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Growth in Weight of Selected Organs, Tissues and Systems in the Pig

William J. Loeffel and Robert M. Koch[1]

From early time the phenomenon of growth has challenged the attention of research workers. Growth involves increase in size or weight as well as changes in proportion or differentiation. In its theoretical quantitative aspects, growth rate tends to be multiplicative in nature, leading to an exponential form.

However, as pointed out by Needham (1964), there are controls which keep the intrinsic rate within some bounds. Thus, measured rates are controlled rates rather than intrinsic proliferation rates. The mathematical expression used to describe observed growth patterns may depend on one or several factors such as:

1. Stage of growth covered by the observations.
2. Criterion of growth selected.
3. Accuracy and number of observations.
4. Use to be made of the measure of growth.

Thus, exponential, logistic, or linear regression equations have variously been used to describe growth data.

As a result of investigations at the Nebraska Agricultural Experiment Station in 1929, 1930 and 1931 to determine the effect of weight and degree of fatness of the pork carcass upon the quality and palatability of the meat, 40 pigs were slaughtered, five each at the approximate live weights of 70, 80, 90, 100, 115, 135, 160, and 180 kg. This corresponds to carcass weights ranging from 50 to 150 kg. The results of the meat investigations and feedlot data were reported elsewhere (Loeffel et al., 1943). This study reports data relative to the weight of selected tissues and organs, as determined by dissection at slaughtering time.

MATERIALS AND METHODS

Duroc, Berkshire, and Chester-White breeds from the University herds were used in this study. These pigs were started on feed when they weighed approximately 35 kg. They were fed on concrete floors

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[1] Department of Animal Science. The data presented herein were collected by the late W. J. Loeffel, but have remained unpublished. The second author, at the request of several workers who knew of these investigations, analyzed these data and revised the original manuscript consistent with the analysis performed.

with access to self-feeders containing shelled corn and a protein supplement. Twenty-two barrows and 18 gilts were used in the slaughter studies. An effort was made to divide the pigs as evenly as possible as to sex at each slaughter period. The pigs were weighed weekly as a regular routine and daily as the lot average approached a stipulated slaughter weight.

Pigs were kept off feed for 12 hours and then slaughtered in the University meat laboratory. Every effort was made to keep the methods uniform for comparable results. At slaughter time, the various organs were weighed and measured. Those organs, which made up the alimentary canal, were ligated and separated. They were weighed with their contents and then the contents were removed by gentle stripping. The empty organs were then weighed. A summation of the weights of the contents of these organs was denoted as the digestive tare.

The pigs were dressed "shipper style," that is the leaf lard, kidney, ham facings and head were left on the carcass. The tongue was removed at slaughter. The cooler used to chill the carcasses was used for other meats and since the load varied from time to time, the humidity also varied. Because of this variability, it was thought best to compute dressing yields on the hot carcass weight rather than on a chilled basis.

After chilling, the right side of the carcass was cut up into standard wholesale cuts. These cuts were separated into fat, lean, bone and skin. Usually about six persons were used to do the dissecting although some variation in the size of the crew occurred. Each cut was weighed and roughly dissected, the parts being turned over to different members of the crew in order that the boning be completed as quickly as possible. When the boning was completed, the various separates were weighed and the aggregate weight checked against the initial weight of the cut. Naturally some shrinkage occurred due to evaporation and also to some grease and moisture being absorbed by the table tops. Every effort was made to keep shrinkage to the minimum by rapid and skillful work. Small cuts and those with a large surface area were dissected first.

The data were analyzed by regression using linear and quadratic curvilinear forms. Each organ or tissue was considered as a dependent variable with hot carcass weight being the independent variable.

RESULTS AND DISCUSSION

Figure 1 shows the distribution of the pigs as regards liveweight and hot carcass weight at the selected slaughter points. Table 1 gives the average weights of carcasses, tissues and organs. The 70 kg. pigs dressed out 73.2%. This increased regularly with increasing weight and fatness to 82.7% for the 180 kg. pigs. These figures are in close

