Methods of Control.

The best means of control is to spray the foliage in May with lead arsenate as is done for canker worms. The poison may be applied as soon as there is sufficient foliage to hold the poison. If applied too early, other leaves will put out upon which the caterpillar may feed and two sprayings may be required. If applied too late, considerably injury will result before the caterpillars are killed. In the average season, about the middle of May will probably be the best time. From three to five pounds of powdered lead arsenate per 100 gallons of water may be used, and if one pound of caseinate spreader is added, it will be possible to give a better coating to the foliage.

Literature.

[1] Britton, W. E., Report Conn. Agr. Expt. Station, page 184, 1915.
[2] Felt, E. P., 30th Report, New York State Entomologist, page 59, 1914.
[3] Schoene, W. J., New York (Geneva) Agr. Expt. Station, Bull. 423, page 376, 1916.
[4] Slingerland, M. V., and Crosby, C. R., Manual of Fruit Insects, page 89, 1914.

SUBSTANCES ATTRACTIVE TO THE CABBAGE MAGGOT FLY.

R. B. Friend.

The experiment described below was carried on at the Experiment Station Farm, Mount Carmel, in the spring of 1924 for the purpose of finding some substance which would attract adult females of the cabbage maggot (*Hylemyia brassicae* Bouché) before oviposition occurred. This fly lays its eggs just below the surface of the ground close to the stem of the young cabbage plant. Believing that the odor of the cabbage plant would be attractive to the flies, especially if combined with some sweet substance, materials were tried which contained extracts of the cabbage plant or pieces of the plant itself. In view of results obtained by the New Jersey Station with a honey and yeast mixture in attracting the adults of *H. ceparum*, this medium was used extensively in our experiments. The following mixtures were tried over periods of varying length, the number of trials depending on the promise shown by the bait.

1. Residue from distilled extract, honey, yeast and water.
2. Pieces of cabbage, honey, yeast and water.
3. Pieces of cabbage, molasses, yeast and water.
4. Brown sugar, yeast and water.
5. Extract of the cabbage plant.
6. Residue from distilled extract.
7. Extract of the cabbage plant and ground charcoal.
8. Honey, yeast and water.
9. Molasses, yeast and water.
10. Pieces of cabbage, brown sugar, yeast and water.

The extract of the cabbage plant was prepared by grinding the entire plant in a food grinder, adding to this an amount of 95 per cent. ethyl alcohol in cubic centimeters equal to the weight of the cabbage in grams (this amount was sufficient to cover the ground cabbage) and letting this mixture stand at room temperature a week. It was then filtered in a press, and the resulting clear alcoholic extract distilled under reduced pressure at bath temperature of 65°-75° C. to about one-twentieth of the original volume. Most of the odoriferous substance apparently remained in the residue. Any reference to extract refers to the filtered but not distilled alcoholic extract, and references to residue refer to the residue left after distilling the extract.

The material in each trial was placed in the pan of a Hodge fly trap and kept from drying by the addition of water. About five grams of honey, molasses or sugar was used with enough water for 60 cc. About 20 cc. of residue was used, and when yeast was used, a cube five millimeters thick was found sufficient. The extract was always used pure. If pieces of cabbage were used, five or six pieces of leaf about 2 cm. square were added. In the trials with charcoal, two teaspoons of ground charcoal were added. The traps were set on the ground and in the rows between plants, being about twenty feet apart. The cabbage plot contained three rows of plants and was about 200 feet long. Examination of traps was made each day, the flies killed and removed, and water was added if necessary. One of these traps is shown on Plate XXXI, a.

The experiment was carried on from May 20 to June 10, and Table I gives the results obtained. These figures are totals of five species of the genus *Hylemyia*, *H. brassicae* Bouché, *H. ceparum* Meigen, *H. cilicrura* Rondani, *H. cinerella* Fallen, and *H. trichodactyla* Rondani, of which *cinerella* and *ceparum* probably do not attack the Cruciferae. It will be noticed that between May 22 and May 27, when conditions were similar for all materials then tried, that the residue-honey-yeast-water formula proved by far the most attractive, and the cabbage-yeast-molasses-water formula was next, although the difference between the latter and the molasses-yeast-water formula was insignificant. If the table is examined carefully and the dates noted, it will be apparent that the residue-honey-yeast-water formula is far superior to any other tried. The addition of yeast in quantities sufficient to form a noticeable ferment was of distinct value, as without this the materials were much less attractive. Other baits tried but found of little value were mustard oil (allyl isothiocyanate), allyl alcohol, ethyl alcohol, methyl alcohol, isopropyl alcohol, butyl alcohol, honey, brown sugar, water, and yeast. These were used with water in all cases. The addition of charcoal removed the attractiveness. The residue in itself was by no means as attractive as when mixed with yeast and honey.

The durability of the attractiveness of the materials was observed, and Table II gives these figures. The residue-honey-yeast-water formula was by far the most durable and the pure extract the least. The volatility of the alcohol in the extract rendered it unattractive after a day. This was also true of the alcohols tried. In one instance the residue-honey-yeast formula remained attractive two weeks with the addition of water only. In Table II, the dates begin at May 16, as four traps were set on that date, although the main part of the experiment did not begin until May 20. As soon as any yeast bait became dry, the yeast died and had to be replaced. The need of sugar as food for yeast is obvious, and the sugars are, of course, attractive in themselves.

The total number of flies of all species caught was 1,841 females and 583 males, and the greatest number in any one day was 70 with the pure extract on May 23, and 61 with the residue-honey-yeast-water formula on May 27. An estimation based on a determination of 348 individuals taken at various times in the course of the experiment indicates that 68 per cent. of the females and 76 per cent. of the males were *H. cilicrura* and only five per cent. of the females and two per cent. of the males were *H. brassicae*, these two species being the ones with which we were most concerned. The relative extent to which these species attack cabbage is not known. A warm bright day gave more flies than a day that was cool or cloudy. The occurrence of rain gave little trouble with the baits, as the wire of the traps protected the pans and prevented an overflow. The traps were staked down to prevent the wind from turning them over. A change in the relative position of the traps indicated that this factor was negligible. The plot sloped but little and conditions were uniform in this respect. The great predominance of females over males might have been due in part to the odor of the cabbage plant, the females being attracted to this plant to oviposit. Several females were examined for eggs, and of those examined 75 per cent. contained eggs in varying stages of development, the number of eggs per female running up to 44. In a series of similar experiments with the onion maggot (*Hylemyia ceparum*) all the females were examined each day, and eggs were found in from 76 to 91 per cent. of the individuals. There is no doubt but what most of the flies caught were females, and of the females, the great majority had not finished ovipositing.

No check plot was used, so no definite idea of the effectiveness of the use of traps as a control measure could be obtained. On May 8, 570 plants were set out and on June 13, 569 were still growing. When a plant wilted, it was at once examined for maggots; in only one case were maggots the cause of the death of a plant. Several plants were retarded by other factors, including cutworms, and there is a possibility that some maggots were present in numbers too small to kill or wilt the plant. On August 7, 163 plants were so retarded as to be useless. The cabbage maggot was not a serious pest around New Haven this season.

In experiments elsewhere, allyl isothiocyanate and allyl alcohol have proved attractive to *Hylemyia cilicrura* and *Hylemyia ceparum*, and further trials will be made with these materials with the cabbage maggot.

I am indebted to Dr. H. C. Huckett for assistance in determining the species of Anthomyiinae taken in the experiment.

TABLE I.

NUMBER OF FLIES CAUGHT AT MOUNT CARMEL, 1924.

Formulae	Total Female	Total Male	Average per trap Female	Average per trap Male	Average per trap May 22-27, inc. Female	Average per trap May 22-27, inc. Male	Average per trap May 20-June 3 inc. Female	Average per trap May 20-June 3 inc. Male
Honey-Yeast-Water-Cabbage........	21 traps		21 traps		5 traps		18 traps	
May 20-June 5, inc.	297	85	14.1	4	10.2	3.8	14.6	4.4
Honey-Yeast-Water-Residue........	33 traps		33 traps		5 traps		18 traps	
May 20-June 10, inc.	466	118	14.1	3.6	32	8.6	17.5	4.7
Residue...........	27 traps		27 traps		8 traps		21 traps	
May 20-June 10, inc.	282	87	10.4	3.2	11	4.5	11.3	3.6
Extract...........	28 traps		28 traps		15 traps		28 traps	
May 20-June 3, inc.	337	129	12	4.6	14.7	5.7	12	4.6
Extract-Charcoal...	7 traps		7 traps					
May 20-27, inc.....	52	11	7.4	1.6				
Yeast-Honey-Water.	2 traps		2 traps					
May 22-23, inc.....	17	6	8.5	3				
Yeast-Brown Sugar-Water.........	5 traps		5 traps		5 traps			
May 22-27, inc.....	73	23	14.6	4.6	14.6	4.6		
Yeast-Molasses-Water..........	5 traps		5 traps		5 traps			
May 22-27, inc.....	84	27	16.8	5.4	16.8	5.4		
Brown Sugar-Yeast-Water-Cabbage..	5 traps		5 traps		5 traps			
May 22-27, inc.....	44	18	8.8	3.6	8.8	3.6		
Molasses-Yeast-Water-Cabbage..	5 traps		5 traps		5 traps			
May 22-27, inc.....	86	22	17.2	4.4	17.2	4.4		

The number of traps is the total gained by considering one trap set one day as one, two traps in one day two, one trap for two days two, etc.

TABLE II.

DURABILITY OF ATTRACTIVENESS.

		May 16	17	18	19	20	21	22	23	24	25	27	30	June 1	3	5	7	10
Residue Honey Yeast Water	Female	15	10	7	13	5	11	11	29	23	36	61	16	10 —	20	5	32	1
	Male	6	2	2	5	7	6	8	12	3	9	11	1	0 —	4	1	2	1
	Female	..	..	..	..	3	13	discontinued					14	7	1	0 —	5	3
	Male	..	..	..	..	1	4	..	..	..	..	..	5	3	0	0 —	3	1
	Female	..	..	..	..	..	..	..	..	..	..	..	23	29	3	0 —	7	14
	Male	..	..	..	..	..	..	..	..	..	..	..	8	3	0	0 —	3	7
Cabbage Honey Yeast Water	Female	7	5	5	11	4	7 —	23	13	5	4	6 —	31	19	4	11	..	..
	Male	7	3	2	3	2	3 —	10	5	1	1	2 —	8	4	0	2	..	..
	Female	..	..	..	..	2	5	discontinued					33	18	4	10	..	..
	Male	..	..	..	..	2	10	..	..	..	..	..	3	1	1	3	..	..
	Female	..	..	..	..	..	..	..	..	..	..	..	41	37	6	14	..	..
	Male	..	..	..	..	..	..	..	..	..	..	..	6	21	0	0	..	..
Residue	Female	..	..	..	..	0	0 —	2	21	12	4	24 —	33	45	14	15 —	18	6
	Male	..	..	..	..	0	1 —	2	13	3	2	6 —	9	8	0	3 —	2	4
	Female	..	..	..	..	1	2	discontinued		1	7	17 —	4	12	0	1 —	2	2
	Male	..	..	..	..	0	0	..	..	0	1	9 —	3	2	0	2 —	0	0
	Female	..	..	..	..	..	..	..	..	..	..	..	22	13	4	..	..	..
	Male	..	..	..	..	..	..	..	..	..	..	..	10	7	0	..	..	..
Extract	Female	..	..	..	..	5	5 —	18	30	10	1	19 —	20 —	12 —	3	..	..	..
	Male	..	..	..	..	6	6 —	10	20	2	1	3 —	1 —	2 —	0	..	..	..
	Female	..	..	..	..	11	2 —	9	14	2	3	1	..	..	..	..	..	..
	Male	..	..	..	..	9	2 —	9	6	0	0	1	..	..	..	..	..	..
	Female	..	..	..	..	..	..	17	70	13	7	7 —	19 —	17 —	0	..	..	..
	Male	..	..	..	..	..	..	14	16	3	0	0 —	4 —	7 —	1	..	..	..
	Female	..	..	..	..	..	..	..	..	..	..	..	7 —	12 —	3	..	..	..
	Male	..	..	..	..	..	..	..	..	..	..	..	1 —	4 —	1	..	..	..

Each time the bait was renewed is indicated by a dash (—), except when water alone was added. Each line (male and female) gives results of one series with one trap.

EXPERIENCES IN DUSTING TO KILL PEA APHID, CABBAGE APHID, AND ONION THRIPS.

R. B. FRIEND AND B. H. WALDEN.

The following experiments were carried on to determine whether or not nicotine dust (commercial brands containing 2.75 per cent. nicotine and 3 per cent. nicotine) would kill the insects in question. In all these experiments a rotary hand duster was used. Some of the dusting was done at the Experiment Station Farm at Mount Carmel, and some was done at other farms in the State.

The cabbage aphis, *Brevicoryne brassicae* L., when infesting cabbages to any great degree, causes the leaves to curl and checks the growth to such an extent that solid heads do not form. At the farm of Mr. E. M. Wooding at North Haven, one application of 3 per cent. nicotine dust at the rate of 50 pounds per acre (applied by Mr. Wooding) practically eliminated the aphids. The dust was applied on a two-acre plot between 7:00 A.M. and 1.00 P.M., July 26, 1924. The infestation had progressed to the extent that some of the leaves had curled. Experiments at the Station Farm where the infestation was somewhat lighter showed a good control with 2.75 per cent. nicotine dust. Dusting should be done as soon as the aphids appear in small numbers on the plants and before the leaves are curled, when a lighter application than the above would probably give equally good results. If the leaves have curled, it will require more time to make the application, as the nozzle of the duster should be inserted into the curled leaves to reach the aphids thus protected. The best time for dusting seems to be in the late afternoon of a warm, quiet, clear day.

The pea aphis, *Illinoia pisi* Kalt., was only locally abundant around New Haven in 1924. A badly infested field of garden peas situated near the Station was treated with a very heavy application of 2.75 per cent. nicotine dust on June 25, 1924, at 10:00 A.M. The temperature was about 82° F., and the day clear. A rather strong south wind was blowing. The vines were well grown, the peas being almost ready to pick, and the infestation was very heavy. Dust was applied at the rate of about 140 pounds per acre, and a count of aphids was made the following day. This count was made from three random samples from the dusted area and three random similar samples from the undusted area. The dusted plants had 181 live aphids, against 1,663 on the checks, 89 per cent. being killed. As this application of dust was much heavier than would ordinarily be applied, recommendations as to control cannot be made from this experiment. Further work will be carried out along this line. In Maryland, experiments of Cory and Potts (Univ. of Maryland Agr. Expt. Sta., Bulletin 261, February, 1924) where large areas were dusted with power dusters, show that 5 per cent. dust at not less than 30 pounds per acre will give an economical control when applied with the aid of a long trailer. For details, see their bulletin. The pea aphid and the hand duster in operation are shown on Plate XXXI, b and c.

The onion thrips is difficult to control because there are always many individuals down in the sheath of the leaf protected against the treatment. A heavy application of 2.75 per cent. nicotine dust was applied to Ebenezer onions (sets) at the farm of W. S. Morris & Company in Wethersfield on July 16, 1924. The dust was applied at 2:00 P.M. The day was fair and warm, and the wind fairly strong. A count of thrips from dusted and untreated areas showed little control, if any, with the dust. The onions were well grown (about 15 inches high), and the infestation of thrips heavy. On July 21, the above plot was again dusted, together with an additional untreated area. This application was at the rate of 200 pounds per acre and was applied at 3:00 P.M. The day was fair and warm, and a rather strong west wind was blowing. On July 24, random samples were taken from the untreated and treated areas. As field observations showed the dust killed the thrips which were on the exposed parts of the leaves, that is, not in the sheath; the plants examined were cut one inch above and one inch below the sheaths and thrips counted in this sheath area only. The plants from the check area (untreated) showed 551 thrips as against 291 for the area dusted once and 98 for the area dusted twice. However, the lowest count plant from the check area had fewer thrips than the highest count plant from the area dusted once. All the plants dusted twice had a small number of thrips in the sheath.

Plots of young onions (6 inches high) in the Station garden at New Haven were dusted under favorable conditions July 25 and July 28, 1924. Field observations indicated that there were many live thrips in the sheath of the leaves, although those on the exposed parts of the leaves were killed. Apparently 2.75 per cent. nicotine dust, even though in excessive quantities, will not fully control the onion thrips when applied with a hand duster as above. Further experiments will be conducted with nicotine dust on this insect.

In dusting vegetables for aphids, the dust should be applied late in the afternoon and if possible when there is no breeze blowing. The temperature should be high, above 70° F., for good results. Dusting should not be delayed until the infestation is severe enough to wilt or curl the leaves, as even a heavy application of dust will then give less satisfactory results than a light application put on when the insects are not very numerous. Higher concentrations of nicotine in the dust as a rule will give better results than lower concentrations, other things being equal, and less dust will be required.

From our observation with the majority of hand dusters, it is necessary to use a larger amount of dust to cover the plants thoroughly than is required with a power duster that drives the dust with greater force into every part of the plant.

HINTS ON PHOTOGRAPHING INSECTS[1]

B. H. WALDEN.

It is rather difficult to know just what will be of interest to this gathering regarding insect photography, as some of you have had considerable experience in photographic work while others may have no occasion to take pictures.

In general, photographing insects is somewhat similar to making portraits; it is necessary to arrange a miniature studio and follow the same principles in lighting, exposure, etc. So instead of strictly following the subject, I am planning to take up certain points regarding which there has been more or less inquiry by different ones who are interested in insect photography.

The question of lenses is one that has probably received more attention than any other. Many are puzzled to understand why

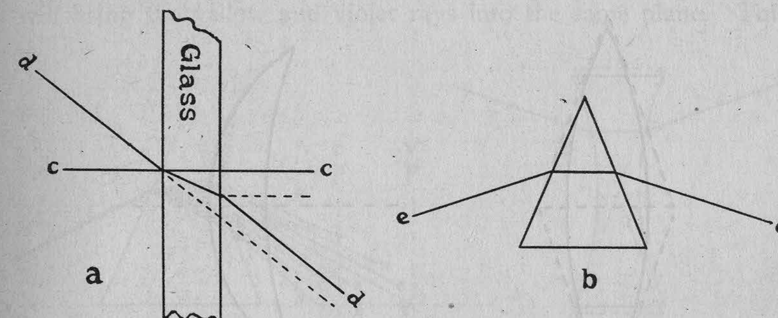


Figure 8. a. c. c. represents a ray of light passing from air through a plate of glass at right angles to its surface; d. d. a ray of light bent in passing from air through glass when entering the surface at an oblique angle. b. e. e. Showing the way that a ray of light is bent in passing through a prism.

a photograph taken with a cheap single lens may be apparently as good as one made with an expensive anastigmat lens. Frequently the dealer is not clear in explaining the limits of the different types of lenses, and often overrates the advantage of the anastigmat lens.

In order to point out the development of the photographic lens, it is necessary to consider some of the first principles in optics.

We see objects by the light that is reflected from their surfaces. The surface of the object can be considered as being made up of an infinite number of points, each of which is reflecting rays of light, and the function of the photographic lens is to gather as many as possible of these rays and transpose them onto the plate or film in such a manner as to form a reproduction of the object.

[1] Paper read before the meeting of Connecticut Entomologists, New Haven, October 31, 1924.

A ray of light travels in a straight line as long as it continues in the same medium, such as the air, and will continue in a straight line if it passes from the first medium into another medium of the same density. If the ray of light passes from one medium to another of different density, i. e., from air to a plate of glass, and enters the latter at right angles to its surface, it will still continue in a straight line (see Fig. 8a, c.c. = a ray of light entering at right angles), but if the ray of light enters the glass at an oblique angle, it is bent away from a straight line. Upon leaving the glass and again entering the air, the ray will be bent parallel to the direction to which it entered (see Fig. 8a, d.d.). The ray of light when entering a denser medium is bent toward the normal (represented by c.c. Fig. 8a.) and when passing from denser medium to a rarer one is bent away from the normal.

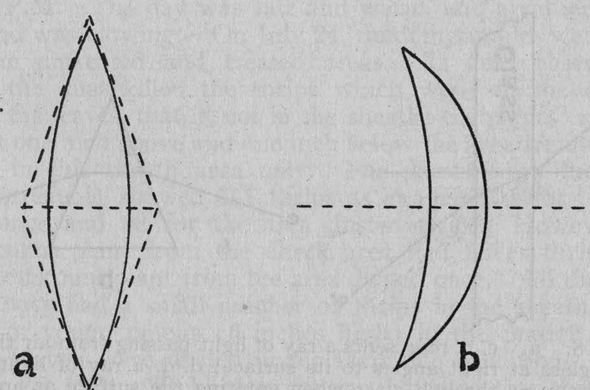


Figure 9. a. Showing the shape of a lens designed from prisms placed base to base; b. A meniscus lens, the simplest form of photographic lens, made from a single piece of glass.

This bending of light rays is called refraction and the degree of refraction depends upon the difference in density of the media and the angle at which the ray enters a different medium. According to the laws of refraction, if a ray of light is passed through a prism, the rays of light will be bent as shown at e.e. Fig 8b. If two prisms are placed base to base as shown in Fig. 9a, we have the principle upon which a simple lens is constructed, although the lines of the lens must be curved; every portion of the surface of a lens is a perfect arc of a circle. A lens of this form, however, is not suitable for photographic purposes. Fig. 9b. shows in cross-section the shape that the simplest photographic lens made from a single piece of glass must be constructed. This is known as the meniscus lens, so called from the crescent shape.

If such a lens is placed in a camera and an object is focused

on the ground glass and photographed, the negative will not be sharp. The reason for this is as follows. When light is passed through a prism, in addition to the bending of the rays as is shown in Fig. 8b., they are separated into the various colors of which the white light is composed. Each of the colors have a different wave length, red and yellow having the longest come at one end of the scale, and the violet and blue with the shortest wave lengths are at the other (Fig 10a.). Furthermore, the yellow rays are the "visual" rays or the ones by which we see the object on the ground glass, and the violet rays are the "chemical" rays or the ones which effect the sensitive film, so that when we focus such a meniscus lens, the ground glass will be in a plane of the yellow rays back of the plane of the violet and blue rays (see Fig. 10a, C. P. and V. P.

It is not possible to make a lens of a single piece of glass that will bring the yellow and violet rays into the same plane. This

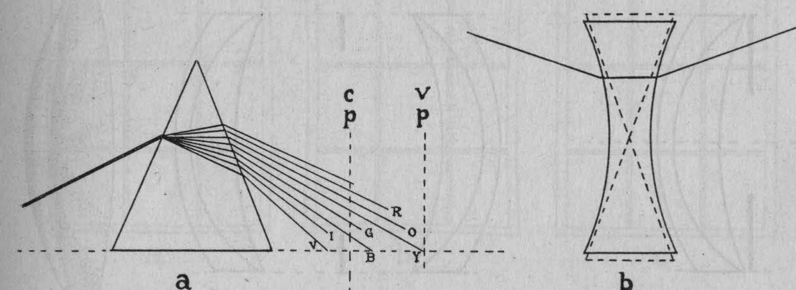


Figure 10. a. A ray of light separated by a prism into the principal colors of which it is composed; v. p., the visual plane and c. p., the chemical plane. b. A negative lens designed from two prisms placed tip to tip, showing the direction a ray of light is bent.

fault is known as chromatic aberration. These lenses are used, however, in some of the cheapest fixed focus box cameras by placing the lens so that the chemical rays will focus on the plate or film.

If a lens is designed from two prisms placed with the points together instead of the bases, the rays of light would be bent out or diverge instead of being bent in or converging as with the latter (Fig 10b.). The converging lens is also called a positive lens and the diverging lens a negative lens.

By using two kinds of glass of different density and combining a converging and diverging lens (Fig. 11a.), it is possible to bring the focus of many of the visual and chemical rays into the same plane. This type of lens is known as an achromatic meniscus. While this lens is a decided advance over the simple meniscus lens, it is not possible to control the rays of light at the edges of the lens, so that it is necessary to cut out these rays with a stop, and use only those rays coming through the central portion. If we photograph an object with straight lines, such as a window, placing the stop behind the achromatic lens, the lines at the edges of the window in the photograph will curve outward (Fig. 12a.) If the stop is placed at the front of the lens, the edges will curve inward (Fig. 12b.) By combining two of these lenses with the concave surfaces toward each other and placing the stop between the two, this defect will be overcome and the lines will be straight in the photograph (Fig. 12c.) Such a lens is known as a rectilinear lens (Fig. 11b.) More of the marginal rays can be controlled in a rectilinear than in an achromatic lens, and a stop with a larger opening may be used, which admits between three and four times as much light as the single lens. The rectilinear lens, while satisfactory for many kinds of work,

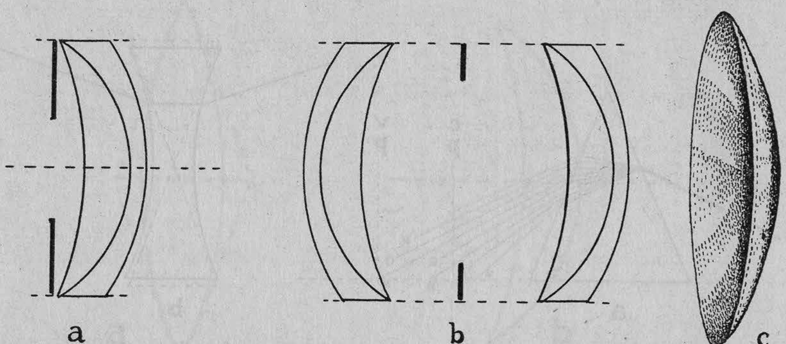


Figure 11. a. An achromatic lens, consisting of a positive and negative component; b. Construction of a rapid rectilinear lens; c. Diagram illustrating curvature of field of rectilinear lens.

still has many defects. The chromatic aberration is not entirely eliminated. If the image on the ground glass is focused sharply at the center, the edges of the field will not be sharp, showing that it is more or less saucer-shaped (Fig. 11c.). This is known as curvature of the field. In addition to this, some of the marginal rays cross those entering through the central portion of the lens and fall on the plate or film at an angle causing a slight blurring of the image. This defect common to the rectilinear lens, is spherical aberration and can only be corrected by using a smaller stop, eliminating the marginal rays and increasing the exposure. In photographing geometric figures or objects with both vertical and horizontal lines with a rectilinear lens, only one series of lines can be sharply focused, due to astigmatism.

Up to about 30 years ago, only two kinds of glass were available for making lenses: crown glass and flint glass. These were

of different density and therefore each would bend the rays at different angles. Positive lenses or elements were usually made of crown glass, and the negative elements of flint glass. Only a certain degree of skill was required to reduce the principal defects, curvature of the field, chromatic and spherical aberration and astigmatism to the limit obtainable with these glasses.

About this time, a new kind of glass was produced which could be made in different degrees of density, and lenses could be made in which the above mentioned defects could be practically eliminated. This is the Jena glass from which the anastigmat lenses are made. These lenses could be further corrected for certain other faults which are essential in certain critical lines, but of little importance to the ordinary workers.

In the anastigmat lens, it is also possible to bring the light rays entering near the margin of the lens into the same plane as

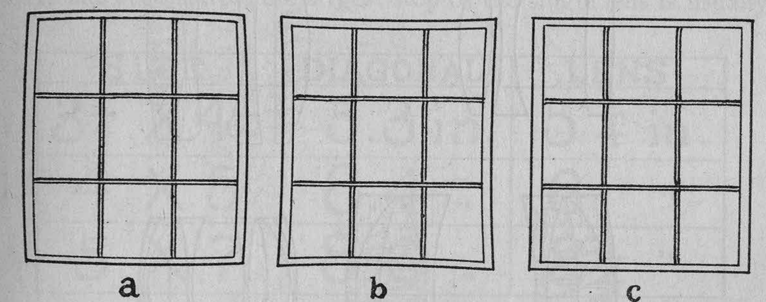


Figure 12. a. Diagram of a window sash showing distortion with the stop behind a meniscus lens; b. The same with the stop in front; c. Lack of distortion when made with a rectilinear lens.

those nearer the center, so that it is not necessary to "stop" them out. For this reason, from 40 to 300 per cent. more light, depending upon the construction, will pass through these lenses than through the rectilinear lens. While the anastigmat lens is comparatively free from optical faults, it is only by using great care in the construction that the defects found in other types of other lenses can be eliminated. The lens glass will vary in density with the amount of heat used in fusing it, and the lens formula must be computed for each lot of glass. The elements are ground and polished to within at least one thirty-thousandths of an inch. This grinding has to be done slowly so as not to heat the glass and cause it to expand. Anastigmat lenses may have from three to 10 glasses in their construction (see Fig. 13) and it is not hard to see why they may cost from five to 10 times as much as rectilinear lenses.

The size of a photographic lens is based on what is known as the focal length. This is approximately the distance from the ground glass or film to the center of the lens, when it is focused on an object at a distance of 100 feet. Cameras for general work are usually fitted with a lens, the focal length of which is equal to, or slightly shorter, than the diagonal of their plates or films: for example, a $3\frac{1}{4}$ x $4\frac{1}{4}$ camera with a diagonal of 5.3 inches will have a lens of about $5\frac{1}{4}$ inches. Fig. 14 gives the diagonals and focal lengths of lenses for three common sizes of cameras. A lens of shorter focal length will give an exaggerated prospective; that is, nearby objects will appear too large and distant objects will be proportionately small. A lens of a focal length longer than the diagonal of the plate will often give a better prospective, but would be too large to fit the average small hand camera. It is also necessary in photographing large objects,

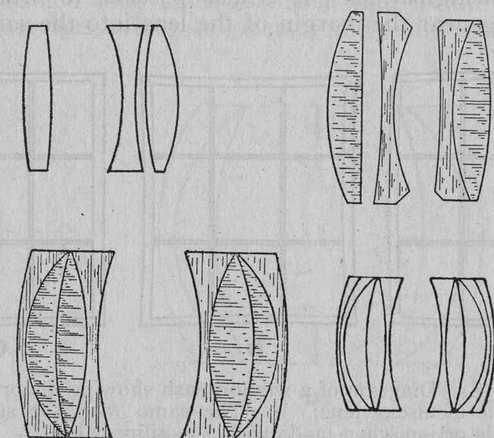


Figure 13. Diagrams of the construction of anastigmat lenses, with from three to ten glasses.

such as buildings, to stand further away to include as much in the view as is done with the shorter focus lens.

Lenses are provided with stops to cut down the size of the aperture. There are two systems in general use, both of which are based on the focal length of the lens. In what is known as the "f" system, the diameter of the opening is a fractional part of the focal length; that is, if the largest stop or opening of an eight inch lens is one inch in diameter (one-eighth of the focal length), it would be marked "f.8" which also indicates the speed of the lens and would be called an f.8 lens. The diameter of each of the smaller stops would be indicated by their fractional value as f.11 (one-eleventh), f.16 (one-sixteenth), etc.

In the other system, called the uniform system (U.S.), the equivalent of f.8 is designated as 4, and the number for each smaller stop is twice that of the preceding and indicates that the

exposure should be doubled. This system is generally used with rapid rectilinear lenses, while stops of anastigmats are usually marked with the f. system. The relative stop values of these systems are given below.

F. System.......	f.6.3	f.8	f.11	f.16	f.22	f.32
U. S. System.....	$2\frac{1}{2}$	4	8	16	32	64

Anastigmats are frequently termed "fast lenses" and the novice may get a wrong impression of what is actually implied by this term. The amount of light which passes through a given sized opening of a meniscus lens, say stop f.16, which is usually the largest stop of this type of lens, is exactly the same as will pass through an anastigmat at f.16. The exposure would be the same for either lens, as the amount of light that can enter to affect the film depends simply upon the relative area of the lens opening.

As has been stated, the largest stop of the single lens is usually

SIZE	DIAGONAL	LENS
$3\frac{1}{4}$ X $4\frac{1}{4}$	5.3 in.	$5\frac{1}{4}$ in.
4 X 5	6.4 "	6 "
5 X 7	8.6 "	$8\frac{1}{4}$ "

Figure 14. Three sizes of cameras, their plate diagonals and the focal length of lenses often used on each.

f.16; that of the rectilinear lens is f.8, twice the diameter of the former, and thus admitting four times as much light. The largest aperture or stop of the anastigmat may be larger than f.2, or the diameter of the lens opening more than one-half the focal length of the lens.

Anastigmats fitted to hand cameras, however, rarely have an opening of more than f.6.3, which admits a little over 60 per cent. more light than the rectilinear lens.

In using these large apertures, or in other words, giving a short exposure with the lens wide open, we lose something that is of extreme importance in scientific photography; the depth of focus. The depth of focus is the degree of sharpness of objects in different planes, or distant and nearby objects in the view that we wish to photograph.

This is a fixed quality in all lenses regardless of the type. Depth of focus depends upon two things; the size or focal length of the lens, and the size of the stop used. The longer the focal length, the less depth; the larger the stop, the less depth.

If we take a 3¼ x 4¼ camera with a f.6.3 anastigmat lens and make a photograph with lens wide open and the distance set for 50 feet, objects from 29 feet to a distance of 170 feet should be sharp. If we make a duplicate photograph, stopping the lens to f.16, objects from 18 feet to infinity, or far as the view extends, should be sharp. Any other 5¼ lens, whether meniscus or rectilinear with stop f.16 will give exactly the same amount of depth and the exposure for all of these lenses will be the same. If, then, we wish to take advantage of the so-called speed of the anastigmat lens, we can only do so by opening up the stops to let in more light and thereby sacrifice the depth of focus in the picture. Fig. 15 shows the relative sized stops of a 5¼ inch lens, with the required exposures and the depth of focus with each stop when the camera is set for 50 feet.

To the average worker, the principal advantage of the anas-

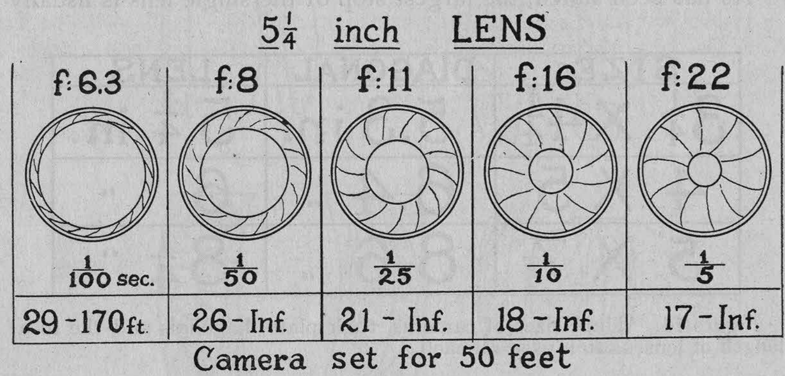


Figure 15. Relative size of the diaphram opening of a 5¼ inch lens with the relative exposures and depth of field with the camera set for fifty feet.

tigmat lens over the rectilinear are the flat field which insures negatives sharp to the edges even when used wide open, and the larger apertures which allow for shorter exposures under unfavorable conditions, although some of the depth must be sacrificed. In general these lenses should be used just the same as a rectilinear.

The loss in the depth of focus with large apertures is more apparent in longer focus lenses such as are used on 5 x 7 to 8 x 10 cameras. This is one advantage in using a small camera for field work. With care in focusing or in using the focusing scale for the principal objects, reasonably sharp negatives can be made with lenses up to the 3¼ x 4¼ size when used wide open. Unless actually cloudy, this will allow exposures of one-hundredth of a second at f.6.3 when photographing spraying operations and similar operations that require a short exposure in order that the movement does not blur the picture.

For photographing insects and their work in the laboratory, it is necessary to have a larger camera with a long bellows. While there are a number of cameras designed for photo-micrograph work, there is no camera on the market that is entirely satisfactory for photographing insects from natural size up to eight or 10 diameters. In our work, we use a 5 x 7 view camera mounted on a stand that allows the camera to be used either in a vertical or horizontal position.

A lens of about four inch focus is used in photographing insects natural size or twice natural size. This requires a bellows extension of twice the focal length for natural size and three times for twice natural size, or eight and 12 inches respectively. In photographing insect eggs or similar small objects, it may be necessary to make the direct photograph six to 10 times natural size. To do this with the four inch lens, it would require a bellows length of 44 inches for the 10 times enlargement; as the camera has only a 22 inch bellows, we use lenses such as are used on motion picture cameras with focal length of only one and one-half or two inches.

The question naturally occurs, how can we use these small lenses designed to use on a film only a little larger than a postage stamp to cover a 5 x 7 plate. We are simply converting the short focus lens into a long focus lens and bringing the object to photograph very near to the lens. As soon as we do this, the values of the stops in the lens are changed in relation to the focal length and the exposure has to be greatly increased in proportion to the given enlargement. If the exposure for natural size is expressed as 1, the increase in exposure for various sized enlargements is as follows:

Times Enlarged...	1	2	3	4	5	6	8	10	12
Exposure........	1	2¼	4	6	8	12	20	30	42

We are using cut films instead of glass plates in most of our work. Regardless of the argument that the films do not lie flat and are inferior to plates, I feel that we are getting equally good results with the films and they have a number of advantages over the plates. Halation is reduced to a minimum and there is no danger of breakage. They are much lighter in weight and about 25 can be stored in the same space as a dozen plates. Panchromatic films with a set of color screens to be used with them are desirable to bring out colors that will not show contrast on regular or even Orthochromatic films.

In photographing insects or their work in the laboratory, the material is placed on a piece of ground glass with the background two or three inches below to eliminate the shadows. From an artistic standpoint shadows may add to the photograph, but they often detract from and add confusion to scientific photographs which should be as simple and clean cut as possible. The background is usually a piece of white cardboard, although various tints of gray are used to bring out contrast with light-colored or white objects. Pieces of white cardboard are also set up for reflectors to light the shaded side of the object.

