VOL. 3 FEBRUARY, 1929 NO. 19

HILGARDIA

A Journal of Agricultural Science

PUBLISHED BY THE

California Agricultural Experiment Station

CONTENTS

UNIVERSITY OF CALIFORNIA PRINTING OFFICE
BERKELEY, CALIFORNIA

HILGARDIA

A JOURNAL OF AGRICULTURAL SCIENCE

PUBLISHED BY THE

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

VOL. 3 FEBUARY, 1929 No. 19

A MACROSCOPICAL ANALYSIS OF THE FLEECES OF FOUR ROMNEY RAMS

J. F. WILSON[1]

Improvement in character of fleece in any flock is largely dependent upon the judicious selection of rams. It is necessary to assume that the fleece character possessed by the sire will in some measure be transmitted to the offspring. In judging rams for quantity and quality[2] of fleece, it is necessary, therefore, to make direct comparisons, and to assume that the offspring of a ram possessing an excellent fleece will have better fleeces than the offspring of another ram possessing a fleece less desirable.

Judging the excellence of a fleece by simple optical examination has been in the past the only method employed by the practical breeder. This method of judging is satisfactory in so far as it concerns the animal and its body characters, but when used for judging fleeces, it is subject to certain very definite limitations and often to serious error. It is quite impossible to judge optically, with any satisfactory degree of accuracy, the variation in the diameter of the fiber; yet uniformity of diameter is one of the characters most closely correlated with the spinning properties of wool. Similarly, judging the general fineness of wool with the eye may be subject to large error. The breeder is apt to correlate too closely the fineness of fiber

[1] Assistant Professor of Animal Husbandry and Associate Animal Husbandman in the Experiment Station.

[2] "Quality," as used here, refers to all of the characteristics of the fleece other than weight and length. It has no reference to the orthodox definition—diameter of fiber.

with the number of crimps per inch, and while crimp is generally associated with fineness, some exceptionally fine wools nevertheless show very little crimp. This fact is exemplified in a fleece now in the possession of the writer. The fleece was produced by a ram of the Australasian Merino × Rambouillet cross. Its lack of well defined crimp and its general bold style indicate on superficial examination about a 64's to 70's fineness. Actual measurement of 300 fibers of shoulder wool with the micrometer caliper, however, showed them to have a mean diameter of slightly less than .0003 inch, or finer than the finest Silesian Merino recorded in Bowman's "The Structure of the Wool Fiber."[1] Most Rambouillet fleeces have a mean diameter of about .0006 inch.

The tests herein described were carried out in the hope that they might lead to a method of judging the fleeces of breeding sheep more accurately than is possible by simple examination. It is realized that the technique involved in this entire study is too laborious to warrant its practical application except, perhaps, to high class stud animals in the best registered flocks. The data indicate, however, that this or some similar method of procedure might prove valuable in the selection of rams of some breeds. A study of the mean diameter, and probable error of the mean, together with a study of the percentage of medullated fibers, in the shoulder and thigh wool of long-wool rams would not involve too much time and would yield valuable information.

The fleeces used for these analyses were furnished by Dr. E. E. Brownell, a Romney breeder of Woodland, California. Three of the four rams which produced the fleeces were imported directly from New Zealand, while the fourth, Brownell 39, was imported in dam from the same country (figs. 1 and 2).

DIAMETER OF FIBER

Samples were taken from ten different places on each ram as follows (fig. 3):

1. Shoulder: about three inches to the rear of the point of the shoulder.
2. Side: at the intersection of two imaginary lines drawn between the withers and flank and between the elbow and hip.
3. Thigh: about two inches above and to the side of the hock.
4. Neck: midway between the brisket and the angle of the jaw.
5. Ear: immediately back of the ear.

6. Cheek: as nearly in the center of the cheek as possible.
7. Back *1:* between the shoulder blades.
8. Back *2:* between the hips.
9. Belly: about two inches in front of the sheath.
10. Scrotum: about the center of the front side of the scrotum.

The samples were washed in benzene to remove natural impurities and were measured at the midsection with a Brown and Sharpe micrometer, reading directly to 1/10,000 of an inch (fig. 4).