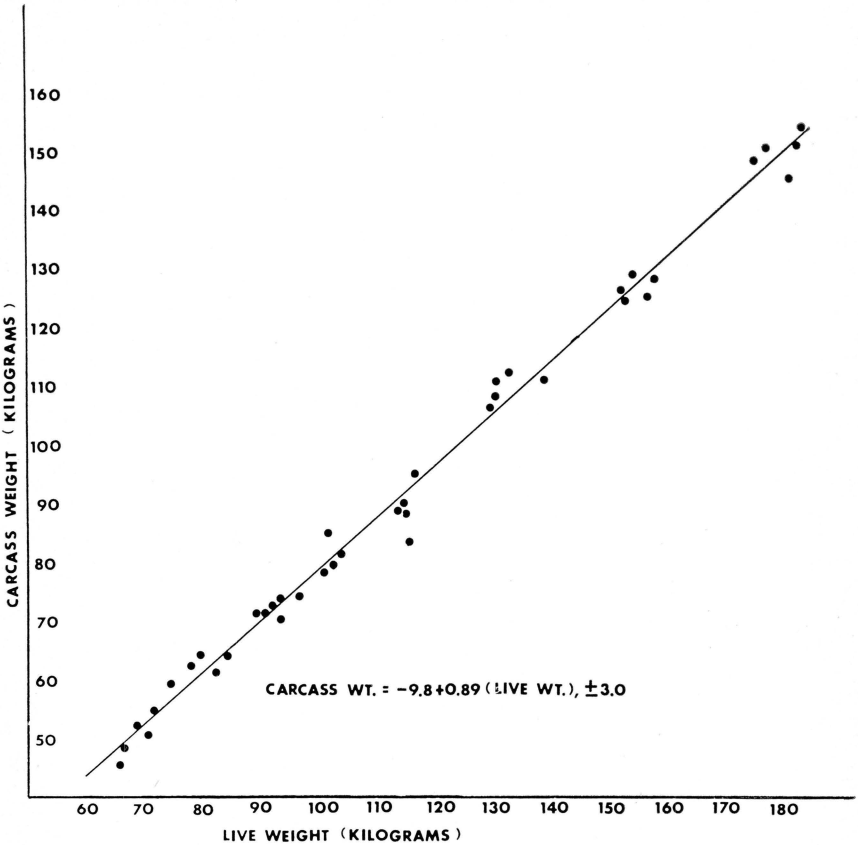

Figure 1. Regression of hot carcass weight on live weight. The dots represent the actual weights of the 40 animals.

accord with those reported earlier by Ohio workers (Robison, 1919) and in New Zealand (Smith, 1957).

The regressions for the various tissues and organs are given in Table 2 along with a graphic presentation in Figures 2 and 3. Curvilinear regressions were shown where these were significantly ($P < .10$) different from linearity. Even though some of the regressions were significantly curvilinear, most of the deviations from linearity were slight as judged by the change in the fraction of the variation associated with regression r^2 and R^2).

Table 3 presents the predicted organ or tissue weights for 10 kg. increments of carcass weight ranging from 50 to 150 kg. which is merely a convenient tabulation of the prediction equations given in Table 2.

Table 1. Average weight (gm.) of body tissues and organs.

	Slaughter group (ave. 5 pigs)							
	1	2	3	4	5	6	7	8
Live weight	68700	79650	91900	100900	114850	132200	154400	179200
Digestive tare	4435	3230	3590	3930	6090	4960	5990	5035
Empty body weight	64250	76400	88350	96950	108800	127300	148350	174200
Carcass weight	50600	62800	71950	80000	89450	110000	127200	150050
Muscle	21520	26000	27600	30260	33560	38650	38160	45000
Separable fat	13560	19920	25630	29930	34970	44900	59860	72230
Leaf fat	1170	1715	2105	3095	2955	3770	5585	7680
Ruffle fat	790	1020	1175	1365	1340	1890	1890	3060
Caul fat	195	335	355	510	480	560	700	1160
Bone	8930	10230	11260	10810	12590	14250	15730	16660
Skin	2215	2425	2560	3095	3225	3655	3920	5585
Bristles	470	625	440	680	675	970	780	940
Blood	2395	2920	2620	3180	3455	3970	3885	4865
Brain	104	106	110	118	118	115	113	119
Spinal cord	37	40	47	48	55	58	55	55
Pancreas	140	110	150	150	160	155	165	155
Spleen	105	120	140	170	155	180	190	190
Kidneys	220	245	280	280	290	330	340	305
Heart	275	295	330	355	360	425	470	465
Lungs	940	880	875	1080	1020	1150	1165	1180
Liver	1565	1550	1660	1785	2015	2200	2290	2030
Esophagus	43	52	62	59	66	73	63	83
Stomach	605	630	705	650	685	765	745	795
Small intestine	1400	1415	1515	1430	1495	1550	1460	1220
Large intestine	1230	1270	1680	1770	1910	2045	2545	2410

Table 2. Linear and curvilinear regression of tissue and organ weights on hot carcass weight.

