body Vertebrae Carcasses

Measurement	D.S.41	D.S.17	D.S.11	D.B. 4	Mean
Length of head (No.1)	278	272	280	289	279.8
Length of neck (No.2)	160	170	175	164	167.3
Length of body (No.3)	754	805	698	753	752.5
Length of leg (No.4)	558	587	585	567	574.3
Depth of body (Total of Nos.5,6, and 7)	320	311	295	308	308.5
Thickness of fat (Av. of Nos. 5,8,9,10 and 11)	40	39	34	37	37.5
Circumference of leg (No.12)	138	144	148	147	144.3
Width through shoulders (No.13)	142	133	137	130	135.5
Width through hams (No.14)	144	134	142	141	140.3
Aitch bone to hock (No.15)	360	371	361	370	365.5
Plumpness of ham (No.16)	463	448	470	442	455.8
Total length of body vertebrae	652	688	678	648	666.5

*Carcasses from hogs in feeding experiment. Measurements in millimeters.

Table XIII Continued
CARCASS MEASUREMENTS*

Twenty-one Body Vertebrae Carcasses

Measurement	P.S.12	D.B.16	D.B.37	D.S.36	D.B. 7	Mean
Length of head (No.1)	282	279	263	232	300	271.2
Length of neck (No.2)	154	182	171	161	161	165.8
Length of body (No.3)	742	805	760	777	801	777.
Length of leg (No.4)	565	574	564	559	594	571.2
Depth of body (Total of Nos.5,6, and 7)	331	308	306	332	318	319
Thickness of fat (Av. of Nos.5,8,9, 10 and 11)	31	41	35	45	34	37.2
Circumference of leg (No.12)	138	141	146	133	143	140.2
Width through shoulders (No.13)	137	133	135	141	138	136.8
Width through hams (No.14)	149	123	138	141	137	137.6
Aitch bone to hock (No.15)	365	355	352	351	376	359.8
Plumpness of ham (No.16)	502	422	453	479	445	460.2
Total length of body vertebrae	662	709	682	687	713	690.6

*Carcasses from hogs in feeding experiment. Measurements in millimeters.

Table XIII Continued
CARCASS MEASUREMENTS*

Twenty-two Body Vertebrae Carcasses

Measurement	P.S.3	B.S.22	B.S.12	B.S.3	Mean
Length of head (No.1)	297	256	265	263	270.3
Length of neck (No.2)	167	162	155	157	160.3
Length of body (No.3)	782	783	801	787	788.3
Length of leg (No.4)	575	526	534	530	541.3
Depth of body (Total of Nos.5,6 and 7)	309	309	298	308	306
Thickness of fat (Av.of Nos.5,8,9,10 and 11)	38	32	32	34	34
Circumference of leg (No.12)	146	144	145	158	148.3
Width through shoulders (No.13)	139	144	136	142	140.3
Width through hams (No.14)	144	140	140	141	141.3
Aitch bone to hock (No.15)	360	345	356	338	349.8
Plumpness of ham (No.16)	474	462	471	473	470.
Total length of body vertebrae	697	705	717	692	702.8

*Carcasses from hogs in feeding experiment. Measurements in millimeters.

group with the larger number of vertebrae. The 20 vertebrae carcasses averaged 752.5 millimeters, the 21 vertebrae group averaged 777 millimeters, and the 22 group averaged 788.3 millimeters. Between the first and third groups an increase of ten per cent in body vertebra increased the length of body less than five per cent. The length of the leg was noticeably shorter for the 22 vertebrae group. This can probably be explained by the fact that three of the pigs with 22 body vertebrae were Berkshires, and there were no pigs of the same breed in the other groups. The Berkshire pigs in the College herd are noticeably shorter legged in proportion to the length of body than the other breeds. Measurements 5, 6, and 7 were added together to give the depth of the body. The three lots showed no consistent difference with respect to depth of body. Measurements 5, 8, 9, 10 and 11 were averaged because all were measurements of depth of back fat at different points. Here again the fact that the 22 body vertebrae group have a slightly smaller thickness of fat back may be due to breed. Measurement number 16 for the plumpness of ham, shows a slightly higher average for the 22 body vertebrae group but is of questionable accuracy. This measurement varied greatly with slight change of its location.