The data in table 1 show conclusively that the shoulder wool of these Romney rams was not the finest found in the fleece. This fact is at variance with the statements of "Shepherd Boy,"(2) Hawkesworth,(3) Matthews,(4) and Horlacher(5) that the finest wool in the fleece is found on the shoulder. On three of the four rams, the finest wool was found on the ear or the cheek, while the fourth ram produced the finest wool on the scrotum. Mathematical calculation, by the "Student"(6) method, shows that in these rams, the odds are 47 to 1 that the wool from the ear is finer than that from the shoulder.

It has been customary to consider that the coarsest wool in the fleece invariably comes from the thigh, yet these data indicate that this may not always be true.

The probable errors indicate in a general way the uniformity of diameter of fiber. The data show that in three of the fleeces, the thigh wool was the least uniform, while in the fourth fleece, from the Short ram, the belly, back *2,* and the side were all relatively non-uniform. The ear and cheek samples showed in general the greatest uniformity.

TABLE 1

DIAMETERS OF FIBERS OF ROMNEY RAMS IN TEN-THOUSANDTHS OF AN INCH

Name of ram	Mean diameter of 100 fibers from:										Mean of all samples
	Shoulder	Side	Thigh	Neck	Ear	Cheek	Back *1*	Back *2*	Belly	Scrotum	
Brownell 39	9.09 ±1.26	10.11 ±1.12	11.12 ±1.51	10.56 ±1.06	8.14 ±.86	8.42 ±.99	9.97 ±1.26	11.67 ±1.07	10.95 ±1.32	10.07 ±1.42	10.01
Short 315	10.08 ±1.11	11.00 ±1.76	12.80 ±1.58	9.42 ±1.13	7.90 ±.69	8.18 ±.70	10.47 ±1.21	11.99 ±1.77	13.55 ±1.77	11.81 ±1.17	10.72
Matthews 139	10.90 ±1.39	12.40 ±1.26	14.80 ±1.73	11.16 ±1.02	10.62 ±1.30	10.95 ±1.17	11.41 ±1.25	13.77 ±1.62	13.68 ±1.63	10.10 ±1.03	11.99
Goulter 108	10.19 ±1.35	10.38 ±1.32	13.67 ±1.75	11.42 ±1.30	9.25 ±1.01	7.94 ±1.18	10.24 ±1.53	11.07 ±1.45	12.78 ±1.46	10.78 ±1.13	10.76