Tissue	Linear regression[a]					Curvilinear regression[b]					
	$\bar{y}$ (gm.)	b (gm./kg.)	$\pm S_b$[c]	$\pm S_Y$[d]	r^2	b_1 (gm./kg.)	$\pm S_{b1}$[c]	b_2 (gm./kg.^{2})	$\pm S_{b2}$[c]	$\pm S_Y$[d]	R^2
Live weight	115220	1114	52	3320	0.99						
Digestive tare	4655	17	9	174	0.09						
Empty body weight	110565	1098	13	2570	0.99						
Muscle	32590	223	13	2770	0.87	402	93	−0.89	0.45	2670	0.89
Total fat	43230	686	16	3240	0.98	447	107	1.19	0.53	3080	0.98*
Separable fat	37620	595	14	2840	0.98	445	97	0.75	0.48	2780	0.98
Leaf fat	3510	62	4	810	0.86	9.3	27	0.26	0.13	780	0.88
Ruffle fat	1563	20	2	410	0.73	−5.5	14	0.13	0.07	395	0.75
Caul fat	536	8.2	0.7	134	0.80	−3.1	4	0.056	0.02	124	0.83**
Bone	12560	79	4	850	0.90						
Skin	3335	30.6	2.9	584	0.75	−15	19	0.23	0.09	550	0.78
Bristles	698	4.7	1.0	206	0.36						
Blood	3410	22.8	2.2	445	0.74						
Nervous system	162	0.31	0.06	13	0.39	1.61	0.39	−0.0065	0.0019	11	0.54**
Brain	113	0.12	0.04	8	0.21	0.58	0.25	−0.0023	0.0012	7	0.27
Spinal cord	49	0.19	0.04	8	0.37	1.04	0.25	−0.0042	0.0012	7	0.52**
Pancreas	149	0.29	0.17	33	0.08						
Spleen	156	0.86	0.14	29	0.49	2.90	0.95	−0.010	0.005	27	0.55*
Kidneys	287	0.94	0.25	50	0.27	4.85	1.66	−0.0195	0.008	48	0.37*
Heart	371	2.08	0.19	38	0.76	4.39	1.30	−0.012	0.006	37	0.79
Lungs	1038	3.13	0.78	158	0.29						
Liver	1887	6.75	1.40	281	0.38	30.32	9.10	−0.118	0.045	262	0.48*
Digestive tube	4051	13.40	3.00	600	0.35	56.35	19.90	−0.214	0.100	573	0.42*
Esophagus	63	0.32	0.06	13	0.40						
Stomach	698	1.73	0.46	93	0.27						
Small intestine	1436	−1.50	1.20	248	0.04	14.12	8.40	−0.078	0.041	241	0.12
Large intestine	1855	12.80	1.90	385	0.54	38.31	12.90	−0.127	0.060	371	0.59

[a] $Y = \bar{y} + b(C - \bar{c})$: $\bar{c} = 92.76$.
[b] $Y = \bar{y} + b_1 (C - \bar{c}) + b_2 (C^2 - \bar{c}^2)$: $\bar{c}^2 = 9617$
[c] S_b is the standard error of the preceding regression coefficient.
[d] S_Y is the standard deviation from regression.
* Curvilinear regression significant at $P < .05$.
** Curvilinear regression significant at $P < .01$.
No asterisk for curvilinear regressions indicates $P < .10$.

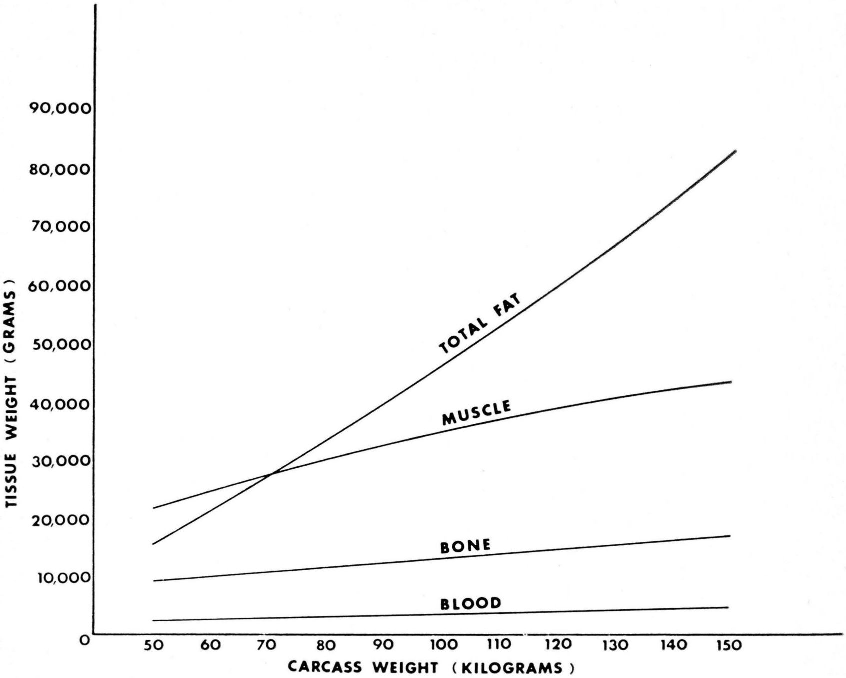

Figure 2. Change in weight of various tissues with changes in carcass weight.

