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A STUDY OF THE FACTORS  
INFLUENCING THE COMPOSITION OF BEEF FAT

by

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# THE COMPOSITION OF BEEF FAT.

## PART I.

### HISTORICAL PART.

#### The Origin of Fat.

The views upon the origin of body fat have undergone a number of changes in the last sixty or seventy years. These views have changed from the idea that body fat originated from the ingested fat to the later views that it originated from either protein or carbohydrate or a mixture of these. Hawk's Physiological Chemistry supports the idea that it may be formed from three sources; "Body fat is formed partly from the ingested fat and partly from the carbohydrates and the 'carbon moiety', i.,e., carbon content of protein material in the food".

Each investigator has questioned the theories of the others until at the present time one is able to find a great deal of material in support of any one view. Rosenfeld (Ergebnisse der Physiologie 1(1902), 1, p.651-678) gives Dumas and Prout credit for the theory that body fat originated directly from the food fat as early as 1840. But under more careful research Liebig demonstrated that food fat will not account for all the fat of the body and proved his point by the fact that the fat from cows milk may be greater in quantity than the

fat contained in the food. And in the light of data shown elsewhere in this paper it is very clear that a portion of the fat of the cows milk does come from another source. He also investigated the fats of sheep and hogs finding the fat of each species of animal to be more or less peculiar and differing in composition from the fat taken in as food. "In hay or the other fodder of oxen, no beef suet exists, and no hogs lard can be found in the potato refuse given to swine". His conclusion was that body fat had its source in carbohydrate food, which view was in harmony with the experience of Agriculturalists as to the use of this food in fattening animals for market.

The next theory to gain credence was that of Carl Voit (Hermann's Handbuch der Physiologie 6(1881) I Theil S. 1 - 575). After elaborate feeding experiments, he concluded that the fat of the body was due primarily to protein and that the carbohydrate or fat of the diet serves only to protect a part of this protein from oxidation. Pflüger finds fault with the theory of Voit, claiming that his data was based upon erroneous analyses of meat used in his experiments. (Pflüger, "Archiv. f. die Gesamte Physiologie", 51, 229, 1892 and 77, 521, 1899).

Hofmann (Hawk Physiological Chemistry) in experimenting with fly maggots thought he found very satisfactory and conclusive proof of the formation of

fat from protein material. He divided them into two groups, analyzing one group for the normal content of fat and the other group, after having developed for some time in blood (84 per cent of the solid matter of blood plasma being protein) was analyzed for its percentage of fat. It was found that the fat content had increased from 700 to 1100 per cent as a result of such a diet.

Hawk (l.c.) gives Pettenkofer and Voit credit for the most conclusive evidence of the formation of fat from protein. These investigators fed dogs large amounts of lean meat daily, and through subsequent urinary and fecal examinations were enabled to account for only a part of the ingested carbon, although obtaining a satisfactory nitrogen balance. This discrepancy in the carbon balance was explained upon the theory that the protein of the ingested meat had been split into a nitrogenous and a non-nitrogenous portion in the organism, and that the non-nitrogenous portion, the previously mentioned "carbon moiety" of the protein, had been subsequently transformed into fat and deposited in the tissues of the body as such.

E. Weinland (Physiol. Inst., München Z. Biol., 52, 441 - 53) working with the larva~~s~~ of Calliphora (blow-fly) to prove that fat is formed from protein, ground them in a mortar with Witte's peptone and water to form a homogenous mixture. He placed these mixtures at 38° C for twenty-four hours and determined the fat

content. It was found to have increased as much as fourteen per cent in some instances. The active agency in this transformation of fat is the larval tissue since the tissues of both the dead and living larvae possess this property. Data are given from control tests which show that the action of bacteria in this transformation of protein was excluded.

The theory that fat is formed from protein is still an open question but in the absence of protein fat is not stored in the organism showing that protein feeding is conducive to fat formation. Another view quite common today is that the body fat is formed partly from the fat of the food, particularly in Carnivora and partly from the carbohydrates of the food, in herbivora, in whose diet this food stuff forms such a large part.

G. von Bergmann and K. Reicher (Berlin, Z. exper. Path, 5, 761) could not substantiate Pavy's hypothesis that carbohydrates are converted into fats in the intestinal walls.

The next phase of this problem to receive attention by the investigators was to prove that the food fats may be deposited as such in the fat tissues of the organism. Radziejewski in 1866 (Centralbl. für d. Med. Wissensch. 1866, 353) (Virchow Archiv. 43(1868), 268 - 286) by feeding erucic acid and rape seed oil failed to secure a marked deposition of erucin.

He also found that while the sodium soap of palmitic acid and rape seed oil was readily absorbed in the intestinal canal, only small traces of the foreign fat could be detected in the body of a dog. This led him to the conclusion that inasmuch as there was a deposition of fat the animal organism was able to synthesize a foreign oil into a neutral fat.

Subbotin's (Zeit. für Biologie 6(1870), 73-94) work resulted almost the same as Radziejewski's. His work showed that the direct transference of the fat of the food, from the intestinal canal into the fatty tissue to be highly improbable. But Franz Hofmann's (Zeit. für Biologie 8 (1872) 153-181) experience with a dog, led him to reach the very opposite conclusion. He starved a dog weighing twenty-six kilograms until its weight was reduced to sixteen kilograms. It was then fed for five days on a little meat and large quantities of fat. Upon being killed the body was found to contain 1353 grams of fat, of which only 131 grams could have come from the protein used, assuming that this material can serve as a fat former. Much of the fat found therefore was probably derived from the fat of the food. This seems to show that the cells along the intestinal canal absorb the fat as it is contained in the food.

And to demonstrate this fact of the absorption of fat, A. V. Fekete, (Physiol. Inst. Univ. Budapest.



Arch. ges. Physiol. 139, 211-33) investigated the form in which fats are absorbed. For this experiment he employed lanolin (wool fat) on account of its stability and also olive oil containing Ca ions to render insoluble and non-absorbable any fatty acids already there. A lanolin emulsion brought into an isolated piece of small intestine was found not to be absorbed as such. In fact, in some experiments the amount of ether soluble substances increased, indicating that the secretion of fatty substances is stimulated by the presence of fats in the intestine. The lymph of starving dogs, as well as that of suckling dogs fed on lanolin emulsion or on olive oil containing Ca, showed no difference in their fatty acid content, a fact which cannot be attributed to error or to individual differences. The author concludes that the absorption of fat occurs only in dissolved form. In justification of his choice of determining the fatty acid content of lymph as a measure of absorbed fat, other experiments were made which showed that absorption of fat occurs only through the lymphatic system.

O. Frank (Archiv. f. Physiologie, 1892, 497 and 1894, 297) explains how the fat absorbed by the intestinal cells may be carried by the lymphatic vessels to the thoracic duct and thence to the venous circulation. But a portion of this fat must pass through the liver, which

organ, J. B. Leathers, (Lancet, 176, 593-9) thinks must "desaturate" the fat, making it more available as a source of energy, thus precluding a chance for it to be stored in the body in the same form as it was ingested. He also states that a conversion in the liver of food fat into phosphatide fat or organized fat may precede this "desaturation".

A. Lebedeff's (Centralbl. fur d. Med. Wissensch 8 (1881) work with dogs, supports the view of the laying up of a foreign fat by the cells of the fatty tissue. He starved two dogs for a month, causing them to lose forty per cent of their weight and completely breaking down their body fat. One dog was fed linseed oil and a little fat free meat and the other mutton tallow. In three weeks it was found that they had laid on enough fat to regain their original weight. Upon analysis of the fat taken from the dog fed upon linseed oil, a fat, very similar to linseed oil both in its physical and chemical properties, was obtained. The fat samples taken from the second dog compared very favorably with mutton tallow. Both dogs were in good physical condition. But in his later experiments it was demonstrated that more work needed to be done along this line to verify his first conclusions. While tributyrin was absorbed in the intestinal canal of the dog, but very little of it could be detected in the fat samples analyzed. Also geese fed



upon peas and starch and peas and butter did not lay on any appreciable amount of fat. (Zeits. fur Physiol. Chemie 6(1882) 139-154).

Immanuel Munk obtained very favorable results to prove that food fat was stored up as such in the animal organism. (Virchom. Archiv. 95 (1884) 407-467). He found rape seed oil and erucin in the fat of dogs fed upon it. He fed 2858 grams of the fatty acids from mutton tallow to a dog and succeeded in obtaining a deposition of this fat in the dog. But he was of the opinion that such a deposit of foreign fat was not permanent as the animal in question was able to synthesize this foreign fat into its own specific kind of body fat as fast as needed.

Salkowski (Festschrift f. Virchoms Jubiläum 1891, 23) showed that oleic acid is changed over to a solid fatty acid in the animal body, thus confirming the work of Munk.

Rosenfeld (Allgem. Medizin Central-Zeitung 1897, Mr.60) after starving a bitch dog, fed it upon mutton tallow and found that the fat as later analyzed proved to be almost pure mutton tallow. When the dog was fed meat poor in fat, its milk contained fat which gave the same iodine value as mutton tallow.

W. Lummert (Pfluger Archiv. 71 (1898), 176-208) endeavored to investigate the properties of those fats laid on during the feeding of fat free food, such as protein and carbohydrate. He starved his dogs until they

were as fat free as possible and then fed them on a diet of proteid. His ducks and geese would not feed on a diet of fat free food. The four dogs were fed as follows; two received fat free meat, casein, sodium caseinate and starch, the third in addition to the above mentioned diet received cane sugar, the fourth laevulose. The physical and chemical constants of the fats of the four dogs did not vary from one another and were within the limits already found for such animal fats. But the laying on of this fat was not sufficient to warrant his concluding that it was due to carbohydrates. As to the composition of these fats he is satisfied that they were the triglycerides of the three acids, palmitin, stearic and oleic and that the fatty acids or alcohols of the fatty series were present in a minimum amount.

Rosenfelds later work along this line convinced him that the laying on of foreign fat was permanent, directly in conflict with the work of Munk. (Verhendl. des 17, Kongress f. inn Med, 1899, 503). In this work he endeavored to produce a laying on of food fat by feeding mutton tallow and cocoa butter to a dog. He succeeded in this and after discontinuing this feed for a month he was able to obtain samples of fat from the dog which seemed to be almost pure tallow. And furthermore, he showed that dogs were able to use this foreign fat in ~~much~~ the same manner as their own. To verify his previous

work he fed mutton tallow to gold fish and carp whose fat has an iodine value of 108 - 110 and found a gain in fat as high as ten per cent in some instances. (Berliner Klinische Wochensch 1899 Nr. 30). But as the iodine value of this fat was now only 79 and the iodine value of mutton tallow is only 33, he felt as though he had proven conclusively that the mutton tallow had been laid on as such. These results tend to verify his contention that body fat is formed from food fat and that the kind of food determines the kind of fat.

V. Henriques and C. Hansen (44 Ber. K. Vet. Landbohøjskoles Lab. Landökon Forsög (Copenhagen) 1899) fed linseed oil to pigs and the iodine value of their fats indicated the presence of linseed oil as such in the samples examined.

Rosenfeld (Allgem. Med. Central-Zeitung 1901 Nr. 73), working upon carnivorous sea animals found more evidence to support his previous conclusions. His results are as follows, showing that the iodine value of the animal fat varied according as the food fat:-

Animal Investigated	% Fat	Iodine Value	Food	% Fat	Iodine Value
Cottus scorpius	13.0	118.0	Carc. Maenas	4.9	142.0
Homarus Vulgaris	6.9	97.8	Pleuronectes	9.8	107.0
Ammodytes lanc.	13.0	124.0		24.0	125.6
Rhombus Max	13.0	134.4	Plat. Ammo- dytes tobiamus	24.0	125.6

Further than this, he fed barley to rabbits and

noticed that their fat had the same greasy, white appearance as barley oil. (Ergeb. der Physiologie I. 1, 651-678).

C. Amthor and J. Zinc (Zeit. fur analyt. Chemie 1897, 1-17), through a series of experiments upon 25 animals both wild and domesticated, found that the fats of the wild carnivora in having higher physical constants and lower Iodine values and the similarity of the fats of the wild herbivora is therefore due to the similarity of the feed of the sheep, ox and horse. These animals living upon green stuffs have a hard fat indicating a low content of olein, while those animals if fed on corn would show a soft fat probably due to a soft oil in the corn.

J. Sanarens (Lab. Agr. Havre. Ann. fats. 4, 72-5), confirms the opinion that the fat of pigs and cows fed on cotton seed meal as well as the butter fat gives a Halphen reaction corresponding to 2-4 per cent of added cotton seed oil. The Becchi test is positive on fats but negative on fatty acids. The physical and chemical constants are practically the same as those for fats from similar animals fed on corn.

J. Kohnig and J. Schluckebier (Z. Nahr. genussm., 15, 641-61), in their studies upon the influence of fat in rations upon the fat of pigs, used pigs six or eight weeks old. They were fed on milk, potatoes, cotton seed, coconut cake, sesame oil and corn for varying lengths of time, from fifty-two days to one hundred seventy-four days. In nearly all cases it was necessary to feed milk and barley

meal to keep up the appetites of the pigs. The fatty tissues of the back, head, hams, bellies and intestines were separated and the fat extracted with ether. A comparison of the saponification number, Iodine value and refractive index of the fats and volatile fatty acids of the various parts of the body, with that in the original rations indicate that the variety of food has no influence upon these constants and that, with the exception of the intestinal fat, they are the same for all regions. The intestinal fat has a higher melting point ( $41^{\circ}$ ) and a lower Iodine value (58.2) than any other fat. All the fat from the cotton seed fed pigs gave the Halphen reaction for cotton seed oil. Similarly in the case of sesame oil, all the fats showed a positive test by the Baudouin method, contrary to what would be expected, as the butter fat from cows, similarly fed, has never been known to respond to this action.

In Bulletin No. 29, 1893 of the Texas Agricultural College, it was found that the feeding of cotton seed meal and cotton seed influenced to a less degree beef tallow and lard, while on mutton suet its influence was almost as marked as upon butter. The melting point of lard from the cotton seed meal is notably higher than where the hogs are fed on other grains but there is nothing distinctive in the Iodine value. The Iodine values ran as high as fifty-two while the melting point was up to  $46.5^{\circ}$  degrees. Butter from cows fed a three-fourths ration of cotton seed



meal gave an Iodine value of 35.7 and a melting point of 41.5. In the case of sheep three samples of fat were taken from the kidney, caul and body fat. The melting point of the kidney fat in two sheep show a difference of a little more than four degrees, the melting point averages about 50.8 degrees as compared with 45.8 degrees where the sheep were fed on corn meal. The Iodine absorption of the body fat shows a variation of more than eleven running from twenty-seven in the body fat of corn meal fed sheep to thirty-eight in cotton seed meal fed sheep. In the case of cattle, two steers were fed on corn and eight were fed on raw seed, boiled seed and parched seed or meal. The average melting point for the two fed on corn is 46.3 degrees for kidney fat. The average for the same fat from the other eight is 50.4 degrees, a difference of 4 degrees in favor of the steers fed on cotton seed meal. For the caul fat the average analysis from the two steers fed on corn is 46.5 degrees, while the average analysis from the eight steers fed on cotton seed is 49.7 degrees, a difference of more than 3 degrees. In the body fat (loin fat) with an average from the corn fed steers of 36.9 degrees and from the eight steers fed on cotton seed meal an average of 45.6 degrees or a difference of nearly 9 degrees. This is the most marked case. The results of the Iodine absorption are disappointing. There is no regularity, but if anything the effect of the cotton seed meal seems to lower the Iodine absorption.

P. M. Raikow (Chem. Ztg. 28(1904), 272-273), working along the same line gives evidence to show that bears living upon hazel-nuts lay on a fat similar to that of hazel-nuts but having lower physical values and higher Iodine values than the dog, fox or cat.

J. H. Grisdale (Ontario Agricultural and Expt. Union Rpt. 1902, 41-42) commenting upon the softening influence of corn oil, states that the feeding of skim milk or whey will tend to insure firm pork and that in the feeding of corn some other food must be given to offset the softening influence of the corn oil upon the pork. And in support of this O. Lemmerman and G. Linkh (Landw. Jahrb. 32 (1903), 635-653) state that bacon from pigs fed on palm nut cake is firmer than that of pigs fed on corn.

Henriques and Hansen (Skand. Archiv. Physiol. 14(1903), 390-397) fed hens linseed and hemp seed and were able to prove that portions of the fat from such food passed into the egg unchanged, thus showing the egg to be very similar in this respect to the body fat.

S. Weiser and A. Zaitschek (Pflüger. Archiv. 93(1903), 128-133) fed maize and broom corn seed to geese but did not succeed in causing a deposition of the fat of these two grains. They did, however, prove that the fats gained by the geese from the two grains were identical. Inasmuch as these grains differ in chemical composition, it seemed to show that the fat

was formed from the carbohydrates present as the fat in the grain did not equal the amount of fat laid on. Zaitschek (Pflüger. Archiv. 98(1903) 614-622) upon feeding hens whole milk found the formation of a body fat very similar to butter fat but lacking the volatile acids of such fat.

A. D. Emmet and H. S. Grindley (Jour. Amer. Chem. Soc. 27(1905), 263-270) to prove their assertion that the oil of cotton seed may be stored up as such within the body, fed cotton seed meal to hogs and were able to find in the lard of the hogs a considerable quantity of cotton seed oil.

Martin Thiemich (Jahresbericht für Kinderheilk 61, 174-177) to show a definite deposit of palmin, fed a dog in pup as much palmin as possible (containing olein and palmitin). The Iodine value of the fat in the newly born puppies was from 45.9 to 47.4 and the subdermal fat of the mother had the Iodine value of 30.9 to 31.7. Normal values are 70 for the fat of a puppy and 50 for the subdermal fat of a grown dog. This the author thinks shows a definite deposit of palmin.

E. Abderhalden and C. Brahm (Z. Physiol. Chem., 65, 330-5) found that the fat deposited after feeding large amounts of mutton tallow or rape seed oil gave the reaction of the fat fed. This was not the case with the cell fat separated from the deposited fat by digestion with gastric juice or with dilute HCl.



The Effect of Good and Poor Nourishment  
Upon the Water and Fat Content of the Animal Body.

Carl Voit's experience (Hermanns Handb. d. Physiol. 6(1881), 1-575) along this line showed that where insufficient nourishment is given to any organism the whole body becomes watery; while on the contrary, a well nourished body contains more fatty tissue with less water content, making therefore more dry substance in the organism.

M. A. Muntz (Comptes. Rend. des Seances. 90(1880), 1175-1177) gives the fat of very fat animals in the following tables:

Fat of Intestines of	Melting point °C	% Solid Fatty Acid.	% Liquid Fatty Acid.
Ox "charolais" prize of honor	40.4	38.0	62.0
Ox durham First prize	39.5	35.0	65.0
Ox durham Second prize	38.3	32.0	68.0
Ox "charolais" Ordinary	42.1	42.0	58.0
Ox "charolais" lean	49.7	77.0	23.0
Cow durham prize of honor	30.0	34.0	66.0
Cow "durham-charolais" second prize	31.5	20.0	80.0
Cow "durham-charolais" thin	47.2	61.0	39.0
Hog Normandy prize of honor	36.5	28.0	72.0
Hog Normandy ordinary	38.3	32.0	68.0

It will be noticed from these figures that the fat of the very fat animals is very low in solid fatty acids, and that the thin animals have a higher melting point and lower liquid fatty acid content than the fat animals.

R. Ross and J. Race (Analyst 36, 213) found the usual constants of fat and fatty acids but very high Zeiss and Iodine values in the fats of chickens and turkeys which had died from overfeeding.

For goose fat J. L. Mayer (Pharm. J. 85, 94-5) found the following:

Free Acids	Melting Point	Iodine Number	Saponification Number	Acid Number
	14.5°	72.66	191.0	0.413
Mixed Fatty Acids	38.5°	65.37	—	—

In the Tierärztl. Zentr. 33, 195-201, 213-15 through the Chem. Zentr., 1910 II 588, Franz Puntigan arranges all the properties of buffalo meat in which it differs from beef to give a practical method of distinguishing these meats. He has shown that beef has a much higher food value than buffalo meat. The properties of buffalo fat were especially studied as a means of distinguishing this meat from others. Investigations of muscle fat gave a melting point of 51.2° (of the fatty acids 45.3°), acid number 19.52, saponification number 171, Iodine number 48.17. Fat from the Interstitial tissues gave a melting point 48.1° to 51.5° (of the fatty acids 46.4 to 54.1°) acid number 1.00-5.62, saponification number 185-190 and Iodine number 30.98-42.66. From its chemical and physical properties

buffalo fat is worth much less than beef fat, corresponding more nearly to mutton fat.