The chief requisite in photographing caterpillars is patience. As a rule the specimens will appear natural only when photographed alive. Better results can be obtained with one to three specimens than where more are included. When possible the specimens should be placed on some of the food plant which shows characteristic work of the species. The food plant must lie as flat as possible, and twigs or leaves out of the general plane should be removed as they will be out of focus in the photograph. Most of the caterpillar photographs are made natural size as enlarging them would require too long an exposure. The lens should be stopped down as much as possible, depending upon the activity of the insects. As we use daylight for most of the exposures, it requires from five to 10 seconds with f.8 stop; more often a smaller stop is used. With the specimens focused and the cap over the lens, the slide is drawn from the plate holder. It is then a case of watching and waiting for the specimens to become still for the required exposure.

Slightly pinching a caterpillar or tapping it with a pencil will sometimes cause it to remain quiet. In some cases it is necessary to stupify the specimens with chloroform but this should only be done when they will remain quiet in no other way.

There are many occasions to make illustrations of adult insects from dead specimens. Though there has been some controversy as to whether the specimens appear more natural to the average person if symmetrically set or photographed without such preparation, in either case a specimen will not appear as in nature and the writer feels that an illustration of an insect is more satisfactory if it shows all six legs than when it gives the impression of having but one or two.

It is often desirable to show butterflies and moths with the wings folded in a resting position. Large specimens can often be photographed alive in a characteristic resting position. Where we wish to show the wing-spread and especially the under wings, carefully set specimens make much better photographs than those set in a careless manner. Pinned specimens are usually set in a piece of cork covered with white paper. Where possible it is well to cut off the head and portion of the pin above the insect close to the body.

In making enlarged photographs of small insects, it is often difficult to focus the object due to a certain amount of play in the camera adjustments. To overcome this an ordinary dissecting microscope has been fitted with a glass object carrier on the lens arm. The object to be photographed is placed on this, the camera bellows set for the right magnification and the object brought into the focal plane by using the rack and pinion of the dissecting stand.

The exposures in insect photography should be fully timed. If the detail is present in the negative, sufficient contrast can often be obtained with the proper grade of photographic papers. Satisfactory prints, however, cannot be made from under-exposed negatives; if the detail is lacking there is no way to supply it and if possible another negative should be made.

Good insect photographs after all depend largely upon the experience of the operator and his ability to use the available apparatus and materials to the best advantage.

MOSQUITO CONTROL WORK IN CONNECTICUT.

Season of 1924.

R. C. BOTSFORD.

The Director of the Connecticut Agricultural Experiment Station is charged by Statute with the maintenance of drainage works for mosquito elimination, inspected and approved by him. He may also upon request inspect and survey mosquito breeding areas, furnish estimates of cost of treating these areas and supervise or regulate the work. The area of 5,000 acres of ditched salt marsh under State maintenance and contained in nine shore towns was patrolled from April 1 until October 1. Ditches were kept free from obstructions and when found in bad condition, were recut and graded as far as funds would permit. About 155,000 lineal feet were recut. As a result there were but few spots where salt marsh pools would have remained long enough to develop adult mosquitoes. In such cases, oil was sprayed on the pools at the proper time.

The inland or fresh water work is at present limited to making investigations of mosquito infested areas upon request. In such instances, practical advice is given concerning the elimination of each particular breeding place.

Mosquito control work has been generally successful this season and there has been a notable increase of interest shown throughout the State in the mosquito problem.

The expenditures for the year 1924 were as follows:

New work and maintenance work supervised by the State where funds were provided by individuals, associations or towns:

Fairfield	$3,556.97	
Stamford	1,300.00	
Westbrook	1,080.00	
		$5,936.97
Maintenance work in 9 towns (State funds)	5,019.95	
Supervision, tools, etc. (State funds)	2,734.75	
		7,754.70
Total		$13,691.67

The following table shows the present condition of the salt marsh areas in the coast towns. It was prepared from data immediately available and is subject to correction.

Town	Salt Marsh Acres	Salt Marsh Ditched	Maintained by State	Total Cost of Ditching	Labor, Cost of Maintenance 1924	Labor, Cost to Complete
Greenwich	....	....	None	....	....	....
Stamford	300	300	200	$2,800.00	$236.00	....
Darien	300	300	None	3,800.00	....	....
Norwalk	600	600	None	7,500.00	....	....
Westport	350	50	50	Ditched with Fairfield	....	$5,000.00
Fairfield	1,200	1,200	1,200	8,400.00	900.00	....
Bridgeport	173	....	....	....	....	3,000.00
Stratford	1,315	....	....	....	....	16,000.00
Milford	630	....	....	....	....	8,000.00
West Haven	463	222	222	Ditched with New Haven	194.00	3,500.00
New Haven	750	750	750	12,000.00	592.50	....
Hamden / North Haven	2,042	....	....	....	....	25,000.00
East Haven	482	150	50	Ditched with New Haven	42.75	6,500.00
Branford	895	578	578		787.55	4,500.00
Guilford	1,085	1,085	1,085	20,000.00	545.52	....
Madison	1,005	1,005	1,005		1,674.43	....
Clinton	766	....	....	....	....	10,000.00
Westbrook	500	90	None	1,517.61	....	5,000.00
Old Saybrook	1,373	60	None	....	....	17,000.00
Lyme	493	....	....	....	....	7,000.00
Old Lyme	1,393	....	....	....	....	17,000.00
East Lyme	424	....	....	....	....	5,000.00
Waterford	204	....	....	....	....	3,000.00
New London	34	....	....	....	....	500.00
Groton	304	50	50	1,000.00	47.20	4,000.00
Stonington	555	....	....	....	....	7,500.00
Totals	17,636	6,440	5,190	$57,017.61	$5,019.95	$147,500.00

THE WORK BY TOWNS.

NEW HAVEN.

The town of New Haven contains about 750 acres of salt marsh, all of which was ditched for mosquito elimination during the period from 1912-1917. These salt marsh areas were patrolled continuously from April 1 to October 1, and about 20,500 lineal feet of ditches found in bad condition were recut and graded. Some breeding was discovered where drainage was not yet perfect, but oil was sprayed on the water at the proper time to prevent emergence. There was practically no emergence of mosquitoes from the salt marshes in the town of New Haven in 1924. In spite of this fact, New Haven was more or less infested with salt marsh mosquitoes throughout the summer. This was due to mosquitoes migrating from breeding places in bordering towns.

It is recommended that a tide gate be placed in Little River at Middletown Avenue.

WEST HAVEN.

The salt marshes in the town of West Haven seem to furnish the principal salt marsh mosquito nuisance in New Haven. There are yet about 250 acres of marshes in this town which have not been ditched for mosquito elimination, and in some of these areas breeding places exist throughout the season. A sluiceway with tide gate should be installed in the outlet of the Old Field Creek, extending from Beach Street about 300 feet into the bay, and the creek dredged from Beach Street to Peck Avenue. At times the creek and marsh become so heavily polluted that the killyfish, the natural enemy of the mosquito, either perish or are driven back into the bay. Mosquitoes breed here in immense quantities. This public nuisance is entirely unnecessary and should be abated.

EAST HAVEN.

There are about 482 acres of salt marsh in this town. About 150 acres of this have been treated for mosquito elimination and were kept free from breeding throughout the season. The remaining 332 acres should be treated before relief from mosquitoes can be expected.

The State rifle range was inspected on April 15. Every depression in the wooded area was holding water and breeding mosquitoes. Later in the season when the ranges are in use, these mosquitoes are very troublesome. It is then too late to do anything about it. These breeding places should be filled where practical, or drained or oiled during April, May and June.

BRANFORD.

More than 17,000 lineal feet of ditches were recut and graded in this area since the fall of 1923. A 20 x 24 inch ditch about 400 feet long was dug at Sunset Beach to simplify a drainage problem there. The marsh area under State supervision was thoroughly patrolled throughout the season, and all ditches kept free from obstructions. There was no salt marsh mosquito breeding in this area.

The drainage of the Sybil Creek marsh north of the tide gates on the Indian Neck Road could be improved by a new tile outlet about 400 feet long running eastward and emptying directly into Long Island Sound. More than 317 acres of salt marshes in Branford are not ditched or treated for mosquito elimination.

GUILFORD.

Drainage of the salt marsh areas of this section was well maintained throughout the season. A reported abundance of mosquitoes in one locality led to the discovery of a small corner of salt marsh which will require additional ditches. Repair work was begun on the stone dike at Shell Beach; 25 lineal feet of wall was rebuilt, and this will be continued as funds become available.

MADISON.

Mosquito breeding in Madison was well controlled. Over 8,000 feet of ditches were entirely renewed in the Hogshead Point section. Seven corrugated iron culverts were installed in beaches to replace wooden structures destroyed by storms, and one new 36 inch iron tide gate installed near East River on the Post Road. (See Plate XXXIV

At Hammonassett State Park, labor and oil were furnished by the State Park and Forest Commission to control the breeding in the salt marshes contained in and adjacent to the park. The area was thoroughly patrolled and oiled when necessary, and in addition, more than 43,000 feet of damaged ditches recut. A striking reduction in the number of mosquitoes in the park was reported, due to this work.

WESTBROOK.

The drainage work was started as soon as the weather permitted and continued until the funds were exhausted. This fall more funds were turned over to the Station to continue the work. The ditching of the Fisk marsh and Rushy meadow are practically completed. The culvert draining the Fisk marsh continued to function perfectly throughout the season. The Rushy meadow culvert was relocated and extended 50 feet. Ditching of the Patchougue River marshes near the center of the town was started on December 3 and discontinued on December 20, due to cold weather. Some reduction in the number of mosquitoes was reported this season.

GROTON.

The small ditched area at Groton Long Point was thoroughly patrolled. Ditches were put in good condition by recutting and grading where necessary. No breeding pools existed. The bridge over the marsh outlet should be replaced or a culvert installed in its place.

FAIRFIELD.

The town of Fairfield continues its interest in mosquito elimination and has co-operated with the State throughout the year.

The salt marshes were kept free from breeding the entire season by keeping the ditches cleared and oiling certain pools at the proper time. The fresh water work was continued under the same arrangement as last year, and the drainage work extended and improved. The Fairfield Improvement Association, the town, and individuals supply the bulk of funds for this work from year to year.

STAMFORD.

The Stamford salt marsh area under State maintenance at Shippan Point was well patrolled and the ditches kept open so that the marshes were well drained throughout the season. About 5,500 lineal feet of ditches were recut. No mosquitoes developed on this area. In the meantime, mosquitoes were reported breeding in Southfield marshes, Gourley Tract Swamp and other areas not under State supervision. Upon request of the Health Commissioner of Stamford, an estimate of the cost of treating these breeding places was furnished by the State. The work was started on July 1, and supervised by the State without charge. Eleven thousand feet of old ditches were recut, and 1,300 feet of new ditches and 500 lineal feet of tile and iron pipe were installed. (See Plate XXXIII, b.)

Fresh water breeding places were oiled, and several miles of fresh water ditches cleaned. A reduction in the number of mosquitoes has been reported.

. . . . .

The law passed in 1913, declaring mosquito breeding places a public nuisance and authorizing health officers to abolish them remains on the Statutes and is as follows:

Section 2408. **Mosquito breeding places; treatment.** Any accumulation of water in which mosquitoes are breeding is declared to be a public nuisance. When it has been brought to the attention of a health officer or board of health, through the complaint of any citizen, or when discovered by any inspector or agent of said health officer or board of health, that rain water barrels, tin cans, bottles or other receptacles, or pools near human habitations are breeding mosquitoes, it shall be the duty of said health officer or board of health to investigate and to cause such breeding places to be abolished, screened or treated in such manner as to prevent the breeding of mosquitoes. The health officer, or any inspector or agent employed by him, shall have the right to enter any premises in performance of his duties under this section.

NOTES ON MISCELLANEOUS INSECTS.

Miners in Milkweed Pods: Milkweed pods infested by larvae were collected in Manchester, August 14, 1924, by Mr. J. L. Rogers, Assistant, and were placed in the insectary. On September 27, an adult emerged and another one was obtained on October 25. The adult insect is a black weevil or snout beetle, *Rhyssematus lineaticollis* Say.

Walnut Bud Moth: On June 11, 1924, we received from Mr. B. M. Gillette, Taintor Hill, Suffield, some specimens of brown larvae infesting a Japanese walnut tree. This insect had prevented the owner from obtaining any nuts and is probably the walnut bud moth, *Acrobasis caryae* Grote, though it may prove to be some other related species. In 1912, we had no difficulty in holding this insect in check by spraying thoroughly with lead arsenate.

Sawfly on Arbor-Vitae: On July 10, 1923, Messrs. M. P. Zappe and J. L. Rogers, while in Manchester, noticed some sawfly larvae feeding upon small arbor-vitae nursery trees. A few larvae were found on each tree though no particular injury could be detected. The larvae were grayish green in color, without prominent markings. The material was placed in cages in the insectary and adults emerged on March 10, April 24 and May 22, 1924. Specimens were sent to Mr. S. A. Rohwer, who identified them as *Monoctenus juniperinus* MacGillivray, a species described in 1894 from material collected at Ithaca, N. Y.

Leaf-Roller on Pin Oak: In Fairfield County and in other parts of the State, pin oaks were attacked and in some cases nearly defoliated by a leaf-roller, presumably *Tortrix quercifoliana* Fitch. This insect was observed in New Haven where it caused slight injury, and in Greenwich and Stamford, where it was much more abundant. One pin oak growing naturally in a field north of Stamford was completely stripped by June 9, and is shown on Plate XXV, b. Probably a thorough spraying with lead arsenate would prevent such injury.

Biting Dog Louse in Connecticut: On April 11, specimens were received from Pomfret, of the biting dog louse, *Trichodectes latus* Nitzsch, which had infested a collie dog. The dog had been treated by a veterinarian without complete success. The owner was advised to shampoo the dog thoroughly with a miscible oil that will mix with water. Several treatments may be necessary to get rid of the pest, and a few hours after each treatment, the material should be removed by washing in clear water. This insect belongs not to the Parasitica but to the Mallophaga, and though it is supposed to be quite common, this is our first record of its occurrence in Connecticut.

The Azalea Scale: On June 23, a twig of rhododendron was brought to the Station from the neighboring town of Orange, and on the bark were many small white tufts, that resembled felt. This is the azalea scale, *Eriococcus azaleae* Comst., a species often found on shrubs of the heath family, Ericaceae, and occasionally on Crataegus or hawthorn. We have previously recorded the species from Hartford and New Haven. Both sexes are enclosed in a dense white felt-like sac, ovoid in shape. Should this scale become sufficiently abundant to cause injury, no doubt spraying with a miscible oil, or with nicotine solution and soap would free the plant from the scales.

Tropical Cockroach in Greenhouse: Several adult and immature cockroaches were received from Rowayton, on June 13. They were present in a commercial greenhouse where it had become quite a nuisance. The insect in question is *Pycnoscelus surinamensis* Linn., the same species that became a pest a few years ago in the rose houses of A. N. Pierson, Inc., Cromwell, Conn., by eating the bark from newly-set plants, an account of which has already been published.[1] It was found that the roaches would congregate under boards and in the corners of the benches where they could be surprised by a spray of clear kerosene which brought them to a quick death. Of course this spray must not come in contact with the foliage.

Spiny Caterpillars on Hollyhocks: During June, hollyhocks in the writer's garden were attacked by spiny caterpillars which fed upon the leaves. Some were killed by crushing but no poison was applied. On June 25, material was brought to the laboratory and some parasites were obtained. The species attacking hollyhock was the hop merchant butterfly, *Polygonia comma* Harris. The larva is nearly one and one-half inches in length when full grown and is dark brown on the back with two faint lighter median lines; below the spiracles and the entire ventral surface is light brown. Head and legs, dark brown, prolegs light brown. Each segment dorsally bears a transverse row of branched spines, and many hairs which are light brown. Two parasites emerged on July 8.

Sawfly Feeding on White Pine: Sawfly larvae on white pine were received on July 19 from Mount Carmel where they had defoliated several pine trees. The larvae were whitish, with black spots, and black heads. There were many pupae in the package and also many larvae which had contracted in size, preliminary to pupation. This material was caged in the insectary and on August 8, 13 adult sawflies and four parasites emerged. The species was formerly known as Abbott's sawfly, and occurs in literature under the name of *Lophyrus abbotti* Leach, but is now called *Neodiprion pinetum* Norton. It seems to be quite common

[1] Report Conn. Agr. Expt. Station for 1917, page 302.

in Connecticut and reports are received occasionally of small trees being stripped. Of course, spraying with lead arsenate will prevent defoliation.

Mealy Bug on Taxus: On April 30, specimens of mealy bug were received from Mr. Samuel Stewart, from the premises of Mr. Henry Osborn Taylor, Cobalt. The insects were on yew or Taxus trees growing out of doors. On June 13, more material was received from Mr. Taylor, and some of this was sent to Mr. Harold Morrison of the Bureau of Entomology, Washington, a specialist on scale insects. Mr. Morrison replied that the same scale had been received from Rutherford, N. J., on imported Japanese Taxus. At the time, it was identified as *Pseudococcus kraunhiae* Kuwana, but later Professor G. F. Ferris of Stanford University, Cal., showed that *kraunhiae* is something entirely different. Mr. Morrison has been unable to associate this material with any other described Japanese species, though possibly may later be able to do so. There is of course a possibility that this species has not been described. Shown on Plate XXXV, b.

The Bag Worm: A cocoon was received, May 1, 1923, of the bag worm, *Thyridopteryx ephemeraeformis* Haw., from a garden in New Haven. Eggs hatched in the bag May 11, and the tiny larvae immediately began to make bags for themselves from the leaves of the arbor-vitae twig on which the cocoon was fastened. Miss Finley observed their development and made notes. Some of the larvae tore off particles from the old bag for their coverings but others used green tissue from the leaves. The larvae molted five times inside their bags, which were then suspended by silk threads. Two adults emerged September 7, 1923. This insect, though common in New Jersey and southward, is seldom found in Connecticut unless brought in on arbor-vitae or some other food plant from the south. Occasionally, however, it is seen along the shore and may possibly survive the winters here in case they are mild.

Blue Elm Beetle in Branford: On June 20, I received from the Davey Tree Expert Co., Kent, Ohio, several small blue beetles, which one of their men, Mr. W. W. Tuomey, collected at the base of an elm tree on the grounds of Dr. A. J. Tenney, Branford, Conn. A report was sent to the firm, but on August 4, more specimens were received from Mrs. Tenney. These beetles were present in large numbers around the trunks of some trees close to the ground. This is the same species as has been received from other localities in years past as follows: Salisbury, feeding on elm and hickory, August 14, 1902; Old Saybrook, on elm, April 27, 1908; West Haven, on elm, September 11, 1922. This species is *Haltica* (or *Altica*) *ulmi* Woods, and has been confused with the strawberry flea beetle, *Haltica ignita* Ill., but was described in 1918 by Dr. Wm. C. Woods as a distinct species.[1] Apparently it feeds upon the foliage of elm trees, but is never as abundant as the elm leaf beetle, *Galerucella xanthomelaena* Schrank (*luteola* Muller) though certain trees may be riddled. The same remedy will protect the trees, namely, spraying with lead arsenate.

European Pine Shoot Moth in Connecticut: On October 13, 1923, twigs of red or Norway pine, *Pinus resinosa*, were received from Dr. Arthur H. Graves, formerly of New Haven, who collected the specimens at Tarrytown, N. Y. The buds had been tunneled, and two brown larvae were present and were identified by B. H. Walden, Assistant Entomologist, as the European pine shoot moth, *Evetria buoliana* Schiff. On November 24, twigs of the same species also showing the work of this insect were received by Mr. W. O. Filley, Forester, from Mr. William Bunker, Ridgefield. On June 19, 1924, twigs of Austrian pine were sent to the Station by Mr. E. A. Jones, Superintendent, Waveny Farm, New Canaan. These had the characteristic crooked growth resulting from injury to the buds by this insect. According to Busck,[2] the larvae cannot be reached by the application of insecticides and the only means of control is to prune off and destroy the infested twigs and buds containing the larvae. This can best be done during the fall and winter.

A Beetle from Europe: On June 1, 1922, a letter was received from Dr. E. P. Felt, State Entomologist of New York, regarding a European beetle, *Heterostomus pulicarius* Linnaeus, which had been found in Albany, Columbia, Niagara, Rensselaer, and probably Essex Counties, in New York State, and which had caused some injury to strawberry blossoms and young fruit in one plantation in Columbia County. It had also been sent to Dr. E. A. Schwarz, Washington, from the Arnold Arboretum, Forest Hills, Mass. Just after receiving Dr. Felt's letter, Mr. H. C. Fall reported on some beetles sent him for identification, and among other things there was one specimen of *Heterostomus pulicarius*, collected at Milford, May 2, 1921, by M. P. Zappe. A note to this effect was published in the Journal of Economic Entomology, Vol. 15, page 311, August, 1922. The genus *Heterostomus* belongs to the family Nitidulidae, and until recently has not been reported from North America. According to Notman[3], it can be separated from *Brachypterus* as follows:

Claws distinctly toothed at base.
- Prosternum elevated at tip; elytral epipleurae distinct .... *Brachypterus*
- Prosternum not elevated at tip; elytral epipleurae indistinct .... *Heterostomus*

[1] Bulletin No. 273, Maine Agr. Expt. Station, page 182, 1918.
[2] Bulletin No. 170, U. S. Department of Agriculture, 1915.
[3] Journal New York Entomological Society, Vol. XXVIII, page 30, March, 1920.

Pine Seedlings Nearly Girdled by Hylobius pales: On July 15, Mr. H. W. Hicock brought to the laboratory from some town in Massachusetts some natural white pine which had been nearly girdled, and which showed the characteristic work of one of the large weevils, *Hylobius pales* Herbst. This form of injury has been studied by Mr. H. C. Peirson[1], who finds that the beetle feeds chiefly at night, and eats off the bark from the stems and sometimes the twigs of young seedlings during May and the first half of June. The eggs are laid singly in the bark of freshly cut pine logs or roots of stumps where lumbering operations are being conducted and hatch in 10 to 14 days. The larvae burrow beneath the bark until they become full grown, which is usually about the first of September, when they pupate in cells beneath the bark, usually going into the sapwood about one-fourth of an inch. The adult beetles emerge in the fall, some as early as September 15, and begin to feed upon the nearest pine seedlings. Most of them go into winter quarters in October. Control measures consist of burning the slash over the stumps in early spring, sawing the logs before the adults emerge, and stacking the lumber in open sunny areas where there are no young pine seedlings in the vicinity.

Western Corn Root Worm in Connecticut: On August 29, 1923, the writer collected in the flowers of marsh mallow, *Hibiscus moscheutos*, at Granby, Conn., two slender green beetles belonging to the family Chrysomelidae. A visit to the same place on September 5, 1924, showed that these beetles were quite common on aster, calendula and some other kinds of flowers in the garden and were feeding upon the petals. Mr. Zappe has identified this beetle as the adult of the western corn root worm, *Diabrotica longicornis* Say, a species which occurs in the Middle Western States, though apparently not previously recorded from Connecticut. It has recently been taken by Mr. K. F. Chamberlain at Cornwall, Conn. A brief note regarding the occurrence of this species in Connecticut was published in the Journal of Economic Entomology, Vol. 17, page 601, October, 1924. The beetles commonly feed on corn pollen and silk, and upon the flowers of squash, cucumber, beans, clover, goldenrod, aster, thistle and other blossoms. The larvae attack the corn roots, eating off the small roots and burrowing in the larger ones, doing considerable damage in the corn belt. So far as is known the larvae feed only upon corn, so a rotation of crops is recommended. It is impossible to foretell whether or not this insect will injure the corn crop in Connecticut. The appearance of the adult beetle is shown on Plate XXX, e.

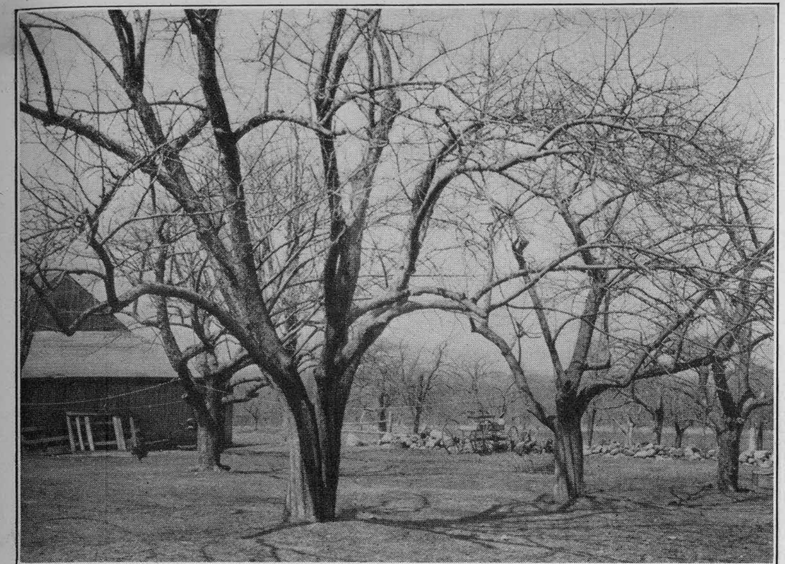
A European Sawfly Leaf-Miner of Birch: During the summer of 1923, it was noticed in several localities in Connecticut that the sprouts of gray birch, *Betula populifolia*, were attacked by a leaf-miner. The presence of this insect was observed at Rainbow in July during the summer meeting of the Entomologists of the Northeastern United States, and some material was collected and placed in one of the automobiles with a view to rearing the adult, but it was forgotten and became dry. Particularly were the mines noticeable in the terminal leaves of sprouts, but they were seldom present in the older leaves, the leaves on the lateral shoots, or on the larger trees. The larva makes a broad blotch mine often involving half and in some cases nearly the whole area of the leaf. During 1924, Mr. R. B. Friend, Assistant Entomologist of this Station, at my request, collected material and brought to the insectary for the purpose of rearing the adults. On August 6, he obtained a number of small sawflies of both sexes. Specimens were sent to Mr. S. A. Rohwer of the U. S. National Museum, who identified the species as *Fenusa pumila* Klug, a European insect which up to this time was not known to occur in the United States. A brief note regarding the matter was published in the Journal of Economic Entomology, Vol. 17, page 601, October, 1924. Since then we have observed the work of the insect in many parts of the State, and Dr. Felt informs me that he has seen its work throughout eastern New York. The appearance of the mined leaves is shown on Plate XXXV, a.

Sawfly Larvae Defoliating Honeysuckle: On June 10, 1923, the writer noticed on Barnett Street, New Haven, a wire fence covered with climbing honeysuckle, *Lonicera* sp., the leaves of which had been mostly devoured. A hasty examination showed that sawfly larvae were responsible for the defoliation, and many were present and feeding. On June 15, 1923, Mr. E. M. Stoddard, Pomologist of this Station, brought to the laboratory additional specimens of the same kind of insect which he found feeding upon honeysuckle in Hamden. Two adults from the Hamden material emerged on March 24, 1924, and one adult from the New Haven material emerged on April 30. Both lots produced adults of the same species, which is one of the larger sawflies, *Abia americana* Cresson. The larvae are nearly an inch in length when full grown and are dull gray in color with yellowish dorsal and latero-ventral stripes. A row of black spots extends the entire length of the back in the middle of the yellowish stripe. Head, dark brown or black; legs, prolegs and ventral surface, yellowish. On July 18, 1924, larvae of this species were received from Mr. J. E. Hopkins of Thomaston, which had completely defoliated a cultivated bush honeysuckle in the village of Northfield. Another species, *Abia inflata* Norton, also feeds on honeysuckle, and on July 7, 1915, larvae were received from Dr. Williams, Bristol. Adults were obtained April 27, 1916. Of course spraying with lead arsenate is a simple remedy to prevent defoliation of honeysuckle shrubs and vines whenever these larvae become abundant and troublesome.

[1] Harvard Forest, Bulletin No. 3, 1921.

Rudbeckia "Golden Glow" Stripped by Sawfly Larvae: On July 11, 1924, the writer visited the truck farm of Mr. H. E. Baldwin, Bayberry Lane, Westport, in company with Messrs. M. P. Zappe, Assistant Entomologist, Dr. G. P. Clinton, Botanist, and W. R. Hunt, Graduate Assistant in Botany. While there, we noticed a bed of *Rudbeckia laciniata*, "Golden Glow," about 12 feet long and perhaps half as wide which had been stripped of its leaves by sawfly larvae. Most of the larvae had left the plants, but some remained and many were found crawling on the ground and in the grass near the flower bed. Mr. Zappe and I collected some material and carried to the insectary with a view to rearing the adults. The full grown larva is about three-fourths of an inch long, ground color light gray or dirty white with a darker gray median stripe, and a row of rather large black spots on each side about half-way between the spiracles and the median stripe. Around the spiracles there are small black dots, two on each thoracic segment and the last abdominal segment, and four on each of the other abdominal segments. Head, black on upper surface and more than half of face; lower portion of head, legs, prolegs and ventral surface of body, light gray or dirty white with yellowish tinge. Mr. R. B. Friend, Graduate Assistant in Entomology, visited the place on July 18, and collected more material and brought home some plants of golden glow upon which to feed the larvae. From all this material, only one adult has been obtained, and it emerged on August 15. This was sent to Mr. S. A. Rohwer of the U. S. National Museum, who identified it as *Tomostethus inhabilis* Norton, a species supposed to feed on pear. As there were pear trees near the golden glow, it is quite possible that a larva from a pear tree was collected with the others which were feeding on golden glow. The species causing the stripping is therefore uncertain, and it is hoped that more material may be obtained next season in order to settle the identity of the species. The larvae and defoliated plants are shown on Plate XXXVI.

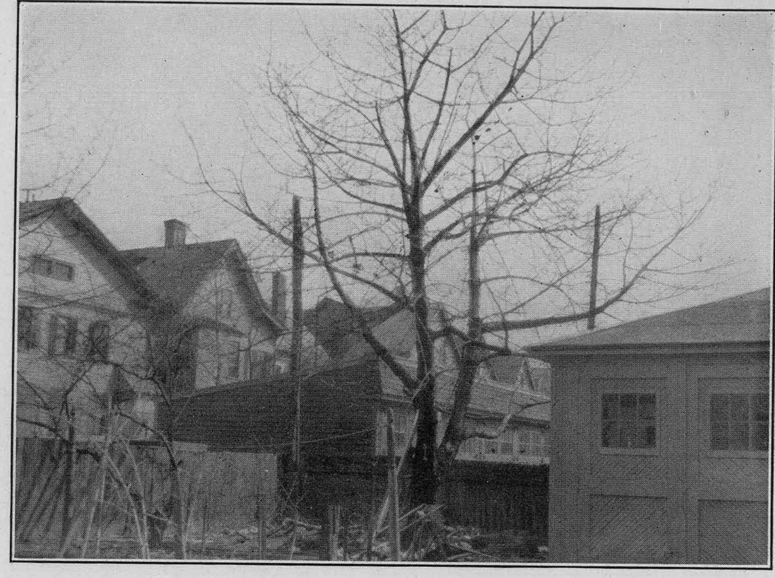
INDEX.



a. Infestation No. 1, Burlington, where 14 egg-clusters were found in this apple orchard. Photo April 10, 1924.

b. Infestation No. 5, Windsor, where 16 gipsy moth egg-clusters were found on willows. Photo April 10, 1924.

GIPSY MOTH INFESTATIONS.



a. The only infestation found in New Haven, on Howard Avenue, near the railroad bridge, on cherry and rose bushes, where six egg-clusters were found. Photo April 16, 1924.

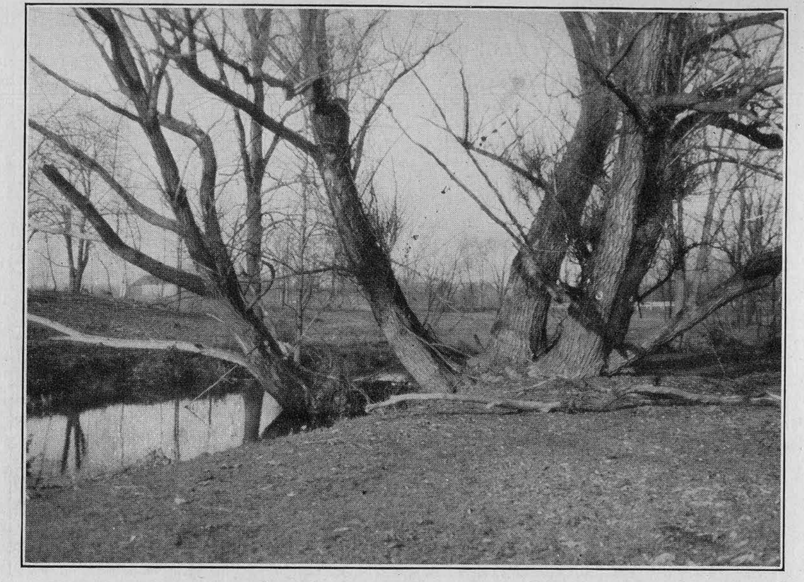
b. Infestation No. 3, Granby, on white oak and cherry. Photo November 27, 1923.

GIPSY MOTH INFESTATIONS.

a. Infestation No. 6, Hartford, on North Meadows, near Windsor Line; 936 egg-clusters were found here. Photo March 26, 1924.

b. Infestation No. 5, New Britain Avenue, Hartford. Forty-two egg-clusters were found here on trees and on buildings. Photo, April 10, 1924.

GIPSY MOTH INFESTATIONS.



a. Infestation No. 14, Suffield, on willows in pasture. Photo November 27, 1923.

b. Infestation No. 17, Suffield. On this willow hedge surrounded by meadow land, 650 egg-clusters were found. Photo November 27, 1923.

GIPSY MOTH INFESTATIONS.

a. Bridgeport infestation, Hillside Home, showing stubble and weeds before burning.

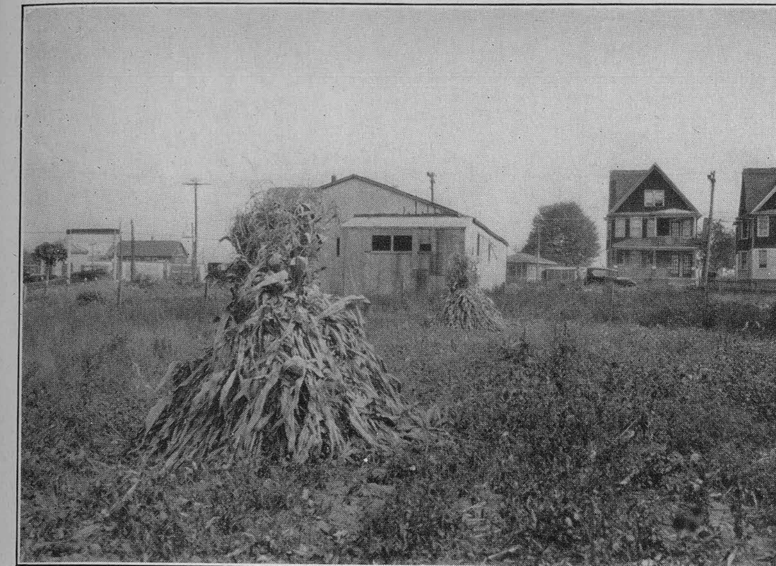
b. Burning stubble in an adjacent field, Bridgeport.

EUROPEAN CORN BORER INFESTATIONS.

a. New Haven infestation, showing broom corn which has grown from seed where clippings had been thrown on dump.

b. Broom corn clippings on dump along Peat Meadow Road, near Grannis Corner, New Haven.

EUROPEAN CORN BORER INFESTATIONS.



a. Infested garden in rear of broom corn factory, Townsend Avenue, Grannis Corner, New Haven, before burning.

b. Same as above; photo taken during the burning operations.

EUROPEAN CORN BORER INFESTATIONS.

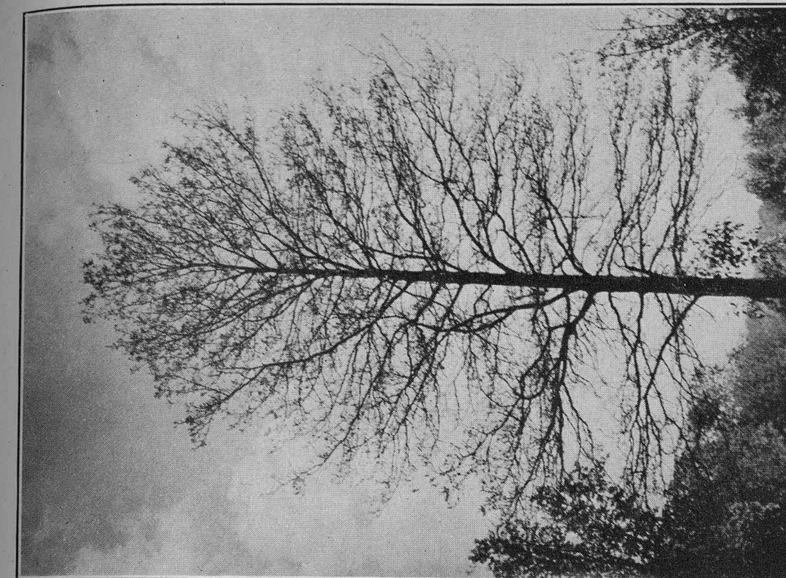
PLATE XXIV.