The vertebrae were measured individually for each one of the above carcasses. The total lengths of the body vertebrae were included at the end of the table of carcass measurements. This measurement shows a decided tendency toward the increased length of body with the increased number of vertebrae. The 20 vertebrae pigs averaged 666.5 millimeters, the 21 vertebrae pigs averaged 690.6 millimeters, and the 22 vertebrae pigs averaged 702.8 millimeters. This difference is as much as one short vertebra between the first two groups, but less than half a vertebra between the 21 and 22 vertebrae groups. The individual vertebra of the 21 group averaged 1.2 per cent shorter and the 22 group 4.2 per cent shorter than the vertebrae

Table XIV
LENGTH OF INDIVIDUAL VERTEBRAE
(Average of 13 carcasses from feeding experiment)

Vertebra*	Thoracic (m.m.)	Lumbar (m.m.)
1	26.5	37.5
2	28.2	38.3
3	28.5	38.8
4	28.5	39.4
5	28.5	39.1
6	28.7	37.1
7	29.2	36.3
8	29.8	
9	30.5	
10	31.2	
11	31.4	
12	32.3	
13	33.2	
14	34.7	
15	35.1	
16	35.0	

*Vertebrae were numbered from the anterior.

of the 20 vertebrae pigs.

From the individual measurements of vertebrae the average length of the thoracic and lumbar vertebrae are shown in Table XIV. There is a gradual increase in the length of each vertebra from the anterior toward the posterior until the fourth lumbar vertebra is reached, after which there is a slight reduction in the length. The lumbar vertebrae were distinctly longer than the thoracic.

Seven pairs of carcasses were selected at the Rose-Vail Packing Company on which carcass measurements were made. Not all of the United States Department of Agriculture measurements could be applied because the carcasses were dressed "packer style" with the bones of the head removed. No attempt was made to measure the length of the heads or necks. Measurements number 15 and 16 were omitted because they seemed hard to obtain with any high degree of accuracy. It was attempted to select carcasses that would show about the same degree of finish and approximately the same weight. In order to find enough that would have a difference of two body vertebrae it was necessary to use carcasses ranging in weight from 155 to 174 pounds. However, they were selected by pairs so that when a light carcass or a heavy carcass was included in one group a similar carcass was selected for the other group.

The means of the measurements for the seven carcasses in each pair are given in Table XV. The average weight was also given. The carcasses with 22 body vertebrae were 43.7 millimeters longer. An increase of ten per cent in body vertebrae increased the length of body less than six per cent. The length of leg and depth of body was also slightly longer. The average depth of back fat was five millimeters less than in the shorter bodied hogs and indicates a possibility that the longer bodied group were not quite so well finished, which would naturally result in their being somewhat longer

Table XV
CARCASS MEASUREMENTS*

Measurement	20 Body Vertebrae	22 Body Vertebrae	Difference
Length of body (No.3)	743.6	787.3	43.7
Length of leg (No.4)	530.6	542.6	12.
Depth of body (total of 5,6 and 7)	343.6	351.9	8.3
Thickness of fat (Av.of 5,8,9,10 and 11)	39.2	33.9	- 5.3
Width through shoulders (No.13)	139.9	140.9	1.0
Width through hams (No.14)	146.1	141.	- 5.1
Average weight of carcasses	153. (pounds)	152.1 (pounds)	- .9

*Average of seven pairs measured at Dewitt. Measurements in millimeters.

and deeper for the same weight of carcass. However, this difference in finish probably would not account for the difference in length. The standard deviation and probable error was not computed because of the small numbers.