L. Pfeiffer (Zeit. für Biologie 23(1886), 340-380) worked with both thin and fat dogs, rabbits and chickens and determined the percentage of fat in the various organs. The water content was found to be greater in thin animals. The condition and species of animal produced some differences.

Schultz (Pflüger. Archiv. 76(1899), 379-410) investigated the absorption of the deposits of fat in underfed animals in order to ascertain the possibility of determining the amount of fat in the animal body by examining a control animal. His work showed that Cholesterol was present to a marked extent in flesh apparently free from fat.

S. Hatai (Amer. Jour. Physiol. 18(1907), 309-320) recently showed in the central nervous system of partially starved albino rats a low per cent of ether-alcohol extract and a high percentage of water.

W. Lummert (Pflüger. Archiv. 71(1898), 176-208) demonstrates that the fats of the animals with which he worked were composed almost exclusively of the triglycerides of stearin, palmitin and olein. But D. Holde and M. Stange (Berichte d. deut. Chem. Gesells. 34(1901), 2402-2408), however, have shown conclusively the presence of mixed glycerides, And Willy Hansen (Archiv. für Hygiene 42, 1-15) confirms this opinion in his work.

P. Hartley (Lister Inst. of Preventive Med. J. Physiol. II., 39, 296-310 through Chem. Zentr. 1909, II, 920)

in telling of the nature of the fat contained in the liver, kidneys and heart says that palmitic, stearic, oleic and linoleic acid as well as an acid of the formula  $C_{20}H_{32}O_2$  were found in the liver. The double linkage in the liver oleic acid lies between the sixth and seventh carbon atoms while in the oleic acid of the adipose tissue the double bond is exactly in the middle of the chain. The high Iodine values of the liver fatty acids and also the ease with which they take up oxygen, from the air, are due to the presence of linoleic acid and the acid of the formula  $C_{20}H_{32}O_2$ .

In addition to the triglycerides of the fatty acids with which we have to deal in animal fats, G. Bouchard (Maiteres Grasses 2, 1459-61) has shown that there is a small percentage of unsaponifiable matter in animal fat. Following the method of Allen and Thomsen (extracting the dried soap with petroleum ether) they give the following results:

Beef suet	0.15 - 0.33%	Commercial samples	0.35 - 0.79%
Mutton tallow	0.21 - 0.24%	Horse fat	0.28 - 0.56%
Commercial samples	0.25 - 0.45%	Poor qualities	0.52 - 1.22%
Cooking tallow	0.27 - 0.38%	lard	0.15 - 0.31%

The figures for bone grease vary according to the method by which the grease was obtained:

With water	0.48 - 0.66%
Petroleum ether	0.86%
Benzine	0.92 - 1.30%
Carbon tetrachloride	0.78%

Glue grease from beef skins	0.04 - 1.00%
" " " goat "	2.58%
" " " sheep "	3.35%
" " " Amer.lamb skins	7.14%
" " " Beef tendons	0.61%
" " " sheep cuttings	5.91%
" " " common	0.92 - 4.80%

Average 2.45%

H. Matthes and W. Heintz (Inst. Pharm. and Nahrm. Chem. Uni. of Jena. Arch. Pharm. 247, 650-7) gives the following results on the unsaponifiable constituents of Japan tallow:

1. About 60% of unsaturated oxygenated liquid products.
2. Myricyl alc., Melts 88°.
3. Phytosterol with a double linkage, melts 139°.
4. Ceryl alc., melts 79°.
5. Saturated alc., melts 65° apparently  $C_{19}H_{40}O$ .

Matthes and Heintz (Ibid. 161-75) also give their results on the unsaponifiable constituents of cotton seed oil. Petroleum ether extracted from the oil 0.71 per cent of unsaponifiable matter as a yellowish brown partly crystalline mass having an agreeable odor. It did not give the Beocchi reaction. Neither Cl nor S could be detected. The Iodine value after four hours was 77.15. The unsaponified matter may be separated into a liquid and a solid

constituent both of which correspond closely in their physical and chemical properties. The liquid portion may be purified by distillation and consists of unsaturated substances containing oxygen. The author expresses the opinion that most of the phytosterols described as new are mixtures of known forms. .



# Composition of the Fat as Affected by the Situation in the Animal Body.

On the formation of fat from protein and fat, Victor Subbotin (Zeit. für Biologie 6(1870), 73-94) analyzed three fats from a dog fed lean meat and palmin (containing palmitin and olein). The following table shows that the external fat has the lowest melting point, the lowest content of palmitin and stearin and the highest content of olein, while in the case of the internal fats just the reverse is true. His results are here shown:

Fat	Melting Point	Per cent Palmitin	Per cent Stearin	Per cent Olein
Subcutaneous	30.5	50.8	9.0	40.2
Mesentery	40.0	53.3	13.2	33.5
Kidney	40.5 - 41.0	56.5	13.9	30.6

Further proof of this condition is shown by the following tables. The data here shown is for two dogs, one fed palmitin and stearin and the other fed in the usual manner:

		Melting Point	Per cent Palmitin	Per cent Stearin	Per cent Olein
Dog 3	Subcutaneous	40.0	52.8	13.2	34.0
	Mesentery	42.0	53.6	13.4	33.0
	Subcutaneous	40.0-40.5	44.87	19.23	35.9
Dog 4	Mesentery	42.5	39.72	32.48	27.8

M. A. Muntz (Comptes. Rend. des Seances 90(1880), 1175-1177) analyzed the fats from the ribs and intestines of four fat sheep. The sheep were fattened thus; sheep

one was a very fat animal, two had been fattened on corn, three on bran and four on oil cake. From the following table it will be seen that the data is in accord with previous investigations, i.,e., that external fat has a lower melting point and a higher liquid fatty acid content:

Animal	Fat	Melting Point of Fatty Acids	Per cent Solid Acids	Per cent Liquid Acids
Sheep 1	Rib	44.7	52.0	48.0
	Intestines	49.2	74.0	26.0
Sheep 2	Rib	40.2	38.0	62.0
	Intestines	46.7	60.0	40.0
Sheep 3	Rib	35.7	26.0	74.0
	Intestines	45.9	56.0	44.0
Sheep 4	Rib	39.5	35.0	65.0
	Intestines	46.5	58.0	42.0

A. Lebedeff gives the following values for a goose fed with peas, to illustrate the same point. (Zeit für Physiol. Chemie. 6(1882), 139-154).

	Melting Point	Per cent Oleic Acid	Per cent Solid Acid
Intestinal Fat	39.5	66.4 - 63.7	29.9 - 31.3
Mesenteric Fat	37.5	68.7	21.2

In the case of human fat the following values are given:



Fat from:	Per cent Oleic Acid	Per cent Solid Fatty Acids.
Liver	68.7 - 68.4	26.6 - 26.8
Liver	60.4 - 61.9	32.8 - 31.9
Lung	76.1 - 73.2	13.7 - 14.0
Subdermal	80.0 - 78.6	16.7 - 14.7
Intestines	74.6 - 76.6	22.0 - 20.9

Here the livers and lung were not in a perfectly healthy state. The livers being very fat and the lung having a fat embolie. The subdermal fat having the highest oleic acid content.

J. Vanvakas ( Ann. Chim. Anal., 15, 64) in work upon ostrich fat used the floating grease from the boiling in water of broken bones and fatty tissue. As the grease cools the fat separates into two layers, a yellow liquid and a heavier white solid with the following analysis:

	Melting Point	Saponification Number	Iodine (Hubl.) Number
Liquid Fat	8°	211	71.12
Solid Fat	45°	—	—

Amthor and Zink's (Zeit. für Analyt. Chemie 31(1892), 381-383) work with the fat from the body of a horse gave the internal fat the highest melting point.

	Kidney	Crest	Rib	Foot
Melting Point	39.00	34.0 - 35.0	36.0 - 37.0	—
Iodine Value	81.09	74.84	81.60	90.30

A. Bomer (Zeit. für Unters der Nahr. und Genussm. 1, (1898), 532-552) investigating the storing of cotton seed oil in hog fat finds that marked differences in the Iodine

value occur in the fats from the different parts of the body of the same hog and the same body fat of different hogs. To show this he gives the tables of v. Raumer (Zeit. für angew. Chemie 1897, 210-215 and 247-254).

Hog Fat	Iodine Value.
Fat back	54.0 and 61.7
Abdominal	50.4
Neck	66.2 - 70.4
Back	63.6 - 66.7
Abdomen	60.4 - 66.7
Upper Thigh	69.5 - 69.6
Ham	67.7 - 69.0

The first two fats are from the local German Market and the others from Armour and Company, Chicago. The order of Iodine values are for the American fats; upper thigh, ham, neck, back and abdomen. Of the two German fats the external fat has a higher Iodine value than the internal fat.

W. Lummert (Pflüger. Archiv. 71(1898), 176-208) investigating the subdermal and intestinal fat of his four dogs gave the following values:

		Melting Point	Iodine Value
Dog 1	Subdermal fatty acids	33.5 - 36.0	63.9
	Intestinal " "	33.5 - 36.5	60.3
Dog 2	Subdermal " "		66.5
	Intestinal " "		66.3

		Melting Point	Iodine Value
Dog 3	Subdermal fatty acids		63.3
	Intestinal " "		65.2
Dog 4	Subdermal " "	33.5 - 37.0	
	Intestinal " "		72.8

While all the values are not given they are very similar with one or two exceptions. Most of the values show that the subdermal fat contains more oleic acid than the intestinal fat.

M. Thiemich (Zeit. für Physiol. Chemie 26(1898-99), 189) working upon children under pathological conditions found that the Iodine values of the liver fat were higher than those of the subdermal fat. For animals he quotes the following tables:

#### PATON.

		Melting Point	Per cent Solid Fatty Acids.
Kittens	Body Fat	26.0 - 27.0	20.0
	Liver Fat	41.0 - 45.0	36.0
Rabbits	Body Fat	24.0 - 25.0	16.6
	Liver Fat	36.0 - 37.0	30.0

#### ROSENFELD.

		Melting Point	Iodine Value
Dog A.	Omentum	52.0	41.0 - 42.0
	Subdermal	48.0	47.0
	Liver	40.0	83.0
Dog B.	Omentum	51.0-52.0	44.5
	Subdermal	51.0	—
	Liver	35.0	75.4

LUMMERT.

Iodine Value of	Dog 1	Dog 2	Dog 3
Liver Fat	87.70	89.9	84.2
Subdermal Fat	63.94	66.5	63.3
Intestinal Fat	60.30	66.3	65.2

In the tables of Rosenfeld and Lummert, the subdermal fat has a higher Iodine value or a lower melting point than the omentum or intestinal fat and also shows that the liver fat is very high in oleic acid. In Paton's table the body fat has a lower melting point and a lower solid fatty acid content than has the liver which does not show a very high oleic acid content. The difference in age and animal may account for this.

Henriques and Hansen (Sommenlignende Undersøgelser over det dyriske Fedts. Kemiske Sammensatning Oversigt over det Kgl. Danske Videnskabernes Selskabs Fordhandlinger, 1900) working with the fats of the dog, horse, ox, pig, goose and camel found that the dermal fat showed uniformly a higher Iodine value and a lower solidifying point than the fat of the internal organs. Three different layers of fat beneath the dermus of the pig, camel and common seal were investigated. The farther the fat was from the surface the lower the Iodine value. They also found that low temperatures tend to increase the Iodine value and lower the melting point of the dermal fat. They also go on to state (Skand. Arch. Physiol. 11(1901), 151-165) that the interior of the body being warmer than the surface, may

effect the chemical composition of the fat found there. And to find out whether this could be true or not, they treated three pigs as follows. One was kept in a warm room, one in a cold room but with its body sewed up in a sheep skin for protection, and the third was left in a cold room unprotected. All three were fed the same for three months. It was then found that the surface fat of number three had formed a high olein content with a low melting point. But their internal fats were much the same.

Lemmerman and Linkh (Landw. Jahrb. 32(1903), 635-653) met with almost the same results in their work upon pigs. Here it was found that the back fat had the lowest melting point, highest Iodine value and refractive index. Then next in order came the fats of the abdomen, kidney and intestines, bearing out the idea of high oleic acid content and low melting point when passing from exterior to interior.

The following is a statement of the results of Raikow (Chemiker - Zeitung 28(1904), 272-273) in his study of the fats of a bear:

	Specific Gravity at 15°.	Iodine Value
Stomach Fat	0.9209	98.5
Kidney Fat	0.9211	107.4

A. D. Emmett and E. C. Carrol (J. Biol. Chem. 1911, 9, 23-5) determined the physical constants of hog fat. Groups of pigs were divided into three lots and fed on a

low protein plane, on a medium plane and on a high plane. Differences in physical constants due to feeding were very slight. "If the data from the various samples be compared with respect to the kind of fats, they show that the values for the Iodine number and melting point are quite different in the case of the back fat when compared with the leaf and composite samples of fat. The following table will show this:

Averages		
Fat from	Iodine Number	Melting Point
Back	51.23	34.10°
Leaf	45.60	42.80°
Composite	45.91	45.70°

Comparing all samples of fat in respect to both the protein feed and the kind of fat and without regard to ancestry, age and type of animal or to individuality, the specific gravity, saponification number, the insoluble acids and the index of refraction appear to be practically constant in each case, averaging all the samples, 0.8934, 196.94, 95.58 and 1.4595 respectively".



Effect of Age of the Animal  
Upon the Constitution of the Fats.

In their endeavor to discover the effect of age upon the constitution of fats, investigators have studied the fats of human beings in all stages of growth. M. Thiemich gives Ludwig Langer (Sitzungsberichte der Wiener Academie der Wissenschaften, Mathem-Naturwissensch. Classe 1881 Vol. 84, 191) credit for discovering that the subdermal fat of a newly born child is poorer in its content of oleic acid and richer in solid fatty acids than the fatty tissue of adults. Langer (Monatshefte für Chemie 2, 382-397) gives the melting point of the fat of a young child at 45° C. Adults fat when allowed to stand separates into two layers, the upper one a yellow liquid solidifying below 0° C and the lower layer crumbly, crystalline and liquid at 36° C. The mixed fatty acids of the newly born child contained 32.75 per cent of solid fatty acids, that of the adult 10-20 per cent. In the following table it will be seen that the fat of the child contains more glycerides of the solid fatty acids, and that of the adult more glycerides of oleic acid:

	Child	Adult
Oleic Acid Per Cent	65.04	86.21
Palmitic Acid Per Cent	27.81	7.83
Stearic Acid Per Cent	3.15	1.93

From the data furnished by Wilk Knöpfelmacher (Wiener Klin. Wochenschr 1897, 228-229; further Jahrb. für

Kinderheilk 45, 177-203) we are enabled to draw the same conclusions. Sixty-seven per cent of oleic acid was found in the dermal fat of a nursing child whereas in the adult as high as 89 per cent may be found. The Iodine value shows 43.3 per cent oleic acid in the newly born child, but this value rapidly rises at the end of the second month with the transformation of "Fettsklerem". In two seven weeks old children the solidifying points were 28° and 30°. In a child six months of age 25°. The following tables for the subdermal fatty acids show a uniform increase with age:

Iodine Value.

1.	Child 23 days, very fat	39.70
2.	" 25 " " "	38.53
3.	" newly born	40.08
4.	" 7 weeks, very thin	42.84
5.	" 7 " " fat	50.35
6.	" 6 months, very fat paniculus	50.98
7.	" 10½ " " " "	55.52
8.	" 12 " " immaciated	63.75
9.	" 17 " rich in fat	64.35

M. Thiemich (Zeit. für Physiol. Chemie 26(1898-99), 189) disputes the claim of Knöpfelmacher and gives tables to show that this increase is not uniform:

	Iodine Value
1. 6 months very well nourished	33.75
2. Same child 14 days later	26.00
3. 5 months, sound and strong	33.85
4. 9 " thin but sound	29.95
5. 8 " sound	31.70



# Iodine Value.

	Dermal Fatty Acids	Liver Fatty Acids.
Newly Born 1	44.8	_____
" " 2	42.4	_____
" " 3	41.8	57.9
" " 4	38.8	42.5
" " 5	49.2	54.05
" " 6	47.0	_____
" " 7 <del>h</del>	40.0	_____
23 days k)	39.7	
25 " k)	38.53	
1 month	38.1	
1 $\frac{1}{4}$ months	50.6	67.0
1 $\frac{1}{2}$ "	48.1	59.2
1 $\frac{1}{2}$ "	_____	45.0
1 $\frac{3}{4}$ " k)	42.8	
1 $\frac{3}{4}$ " k)	50.3	
3 $\frac{1}{2}$ "	53.4	66.4
3 $\frac{1}{2}$ "	53.2	69.8
3 $\frac{1}{2}$ "	53.3	63.2
3 $\frac{3}{4}$ "	58.9	69.1
3 $\frac{3}{4}$ "	54.4	70.2
4 "	41.4	46.7
4 $\frac{1}{2}$ "	42.3	_____
5 "	47.8	60.7
6 "	47.0	59.3
6 " k)	51.0	_____

	Dermal Fatty Acids	Liver Fatty Acids
7 months	48.5	75.6
8 "	48.1	54.2
10½ " k)	55.5	—
12 " k)	63.7	—
17 " k)	64.5	—
23 "	—	80.6

k) These values are from the work of Knöpfelmacher and are for fats obtained from children in pathological condition. The health of the child affects the Iodine value and the olein content.

F. Siegert (Hofmeister's Beiträge Z. Chem. Physiol. u. Pathol 1, 183-188) takes the view of Knöpfelmacher and says that the newly born child gives an Iodine value of 49.2 while one prematurely born 49.4. The Iodine values for children in the first quarter year are 45.0, for the second quarter 50.7, for the third 50.85 and for the last quarter of the first year 58.55. It then rises to 62.35 and increases in the adult to 65.

Hermann Jaeckle (Zeit für physiol. Chemie 36(1902) 53-84) found the olein content of the fat of two children to be 55 per cent and 67.6 per cent. The Iodine value of the fat of seven adults ranged from 62.5 to 73.3 and the olein content from 72.7 per cent to 85.3 per cent. Here the fat was found to contain principally the simple glycerides of olein, palmitin and stearin. In early life the fat is much richer in the solid fatty acids and poorer in

oleic acid.

König and Schluckebier (Zeit. f. d. Unters d. Nahr. und Genussm. 15(1908) 641-661) state that the melting point of the fats of hogs increases with the age of the animal while the Iodine number falls. The body fats possess both the chemical and physical properties of the food fats. The following tables are given:

		Melting Point	Iodine Value
Young Suckling Pigs	Lard Fat	30.7	65.2
	Fat from head	30.5	65.5
	Fat from ham	30.0	65.5
Hogs (Experimental)	Lard Fat	37.9	62.4
	Fat from head	37.2	63.9
	Fat from ham	36.9	64.4
	Fat from Intestines	37.7	61.9
	Fat from Stomach	41.0	58.2
Hogs still older, ready for slaughter.	Lard Fat	44.3	60.8
	Fat from stomach	47.5	55.0

While these results seem to contradict those of other investigators previously recorded, there seems to be, however, a preponderance of evidence to prove that in normal physiological conditions, the olein content of fat increases with age.

## PART II.

### EXPERIMENTAL PART.

#### Object of this Investigation.

During the progress of the nutrition investigations begun at the Missouri Experiment Station in the spring of 1907, a considerable number of beef animals have been slaughtered. Most of these animals were secured at birth and were fed for definite conditions of development. The young steers were divided into three groups as follows: Group I consisted of animals on full feed all the time, Group II consisted of animals fed for maximum growth without the laying on of fat, Group III animals were fed for retarded growth, being permitted to gain one-half pound per day.

At the time of slaughtering these animals and while the carcasses hung in the coolers, samples of adipose tissue were taken to represent the composition of this substance in different parts of the animal. The fresh samples were analyzed for moisture, fat, ash and protein and a portion of the rendered fat preserved for later investigations.

This investigation was undertaken to study the composition of the fats from the different parts of the animal to show in what manner the composition may be influenced by age and condition. Moulton (J. Ind. & Eng. Chem. 1, 761-8) in this laboratory studied the composition of the fats from nine animals. As a preliminary study,

samples of fat were taken from six steers, being the three oldest and the three youngest animals killed up to the time of this investigation. These six were selected with a view to showing the greatest possible range of values due to age and condition. The fats from the six steers showed a great variation in composition and the fats from as many more animals were studied as the time would permit. Three fats of each animal were selected; the kidney fat, taken as typical of the inside fats, the rump fat, a typical external fat and the chuck fat just inside the shoulder joint as typical of an intra-muscular fat.