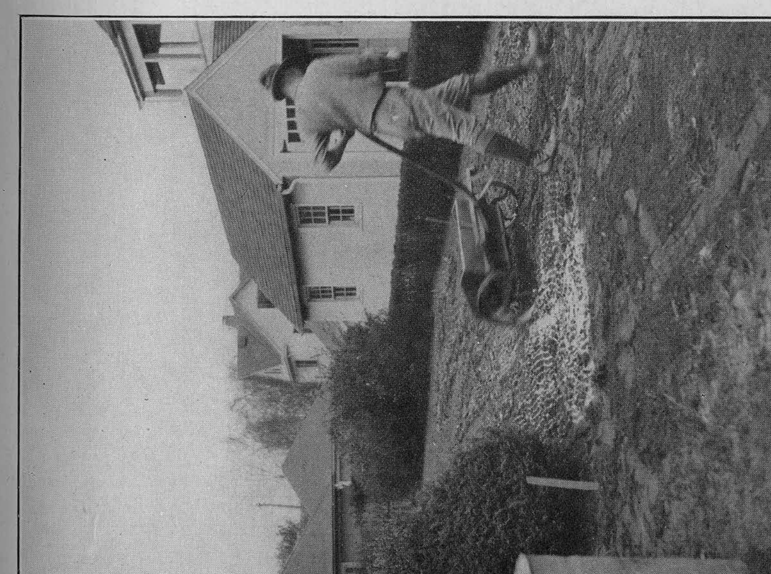
a. Method of distributing carbon disulphide emulsion on lawn infested with grubs.

b. Soaking down an infested lawn after applying insecticide to kill the grubs.

ASIATIC BEETLE INFESTATIONS.

PLATE XXV.



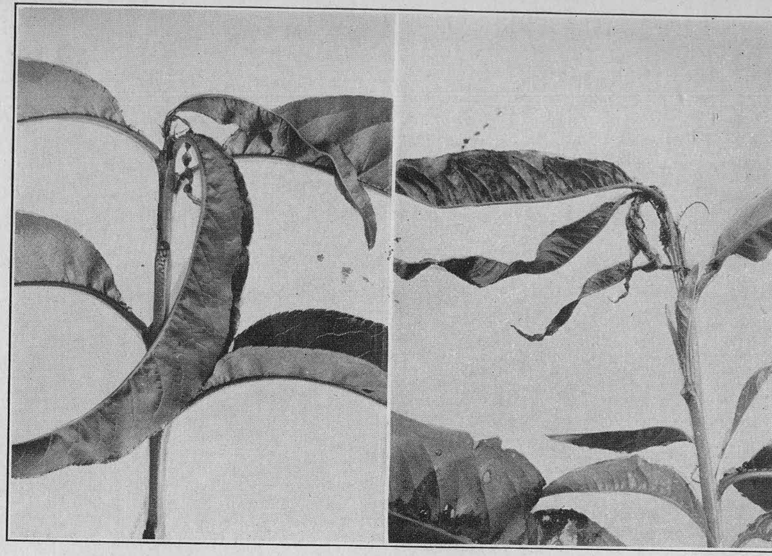


a. Asiatic beetle infestation. Applying cyanide with fertilizer drill.

b. Pin oak nearly defoliated by oak leaf-roller.

ASIATIC BEETLE INFESTATIONS AND OAK LEAF-ROLLER.

PLATE XXVI.

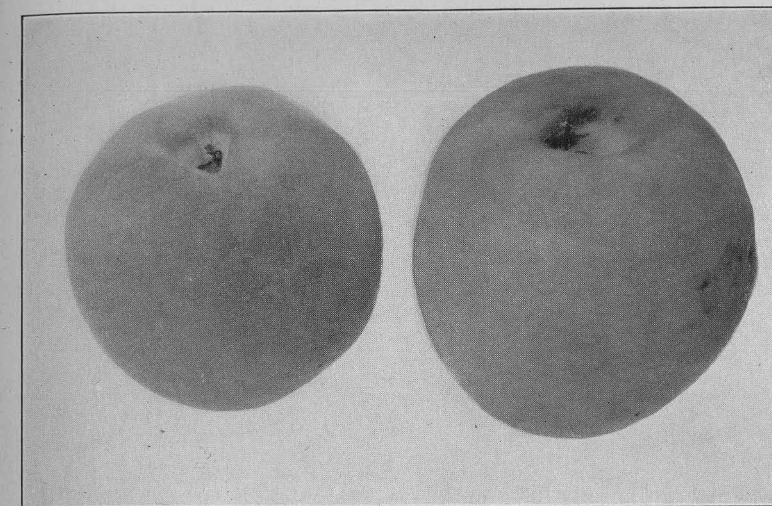


a. Newly infested twig, left; more advanced stage, right.

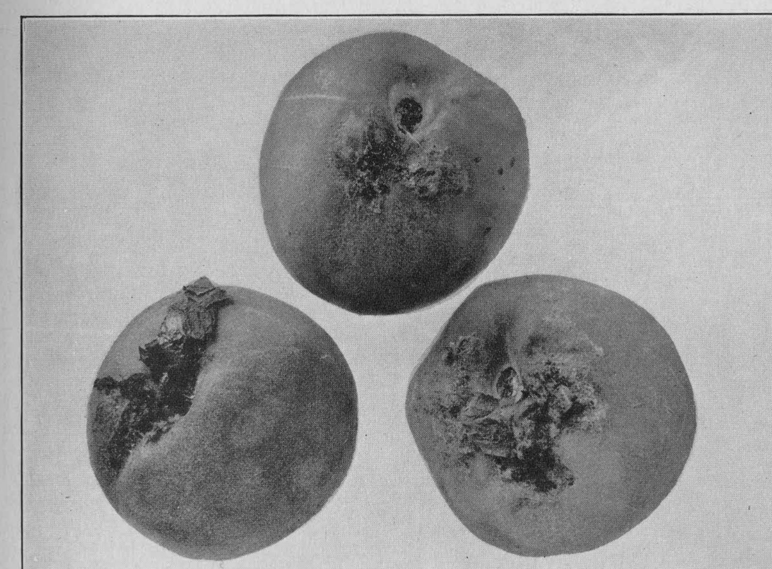
b. Injured twig after the larva has abandoned it, left; similar twig still later showing how laterals are forced out.

ORIENTAL PEACH MOTH.

PLATE XXVII.

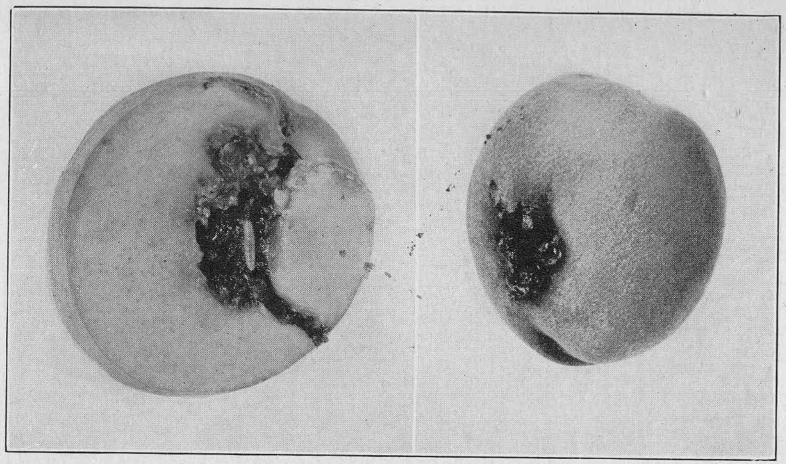


a. Ripe fruit with inconspicuous entrance marks of larvae near stems, late brood.



b. Exterior marks of infestation, early brood.

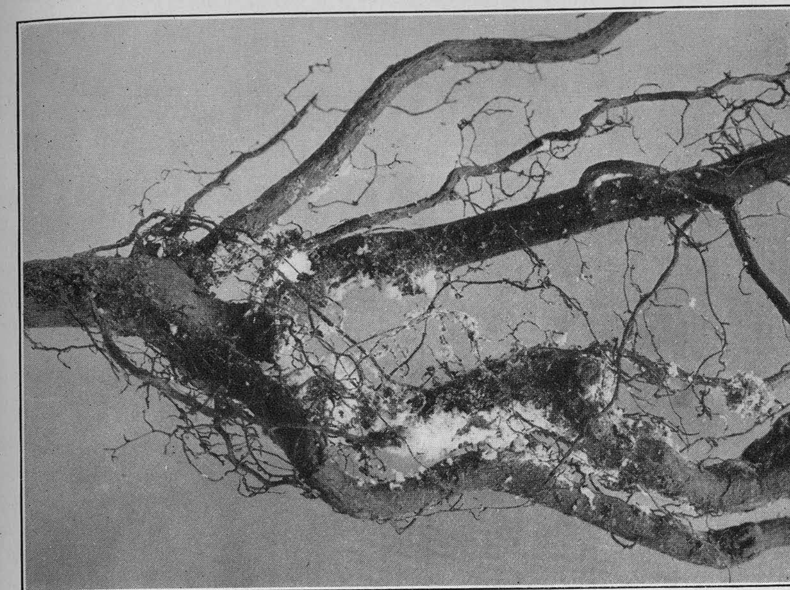
ORIENTAL PEACH MOTH.



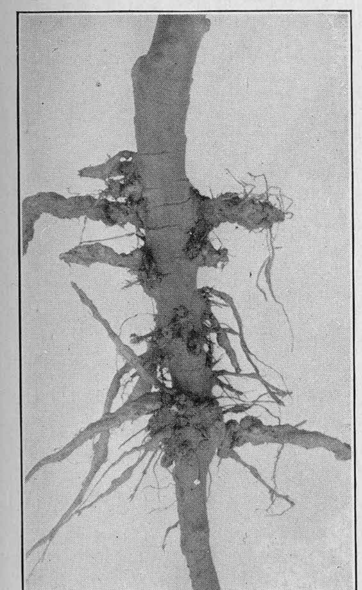
a. Peach with nearly full grown larva, left; exterior marks of infestation right.

b. Ripe peach containing two larvae.

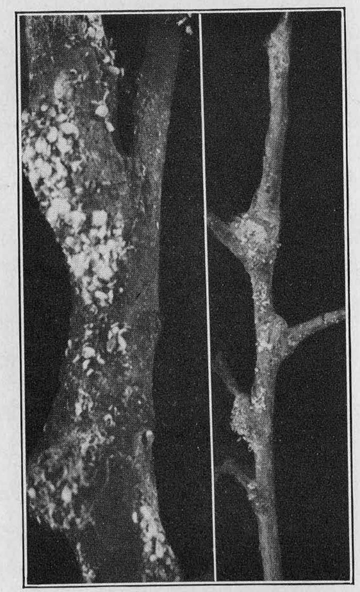
ORIENTAL PEACH MOTH.



a. Woolly apple aphid on roots of young trees.



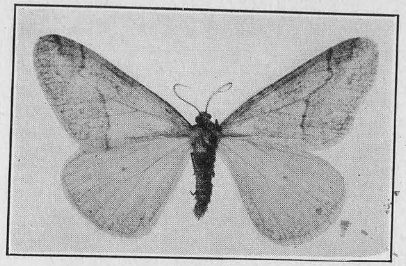
b. Nursery tree from the south. Feeding roots destroyed by decay following woolly aphid galls.



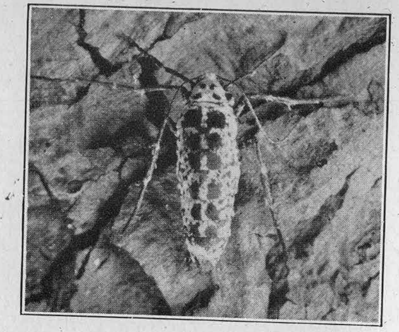
c. Woolly aphids on twigs, showing galls and white flocculent appearance.

WOOLLY APHID OF APPLE AND ELM.

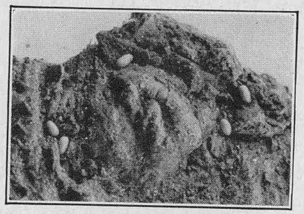
PLATE XXX.



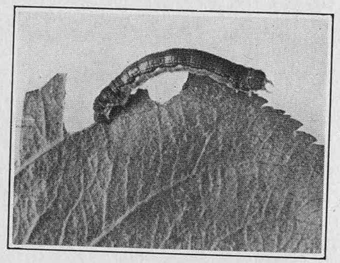
a. Lime tree winter moth; male, natural size.



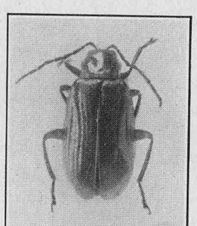
b. Lime tree winter moth; female, twice enlarged.



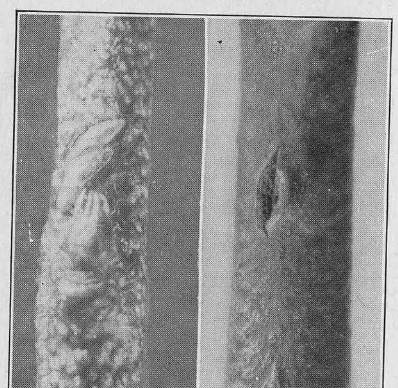
c. Lime tree winter moth; eggs, twice enlarged.



d. Lime tree winter moth; larva, natural size.



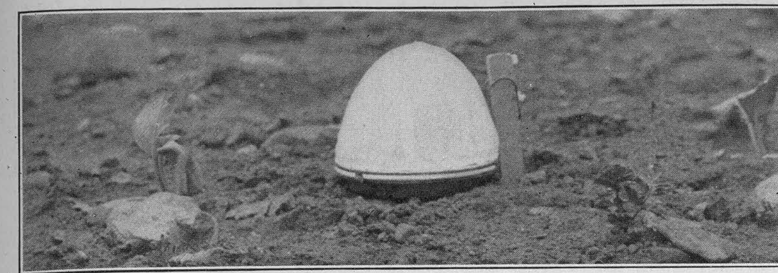
e. Western corn root worm, adult, four times enlarged.



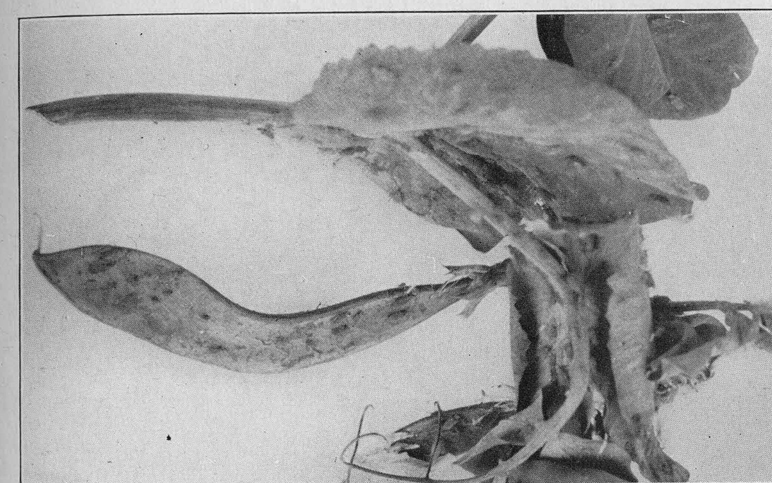
f. Blueberry spittle bug; left, twig with bark removed showing eggs; right, old egg-scar.

LIME TREE WINTER MOTH, WESTERN CORN ROOT WORM AND BLUEBERRY SPITTLE INSECT.

PLATE XXXI.



a. Trap used in experiments in attracting cabbage maggot flies.

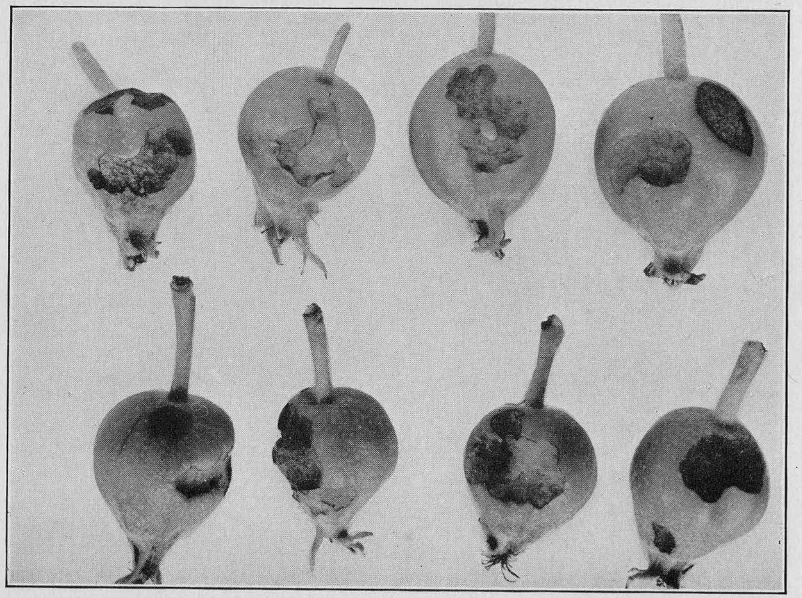


b. Section of pea vine infested with the pea aphid.

c. Applying nicotine dust to pea vines to kill aphids.

FLY TRAP AND PEA APHID.

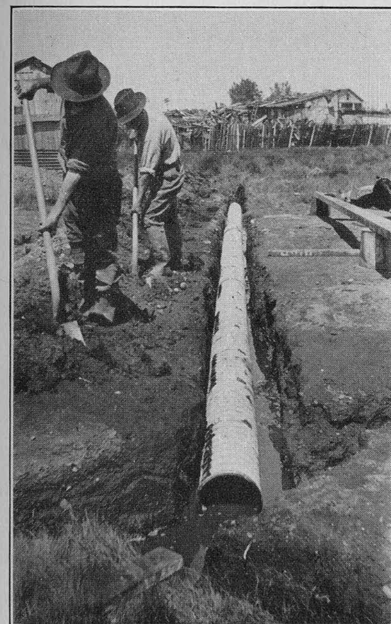
a. Elm trees on Whitney Avenue, New Haven, nearly defoliated by canker worms, May, 1924.



b. Young apples from Station Orchard, Mount Carmel, eaten by canker worms.

CANKER WORM INJURY.

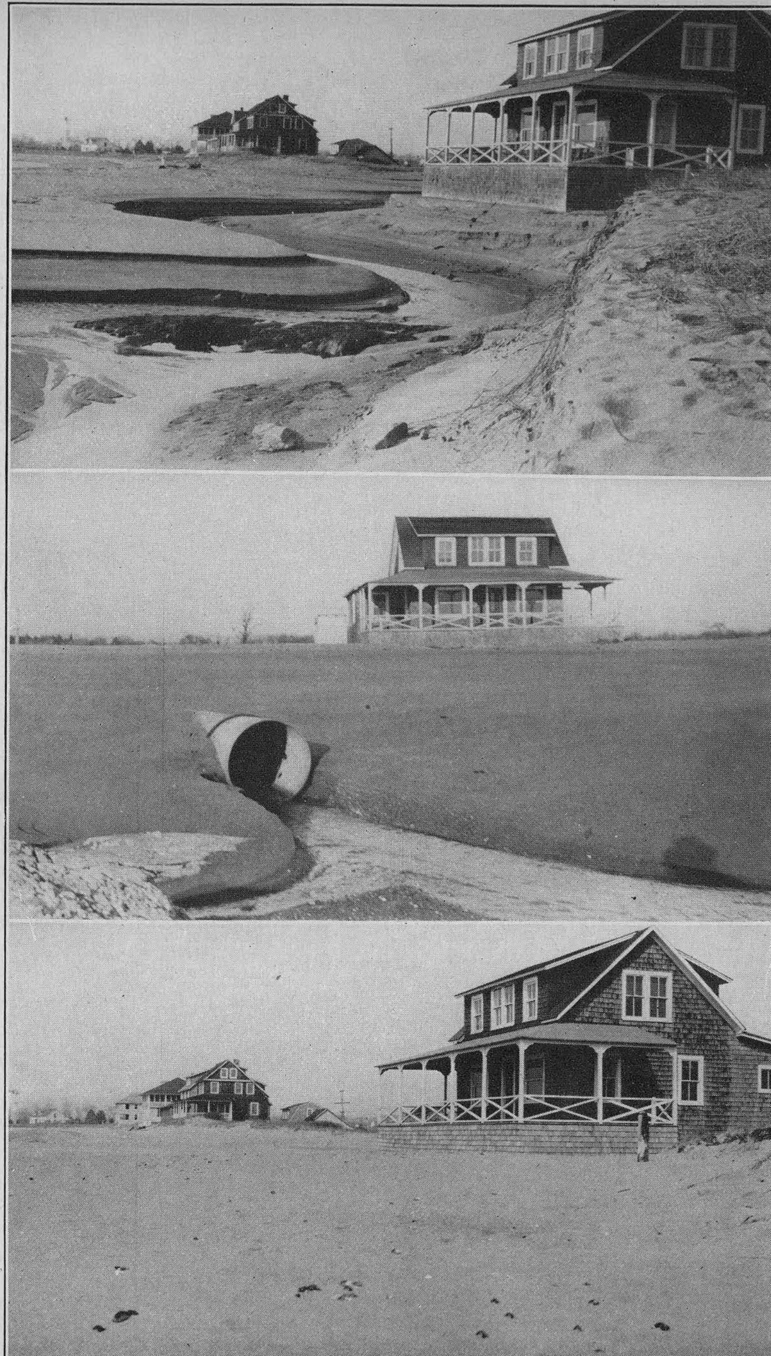
a. Collecting *Anopheles* larvae in ornamental pool.



b. Laying 10 inch corrugated pipe Gourley Tract, Stamford.

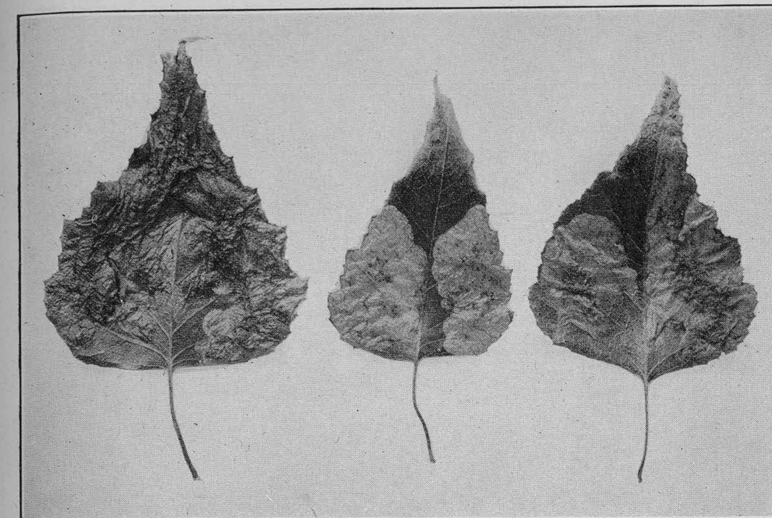
c. Main drainage ditch at Southfield Point, Stamford.

MOSQUITO WORK.



Above. Marsh outlet requiring continual labor to keep open.
Center. Two hundred and twenty feet of pipe installed gives perfect drainage.
Below. Conditions one year later; natural sand fill removes danger of undermining cottage.

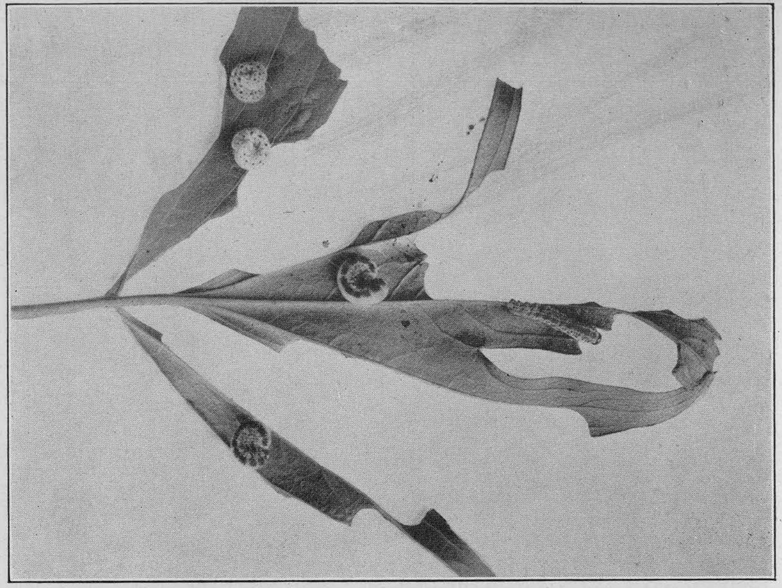
MOSQUITO WORK, MADISON.



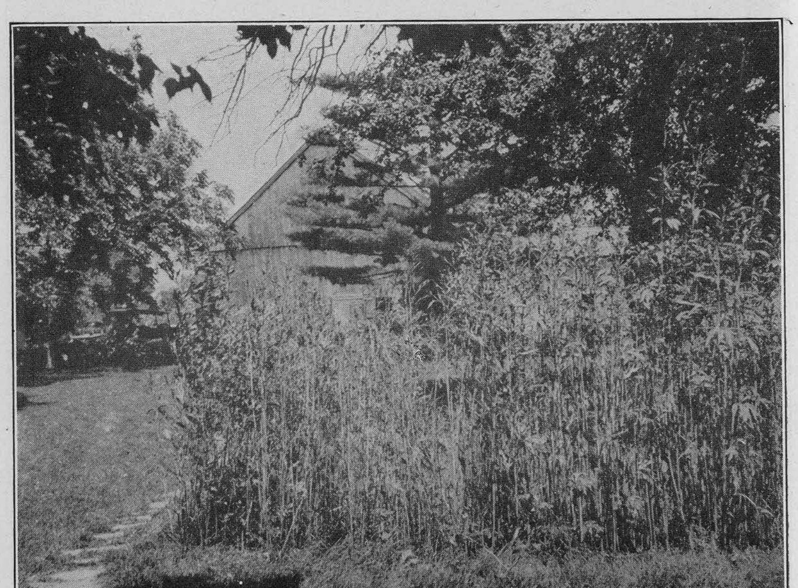
a. Leaves of the gray birch, *Betula populifolia*, mined by a European sawfly leaf-miner, *Fenusa pumila* Klug.

b. Taxus grown out of doors and infested by a mealy bug, *Pseudococcus* sp.

EUROPEAN SAWFLY LEAF-MINER AND MEALY BUG.



a. Sawfly larvae feeding on Rudbeckia "golden glow", natural size.



b. Bed of Rudbeckia "golden glow", Westport, which had been stripped by sawfly larvae.

SAWFLY LARVAE ON RUDBECKIA "GOLDEN GLOW".

BULLETIN 266 MARCH, 1925

Connecticut Agricultural Experiment Station
New Haven, Connecticut

The Improvement of Naturally Cross-Pollinated Plants by Selection in Self-Fertilized Lines

I. THE PRODUCTION OF INBRED STRAINS OF CORN

D. F. JONES
P. C. MANGELSDORF

The Wilson H. Lee Co.

CONTENTS.

SUMMARY.

The results of previous investigations on inbreeding corn are reviewed to show the development of the method of selection in self-fertilized lines.

Four varieties of corn have been self-fertilized and selected for five generations. Eighty-six lines were started and twenty of these were lost or discarded.

The method of procedure was to grow three progenies in each line and self-pollinate five of the most desirable appearing plants in the best progeny each year.

A large number of clear-cut recessive abnormalities appeared during the course of the inbreeding. In all except one case these were eliminated by the fifth generation.

No significant difference in yield was found between segregating and non-segregating progenies in lines showing recessive abnormalities in the previous generation. Also lines having recessive abnormalities at the start showed no greater reduction in yield during the five generations than lines that were free from them throughout the experiment.

All lines showed a marked reduction in yield and a slowing down of the rate of growth. Although great differences were shown, no lines were as productive as the original variety. No appreciable correlation was found between the characters of the seed ear, weight of seed, size of seedling, or the appearance of the plants at pollinating time and the production of grain in the same generation.

Some correlation in certain characters was found between the first and last generations, particularly in height of plant and in per cent. of moldy ears. Less association was shown in amount of tillering and in smut infection, while in productiveness practically no relation was found, showing that good and poor yielding strains may come from productive or unproductive plants at the start.

THE IMPROVEMENT OF NATURALLY CROSS-POLLINATED PLANTS BY SELECTION IN SELF-FERTILIZED LINES.

I. The Production of Inbred Strains of Corn.

D. F. JONES and P. C. MANGELSDORF

The improvement of naturally self-fertilized plants, particularly the small grains, has gone steadily forward following the development of effective methods of procedure. In contrast to the older methods of mass selection based upon appearances, stands the system of individual plant selections chosen on the basis of the performance of their progeny, as worked out by Louis de Vilmorin in 1856 and later applied by Hjalmer Nilsson in 1891 at Svalöf in Sweden and by W. H. Hays at the Minnesota Agricultural Experiment Station in 1892. Although the early methods of applying the progeny performance test involved much unnecessary effort, the principle was sound and its extensive application has resulted in a large number of valuable new varieties of important crop plants, notably wheat and cotton. The theoretical soundness of this procedure, first applied in an empirical way, was later fully established by the re-discovery and demonstration of Mendel's Law, which postulates that a large part of inherited variability is due to the recombination of stable units. This led directly to Johannsen's genotype conception of organisms which appear alike but breed differently and those which are themselves diverse but give similar offspring.

The improvement of naturally cross-fertilized plants, reproduced by seeds, is in no such satisfactory situation. The variation brought about by Mendelian recombination makes it very difficult to have any adequate control over the heredity when inter-pollination is continually going on. Moreover, intensive selection for particular characters often results in decreasing the number of hybrid combinations and this, like all other forms of inbreeding, brings about a reduction in vigor. Any advantage which might come about from the concentration of desirable germplasm is offset by the loss of growth due to consanguinity.

Corn, a monoecious plant and wind pollinated, is almost completely cross-fertilized in every generation. This mode of pollination has brought about a condition in which a continuation of the same degree of germinal heterogeniety is necessary to maintain full vigor. The experimental results of inbreeding and crossing and their theoretical interpretation show clearly why the methods aimed at the improvement of corn in the past have been largely fruitless. Formerly the selection practiced with this plant was largely based upon the appearance of the mature ear. Investigation has shown that corn has now been brought to such a high plane of development that the correlation between the appearance of the seed and the productiveness of the crop grown from that seed is very low; so low in fact that it is often possible to get as good results from planting the poorest looking ears to be found in a field as from the choicest specimens. This is due to the fact that hybrid combinations of hereditary factors which make possible high production can not be transmitted intact and therefore the offspring of any exceptional individual can not all be equally productive.

An early appreciation of this situation following the application of experimental methods to the study of corn breeding led to the ear-to-row system in which selection was based on the performance

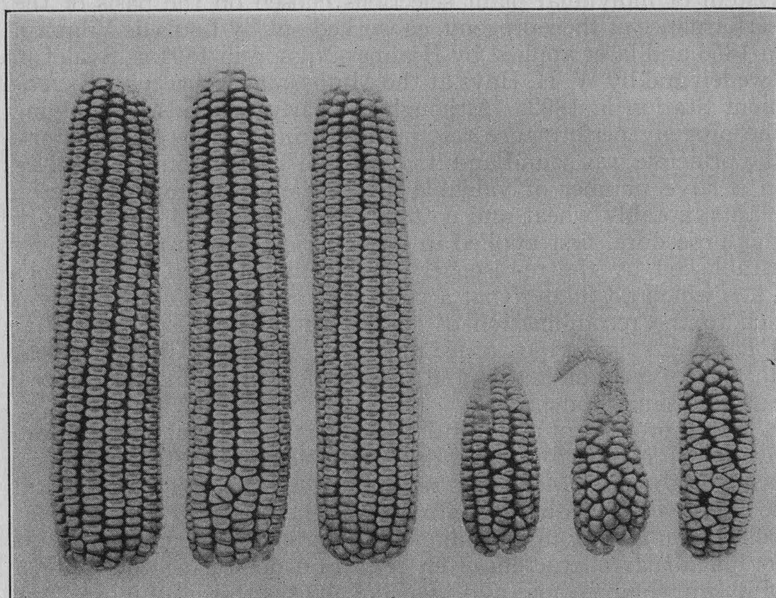


Figure 16. The seed from these large and small ears yielded the same. Their difference in size is due, not to heredity, but to the place where the plants that produced them happened to grow, one lot in a good, the other in a poor situation. This shows the complete lack of correlation in this case between the appearance of the seed ears and their performance.

of the progeny instead of the appearance of the seed parents. Although the progenies differed markedly in yield those above the average failed to maintain their high production in later generations.

In 1908 G. H. Shull outlined a method of corn breeding radically different from any previously followed. In this he called attention to the large number of germinally different types which exist in every field of corn and suggested that these could be separated out

by inbreeding. Although vigor was lost by this process this was to be regained by crossing inbred strains and utilizing only the first following generation in which hybrid vigor is at its maximum. East also advocated the same method and reached the same conclusions as to the importance of hybrid vigor, as the result of independent observations on the effects of inbreeding and hybridization. The crossing of different varieties of corn had been advocated long before this by Beal at the Michigan Agricultural Experiment Station, and Morrow, Gardner and McCluer at Illinois. Two important contributions to methods for corn improvement were made by Shull and East. One was making clear the complex germinal constitution of a variety in a cross-fertilized plant such as corn and the way in which the composition of any particular individual is masked by hybrid vigor. The other was in showing that the maximum degree of hybrid vigor could be secured by first reducing the plants to homozygosity and then crossing, thereby bringing about the greatest number of hybrid combinations of hereditary units. Both East and Shull considered hybrid vigor as a physiological stimulus resulting from the condition of hybridity itself, differing from the specific action of individual hereditary factors. For this reason they stressed the importance of securing the maximum effect of hybrid vigor. The more important service of inbreeding in automatically eliminating abnormalities and serious weaknesses and in making possible the detection and isolation of the potentially most valuable germplasm was not fully appreciated at first by those who attempted to apply this method to corn improvement. For that reason the full utilization of the pure line principle was delayed until hybrid vigor was shown to be merely the expression of dominant hereditary factors. This brought out clearly and forcefully the great value of inbreeding as a means of obtaining the finest hereditary material existing in a cross-fertilized plant like corn by controlling the inheritance through the pollen parent as well as through the seed parent, and fixing this in such a way that it would not be lost. Following up this line of attack a method of corn improvement was outlined in 1920 under the general title of "Selection in Self-fertilized Lines.".* It is here proposed to review the results of inbreeding and crossing which have led to the development of this method and show how inbreeding can best be applied to the improvement of corn and other naturally cross-fertilized plants. As the application of this method is still in progress the plan is to publish the results in a series under the general heading of "The Improvement of Naturally Cross-Pollinated Plants by Selection in Self-fertilized Lines." The first of this series, submitted in the following pages, deals only with the detection and isolation of desirable hereditary qualities in corn, that is, the production of inbred strains which possess either in visible expression or in

*Jour. Agronomy, 12:77-100.

potential power those valued characters that make for increased production. Later publications are planned to deal with the testing and utilization of inbred strains of corn and the application of the same principle and method to other cross-fertilized plants.

Figure 17. Two inbred strains from the same variety that have been grown side by side for eighteen years. The difference in ability to stand erect is inherited.

The Effect of Inbreeding Upon Corn.

All of the main types of corn such as dent, flint, sweet, pop and flour corn have been inbred by self-fertilization for several successive generations. The results have been the same in general for all types. Particular attention has been given to several strains resulting from a variety of Leaming grown originally in central Illinois. Inbreeding was started by Dr. E. M. East in 1905. Four lines descending from three individual plants at the start have been continued to the present time under the direction of Dr. H. K. Hayes and later by the writers, and in 1923 they had been inbred by seventeen successive self-fertilizations. The results obtained have been reported from time to time. Particular reference is made to "Inbreeding in Corn" and the "Distinction between Development and Heredity in Inbreeding" by East, published in the report of the Connecticut Agricultural Station and in the American Naturalist, and "Heterozygosis in Evolution and in Plant Breeding" by East and Hayes in a Bureau of Plant Industry Bulletin. Later results are given in a bulletin of the Connecticut Agricultural Station under the title of "The Effects of Inbreeding and Crossbreeding on Development" and the "Attainment of Homozygosity in Inbred Strains of Maize" in Genetics by the senior writer. As the method of selection in self-fertilized lines

Table I.

Yield and Height of Four Inbred Leaming Strains of Corn Self-Fertilized Seventeen Generations.

No. of Gen. Selfed	Strain A		Strain B		Strain C		Strain D	
	Yield Bu. per Acre	Height Inches	Yield Bu. per Acre	Height Inches	Yield Bu. per Acre	Height Inches	Yield Bu. per Acre	Height Inches
0	74.7	117.3	74.7	117.3	74.7	117.3	74.7	117.3
1	42.3	....	60.9	....	60.9	....	59.1	....
2	51.7	....	59.3	....	59.3	....	95.2	....
3	35.4	....	46.0	....	59.7	....	57.9	....
4	47.7	....	63.2	....	68.1	....	80.0	....
5	26.0	76.5	25.4	81.1	41.3	90.5	27.7	86.7
6	38.9	....	....	....	....	....	....	....
7	45.4	85.0	39.4	....	....	....	41.8	....
8	21.6	....	47.2	83.5	58.5	88.0	78.8	96.0
9	30.6	78.7	24.8	....	....	....	25.5	....
10	31.8	82.4	32.7	84.9	19.2	86.9	32.8	97.7
11	35.1	79.7	42.3	78.6	37.6	83.8	46.2	103.7
12	24.5	77.0	27.2	80.3	20.4	85.2	49.6	100.4
13	26.9	85.5	29.0	83.7	25.1	80.6	25.8	85.3
14	23.6	87.3	38.3	86.9	36.3	87.8	35.2	94.0
15	21.1	85.4	33.4	89.9	30.0	98.2	33.6	99.6
16	17.6	76.1	24.6	89.1	25.3	94.6	29.8	97.7
17	....	....	27.8	91.7	16.9	88.9	19.8	88.4

has been the direct outgrowth of these investigations as to the effects of inbreeding, a brief resumé of the results obtained to date will be given here.