Carcasses were center split and after cutting into wholesale cuts, one side was dissected into fat, muscle, bone, and skin. The growth of the major tissues comprising carcass weight (lean, total fat, bone, skin), blood and the empty body weight (including all organs and tissues) are given in Table 2. A graphic representation of changes in some of these tissues is presented in Figure 2.

Empty Body Weight

Empty body weight is the sum of all body tissues and organs. Empty body weight increased linearly with carcass weight. Apparently the sum of the various curvilinear growth patterns cancelled each other and yielded an essentially linear regression that was very closely (99%) associated with variation in carcass weight.

The regression coefficient for empty body weight of 1098 gm./kg. of carcass weight indicates the sum of the non-carcass tissues and organs increased 98 gm./kg. of carcass weight or 10% of carcass weight.

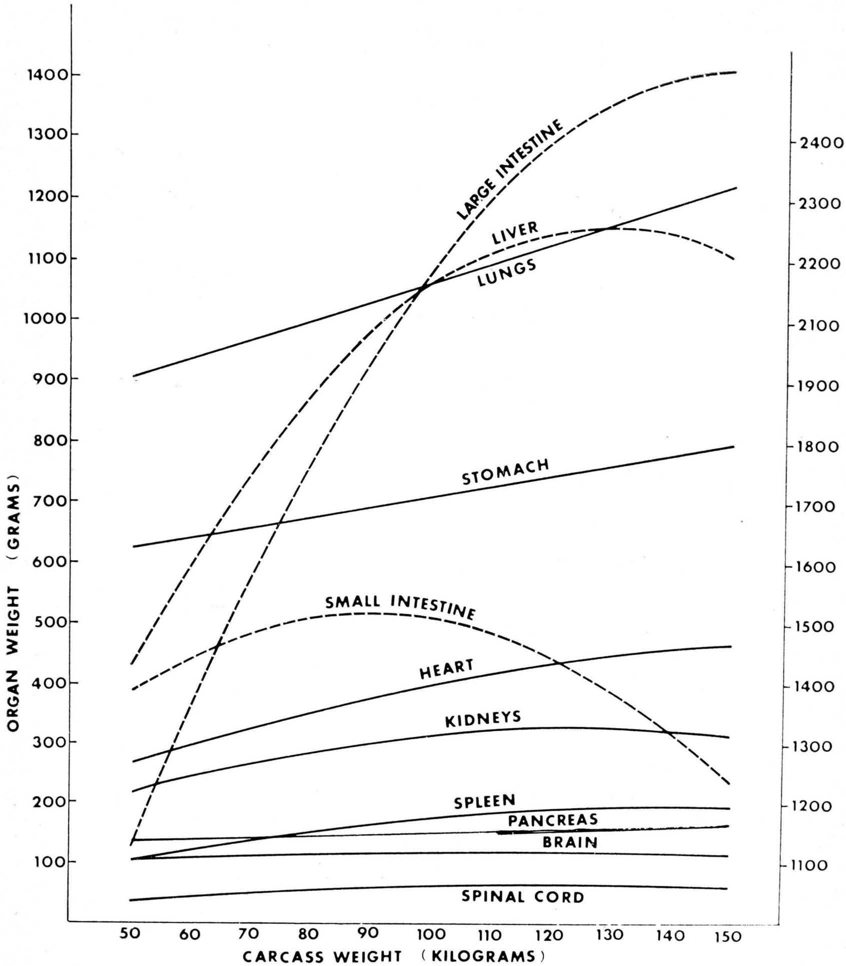

Figure 3. Change in weight of various organs with increased carcass weight. Spinal cord, esophagus, brain, spleen, pancreas, kidneys, heart, stomach, and lungs are measured against the scale of organ weight shown on the left of the figure. Small intestine, large intestine, and the liver as shown by the dotted lines are measured against the scale at the right side of the figure.

Digestive Tare

Digestive tare was the weight of the contents of the stomach, small and large intestines. The average weight of the tare of all 40 pigs was 4.7 kg., although the extreme variation was from 1.8 to 10.1 kg. There was a slight tendency for the weight of tare to increase

Table 3. Estimated organ or tissue values (gm.) from regression equations by 10 kg. increments of carcass weight.