## Method of Preparation and Analysis.

Samples of fat tissue from the various parts of the steer were taken as the carcass hung in the cooler. All such samples were thoroughly ground and mixed and a portion taken for moisture, fat, ash and protein determinations, the remainder being rendered for melting point and Iodine value determinations.

The samples of fat were rendered on the hot water bath, squeezed through muslin and then filtered through paper filters. The clear fats were collected in 50 cc. Erlenmeyer flasks, dried in a vacuum oven at 60° C and a pressure of 60 cm. All the samples were kept in cold storage until ready for use.

The fresh samples of fatty tissue were analyzed as follows:

Moisture Content. Preparation of the tubes for Moisture and Fat. These tubes were of glass and about the right size to slip in and out of a small Soxhlet extractor freely. Over one end of the tube a piece of hardened filter paper was wired on with aluminum wire. A plug of fat free cotton was inserted in the tube, which was then thoroughly dried and weighed to a constant weight.

A portion of the thoroughly ground and mixed sample was placed in a glass stoppered weighing bottle holding 50 to 75 grams of fat. An aluminum spoon and a short glass stirring rod were placed in the bottle. Samples of



about five grams each were weighed out in triplicate by the method of differences. The samples thus weighed out were rolled and thoroughly mixed with fat free cotton to prevent the meat drying up into a hard mass, from which the ether could not extract all the fat. Formerly sand was used for this purpose but owing to the danger of loss of some of the small grains of sand it was discarded for the cotton which was found to be just as good for extraction work and gave less chance for error. The fat samples thus mixed with cotton insure thorough extraction with ether. After rolling in cotton the fat samples are then ready for the small glass extraction tubes. A plug of cotton is inserted in the lower end of the tube, next the cotton containing the fat and last another plug of cotton.

The extraction tubes thus prepared were placed in small vacuum desiccators (no two samples of the same fat being placed in the same desiccator). The small vacuum desiccators had well ground and lubricated surfaces where the parts fitted together and contained about one inch of pure, concentrated sulphuric acid. The desiccators were exhausted by means of a Geryk vacuum pump and allowed to stand in a cool place for about forty-eight hours. The desiccators were gently rotated every few hours to mix the upper watery layer of acid with the lower concentrated layer. The extraction tubes were then transferred to another desiccator containing fresh acid and again held in a vacuum for about twenty-four hours. They were then weighed in glass stoppered weighing bottles. This process

was repeated until the weights became nearly constant. The loss in weight represented the moisture content. The results obtained by this method were very satisfactory and the triplicate analyses agreed very closely.

Fat. The glass extraction tubes from the above determination were placed in Soxhlet extractors and extracted with ether distilled over sodium for twenty-four hours. The ether remaining in the tube was driven off at a temperature not to exceed 60° C and the tubes were then dried in a vacuum desiccator for twenty-four hours. The fat content was determined by the loss in weight. Very close checks were obtained.

Ash. Samples of from eight to ten grams were weighed and transferred to a large size porcelain crucible. They were then ignited over a low flame until sufficiently charred to prevent spattering of the melted fat. The charred mass was then ignited until perfectly white. The crucibles were allowed to cool in a desiccator and weighed. The loss in weight represented the weight of ash. The triplicate results were very satisfactory.

Protein. Samples of from three to five grams were weighed out in triplicate into 9 cm. filter papers, and transferred to 500 cc. Jena Kjeldahl flasks. They were then digested with concentrated sulphuric acid, using mercury and potassium sulphate. The ammonia was distilled off and determined in the usual way using tenth normal hydrochloric acid and cochineal. The per cent of nitrogen

found multiplied by the protein factor 6.25 gave the protein content.

Method of Investigation  
for the Rendered Fats.

The rendered and filtered fats were taken from cold storage, melted and thoroughly mixed. The 50 cc. Erlenmeyer flask containing the fat sample was allowed to cool nearly to the point where the fat would begin to solidify and then weighed. A portion of the fat was then poured out by means of a stirring rod, determining the weight of sample taken for analysis by differences. The melting point, saponification value and Iodine value were determined as follows:

Melting Point. This determination was carried out as per Wiley's Official Method as given in detail on Page 133 of the Official and Provisional Methods of Analysis, A. O. A. C. 1907 Revised. The flat discs of fat were prepared according to the method recommended by Steenbock, (J. Ind. Eng. Chem, 1910, II, 480) except that the test tube containing the alcohol and the fat disc ~~was~~ not kept in a vacuum desiccator. When this test tube is heated the temperature at which the disc rolls up into a sphere is taken as the melting point.

Saponification Value. The saponification value was determined as given in detail on Page 137, Bulletin 107 Revised.

Iodine Value. The Iodine value was determined by the method of Wijs. The procedure was as outlined on Page 136, Bulletin 107 Revised, excepting that Wijs solution was employed and the details slightly modified to agree with the accepted practice when using a Wijs solution.

Condition and Age of Steers at Time  
of Slaughtering.

The six steers described here were a part of the group known as the "Use of Food" animals. They were all fed the same kind of feed consisting of two parts of grain ( six parts corn, three parts oats, one part linseed) and one part alfalfa hay.

Steer No. 500 was a grade Hereford, four years old. He was a Group III animal, the thinnest old steer killed in this experiment and graded as No. 3 according to the packing house standard of grading.

Steer No. 501 was a high grade Hereford, three years and eleven months old. He was a Group I animal and was the oldest and fattest animal of the "Use of Food" group.

Steer No. 512 was a grade Hereford, three years and eleven months old. He was a Group II animal and while being as old as No. 501 was only in medium condition and was graded as No. 2.

Steer No. 538 was a grade Hereford, ten months old. He was a Group II animal.

Steer No. 540 was a grade Hereford, ten months old. He was a Group III animal and was very thin. Steers No. 540 and No. 538 were very hard to grade as they were too thin and too young for good beef and too old for veal.

Steer No. 541 was a grade Hereford, ten months

old. He was a Group I animal, very fat and graded as Baby Beef.

Several fats were studied from the following animals in an endeavor to determine whether the tendency as displayed by the first six "Use of Food" animals would hold for a large number of animals. These animals were all Herefords and are described as follows:

Steer No. 525 was a Group III animal, two years and two months old.

Steer No. 529 was a Group I animal, three years and two months old. His first six months he was on a restricted ration and the next six months he was on body maintenance feed so as not to gain a single pound, after which he was on full feed the rest of his life.

Steer No. 527 was a Group I animal, three years and three months old and was on full feed all his life.

Steer No. 515, Group I animal, two years and eleven months old.

Steer No. 532, Group I animal, one year and five months old.

Steer No. 526, Group II animal, three years and four months old.

Steer No. 507, Group II animal, two years and ten months old.

Steer No. 523, Group II animal, two years and two months old.

Steer No. 588 was taken when about two and a



a half years old, a very fat show steer and kept for about three years at body maintenance weight.

Steer No. 596 was a high grade Hereford, moderately fat and about two years and ten months old.

Steer No. 48 was a grade Shorthorn, very fat and nearly five years old.

Cow No. 63 was a registered Jersey, very thin and about five years and eleven months old.

Jerry was a grade Hereford show steer, three years old.

Look-Me-Over was a registered Shorthorn show steer, three years old, very fat and soft.

Fyvie Knight was World's Champion Angus steer for 1909. He was about three years old.

Bobbie was a grade Angus, about three years old. He was a show steer.

In addition to the analyses of the adipose tissue, the melting point, Iodine number and saponification number were determined. The Iodine value shows the greatest variation in the different fats and seems to give the greatest index to the conditions of the animal. The Iodine number of all the fats was determined of the oldest group of animals as well as the youngest. Also the Iodine number of the kidney fat, an intestinal fat and the rump fat, an external fat of a number of other animals. The chuck fat, an intra-muscular fat, was also analyzed in several instances to show its relative position

as compared with the kidney and rump fats.

The Iodine number gives a measure of the amount of olein present in beef fat. Beef fat being composed of the three simple triglycerides of stearin, palmitin and olein, a high Iodine value corresponds to a low melting point, but this does not seem to hold true for butter fat. In data obtained from the Dairy Department, as yet unpublished, it was shown that butter fat does not always follow this rule because of the various other fats and fatty acids. It has been found that a low Iodine number accompanies an increase of the Reichert-Meissl number but this does not necessarily mean a raise in the melting point. It requires three times as much oleic acid to give the same Iodine number as one part of linolenic acid, which may be present in the butter fat.

The Dairy Department fed Cow No. 62 enough feed to keep up her normal fat content in the milk as well as her body maintenance. They then cut down the feed to just enough to maintain the body. The production of milk fat staid the same although the pounds of milk decreased. The Iodine number increased from 32.24 to 48.00 while the melting point decreased from 33.87 to 30.50. The Reichert-Meissl decreased from 26.17 to 23.88. This shows the relation between the Iodine number and the melting point and also indicates that the milk fat seemed to approach the body fat in composition. This tendency was most marked in Cow No. 62, although several other cows showed the same tendency.

In the work on the saponification number of the fats such a small variation was found that it was not deemed of value to study this determination farther. The values found were as follows:

Lowest Melting Point	Highest Melting Point	Saponification Number	C <sup>o</sup> ndition
17.46		200.87	Old and Fat
	46.04	196.97	" " "
35.63		191.23	Old and Lean
	48.50	194.92	" " "
	49.56	195.06	" " "
31.63		200.45	Young and Fat
	46.30	194.51	" " "
Average for seven values		196.43	

No specific gravity determinations of any of the fats were made because previous work along this line proved such determinations to be valueless as giving any insight into the structure of the fat.

## Discussion of Data.

The accompanying cuts will give some idea of the conditions of six "Use of Food" animals studied in this investigation. Cuts I to IV give the side, rear and front views of Steers No. 501, No. 512 and No. 500 at the time of slaughtering. Cut V gives the side view of the three calves No. 541, No. 538 and No. 540 at the age of ten months. This shows their condition at the time of slaughtering. The three calves were fed the same as the older steers No. 501, No. 512 and No. 500 and throughout this experiment the characteristics of the younger animals were maintained in the older ones.

The first four tables given below show the percentages of Protein, Moisture and Fat in the adipose tissue of eight "Use of Food" animals. Steer No. 512 is given the first place in tables I, II and III, he being taken as a standard for comparison. The order of the fat samples was determined by the ascending values in No. 512 in each table, making the orders very much the same in tables I and II and almost the reverse order in table III. In these tables it will be noticed that the adipose tissue of the very fat animals No. 501 and No. 541 are much lower in moisture and protein and very much higher in percentage of fat than the very thin animals No. 500 and No. 540, showing that the relative amounts of moisture, fat and protein of the fatty tissue are more dependent upon the condition of the animal than upon the age. The internal fats are

lowest in percentage of moisture and protein and highest in fat of any of the samples, the subdermal fats being just the reverse. Table IV shows that the internal fats have the highest melting points as well. The kidney fat furnishes the best example of this although in the case of No. 527, table VI, we have an exception which did not apply to No. 529. Here the kidney fat of No. 527 is higher in moisture and protein than the caul or inside rib fat. The marrow fat follows the kidney fat closely in every case except for the percentage of fat in the rump of No. 512. The marrow of No. 500 contains the least protein and moisture and most fat of any of the animals. The intra-muscular chuck fat of the thinnest animal contains more moisture and protein than in any of the other animals as well as some of the external samples of the same animal. The cod fat while classed as an external fat, on account of its location in the body, in values for moisture, fat and melting point closely resembles an internal fat.

In the melting point and Iodine value determinations on these composite fat of a still-born Jersey calf, the results indicate its composition as being similar to an internal fat and particularly the marrow fat of steers No. 501 and No. 512.

Table V should be considered in connection with Plate I of the curves. The table gives the arrangement of the cuts of the three oldest and three youngest steers according to the ascending Iodine values for No. 512 but



in the arrangement of the cuts for the plate, the majority of instances giving ascending values determined the order.

The order in this plate and table V being somewhat different yet the curve for No. 512 is a uniformly ascending curve.

It will be seen that the Iodine values increase from inside to outside while the melting points decrease in the same order. Here again the cod fat acts like an inside fat.

The order of the cuts as determined by the increasing Iodine values is as follows: kidney, intra-muscular chuck, marrow, cod, inner last rib, intra-muscular ninth and tenth rib, brisket and round. The values for the melting points do not decrease so uniformly, but they follow the same order in general. Thus while the Iodine value increases with age and fatness, Plate I shows that the melting point decreases demonstrating the relation existing between these two values.

Cut VI shows the inside of the right half of the carcass of the steers No. 501, No. 512 and No. 500. In the carcass of No. 501 we have a No. I Prime Beef but very much overdone. He had a very thick covering of fat on his body which is not present in the other two animals. The brisket fat of No. 501 is very thick with but very little of the muscle showing at all while in No. 512 and No. 500 there is almost as much muscle as fat to be seen. Another very striking comparison may be made in the quantities of cod fat on the three animals. In No. 501 the cod fat is very excessive, in No. 512 only medium and in No. 500 it is



very scant. The kidney fat also shows a marked decrease in the three animals going from a great excess in No. 501 to almost nothing in No. 500.

Cut VII and VIII show the twelfth rib from the right side of the animals. Cut VII shows a very close resemblance between No. 512 and No. 500, the meat of No. 512 showing, however, a little more marbling. But the difference between cuts VII and VIII shows how very much fatter No. 501 was than either of the other two.

Cut IX gives a view of the sixth, eighth and tenth ribs of the three oldest animals. This gives a very striking comparison in regard to the condition of these animals. No. 501 with his excessive outside fat and well marbled muscle, No. 512 with only a medium amount of fat and No. 500 very poor in fat and scarcely any marbling at all.

Cut X illustrates the relative amounts of fat laid on by these three steers in a cross section of the loin. Here the loin of No. 512 is shown as being not too fat but much fatter than No. 500. The loin of No. 512 would pass as second grade cow stuff but lacks quality as the bones were too prominent. The loin of No. 500 is very poor in fat with no marbling. In the loin of No. 501 we see the the same marked deposition of fat both inside and outside.

Cut XI shows a comparison between the carcasses of the three younger animals, No. 541, No. 538 and No. 540. Nearly the same things may be said concerning the fat of No. 541 as in the case of No. 501. A tendency is shown

here for an excessive covering of fat on the outside of the body and a large quantity of fat around the kidney, skirt and cod. Whereas in No. 538 and No. 540 but very little fat is stored inside the body but more, however, in No. 538 than in No. 540.

Cut XII shows the cross section of the loin of the three steers. There is not much difference in the amount of fat on the inside of the cuts of the two animals, No. 538 and No. 540, but No. 538 shows more marbling and a greater amount of fat on the outside. The loin of No. 501 shows an excess of fat both inside and outside.

Cut XIII is a rear cross section of the ribs looking at the tenth. This shows a good layer of fat over the outside of No. 538 and excessive marbling as compared with the other cuts of the same animal shown here. The rib cut of No. 500 shows little or no marbling and a very poor layer of fat over the outside. The cut of No. 501 shows a good deposit of fat both inside and outside with good layers of fat between the muscles.

In table VI we have given the moisture and fat values for adipose tissue for steers No. 527 and No. 529 and the protein values for No. 527. Steer No. 527 was taken as a standard because he had been on full feed all his life. The order of the fats is arranged according to position in the body from inside to outside. The tendency here is much the same as in the case of the six animals just discussed, the percentage of moisture and

protein increasing from inside to outside and the percentage of fat just the reverse. It will also be seen from this table that the percentage of fat in the various cuts of No. 529 is not so high in most instances as in No. 527.

Table VII gives the Iodine values of the cuts of Steers No. 527 and 529 according to the position in the body from outside to inside. The values range from 44.17 to 66.89 in No. 527 and from 43.10 to 66.11 in No. 529, yet the curves for these two animals as shown in Plate II follow each other very closely, probably as close as it would be possible to obtain from any two animals fed the same all the time. Both animals had thus reached the same high stage of condition of the fat.

The difference in weight and fatness of the animals was, however, rather great. Steer No. 527 had been full fed all his life while No. 529 was fed for retarded growth the first six months and then for body maintenance the next six months. After the first year, No. 529 was placed on full feed to see if the stunting was permanent. The following table of weights is given to show how nearly No. 529 evened up with No. 527.

Age	Pounds		Approx. Diff. in Pounds	527 Gain in Pounds	529 Gain in Pounds
	527	529			
4 weeks	167.8	173.4	6		
6 months	508.0	202.3	306	340	29
1 year	913.5	206.8	707	405	4
18 months	1187.3	629.7	558	274	423
2 years	1425.6	1013.7	432	238	384
2½ "	1641.9	1259.2	383	216	246
At time of slaughtering 3 yrs.	1861.5	1544.7	317	220	285

As calves between four and five weeks old, No. 527 and No. 529 were apparently in the same condition and of nearly equal weight. The table shows that No. 529 made very rapid gains and greater gains in weight than No. 527 after the first year but was unable to close up the gap between them. At the time of slaughtering the steers were still 317 pounds apart and it is doubtful if No. 529 could have ever overcome this lead.

Cut XIV gives a view of No. 529 at the age of four months after he had been fed on a restricted ration. No. 527 was on full feed all the time.

Cut XV shows the same steers at the end of one year during the last half of which No. 529 was on maintenance feed so as not to gain in weight. A difference of 707 pounds is shown in the weights of the two animals.

Cut XVI illustrates the remarkable growth of No. 529 after one year on full feed making him weigh within 430 pounds of No. 527. Both steers are two years old.

Cut XVII and XVIII shows the two steers at the time of slaughtering, about three years and three months old. Both are apparently in good condition and weigh within 300 pounds of each other. In addition to the foregoing table another one might well be added to show the proportion of lean, fat and bone in one of the cuts of meat.

Rib Right, Steer No.	529	527	Per Cent of Total	
			529 Cut	527
Total Weight in grams	18316	28394		
Lean	8995	12930	49.1	45.5
Fat	6691	12139	36.5	42.8
Bone	2576	3273	14.1	11.5

This table shows both a smaller weight of fat and a smaller percentage of fat in the rib of No. 529 than is shown in the case of No. 527.

Cut XIX shows the sixth rib from the right side of both animals. The rib of No. 527 was much the fatter of the two, showing a little more marbling and thicker layers of fat between the muscles.

Cut XX gives the chuck, round and loin cuts of No. 527 and No. 529 and shows the same differences as does the rib cut. In spite of this physical difference, - the permanent stunting of No. 529 and excessive fatness of No. 527 - there is, as we have seen, but slight difference between them in composition of the fatty tissue and the physical constants of the fat.

Table VIII gives the Iodine values for the kidney, rump and chuck fats arranged according to increasing age of the animals within the group. Starting in each group with a steer about ten months old the ages range up to four and five years and the Iodine values reach their maximum at about four years. In each group there is quite a variation of values with the two old animals No. 501 and No. 512 running above No. 541 and No. 538 whereas No. 500 an old animal in



group three falls below No. 540 the youngest animal of the group. Plate III may well be studied here. In this plate we have eliminated everything but age. The animals were fed the same all the time and up to the age of No. 532, about one and one-half years, the kidney and chuck fats have a tendency to become firmer, but the rump fat seems to get softer all the time, i., e., to increase its content of olein. After the first year and a half the Iodine value of the internal fats constantly increases. The Iodine value for the new born calf was given as 41.69 showing it to be much softer than either the chuck or kidney fat of steer No. 541 at ten months old.

Tables IX and X give the Iodine values for the kidney, rump and chuck fats arranged in ascending order, showing the different order of animals within the groups. Table X differing from IX in that only those animals are considered where all values for all three fats are given. But with the throwing out of some of the animals of table IX the averages for each cut in X remain practically the same. In connection with these two tables, plates IV, V and VI may be considered. These plates give the Iodine values of the kidney, rump and chuck fats. In plate IV the kidney fat is taken as a standard and the animals arranged so as to give ascending values to the curve. This causes extremely irregular curves for the chuck and rump fats and shows nothing at all in regard to them. But in regard to the arrangement of the animals we find that steer



No. 500, one of the oldest steers, is very near the lower end of the curve while nearly all the old animals fall at the upper end of the curve. Steer No. 541 holds a place a little beyond the middle of the curve and close to No. 512, a very old animal. Here age seems to have but very little influence whereas condition counts a great deal. Steers No. 527 and 529 also come very close to Steer No. 501, which animal was old and extremely fat. The same may be said of the curves shown in plates V and VI, although as was shown in plate III where great differences in condition were eliminated, age is of primary importance as it will tend to raise the Iodine number.

In plate VII where we have age and good condition as it is given in Group I a uniform curve results but in Group II where the condition is medium, age has less influence. In this plate the values are plotted according to group and increasing age. It will also be noticed in Group I and II the kidney and chuck fats give a lower Iodine value up to the time an animal is about one and one-half years old as represented by No. 523 and No. 532. Here as in all the plates the Iodine values for the chuck fat falls between the kidney and rump fats, indicating it to be a representative fat to be used in comparisons between internal and external fats.