The method of inbreeding followed in the earlier experiments was to self-pollinate a number of plants at random and use one of these as the progenitor for the following generation. Such a family descending from a single self-fertilized plant in each generation is called a line or strain. The yield of grain and height of plant of four lines from Leaming during seventeen successive self-fertilized generations compared to the non-inbred variety are given in Table I. The four lines *A*, *B*, *C*, *D*, were derived at the start from three different plants. One of these was separated in the third generation into two lines, *B* and *C*. These have been continued separately since. Other lines were started from the same variety but have since been lost on account of failure to secure self-pollinated seed. In some cases this loss has been accidental, but for the most part these strains were maintained previous to their extinction with great difficulty and showed a much greater reduction in growth and vigor than the other strains which survived.

Although there is wide variation in yield of grain and height of plant from year to year the general direction is downward. After the ninth generation size and productiveness have remained on about the same level. The original variety yielded at the rate of eighty-eight bushels per acre the year it was first self-fertilized. In 1916 seed of the same variety was obtained from the original source and grown in comparison with these strains, then in the ninth or tenth generation. On account of its change to a new location under conditions to which it was not as well adapted as the inbred strains, which had been grown there for many years, no strict comparison can be made. In spite of their possible advantage the inbred strains were only from one-half to one-third as productive and were also noticeably reduced in height.

This decrease in yield which results from a reduction in size of all parts of the plant and a lessening of the growth rate has so far been the universal result of inbreeding corn as far as known to the writers. Several hundred self-fertilized strains have been grown long enough to bring this out clearly. Accompanying the lessening of productiveness and growth vigor there has been a reduction in variability. From a variety that showed the usual variation in height, color of silks, glumes and leaf sheaths, number of ears, position of the ear and other details in all parts of the plants there resulted in the four self-fertilized lines a marked uniformity among all of the plants within each line. This similarity in type became noticeable in the earlier generations of inbreeding, and after seven or eight successive self-fertilizations every plant in any one line was as much like every other plant in that line as any two plants in a naturally self-fertilized species, such as wheat or tobacco, from seed from the same individual. In other words, the variability that resulted from the recombination of hereditary factors was in time eliminated.

Figure 18. Two inbred strains from the same variety of flint corn, one with many tillers and the other without any.

Where the original variety had some plants with colored silks and others with uncolored, some of the lines now have all their plants with red silks while in others all the silks are green. In some lines the foliage on all the plants is a bright glossy green, in others a dull bluish green. All the plants of one of the lines remain green and stand firmly erect throughout the season while in other lines the foliage turns yellow towards the end of the growing season and in still another the plants frequently go down on account of a weak root system. Differences in susceptibility to smut are shown in these four strains as brought out in table II. In every detail of structure of the plant, including tassel and ears, all the individuals of one line are remarkably alike and noticeably different from the other lines. Some of these differences are shown in the accompanying illustrations, figures 17, 18 and 19. The uniformity within the line and the differences between the several lines are brought out statistically in tables III to VI, which show the height of plant, length of ear, number of nodes and rows of grain on the ear for the original variety and the four strains derived from this variety.

TABLE II.

Per cent. of Plants Showing Smut Infestation in Four Inbred Leaming Strains.

Strain	1917	1918	1919	1920	1921	1922	1923	Ave
A	.3	.7	1.9	14.3	15.2	3.0	.0	5.1
B	9.8	25.9	8.6	32.8	50.0	27.3	69.0	31.9
C	.5	9.1	4.1	6.0	13.8	17.5	52.7	14.8
D	.0	1.0	1.4	25.0	4.1	2.2	.7	4.9

During the early generations of self-fertilization various forms of abnormalities appeared. The most frequent of these are seedlings wholly or partially lacking in chlorophyll, various types of striped plants, golden plants, dwarfs, plants with ears showing many poorly developed and aborted seeds, and others with sterile tassels and ears. These are a few of the more strikingly aberrant types. Some of these are able to produce seed and when self-fertilized come true to their abnormal condition. Others are wholly incapable of reproduction and are eliminated, but the inbred strains in which they appear may continue to produce them regularly as part of their offspring in the following generations. After several generations these abnormalities are usually no longer produced and the remaining plants are all normal in type although reduced in size and in rapidity of growth. Many of the abnormal forms which appear in large numbers in the inbred families are occasionally seen in fields of corn which have never been artificially self-fertilized. Obviously, inbreeding is not responsible for their creation. They are recessive in mode of inheritance; that is, when crossed with other plants the following generation is all normal but the abnormality reappears in the subsequent generations.

Figure 19. Differences in height of two inbred strains from the same variety self-fertilized four generations and selected for vigor and productiveness but not for height.

TABLE III.

Frequency Distribution of Height of Plant of Leaming Corn and Four Inbred Strains Derived from It.

	Height of Plant in Inches.																				
	58.5	63.5	68.5	73.5	78.5	83.5	88.5	93.5	98.5	103.5	108.5	113.5	118.5	123.5	128.5	133.5	138.5	143.5	N	A	C. V.
Variety	..	..	..	..	..	..	..	5	7	17	33	37	32	33	31	13	4	1	213	117.3±.48	8.81±.29
Strain A	2	2	2	24	48	37	4	..	..	..	..	..	..	..	..	..	..	..	119	78.6±.33	6.78±.30
Strain B	3	6	10	11	24	42	59	39	7	..	..	..	..	..	..	..	..	..	201	84.6±.41	10.22±.35
Strain C	..	1	2	9	11	26	21	21	12	2	..	..	..	..	..	..	..	..	105	86.7±.54	9.46±.44
Strain D	..	..	..	..	2	2	18	56	79	50	8	4	..	..	..	..	..	..	219	97.9±.26	5.91±.19

TABLE IV.

Frequency Distribution of Length of Ear of Leaming Corn and Four Inbred Strains Derived from It.

	Length of Ear in Inches.												
	2	3	4	5	6	7	8	9	10	11	12	N	A	C. V.
Variety	..	..	5	15	32	65	61	37	10	2	1	228	7.5±.06	19.07± .63
Strain A	..	4	17	69	24	..	..	..	..	..	..	114	5.0±.04	14.18± .65
Strain B	8	31	88	82	2	..	..	..	..	..	..	211	4.2±.04	19.94± .68
Strain C	1	4	16	26	32	6	..	..	..	..	..	85	5.2±.08	20.17±1.08
Strain D	..	3	17	31	58	81	27	2	..	..	..	219	6.3±.05	19.00± .63

TABLE V.

Frequency Distribution of the Number of Nodes of Leaming Corn and Four Inbred Strains Derived from It.

	Number of Nodes.												
	8	9	10	11	12	13	14	15	16	17	18	N	A	C. V.
Variety	..	..	2	5	23	49	79	60	11	12	4	245	14.1±.06	10.07±.31
Strain A	..	..	..	5	21	66	26	1	..	..	..	119	13.0±.05	5.97±.26
Strain B	1	2	11	33	103	51	8	1	..	..	..	210	12.0±.05	8.21±.27
Strain C	..	1	2	15	30	44	16	..	..	..	..	108	12.5±.07	8.18±.38
Strain D	..	1	1	48	113	59	9	..	..	..	..	231	12.1±.04	6.77±.21

TABLE VI.

Frequency Distribution of the Number of Rows of Grain on the Ear of Leaming Corn and Four Inbred Strains Derived from It.

	Number of Rows of Grain on the Ear.									
	12	14	16	18	20	22	24	26	N	A	C. V.
Variety	3	14	51	75	52	21	7	4	227	18.4±.12	14.22±.46
Strain A	39	70	3	2	..	..	..	..	114	13.4±.08	8.94±.40
Strain B	..	..	1	22	56	78	43	6	206	21.5±.09	9.38±.31
Strain C	..	24	42	18	1	..	..	..	85	15.9±.11	9.26±.48
Strain D	11	90	86	26	2	..	..	..	215	15.2±.07	10.50±.34

In ordinary fields of corn they are generally kept out of sight by continual crossing with normal types which are dominant. Plants carrying such factors for abnormality, when self-fertilized, produce them in approximately one-fourth of their progeny. Some of the normal plants in the same progeny carry the abnormality and some do not. Sooner or later, progenitors are used which do not carry any of these striking abnormalities, after which they cease to appear.

The rate at which reduction in growth takes place and the final size and productiveness of the several lines, after the reduction comes to an end, vary in different lines. Of the four Leaming strains the *D* line has regularly been taller and larger and has yielded more than the others. The rate of reduction has been nearly alike in all of the four lines although *A* was reduced in yield somewhat more quickly than any of the others. The attainment

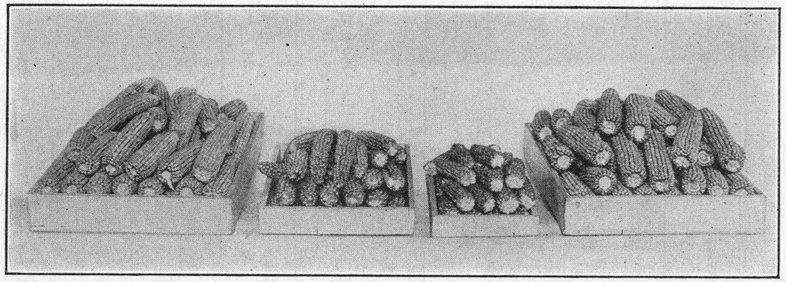


Figure 20. Comparative production of a variety of Leaming corn, two inbred strains derived from this variety, and their first generation hybrid. Grown in adjoining rows, they yielded 96, 32, 20 and 115 bushels per acre respectively.

of uniformity may also proceed at a different rate, depending upon the degree of heterozygosity of the plant chosen as progenitor. Some strains remain variable for many generations while others become uniform in nearly every feature after a few generations of self-fertilization.

From the foregoing facts it is obvious that inbreeding is a process of sorting out. From a mixture of many genetically different individuals all varying in hereditary composition and in heterozygosity any number of homozygous lines can be ultimately obtained, each differing to a greater or less degree from every other. A naturally cross-fertilized species is thus changed into an artifically self-fertilized species. In uniformity and constancy these artificially inbred plants are quite comparable to naturally self-fertilized species, with the important difference that in corn they are markedly reduced in size and vigor.

Result of Crossing.

The vigor which is lost by inbreeding is at once restored when two self-fertilized lines descending from different plants at the start

Figure 21. Two inbred strains and their first generation hybrid showing differences in time of flowering.

are crossed. This is shown in figure 20. Here the ears produced by the original non-inbred variety are shown in comparison with the ears produced by two lines self-fertilized 12 generations and the first generation hybrid between these two lines. An equal number of plants of the four lots were grown in adjoining rows and yielded 96, 32, 20 and 115 bushels per acre respectively. A comparison of a large number of first generation crosses between inbred strains derived from the same variety showed that the yield of the hybrids was increased 180 per cent., height of plant 27, length of ear 29, number of nodes 6, and rows of grain on the ear 5 per cent. above the average of their inbred parents.* From this it is seen that size characters such as height of plant and length of ear are affected more noticeably by hybrid vigor than the number of parts, such as nodes and rows of grain on the ear, while yield, which sums up

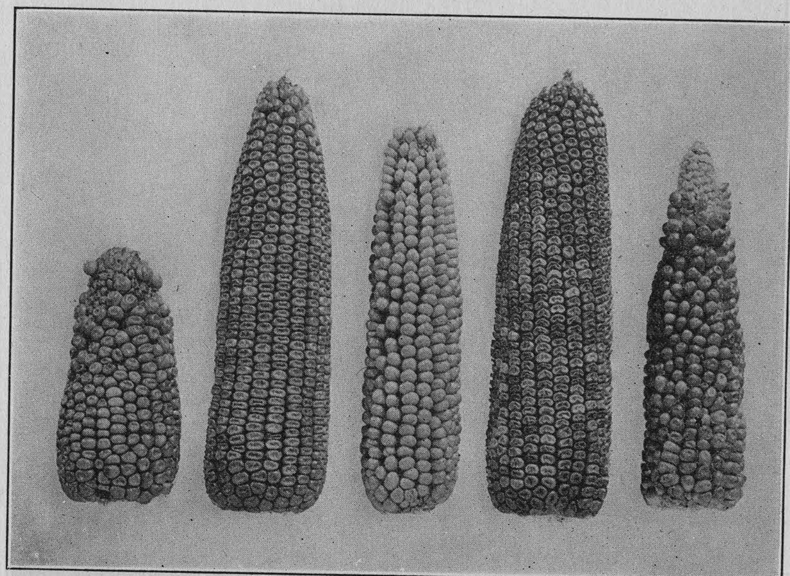


Figure 22. Representative ears of three inbred strains of dent corn and two first generation hybrids resulting from the crossing of the two adjoining types, harvested at the same time to show the difference in maturity.

the entire growing capacity of the plant, is increased more than anything else. In other words hybrid vigor has much the same effect as favorable environmental factors. Fertile soil, good season and careful cultivation influence the growth of the corn plant. Under these conditions corn grows taller, the ears are larger and the production of grain is much greater than under the less favorable conditions, while the number of nodes or the rows of grain on the ear are not so much changed.

*"The effects of inbreeding and crossbreeding upon development." Connecticut Agric. Exper. Station Bull. 207.

Another noticeable effect of crossing inbred strains of corn is that of hastening the time of flowering and maturing. Figure 21 shows two inbred strains in which the tassels are just beginning to appear. No silks are out. The first generation hybrid of these two strains in the center is shedding pollen from nearly all of the tassels and the silks are well out on many of the plants. Representative ears of three inbred strains and first generation hybrid ears resulting from the cross of the two adjacent strains are pictured in figure 22. All were picked at the same time and show the greater maturity of the hybrid ears.

All of the combinations of inbred strains have shown increased

Figure 23. A first generation hybrid showing the uniformity in height and in tassel type. The two inbred parental strains are in the adjoining rows at the left.

growth and yield whether the parental strains come from the same original variety or from different varieties. Some combinations have yielded more than others. A few have been better than others in many respects. Crosses between strains from different varieties have not been conspicuously better than crosses within the variety although no extensive test of this point has been made. Furthermore, no reliable comparison of the yield of the hybrids with the original variety can be made because this variety is not well adapted to the local conditions in which the self-fertilized lines have been grown for many years. Kiesselbach reports the average yield of seven first generation hybrids tested two years as 52 bushels per acre in comparison with 42 bushels for the original variety. This is an increase of 24 per cent. The highest yielding hybrid produced 59 bushels or an increase of 40 per cent.

The most noticeable and important feature of the first generation hybrids between fixed inbred strains is the even growth, similarity in size and structural details and uniform production of all plants where the growing conditions are equal. This is shown for height of plant and tassel type in figure 23. Barring accident every plant is like every other plant. They grow to the same height. All ears are borne usually at the same node. The tassels and silks appear at the same time and the plants all ripen within a few days of each other. The fact that every plant produces a good ear is a most important factor in making crosses between strains so productive. In ability to yield from every plant and in uniformity of ripening, these first generation corn hybrids are equal to any naturally self-fertilized crop such as wheat and tobacco or any vegetatively propagated plant as potatoes and sugar cane. Since corn is very susceptible to damage by unfavorable weather at pollinating time, the uniformity in flowering may be undesirable particularly in those regions where hot dry weather is a frequent occurrence at this critical time. For that reason some other method of utilizing inbred strains may prove to be more practicable. This will be considered more fully in later publications. It is sufficient here to point out that in these first generation hybrids we have a new kind of corn which in many important respects is radically different from the mixtures of hybrids of varying degrees of heterozygosity now constituting an ordinary field of corn.

An Interpretation of Hybrid Vigor.

The observations of gardeners and animal husbandmen have led to a general conviction that crossing somewhat different but related plants or animals usually results in a greater growth. Many instances of this phenomenon of hybrid vigor, in which the offspring excel both parents have been noted in the higher plants and in mammals, birds, insects and some of the lower forms of animals. Larger size or more rapid growth usually results when the parents are visibly different in some respects but are sufficiently related to produce fertile offspring. Many notable cases of hybrid vigor also occur in wider crosses where the offspring are partially or wholly sterile. This is well illustrated by the mule, which is sterile. A similar wide cross in plants is the combination of the radish and cabbage in which the hybrid makes a luxuriant growth but sets no seed. Some species crosses show no increased vigor but on the other hand may be extremely weak. East and Hayes have given several illustrations of tobacco hybrids which are barely able to live and make only a weak growth. Many crosses

of different species in animals and plants do not develop normally. Hybrid weakness as well as hybrid vigor must be taken into consideration although this is not be to expected in crosses that are fertile.

After the limits of physiological compatibility are reached cross-fertilization cannot be accomplished. A series can therefore be arranged as follows: (1) Crosses between organisms which are so nearly alike in germinal constitution that no increased growth

Figure 24. Crossed corn showing vigorous growth.

results. (2) Crosses between germinally diverse but closely related organisms that grow to a larger size and at a more rapid rate and are fully fertile. (3) Sterile crosses between more distantly related organisms which are extremely vigorous. (4) Sterile crosses which are weak and often abnormal. (5) Crosses which cannot be made on account of the germinal difference in the forms united.

Hybrid vigor in domestic animals and cultivated plants most frequently results when breeds or varieties of different type are brought together. Thus it is a common practice to cross the bacon and lard types of hogs or the mutton and wool breeds of sheep to secure some of the advantages of both parental races. Dent and flint varieties of corn when crossed usually give greater increases in yield than crosses within either type. In these diverse crosses many of the desirable features of both parental races are brought together. How this works is well illustrated in the cross of a "golden" type of corn which is deficient in chlorophyll with a "dwarf" as shown in figure 26. The plants resulting from this cross are tall, normally green and quite vigorous and productive. In this particular case one parent contributes normal stature and the other normal chlorophyll. Both these characters are dominant over the recessive condition so that all the hybrid plants

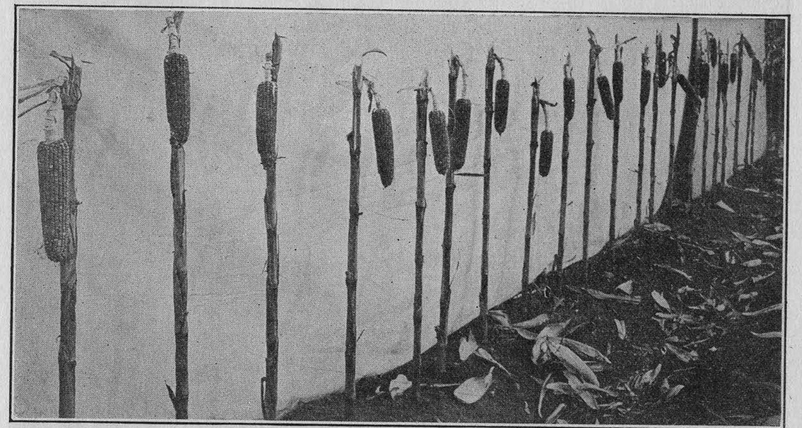


Figure 25. It is the uniform production of a good ear on every plant that makes the first generation hybrids between inbred strains so productive.

are alike in their tall stature and green color. Another case is shown in figure 27 of two dwarfs which are genetically different and which, when crossed, give a tall, vigorous hybrid. One of the dwarfs lacks something essential to normal height and all the plants are alike as long as they are not out-crossed. The other dwarf is lacking in some other essential factor present in normal corn. When these two small plants are combined each type supplies what the other lacks so that the result is normal stature in all the hybrid plants the first year after crossing. These illustrations of the result of crossing are extreme cases which show how conspicuous abnormalities are suppressed by crossing so that the hybrid offspring are able to make a greater growth than either parent. The same situation in principle exists in all crosses from

which hybrid vigor ensues. Different organisms possess different hereditary qualities. When brought together there is always a tendency for the hereditary factors which make for greater growth vigor to dominate the factors for lesser growth. The bringing

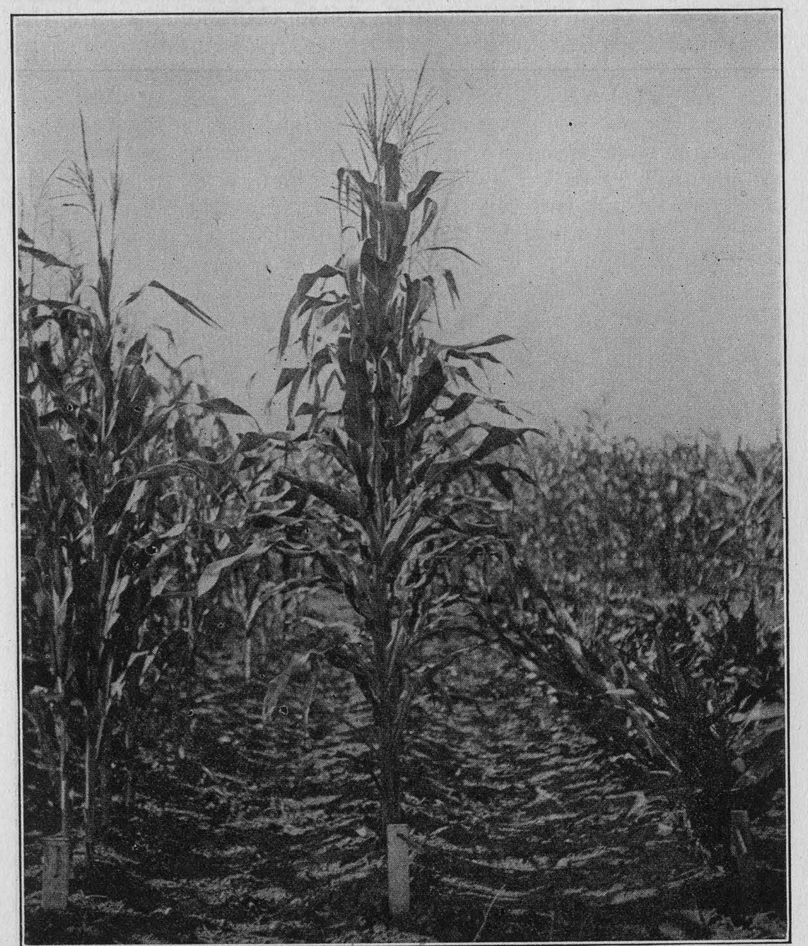


Figure 26. The result of crossing a golden, liguleless type, on the left, with a green dwarf on the right. The hybrid, in the center, has tall stature, normal foliage and green chlorophyll due to dominant factors contributed by each parent.

together of the best of both parents in this way gives the hybrid offspring a temporary advantage over either parent in the first generation following the cross. Recessive weaknesses are continually occurring as mutations as shown by the many controlled observations on the fruit fly and other forms of life. In cross-fertilized organisms, and particularly in domesticated animals and plants, crossing keeps these covered over and out of sight by combining them with normal factors. Many of these recessive weaknesses are not distinct and visible characters as are the

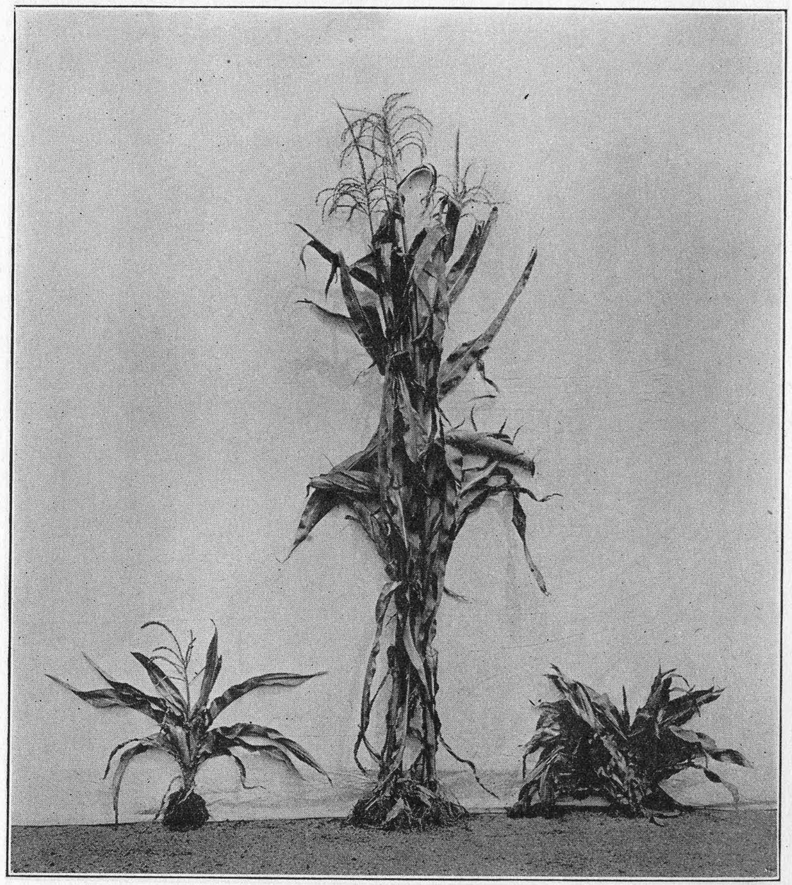


Figure 27. Two genetically different dwarf types give tall plants when crossed, due to the fact that the normal growth factor which each lacks is supplied by the other.

chlorophyll deficiency or dwarfness in corn but nevertheless they weaken the organism in some way. When such crossbred races are inbred, the heterozygous combinations are reduced and the resulting individuals which are homozygous to a greater and

greater degree, as the inbreeding is continued, show the recessive weaknesses and are either unable to reproduce themselves or are reduced in size and rate of growth to a point below that of the original stock. The inbred individuals each receive some of the hereditary factors for vigorous growth. Some receive more than others as a chance allotment and are therefore better able to survive the inbreeding process. Others are so weakened that they perish. On account of the way in which the hereditary mechanism operates it is extremely improbable that any one individual will receive all the more favorable growth factors, and in actual practice inbred strains of corn are all reduced by inbreeding. It is theoretically possible to obtain individuals which possess an unusually large share of the more favorable growth factors or even all of them and for that reason show no reduction from inbreeding. Darwin obtained self-fertilized races of *Ipomea* and *Mimulus* which were more vigorous than the naturally cross-fertilized variety at the start. Cummings reports self-fertilized strains of squash that are as productive as the original variety and much more uniform in type. King has obtained inbred rats after long-continued brother and sister mating that are fully as vigorous as the material with which she started. The fact that no such result has been obtained with corn shows how dependent this plant has become upon cross-fertilization to maintain production.

The Transitory Nature of Hybrid Vigor.

The increased growth resulting from crossing is quickly lost in the following generations when the hybrid individuals are bred among themselves or again inbred. In other words, hybrid vigor is a temporary manifestation which ordinarily cannot be fixed and made permanent in sexually reproduced offspring. The reason for this is readily appreciated when the illustrations previously given are followed into the later generations. The cross of the golden and dwarf corn gives all normal tall green plants in the first hybrid generation. Seed from these hybrid plants, either selfed or inter-crossed, always gives in the next generation all the possible combinations of characters that went into the cross. In this particular case the golden plants also lacked the ligule which is the small extension of the leaf sheath surrounding the stalk above the leaf blade. Liguleless plants hold their leaves in a characteristically upright position close to the stalk. In the second generation of this cross of liguleless golden by dwarf, eight different kinds of plants are produced. These are shown in figure 28. Due to the recombination of Mendelian units, this generation is extremely variable, and while some of the tall, green, liguled plants may be as vigorous and productive as the first crossed plants this generation as a whole averages much less productive. By further inbreeding, eight distinct pure-breeding combinations of these three characters can be obtained and within each type still further minor differences could be established. Crossing any two of these types gives increased growth and restores the normal condition provided the factors for normal growth are all present in one or the other type.

In the same way the vigorous and productive crosses between inbred strains of corn fall off in size and yield in the second generation and are much more variable. This always results whether the first crossed plants are self-fertilized or are inter-crossed among themselves. If the inbred strains are uniform and fixed in their type the first generation hybrid plants are germinally all alike so

Figure 28. The second generation offspring from the crossing of golden, liguleless by dwarf. Eight different combinations of these three characters are obtained by Mendelian segregation and recombination.

that it is easily understood why self-fertilization and inter-crossing give the same result. To test this out two inbred strains were crossed after 14 generations of self-fertilization. A number of the hybrid plants were self-fertilized and an equal number were interpollinated. The seed of these two lots was planted in alternate rows, replicated three times. The self-fertilized plants averaged 76.2±.57 inches in height in comparison with the intercrossed plants which averaged 73.8±.70. In production of grain they stood respectively 22.2±1.2 and 22.0±2.4 bushels per acre. In neither case are the differences significant.

Inbreeding after Crossing.

When the second generation plants are allowed to intercross naturally no further reduction in vigor is expected. Variability and yield should remain at the same level thereafter until natural or artificial selection eliminates certain strains. But when the second generation plants are self-fertilized there is a further reduction in size, and if the inbreeding is continued the decline in size and vigor and in variability proceeds in approximately the same way as when the parental strains were first inbred. This is shown in figures 29, 30 and 31.

In this demonstration of inbreeding after crossing, two inbred strains, self-fertilized for eight generations, were crossed and the first generation plants again self-fertilized. In the second generation a single plant was again chosen as the progenitor and pollinated in the same way, and this was continued for eight successive

Figure 29. The result of inbreeding after crossing. Two inbred strains at the left, their first generation hybrid adjoining, followed by seven successive generations self-fertilized.

generations. Seed was saved from each year's selfing up to the fifth generation. Since corn seed will not retain its germination satisfactorily for more than six years, single plants were again self-fertilized the fifth year in each generation and this seed was used from then on. All eight inbred generations were grown in 1923 along with the two parental strains as shown in the accompanying illustrations. This demonstration has been grown each year since the original cross was made and the yields obtained in the different years are given in table VII. Production has varied rather widely from season to season and from generation to generation. This is due in part to the character of the individual plants chosen for progenitors. A very noticeable drop takes place from the first to the second generation amounting to over 30 per cent. as an average of the six years. Kiesselbach tested the first and second generations of eight hybrid combinations of different strains during two seasons and obtained an average of 52.2 and 27.8 bushels per acre respectively for the two generations, to be compared with 41.7 bushels for the original corn from which the inbred strains were obtained. He secured his seed for the second generation by pollinating several first generation plants with composite pollen from 15 sib plants. The reduction from the first to the second generation of nearly 50 per cent. is even greater than in our case where the plants were self-fertilized. Kiesselbach also grew a third generation from seed of interpollinated plants. The comparative yields obtained for the first, second and third generations were 51.5, 29.4, and 25.6 bushels per acre. The reduction from the second to the third as would be expected from this mode of pollination is small compared with the drop from the first to the second. Continued inter-pollination should cause no further decrease in yield unless particularly unfavorable strains are isolated.

The average height of these successive self-fertilized generations compared with the first generation hybrid and the parental strains is shown graphically in figure 32. There is a continued

TABLE VII.

The production of grain in bushels per acre, of two inbred strains of corn and their hybrid and the F_1 to the F_8 generations successively self-fertilized.

Year Grown	P_A	P_B	F_1	Generations F_2	F_3	F_4	F_5	F_6	F_7	F_8
1917	22	6	65	56	....	....	....	....	....	....
1918	27	24	121	128	15	....	....	....	....	....
1920	16	28	128	48	35	29	10	....	....	....
1921	20	13	73	55	49	33	15	23	....	....
1922	20	26	160	83	74	68	49	36	23	....
1923	13	21	61	45	41	47	16	23	26	27
Ave.	20	20	101	69	43	44	23	27	25	27

reduction in each generation, but the decrease is much less during the last three generations than in the first four. From the first to the fifth generation there is a decline of 27.2 inches in stature and from the fifth to the eighth 8.6 inches. The rate of growth as measured by the daily gain in height is also steadily reduced as shown in figure 33, the decline being greater during the first stage of inbreeding than in the last. The differences between the last two generations in all measurable characters, including yield, height, length of ear and rate of growth, are so small that it seems evident that the reduction in size and vigor is rapidly approaching an end. The last two generations are so similar in appearance that they cannot be distinguished in the field. In tassel type, foliage character, position of the ear on the stalk, and in the size and conformation of the ears these two generations are practically identical.

The reduction in variability from the first to the eighth generation was very noticeable in the field. One of the parent strains has green silks, the other red. The first generation hybrid plants

all had red silks. The second, third and fourth generations segregated for this color while the remaining generations were all uniformly colored. Height of plant, position of the ear on the stalk, form of tassel and all structural details were noticeably uniform in the parents and the first hybrid generation. The plants in the generations from the second to the fifth were quite variable but later became more and more uniform until in the last two generations they showed as little variation as either of the parental strains.

The inbred strain which resulted from this second period of self-fertilization differs from both parental strains. In tassel, ear, and character of the foliage it is quite unlike either but is noticeably susceptible to smut like one of the parents. In other words,

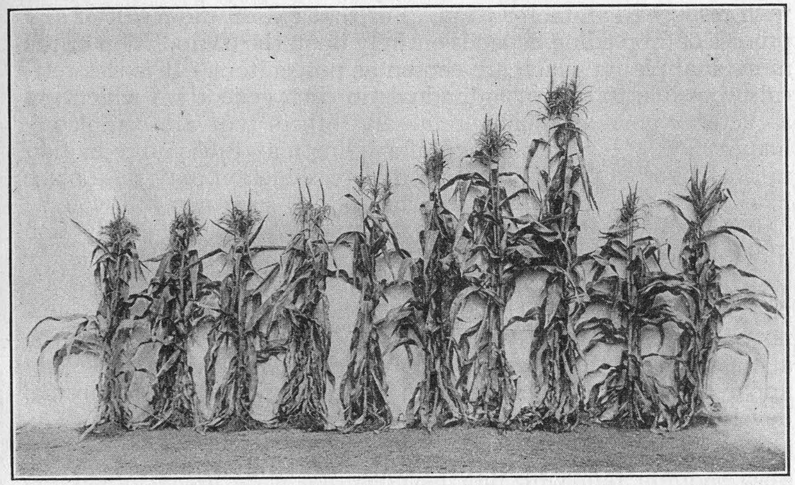


Figure 30. Inbreeding after crossing. Representative plants from the generations shown in figure 29.

Mendelian recombination has taken place so that the details of structure are altered. Apparently this inbred strain has about the same number of favorable growth factors, and for that reason it is no better or no worse than the parental stocks that went into the vigorous and productive hybrid from which the new strain was derived a few generations before.

For all practical purposes the reducing effect of self-fertilization in this particular case has ceased at the sixth inbred generation. This closely parallels the course of events when the parental strains were first inbred. Theoretically the loss of vigor follows the rule of halving the remaining difference in each generation. If we take an individual heterozygous for a single Mendelian pair of factors such as *Aa* we expect in the next generation fifty per cent. of the plants homozygous for this pair of factors and having the composition *AA* or *aa*; the other fifty per cent. will on the average still be heterozygous for this factor pair; i. e. *Aa* in composition. In choosing a single self-fertilized individual for the progenitor the chances are even that it will be homozygous or heterozygous. This holds for any number of factor pairs and since each pair when once alike must remain so thereafter in self-fertilization the number of mixed pairs is steadily reduced by half in each generation. Starting with an individual 100 per cent. heterozygous, the following generations would be on the average 50, 25, 12.5, 6.25, 3.125, 1.5625, etc.

Naturally the progeny of any heterozygous individual will vary greatly in composition. Some will be nearly or completely homozygous while others will be nearly or completely heterozygous with respect to all factor pairs. For that reason the result of any process of inbreeding depends entirely upon the composition of the individual plants which are chosen as progenitors. It is theoretically possible to obtain individuals in each generation which are as heterozygous as their parents and others that are completely homozygous. For that reason inbreeding may cause no reduction in size, vigor or variability, or complete reduction may take place in a single generation. The chances that such a result will be obtained, however, are extremely remote. Actually the reduction follows the rule of halving the remaining difference very closely so that it is evident that a very large number of factors play a part in hybrid vigor. How many such factors there are, we have no way of estimating at the present. Many factors which bring about visible differences possibly have no effect upon vigor but apparently the number of them which are essential to normal development in corn is exceedingly great.

The Attainment of Complete Homozygosity.

Whether complete fixity of type, absolute homozygosity, is possible of attainment by continuous self-fertilization has been previously discussed. (Jones 1924.) The experimental results show that small germinal differences may remain after many generations of inbreeding. Two lines separated from one in the third generation and then continued separately for several generations gave a marked increase in size when crossed, although not as great as in the case of lines separated at the beginning, showing that two self-fertilizations had not produced much uniformity in germinal constitution. The four original Leaming strains were continued as single lines up to the eighth generation. At that time they were all remarkably uniform and apparently fixed in their type. Then each line was separated into two lines which were continued separately thereafter for eight or more additional generations. At that time two of the paired lines had remained exactly alike. No visible differences in any respect could be seen.

One of the paired lines differed only in color of the seeds, one being noticeably brighter in color in some seasons. As the growing conditions were alike for all plants this slight difference can not be accounted for in any other way than as an heritable difference. The other paired line differed noticeably in many respects. One of the members was taller, the leaves were broader and lighter colored and the ears were larger, the seeds broader and duller in color.