The thirteen carcasses from the pigs in the feeding experiment were cut into wholesale cuts and weighed to the nearest gram. The hams were cut off one-half way between the aitch bone and the last lumbar vertebra and through the middle of the fourth sacral vertebra. The head was severed with a square cut just caudad of the occipital bone. The shoulder was cut from the back and side between the second and third thoracic vertebrae and between the distal ends of the first and second ribs. The loin was cut from the side at the lower edge of the tender loin on the rear end and squarely below the edge of the backbone at the front end. The ribs were not separated from the side nor the loin from the fat back. Error, due to variation in the amount of meat taken with either of these cuts in the separation, was thus avoided. Comparison was also made of the percentage which each cut constituted of the total weight of the carcass. The results are shown by grouping the carcasses according to the number of body vertebrae in Table XVI.

The number is, of course, too small to justify any conclusions. The mean weight of loin and fat back is slightly higher for the 21 and 22 body vertebrae groups than for the 20. The difference was only .82 per cent between the 20 and 21 body vertebrae groups and practically the same for the 21 and 22 groups. Although the percentage of side for the 21 body group was .5 per cent larger, it was even lower in the 22 body vertebrae group than in the 20.

The seven pairs of carcasses that were measured and five additional pairs, were selected for cutting records at the Rose-Vail Packing Company. The system of cutting was exactly the same as used on the carcasses from the feeding experiment. The two cutting records could not be combined because

Table XVI

WEIGHTS AND PERCENTAGES OF WHOLESALE CUTS

(Carcasses of pigs in feeding experiment)

Pig Identification	Head	Shoulder	Loin and fat back	Side	Ham
Twenty Body Vertebrae					
D. S. 11					
Weight	6118	17909	16320	12064	16443
Percentage	8.89	26.01	23.70	17.52	23.88
D. S. 41					
Weight	5784	16722	18037	11801	14699
Percentage	8.63	24.94	26.90	17.60	21.92
D. B. 4					
Weight	6390	17091	17419	11313	14842
Percentage	9.53	25.49	25.98	16.87	22.13
D. S. 17					
Weight	5980	17918	17960	11819	15358
Percentage	8.66	25.95	26.02	17.12	22.25
Average					
Weight	6068	17410	17434	11749	15336
Percentage	8.92	25.60	25.64	17.28	22.55
Twenty-one Body Vertebrae					
P. S. 12					
Weight	5882	16762	17040	14875	16603
Percentage	8.27	23.55	23.95	20.90	23.33
D. B. 37					
Weight	5284	16705	16495	9989	15446
Percentage	8.27	26.13	25.81	15.63	24.16
D. S. 36					
Weight	6215	17144	19647	12370	15413
Percentage	8.78	24.22	27.75	17.47	21.77
D. B. 7					
Weight	6038	17872	17805	11827	15013
Percentage	8.81	26.07	25.97	17.25	21.90
D. B. 16					
Weight	6316	16633	19778	12282	13611
Percentage	9.20	24.24	28.82	17.90	19.84
Average					
Weight	5947	17023	18153	12269	15217
Percentage	8.67	24.84	26.46	17.83	22.20
Twenty-two Body Vertebrae					
P. S. 3					
Weight	6212	17134	18223	11081	15759
Percentage	9.08	25.05	26.64	16.20	23.04
B. S. 12					
Weight	5934	17185	18768	12015	15581
Percentage	8.54	24.73	27.01	17.29	22.42
B. S. 22					
Weight	5494	17578	17180	12029	14084
Percentage	8.28	26.49	25.89	18.13	21.22
B. S. 3					
Weight	5994	17059	18745	11977	15502
Percentage	8.65	24.62	27.06	17.29	22.38
Average					
Weight	5908	17239	18229	11776	15232
Percentage	8.64	25.22	26.65	17.23	22.26

Table XVII
WEIGHTS AND PERCENTAGES OF WHOLESALE CUTS
(Average of 14 pairs of carcasses)

	Carcass with 22 body vertebra		Carcass with 20 body vertebra		Difference of means	Standard error of difference
	Weight	Percent of carcass	Weight	Percent of carcass		
Head	33404	3.97	36832	4.28	.33	.03
Shoulder	207207	24.61	202542	23.56	1.01	.49
Loin and fat back	220804	26.23	216297	25.16	1.17	.69
Side	162118	19.26	174571	20.31	1.08	.80
Ham	192190	22.83	201351	23.42	.62	.48
Leaf lard	26122	3.10	28010	3.26	.16	.29

the carcasses at the packing plant were dressed "packer style" with the head bones removed. The average weights and percentages of the wholesale cuts are shown in Table XVII.