Plate VIII gives the Iodine values for the animals according to age and condition by dividing them into three groups. The first group is considered as under one year

old. Here we find rather uniformly increasing Iodine value with increasing fatness. The second group considers the animals from one year to three years old. The tendency here is much more marked than in the first group while in the last group the upward tendency is the greatest, except in the case of the rump fat where the variation is not so uniform. The same tendency is shown here for each group as is shown in plate III for Group I. The effect of age is shown by each succeeding group averaging higher than the preceeding.

In Plate IX we have considered nothing but age and found no uniform variation. There are too many other factors to be considered, which more than overbalance age.

In tables XI, XII and XIII we have given the Iodine values for kidney and chuck fats, rump and chuck fats and kidney and rump fats arranged in ascending order to show the different arrangement of the animals within each group. From these tables, plates X, XI and XII were drawn. Plate X shows the ascending Iodine values for the kidney and chuck fats. The red dotted line indicates the average curve for each fat showing it to be an ascending curve except for Group II of the chuck. Plate XI shows the same plan for all three fats, kidney, rump and chuck, for each group. The dotted lines between the groups indicate the connection of one group with the next. Here an overlapping of the groups is clearly shown and the

average value for each group shows an ascending curve in the case of the chuck fat of Group II as previously mentioned. Plate XII is taken from table XIII and gives a curve representing the Iodine values of the kidney and rump fats in ascending order.

Throughout this investigation the relation between the melting point and the Iodine value has been apparent. The Iodine value increases with age and fatness while the melting point decreases with almost the same uniformity.

### Conclusions.

1. The percentage of fat present varies with the location of the fatty tissue in the animal body.
2. The percentage of fat increases from outside to inside while the percentage of moisture and protein decreases.
3. For animals on the same plane of nutrition, age produces an increase of fatness and a corresponding decrease of moisture.
4. In the adipose tissue a high percentage of fat is accompanied by a low percentage of moisture and protein.
5. A high percentage of moisture and protein is accompanied by a low percentage of fat and is indicative of the degree of fatness of the animal.
6. The Iodine value of the fat from the fatty tissue of an animal increases with the age and the degree of fatness of the animal.
7. The Iodine value of the fat increases from inside to outside of the body while the melting point falls in almost the same ratio.

### PART III.

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TABLE I.  
PERCENTAGE OF PROTEIN IN ADIPOSE TISSUE.

SAMPLE.	512	501	500	541	538	540
Kidney.	1.1438	1.1875	2.5630	1.2630	2.1250	11.1938
Marrow.	1.1625	1.3875	0.9188			
9&10 Rib, Intra.	2.5625	2.1563	3.8125			
Crops, Outer.	2.6875	2.3125	4.5313			
9&10 RIB, Outer.	2.9375	2.3125	5.6250			
Last Rib, Outer.	3.4375	1.6250	7.8438			
Rump.	3.5625	3.0625	5.1563			
Codl.	3.6250	2.5000	4.9375			
Chuck, Intra-M.	4.1250	2.5625	6.9375	4.7125	2.6250	
Brisket.	7.7813	3.5625	7.3125	4.2563		
Round, Outer.	13.8438	5.8125		6.1688	10.6688	8.4750
Last Rib, Inner.		2.5973				
Outside Over Rib Area.				3.0438		



TABLE II.

## PERCENTAGE OF MOISTURE IN ADIPOSE TISSUE.

SAMPLE.	512	501	500	541	538	540
Kidney.	4.482	5.462	7.026	4.494	6.747	13.401
Marrow.	10.084	10.169	9.460			
Cod. II	10.421	12.562	18.284			
9&10 Rib, Outer.	10.590	9.999	9.635			
9&10 Rib, Intra-	10.695	9.603	12.663			
Crops, Outer.	11.079	10.225	13.939			
Rump.	11.495	10.096	13.800			
Last Rib, Outer.	16.117	6.669	19.647			
Chuck, Intra-M.	21.072	14.707	25.543	15.892	20.147	
Brisket.	33.287	17.890	49.328	39.796		
Round Outer.	42.949	25.418				
Last Rib, Inner.		8.152				
Outside over Rib.				12.533		

TABLE III.

## PERCENTAGE OF FAT IN ADIPOSE TISSUE.

SAMPLE.	512	501	500	541	538	540
Round, Outer	42.725	66.561				
Brisket,	59.688	77.988	42.412	51.2 66		
Chuck, Intra-	74.107	81.857	67.502	76.925	72.150	
Last Rib, Out.	79.839	91.107	72.686			
Crops, Outer	86.001	86.174	81.308			
9&10 Rib, Out.	86.074	77.971	86.165			
9&10 Rib, Intra-Musc.	86.335	87.092	83.527			
Cod.	87.382	84.532	76.559			
Marrow.	88.2 97	88.390	89.251			
Rump.	91.238	85.690	80.895			
Kidney.	93.915	94.811	90.275	94.350	90.964	79.809
Last Rib, Inner.		88.954				
Outside over Rib area.				84.387		

TABLE IV.

## MELTING POINT DETERMINATIONS.

SAMPLE.	DEGREES CENTIGRADE.					
	512	501	500	541	538	540
Round, Outer.	19.76	17.46				
Brisket.	19.86	18.53	27.46	31.63		
9&10 Rib, Outer	21.35	19.26	37.05			
Last Rib, :	21.95	24.73	35.63			
Rump.	22.66	19.30	37.27			
Crops Outer.	28.28	19.40	42.00	39.05		
9&10 Rib, Intra	32.00	26.26	42.30	41.13	47.53	46.66
Cod.	35.42	23.50	43.23			
Chuck, Intra-M.	44.90	26.90	48.50	44.80	46.86	
Marrow.	45.75	46.04	45.53			
Kidney.	47.60	37.36	49.56	46.30	49.90	50.10
Last Rib, INNER		27.93				
Outside over Rib area.				37.90		
Composite of New Born Calf.				41.30		

TABLE V.

Iodine Values for the Different Cuts of the Oldest and Youngest "Use of Food" Animals.

SAMPLE.	512	501	500	541	538	540.
Chuck, Intra-M.	37.02	61.94	36.56	41.65	36.32	
Kidney	37.79	51.08	25.90	37.13	31.21	30.81
Marrow(Round)	40.92	41.31	44.08			
Cod.	49.38	63.50	43.00			
Crops, Outer	62.09	64.77	49.03	49.48		
9&10 Rib, Intra	62.25	58.80	46.33	45.19	33.34	37.68
Last Rib, Outer	65.97	58.60	55.38			
Rump	66.24	65.27	53.25			
9&10 Rib, Outer	69.00	66.22	53.18			
Brisket	70.09	66.80	63.31	57.06		
Round, Outer	71.44	67.97				
Last Rib, Inner		60.55				
OUTSIDE over Ribs.				49.36		
Composite Fat of New Born Calf				41.69		

TABLE VI..

SAMPLE.	MOISTURE.		FAT.		PROTEIN
	#527	#529	#527	#529	#527
Caul.	3.271	4.280	96.093	95.011	0.5313
Inside Ribs, Over plates,	3.858	4.653	94.338	91.460	1.5313
Kidney.	5.421	2.646	93.227	96.773	1.1690
Last Rib, Middle	6.996	6.590	91.221	91.831	1.4688
Cod .	7.862	8.421	90.230	89.793	1.7813
Rump.	8.118	8.540	89.3680	89.014	7.7060
Chuck, Intra-M.	8.705	16.621	88.528	79.919	1.9063
9&10 Rib, Intra-	8.883	8.761	89.466	89.197	1.5000
Last Rib, Outer	9.094	6.165	87.555	92.092	2.4063
9&10 Rib, Outer	10.462	8.331	86.992	87.820	2.2813
Crops, Outer	11.091	15.612	86.816	77.937	0.0688
Round, Outer	14.123	11.527	82.448	83.750	4.7060
Brisket,	15.404	14.641	81.412	82.348	3.1250

TABLE VII.

## IODINE VALUES FOR STEERS 527 and 529.

SAMPLE.	527	529
Caul.	44.49	43.10
Kidney.	47.53	45.16
Chuck.Intra-M.	59.42	47.02
Cod.	49.96	51.46
9&10 Rib,Intra.	53.25	51.53
Last Rib, Middle	60.80	59.26
Crops,Outer	44.17	47.73
Last Rib,Outer	63.99	59.97
Rump.	63.12	63.72
9&10 Rib,Outer	63.90	59.99
Brisket.	63.11	62.19
Round.	66.89	66.11
Inside of Ribs, Over Plates.	46.72	---



TABLE VIII.

Iodine Values for the Kidney, Rump, and Chuck Fats arranged According to Increasing Age of the Animals Within Each Group.

Group	NO. of Animal.	Age.	Kidney	Rump	Chuck
I	541	10 mo.	37.13		41.65
	505	10 mo., 17 da.	34.95	44.05	40.56
	594	10 mo. 24 da.	33.25	47.55	43.20
	532	1 yr, 5 mo.	31.80	50.79	39.78
	596	2 yr, 10 mo.	35.87	54.62	40.33
	515	2 yr, 11 mo.	41.88	57.58	44.00
	Saunders	3 yrs.	49.39	66.35	56.76
	527	3 yrs, 2 mo	47.53	63.12	59.42
	529	3 : 3 mo	45.16	63.72	47.02
	12 1	3 : 6 mo	40.84	46.32	46.90
	501	3 yrs, 11 mo	51.08	65.27	61.94
	48	5 yrs nearly	40.64	58.37	
	588	5 yrs 6 mo	43.68	67.65	
II	538	10 mo	31.21		36.32
	503	11 :	29.50	37.13	34.04
	593	16: :	34.10	42.89	42.58
	523	2 yrs 2 mo	25.59	46.67	33.86
	507	2 : 10 mo	34.36	60.65	41.60
	526	3 : 4 mo	30.13	53.19	39.80
	512	3 : 11 mo	37.79	66.24	37.02
III	540	10 mo	30.81		
	597	16 mo	32.44	40.70	40.15
	52 5	2 yrs 2 mo	27.31	41.85	
	18	3 : 6 :	33.41		45.88
	500	4 :	25.90	53.25	36.56

Average values for each group.

	Kidney	Rump	Chuck
I	41.01	57.11	47.41
II	31.81	51.13	37.90
III	29.97	45.2 6	40.86

TABLE IX.

Iodine Values for Kidney, Rump, and Chuck Fats Arranged in Ascending Order Showing Different Order of Animals Within the Groups.

GROUP	ANIMAL	KIDNEY	ANIMAL	RUMP	ANIMAL	CHUCK
I	532	31.80	505	44.05	532	39.78
	Geordie	32.90	121	46.32	596	40.33
	594	33.25	594	47.55	505	40.56
	505	34.95	532	50.79	541	41.65
	Bobbie	35.25	Bobbie	52.80	Bobbie	42.05
	596	35.87	596	54.62	594	43.20
	541	37.13	515	57.58	515	44.00
	48	40.64	48	58.37	121	46.90
	121	40.84	F.Knight	59.73	529	47.02
	515	41.88	527	63.12	Saunders	56.76
	588	43.68	529	63.72	527	59.42
	F.Knight	44.22	501	65.27	501	61.94
	529	45.16	Jerry	66.23	Geordie	
	Jerry	45.28	Saunders	66.35	Jerry	
	527	47.53	588	67.65	F.Knight	
	Saunders	49.39	541		48	
	501	51.08	Geordie		588	
II	523	25.59	503	37.13	523	33.86
	503	29.50	593	42.89	503	34.04
	526	30.13	523	46.67	538	36.32
	538	31.21	526	53.19	512	37.02
	593	34.10	507	60.65	526	39.80
	507	34.36	512	66.24	507	41.60
	512	37.79	538		593	42.58
III	500	25.90	597	40.70	500	36.56
	525	27.31	525	41.85	597	40.15
	540	30.81	500	53.25	18	45.88
	597	32.44	63	59.86	525	
	18	33.41	18	43.22	540	
	63	37.38	540		63	

## AVERAGES FOR EACH GROUP.

	KIDNEY	RUMP	CHUCK
I	40.60	57.61	46.97
II	31.81	51.13	37.90
III	31.20	48.92	40.86

TABLE X.

Iodine Values for Kidney, Rump and Chuck Fats in Ascending Order for Animals Where All Three Fats Were Given.

GROUP	ANIMAL	KIDNEY	ANIMAL	RUMP	ANIMAL	CHUCK.
I	532	31.80	505	44.05	532	39.78
	594	33.25	121	46.32	596	40.33
	505	34.95	594	47.55	505	40.56
	Bobbie	35.25	532	50.79	Bobbie	42.05
	596	35.87	Bobbie	52.80	594	43.20
	121	40.84	596	54.62	515	44.00
	515	41.88	515	57.58	121	46.90
	529	45.16	527	63.12	529	47.02
	527	47.53	529	63.72	Saunders	56.76
	Saunders	49.39	501	65.27	527	59.42
	501	51.08	Saunders	66.35	501	61.94
	523	25.59	503	37.13	523	33.86
II	503	29.50	593	42.89	503	34.04
	526	30.13	523	46.67	512	37.02
	593	34.10	526	53.19	526	39.80
	507	34.36	507	60.65	507	41.60
	512	37.79	512	66.24	593	42.58
	500	25.90	597	40.70	500	36.56
III	597	32.44	500	53.25	597	40.15
AVERAGES FOR EACH GROUP.						
I	KIDNEY		RUMP		CHUCK	
I	40.64		55.65		47.45	
II	31.91		51.13		38.15	
III	29.17		46.98		38.35	

TABLE XI.

Iodine Values for Kidney and Chuck Fats Arranged in Ascending Order Showing Different Order of Animals Within the Groups.

GROUPS	ANIMAL	KIDNEY	ANIMAL	CHUCK	AVERAGES FOR	
					KIDNEY	CHUCK
I	532	31.80	532	39.78	40.34	46.97
	594	33.25	596	40.33		
	505	34.95	505	40.56		
	Bobbie	35.2 5	541	41.65		
	596	35.87	Bobbie	42.05		
	541	37.13	594	43.2 0		
	12 1	40.84	515	44.00		
	515	41.88	121	46.90		
	529	45.16	529	47.02		
	527	47.53	Saunders	56.76		
	Saunders	49.39	527	59.42		
	501	51.08	501	61.94		
	523	25.59	523	33.86	31.81	37.90
	503	29.50	503	34.04		
II	526	30.13	538	36.32		
	538	31.21	512	37.02		
	593	34.10	526	39.80		
	507	34.36	507	41.60		
	512	37.7 9	593	42.59		
	500	25.90	500	36.56	30.58	40.86
	597	32.44	597	40.15		
III	18	33.41	18	45.88		

TABLE XII.

Iodine Values for Rump and Chuck Fats Arranged in Ascending Order Showing the Different Orders for Animals Within the Groups.

GROUP	ANIMAL	RUMP	ANIMAL	CHUCK	AVERAGES FOR	
					RUMP	CHUCK
I	505	44.05	532	39.78	55.65	47.45
	121	46.32	596	40.33		
	594	47.55	505	40.56		
	532	50.79	Bobbie	42.05		
	Bobbie	52.80	594	43.20		
	596	54.62	515	44.00		
	515	57.58	121	46.90		
	527	63.12	529	47.02		
	529	63.72	Saunders	56.76		
	501	65.27	527	59.42		
	Saunders	66.35	501	61.94		
II	503	37.13	523	33.86	51.13	38.15
	593	42.89	503	34.04		
	523	46.67	512	37.02		
	526	53.19	526	39.80		
	507	60.65	507	41.60		
	512	66.24	593	42.58		
III	597	40.70	500	36.56	46.98	38.35
	500	53.25	597	40.15		

TABLE XIII.

Iodine Values for Kidney and Rump Fats in Ascending Order.

GROUP	ANIMAL	KIDNEY	ANIMAL	RUMP	AVERAGES FOR	
					KIDNEY	RUMP
I	532	31.80	505	44.05	41.39	57.61
	594	33.25	121	46.32		
	505	34.95	594	47.55		
	Bobbie	35.25	532	50.79		
	596	35.87	Bobbie	52.80		
	48	40.64	596	54.62		
	121	40.84	515	57.58		
	515	41.88	48	58.37		
	588	43.68	F.Knight	59.73		
	F.Knight	44.22	527	63.12		
	529	45.16	529	63.72		
	Jerry	45.28	501	65.27		
	527	47.53	Jerry	66.23		
	Saunders	49.39	Saunders	66.35		
	501	51.08	588	67.65		
II	523	25.59	503	37.13	31.91	51.13
	503	29.50	593	42.80		
	526	30.13	523	46.67		
	593	34.10	526	53.19		
	507	34.36	507	60.65		
	512	37.79	512	66.24		
III	500	25.90	597	40.70	30.76	48.92
	525	27.31	525	41.85		
	597	32.44	500	53.25		
	63	37.38	63	59.86		



OUT I.



501

AT TIME OF SLAUGHTERING.

CUT II.

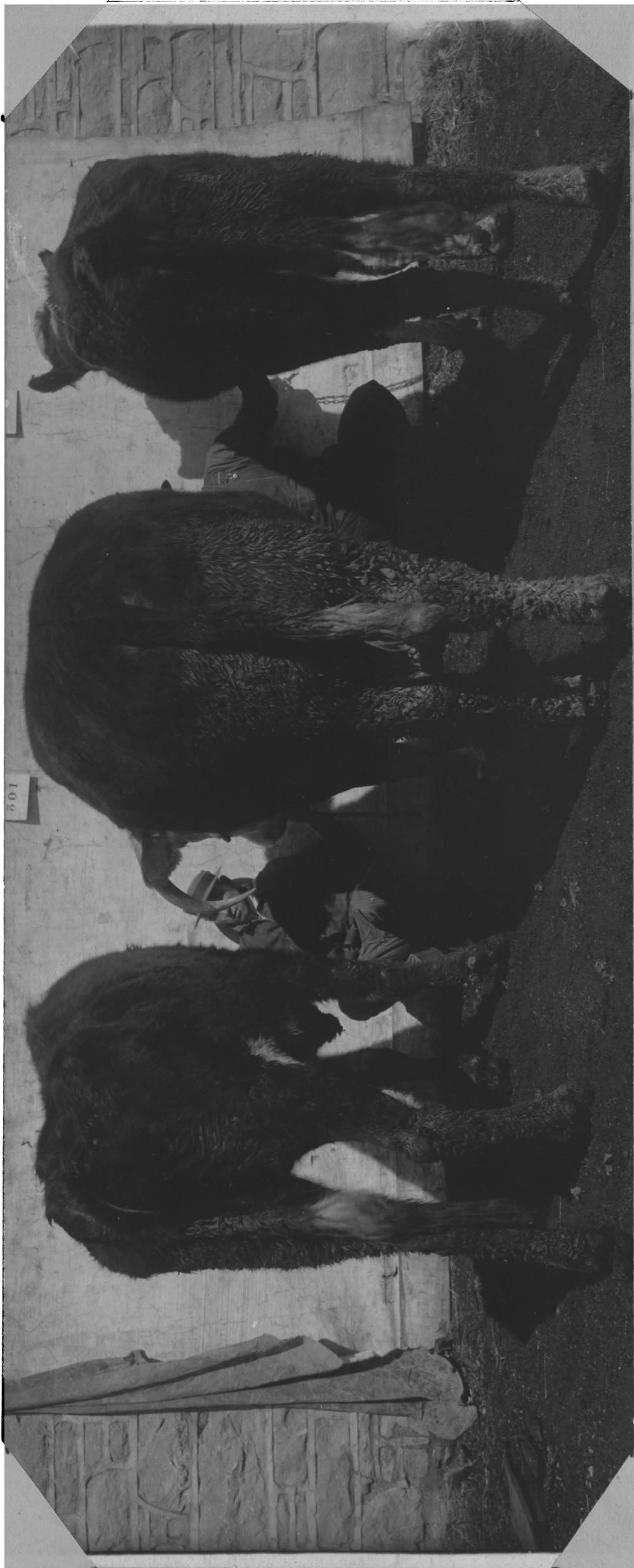


512



500

AT TIME OF SLAUGHTERING.



500

501

502

CUT III.



CUT IV.



CUT V.