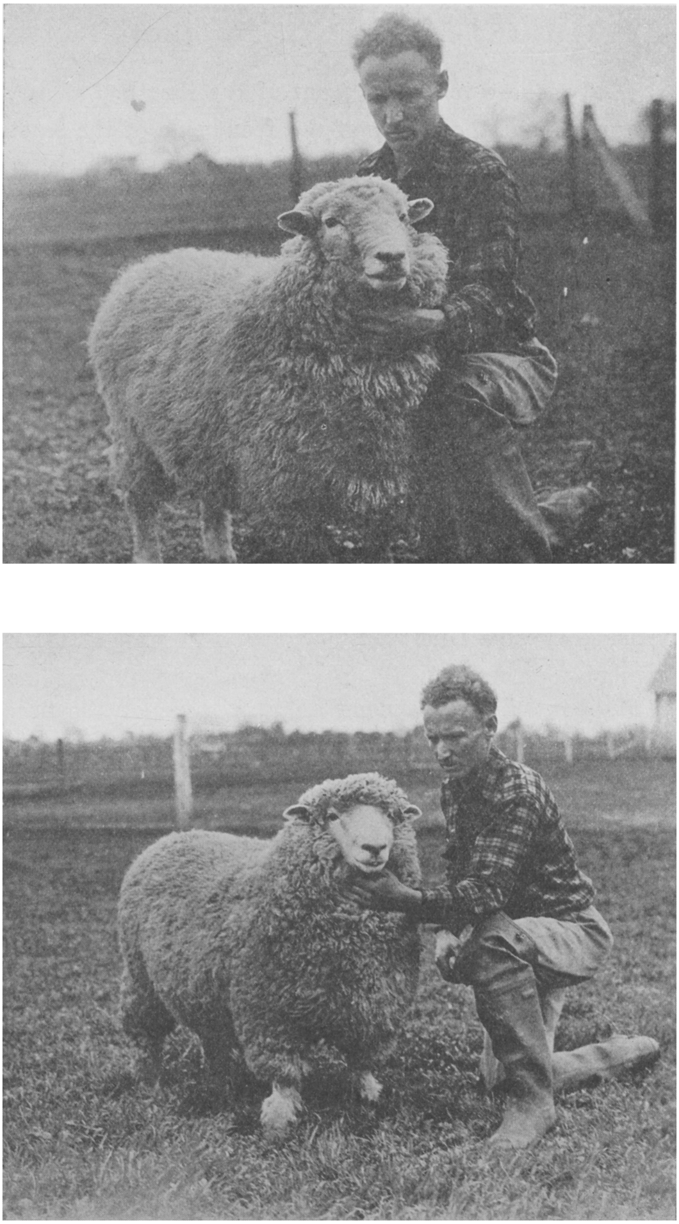

Fig. 1. Rams whose fleeces were used in this experiment. Upper, Brownell 39; lower, Short 315.

Fig. 2. Rams whose fleeces were used in this experiment.
Upper, Matthews 139; lower, Goulter 108.

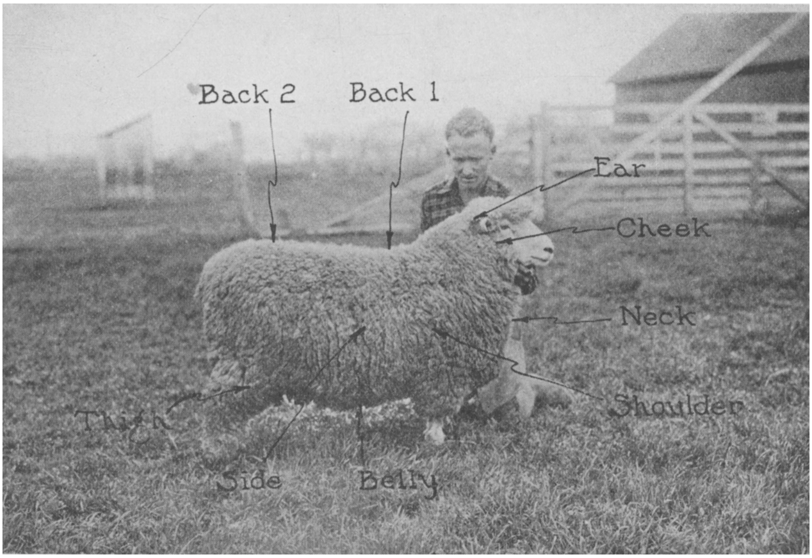

Fig. 3. Showing where the samples were taken.

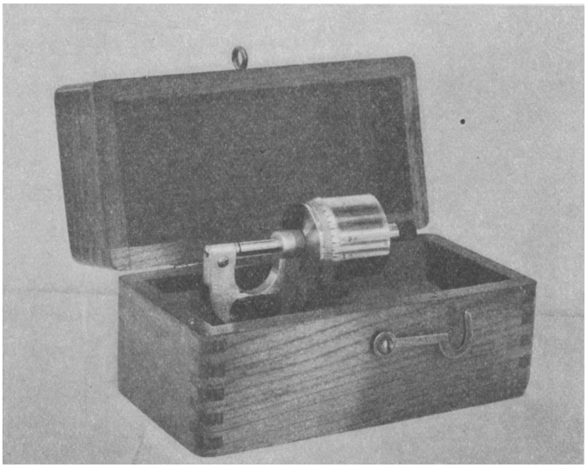

Fig. 4. Type of micrometer used for measuring the diameters of the wool fibers.

PERCENTAGE OF MEDULLATED FIBERS

The medullated or tubular wool fiber occurs in nearly all breeds of sheep, but is found most frequently among the long-wool breeds. It is considered a serious defect in the fleece and is thought to be responsible for harshness of the wool, poor dyeing properties, and lack of elasticity.

The method of detecting the medullated fiber macroscopically has been previously described by the writer.[7]

Medullation of the wool fiber may be complete from the proximal end to the distal end; it may be intermittent to any degree, or entirely absent.

Table 2 indicates that the medullated fiber occurred most frequently in the rear portions of the fleece. The side, thigh, back 2, and belly contained by far the largest proportions of medullated and partly medullated fibers, while the shoulder, neck, ear, cheek, and back 1 were comparatively free from the presumed defect. Comparison of table 1 with table 2 shows that the coarser parts of the fleece contained the highest proportions of medullated fibers.