	Carcass weight										
	50	60	70	80	90	100	110	120	130	140	150
Live weight	67590	78730	89870	101000	112150	123290	134430	145570	156700	167850	178990
Digestive tare	3930	4100	4270	4440	4610	4780	4950	5120	5290	5460	5630
Empty body weight	63620	74600	85580	96550	107540	118520	129500	140480	151460	162440	173420
Muscle	21740	24780	27640	30320	32830	35160	37310	39280	41080	42700	44140
Total fat	15650	21430	27440	33700	40190	46920	53890	61100	68540	76230	84150
Separable fat	13250	18530	23950	29530	35250	41130	47150	53330	59650	66130	72750
Leaf fat	1260	1640	2070	2555	3090	3675	4315	5005	5750	6545	7390
Ruffle fat	875	960	1075	1215	1380	1575	1790	2035	2305	2600	2925
Caul fat	270	300	340	395	460	535	620	720	830	950	1080
Bone	9170	9970	10760	11550	12340	13130	13920	14710	15500	16290	17080
Skin	2340	2440	2590	2785	3030	3315	3645	4025	4450	4920	5440
Bristles	500	545	590	640	685	730	780	825	875	920	965
Blood	2435	2665	2890	3120	3345	3575	3805	4030	4260	4485	4715
Nervous system	139	148	156	162	167	171	173	175	174	173	170
Brain	104	108	110	113	115	116	117	117	118	117	116
Spinal cord	34	40	45	49	53	55	57	57	57	56	54
Pancreas	137	139	142	145	148	151	154	157	160	163	166
Spleen	103	121	137	151	163	173	181	187	191	193	193
Kidneys	218	245	268	287	303	314	322	325	325	321	313
Heart	269	299	328	353	377	398	417	433	447	458	468
Lungs	905	935	965	1000	1030	1060	1090	1125	1155	1185	1220
Liver	1430	1605	1755	1880	1980	2060	2115	2150	2155	2140	2100
Digestive tube	3165	3495	3780	4020	4220	4380	4490	4560	4590	4575	4520
Esophagus	49	52	55	59	62	65	68	71	75	78	81
Stomach	625	640	660	675	695	710	725	745	760	780	795
Small intestine	1390	1440	1480	1505	1515	1510	1485	1445	1395	1325	1240
Large intestine	1120	1365	1580	1775	1940	2085	2200	2290	2355	2400	2410

with advancing live or carcass weight as well as the variability of tare. At 50 kg. of carcass weight, the digestive tare was 7.9% of carcass weight, while at 150 kg. carcass weight the tare was 3.8% of carcass weight.

Muscle

All muscles were dissected from one-half of the carcass and the weight doubled to obtain the carcass total. The regression of muscle on carcass weight deviated slightly from linearity. The curvilinear regression equation for muscle reached a maximum value at 256 kg. of carcass weight which was beyond the range of values observed in the study. All of the growth measured here as muscle cannot be considered as an increase in protein and water as considerable intramuscular and some intermuscular fat would be included. The weight of muscle doubled as carcass weight tripled. Muscle represented an average of 35% of the carcass weight over all weights of carcasses.

Fat

Fat as used here is the mechanically-separable fat or that which could be dissected out. The weight of the carcass fat was multiplied by two to give entire carcass fat to which was added the leaf fat as well as the caul (omentum) and ruffle (mesenteries) fat as the measure of total fat.

Caul fat comprised only 1.2% and ruffle fat 3.6% of the total fat. The increase in grams and as a percent of initial values at 50 kg. was the smallest, 400 and 335%, respectively, of the various types of fat deposits measured.

Leaf fat, which comprised 8% of the total fat, increased in amount by 585% as the carcass weight increased from 50 to 150 kg.

Separable fat was by far the largest part (87%) of total fat and increased by 550% over the range from 50 to 150 kg.

The average weight of the leaf and separable fat represented 44% of the average carcass weight. At 50 kg. carcass weight, fat comprised 29% of the carcass while at 150 kg. carcass weight it represented 53% of the carcass weight. In contrast, muscle constituted 35% of the average carcass, 43% at 50 kg. carcass weight, and 29% at 150 kg. carcass weight.

Bone

The bones were dissected from one side of the carcass and weighed. To this weight was added the weight of two feet and one-half head and doubled. The feet in addition to the bone contained some skin and tendons and the head some flesh, skin, and fatty tissue.

Bone increased linearly with carcass weight. The increase amounted to 7900 gm. or 86% of the initial weight at 50 kg. Bone comprised an average of 13.5% of the carcass weight.