541

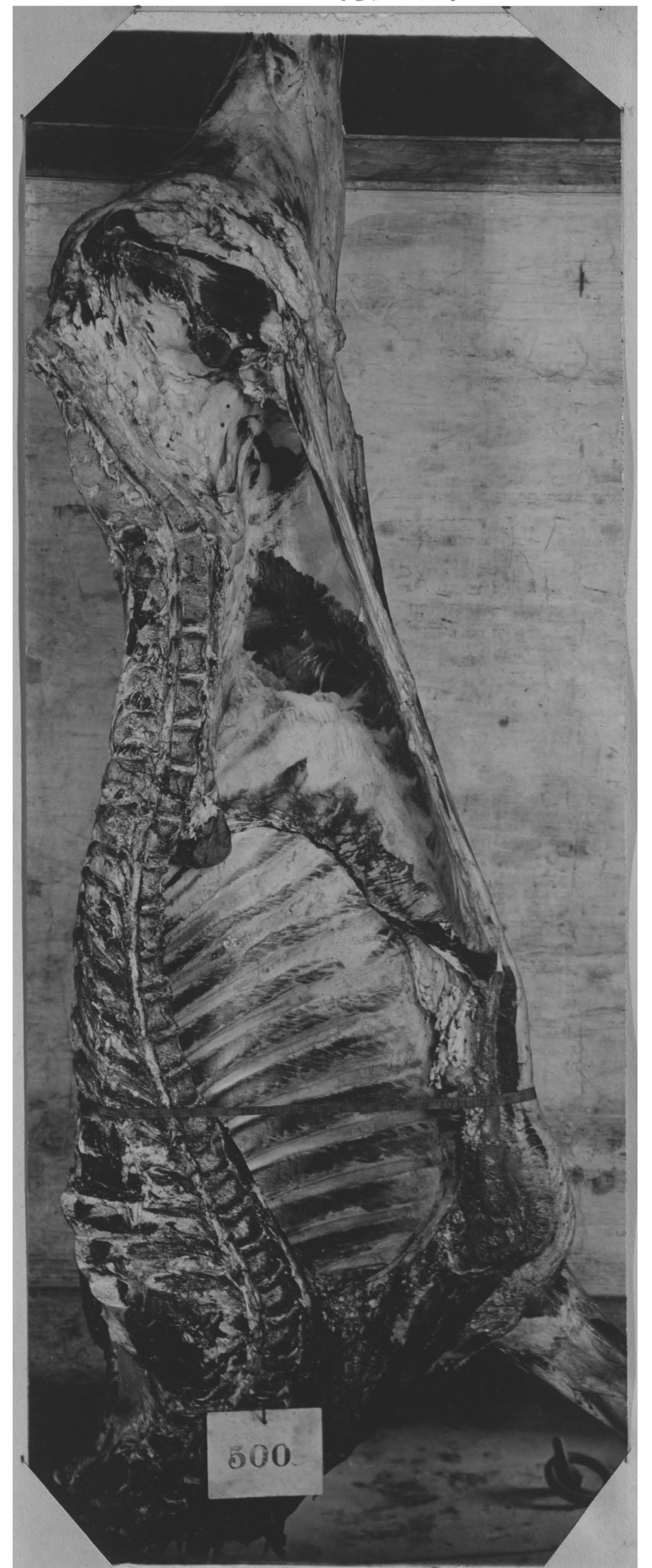


538



540







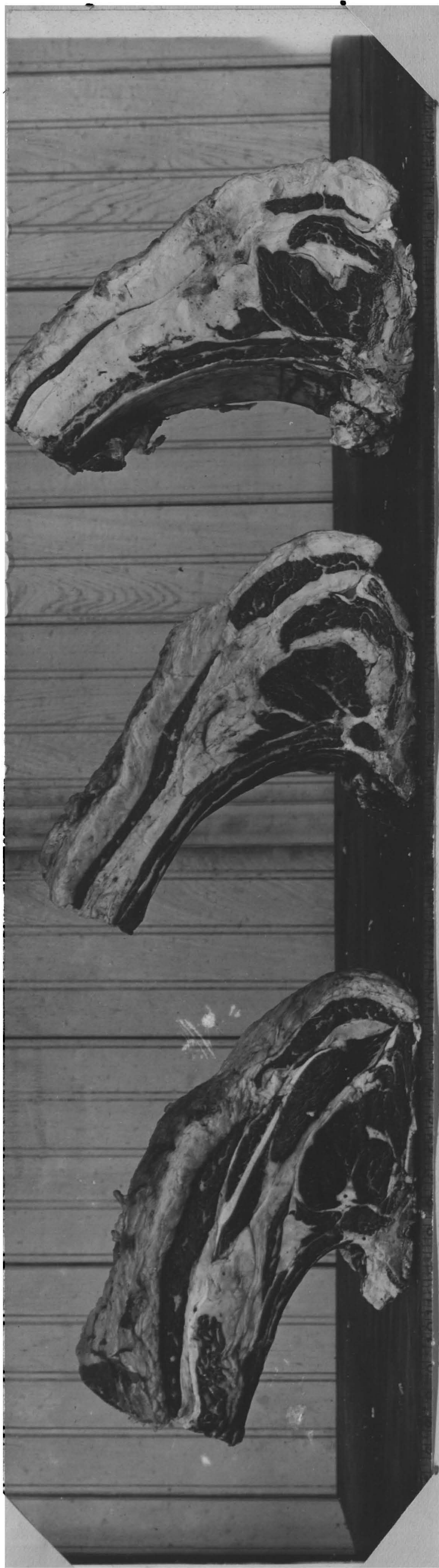
CUT VII.



CUT VIII.



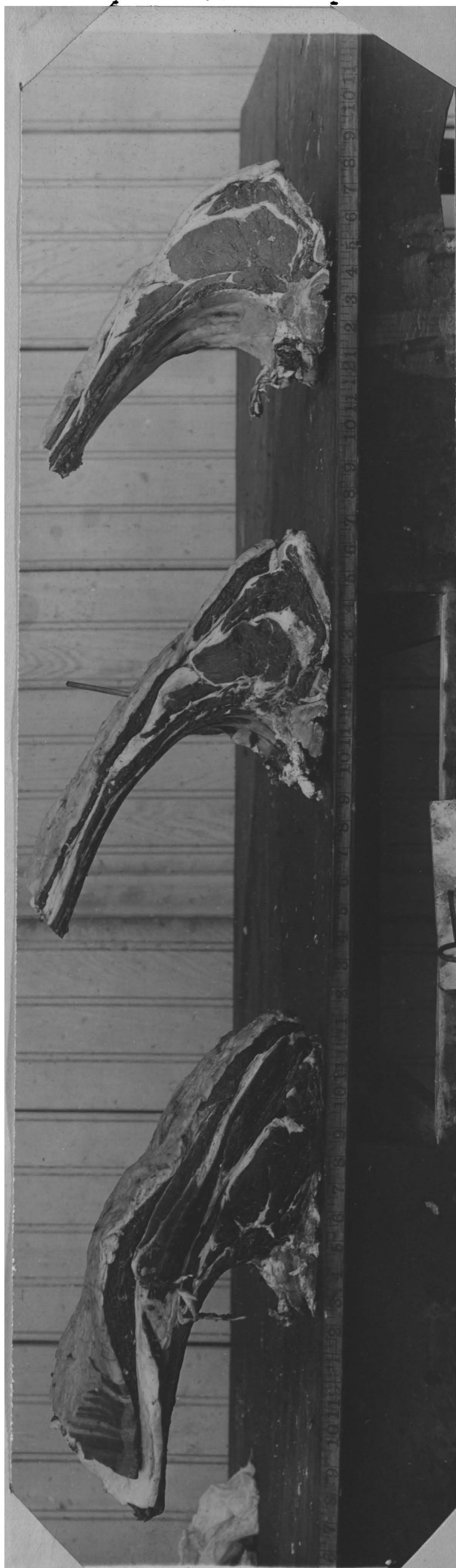




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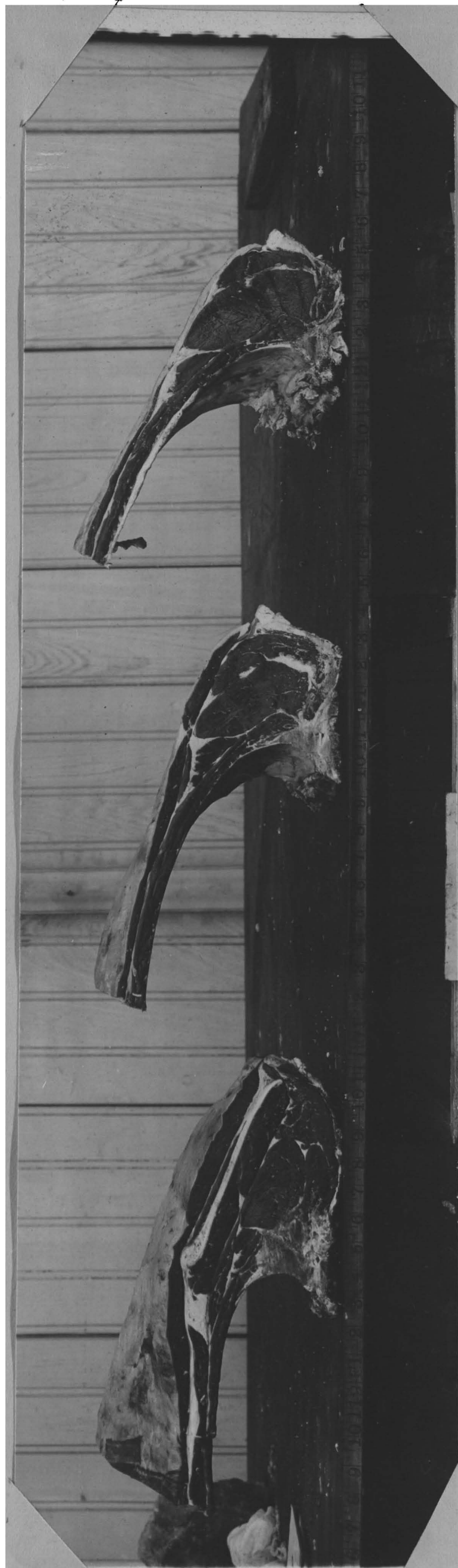
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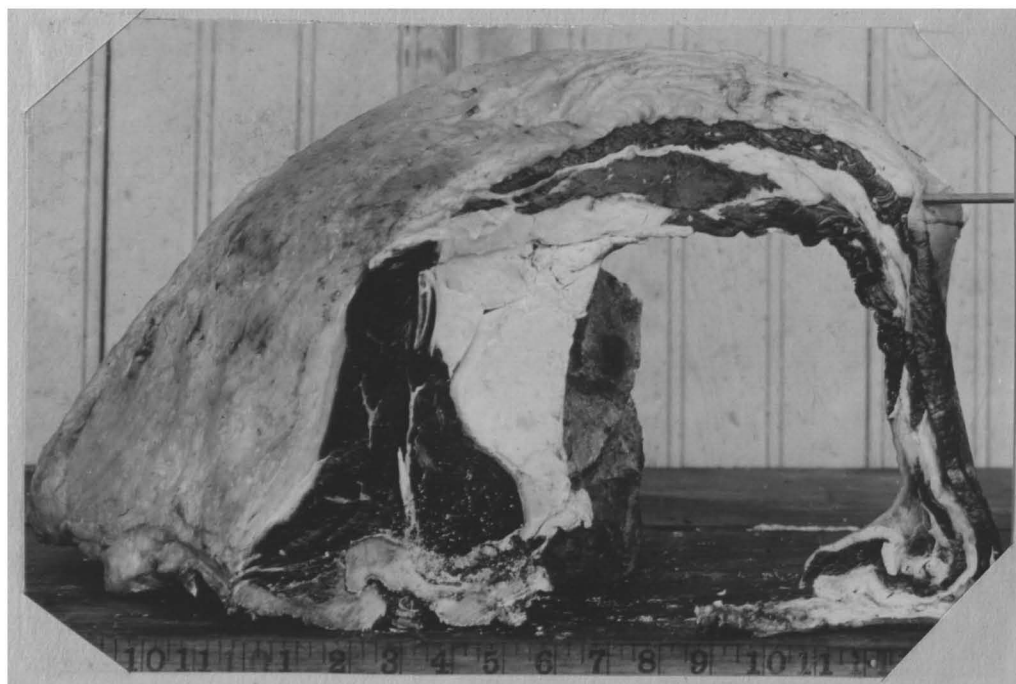
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CUT X.



501

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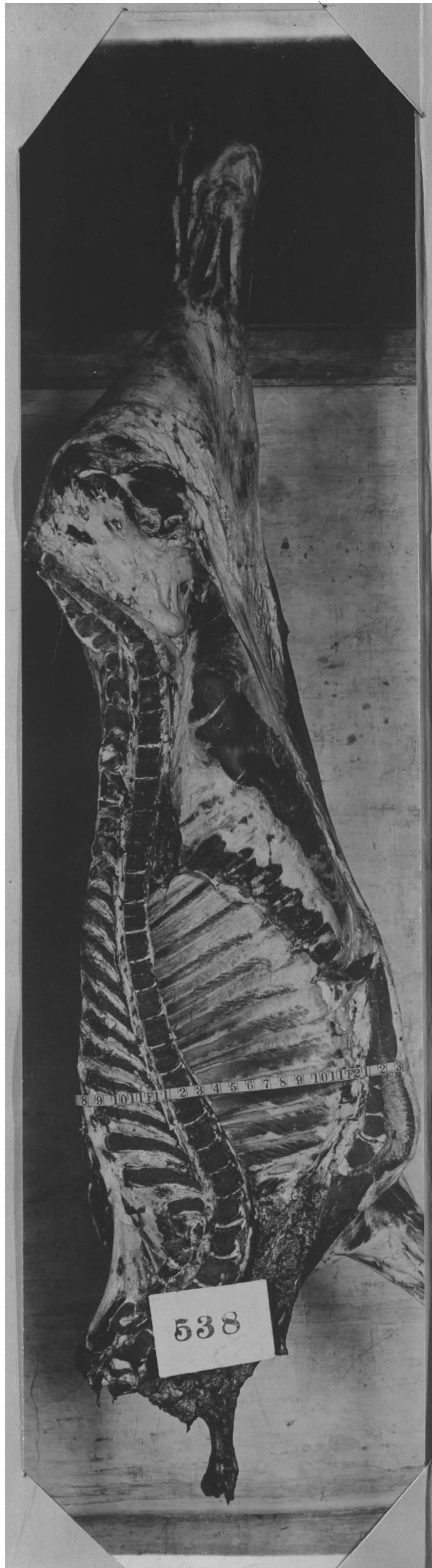
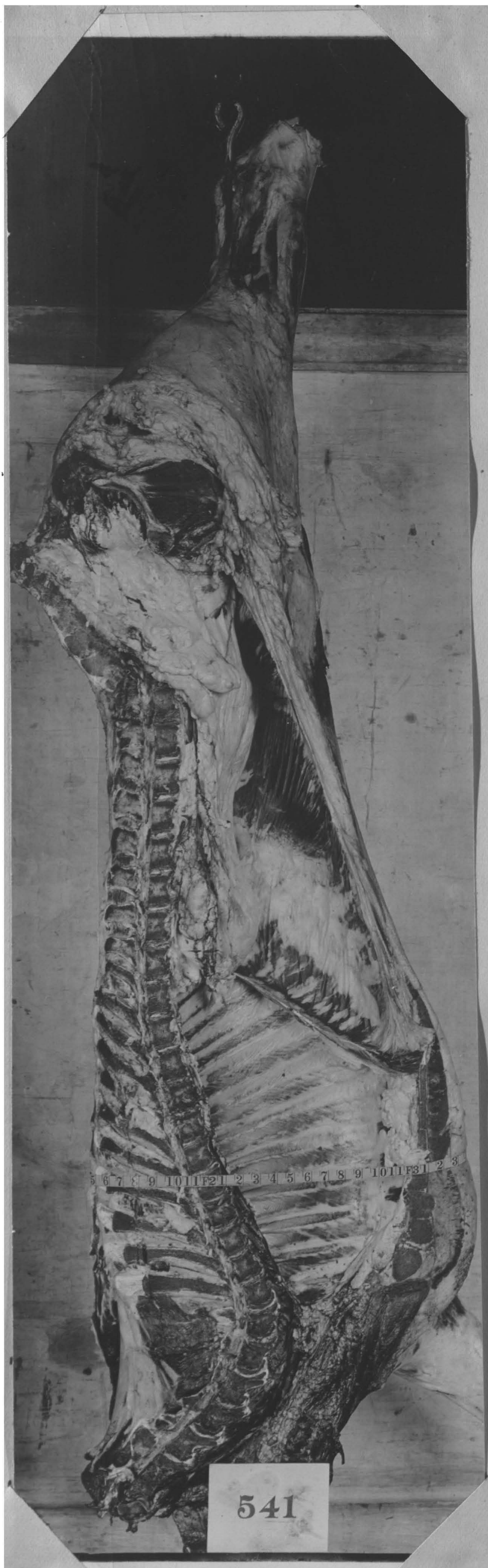


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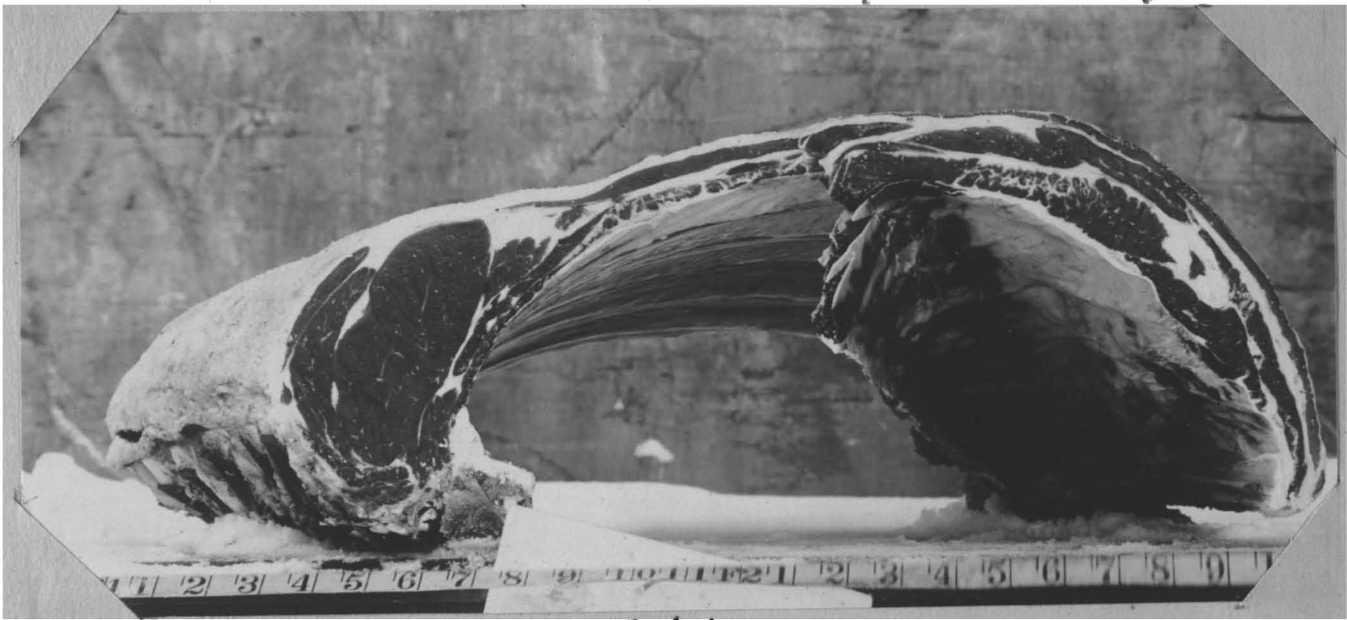
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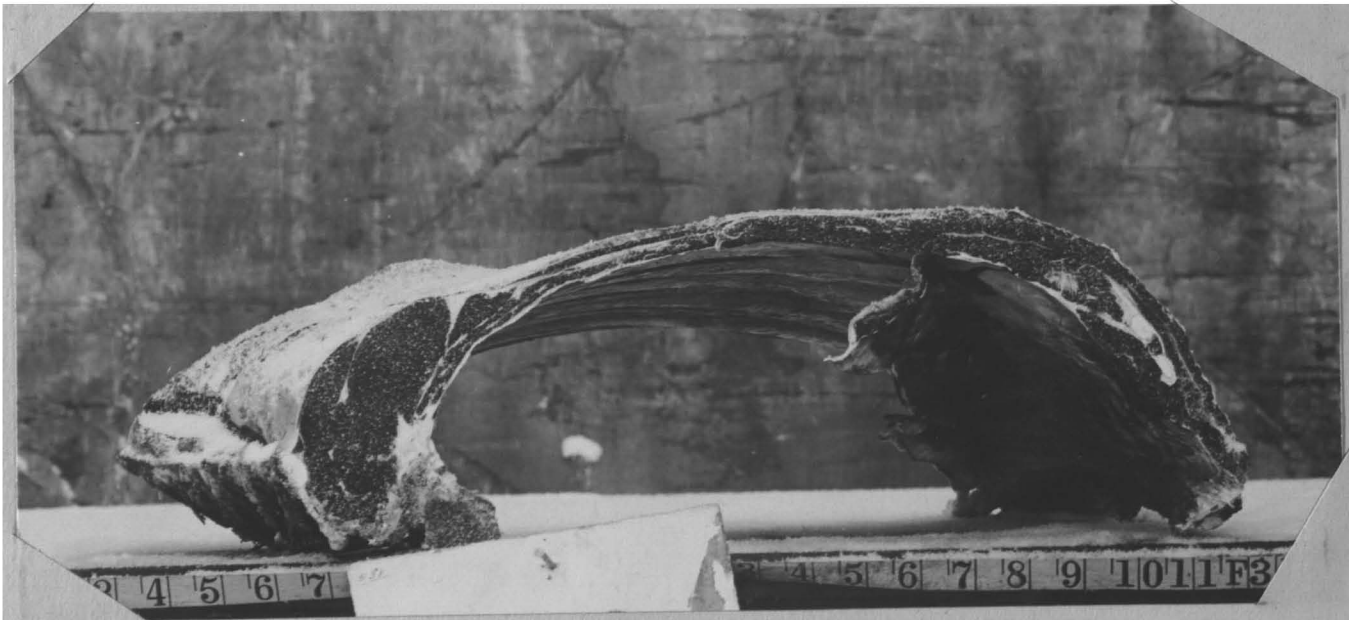




CUT XIII.