TABLE 2

NUMBERS OF MEDULLATED AND NON-MEDULLATED FIBERS IN VARIOUS PARTS OF FLEECES OF ROMNEY RAMS

Name of ram	100 fibers from:										
	Shoulder	Side	Thigh	Neck	Ear	Cheek	Back *1*	Back *2*	Belly	Scrotum	*Totals*
Brownell 39											
Non-medullated	95	59	38	88	100	100	100	52	46	70	*748*
Partly medullated	5	39	29	12	0	0	0	48	34	27	*194*
Medullated	0	2	33	0	0	0	0	0	20	3	*58*
Short 315											
Non-medullated	63	52	42	74	99	97	83	50	42	92	*694*
Partly medullated	31	36	47	24	1	3	17	29	53	8	*249*
Medullated	6	12	11	2	0	0	0	21	5	0	*57*
Matthews 139											
Non-medullated	92	78	41	96	100	97	78	53	61	96	*792*
Partly medullated	8	22	55	4	0	3	22	46	37	4	*201*
Medullated	0	0	4	0	0	0	0	1	2	0	*7*
Goulter 108											
Non-medullated	85	46	48	79	96	72	84	81	44	43	*678*
Partly medullated	14	50	40	20	4	21	16	19	49	55	*288*
Medullated	1	4	12	1	0	7	0	0	7	2	*34*
Totals											
Non-medullated	335	235	169	337	395	366	345	236	193	301	*4000*
Partly medullated	58	147	171	60	5	27	55	142	173	94	
Medullated	7	18	60	3	0	7	0	22	34	5	

If the medullated fiber is to be considered a serious defect, Brownell 39 and Matthews 139 have fleeces superior to the two other rams. Judging by simple optical examination, however, Short 315 would be rated as high as the Matthews ram, although the fleece of Brownell 39 was outstanding. The fleece of Goulter 108 would be considered easily the poorest fleece of the four.

RATIO OF STAPLE LENGTH TO FIBER LENGTH

The purpose of this phase of the analysis was to attempt to show arithmetically the degree of crimp in the wool. The method usually employed of ascertaining the number of crimps per inch does not indicate the degree or definiteness of crimp. Thus two fibers of fine wool may each have twelve crimps to the inch. But one fiber may have the crimp exceptionally well defined, while in the other the crimps may be so slight as to be almost negligible. Obviously the fiber with the well defined crimp is more desirable, other things being equal, since it would be the longer when straightened out and would, therefore, possess superior spinning properties. The ratio of staple length to fiber length gives no indication of the number of crimps to the inch, but determines roughly whether or not the crimp is well defined.

For this test the staple as it came from the fleece was placed on a photograph trimming board and cut off at both the proximal and distal ends in a manner which left a section of the staple exactly two inches long. These two-inch samples, taken from the midsection of the staple, were used in the study of the ratio of staple length to fiber length. The actual length of the fiber is far greater than the apparent length, on account of the crimp. One hundred fibers were drawn from each of the two-inch bundles, and the actual length of each fiber was measured. The results are presented in table 3.

TABLE 3

RATIO OF STAPLE LENGTH TO FIBER LENGTH IN FLEECES OF ROMNEY RAMS

Name of ram	100 fibers from:									Average of all samples
	Shoulder	Side	Thigh	Neck	Ear	Cheek	Back *1*	Back *2*	Belly	
Brownell 39	1:1.20	1:1.35	1:1.70	1:1.15	1:1.45	1:1.40	1:1.30	1:1.50	1:1.35	1:1.38
Short 315	1:1.30	1:1.35	1:1.90	1:1.45	1:1.25	1:1.40	1:1.40	1:1.55	1:1.35	1:1.44
Matthews 139	1:1.45	1:1.30	1:1.95	1:1.20	1:1.25	1:1.25	1:1.40	1:1.45	1:1.40	1:1.40
Goulter 108	1:1.30	1:1.35	1:1.80	1:1.45	1:1.25	1:1.38	1:1.35	1:1.40	1:1.60	1:1.43