Crossing these paired lines gave significant increases in all measurable characters in the one strain whose paired lines were visibly different. The other strains all showed slight but apparently significant increases in some characters. The two strains whose paired lines showed no visible differences were again tested after fourteen generations of self-fertilization in the following way. The two strains which were distinct from the beginning were crossed and gave the usual vigorous and uniform hybrid plants. A

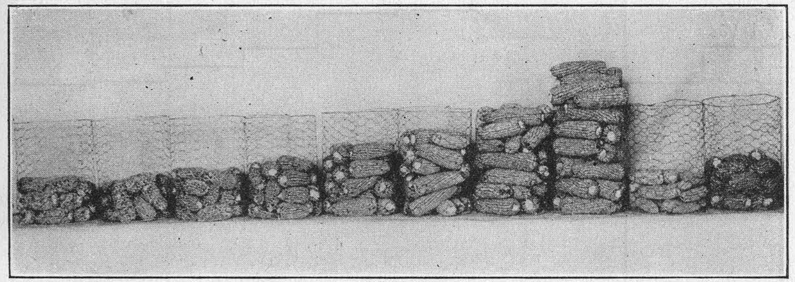


Figure 31. Inbreeding after crossing. The production of grain from the plants shown in figure 29.

number of these were self-fertilized and an equal number were inter-pollinated by sib plants. A careful test failed to show any differences in size or productiveness in the plants grown from these two lots of seed. If the parental strains were not germinally alike within themselves, intercrossing the first generation hybrid plants would not cause such a decrease in heterozygosity as self-fertilization. The fact that no difference was shown indicates that the parental strains were completely homozygous for all factors which influence growth vigor. However, this test is not a very delicate one and final proof awaits the crossing of the paired lines which have been separated in the seventeenth generation and will be carried along for several additional generations.

Mutations in Corn.

Complete homozygosity may be impossible to attain because of spontaneous variations, mutations, occurring from time to time.

During the seventeen years in which the four inbred Leaming strains have been under observation only two apparent germinal changes have been recorded. Until a fairly high degree of uniformity was reached, after six generations, various abnormalities occurred singly or in greater numbers in the rather small progenies that were grown. Presumably these were, at least in the great majority of cases, merely segregations from a heterozygous complex. But new characters appearing after uniformity is obtained which have not been noted previously have every indication of being mutations. Two such have been observed in different lines. One produced in the thirteenth generation a single self-pollinated ear segregating for defective seeds. All of the lines had been examined for the new character during three previous generations, without noting anything of this kind, and since the character

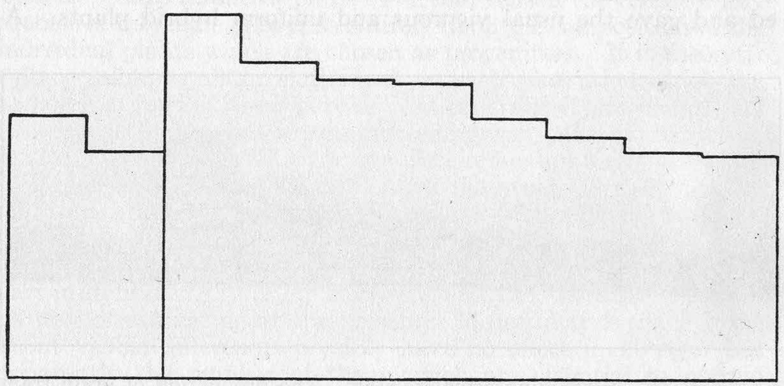


Figure 32. Graph showing the height of the two parental strains and the generations from the F_1 to F_8.

segregated as a single Mendelian recessive when out-crossed, there is every reason to assume that a germinal change took place shortly before its appearance. Among approximately a thousand plants of another line, self-fertilized more than ten generations, which has always produced white cobs, four ears were found with light red cobs. The cobs of this strain are flattened and the plants are otherwise easily identified. The red cob plants were examined at harvest and noted to be typical for the strain in all respects except cob color. Neither of these changes could have been due to out-crossing. Stray pollen from any outside source immediately results in vigorous plants twice as large as the inbred plants ever grow and the crossed plants are completely changed in type. Since the mutant plants were in other respects typical plants of the strain and were no larger they could not have resulted from out-crossing.

Two additional changes have occurred in other inbred material

such that they have every indication of being recent germinal alterations. One strain after five generations produced for the first time striped, variegated plants which bore no pollen or seed. They occured in later generations in about 25 per cent. of the offspring from normal plants. Another strain after nine generations gave small narrow-leaved dwarf plants which were quite distinct from the normal plants. They produced a small amount of pollen and when out-crossed to normal plants they reappeared in later generations showing that the change was heritable.

These four apparent mutations are all that have been noted in a large number of uniform strains which have been under observation for many years. Hayes and Brewbaker record the production of chlorophyll deficient seedlings in four lines out of 953 which had

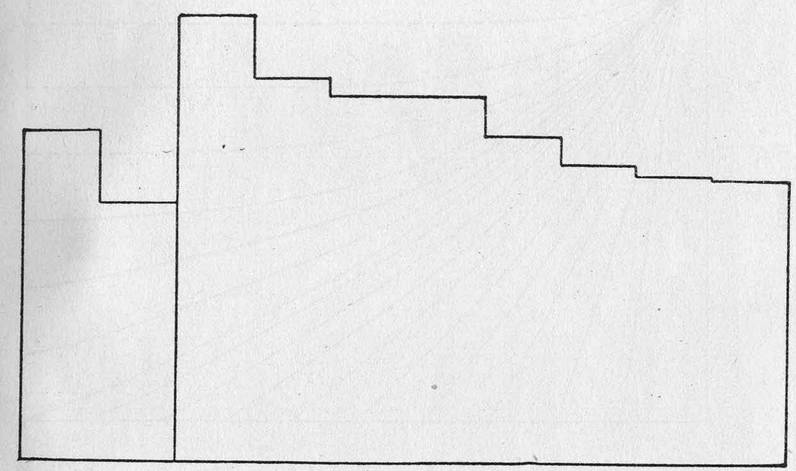


Figure 33. Graphs showing rate of growth (average daily gain in height) for the same generations as in the preceding illustrations.

not shown such abnormalities previously. In these cases the appearance of the abnormalities may have been due to delayed segregation, since the lines had not been reduced to uniformity and constancy. While it is evident that corn does mutate, the frequency of these changes is so low that inbred strains, when once reduced to uniformity, are stable for all practical purposes. Some care will be needed to maintain self-fertilized lines true to type, and when recessive abnormalities appear those progenies which show them will have to be discarded.

The Value of Inbreeding.

This review of the effects of inbreeding and crossing upon corn has been given in considerable detail because the facts learned from these investigations form the basis for the method of improvement by selection in self-fertilized lines. In the inbreeding experiments just described no selection of superior individuals to perpetuate the strain was made. The aim was to take normal plants at random and note the outcome. Nevertheless a great deal of natural selection has taken place. All abnormalities which interfere with or markedly reduce reproductive ability have been automatically eliminated. In this way many chlorophyll deficiencies, endosperm abnormalities and inherited sterility in tassels and ears, unfavorable conditions almost always present in every cross-pollinated

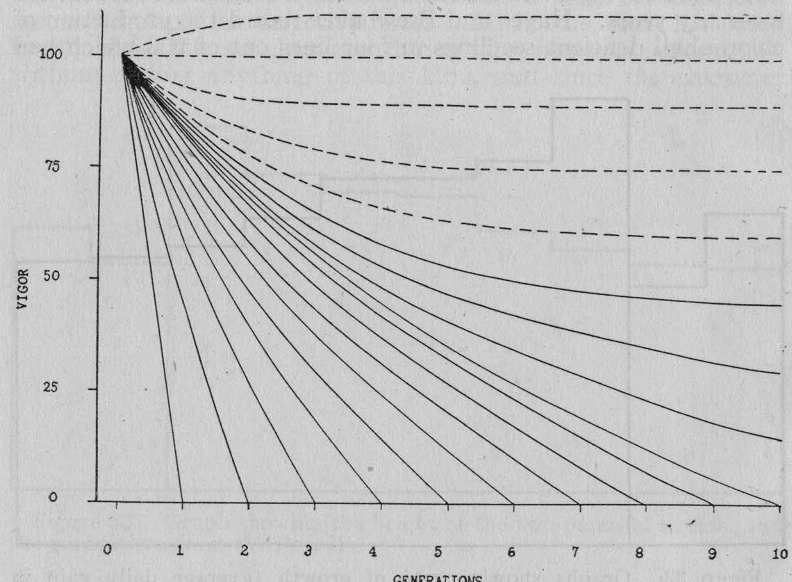


Figure 34. A diagrammatic representation of the actual and theoretical results of inbreeding corn. The solid lines represent strains which have already been obtained, the dotted lines those which may be expected when corn is worked with more extensively.

variety of corn, have been cleaned out. But this outcome of inbreeding, valuable as it may be, is less important than the control over the heredity made possible by hand pollination and the resulting fixity of type.

In common practice, selection with nearly all cross-fertilized plants has been based on the appearances of the plant or upon the performance of the progeny, and no adequate control of the heredity brought in from the pollen parent has been possible. As generally practised, corn breeding has been similar to a system of animal breeding in which selection is carried on only with the dams paying no attention whatever to the sires. The disastrous

result that such a system would have upon purebred live-stock can readily be appreciated. With all cross-fertilized plants it would be theoretically possible to follow the method now used in animal breeding. Certain desirable individuals could be chosen as seed parents and others as pollen parents. Pollination could be made by hand and the progenies compared on the basis of their performance. There is no doubt that this system followed up as carefully as it is in mating farm animals would give equal results. But such a method is wholly impracticable on account of the small value of the individual plant. The time spent on selecting the

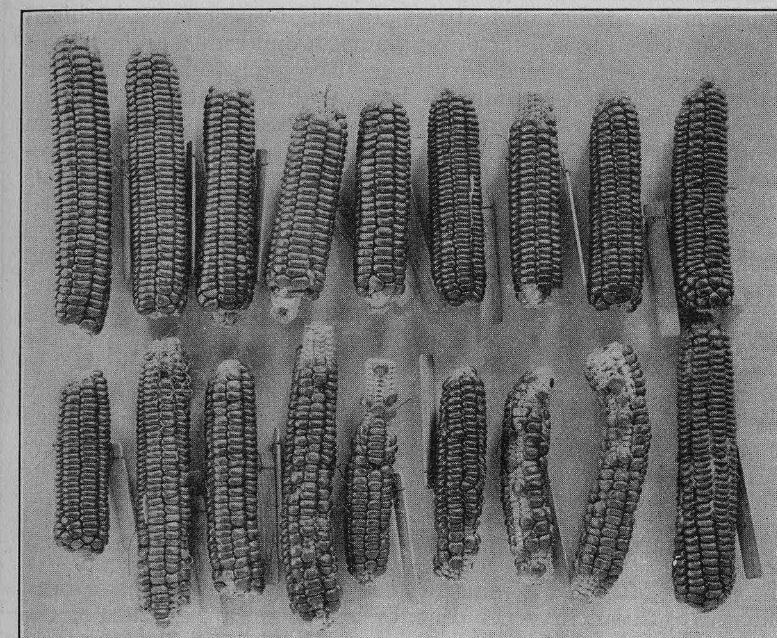


Figure 35. Self-pollinated ears grown on selected plants of Burwell's Yellow Flint, No. 40. Each ear is the starting point of a selected line. These are numbered 1 to 9, top row, and 10 to 18, bottom row, left to right.

parents and on pollinating each generation would not be repaid by the possible gains. Furthermore, with corn, selection is greatly handicapped due to the fact that the principal objective, production of grain, is not visible until after pollination.

A new method of attack, which will make possible a control of the heredity transmitted thru the pollen as well as thru the egg, is needed for all naturally cross-fertilized plants. Since inbreeding is a sorting-out process, selection carried on during the time the plants are being reduced to uniformity and constancy makes it possible to look for desirable qualities with a certainty of being able to hold them, when once secured, that has never before been possible. From this viewpoint inbreeding is not so important as a method of gaining the maximum effect of hybrid vigor when the inbred strains are crossed as it is of separating out and making visible the very best hereditary qualities that may exist in a heterozygous stock. Strains when once reduced to fixity remain the same indefinitely, barring mutations. With due regard to seasonal variation, crosses between inbred strains give the same result whenever the same combination is made. The uniform production of the first generation hybrids between homozygous strains is an important feature. In this respect cross-fertilized plants are equal to self-fertilized plants in uniformity and fixity of type and have the added advantage of crossing to bring together and use in the first generation the desirable qualities within the species, which in a self-fertilized organism can be used only when recombined and fixed in a homozygous condition. It should therefore be clearly understood that the crossing of inbred strains as such is without particular value and that the opportunity afforded to find and to fix the very best hereditary qualities possessed by a cross-bred race is the more important function of inbreeding. Crossing is merely a means of utilizing this good heredity by giving it maximum vigor. It is to be expected that many inbred strains will have only medium value and give no improvement over the original variety when crossed. The bulk of the germplasm in every population is mediocre. Of necessity only the exceptionally few will give outstanding results. For these reasons the outcome of selection in self-fertilized lines depends upon how extensively and skillfully it is applied.

Possibility of Obtaining Vigorous Inbred Strains.

Most of the inbred strains of corn so far produced have been reduced to about fifty per cent. or less of the production of the original cross-bred varieties. Some strains have failed to reproduce after one generation of self-fertilization. Others have persisted in a weakened condition for several generations and then perished. Still other strains are able to survive, but are continued only with the greatest difficulty. The majority of the self-fertilized lines, when uniformity and fixity of type are reached, are about one-third as productive as at the start. A few are exceptionally good. They grow more vigorously and yield more than the rest and are equally uniform and fixed in their type. But even the best of these are still below the original variety in amount or quality of grain produced. On the basis of hybrid vigor being due to dominance of the more favorable factors it is theoretically possible to secure inbred strains that will show little or no reduction in vigor, and a few may sometime be obtained that are even more vigorous and productive than the cross-bred variety. This is deduced from the fact that most heterozygous combinations of factors are less effective than the homozygous combinations of the same factors. Thus the cross of yellow and white corn gives a lighter color than pure yellow. The cross between a determinate growth type of tobacco with an indeterminate growth type (Jones, 1921) which involves a single factor, differs from either parent in size of plant and number of leaves. Dominance is seldom perfect and while there is little direct evidence in this respect for characters

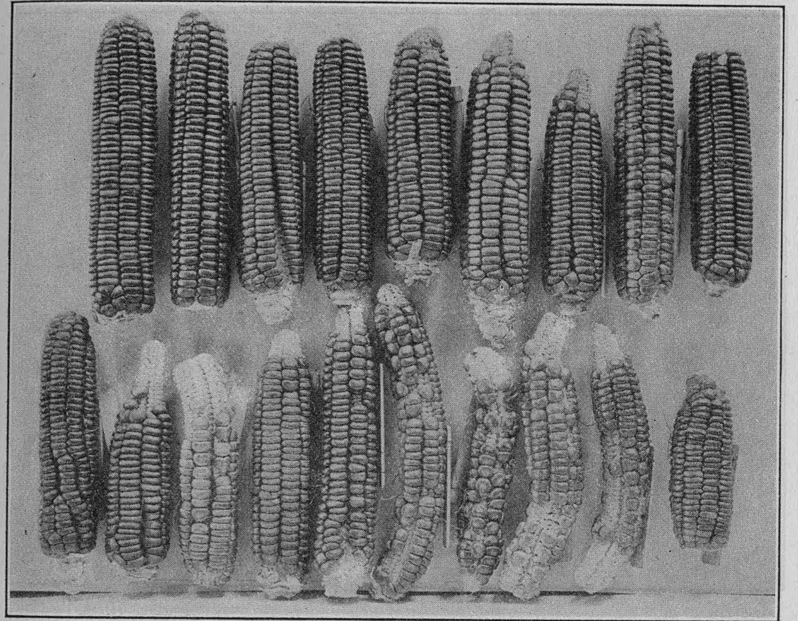


Figure 36. Self-pollinated ears grown on selected plants of Gold Nugget, No. 105. Each ear is the starting point of a selected line. These are numbered 2 to 10, top row, and 11 to 20 bottom row, left to right. (Ear 1 was shelled before photographing. It was similar to No. 2.)

which directly affect vigor there is every reason to expect that a homozygous combination of all the more favorable dominant growth factors will make possible a greater development than the heterozygous combinations of the same factors with weaker allelomorphs. However, as just noted, certain results are obtained from heterozygous combinations that can not be obtained from either factor alone. If there are many of these that play a part in growth vigor, then heterozygosity may be indispensable to maximum development. Moreover, recombinations of large number of factors are extremely difficult to obtain and since favorable and unfavorable growth factors are distributed indiscriminately throughout the hereditary mechanism the chances of securing self-fertilized strains of corn which equal the cross-bred varieties are so exceedingly small that there is little hope of obtaining them. The most that can reasonable be expected are inbred strains which are appreciably better than any that have so far been produced. The results that have already been obtained from self-fertilizing corn, and the theoretical possibilities, some of which may be attained in the future, are shown diagrammatically in figure 34.

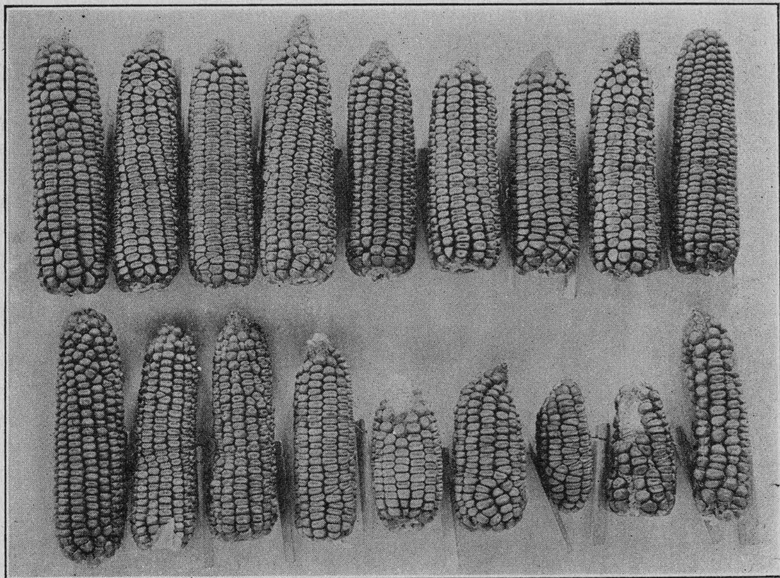


Figure 37. Self-pollinated ears grown on selected plants of Century Dent, No. 110. Each ear is the starting point of a selected line. These are numbered 1 to 9 top row and 10 to 18,bottom row, left to right.

Selection in Self-Fertilized Lines.

To demonstrate the value of inbreeding as a means of isolating good heredity a system of selection in self-fertilized lines was begun in 1918. Four varieties of corn were chosen as material with which to work. These varieties have been grown in Connecticut for many years and are well adapted. In a variety test of long duration they have proven to be among the best in production of grain and in other qualities. The four varieties are as follows:

Burwell's Yellow Flint, No. 30 and No. 40. An eight rowed yellow corn of the Canada Flint type. The ears are medium in size, one or two on the stalk. The plants are medium in maturity.

Gold Nugget, No. 105. An eight rowed yellow flint corn with large ears, broad kernels and heavy cobs. The stalks are large with few suckers. The plants mature late in the season.

Century Dent, No. 110. A light yellow dent corn with broad, smooth, shallow dented kernels. The ears are medium in size and have from 14 to 18 rows. The plants are medium in size and mature well in practically every season.

Beardsley's Leaming, No. 112. A yellow dent corn with tapering ears with 16 to 22 rows and small, shallow kernels. The stalks are large. This variety is later in maturing than Century Dent and is usually more productive.

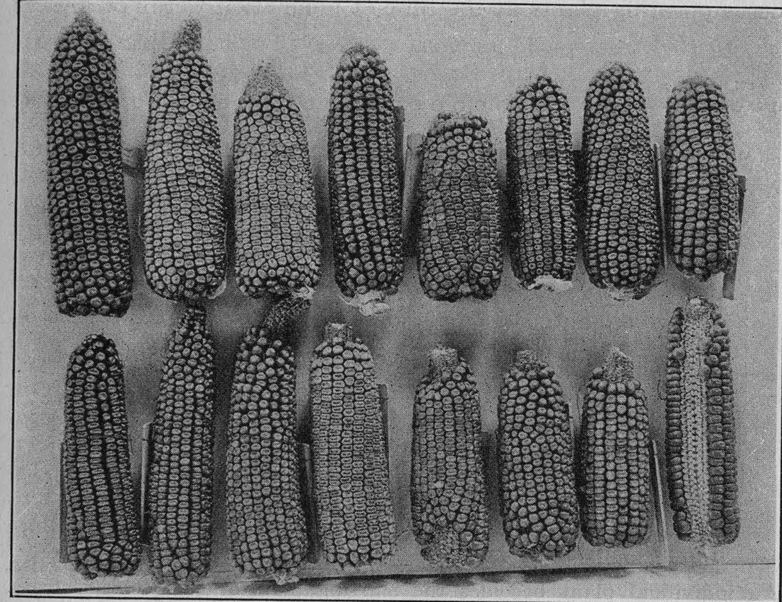


Figure 38. Self-pollinated ears grown on selected plants of Beardsley's Leaming, No. 112. Each ear is the starting point of a selected line. These are numbered 1 to 8, top row, and 9 to 16 bottom row.

The plan of procedure was to self-fertilize a number of the best plants in each of these four varieties and to use each of these plants as the starting point of an inbred line. These lines were to be continued by self-pollination of the best plants in each generation until uniformity and constancy were reached. Accordingly from about 60 plants each of the four varieties grown from a general mixed lot of seed, 20 plants of each variety were selected at pollinating time and self-fertilized. These four lots of ears are shown in figures 35 to 38. Some of the self-pollinated plants failed to set seed but all of the ears that had enough seed to work with were planted. The original hand-pollinated ears were ranked according to their appearance in size, form of the ear and quality of the seed. Ear number one represents the best, number two the next best and so on down. The ear numbers became the numbers for the self-fertilized lines derived from them. Therefore, the number of the line shows how its original progenitor was classified. It is of considerable interest to note to what extent good strains can be obtained from unpromising ears at the start.

Each self-pollinated ear was planted in a row the following year and five plants of each were again selected at pollinating time as the most desirable and were self-fertilized. It was noted that the best appearing plants at the time of pollination were not always

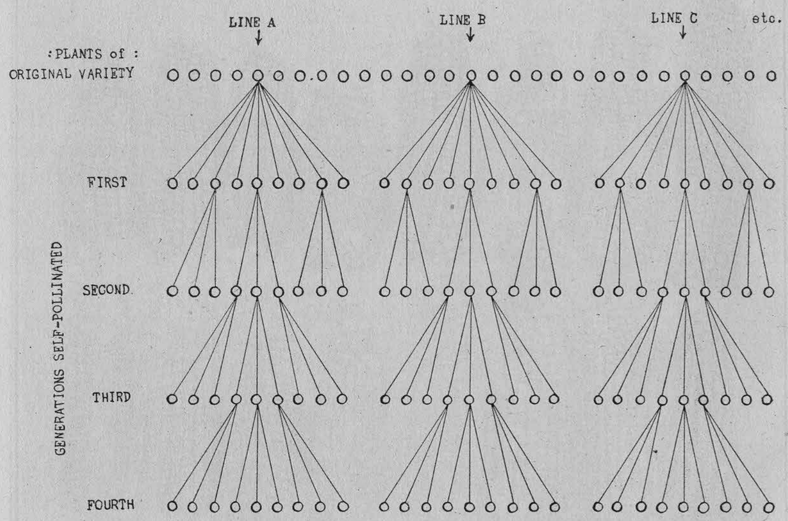


Figure 39. Diagram of a method of selection in self-fertilized lines. An individual plant becomes the starting point of each inbred strain. Three progenies are grown but only one is selected to continue the line.

the most productive at maturity. For this reason more plants were self-pollinated than there were progenies planted, thus allowing for some failures of pollination and also to permit of some selection among the hand pollinated ears. Also, in order to base selection upon progeny performance rather than upon the appearance of the seed ear, three progenies from each line were grown each year. At pollinating time the best appearing progeny was chosen and five plants were again self-fertilized, the other two progenies being discarded. This method of carrying on selection is shown diagrammatically in figure 39.

About thirty plants were grown in each progeny. From three to five times this number of seeds was planted and the poorest

seedlings pulled out after they were well started, leaving the tallest and most vigorous plants. An even stand was obtained in most cases. The end plants in each row were usually avoided in selecting the plants for hand-pollination as these are nearly always larger and better developed than the others on account of their better opportunity to grow.

METHOD OF POLLINATION.

The plants were pollinated by hand as shown in figures 40 and 41. The general method used is as follows:* A three pound manila grocer's bag is placed over the ear shoot before the silks appear. The tassels are covered with an eight or ten pound bag as soon as they are above the upper leaves. When the silks are about three-fourths out, pollen is dusted over them and the tassel bag placed over the ear. Care is taken not to touch the silks or the inside of the tassel bags with the hands in order to avoid contamination with foreign pollen. If the silks extend more than three or four inches beyond the tip of the ear they are cut back with a knife sterilized in alcohol. After the first generation or two, out-crossed plants can be easily noted by their much greater size and darker green color so that contaminating pollen is not a cause for great concern. Effort is made to pollinate as rapidly as possible. Only one application of pollen is made. If sufficient seed does not result from this application the ears are not used. Some good plants are lost because all the pollen has been shed and has lost its viability before any silks appear. This tendency to protandry is accentuated in some inbred lines. Such strains could be maintained by sib-crossing but since this method of inbreeding is much less effective than self-fertilization in bringing about homozygosity the latter system has been rigidly adhered to. In this way sterility and recessive abnormalities of all kinds are most quickly eliminated.

SELECTION OF EARS FOR PLANTING.

Each hand-pollinated plant is tagged with a printed form upon which notes as to the character of the plants in the field and the hand-pollinated ears when mature are entered as follows:

Pedigree number	Color and markings of foliage
Field plot number	Infection on plant
Height to ear-bearing node	Smut on ear
Height to first branch on tassel	Mold on ear
Number of ears containing seed	Number of rows of grain on ear, regularity of rows, and length of ear
Number of leaves	Color and general character of seeds
Number of tillers	Color and shape of cob.
Posture, whether erect, leaning, bent, broken or fallen	

* A method of pollinating proposed by Jenkins and known as the "bottle method" was also tried. Under our conditions it did not prove as satisfactory as the procedure described here.

At harvest these tags are transferred to the hand-pollinated ears. In choosing the three ears for planting in each line, from the five ears pollinated, the characters of the plants in the field as well as the size and appearance of the ears are taken into consideration, chief attention being given to ability to stand erect, color of foliage, freedom from smut and other infection on the plant and ear and absence of mold on the ears.

ELIMINATION OF SELF-FERTILIZED LINES.

In all, 86 self-fertilized lines were started, distributed among

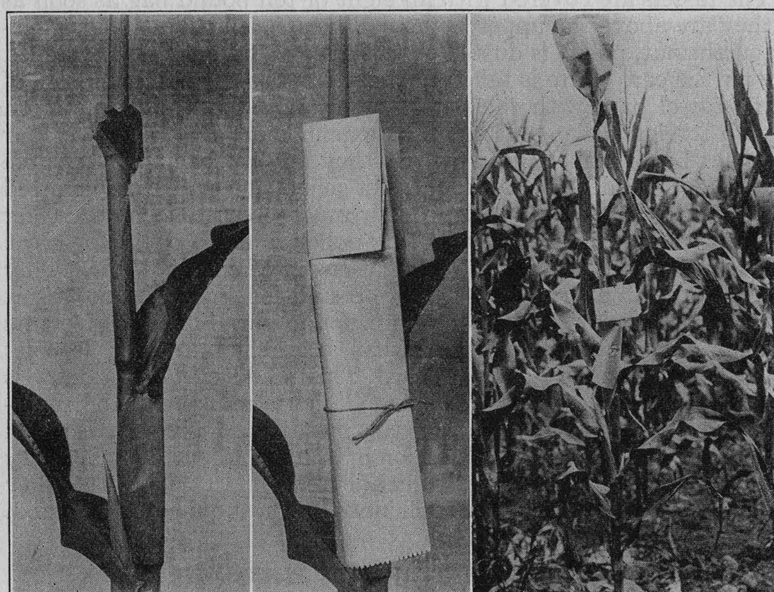


Figure 40. Plant bagged for hand pollination. Small bags can be used over the ear shoot and the tassel bag placed on the ear when pollinated. Wire clips are now used to hold the bags on the ear and tassel.

the four varieties as follows: From Burwell's Yellow Flint number 40 there were 18 ears self-pollinated in 1918, ranked and numbered from 1 to 18 in order of their excellence as shown in figure 35. In addition to these there were 14 ears of the same variety which had been self-fertilized in 1914 for another purpose and not used. These were included among the Burwell strains with the variety number 30 to distinguish them from the other strains which were ranked according to their appearance. The fact that these ears had been held five years before planting has interest in connection with the possible elimination of abnormalities due to the age of the seed, as will be noted later. From the Gold Nugget variety, number 105, twenty lines were started (figure 36); from Century Dent, number 110, eighteen lines (figure 37), and from Beardsley's Leaming, number 112, sixteen lines were started (figure 38).

The once self-pollinated ears beginning these 86 lines were planted in 1919 and hand-pollinated ears were obtained from all lines except one in Gold Nugget and two in Century Dent. These failures to produce seed in all five pollinations in each line may have been due to delayed pollination and unfavorable weather conditions. But since good ears were obtained in the other lines

Figure 41. Pollinating corn. Only one man is necessary for this operation. Care is taken not to touch the silks or the inside of tassel bag. If the silks are more than three inches long they are cut back to about one inch with a knife sterilized in alcohol.

it is fair to assume that these lines were less vigorous or for some reason were not as able to reproduce under this method of pollination. In the second generation two more lines were lost because no self-pollinated seed was obtained. In the third generation four lines were discontinued. In two of these no hand-pollinated ears were obtained, and the other two were so badly damaged by mold that they were discarded.

In the fourth generation eleven lines were eliminated. Nine were discarded because they were so very poor and unpromising that it was thought advisable not to carry them further. Some of these failed to produce any seed on any plants. All of the hand-pollinated ears of two lines proved to be out-crossed, due possibly to the fact that the bags covering the ears of the previous generation were broken and allowed foreign pollen to enter. By the fifth generation practically all of the lines had become uniform and stable. All that had survived up to this point gave promise of being able to continue indefinitely if sufficient effort was put forth and provided the season was not too unfavorable. During the course of the five-year selection period the following lines were eliminated for various reasons:

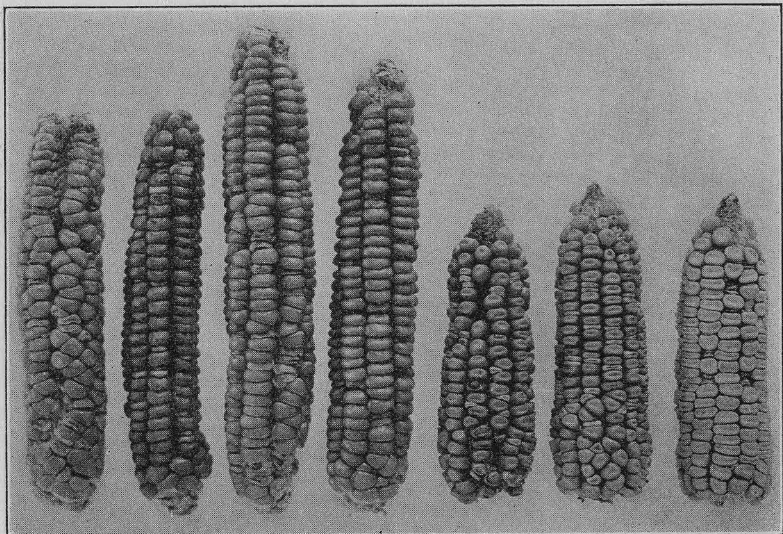


Figure 42. Self-fertilized ears showing defective or aborted seeds.

In No. 30, line 2 was accidentally lost.
In No. 40, lines 2, 5, 11, 12, 17, 18 were discarded.
In No. 105, lines 1, 4, 5, 12, 19 were lost or discarded.
In No. 110, lines 8, 12, 13, 14 were lost or discarded.
In No. 112, lines 2, 5, 11, 13 were discarded.

In all, 20 lines were not continued to the end of the fifth generation. Three of these were accidentally lost thru no fault of their own. The others were too poor to be carried along. An examination of the original ears from which these lines came (figures 35 to 38) shows no marked relation between their poor behavior and their appearance when first pollinated. Dividing each lot of ears into two equal groups and not counting the three lines that were

accidentally lost, we find that seven from the best appearing lines at the start were discarded and ten from the poorest.

The original plan was to keep all lines that could be successfully propagated even though they became extremely poor. It was fully appreciated that inbred strains may themselves be very

Figure 43. Seedlings lacking chlorophyll are common hereditary variations in corn.

undesirable and still have potentially great value when crossed with other strains. For this reason no lines were discarded unless the amount of seed produced was so small that enough plants to permit satisfactory measurements could not be grown. Many lines were continued which were extremely weak, unproductive and showed markedly undesirable characters. They were continued to compare them in crossing with other strains. The results of these comparisons will be reported in a later publication. It should be emphasized here that the 20 lines, or 23 per cent. of the original number, which were lost or discarded, represent for the most part extremely poor and undesirable material that would probably be lost in any selection experiment. By growing a larger number of plants in order to give a greater opportunity for selection and by hand-pollinating a larger number of individuals it would probably have been possible to continue many of these lines and some might even have turned out to be good strains in the end. Whether it is worth while to work more intensively with a few lines or expend the same amount of time on a larger number of strains less intensively selected is one of the most important problems to be considered.

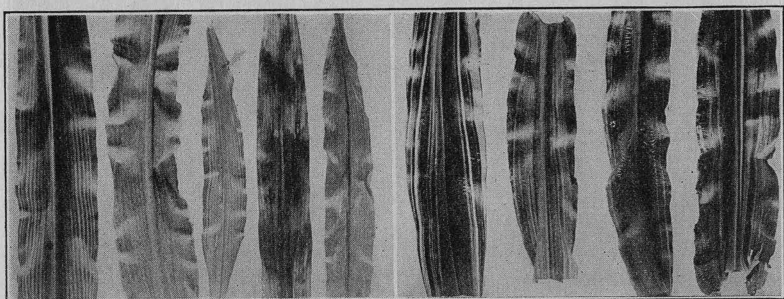


Figure. 44 Various types of chlorophyll deficiencies found in inbred strains of corn.

THE PRODUCTION OF ABNORMALITIES

An examination of the original ears after the first self-fertilization (figures 35 to 38) showed eight that were segregating for small, dull colored seeds that were clearly abnormal. These recessive seeds varied on different ears from almost entirely empty pericarps to seeds nearly normal in size but shriveled and opaque in appearance, as shown in figure 42. These aborted seeds, in most cases, failed to grow and those which did germinate, produced abnormal seedlings none of which reached maturity. The normal seeds from ears showing defectives when planted produced segregating ears on some of the plants in the following generation. In addition, five ears which were not clearly segregating in the first generation produced some ears with abnormal seeds in their second generation progenies. It has since been found that this defective seed condition is due to a large number of lethal or semi-lethal factors which are hereditarily distinct. They are widely distributed in all kinds of corn. In cross-pollinated plants only a few of these abortive

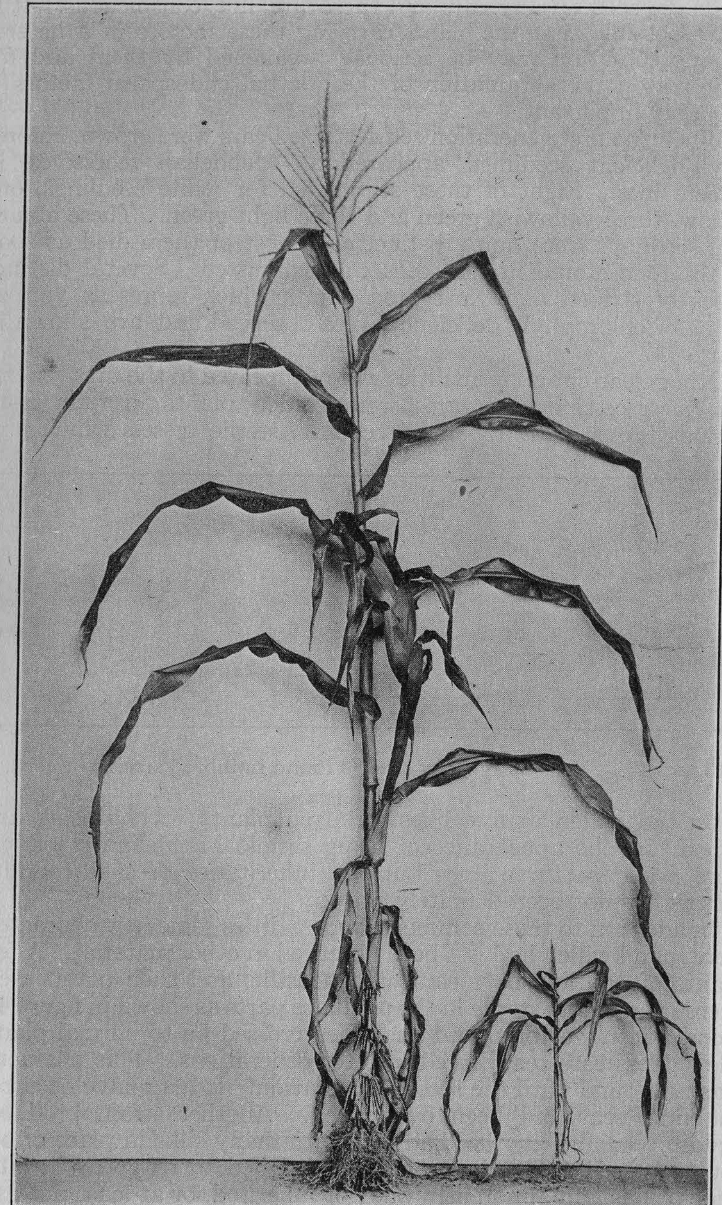


Figure 45. A chlorophyll-deficient dwarf compared to a normal plant in the same family.

seeds are seen on any ears and these are not conspicuous. It is quite possible that the plants carrying these factors in a heterozygous condition may be seriously weakened by them and for that reason the elimination of these lethal endosperm factors is probably important.