541



538



540

CUT XIV.



529

FOUR MONTHS OLD.



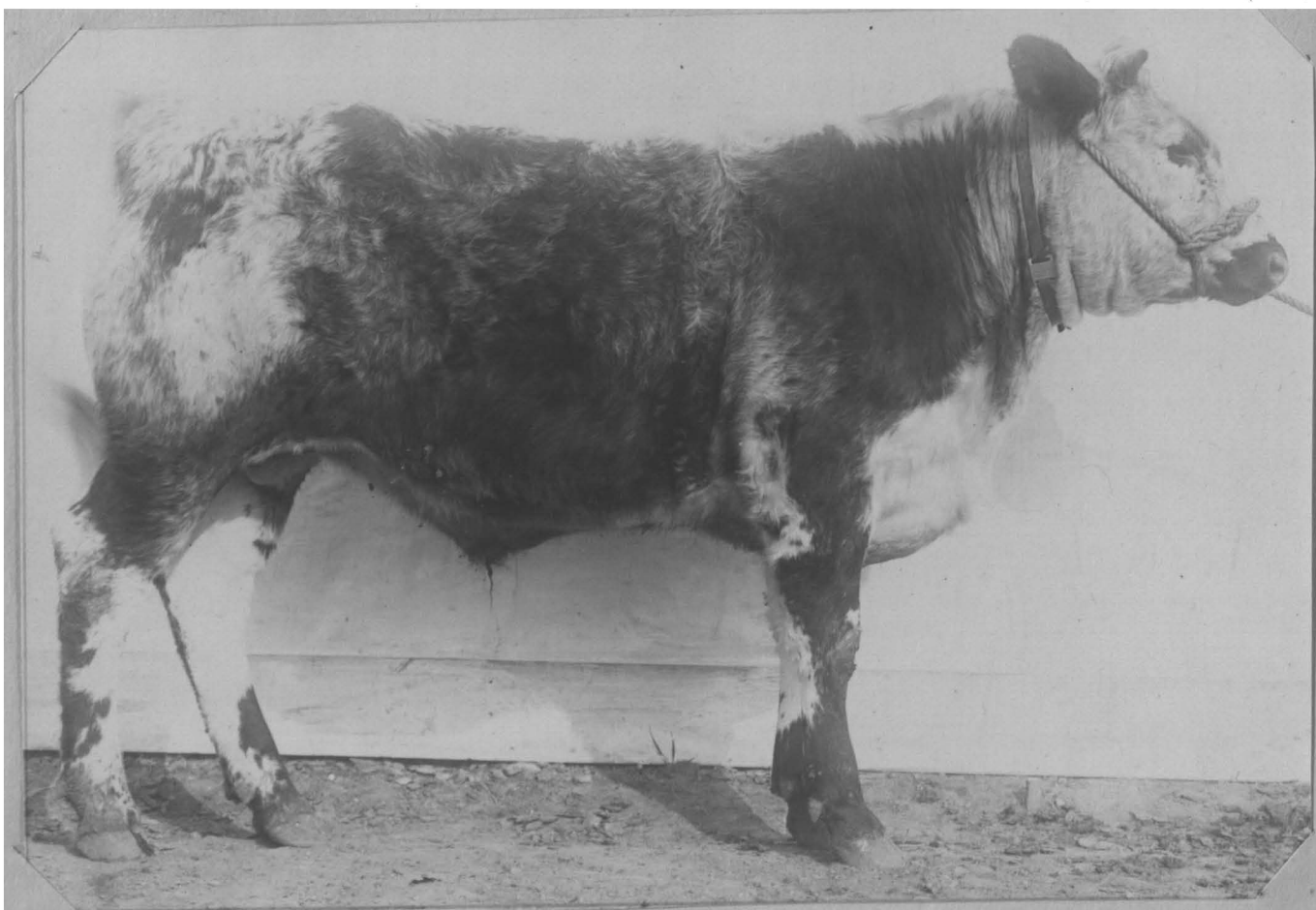
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FIVE MONTHS OLD.

CUT XV.



529



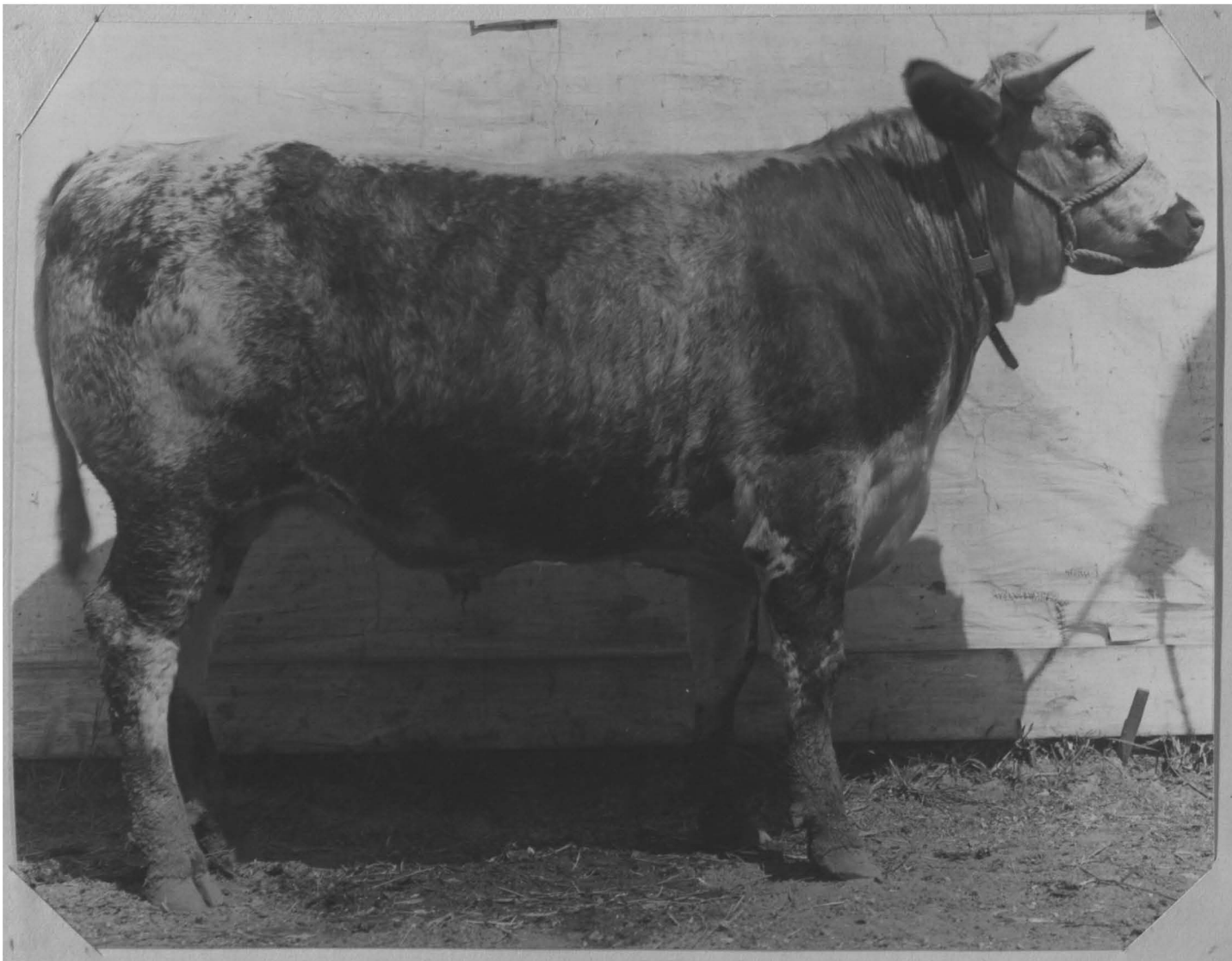
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ONE YEAR OLD.

CUT XVI



529

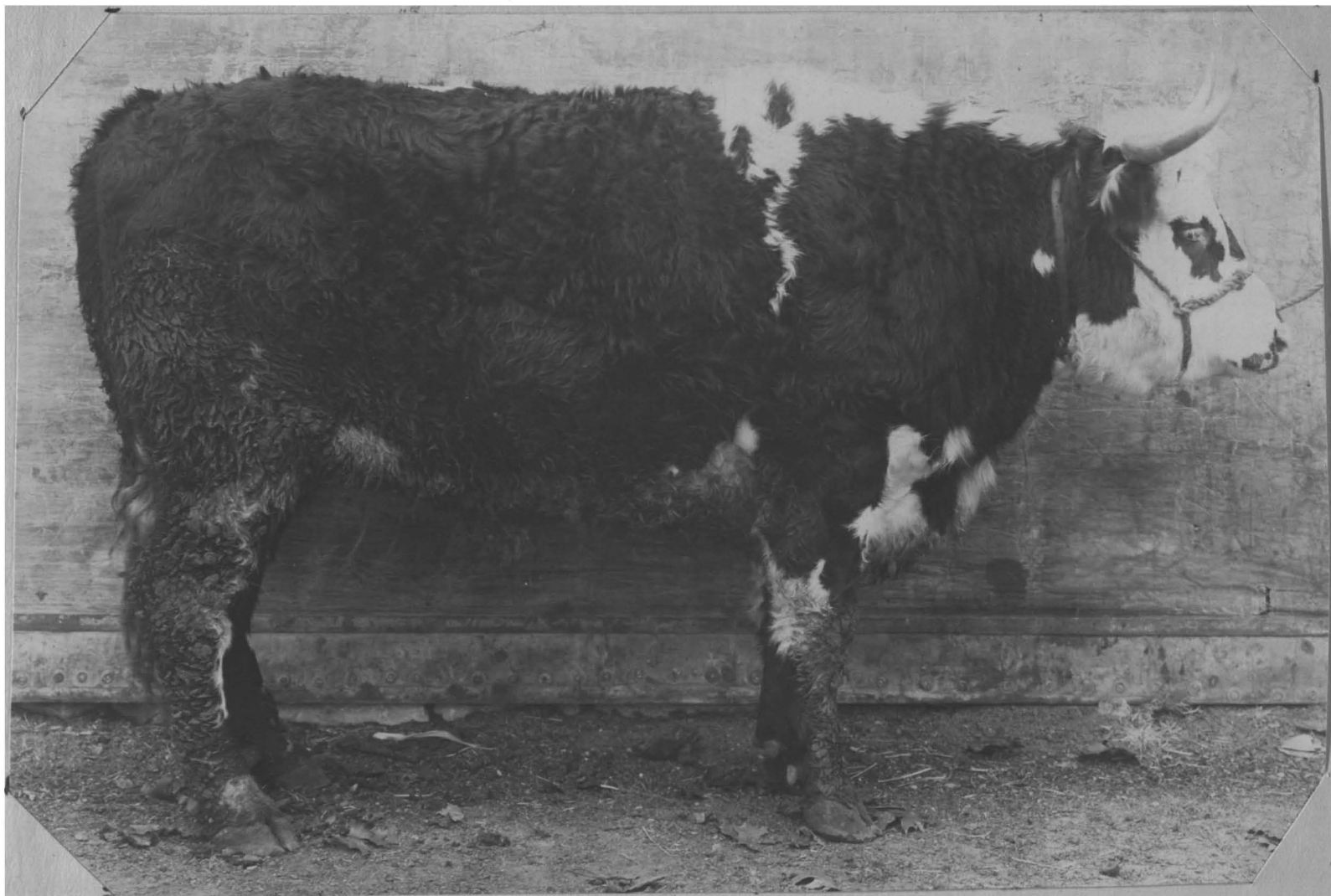


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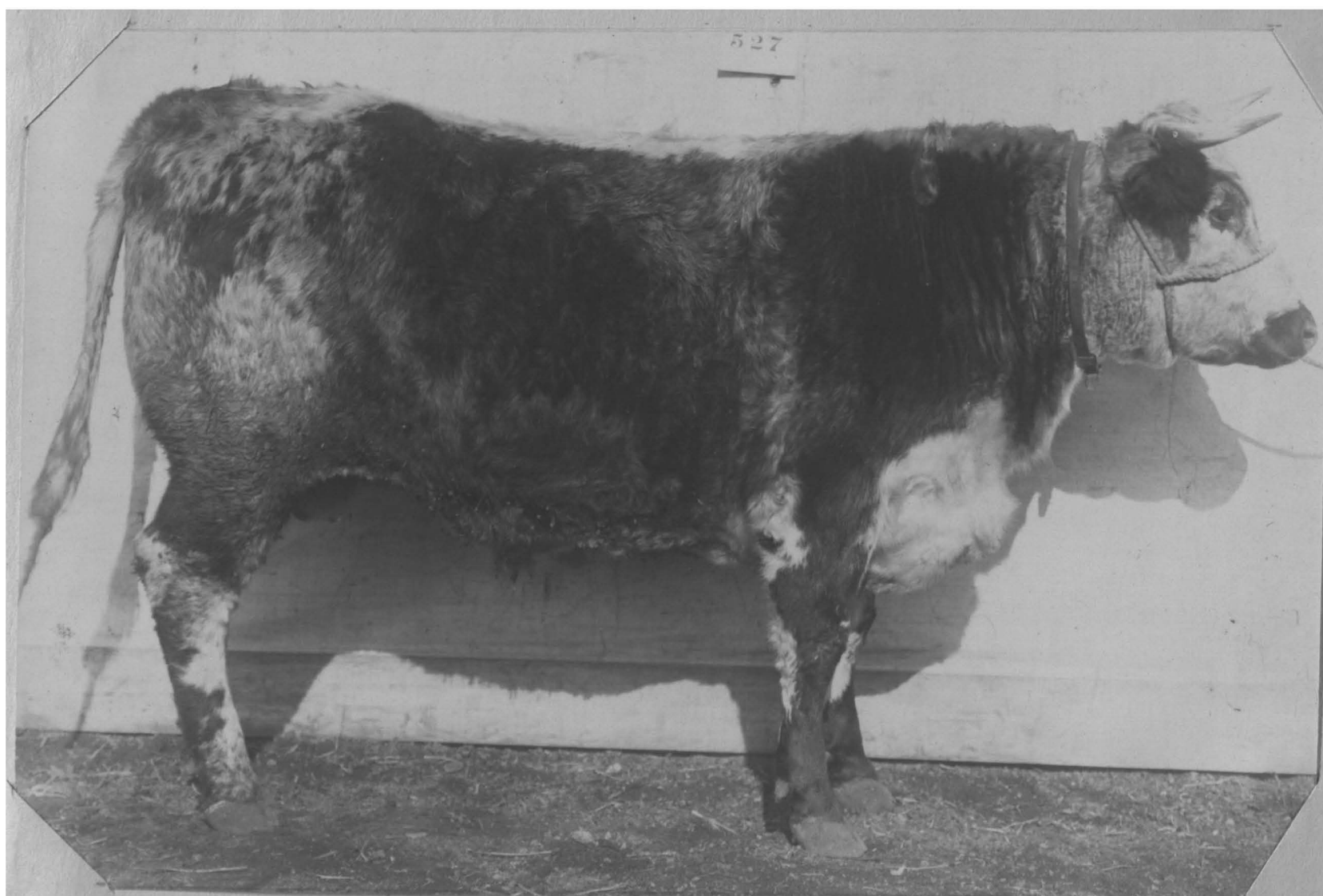
TWO YEARS OLD.



CUT XVII



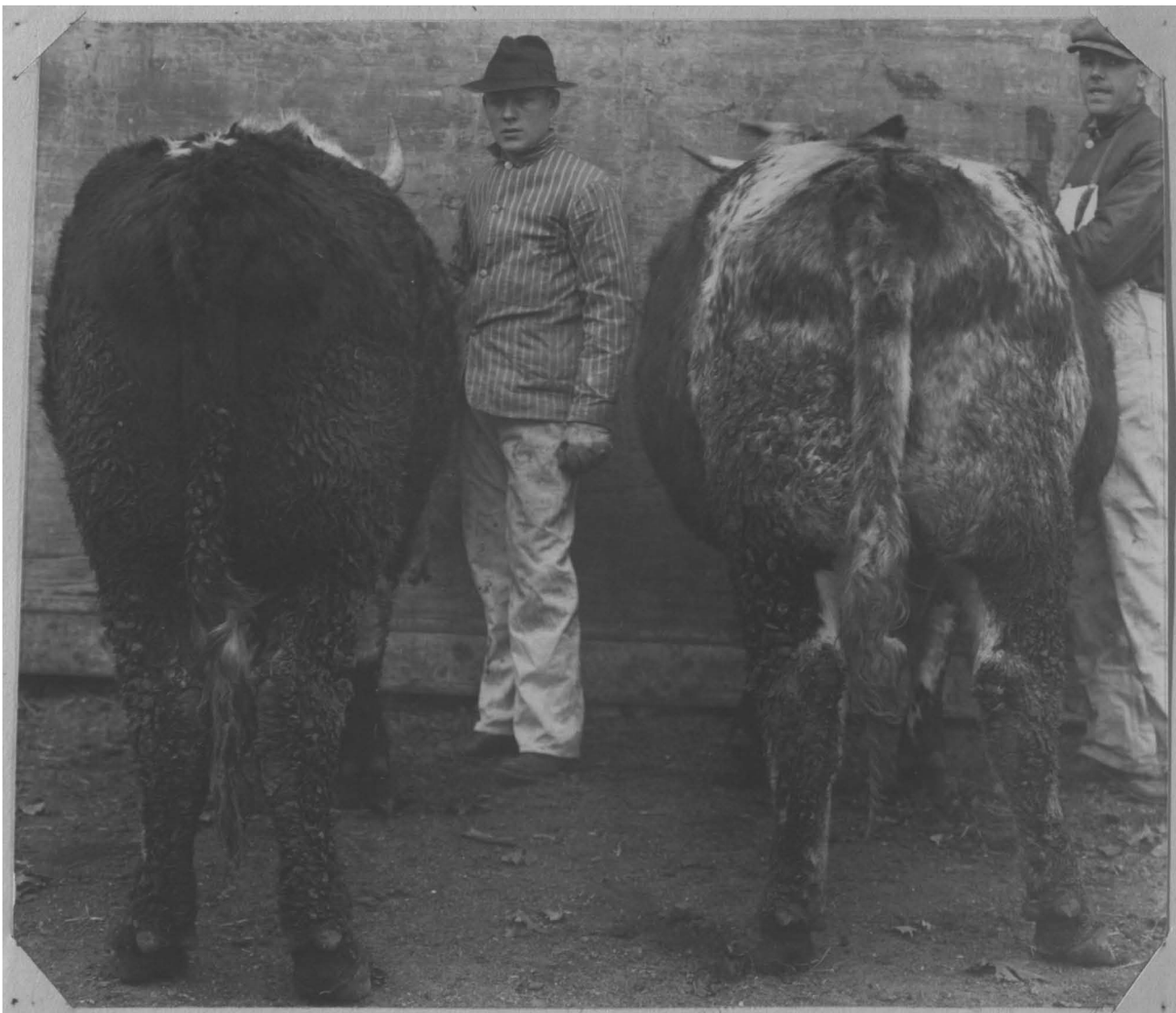
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527

AT TIME OF SLAUGHTERING.