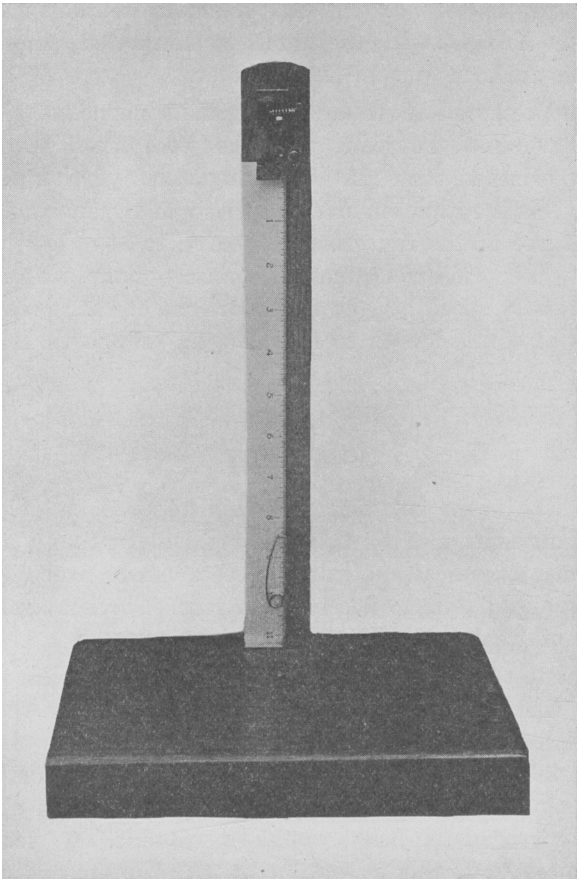

Fig. 5. Device for measuring the actual length of wool fibers.

The apparatus used to measure the length of the fibers was devised by the writer (fig. 5).

The thickness of the jaws of the upper clamp is $\frac{1}{16}$ of an inch. The scale is placed in such a position that the "0" corresponds to the upper edges of the jaws of the clamp. The end of the fiber is pulled through the jaws until the tip is flush with the upper edges of the jaws, after which the clamp, containing the fiber, is placed on the brass peg. A small specially designed 'safety pin' clamp, made of piano wire, is then attached to the lower end of the fiber in such a way that the lower fiber tip is flush with the lower side of the jaws of the pin. This 'safety pin' clamp weighs 0.8 of a gram and is just heavy enough to remove the crimp from the Romney fiber without stretching it perceptibly. By its use the error attendant upon stretching the fibers straight with the hands is eliminated, since the apparatus gives a uniform tension to each fiber.

The data presented above are in the main inconclusive and inconsistent. They show, however, that the wool from the thigh was more boldly crimped than that from any other portion of the fleece measured. This is rather surprising in view of the fact that the thigh samples in three of the four rams appeared to have less pronounced crimp than was found among most of the other samples from the same sheep. Generally speaking, the finer portions of the fleeces showed a larger ratio of staple length to fiber length, though there were some exceptions.

SUMMARY

It should be borne in mind that this paper deals only with the fleeces of four individuals of one breed. Before any satisfactory method of macroscopical analysis of fleeces can be evolved, it will be necessary to apply tests to fleeces from several breeds representing a wide range of wool types.

To complete the macroscopical analysis would require much work other than that herein described. Most particularly the clean or scoured weights of the fleeces, representing exactly twelve months' growth, should be obtained. A study of the density of the fleeces, by calculating the number of fibers to a square inch of skin surface on different parts of the body, would be valuable. As yet it has not been convenient to do this in connection with the present study. The results presented, however, indicate that breeders of stud sheep of some breeds might well adopt a method of studying fleeces other than by simple examination. The micrometer should not supplant the breeder's individual judgment, but should aid him in formulating an opinion of the merits of the fleece. The test for medullated fibers is so simple that it can, with a little practice, be performed by any intelligent breeder, and the technique involves only a few cents for equipment. If these hair-like fibers are to be eliminated from the coarse-wool breeds of sheep, the elimination must take place through proper selection of breeding sires. The shoulder and thigh wool from such animals might be tested for percentage of medullated fibers. It is doubtful if the ratio of staple length to fiber length is of value in a study of fleeces from the long-wool breeds, although it might yield interesting information if applied to the fine-wools.

Selection of sheep by optical examination has in the last 100 years resulted in an enormous increase in fleece weights. Indications are that the limit of such weights is still a long way from realization, although the law of diminishing returns is probably now retarding progress. It is probable also that during the same length of time considerable progress has been made in improving the character of the fleece. Here, however, we have no method of measuring achievement. The solution of problems of wool production most intimately associated with the quality of the finished cloth will probably demand a method of judging wool other than by the simple examination employed in the past.