When the first generation self-fertilized ears were grown, chlorophyll-deficient seedlings appeared as Mendelian recessives in fifteen lines. Eight of these segregated for white seedlings, one yellow, three yellowish green and three light green. These abnormal seedlings were quite distinct and most of them died as soon as the food stored in the seeds was exhausted. Several distinct types of striped and variegated plants which represent various forms of chlorophyll deficiency were observed and are shown in figure 44.

Other clear-cut abnormalities which appeared in the first generation as recessive segregates were golden plants in four lines, various forms of dwarfs in three lines, sterile tassels which pro-

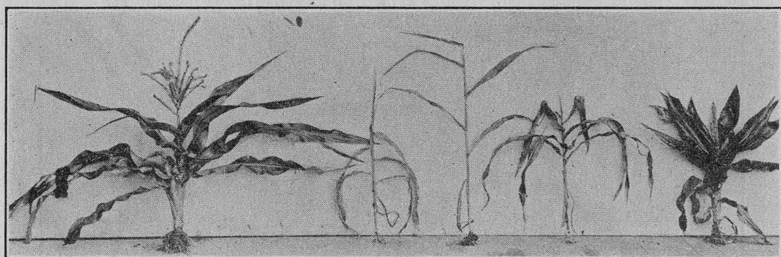


Figure 46. Various types of dwarfs found in inbred strains of corn.

duced no pollen in five lines. Barren plants without ears and which had the appearance of being simple Mendelian recessives were found in three lines but the inheritance of such sterility factors has not been definitely proven.

In addition to these common abnormalities some new characters were found which had not been observed in other material. A few plants of one line bore ears with no silks and such plants were therefore entirely sterile in the pistillate parts as shown in figure 47. Good pollen was produced and when crossed on to normal plants the silkless ears reappeared in later generations. This character was not found until the second generation. It may have occurred the first year and been overlooked. Another strain produced square cobs and another had ears with many silks in place of one for each seed. This latter character failed to reappear in later generations and apparently was not inherited, or at least not as a simple recessive. Many other variations from normal occurred. They differed in degree of abnormality, some affecting the plants much more seriously than others.

In twelve lines no abnormalities were noted in the first two generations, but in the third or fourth generation, various types appeared, in the form of chlorophyll-deficient seedlings, striped and variegated plants, dwarfs, seedlings with tube leaves instead of normally flat, and plants with only the mid-ribs in place of normal leaves. In some of these cases recessive segregates may not have appeared in the first generations on account of elimination due to poor germination or they may have been thinned out with

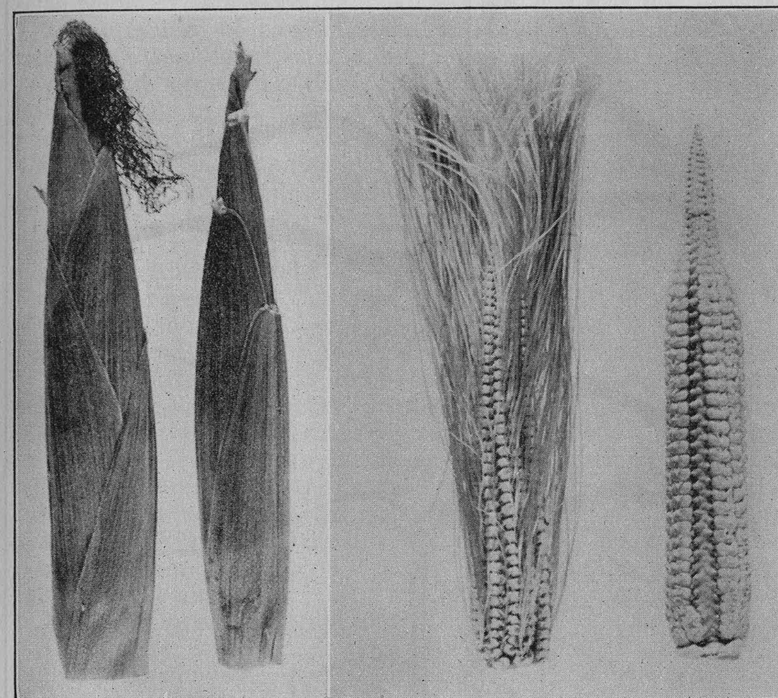


Figure 47. Silkless ears compared to normal specimens from the same family.

the weaker seedlings. In some cases, however, there seems to be no question that they are due either to original mutations or to delayed segregation resulting from some complicated mode of inheritance. A good illustration can be given in the production of the narrow-leaved plants shown in figure 48. Such a striking variation as this could not be easily overlooked. All the selected lines were carefully examined for abnormalities throughout the season, beginning with the early seedling stage. Narrow-leafed plants were first observed in the third generation in lines 112-13

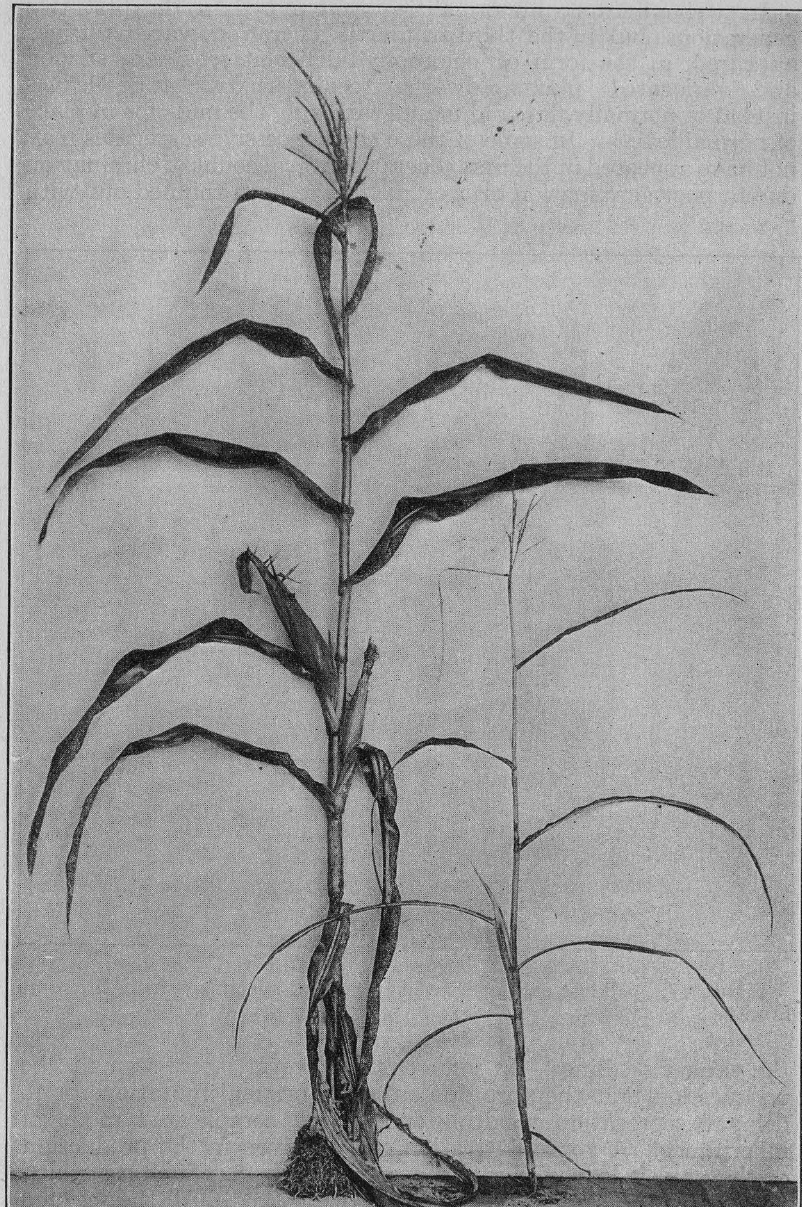


Figure 48. Plants with narrow leaves occurred in two inbred lines.

and 112-14. All three progenies of 112-13 produced some abnormal plants; two, nine and eleven narrow-leafed individuals appearing in the different progenies in a total of about 25 plants in each. This line had been segregating previously for dwarfs, golden plants, yellowish seedlings and striped dwarfs. Line 112-14 produced one narrow-leafed plant in the third generation. Though only normal plants were self-pollinated in the third generation, all of the fourth generation plants in line 112-13 were abnormal, being short and with streaked and wrinkled leaves varying in width from a mere mid-rib to nearly full width. The plants were so poor that no self-pollinated ears were obtained and the line was lost. Line 112-14 produced no narrow leaves in the fourth generation. All the plants were described as uniform, leafy but short in stature. In the fifth generation three progenies, all from ears borne on normal plants in the fourth generation, were grown. No plants were obtained from one and only a few in the other two. All of these had typical narrow leaves and were badly stunted. They made a feeble growth and produced no ears.

Pollen from typical narrow-leafed plants of the third generation out-crossed on to normal plants failed to show any abnormal plants in either the first or the second generation. Five self-fertilized progenies of the third generation were grown and in about 30 plants one narrow-leafed plant was found. The inheritance of this abnormality is not understood.

In the fourteen lines of Burwell's Flint which came from ears self-pollinated in 1914 and not planted until 1919 no abnormalities of any kind were noted in the first two generations. In the third and fourth a few chlorophyll-deficient seedlings, striped plants and tube leaves appeared. In contrast to this are the 18 lines of the same variety self-pollinated in 1918 and planted the following year which segregated the first generation for defective seeds, dwarf plants and chlorophyll-deficient seedlings in five lines. Five other lines of this lot were so poor they were discarded, while none of the 1914 lot were eliminated. Though the number of lines is too few to be conclusive it seems that the delay of five years in planting may have eliminated many abnormalities by the death of the seeds carrying them. A germination test ot these ears, made in 1919, showed a viability ranging from 10 to 100 per cent. Eight of the 14 ears germinated 90 per cent. or less. None of the one year old self-pollinated ears of the same variety germinated less than 85 per cent. and only two were less than 95 per cent. There was clearly an elimination of seeds in the five-year resting period and this could easily have been selective, the seeds carrying the recessive abnormalities being less viable. If this is proven to be the case, some method of destroying the less viable seeds such as exposure to high temperature, alternate germinating and drying or similar harsh treatment may be an effective means of weeding out defective germplasm.

Many of these recessive abnormalities after they once appeared,

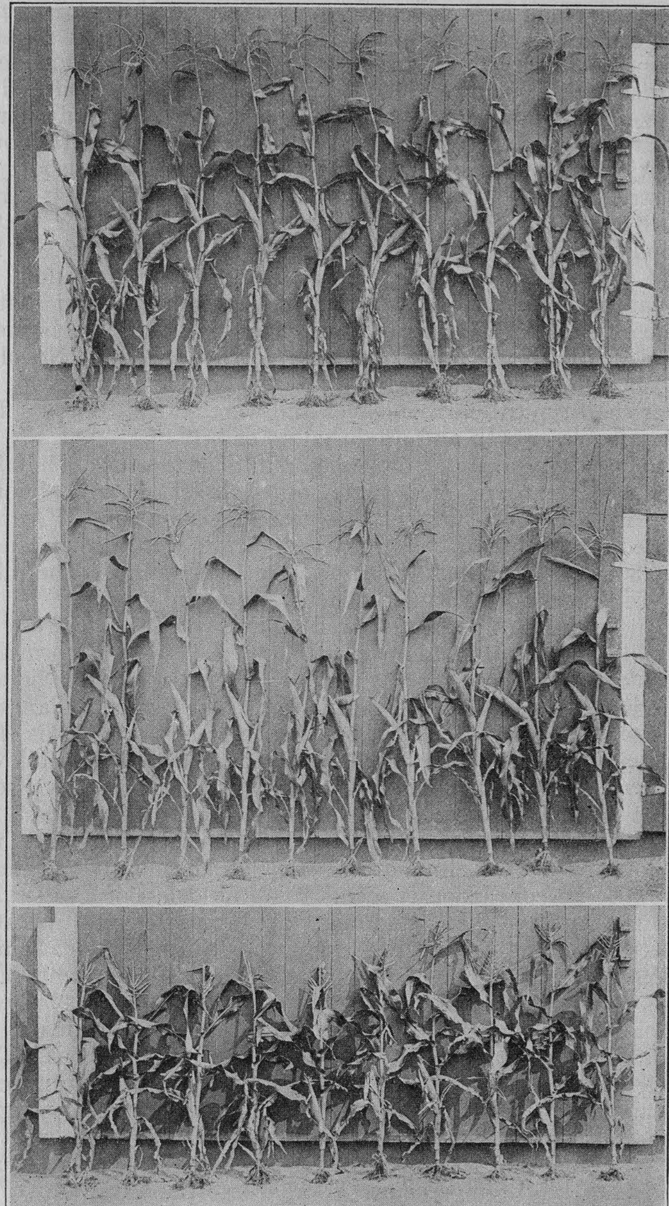


Figure 49. Representative plants of three flint lines; from top to bottom they are 40-4, 105-10, and 105-20.

kept reappearing in the following generations, but were finally eliminated, in every case except one, by the fifth generation. One line which was vigorous and productive and quite uniform in the fifth generation has segregated for white seedlings in every generation. Selection of progenies has usually been based upon productiveness and general appearances of the plants without regard to whether they were segregating for abnormalities or not.

Out of the original 86 lines only 32 lines or 37 per cent. showed no clear-cut recessive abnormalities during the five generations they were self-fertilized. As stated before, 13 lines or 15 per cent. segregated for defective seeds, and 15 lines or 17 per cent. for chlorophyll-deficient seedlings. Many of the lines had several types of abnormality. In a lot of 575 self-fertilized ears from six varieties of white flint corn in another selection experiment there were found 19 ears or a little more than 3 per cent. segregating for defective seeds. Of these, 441 were grown and 40 lines or 9 per cent. were found to be segregating for chlorophyll-deficient seedlings. Hutchison self-fertilized 2,110 ears from a large number of different varieties of corn commonly grown in various parts of the country and found 3 per cent. segregating for defective seeds and 36 per cent. for various seedling characters, of which the greater number were chlorophyll deficiencies.

The widespread occurrence of these recessive abnormalities is fully established. In normally cross-pollinated plants they are comparatively rare in appearance since they are present as recessives in the heterozygous condition. To what extent, if any, they reduce growth in the heterozygous condition has not been established. Lindstrom (1920) suggests that in eliminating these recessive abnormalities many desirable factors with which they are linked may also be taken out. Since these recessives are presumably scattered throughout the chromosomes many other factors both good and poor will be taken out with them.

It has been argued that the recessive abnormalities tend to be eliminated by natural selection except in those cases where they happen to be closely linked with exceptionally favorable growth factors, in which case they would be preserved, and in weeding them out the factors which promote growth would be lost with them. The only answer to such an argument is to see what the facts are. Twenty-five lines segregating for clear-cut abnormalities gave progenies in the following generation, some with and some without the recessives. The 25 progenies which still carried the recessives averaged 50.8 bushels per acre yield in comparison with 50.4 bushels for the 25 progenies grown in the adjoining rows, and from which the abnormalities had been eliminated. An equally good stand was obtained in each case, as an excess of seed was planted and the recessive abnormalities thinned out. The difference in yield in the two lots is not significant. If there are favorable growth factors in the segregating progenies which are not present

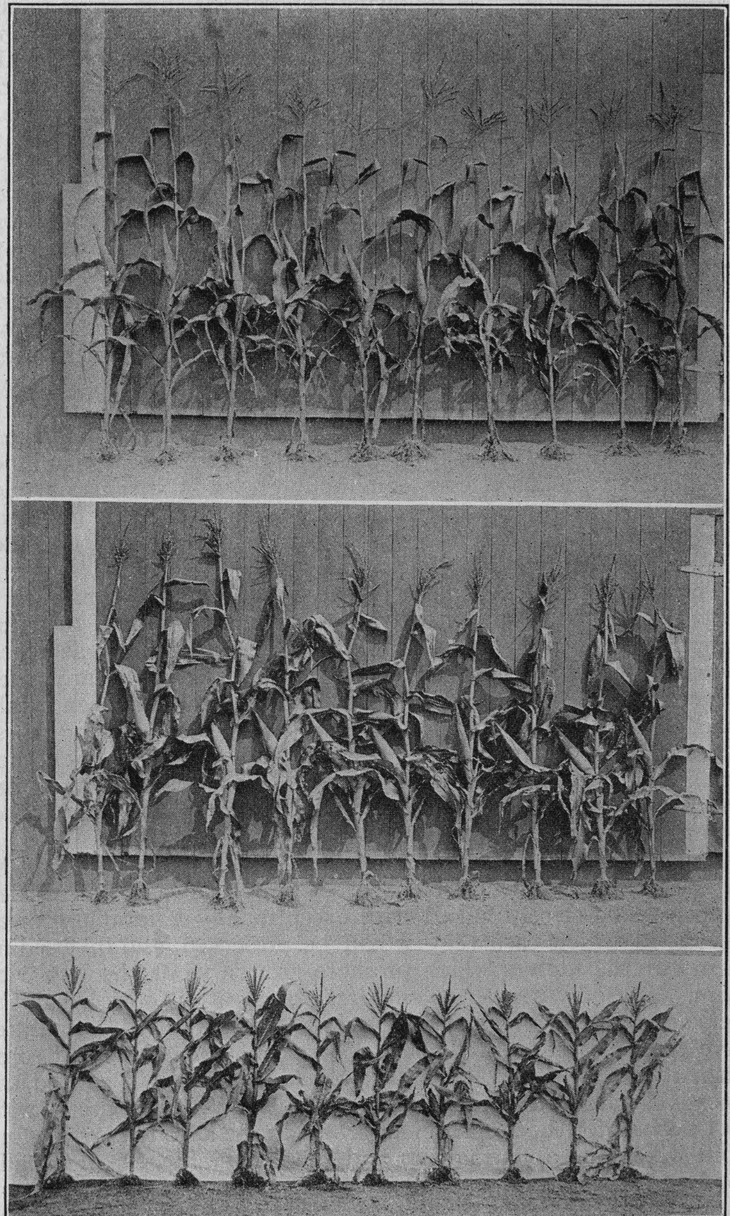


Figure 50. Representative plants of three early dent lines; from top to bottom they are 110-4, 6, 10.

in the non-segregating progenies from the same grand-parental plant they have no more effect than to counterbalance any weakening influence that the recessive abnormalities may have in the heterozygous condition.

Another comparison is made by finding the average per cent. reduction in yield of all segregating lines from the first generation to the fifth generation, by which time the abnormalities were eliminated. This reduction was found to be 57.1 per cent. compared to the reduction of 58.1 for all lines which were free from abnormalities at the start. If any favorable growth factors were lost when the recessive characters were weeded out, their departure caused no greater reduction in yield than took place in the other material from which no abnormalities were removed.

From this it seems evident that the chances are no greater for good factors to be eliminated than poor ones and with other things being equal it seems highly desirable to take out these clear-cut recessive abnormalities. In fact it is necessary, in most cases, to eliminate all lethal and semi-lethal factors, in order to bring the strains to uniformity.

THE APPROACH TO UNIFORMITY AND CONSTANCY.

As expected, the first and second generations were quite variable but in the third generation, after three successive self-fertilizations, a number of lines became fairly uniform in height of plant, color of foliage and in general characteristics. In the fourth generation the majority of the lines had become well fixed in their type, and after five generations all of the selected lines, with a few exceptions, were alike within themselves. This uniformity was apparent in the plants of each progeny and in the similarity among the several progenies of the same line. A few lines remained variable throughout the five generations. As a rule the lines that showed uniformity in the third generation declined somewhat in size and yield in the two subsequent generations. Practically all of the best strains can be picked in the fifth generation. Many of them can be recognized in the fourth and a few in the third. However, it is necessary to have a record of their performance during two and preferably three seasons after uniformity is reached in order to be sure that they are fixed in their type. Several strains that were considered to be very promising in the third generation declined so in vigor and productiveness in the two following generations that they were much inferior to strains that had, earlier, been far less promising. On the other hand a few of the most vigorous and productive lines in the fourth and fifth generations were not noted as being promising in the third. While it cannot be asserted positively that strains which are uniform and good in appearance during the fourth and fifth generations will maintain themselves without further reduction the evidence from the older inbreeding experiments indicates that

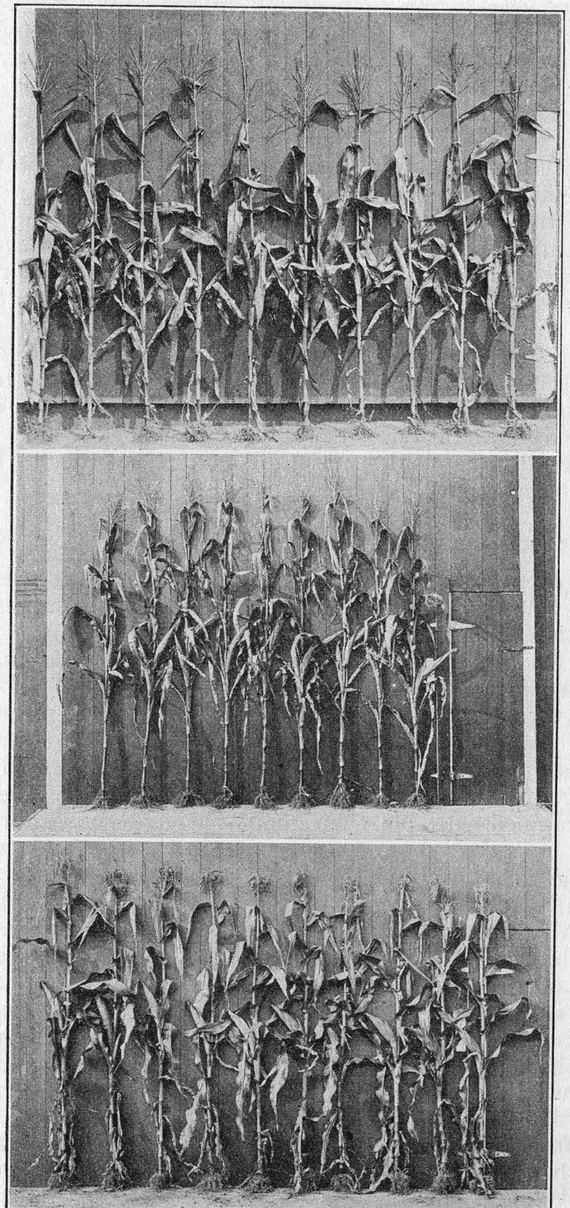


Figure 51. Representative plants of three late dent lines; from top to bottom they are: 112-1, 4, 9.

they can be expected to maintain their level of vigor without much loss. Therefore in carrying out a selection process of this kind the fourth and fifth generations are the most important in affording an opportunity to pick the best-appearing self-fertilized strains.

The selection process was carried out with the aim of securing the most vigorous and productive inbred strains, uniform and fixed in their type so that their good qualities could be maintained indefinitely. For this purpose five generations of self-fertilization are necessary in most cases.

Differences in the Selected Lines.

In the fourth generation all of the selected lines had become strikingly differentiated. Differences in height, color of foliage, size and shape of ears made each line distinct from every other line. In the Burwell Flint lines differences in average height ranged from 51 to 98 inches, in the Gold Nugget lines from 44 to 84, in the Century Dent from 44 to 76 and in the Beardsley's Leaming lines from 54 to 100. Color of foliage varied from very dark bluish green, through all gradations in shade to light green and yellowish green. In some lines the leaves were streaked with alternate rows of light and dark tissue. Various forms of fine and coarse flecking and mottling of the leaves were a regular feature of some strains while others were entirely free from this physiological irregularity of the chlorophyll.

The flint strains were most noticeably different in number of tillers. A number produced no large tillers and some had only a very few inconspicuous shoots from the base of the plants. Others branched very freely, producing many large branches on every plant. Many of these were as large as the main stalk and bore ears. Some strains regularly produced seeds in the tassels on nearly all plants while others never did this.

The ability to stand erect throughout the season is one feature that has been carefully selected for in all lines. Marked differences in this respect were shown, being greater in some seasons than in others. Certain lines regularly went down sometime during the latter part of the season while others stood stiffly erect up to maturity. Equally pronounced differences in time of flowering are shown by the lines derived from the same variety. Most of the lines matured satisfactorily every season while others were so late as to be barely able to ripen seed. The weakening effect of inbreeding delays maturity in all lines but in spite of this some were earlier in ripening than the variety from which they were derived. Along with these differences in maturity were great dissimilarities in character of the grain. The seeds of some were hard, translucent and bright colored; others were soft, dull colored and in some lines regularly moldy.

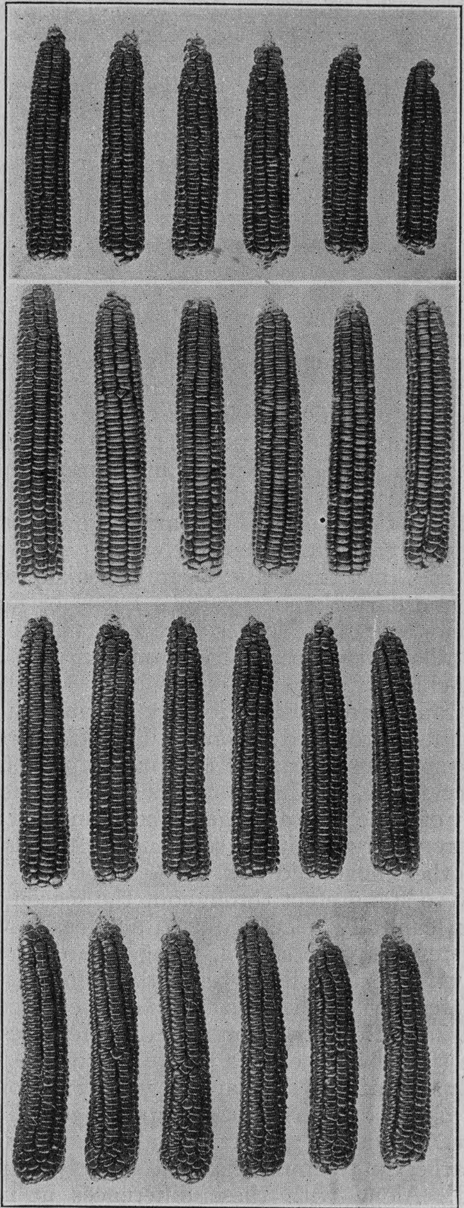


Figure 52. Representative ears of four productive Burwell Flint lines; from top to bottom they are: 30-19, 40-1, 7, 8.

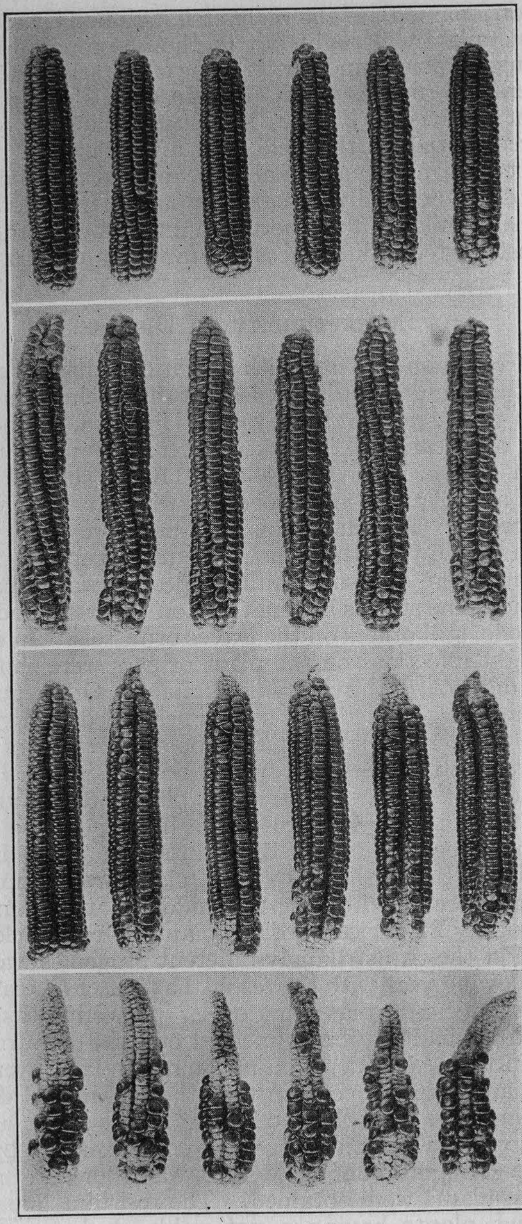


Figure 53. Representative ears of four unproductive Burwell Flint lines; from top to bottom they are: 30-5, 6, 40-15, 16.

The features named are the more striking ones. Differences in structural details are brought out in the accompanying illustrations showing the plants and ears of some of the selected lines in the fourth generation (figures 49 to 57). In details of structure and arrangement of parts the lines are so distinct that they can usually be easily recognized in the field and after harvest. In a few features certain strains may be alike. Some strains have similar plants but differ decidedly in ear structure. In others the ears are somewhat similar but are borne on markedly different plants. For the most part the differences are far more obvious than the similarities.

Susceptibility to Disease.

The most common diseases with which corn has to contend in Connecticut are smut (Ustilago), leaf blight (Helminthosporium), and various root, stalk and ear roots (Diplodea, Gibberella and other forms of Fusarium). Marked differences in smut infection were shown. Two lines 105-14 and 110-17 showed no smut infection on any plant in any progeny during the five generations they were grown. Eleven strains had no more than one plant affected in any one year throughout the same period. The place on the plant where the smut balls appeared was usually quite characteristic, some strains having them on the basal nodes, others at the ear node, still others on the leaves or tassels. In some lines numerous light infections on the plant or ears were shown which apparently did not do any serious damage. Other strains had many plants badly injured and sometimes killed outright during mid-season. The most striking case of segregation of susceptibility to parasitism by the smut fungus occured in line 110-3. In the first generation four per cent. of the plants were smutted. In the second three progenies were grown having twelve plants in each. In one progeny none of the plants had any indication of smut infection. In another all of the plants were smutted and most of them were killed during the middle of the summer. In the third progeny 27 per cent. of the plants were attacked. The original seed of the two strikingly different progenies was planted again the following year with the result that out of 57 plants of the resistant progeny, only one plant or 1.7 per cent. was infected. The smutted lot had 14 plants infected out of 31 grown, or 45.2 per cent. In the next generation no smutted plants were seen in the one line and 65.6 per cent. in the other. Marked differences were shown in the seeds of the two lines. Plants of the susceptible line were extremely weak but the seeds were normal in appearance. However the germination of these seeds was poor and in the fifth generation no plants were obtained. The resistant line produced more vigorous plants having a noticeably darker green color. All of the seeds produced on these plants were distinctly abnormal. When dry they were shriveled and discolored although not showing

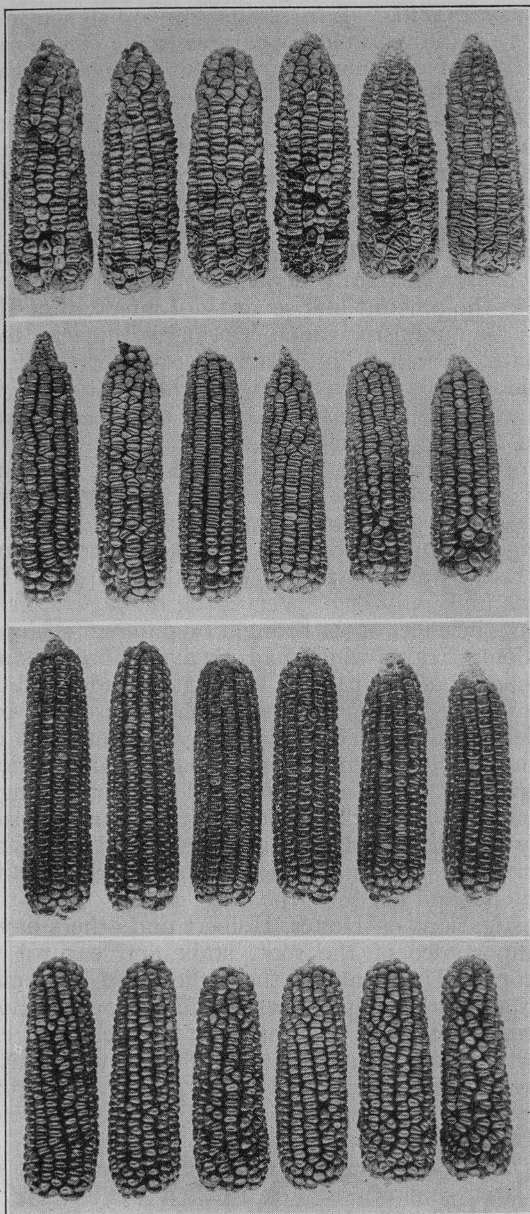


Figure 54. Representative ears of four Century Dent lines: from top to bottom they are: 110-3, 4, 5, 10.

any of the usual molds. Ears of this line are shown in figure 54. In spite of their unfavorable appearance some of the seeds germinate and the plants produced are about as good as the average inbred strain of the same variety.

None of the smut-free lines were outstandingly good in other respects and some of the most vigorous and productive strains now regularly show a high percentage of smut infection. The smut-free or low-smut strains may have value in crossing with other strains which have good qualities but are lacking in smut resistance.

The growing season of 1922 was unusually wet and the selected lines then in the fourth generation showed very pronounced differences in the amount and severity of infection of Helminthosporium. This organism, which is seldom injurious to ordinary cross-pollinated corn, readily attacks many inbred plants and on some completely kills the leaves after seed formation begins. Leaf blighting due to this organism had been noted each year in some lines but in the wet season of 1922 it was particularly injurious. Seventeen of the eighty-six lines showed heavy infection. Some of them lost all their foliage prematurely and the ears were badly stunted, the grains being small and poorly developed. Some of the most vigorous and productive strains in former years were so injured in this way as to give them a very low rating. The following year was unusually dry. Very little damage from this cause was seen, but the effect of the drought on different strains was very striking. Some strains which had always before produced green luxuriant foliage had their leaves killed at the sides and tips by the dry heat and were unproductive for that reason. Most of the strains which had been badly injured by leaf infection in the wet season were beautifully green throughout the dry period of 1923 and were among the best appearing and most promising of all the selected lines. These marked differences in different seasons makes it extremely difficult to judge the value of inbred strains and makes it necessary to test them during several years after they have become uniform and fixed in type.

The investigations of Hoffer, Holbert and others have emphasized the importance of the root, stalk and ear rot organisms attacking corn. The results of the earlier inbreeding experiments indicated that marked differences would be found among inbred plants to resist infection. Throughout the selection experiment great importance was placed on the ability of the plants to stand erect throughout the season and have the ears free from any indication of mold. Fallen plants or moldy ears were avoided whenever possible. The most outstanding differences in ability to stand erect and in freedom from mold on the ears, were seen in the third and later generations. In 1922, a wet season, four lines (30-6, 105-20, 110-2, 110-15) had all the plants of all three progenies erect throughout the season. This same year twelve lines (30-8, 30-9, 105-3, 105-18, 110-1, 110-2, 110-6, 110-7, 110-18, 112-6,

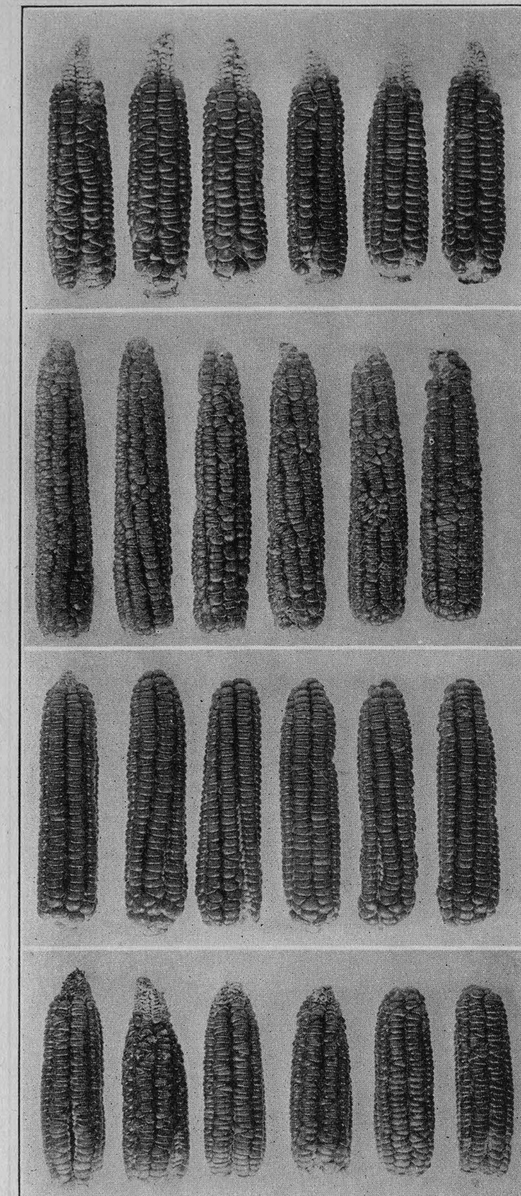


Figure 55. Representative ears of four Gold Nugget flint lines; from top to bottom they are: 105-3, 10, 17, 20.