CUT XVIII



529

527

AT TIME OF SLAUGHTERING.



CUT XIX.



527



529

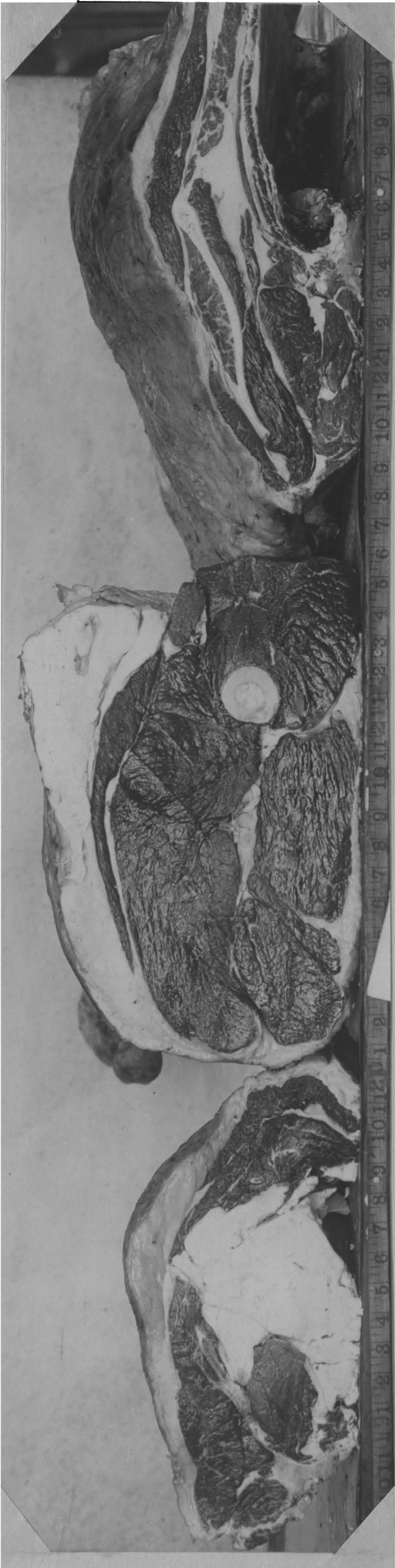
SIXTH RIB, RIGHT SIDE.



LOIN

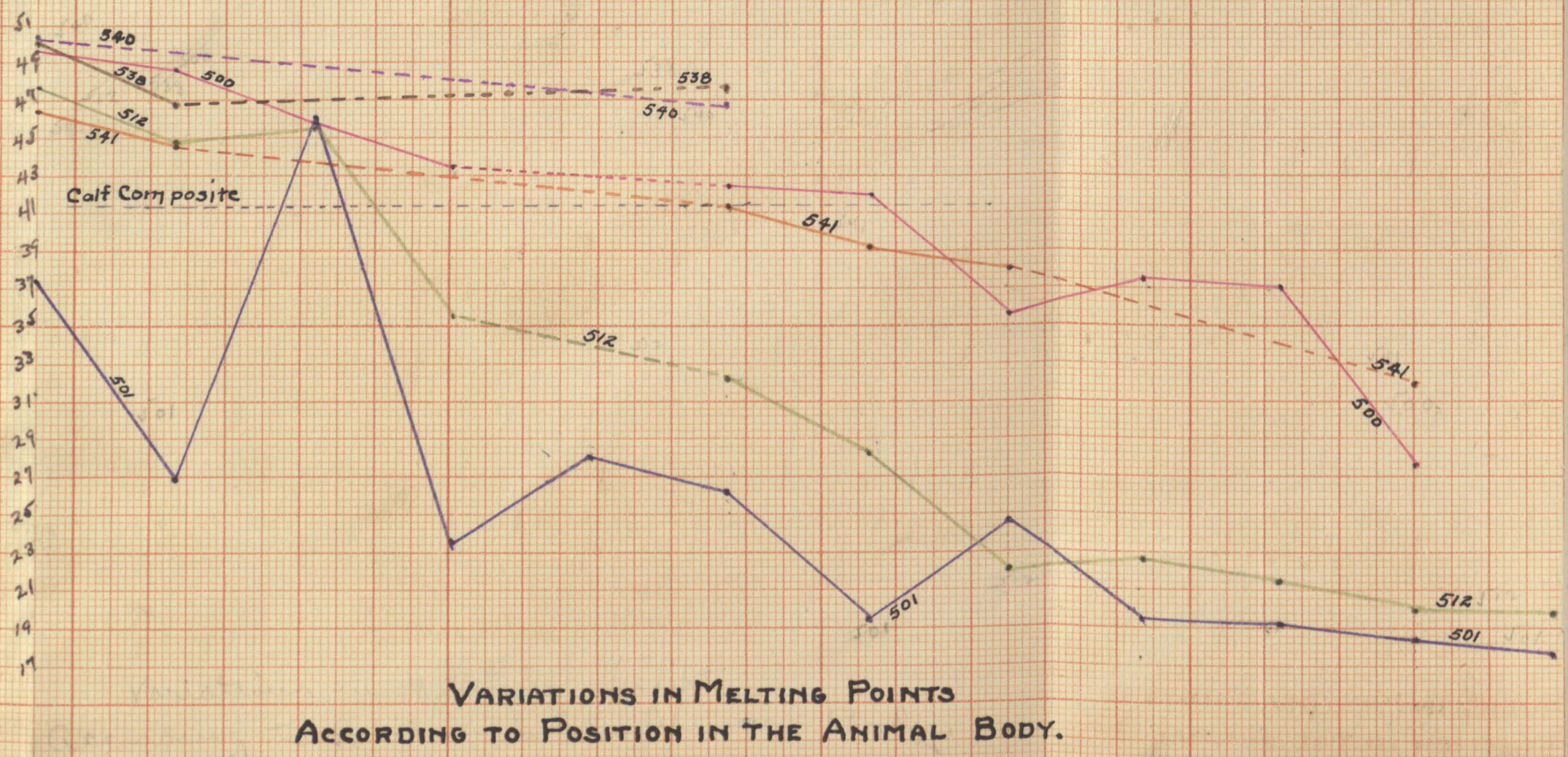
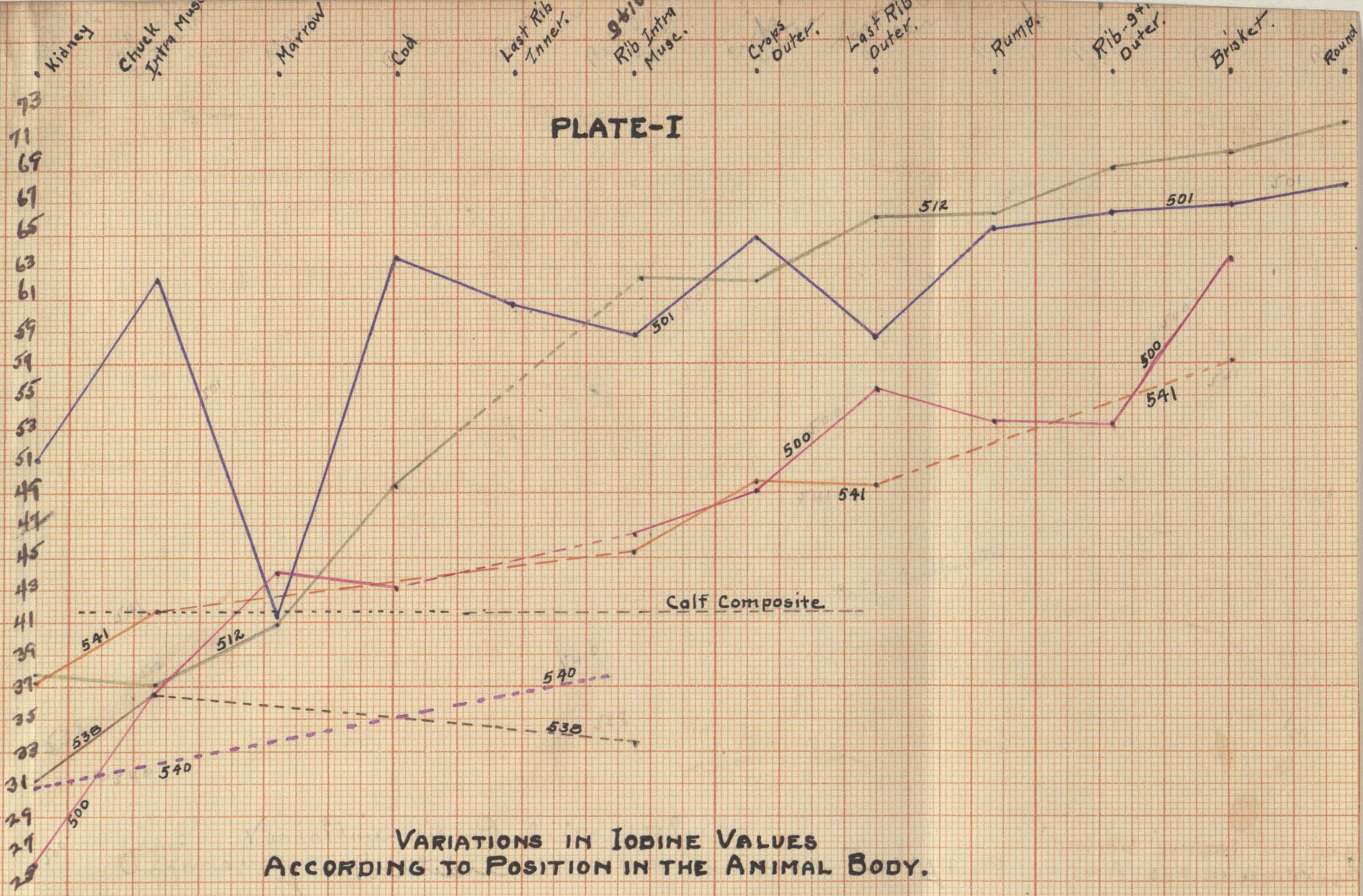
ROUND

CHUCK



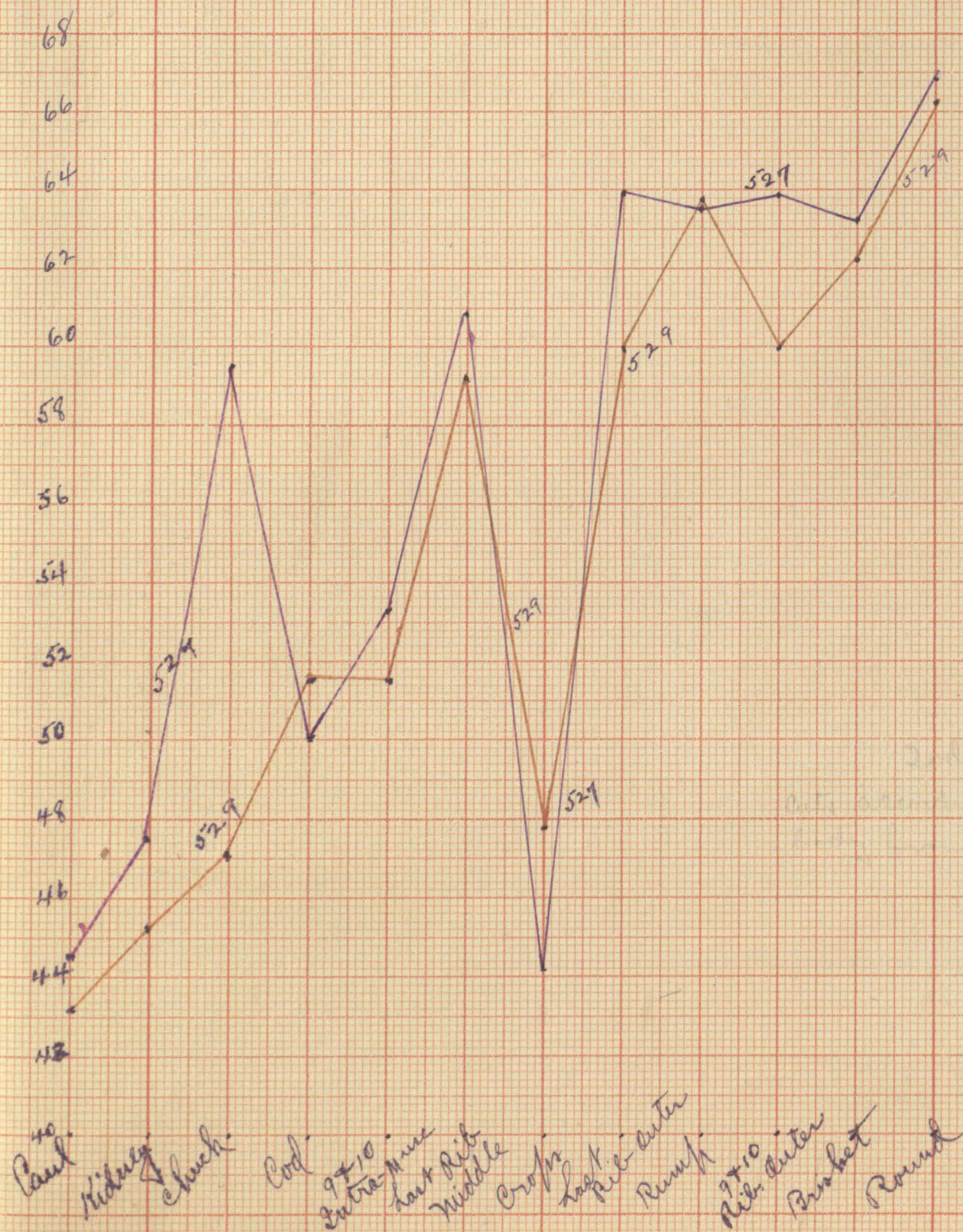
529







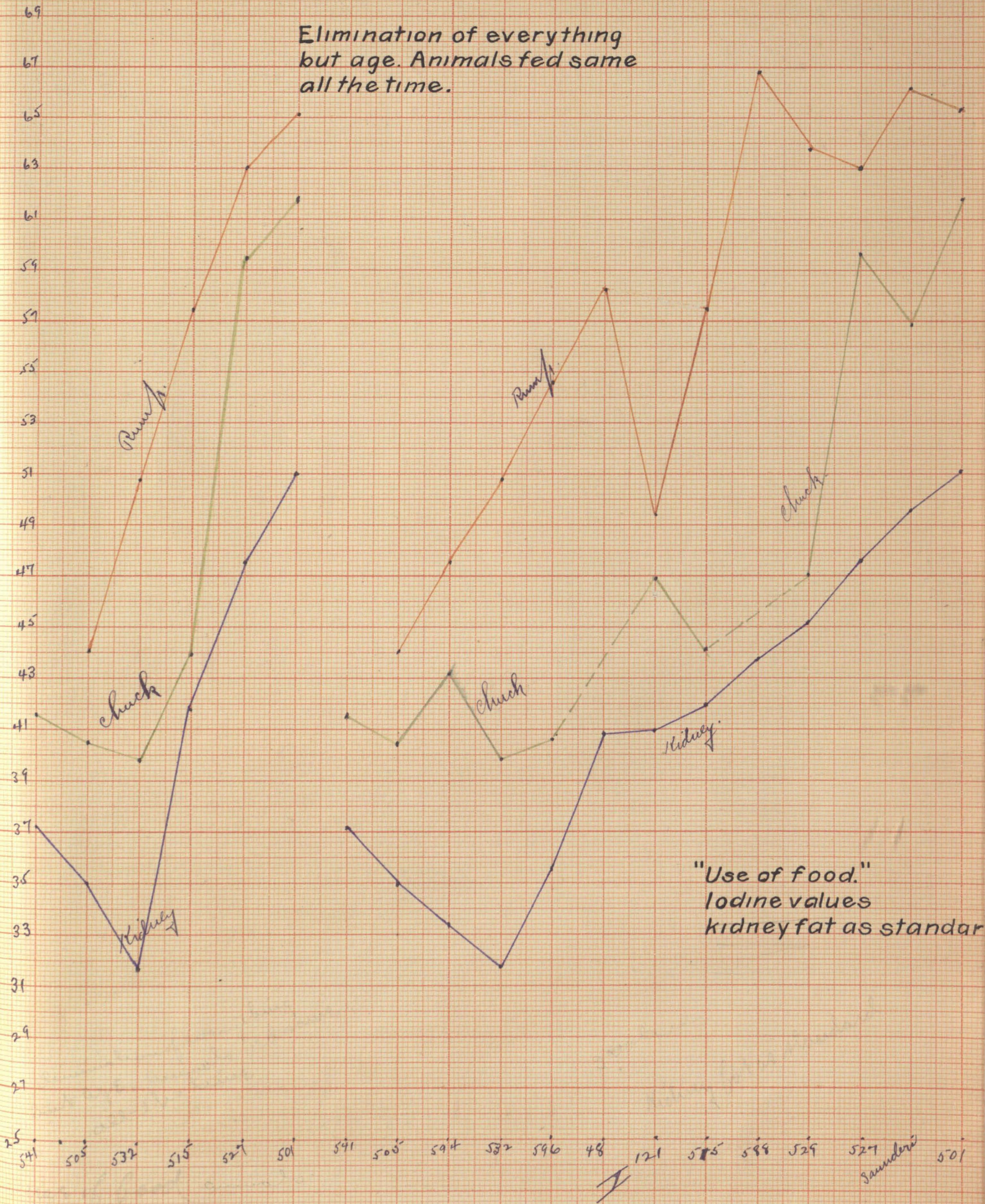
Iodine Values  
of cuts according to  
position in body from  
inside to outside.





# PLATE-III

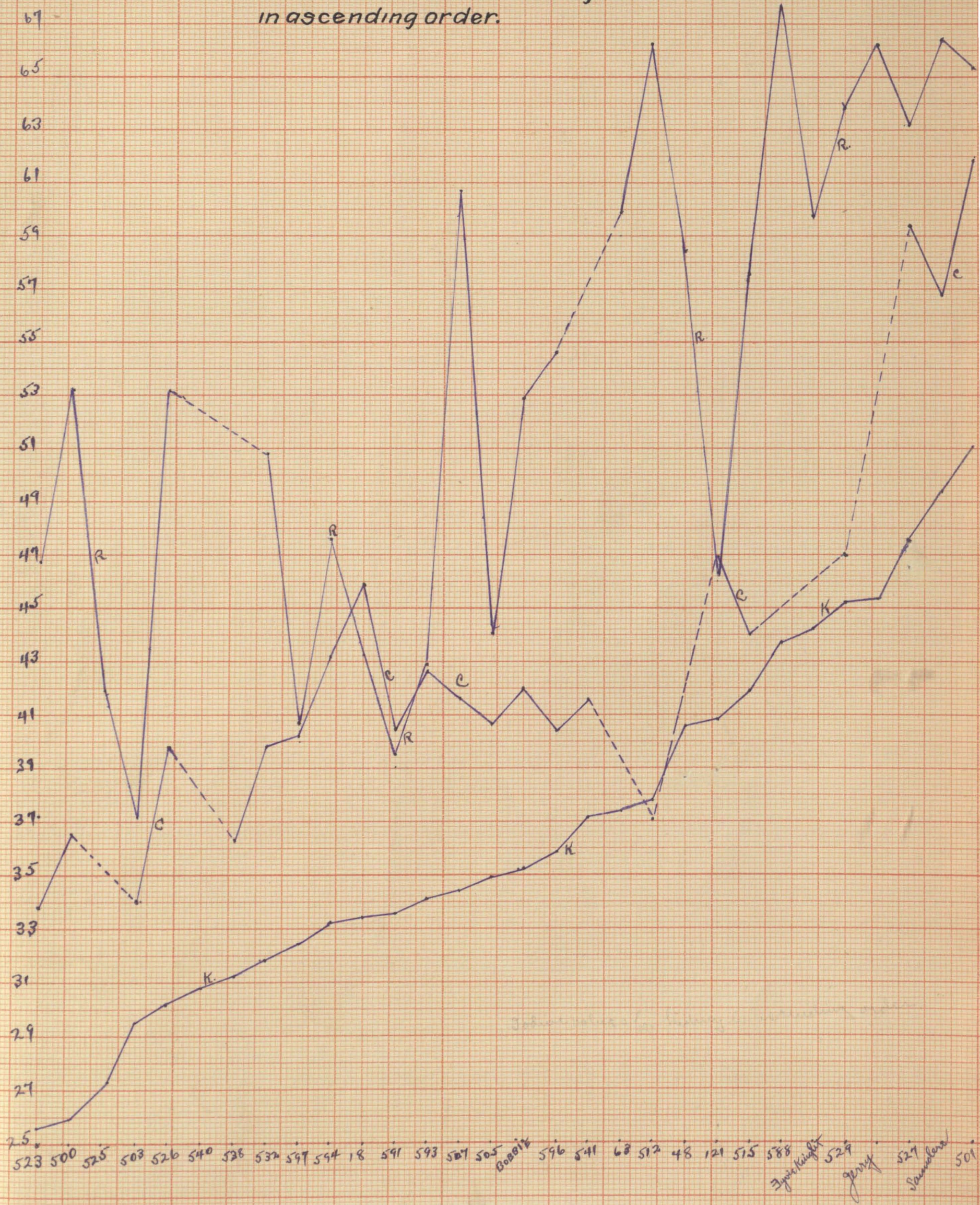
Elimination of everything  
but age. Animals fed same  
all the time.