The mean percentage of loin and fat back is slightly larger for the carcasses with 22 body vertebrae, but the difference in the mean percentages is only 1.17 and is less than twice its standard error of difference of .69. This would not usually be considered a significant difference but the odds that a difference exists in favor of the longer carcasses are 20 to 1. The difference in percentage of shoulder is also close to the point usually considered significant, being 1.01 $\pm$ .33. The odds that a difference in favor of the 22 group are 22 to 1. A mathematically significant difference is shown between the two groups in the percentage of head. This could not be considered reliable as there was considerable variation in these cuts due to the removal of the head bones with varying amounts of flesh.

SUMMARY

The vertebrae of 319 pigs from the Michigan State College herd were counted. Variation ranged from 19 body vertebrae consisting of 13 thoracic and 6 lumbar to 23 comprising 16 thoracic and 7 lumbars. The variation and the mean number of body vertebrae was practically the same for both males and females. Of the five breeds examined the Yorkshire, Chester White, and Poland China were about equal with a mean number of body vertebrae ranging from 21.03 to 21.23. The Berkshires had slightly higher counts but the numbers examined were too small to justify definite conclusions. The Durocs were distinctly lower in number of vertebrae, their mean being 20.55.

The vertebrae of carcasses from the Michigan State College swine herd out-numbered the vertebrae of carcasses from central Michigan farms. The mean difference was .445 with a standard error of difference of .066 which is statistically significant. This difference appears to be due to more careful and rigorous selections practiced in the College herd toward the present approved type.

X-ray photography proved unsatisfactory as a method of determining the number of vertebrae in live pigs in a large percentage of cases under the handicaps encountered. Errors made in their use were not discovered until the pigs were slaughtered.

There was only a slight and insignificant advantage for the hogs with the larger number of vertebrae as shown by the rate of gain in the feeding test. There was no difference in the economy of the gain.

The slaughter data involves too small a number of pigs for any conclusion on the size of vital organs. The diaphragm did not move caudad to the full extent of the increased length of the thoracic column by increasing numbers of ribs and thoracic vertebrae. It was always attached at the

level of the sixth pair of ribs at the breast. With 14 pairs of ribs the attachment at the back was even with the 14th rib, and was between the 14th and 15th or even with the 15th in carcasses with 15 or 16 pairs or ribs. Extra vertebrae seemed to lengthen the abdominal more than the chest cavity.

The larger number of vertebrae were associated with longer carcasses, and longer thoracic and lumbar vertebral columns. In some cases the extra number was offset by shorter individual vertebrae.

No significant differences were found in the yield of wholesale cuts of higher value from the carcasses with 20 and 22 body vertebrae studied.

In this feeding experiment from which carcasses were secured for the measuring and cutting records, it was unfortunate that pigs with greater variation were not used. Larger numbers would also have been advisable. Access to a large number of pigs with known vertebral variations is needed to initiate such an experiment. It would have been better if all of the pigs could have been of the same breed.

A better source and supply of pigs should have been available for the cutting records. These records should give the most valuable information regarding the economic value of extra ribs and vertebrae.

LITERATURE CITED

Carroll, W. E., Bull, S., Rice, J. B., Laible, R.J. and Smith, R. A., 1929. Swine type studies. University of Illinois Agricultural Experiment Station Bulletin No.321.

Shaw, A. M., 1929. Variations in the skeletal structure of the pig. Scientific Agriculture Volume X, No.1: 23 - 27.

Shaw, A. M., 1930. A method of determining the variations in the vertebral column of the live pig. Scientific Agriculture Volume X, No.10: 690 - 695.

Vaughan, H. W., 1930. Types and market classes of livestock. R. G. Adams and Company.

ROOM USE ONLY