Skin and Bristles

The skin as used here comprises all of the skin, less bristles, except that from the head, feet and tail. The skin, of course, was subjected to considerable drying action by the air and undoubtedly some of the variations observed are due to differences in drying. Variation due to errors in separating skin and fat would also contribute to the deviations from expected. Even so, the R^2 value of 78% does indicate a high percentage of the variations measured were associated with variation in carcass weight. The weight of the skin increased in curvilinear fashion such that the rate of increase at the higher carcass weights was more rapid than at the lighter carcass weights. Skin weight increased by 233% as carcass weight increased from 50 to 150 kg.

After scalding and scraping, the bristles were spread on paper to dry. The shell of the hoof and dewclaws and some scurf were included. When air dry, they were weighed. The variation relative to the expected values showed the greatest variation of any of the tissues. Bristles almost doubled their weight (95% increase) as carcass weight increased from 50 to 150 kg.

Blood

In slaughtering, the pigs were shackled by a hind leg, hoisted and bled. The blood was caught in a container and weighed. It is recognized that this does not represent the total blood and that much variation occurred in the thoroughness with which it was drained from the body. The weight of the blood increased linearly from 2435 gm. at 50 kg. of carcass weight to 4715 gm. at 150 kg., an increase of 94%. The fraction of variation in blood weight associated with variation in carcass weight was 74%. This is the smallest fraction for the tissues, but is larger than any of the organ weights, except the heart.

Central Nervous System

When the head was removed from the carcass, it was split and the brain removed and weighed. After splitting the carcass, the spinal cord was also removed for weighing. The meninges were removed in both cases before weighing. The brain constituted about two-thirds of the weight of the central nervous system. The weight of the brain increased over the range of weights studied from 104 gm. at carcass weights of 50 kg. to a maximum of 118 gm. at 132 kg. of carcass weight. The quadratic curve introduces a decline which may be an artifact. The (Table 1) average weight was 118 gm. in slaughter groups 4 and 5, was 115 and 113 gm. in groups 6 and 7, then increased to 119 gm. in group 8. These discrepancies could well be due to sampling variation. The increase was about 13% of the weight at 50 kg.

The spinal cord increased from 34 gm. in weight by about 68% to the maximum point of the curve which was reached at 124 kg. of carcass weight. The fraction of the variation in organ weight associated with variation in carcass weight was about twice as high for the spinal cord as for the brain. One would expect the weight increase of the spinal cord to be more closely related to increased body weight over the range in weights studied because the spinal cord as the messenger trunk of the system must expand to carry the signals from the brain to the body as it grows. The brain had apparently completed its major growth prior to the weights observed in this study. The slight decline in weight of the spinal cord may be due to errors of measurement and the artifact caused by the fitting of a quadratic curve.

Pancreas

Pancreas weight increased linearly by 29 gm. as carcass weight increased from 50 to 150 kg. This amounts to a 21% increase while carcass weight tripled suggesting that the majority of pancreas growth occurred prior to the animal weights covered by this study. How much of the increase in pancreas weight was secretory tissue and how much was due to fatty infiltration cannot be said. Only 8% of the variation in pancreas weight was associated with increased body weight.

Spleen

Spleen weight increased 88% from the initial weights at 50 kg. of carcass weight to a maximum, reached at 145 kg. Only 55% of the variation in spleen weight was associated with differences in carcass weight.

Kidneys

Growth of the kidneys was significantly curvilinear, increasing by 53% to a maximum size at 128 kg. of carcass weight. The protein intake of these pigs reached a maximum at liveweights roughly corresponding to 95 kg. of carcass weight.

Heart

The growth of the heart as related to carcass weight was slightly curvilinear as judged by the small increase in variation associated with regression ($R^2 = 76\%$ and 79%) for the linear and curvilinear forms. The heart was more closely associated with differences in carcass weight than any of the other organs studied. The heart increased from 269 gm. to 468 gm. or a 74% increase as carcass weight increased from 50 to 150 kg. Not all of the increase in weight represents an increase in the functional organ for there was an appreciable deposition of fat around the coronary portion of the heart at the heavier weights.

Lungs

The trachea was separated from the lungs where the bronchi entered the lungs proper. The regression of lung weight on carcass weight was linear, but much of the variation in lung weight was not associated with increased body weight ($r^2 = 29\%$). In some cases, blood had been sucked into the lung tissue due to faulty sticking. At 50 kg. carcass weight the lungs weighed 905 gm., increasing by 35% as carcass weight reached 150 kg.

Liver

Liver weight varied markedly within animals of similar weight and also over the range of weights studied. These weights represent the weight of the liver itself without either the gall bladder or the bile it contained.