# PLATE-IV

Iodine values for kidney fat  
in ascending order.





# PLATE-V Iodine values for rump fat in ascending order.

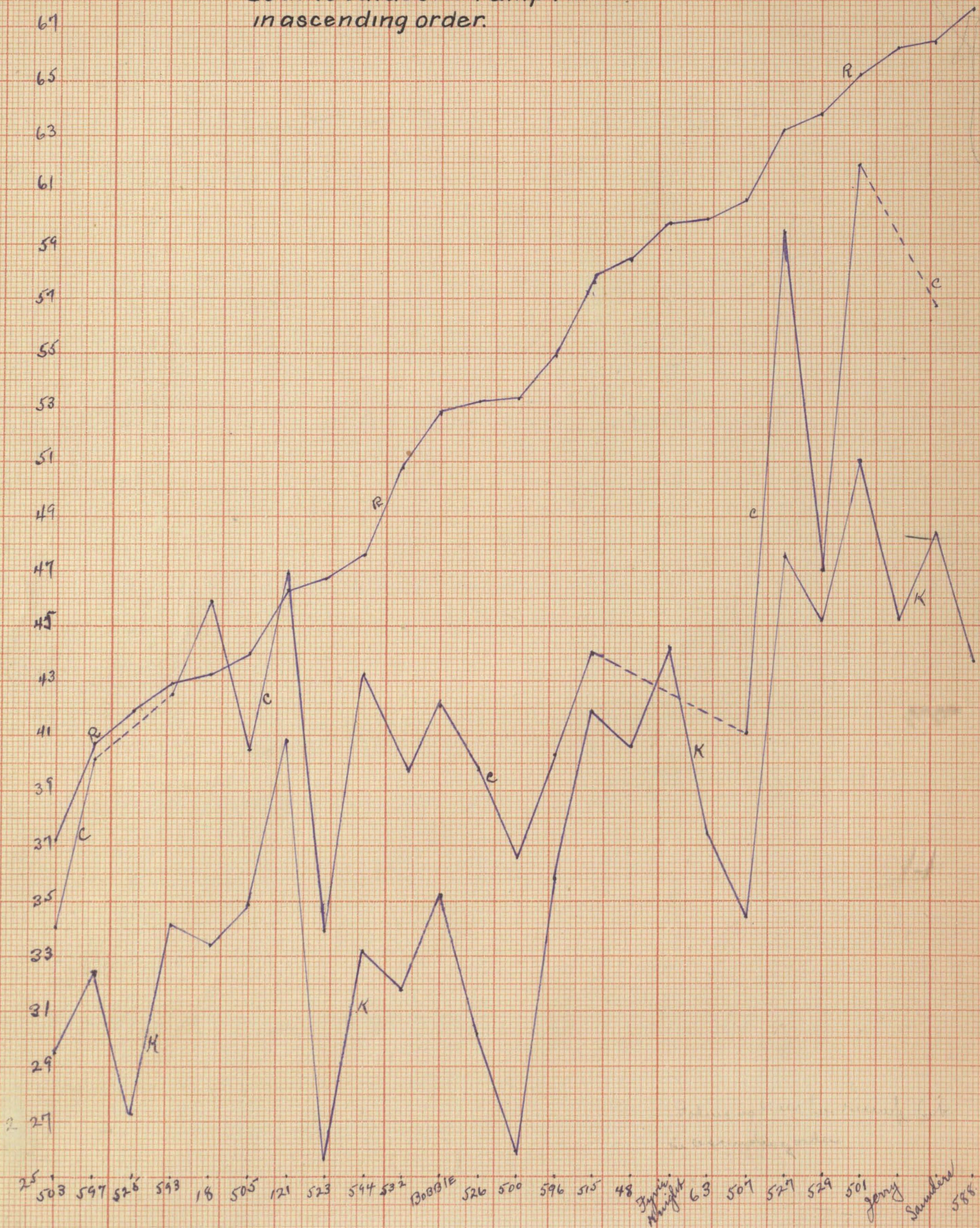
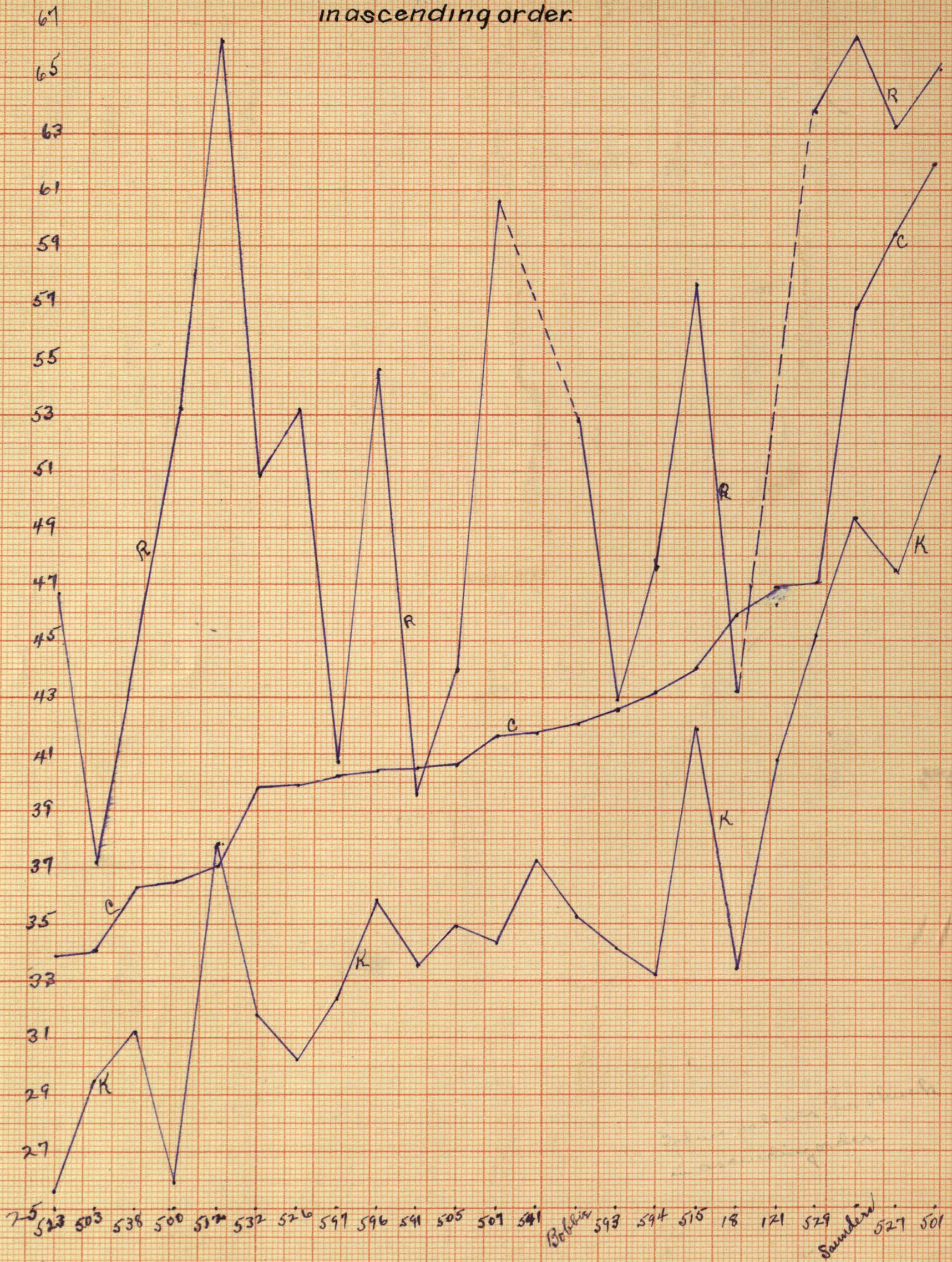




PLATE-VI  
Iodine values for chuck fat  
in ascending order.





71

# PLATE-VII Iodine value according to group and increasing age.

69

67

65

63

61

59

57

55

53

51

49

47

45

43

41

39

37

35

33

31

29

27

25

Pump.

Pump.

Pump.

chuck

chuck

chuck

Kidney.

Kidney

Kidney

540

525

500

536

503

523

509

526

512

541

508

532

515

529

527

501

~~III~~

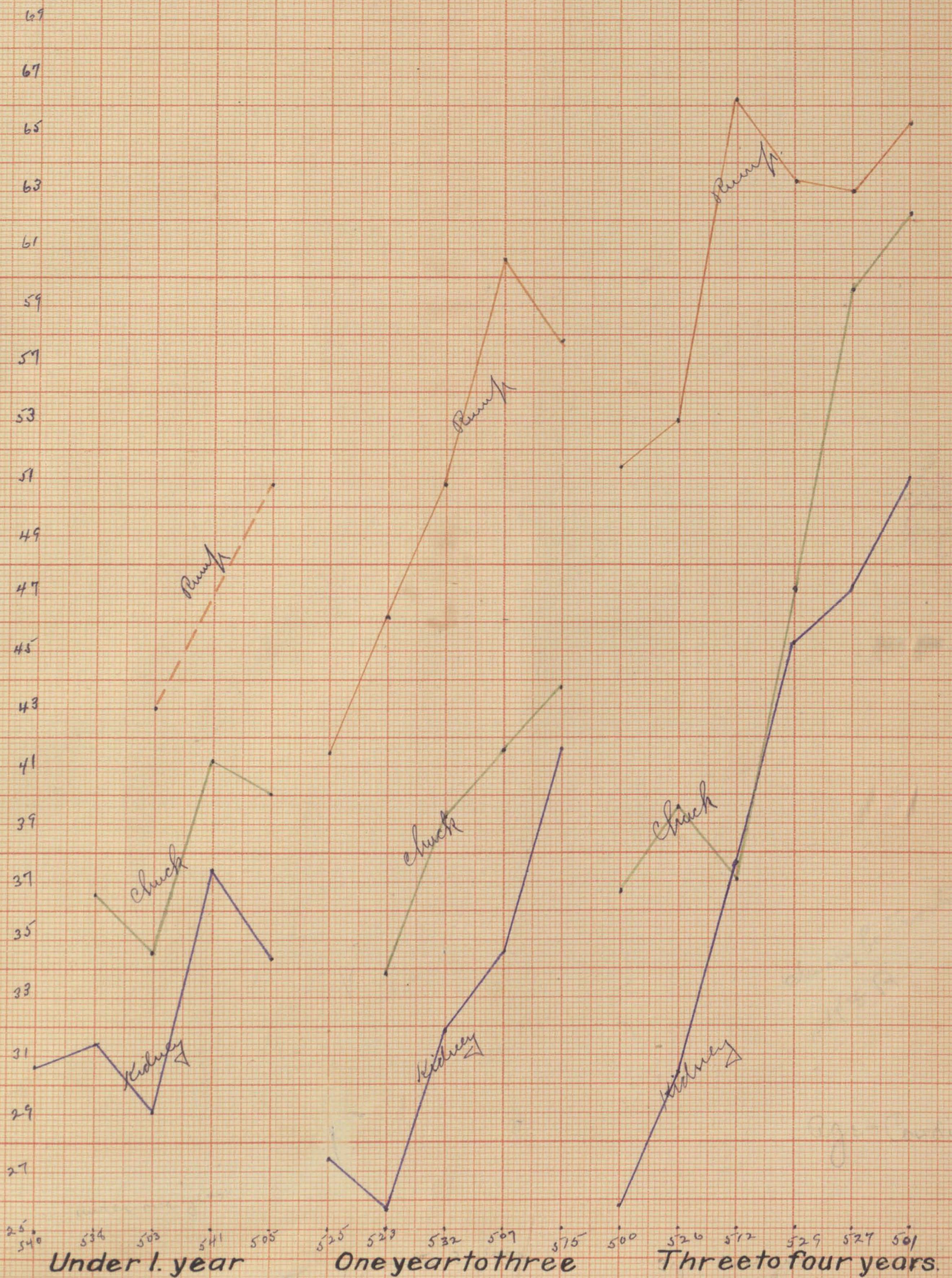
~~II~~

~~I~~



# PLATE-VIII

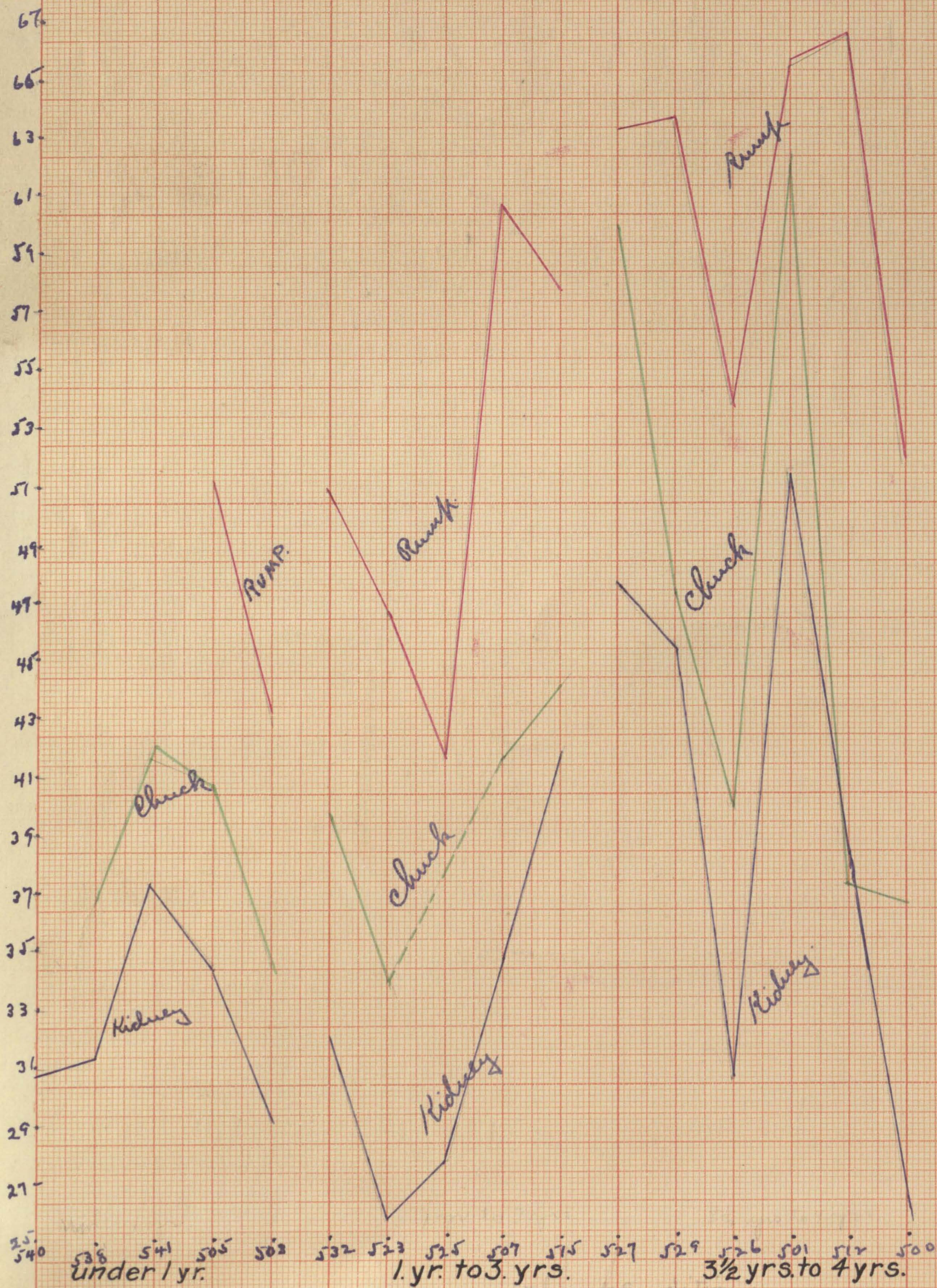
Iodine values according to age and condition.





# PLATE-IX

Iodine values according  
to age alone without condition.





# PLATE-X

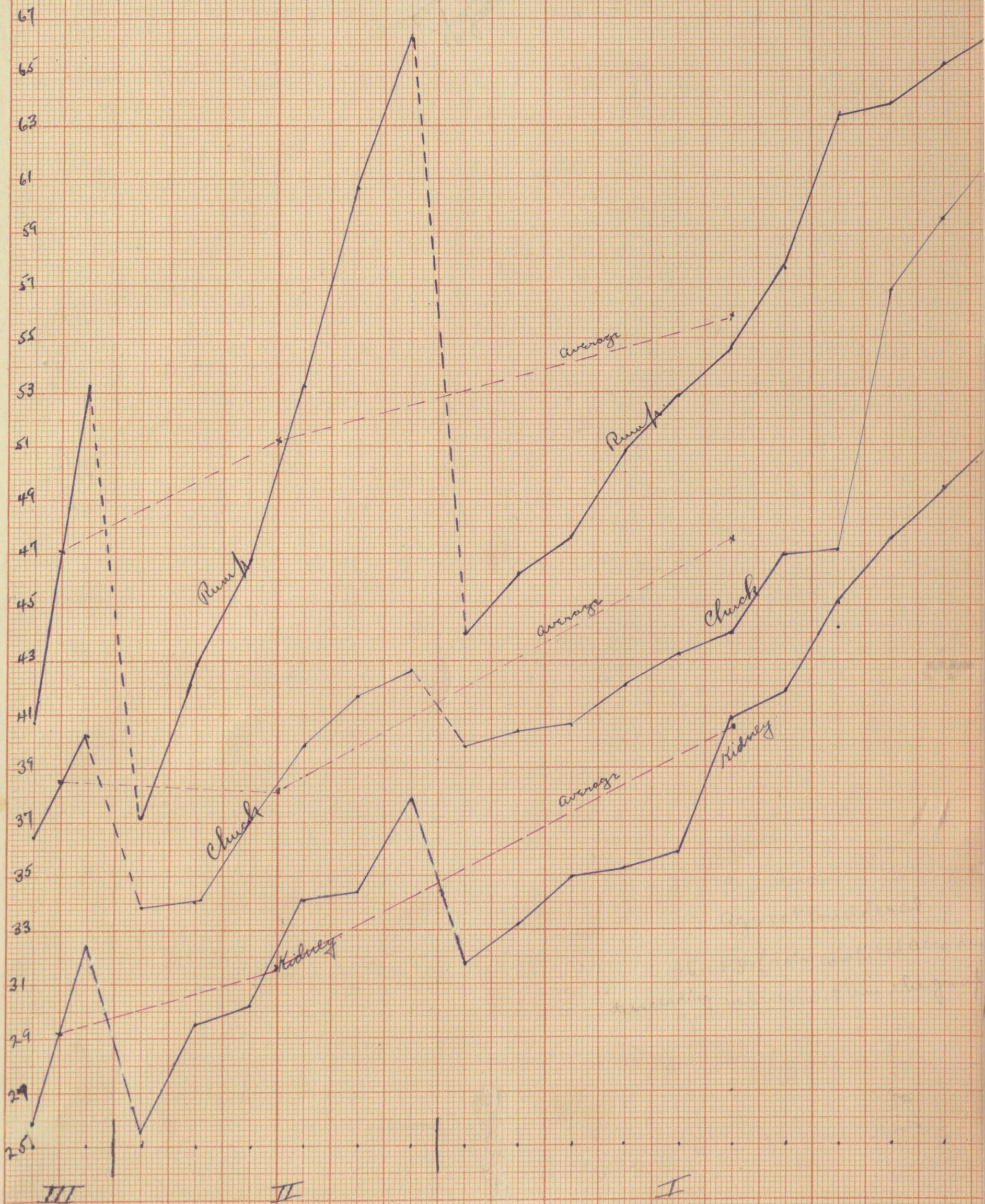




# PLATE-XI

Iodine values, age  
not considered.

STANDARD CROSS SECTION PAPER  
No 303 \* MILLIMETER





# PLATE-XII.