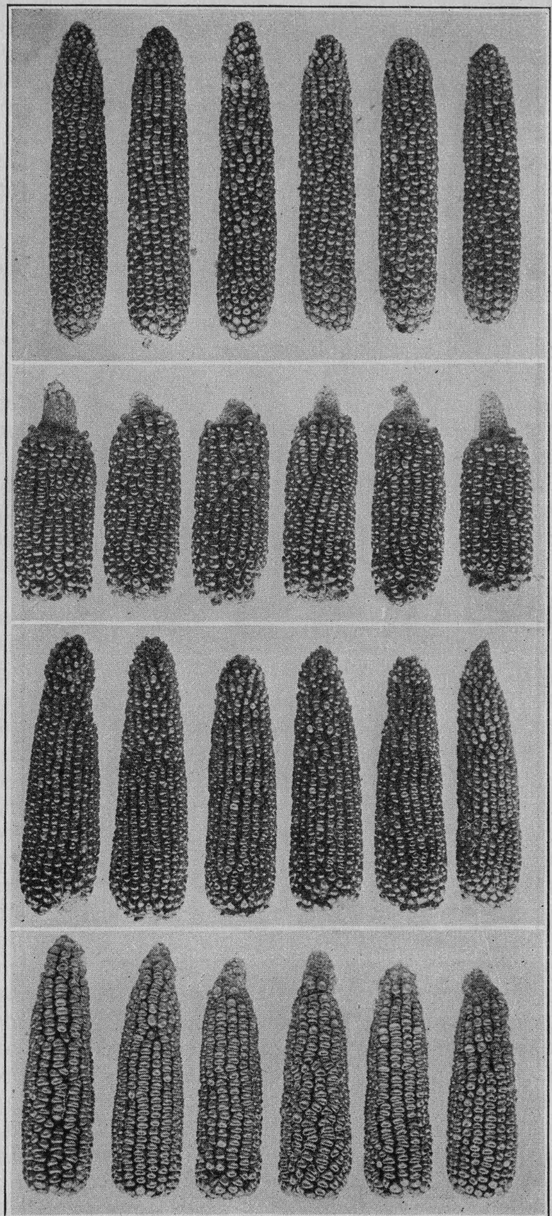


Figure 56. Representative ears of four productive Beardsley's Leaming lines; from top to bottom they are: 112-1, 4, 6, 9.

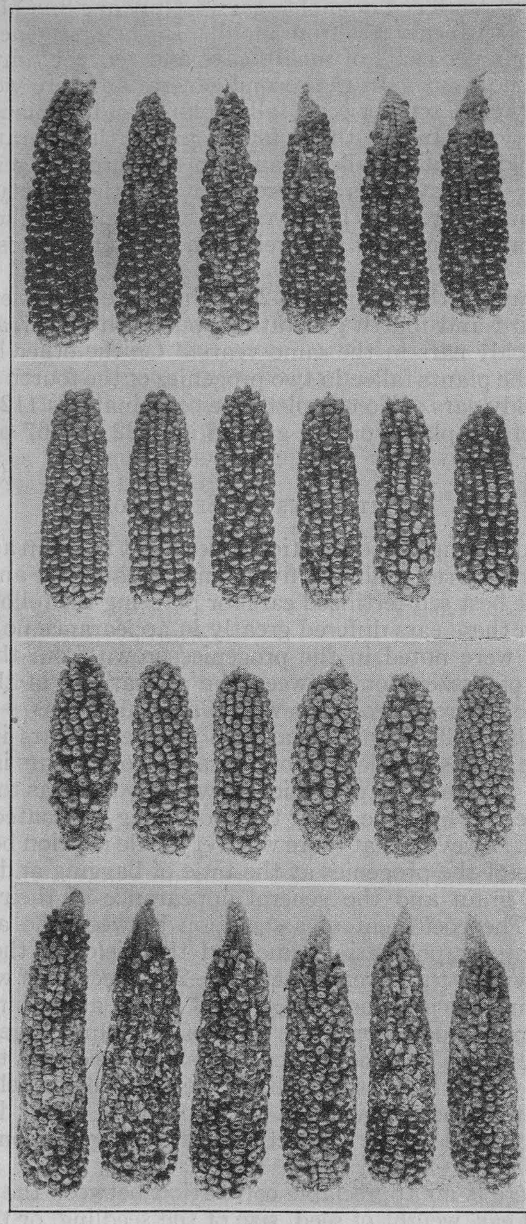


Figure 57. Representative ears of four unproductive Beardsley's Leaming lines; from top to bottom: 112-3, 10, 14, 15.

112-7, 112-8) produced no moldy ears. Only one line 110-2 had all plants erect with ears free from mold. In the first generation this line had four per cent. of moldy ears and ten per cent. of fallen plants but no smut. In the second generation there were ten per cent. moldy ears, ten per cent. fallen plants and no plants showing smut infection. In the third, fourth and fifth generations there was no mold, smut or fallen plants on the three progenies grown each year. This strain is also productive for the variety, although surpassed in this respect by several other strains. The seeds are hard and bright but very pale yellow in color and almost white on top.

In contrast to this is line 105-20 with all the plants erect in the second, third and fourth generations but with 29, 17 and 44 per cent. of moldy ears in the same years. On the other hand, 40-8 had all of the plants fallen in two progenies of the fourth generation and no moldy ears. To complete the combinations 112-11 had 87 per cent. of the plants on the ground in 1922 and 67 per cent. of ears moldy.

Criterions of Selection.

At the beginning of the selection experiment the plan as previously stated was to self-pollinate five plants in each line and to select three of the best self-fertilized ears for planting the following year. Even when these ears differed greatly in appearance no consistent differences were noted in the progenies grown from them. The coefficient of association between the appearance of the ear and yield of the different progenies within several lines is —.18. This indicates that self-pollinating a large number of ears in order to make more extensive selection of desirable looking ears is of doubtful value. Of the three progenies grown only one was to be chosen to continue the line, the other two not being pollinated. It was soon noted, however, that there was very little relation between the appearance of the progenies at the time of bagging and their production of grain and the general appearance of their plants at harvest. The coefficient of association between the appearance of the plants at pollinating time and the yield of the different progenies within the several lines is —.28. Seedlings were grown in the greenhouse and their weight and height after thirty days of growth were compared with the yield of the same progenies in the field. The third and fourth generations showed that those progenies that had the tallest seedlings yielded 1.6 bushels per acre more than the other progenies in the same lines. This difference is hardly enough to make a selection of the progenies on this basis worth while.

Since there is no appreciable correlation between the characters of the seed ear, weight of seed, size of the seedling, or the appearance of the plants at pollinating time and production of grain the only selection of progenies that can be made with any degree of

effectiveness is at maturity. Here also yield is highly influenced by the amount of heterozygosity remaining. In some lines there are more homozygous combinations than in others and they are correspondingly less vigorous and productive although they may be potentially more desirable. For this reason final judgment must be left until the plants are reduced to uniformity and constancy. Hence it is interesting to note what resemblance the resulting inbred strains, when finally reduced to uniformity and fixity of type, have to the same strains in the first generations of inbreeding.

Classification of Selected Lines.

Taking into consideration all features of these selected lines as they grow in the field and after harvest in the fourth and fifth generations and giving most importance to the production of bright sound grain, the four outstanding good and poor strains in each variety are listed as follows, with their yields in bushels per acre in the fifth generation compared with that of the original variety grown the same year:

Burwell's Flint 51.2

Good Lines		*Poor Lines*	
Number	*Yield*	*Number*	*Yield*
30–5	12.2	30–10	44.2
30–19	15.3	30–18	18.3
40–4	33.6	40–3	35.1
40–8	25.9	40–16	24.4

Gold Nugget 54.0

Good Lines		*Poor Lines*	
Number	*Yield*	*Number*	*Yield*
105–11	29.0	105–3	9.2
105–15	33.6	105–8	13.7
105–17	22.9	105–13	7.6
105–20	10.7	105–16	29.0

Century Dent 48.3

Good Lines		*Poor Lines*	
Number	*Yield*	*Number*	*Yield*
110–2	15.3	110–1	28.9
110–4	16.8	110–9	4.6
110–5	10.7	110–15	1.5
110–10	19.8	110–17	12.2

Beardsley's Leaming 49.5

Good Lines		*Poor Lines*	
Number	*Yield*	*Number*	*Yield*
112–1	42.7	112–3	10.7
112–6	27.5	112–7	21.4
112–9	33.6	112–14	.0
112–12	12.2	112–16	9.2

This is purely an arbitrary classification based upon the general appearance of the plants and ears. Some of the poor lines yielded more than the good lines but produced a very poor quality of grain. The original ears from which these lines descended (figures 35 to 38) show that there is no relation between the good and poor strains after uniformity was attained and the appearance of the seed ears from which they came. Low and high numbers are represented about equally in the good and poor strains.

Correlation Between the First and Last Generations.

In order to find out whether the elimination of the poor lines at the beginning of the inbreeding period is advisable, the correlation between the behavior of the plants in the first generation and the last generation has been worked out for the most important characters. In Table VIII are shown the coefficients of association

Table VIII.

Coefficients of association between early and later generations of self-fertilized corn.

Generations Compared Variety	1–4 Height	1–4 Mold	1–5 Tillers	2–5 Smut	1–4 Yield
Burwell's Flint	.60	.89	.64	—.08	0
Gold Nugget	.35	0	.38	.38	.14
Century Dent	.80	.80	—.72	.72	.28
Beardsley's Leaming	.95	.38	.50	.20	.50
Ave. Flints	.50	.65	.55	.10	.05
Ave. Dents	.89	.63	.17	.52	.38
Average	.71	.64	.27	.27	.19

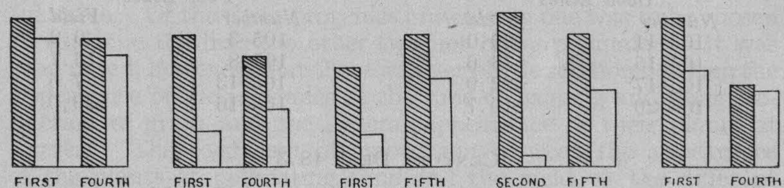


Figure 58. Diagram representing the average of the upper and lower groups in the first generations and the average of the same lines in the last generations, based on the data in Table IX.

between the first or second inbred generation and the fourth or fifth for height of plant, per cent. moldy ears, number of tillers, per cent smutted plants, and yield of grain. The fifth generation, grown in 1923, was so variable on account of the extremely dry season affecting different parts of the field unevenly that the coefficients for height and yield are based on the first and fourth generations. There was very little smut infection in the first

generation and practically no mold in the fifth so that the coefficient for per cent. smut is based upon the second and fifth generations and for per cent. mold upon the first and fourth.

The figures show a fairly high association for height of plant and moldy ears. This means that by selecting the highest lines in the first generation the resulting inbred strains in the fourth generation would tend to be taller than the average. Similarly, by selecting lines at the start that were free from mold, inbred strains could

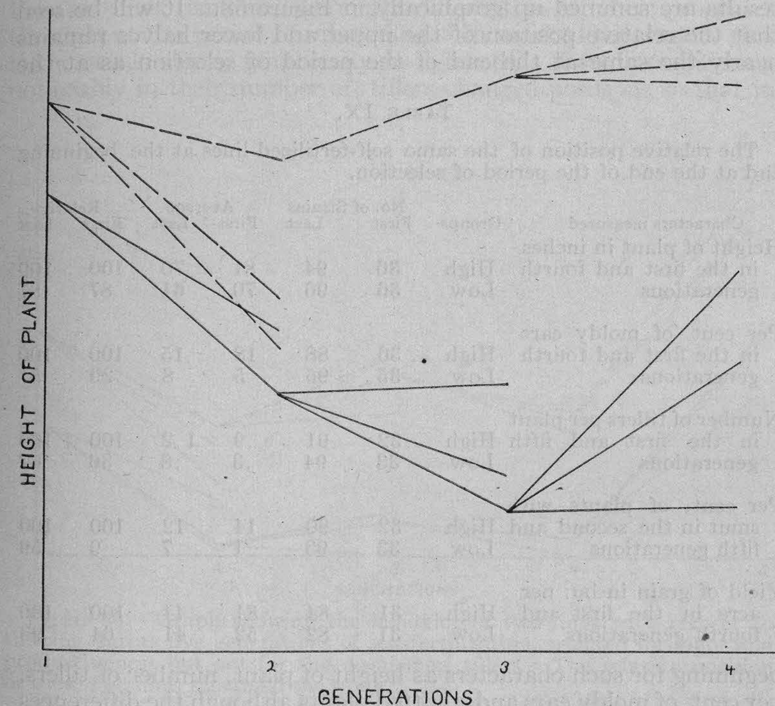


Figure 59. Graph showing the behavior of two lines with respect to height during four generations of self-fertilization, selected for vigor and productiveness but not for height. From one to three progenies are grown in each generation.

finally be attained that would on the average be freer from moldy ears than other strains which showed more mold at the start. This relation does not hold so well for the other characters; number of tillers and per cent. smut. For these the coefficients are low and in two of the varieties a negative correlation is shown. This means that lines without tillers and showing low smut infection may be obtained from plants at the start which have tillers and are susceptible to smut infection.

Another method of bringing out the relation between the several lines at the start and at the end of the selection period is to separate all the lines of each variety into the upper and lower halves, with respect to the characters studied, in the first generation and then compare the average of these two groups with the averages of the same lines after being inbred for four or five generations. This has been done in Table IX, making the separation within each variety into equal sized groups in the first generation. Thus the basis for separating the groups is the median instead of the mean. The results are summed up graphically in Figure 58. It will be seen that the relative position of the upper and lower halves remains nearly the same at the end of the period of selection as at the

TABLE IX.

The relative position of the same self-fertilized lines at the beginning and at the end of the period of selection.

Characters measured	Groups	No. of Strains First	No. of Strains Last	Average First	Average Last	Relative First	Relative Last
Height of plant in inches in the first and fourth generations	High	36	94	81	70	100	100
	Low	36	96	70	61	87	87
Per cent. of moldy ears in the first and fourth generations	High	36	88	18	15	100	100
	Low	35	95	5	8	29	57
Number of tillers per plant in the first and fifth generations	High	32	91	.9	1.2	100	100
	Low	33	94	.3	.8	36	67
Per cent. of plants with smut in the second and fifth generations	High	32	90	14	12	100	100
	Low	33	93	1	7	9	59
Yield of grain in bu. per acre in the first and fourth generations	High	31	84	81	44	100	100
	Low	31	82	52	41	64	93

beginning for such characters as height of plant, number of tillers, per cent. of moldy ears and smutted plants although the differences are generally less at the close than at the start. This tendency to change during the period of inbreeding is most marked for yield of grain. In this respect the high and low groups are very nearly alike at the end of the selection period in spite of the fact that all along attention has been given to productiveness. These results indicate that it is unwise to eliminate the unproductive strains in the first generations, as from them lines may be obtained that are as productive as those from high yielders at the start. Other characters can apparently be somewhat more surely selected for at the beginning of the inbreeding period. If such characters as freedom from mold and smut are of chief importance it might be advisable to eliminate those lines which show much mold and smut in the first inbred generations.

The general tendency for some of the lines to hold the same relative position throughout the process of selection is illustrated by the height of plant of two lines shown graphically in figure 59. In the first inbred generation the two lines averaged 69 and 77 inches in height. In the second generation two progenies overlapped but from then on they were clearly distinct, the difference in height increasing until the end of the selection period. The same result is shown in the average number of tillers per plant of two other lines as brought out in figure 60. Differing at the start the two lines remained distinctly different in all their progenies throughout the period of inbreeding. In marked contrast to this is the result shown graphically in figure 61. Two lines differing noticeably in their number of tillers changed positions so that in

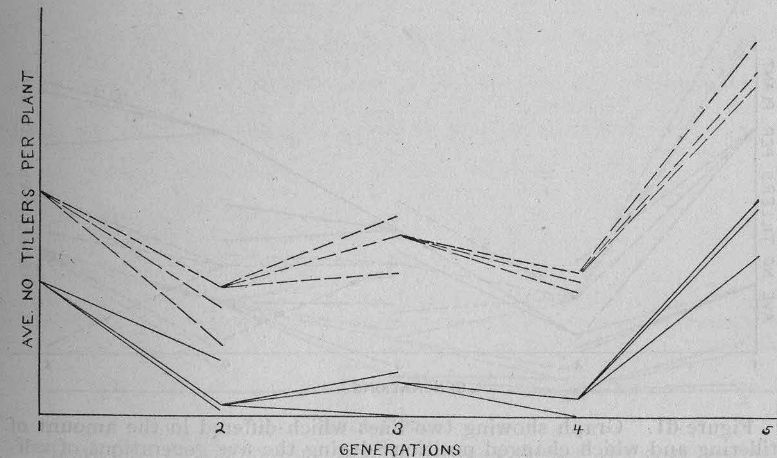


Figure 60. Graph showing the behavior of two lines with respect to tillering during five generations of self-fertilization, selected for vigor and productiveness but not for the number of tillers. The relative position of these two lines remained the same.

the end the few tiller strain at the start averaged more tillers on all progenies than did the many tiller strain. Similarly two strains which were alike in this respect at the start became extremely different as uniformity and constancy was reached, as shown in figure 62.

LIMITING FACTORS.

In planning and carrying out a selection program the best procedure will depend upon the number of plants which can be grown and the number of hand pollinations which can be made in a season. Where the facilities available for artificial pollination is the limiting factor, and this is usually the case, the best procedure is to self-pollinate just enough plants to continue as many lines as possible until a reasonable degree of homozygosity is reached. If the amount of land available to grow the plants is the limiting factor it would be better to pollinate a larger number of plants within each line, although extensive selection within a progeny has been shown to have little value, as the better individuals are almost certain to be more heterozygous, making it difficult to arrive at their true value. More attention should be paid to increasing the number of progenies within the more desirable appearing lines, basing selection on their behavior throughout the season and their uniformity and productiveness at maturity.

The method now being used at this station is to grow three progenies in each line and to pollinate two plants in each progeny. On the basis of the general appearance of the plants in the field and

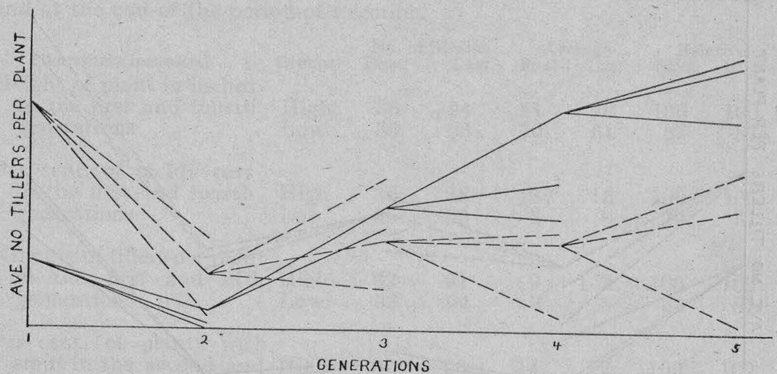


Figure 61. Graph showing two lines which differed in the amount of tillering and which changed positions during the five generations of self-fertilization.

their productiveness at maturity the best and second best progenies are noted where there is an appreciable difference. Two ears from the best progeny and one from the second best are used for planting the following year. If no differences are shown, one ear from each of the three is planted. This procedure is based upon the results in the five-year selection experiment described above in which no reliable criterions of selection were found which could be used before the time of pollination. It is still provisional and will be modified as future experience justifies. It is possible that better results can be obtained by paying still less attention to selection during the reduction period than the method outlined. By expending the same amount of time and effort on more lines, growing only one progeny in each generation and pollinating only enough plants to insure the perpetuation of the strain until uniformity and constancy are reached, more diverse material would be available

from which to select the best inbred strains. In this procedure there would be the possibility, and even probability, of missing altogether valuable material which might exist in some lines. However, since it has been shown that many of the lines change greatly during the reduction process, selection during this period will always be somewhat ineffective. From a theoretical standpoint the best method is the one which will produce the largest number of fixed strains from which to choose the ones best suited to the purpose for which they are to be used.

In this connection one further point should be mentioned. Whenever any particularly outstandingly good strain has been obtained there is the possibility that still better material may exist in that strain in the earlier generations. This would indicate that it

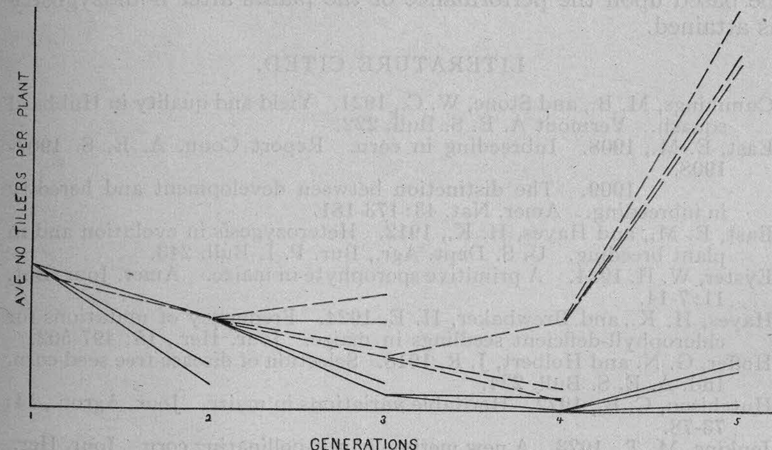


Figure 62. Graph showing two lines which showed the same amount of tillering at the start but differed widely at the end.

might be well worth while to go back to the earlier generations and grow as much of this material as possible from the remaining seed in order to obtain the very best germplasm available in this strain. In fact, this procedure has already been followed with several of the more promising lines and it has been possible to isolate new strains which are distinctly superior in some respects to the old ones.

Conclusion.

The one fact that stands out from the results secured in this selection experiment is that there is no single criterion by which high-yielding strains can be obtained. During the process of inbreeding, with the resulting segregation and recombination and the automatic elimination of heterozygous combinations of factors, selection for particular characters is somewhat effective. By choosing tall plants as progenitors in each generation tall strains can be produced. By selecting plants free from tillers, strains with few tillers can be obtained. Similarly, freedom from disease infection, as far as resistance is inherited, can be expected by selecting during the reduction period only those plants which show no infection in fields where infection is present. Even with these characters the association is far from complete. But productiveness, yield of grain, which sums up the plant's entire energies shows no such simple relation. High yielding strains may come, and have come, from plants which are poor producers. Promising strains during the first generations may be very unproductive or undesirable in some respect when finally reduced to uniformity and constancy. This emphasizes the fact that effective selection must be based upon the performance of the plants after homozygosity is attained.

LITERATURE CITED.

Cummings, M. B., and Stone, W. C., 1921. Yield and quality in Hubbard squash. Vermont A. E. S. Bull. 222.

East, E. M., 1908. Inbreeding in corn. Report Conn. A. E. S. 1907-1908.

1909. The distinction between development and heredity in inbreeding. Amer. Nat. 43: 173-181.

East, E. M., and Hayes, H. K., 1912. Heterozygosis in evolution and in plant breeding. U. S. Dept. Agr., Bur. P. I. Bull. 243.

Eyster, W. H. 1924. A primitive sporophyte in maize. Amer. Jour. Bot. 11: 7-14.

Hayes, H. K., and Brewbaker, H. E. 1924. Frequency of mutations for chlorophyll-deficient seedlings in maize. Jour. Her., 15: 497-502.

Hoffer, G. N. and Holbert, J. R. 1918. Selection of disease-free seed corn. Ind. A. E. S. Bull. 224.

Hutchison, C. B., 1922. Heritable variations in maize. Jour. Agron., 14: 73-78.

Jenkins, M. T., 1923. A new method of self-pollinating corn. Jour. Her., 14: 41-44.

Jones, D. F. 1918. The effects of inbreeding and crossbreeding upon development. Conn. A. E. S. Bull. 207.

1920. Heritable characters of maize, IV. A lethal factor-defective seeds. Jour. Her. 11: 160-167.

1921. The indeterminate growth factor in tobacco and its effect upon development. Genetics, 6: 433-444.

1924. The attainment of homozygosity in inbred strains of maize. Genetics, 9: 405-418.

Kiesselbach, T. A., 1922. Corn investigations. Neb. A. E. S. Res. Bull. 20.

King, H. D., 1918. Studies on inbreeding, I-III. Jour. Exper. Zool. 26.

Lindstrom, E. W., 1920. Chlorophyll factors of maize. Jour. Her. 11: 269-277.

1923. Heritable characters of maize XIII. Endosperm defects: sweet defective and flint defective. Jour. Her., 14: 127-135.

Mangelsdorf, P. C., 1923. The inheritance of defective seeds in maize. Jour. Her., 14: 119-125.

BULLETIN 267 MARCH, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

The Twenty-ninth Report on Food Products and the Seventeenth Report on Drug Products For 1924

By

E. M. BAILEY

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

March, 1925

The Wilson H. Lee Co.

CONTENTS AND SUMMARY.

Materials	Page	Sampled by, or at request of: Station Agent	Dairy and Food Commissioner	Individuals	Total	Adulterated, below standard, or otherwise illegal
FOODS.						
Carbonated Beverages	425	...	172	...	172	3
Cereal Products	426	3	1	...	4	1
Cacao Products; Cocoa, etc	426	37	1	3	41	...
Diabetic, Special and Miscellaneous Foods	429	44	...	38	82	...
Eggs	438	...	12	...	12	8
Fats and Oils:						
Butter	438	...	30	1	31	14
Olive Oil	439	...	4	2	6	2
Flavoring Extract, Vanilla	439	27	1	...	28	3
Flour, Graham, etc	442	7	5	3	15	1
Gelatin	446	...	...	2	2	...
Ice Cream	446	...	269	3	272	3
Meat Products:						
Hamburg Steak	447	...	62	...	62	22
Frankfurts	448	...	34	...	34	...
Casings	448	...	2	...	2	15
Pork Sausage	449	...	15	...	15	...
Milk and Milk Products:						
Market Milk	449	...	730	168	898	241[1]
Evaporated Milk, etc	450	1	6	2	9	...
Chocolate Milk	452	...	...	1	1	...
Cream	452	...	4	...	4	...
Buttermilk	452	5	...	...	5	...
Human Milk	453	...	...	19	19	...
Spices:						
Ground Nutmeg	454	8	...	...	8	...
Sage	454	9	...	...	9	...
Syrups:						
Maple Syrup	455	...	6	1	7	1
Molasses	456	...	20	...	20	5
Honey	456	...	1	...	1	...
Tea	456	12	...	...	12	...
Vinegar	460	...	39	26	65	4
Miscellaneous; Examined for Poisons etc	460	...	8	34	42	...
Total	...	**153**	**1422**	**303**	**1878**	**323**

[1] Official samples; includes 192 below standard only.

Materials	Page	Sampled by, or at request of: Station Agent	Dairy and Food Commissioner	Individuals	Total	Adulterated, below standard, or otherwise illegal.
DRUGS.						
Tablets, Pills, etc.	462	1	91	...	92	6
Prescriptions	482	...	8	...	8	2
U. S. P. and N. F. Drugs	483	1	24	...	25	4
Toilet Preparations	485	...	17	1	18	2
Proprietary Remedies, etc.	486	10	...	...	10	3
Miscellaneous	490	...	...	14	14	...
Total	...	**12**	**140**	**15**	**167**	**17**
Total, Foods and Drugs	...	**165**	**1562**	**318**	**2045**	**340**
Babcock Glassware, etc.	492	...	...	...	3748	69

The Twenty-ninth Report on Food Products and the Seventeenth on Drug Products

E. M. Bailey

An amendment to the food and drug law of this State made about ten years ago brings medicaments dispensed by physicians within the scope of drug control. Such medicaments are very largely in powder, tablet, or pill form and the chief feature of drug inspection during the past year has been a study of the variations in medicaments in pills and tablets as dispensed by physicians. A number of prescriptions and proprietary remedies have also been examined. A shortage in the supply of vanilla beans and the prevailing high prices of the raw material suggested a study of commercial vanilla extracts, and complete analyses of the principal brands found on sale have been made. Cocoa, graham flour, spices, so-called diabetic foods, and miscellaneous natural foods are other food items of interest.

The total number of samples is somewhat less than the average for a number of years past, due to the smaller number of milk samples submitted by the Dairy and Food Commissioner, but the amount of work involved has been greater on account of the difficult and time-consuming analyses of medicinal preparations and the detailed analyses of certain food products. Considerable time has been spent in studies of methods of analysis, chiefly in collaboration with the Association of Official Agricultural Chemists; and cooperation with the Council on Pharmacy and Chemistry of the American Medical Association has been continued.

Credit for the analytical work herein reported is due entirely to Messrs. Andrew, Shepard, Fisher, Nolan and Mathis. Miss Bacon has assisted materially in preparing this and other reports for publication.

I. FOODS.

Carbonated Beverages.

The use of saccharin as a sweetening agent in soft drinks is illegal in this State. One hundred and seventy-two samples were submitted by the Dairy and Food Commissioner and only three were found to contain saccharin. This is about 1.7 per cent. of the total number as compared with 40 per cent. in 1920 and 20 per cent. in 1921. Saccharin was found in about 16 per cent. of samples examined in 1923 but the adulterated samples represented the products of only five manufacturers.

The three samples containing saccharin were as follows:

No.	Brand.	City or Town.	Manufacturer.
28162	Cream Soda	*Bridgeport*	Central New York Bottling Works.
28402	Strawberry Soda	*Danielson*	Danielson Bottling Works.
27870	Cream Soda	*New Haven*	Hamilton Bottling Works.

Cereal Products.

434 *Edgemont Crackers.* The Greer and Green Co., Dayton, Ohio.

437 *Triscuit.* The Shredded Wheat Co., Niagara Falls, N. Y.

438 *Muffits.* Muffits Corporation, Batavia, N. Y.

Analysis of these products are as follows:

No.	434	437	438
	%	%	%
Moisture	5.86	8.91	9.55
Ash	2.88	1.68	1.70
Protein (N. x 6.25)	10.00	11.47	11.97
Fiber	0.58	2.23	2.47
Nitrogen-free extract:			
Starch	59.20	56.69	52.45
Soluble carbohydrate	3.23	4.73	7.58
Undetermined	7.24	12.36	12.59
Fat	11.01	1.93	1.69

A sample of whole grain wheat, **27900** was submitted by the Dairy and Food Commissioner and an analysis already made and published[1] was reported.

Cocoa, Etc.

Cocoa is chocolate from which a portion of the fat has been removed, and, on a moisture and fat-free basis, should contain not more than 8 per cent. of ash, not more than 0.4 per cent. of ash insoluble in acid and not more than 7 per cent. of crude fiber. The term "breakfast cocoa" designates cocoa containing not less than 22 per cent. of fat. Cocoas are sometimes treated by a special process of alkalizing which darkens the color, develops a characteristic flavor and produces a product which remains in suspension longer when prepared for drinking. These are the so-called Dutch or Dutch process cocoas; they are sometimes, but erroneously, called "soluble" cocoas.

Of the plain cocoas, i. e., non-alkalized and unsweetened, given in Table I, all are substantially within the limits of the standard when calculated to moisture and fat-free basis; no fiber content is greater than 7 per cent. and no insoluble ash exceeds 0.4 per cent., excepting **20413** which slightly exceeds that limit. One total ash exceeds 8 per cent. by an insignificant amount, 0.03 per cent.

Three of the four cocoas designated as "breakfast cocoa" contained over 22 per cent. of fat.

Alkali treated or Dutch process cocoas are labeled to show that the mineral constituents are increased by from 1 to 3 per cent. The ash in such products is likely to exceed 8 per cent. and did exceed that figure in all cases, except **21706**, as shown in the tabulation. The range in ash content on the moisture- and-fat-free basis for the products examined is 7.63 to 12.25 per cent.

In addition to the samples listed in the table, two others were examined which require no particular comment.

[1] Conn. Exp. Sta., Bull. 210, p. 204 (1918).

Table I. Analyses of Cocoa, Etc.

Sta. No.	Manufacturer and Brand	Water	Ash	Ash insol. in acid	Nitrogen	Crude fiber	Fat
		%	%	%	%	%	%
20424	Walter Baker & Co., Ltd., Dorchester, Mass., *Baker's Breakfast*	5.35	5.07	0.09	3.59	3.82	26.33
21698	Conn. Butter Co., Hartford, *Reliable Breakfast*	5.37	5.10	0.02	3.80	4.40	23.75
21687	The Massachusetts Chocolate Co., Boston, *Wan-Eta Breakfast*	7.13	4.85	0.19	3.62	4.78	22.82
21648	Northern Pacific Grocery Co., Bridgeport, *Perfection Breakfast*	5.94	5.68	0.16	3.61	4.93	20.61
21704	Boston Butter House, Waterbury, *Boston Butter House*	5.09	4.92	0.03	3.70	4.50	22.58
21642	Brewster Son's Co., Newark, N. J., *L. B. C.*	5.48	5.70	0.20	3.62	3.32	20.78
21683	Direct Importing Co., Boston, *Benefit*	4.76	4.94	0.15	3.80	4.55	22.93
20419	Grand Union Tea Co., Brooklyn, N. Y., *Grand Union*	5.02	5.52	0.14	3.79	4.50	21.22
21656	The Great A. & P. Tea Co., N. Y., *A. & P.*	5.03	5.49	0.11	3.71	4.83	21.81
20410	The Great A. & P. Tea Co., N. Y., *Red Front*	5.68	5.23	0.08	3.72	4.78	21.33
20416	Hershey Chocolate Co., Hershey, Pa., *Hershey's*	5.80	4.90	0.02	3.70	4.11	23.88
21644	Howland Dry Goods Co., Bridgeport, *Crown*	4.78	5.10	0.01	3.84	4.72	27.75
21646	Huyler's, N. Y., *Huyler's*	5.73	5.25	0.16	3.74	4.34	24.18
20418	International Sugar Corp., *Cuba*, Pure Cocoa	5.80	3.32	0.13	3.67	4.58	22.18
21625	A. E. Lamb, New Haven, *Lamb's Quality*	4.95	5.25	0.04	3.80	4.58	23.47
20413	F. L. McClellan, East Hartford, *My Own*	7.87	5.70	0.36	3.37	5.05	20.07
21632	The Mohican Co., N. Y., *Mohican*	6.08	5.08	0.21	3.55	4.55	22.57
21673	Page & Shaw, N. Y., *Natural Cocoa*	5.48	5.30	0.10	3.66	4.60	24.61
21675	Park & Tilford, N. Y., *Park & Tilford*	4.98	5.65	0.07	3.91	5.01	19.09
21617	John A. Pilgard Co., Hartford, *Sterling*	5.13	5.10	0.01	3.94	4.47	22.54
21652	Royal Cocoa Co., Jersey City, N. J., *Economy*	6.98	5.72	0.19	3.55	4.77	23.07
21655	Runkel's N. Y., *Runkel's*	6.55	4.94	0.07	3.59	4.67	22.50
21627	The Stollwerck Chocolate Co., Stamford, *Gold Brand Milk Cocoa*	6.56	5.60	0.15	3.78	2.81	22.46
21709	James Van Dyke Co., N. Y., *Ambassador*	6.51	4.75	0.10	3.56	4.65	21.75

TABLE I. ANALYSES OF COCOA, ETC.—*Concluded.*

Sta. No.	Manufacturer and Brand	Water	Ash	Ash insol. in acid	Nitrogen	Crude fiber	Fat
		%	%	%	%	%	%
21688	Stephen F. Whitman & Son, Inc., Philadelphia, *Instantaneous Sweet Chocolate*	1.83	1.57	0.08	1.12	1.41	21.99
21686	The Williams & Carleton Co., Hartford, *William's* Cocoa	7.39	4.79	0.08	3.48	4.51	20.40
21622	Stephen L. Bartlett Co., Boston, *Havsome* [1], Sweetened Skim Milk Cocoa	3.67	3.70	0.00	2.09	0.84	6.90
21712	Stephen L. Bartlett Co., Boston, *Hollandia* [1] Cocoa and Chocolate Sweetened	3.04	3.19	0.02	1.68	1.96	8.02
20417	Beacon Chocolate Co., Boston, *Ace High* [1]	6.64	6.38	0.12	3.59	4.73	20.88
21670	Bensdorp's Amsterdam Holland, *Royal Dutch* [1]	5.86	6.83	0.08	3.35	4.26	29.04
21711	Droste's Cocoa Works, Haarlem, Holland, *Droste's* [1]	6.11	7.81	0.04	3.30	3.78	23.65
21680	Thomas J. Lipton, Inc., *Lipton's Instant Cocoa* [1]	5.29	5.76	0.12	3.60	4.68	23.79
21659	Royal Cocoa Co., New York, *Royal* [1]	6.63	6.47	0.09	3.57	4.81	22.65
21690	C. J. Van Houton, Holland, *Van Houten's* Cocoa [1]	6.52	8.25	0.06	3.42	4.60	26.16
21630	H. O. Wilbur & Sons, Inc., Philadelphia, *Wilbur-Dutch* [1]	7.67	5.92	0.05	3.79	4.02	20.51
21706	H. O. Wilbur & Sons., Inc., Philadelphia, *Wilbur-Dutch* [1]	8.53	5.58	0.09	3.51	3.95	18.35
	Cocoa Shells.						
436	Walter Baker & Co., Ltd., Dorchester, Mass [2]	9.43	7.76	2.57	2.81	14.83	3.04
	Sampled by Individuals.						
22896	Saville Chocolate Products Co., Pittsburgh, Pa., *Cho-Lay*	1.26	1.35	....	0.87	0.54	5.97
22233	Maltop Company, Buffalo, N. Y., *Chocolate Toddy*	3.32	2.86	....	2.00	0.76	5.73

[1] Dutch process.
[2] Starch 2.59, soluble carbohydrate 2.57

DIABETIC, SPECIAL AND MISCELLANEOUS FOODS.