The liver plays an important role in nutrition, and the great fluctuation in weight may have been due to a variation in time that elapsed between the last feeding and slaughter. While an effort was made to keep this uniform, it could not always be done due to the fact that on certain days as many as six hogs had to be slaughtered. Also, because of the rich blood supply of this organ, the thoroughness of bleeding may have influenced its weight.

The weight of the liver at 50 kg. carcass weight was 1430 gm. and it increased by 51% to a maximum weight of 2156 gm. at 128 kg. of carcass weight. At 150 kg. carcass weight, the liver weight was only 47% above the liver weight at 50 kg. Reasons for the decline are not clear, although it is recognized that extreme fattening may bring about some degenerative changes in the liver. No pathological studies were made of the livers.

Digestive Tube

The digestive tube consisted of the esophagus, stomach, small intestine and large intestine. The digestive organs were ligated and weighed full and empty.

The esophagus increased by 65% over the range of the carcass weights studied but constituted only 1.5% of the digestive tube.

The stomach increased linearly by 28% from the initial weights observed at 50 kg. carcass weight.

Wide variation in the weight of the small intestine was noted and little of this variation (12%) was associated with changes in body weight. The regression of small intestine weight on carcass weight was curvilinear due primarily to lower values in the two initial and the final groups. At 50 kg. the weights averaged 1390 gm. and reached a maximum of 1515 gm. at 90 kg. of carcass weight and then declined to about 1240 gm. at 150 kg. of carcass weight. The size of the sampling errors of the regression of small intestine on carcass weight suggest there was little or no change as weight increased. However, the calculated regression is included to permit comparison.

The weight of the large intestine included the caecum. The weight of the large intestine increased more rapidly than the other digestive organs and reached a maximum of 2370 gm. at 147 kg. of carcass weight. At this point, it was 211% of its weight at 50 kg. The increases in weight of the large intestine were more closely ($R^2 = 59\%$) related to increased carcass weight than any other part of the digestive tube.

After the intestines were weighed, they were measured for length on a table top. The shortest intestinal tract measured 23.8 m. and the longest 35.7 m. The average length of the small intestine was 22.4 ± 2.3 m. Although there was some tendency for length to increase with carcass weight, only 2% of the variation in length was associated with variation in carcass weight. The large intestine averaged $5.8 \pm .09$ m. in length. Its differences in length (0.01 m./kg. carcass weight) were related more closely to differences in carcass weight ($R^2 = 37\%$) than those of the small intestine.

So far as digestive capacity may be measured by the weights of the organs, it appears that heavier animals do have larger capacity although growth in the digestive organs does not keep pace nor is it linearly related to increases in carcass weight.

Deviations from Regression

In general, component tissues of carcass weight tended to have a higher fraction of their variation accounted for by regression than the organs except for the heart. However, one might expect the circulatory system to be closely related to the magnitude of the major tissues it serves.

There was a tendency for the size of the deviations from regression to increase as carcass weight increased. For example, the average standard deviation from regression of the tissues, muscle, fat, bone, and blood from the last 10 animals slaughtered was 2.3 times as large as the comparable standard deviation of the first 10 animals slaughtered.

In the case of the organs, the average standard deviation from regression was only 1.4 times larger for the last 10 animals versus the first 10. There seemed to be no consistent pattern in the relative change in variation. For instance, the ratio of the standard deviation from regression to the mean of the observations for muscle doubled while that for total fat halved where these standard deviations and means were computed from the first ten and the last ten animals, respectively. The ratio is comparable to a coefficient of variation. Thus, it seems difficult to establish a uniform scale of measurement that would be equally suitable for comparing the growth and variability of the many organs and tissues of the pig.

Relationships Among the Tissues and Organs

Where organs or tissues form a system or are parts of a whole such as the nervous system, digestive tube, total fat, carcass and liveweight the relative importance of the component parts in determining the total variation can be assessed by expressing the multiple regression analysis in standard measure according to the method of path coefficients. (Wright, 1921, 1934). In these data the variation studied is not a random sample of pigs taken from a population but represents a stratified population of pigs from a rather extreme range of weights. The comparative partitioning of the variation to various sources is valid, for equal numbers of pigs stratified over this range of weights.

The path coefficient diagrams for the systems are shown in Figure 4. The paths measure the relative importance of the identified traits in causing variation in the dependent variable.

Nervous System

The correlation between the weight of the brain and the spinal cord was 0.49. The direct determination by the brain was $(0.52)^2 = 27\%$ and by the spinal cord $(0.64)^2 = 41\%$.