ACKNOWLEDGMENTS

The writer wishes to make grateful acknowledgment to Dr. E. E. Brownell and to his ranch superintendent, Mr. William R. Hosselkus, both of whose interest in this project was deeply appreciated. To Mrs. A. Alexander, laboratory technician, should go the credit for doing most of the laboratory work incident to securing the data.

LITERATURE CITED

[1] BOWMAN, F. H.
1908. The structure of the wool fiber. 475 p., 78 fig. Macmillan and Company, Ltd., London.

[2] ''Shepherd Boy''
1907. Modern sheep; breeds and management. 333 p. American Sheep Breeder Co., Chicago, Ill.

[3] HAWKESWORTH, ALFRED
1920. Australasian sheep and wool. 594 p. 91 fig. 11 plates. Wm. Brooks and Company, Ltd., Sydney, Australia.

[4] MATTHEWS, J. MERRITT
1924. The textile fibers. 4th ed. 1053 p. 411 fig. John Wiley and Sons, Inc., New York.

[5] HORLACHER, LEVI JACKSON
1927. Sheep production. 418 p. 137 fig. McGraw Hill Book Company, New York.

[6] ''Student.''
1908. The probable error of a mean. Biometrika, **6**:1–25.

[7] WILSON, J. F.
1928. Macroscopical detection of the medullated wool fiber. Science **1742**: 512–513.

The titles of the Technical Papers of the California Agricultural Experiment Station, Nos. 1 to 20, which HILGARDIA replaces, and copies of which may be had on application to the Publication Secretary, Agricultural Experiment Station, Berkeley, are as follows:

1. The Removal of Sodium Carbonate from Soils, by Walter P. Kelley and Edward E. Thomas. January, 1923.
3. The Formation of Sodium Carbonate in Soils, by Arthur B. Cummins and Walter P. Kelley. March, 1923.
4. Effect of Sodium Chlorid and Calcium Chlorid upon the Growth and Composition of Young Orange Trees, by H. S. Reed and A. R. C. Haas. April, 1923.
5. Citrus Blast and Black Pit, by H. S. Fawcett, W. T. Horne, and A. F. Camp. May, 1923.
6. A Study of Deciduous Fruit Tree Rootstocks with Special Reference to Their Identification, by Myer J. Heppner. June, 1923.
7. A Study of the Darkening of Apple Tissue, by E. L. Overholser and W. V. Cruess. June, 1923.
8. Effect of Salts on the Intake of Inorganic Elements and on the Buffer System of the Plant, by D. R. Hoagland and J. C. Martin. July, 1923.
9. Experiments on the Reclamation of Alkali Soils by Leaching with Water and Gypsum, by P. L. Hibbard. August, 1923.
10. The Seasonal Variation of the Soil Moisture in a Walnut Grove in Relation to Hygroscopic Coefficient, by L. D. Batchelor and H. S. Reed. September, 1923.
11. Studies on the Effects of Sodium, Potassium, and Calcium on Young Orange Trees, by H. S. Reed and A. R. C. Haas. October, 1923.
12. The Effect of the Plant on the Reaction of the Culture Solution, by D. R. Hoagland. November, 1923.
13. Some Mutual Effects on Soil and Plant Induced by Added Solutes, by John S. Burd and J. C. Martin. December, 1923.
14. The Respiration of Potato Tubers in Relation to the Occurrence of Blackheart, by J. P. Bennett and E. T. Bartholomew. January, 1924.
15. Replaceable Bases in Soils, by Walter P. Kelley and S. Melvin Brown. February, 1924.
16. The Moisture Equivalent as Influenced by the Amount of Soil Used in its Determination, by F. J. Veihmeyer, O. W. Israelsen and J. P. Conrad. September, 1924.
17. Nutrient and Toxic Effects of Certain Ions on Citrus and Walnut Trees with Especial Reference to the Concentration and Ph of the Medium, by H. S. Reed and A. R. C. Haas. October, 1924.
18. Factors Influencing the Rate of Germination of Seed of Asparagus officinalis, by H. A. Borthwick. March, 1925.
19. The Relation of the Subcutaneous Administration of Living Bacterium abortum to the Immunity and Carrier Problem of Bovine Infectious Abortion, by George H. Hart and Jacob Traum. April, 1925.
20. A Study of the Conductive Tissues in Shoots of the Bartlett Pear and the Relationship of Food Movement to Dominance of the Apical Buds, by Frank E. Gardner. April, 1925.