Digestive Tube

The correlations among the parts of the digestive tube were variable in direction and size. Independent variation in digestive tube weight was determined largely by variations in weight of the large

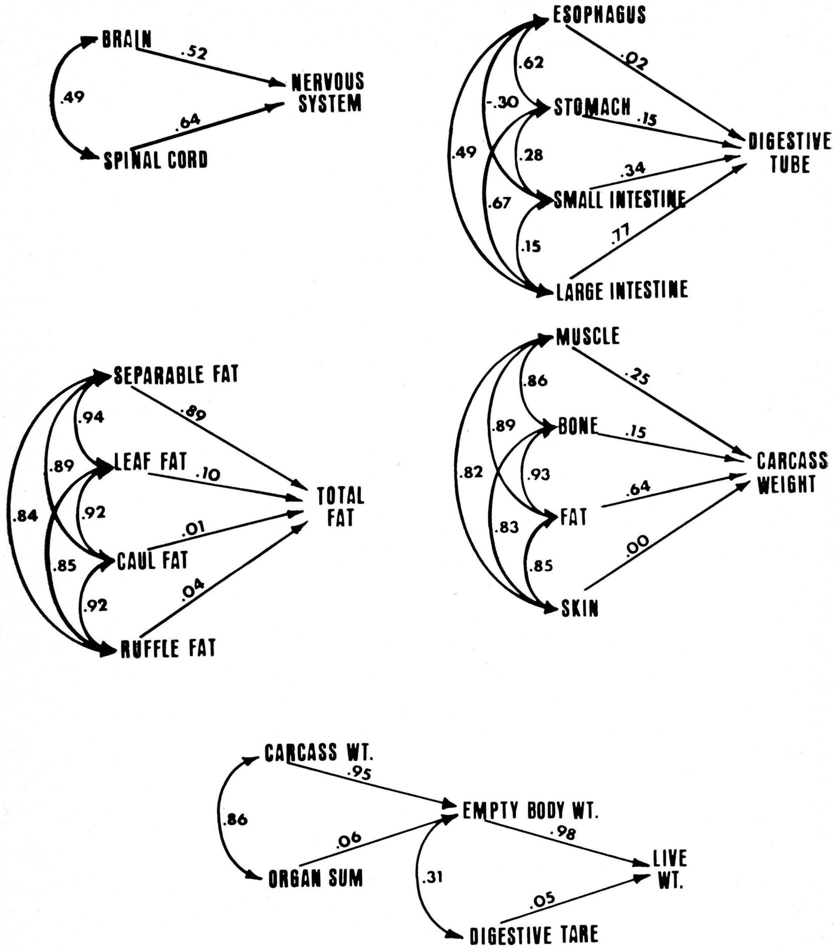

Figure 4. Path coefficient diagrams of systems.

intestine (59%), next by small intestine (12%), to a much lesser extent by the stomach (2%), and the esophagus (0.05%).

Total Fat

All of the components of total fat were closely correlated with one another. By far, the largest source of variation was due to separable fat with leaf fat, ruffle fat and caul fat contributing in that order.

Carcass Weight

Carcass weight was totally determined by muscle, bone, fat and skin. The correlations between these components were high (0.82 to 0.94). Variation in fat was the largest direct determiner of variation in carcass weight accounting for 41% of the variation. Muscle accounted for 6% of the variation, bone 2%, and skin practically none.

Empty Body Weight

Empty body weight is the sum of all the organ weights plus the carcass weight. The sum of the organs was closely correlated with differences in carcass weight (0.86), but they accounted for only a small fraction of the variation, 0.3%, in empty body weight. Variation in carcass weight accounted for 90.4% of the variation, the remainder being determined jointly by the two parts.

Live Weight

Live weight is the sum of the empty body weight and digestive tare. The correlation between digestive tare and empty body weight was positive though relatively small (0.31). Almost all of the variation in live weight was determined by empty body weight (96.6%) with only 0.2% determined by digestive tare. Carcass weight accounted for 87.4% of the variation in live weight.

SUMMARY

The growth of selected organs, tissues, and systems of 40 pigs slaughtered at live weights near 70, 90, 100, 115, 135, 160 and 180 kg. is reported.

The linear or curvilinear regressions of organ or tissue weight on carcass weight are presented along with tabular values of organ and tissue weights at 10 kg. increments of carcass weight between 50 and 150 kg.

In general, the deviations from linearity were slight as judged by the reduction in standard errors of estimate or the fraction of the variation associated with regression. The relative rate of increase for the different organs and tissues were quite variable with organs increasing much less than the major tissues such as fat, muscle, bone, skin and blood. Fat by far showed the largest absolute and relative increase for the range of weights studied.

Although there were curvilinear growth patterns in many of the organs and tissues, empty body weight increased linearly with carcass weight. The relative variation of the components of the nervous system, digestive tube, total fat, carcass weight, and live weight was evaluated by path coefficient analysis.

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