In Table II are given analyses of diabetic, special and miscellaneous foods, eighty-two in number, which have been submitted by physicians, dietitians, patients, or others interested.

The conventional analysis of food shows the composition of the material in terms of several constituent groups, viz., moisture, ash, protein, fat and carbohydrate. Thus, ash represents the mineral elements, protein the nitrogenous materials, fat the true fats or oils and other substances removed by ether, and carbohydrate the starch, sugar and other nitrogen-free substances.

Protein is estimated from total nitrogen, generally by multiplying the nitrogen found by 6.25 on the assumption that protein contains 16 per cent. of nitrogen. But all proteins do not contain this exact amount and, in some cases, other factors are more accurate, e. g. 6.38 for casein protein and 5.7 for gluten. The kind of protein is not established nor is account taken of the fact that all of the nitrogen may not be in protein combination. Fats and oils are extracted by ether, and mineral oil, which is indigestible and which is used to a considerable extent in the manufacture of low-calorie products, will also be included in the ether extract. Crude fiber belongs to the carbohydrate group but it is not reckoned as an available nutrient in human digestion. The remainder of the carbohydrate group is not determined directly but calculated by subtracting from 100 per cent. the sum of all the other groups which have been determined.

As to how much of this carbohydrate group is available in digestion, that portion which is composed of starch, sugars and dextrin is digestible and can be determined by approved methods. In the table of analyses this portion is represented by the items "starch" and "soluble carbohydrate as dextrose". The remaining portion consists of hemicelluloses, gums, mucilages, etc., the availability of which must be regarded as neglible or doubtful.

There is an increasing use of materials of low nutritive value for the preparation of foods intended for low calorie diets. Cellu flour and cellulose flour from corn cobs are materials of this type which have been cited in previous reports of this Station[1]. Ecmo flour, Lister's Low Calorie Flour, and Nutrivoid Flour are new materials of this class which have been examined this year. These products contain but little nitrogen and fat and inconsiderable amounts of available carbohydrate. Cellu flour and the cellulose preparation from corn-cob showed about 60 per cent. of crude fiber while the analyses of the products examined this year show that the fiber content is low and that by far the greater part of the carbohydrate belongs to the undetermined nitrogen-free extract.

The French products distributed by the Hygienic Food Co.,

[1] Conn. Exp. Station. Bull. 227, p. 230; Bull. 255, pp. 172, 174.

excepting one preparation, **917** show from 40 to 80 per cent. of available carbohydrate.

Nut Flakes, **125**, is a product made from the same material of which Ecmo flour is made.

The starch content of Gluten Flakes **22216, 22278,** and **643** has been reduced to about 5 per cent. or less. Hoyt's Special Gluten Flakes and Protein Cereal contain 75 to 80 per cent. of protein with available carbohydrate of from 3 to 6 per cent.

Lister's Starch-free Bran, **22787,** shows more starch than this product generally contains and the second sample, **200**, supports the contention of the manufacturers on this point. Although the amount of starch present is of little practical significance, the manufacturers have voluntarily revised the label of the product to conform more closely to the facts as shown by analysis.

Diabetic Cereal **543**, Krinkles **21580**, and Malted Bran **22397,** are all satisfactorily low in carbohydrate.

Chocolate confections **919** and **920** contain about 30 per cent. of starch and sugar and should be eaten sparingly by the diabetic.

The canned fruits and vegetables examined are products prepared without sugar. Analyses represent the edible solids and liquor combined.

The miscellaneous products, excepting sardines packed in mineral oil, **675,** are normal foods examined as a matter of general dietetic interest.

The single analysis of green olives represents a composite of ten commercial samples and the analysis of ripe olives represents a composite of eight samples. The individual samples, particularly ripe olives, were examined for indications of spoilage, but none were detected.

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS.

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
		%	%	%	%	%	%	%	%	%	%
	Flours, Meals, etc.										
21581	*Curdolac Food Co., Waukeska, Wis.* Curdolac Flour	4.98	7.78	6.58	41.13	....	6.53	0.84	3.76	22.54	12.44
22619	*Jireh Diabetic Food Co., Morris Plains, N. J.* Soycasein Flour	9.16	5.81	12.13	75.81	....	0.30	none	1.36	4.58	2.98
179	*Vitae Health Food Co., Seattle, Wash.* Soya Manna	8.88	4.35	6.58	41.13	....	1.50	none	10.68	14.45	19.01
124	*Efficiency Products Co., Somerville, N. J.* Ecmo (Cellulose) Flour	9.05	1.00	0.66	4.13	....	4.75	none	3.44	77.00	0.63
22788	*Lister Bros., Inc., New York City.* Lister's Low Calorie Flour	7.55	6.10	0.63	3.94	....	5.24	none	1.76	74.84	0.57
22779	*Nutrivoid Diabetic Flour Co., Brooklyn, N. Y.* Nutrivoid Flour	8.23	1.17	0.69	4.31	....	7.18	none	6.08	72.11	0.92
22486	*The Battle Creek Food Co., Battle Creek, Mich.* Cooked Bran	4.15	7.46	2.45	15.31	....	9.19		59.20		4.69

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Bakery Products, etc.	%	%	%	%	%	%	%	%	%	%
	H & R Diabetic Foods, Bronx, N. Y.										
22947	Bread of Low Food Value	24.80	3.43	1.51	9.45	....	9.37	0.99	0.75	27.92	23.29
22946	Bran Biscuit	11.47	4.04	1.06	6.62	....	6.26	1.24	0.92	56.95	12.50
905	Bran Biscuits, Spiced and Sweetened	4.80	3.81	1.22	7.63	....	7.60	1.52	0.68	55.57	18.39
904	Cellu Lemon Cookies	4.33	2.63	1.25	7.81	....	8.65	1.94	2.04	45.12	27.48
	Laboratoire E. Storage, Marseilles, France. (Hygienic Food Co., New York, Distributors)										
916	Madeleines Lucullus	5.20	1.13	1.40	8.75	....	0.38	31.58	15.32	14.21	23.43
917	Vichy Gaufrettes	3.35	2.37	2.36	14.75	....	2.33	7.54	5.84	12.89	50.93
918	Gaufrettes Vanillees	7.63	0.80	1.40	8.75	....	0.30	81.30		....	1.22
920	Nougatines de Vichy	2.15	2.23	1.60	10.00	....	1.20	3.60	37.40	15.07	28.35
	Therapeutic Foods Co. Inc., New York City.										
118	Aleurone Bread	9.89	3.16	10.88	....	62.02	0.27	13.42	2.03	7.54	1.67
119	Bread of Gluten	9.03	3.80	12.56	....	71.59	0.07	5.89	0.40	7.73	1.49
120	Special Diabetic Bread	9.44	2.86	11.06	....	63.04	0.14	14.05	0.96	8.43	1.08
123	Brusson Jeune Gluten Bread	10.01	0.72	6.89	....	39.27	0.14	9.00	3.83	36.04	0.99

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Breakfast Foods, etc.	%	%	%	%	%	%	%	%	%	%
	Efficiency Products Co., Somerville, N. J.										
125	Nut Flakes	9.56	1.04	0.70	4.38	....	5.61	none	2.78	75.59	1.04
	The Pure Gluten Food Co., New York City.										
22216	Gluten Flakes	....	....	7.52	....	42.86	....	....	....	....	....
22778	Gluten Flakes	5.94	3.78	7.77	....	44.29	5.93	2.87	9.96	22.05	5.18
643	Gluten Flakes	7.45	4.14	7.14	....	40.70	4.73	4.73	11.84	24.18	2.23
931	Hoyt's Protein Cereal	5.95	0.98	13.93	....	79.40	0.38	2.05	0.80	8.89	1.55
126	Hoyt's Special Gluten Flakes	8.64	1.01	13.00	....	74.10	0.31	5.24	0.67	8.09	1.94
	Gerda H. Wagner, Brooklyn, N. Y.										
543	Diabetic Cereal	7.45	4.47	1.61	10.06	....	13.28	....	1.35	58.82	4.57
	Lister Bros. Inc., New York City.										
200	Lister's Starch-free Bran	8.16	4.30	2.62	16.38	....	21.14	0.87	0.76	44.37	4.02
22787	Lister's Starch-free Bran	5.65	5.72	2.80	17.50	....	18.88	2.87	2.86	40.97	5.55
	Curdolac Food Co., Waukesha, Wis.										
21580	Krinkles	8.52	4.40	1.73	10.81	....	11.53	0.87	3.90	45.53	14.44

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Breakfast Foods, etc.—Continued.	%	%	%	%	%	%	%	%	%	%
	The Spa, Waukesha, Wis.										
22397	Malted Bran	3.24	2.94	1.56	9.75	....	17.91	1.13	0.88	58.60	5.55
	H & R Diabetic Foods, Bronx, N. Y.										
903	Cellu Cocoa Nibs	3.80	2.79	1.32	8.25	....	8.00	2.11	2.12	42.83	30.10
	Confections, etc.										
	Fritz, Vienna										
22237	Plain Chocolate Bars and Cakes	3.22	2.90	2.41	15.06	....	1.77	4.61	2.36	15.28	54.80
22238	Nut Chocolate	3.39	2.96	3.07	19.19	....	2.17	3.26	1.64	12.99	54.40
22239	Ferment-Scho-Kolade	1.08	1.21	1.00	6.25	....	0.83	2.98	23.76	15.11	48.78
22240	Saccharin-Schokolade	3.46	3.42	2.77	17.31	....	2.45	5.74	6.96	17.98	42.68
22241	Dr. Fromm's Conglutin Schokolade	3.87	7.11	2.91	18.19	....	0.93	3.83	15.58	13.81	36.68
22227	Cakes with Chocolate Icing	4.92	2.25	3.99	24.94	....	1.55	4.28	21.30	9.49	31.27
22242	Peppermint Menthol Bonbons	10.04	1.76	0.32	....	....	....	trace	1.52	(1)	....
	Laboratoire E. Storage, Marseilles, France. (Hygienic Food Co., New York, Distributors)										
919	Pastilles de Chocolat	4.50	4.75	3.36	21.00	....	1.20	3.54	27.16	11.95	25.90
921	Croquettes de Chocolat Sucre	4.88	4.90	3.53	22.06	....	1.28	6.44	23.44	10.55	26.45

[1] Gums present.

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar, as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Confections, etc.—Continued.	%	%	%	%	%	%	%	%	%	%
	The Genesee Pure Food Co., N. Y.										
22629	D-Zerta	25.40 [1]	1.68	13.12	....	72.82 [2]	....	0.00	0.00 [3]	....	0.10
	Fruits and Vegetables. (Canned).										
	John Sexton & Co., Chicago, Ill.										
22427	Edelweiss Apricots	90.50	0.46	....	0.39	....	0.35	0.00	4.38	3.81	0.11
22428	Pride of the West Apricots	90.58	0.48	....	0.37	....	0.34	0.00	4.81	3.32	0.10
653	Alp Rose Blackberries	85.33	0.33	....	0.96	....	2.29	0.00	5.59	4.84	0.66
651	Alp Rose Blueberries	85.89	0.25	....	0.44	....	0.95	0.00	7.60	4.53	0.34
22431	Edelweiss Cherries	89.71	0.32	....	0.64	....	0.14	0.00	4.24	4.86	0.09
22432	Pride of the West Cherries	88.76	0.32	....	0.57	....	0.12	0.00	4.88	5.24	0.11
658	Alp Rose Royal Anne Cherries	86.18	0.36	....	0.63	....	0.15	0.00	7.58	5.05	0.05
650	Alp Rose Grapefruit	90.49	0.43	....	0.69	....	0.17	0.00	4.87	3.30	0.05
654	Alp Rose Logan Berries	85.43	0.34	....	1.04	....	1.82	0.00	5.60	5.09	0.68
22423	Edelweiss Peaches	91.73	0.31	....	0.37	....	0.26	0.00	4.04	3.24	0.05
22424	Pride of the West Peaches	91.72	0.31	....	0.38	....	0.24	0.00	4.76	2.55	0.04
656	Alp Rose Bartlett Pears	89.17	0.21	....	0.26	....	0.61	0.00	4.31	5.34	0.10
22425	Edelweiss Pears	90.35	0.23	....	0.24	....	0.56	0.00	3.70	4.82	0.10
22426	Pride of the West Pears	90.52	0.20	....	0.24	....	0.63	0.00	3.60	4.72	0.09
655	Alp Rose Pineapple, Hawaiian Sliced	85.81	0.35	....	0.36	....	0.27	0.00	8.49	4.61	0.11

[1] Includes undetermined organic acids.
[2] Calculated as gelatin, factor 5.55.
[3] Saccharin present.

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar as Dextrose	Nitrogen-free Extract: Other N-free Extract	Fat, Ether Extract
	Fruits and Vegetables. (Canned)—Cont'd.	%	%	%	%	%	%	%	%	%	%
	John Sexton & Co., Chicago, Ill.										
22429	Pride of the West Pineapple	86.17	0.30	....	0.38	....	0.28	0.00	9.65	3.17	0.05
657	Alp Rose Japan Plums	93.33	0.27	....	0.29	....	0.29	0.00	2.83	2.93	0.06
659	Alp Rose Prune Plums	88.63	0.33	....	0.33	....	0.21	0.00	6.92	3.50	0.08
22430	Pride of the West Prune Plums	88.88	0.30	....	0.39	....	0.21	0.00	4.83	5.27	0.12
652	Alp Rose Red Raspberries	89.02	0.31	....	0.67	....	1.69	0.00	4.81	3.00	0.50
648	Alp Rose Peeled White Asparagus	95.76	0.35	....	1.20	....	0.34	0.00	1.49	0.80	0.06
649	Alp Rose White Asparagus Tips	94.81	0.43	....	1.65	....	0.42	0.00	1.63	0.97	0.09
	The Poms Co., Sarasota, Fla.										
22433	Poms (Canned Grapefruit)	90.54	0.36	....	0.49	....	0.17	0.00	4.24	4.09	0.11
	Miscellaneous.										
	Bakery Products, etc.										
22893	Bread (Graham?)	40.00	....	....	8.89	....	....	....	....	....	1.19
22801	Rye Bread (Jewish)	4.57	2.90	2.17	13.56	....	0.31	63.56	7.42	6.28	1.40
22802	Heavy Dark Rye (Jewish)	4.19	3.84	1.99	12.44	....	1.00	57.77	6.36	12.73	1.67
22803	Medium Dark Rye (Jewish)	4.41	3.31	2.25	14.06	....	0.95	60.75	7.20	7.71	1.61
22800	Vienna Rolls (Jewish)	8.67	1.67	1.95	12.19	....	0.24	60.13	7.56	5.30	4.24
22799	Doughnuts (Jewish)	8.98	1.88	2.05	12.81	....	0.23	58.11	10.90	5.39	1.70
22894	Lister's Soup Powder	5.25	14.78	5.17	32.31	....	4.08	2.14	7.72	17.54	16.18

TABLE II. DIABETIC, SPECIAL AND MISCELLANEOUS FOODS—*Concluded*

No.	Manufacturer and Brand	Moisture	Ash	Nitrogen	Protein N x 6.25	Protein N x 5.7	Fiber	Nitrogen-free Extract: Starch	Nitrogen-free Extract: Sugar, as Dextrose	Nitrogen-free Extract: Other N-Free Extract	Fat, Ether Extract
	Miscellaneous.	%	%	%	%	%	%	%	%	%	%
	Dairy Products.										
22741	Jewish Cottage Cheese	59.36	2.00	4.37	27.88[1]	....	....	....	....	1.61	9.15
22742	Jewish Sour Cream	51.48	0.49	0.64	4.08[1]	....	....	....	1.46[2]	0.88	41.61
	Fish.										
22743	Herring	56.84	7.12	2.99	18.71	....	....	....	....	....	17.33
22744	Salmon	64.21	10.88	3.44	21.51	....	....	....	....	....	3.21
675	Sardines (Canned in mineral oil)	58.50	5.40	3.65	22.80	....	....	....	....	....	13.30[3]
682	Turtle Meat, canned	75.01	0.94	3.74	23.37	....	....	0.00	0.00	0.00	0.68
	Fruits and Vegetables.										
22895	Carob Beans	4.13	2.67	1.00	6.25	....	5.66	0.00	80.67		0.62
401	Olives, green, edible portion[4]	76.33	6.58[5]	0.21	1.29	....	1.13	0.00	0.20	2.33	12.14
455	Olives, ripe, edible portion[6]	75.04	2.72[7]	0.22	1.38	....	0.88	0.00	0.25	1.74	17.99
22225	Quince, fresh, ripe, edible portion	84.14	0.43	0.05	0.30	....	1.80	0.37	4.20	8.62	0.14
22226	Quince, fresh, green, edible portion	84.71	0.47	0.08	0.49	....	1.88	0.47	4.32	7.48	0.18

[1] Factor N x 6.38.
[2] Lactose.
[3] About 80% mineral oil.
[4] Composite of 10 samples.
[5] Salt (NaCl) 5.88.
[6] Composite of 8 samples.
[7] Salt (NaCl) 2.11

Eggs.

Twelve samples of eggs were submitted by the Dairy and Food Commissioner for examination. All were sold as "fresh" eggs with various further qualifying terms. Four samples, (**29454, 30239, 30241, 30242**) were passed as fresh or reasonably fresh, and eight (**29875, 27901, 27866, 27865, 30237, 30238, 30240, 30243**), were classed as not fresh but edible.

The samples which were evidently fresh, or which were passed, had air spaces generally less than 1 inch in diameter, yolks not appreciably settled in the shell and ammoniacal nitrogen ranging from 0.8 to 1.2 mgms. per 100 grams of egg. Those which were classed as not fresh but edible, had air spaces larger than 1 inch, yolks settled in the shell, whites watery, and ammoniacal nitrogen varying from 1.9 to 3.7 mgms. per 100 grams of egg. Some of these having relatively low ammonia contents had probably been held at low temperatures.

Fats and Oils.

BUTTER.

Thirty samples of butter were submitted by the Dairy and Food Commissioner and one by the City Department of Health of New Haven. Twenty-two samples were sweet butter, nine of which were adulterated with water, the amounts ranging from 17.2 to 33.6 per cent. Nine samples were salt butter, of which four were found to be renovated and one to contain 22.6 per cent. of water and only 74 per cent. of fat. The other samples were not found adulterated.

Most of the sweet butter found to contain excess water was sold to various dealers under the representation that it was packed for the Farmington Creamery, a concern which has not been in existence for a number of years.

The adulterated samples are listed below:

No.	Material		Dealer	Manufacturer	Remarks
29955	Sweet butter	*Bridgeport*	Oak Hill Dairy	Own make	Excess water
28406	" "	*Meriden*	L. Zietz	Farmington Creamery	" "
28407	" "		Tomcuzk Bros.	" "	" "
28405	" "		C. & S. Market	" "	" "
28404	" "		L. Kosienski	" "	" "
28403	" "		M. Kosopsky	" "	" "
28400	" "		A. Goldberg	" "	" "
28627	" "	*NewHaven*	A. Gold	Own make	" "
28620	" "		E. Schoenberger & Sons	Farmington Creamery	" "
29956	Salt butter	*Bridgeport*	Oak Hill Dairy	Own make?	" "
27016	" "		L. Mattis	....	Renovated
27017	" "		A. Krufssik	....	"
27018	" "		E. Bergin	....	"
27019	" "	*Fairfield*	L. Bergin	....	"

Olive Oil.

Four samples of olive oil were examined for the Dairy and Food Commissioner. Two were passed and two were adulterated with cottonseed oil.

Adulterated samples were as follows:

D.C. No.	Brand		Dealer
30229	Pure Olive Oil, Lucca.	*Hartford.*	International Importing Co.
28588	B. B. Brand, Lucca.	*Waterbury.*	Frank Pepe.

Two samples were submitted by purchaser or distributor. One, **678**, Gilbert Brand bottled in France for John Gilbert & Son, New Haven, was genuine olive oil, but unusual in that it responded to the Villavecchia test for sesame oil. The test applied to the fatty acids however was negative.

Vanilla Extract.

Flavoring extracts for food purposes are solutions in ethyl alcohol of sapid and odorous vegetable principles.

Vanilla extract is the flavoring extract prepared from vanilla bean, with or without sugar or glycerin, and contains in one hundred cubic centimeters the soluble matters from not less than ten grams of the vanilla bean.[1]

No numerical limits of composition are included in the standard and these must be ascertained from analyses of authentic preparations derived from the several types of vanilla beans.

Twenty-seven samples of vanilla extracts or imitation vanilla extracts were collected by the Station agent, and one was submitted by the Dairy and Food Commissioner. Detailed analyses of these are given in Table III.

Most of the samples examined were labeled as pure or were presumed to be pure from the fact that no declaration to the contrary was made. A number were clearly stated to be imitations. The products presumed to be pure were found, in general, to conform to the limits of composition of pure extracts as established by analyses of authentic samples.[2] Three, Puritan **471**, Royal Scarlet **476**, and Champion **483**, showed excessive ash and other abnormal values which indicate the use of alkali in the process of manufacture.[3] Morrow **486**, although it contained a normal amount of vanillin and no coumarin, did not otherwise show the characteristics of a genuine vanilla extract. Nilla, **30404**, was sold simply as a flavoring extract but the name suggests vanilla while the analysis does not. Its composition closely resembles that of other imitation vanilla. Virginia Dare, **470**, is barely 150% strength assuming the minimum vanillin content of authentic vanilla extract.

[1] Circ. 136.
[2] See Winton, Albright and Berry, Jour. Ind. Eng. Chem., **7**, 518, 1915.
[3] Dean and Schlotterbeck, Ibid. **8**, 703, 1916.

TABLE III. ANALYSES OF VANILLA EXTRACT, ETC.

No.	Brand and Manufacturer	Precipitation with lead acetate			Vanillin gm. per 100 cc	Coumarin gm. per 100 cc	Normal lead No.	Total solids, gms. per 100 cc.	Ash gms. per 100 cc			Alkalinity of ash, cc N/10 acid per 100 cc			Acidity, cc N/10 alkali per 100 cc			No.
		Amt. of ppt.	Color of ppt.	Color of fltr.					Total	Water-sol.	Water-insol.	Total	Water-sol.	Water-insol.	Of total extract	Due to vanillin	Other than vanillin	
474	The Great A. & P. Tea Co., Jersey City, N. J., *Red Front*	Large	Buff	Straw	0.16	None	0.68	14.96	0.35	0.28	0.07	41.0	25.0	16.0	38.0	10.4	27.6	474
488	Austin Nichols & Co., N. Y., *Sunbeam*	Large	Buff	Straw	0.16	None	0.54	18.88	0.31	0.25	0.05	39.0	29.0	10.0	34.0	10.3	23.7	488
497	Baker Extract Co., Springfield, Mass., *Baker's* Pure Extract of Vanilla	Large	Buff	Straw	0.20	None	0.71	15.43	0.36	0.27	0.09	43.0	28.0	15.0	40.0	13.0	27.0	497
471	Boyce Extract Co., N. Y., *Puritan*	Large	Buff	Straw	0.15	None	0.53	8.92	0.69	0.53	0.15	71.0	36.0	35.0	32.0	9.7	22.3	471
487	The Bridgeport Public Market, Bridgeport, *Monogram*	Large	Buff	Straw	0.18	None	0.70	16.84	0.35	0.24	0.11	45.0	26.0	19.0	41.5	11.6	29.9	487
479	Joseph Burnett Co., Boston, Mass., *Burnett's*	Large	Buff	Straw	0.21	None	0.53	9.63	0.31	0.23	0.08	42.7	24.7	18.0	42.0	14.0	28.0	479
490	James Butler, Inc., N. Y., *Essie*	Large	Buff	Straw	0.16	None	0.58	20.26	0.32	0.21	0.11	32.5	20.5	12.0	31.5	10.3	21.2	490
464	The Cloverdale Co., Boston, Mass., *Benefit*	Large	Buff	Straw	0.16	None	0.58	12.67	0.25	0.18	0.07	36.0	21.0	15.0	31.5	10.7	20.8	464
498	J. W. Colton Co., Springfield, Mass., *Colton's Vanilla*	Large	Buff	Straw	0.18	None	0.75	15.43	0.37	0.28	0.10	47.0	29.0	18.0	42.5	12.2	30.3	498
483	Davey Bros., Inc., Bridgeport, *Champion*	Large	Buff	Straw	0.12	None	0.47	8.63	0.67	0.53	0.14	74.0	41.5	32.5	29.0	8.2	20.8	483
492	Andrew Davey, Inc., N. Y., *Atlas*	Large	Buff	Straw	0.15	None	0.51	20.44	0.30	0.23	0.07	36.5	23.0	13.5	30.0	9.6	20.4	492
470	Garrett & Co., Brooklyn, N. Y., *Virginia Dare*, 150% *strength*	Large	Buff	Straw	0.16	None	0.48	15.83	0.29	0.23	0.05	33.5	23.5	10.0	36.0	10.4	25.6	470
485	Howland's, Bridgeport, *Howco*	Large	Buff	Straw	0.19	None	0.71	8.32	0.36	0.28	0.08	42.0	26.5	15.5	38.0	11.5	26.5	485
491	McCormick & Co., Baltimore, Md., *Bee*	Large	Buff	Straw	0.19	None	0.69	8.48	0.40	0.32	0.09	47.5	32.0	15.5	37.0	12.4	24.6	491
472	The Mohican Co., N. Y., *Mohican*	Large	Buff	Straw	0.19	None	0.60	15.66	0.30	0.24	0.06	40.5	27.5	13.0	40.0	12.5	27.5	472
486	Morrow & Company, *Morrow's*	Small	Brown	Straw	0.20	None	0.19	15.63	0.08	0.05	0.03	13.5	9.0	4.5	26.0	13.1	12.9	486
478	The C. E. Sauer Co., Richmond, Va., *Sauer's Pure Concentrated*	Large	Buff	Straw	0.24	None	0.60	20.55	0.30	0.22	0.08	40.5	27.5	13.0	41.5	15.5	26.0	478
480	Schlotterbeck & Foss Co., Portland, Me., *Foss Pure Extract*	Large	Buff	Straw	0.13	None	0.47	13.78	0.25	0.17	0.09	28.7	17.0	11.7	33.0	8.5	24.5	480
484	Seeman Bros., Inc., N. Y., *White Rose*	Large	Buff	Straw	0.12	None	0.60	20.64	0.41	0.29	0.12	42.0	27.5	14.5	40.0	8.1	31.9	484
499	James Van Dyke Co., N. Y., *Ambassador*	Large	Buff	Straw	0.11	None	0.70	15.71	0.41	0.33	0.08	47.5	31.5	16.0	27.5	5.4	22.1	499
476	R. C. Williams & Co., N. Y., *Royal Scarlet*	Large	Buff	Straw	0.14	None	0.51	8.94	0.67	0.51	0.16	67.5	34.0	33.5	32.0	9.4	22.6	476
481	The Williams & Carleton Co., Hartford, *Williams* Pure Extract	Large	Buff	Straw	0.11	None	0.54	13.75	0.36	0.29	0.07	20.0	9.5	10.5	30.0	7.0	23.0	481
468	The Diamond Seal Product Co., Inc., N. Y., *Concord*, Vanillin, Coumarin and Vanilla	Small	Dk. Brown	Dk. Brown	0.20	0.06	0.06	17.64	0.03	0.01	0.01	3.0	1.0	2.0	....	13.1	....	468
30404[1]	Flagg & Co., Hartford, "*Nilla*" Flavoring Extract	Medium	Dk. Brown	Brown	0.50	0.05	0.09	19.74	0.02	0.00	0.02	4.0	1.5	2.5	46.0	32.6	13.4	30404[1]
496	Grand Union Tea Co., Brooklyn, N. Y., *Vanilla and Tonka*	Medium	Dark	Straw	0.17	0.04	0.43	14.13	0.27	0.19	0.08	30.5	17.5	13.0	25.0	11.2	13.8	496
466	The Stuart Brand, Hartford, *Imitation* Flavor of Vanilla	Small	Dk. Brown	Brown	0.37	0.08	0.06	10.52	0.04	0.03	0.01	1.0	0.5	0.5	28.0	24.5	3.5	466
494	The Stuart Brand, Hartford, *Imitation* Flavor of Vanilla	Small	Dk. Brown	Brown	0.43	0.08	0.04	10.61	0.04	0.01	0.03	2.5	0.5	2.0	37.0	28.5	8.5	494
493	Virginia Dare Extract Co., Brooklyn, N. Y., *Little Brown Jug, Imitation* Vanilla	Small	Dk. Brown	Brown	0.12	0.10	0.06	1.31	0.04	0.02	0.02	2.0	1.0	1.0	13.0	8.2	4.8	493

[1] Dairy Commissioner's Sample.

Flour, etc.

Twelve samples of "Graham" and "entire wheat" flours have been examined.

There seems to be no uniform opinion in the trade, or at least among retailers, as to the distinction between these two types of flour. Dr. Sylvester Graham, in his crusade against alcoholism, advocated rearrangement of diet as a remedy for this form of intemperance, and emphasized particularly abstinence from meat and the use of bread made from unbolted wheat meal. This unbolted wheat meal became known as "Graham" flour and such flour, evidently, should have the same composition as the wheat from which it is ground. The coarseness of the product, however, was thought by some students of nutrition at that time, to be an objection since it tended to cause the material to pass through the digestive tract before the nutrients had been sufficiently utilized. Attempts were made, therefore, to remove the coarse, outer (ovary) layers of the wheat berry and to grind the remainder without bolting, thus removing only the indigestible parts of the grain and retaining the entire nutritive value of the wheat. This flour was called "whole wheat flour" or "entire wheat flour."

The attempts to decorticate wheat for making entire wheat flour were, apparently, not very satisfactory, and the introduction of the roller process for milling flour probably discouraged further attempts to perfect methods. Probably many of the Graham and entire wheat flours of trade are recombinations of various fractions obtained in the process of commercial milling.

In Table IV are given analyses of flours sold as "Graham" and as "entire" or "whole" wheat. For comparison, analyses of wheat, of wheat bran and of red dog flour as quoted from Henry and Morrison[1] (protein being expressed on the basis of the factor 5.7), are given; and also analyses of recognized commercial grades of flour, viz., first patent, straight, and first clear as cited from a bulletin[2] of this laboratory.

On the basis of the protein-ash ratios some interesting comparisons can be made. It appears that the ratio is 6 for the whole wheat grain, although according to some analyses[3] it may slightly exceed 10; for bran it is about 2.5; and for the various grades of commercial flours it may be considered to range from 15 to 30, the values less than 20 being for low grade flours, and 20 or above, clear flours or better grades.

With this rough classification in mind, and remembering also that true Graham flour should have the same composition as the wheat from which it is made, and that in true entire wheat flour some of the bran is removed, it appears that, in general, the commercial Graham flours do not exceed 10.0 and are nearer 6.0; and that there are no consistent differences between Graham and whole or entire wheat flours in this respect. Sample **22754** shows a ratio which indicates a low grade or clear flour rather than entire wheat flour; and the ratios in samples **22196** and **28776** indicate mixtures containing abnormal amounts of bran. It may be noted that the low grade flour known as red dog has a protein-ash ratio of nearly the same magnitude as the whole wheat grain; however, in the latter both protein and ash are conspicuously lower.

Three samples of semolina used in making macaroni were submitted by a purchaser and were examined for nitrogen. They contained from 12 to 12.7 per cent. of protein (on the basis of N x 5.7).

[1] Feeds and Feeding, 17th edition.
[2] Conn. Exp. Sta. Bull. 255 (1923).
[3] Leech, Food Inspection and Analysis, p. 322.

TABLE IV. ANALYSES OF "GRAHAM" FLOUR, ETC.

No.	Description of Sample	Moisture	Ash	Nitrogen	Protein (Nx5.7)	Fiber	Nitrogen-free extract	Fat	P/A
	Graham Flour.	%	%	%	%	%	%	%	
D.C.28776	F. A. Healey, Bridgeport. In bulk	11.09	2.40	2.42	13.79	2.36	67.22	3.14	5.7
D.C.28774	The Laramer Co., Willimantic. Choice Graham flour from entire wheat	11.14	1.98	2.30	13.11	2.48	68.45	2.84	6.6
D.C.28791	W. A. Maine, Norwich. In bulk	11.26	1.44	2.50	14.25	1.03	69.30	2.72	9.9
D.C.28794	J. A. Spinetta, New Britain	12.20	1.85	2.10	11.97	2.41	69.03	2.54	6.5
22194	Atlantic and Pacific Tea Co., New Haven, *Grandmother's*	9.53	2.09	2.43	13.85	1.68	70.59	2.26	6.6
22195	Grand Union Tea Co., New Haven, *Wheatsworth*	10.23	1.73	2.02	11.51	1.80	72.85	1.88	6.7
22764	Hartford Market Co., Hartford, *Pillsbury's*	10.02	1.87	2.27	12.94	2.28	70.34	2.55	6.9
22196	Quality Grocery, New Haven, *Schumacher, XXX*	9.23	2.69	1.71	9.75	2.66	72.22	3.45	3.6
	Whole Wheat or Entire Wheat Flour.								
D.C.28793	J. A. Spinetta, New Britain. Mill streams whole wheat stone ground flour	12.49	1.72	2.05	11.69	2.14	69.46	2.50	6.8
22756	E. E. Hall & Son, New Haven, *Purina*	9.95	1.45	2.30	13.11	1.31	72.38	1.80	9.0
22755	Frank S. Platt Co., New Haven	10.10	1.69	1.88	10.72	1.76	73.62	2.11	6.3
22754	Quality Grocery, New Haven, *Franklin*	10.30	0.81	2.10	11.97	0.28	74.86	1.78	14.8

TABLE IV. ANALYSES OF "GRAHAM" FLOUR, ETC.—*Concluded.*

No.	Description of Sample	Moisture	Ash	Nitrogen	Protein (Nx5.7)	Fiber	Nitrogen-free Extract	Fat	P/A
	Wheat Grain and Wheat Mill Products.	%	%	%	%	%	%	%	
	Wheat Grain[1]	10.20	1.90	1.98	11.29	2.20	.....	2.10	6.0
	Wheat Bran[2]	10.10	6.30	2.56	14.59	9.50	.....	4.40	2.3
	First Patent Flour[3]	9.70	0.38	2.00	11.40	....	.....	....	30.0
	Straight Flour[3]	10.00	0.48	2.10	11.74	....	.....	....	24.5
	First Clear Flour[3]	9.77	0.64	2.30	13.11	....	.....	....	20.5
	Red dog flour[4]	11.10	2.50	2.69	15.33	2.20	.....	4.10	6.1

[1] Based on 858 analyses.
[2] Based on 7742 analyses.
[3] Conn. Exp. Sta. Bull. 255. (1923.)
[4] Based on 259 analyses.

Gelatin.

A number of commercial gelatin products have been reported in previous bulletins.[1] Two samples, both submitted by a purchaser, have been examined during the past year.

644. Manufactured or distributed by James W. Dunn, Greenwich, N. Y.

645. Manufactured by the Atlantic Gelatin Co., Boston. Partial analyses are as follows:

	644	645
Ash	1.53%	1.22%
Nitrogen	15.18	15.28
Gelatin (N x 5.55)	84.29	84.80
Fat	0.16	0.09
Keratin	0.06	0.03
Arsenic (parts per million)	none	0.5
Odor (hot water solution)	faint.	faint

State Regulation 52 relates to gelatin as follows:

Gelatin (edible gelatin) is the purified, dried, inodorous product of the hydrolysis, by treatment with boiling water, of certain tissues as skin, ligaments and bones, from sound animals, and contains not more than two per cent of ash and not less than 15 per cent. of nitrogen. It should not contain excessive amounts of metallic impurities. A hot water solution of gelatin should be clear and without offensive odor.

Pending further investigation, amounts of more than 1.4 parts of arsenic, 30 parts of copper and 100 parts of zinc in one million parts of gelatin will be regarded as excessive.

The samples examined were both passed as satisfactory.

Ice Cream.

Two hundred and sixty-nine official samples were submitted by the Dairy and Food Commissioner and three were submitted by manufacturers. Only five were found to contain less than 8 per cent of fat; one of these was sold under a sign or label which declared not less than 4 per cent. and was, therefore, within the provisions of the law, while another was but slightly under 8 per cent. and was passed. Three were deficient by substantial amounts as shown in the following summary:

Ice Cream Below Standard.

29311	Vanilla.	Derby	DeVarvieri and Musanti	7.1%
29301	Vanilla.	New Britain.	Chas. Piccoli	6.0
29184	Vanilla.	New Haven.	Huntington Confectionery Co.	6.9

The samples were secured from fifty-nine cities and towns in the State and may be classified on the basis of fat content as follows:

[1] Conn. Exp. Sta. Bull. 219. p, 221; 227, p 235; 255 p. 189.

	No. of samples.	Per cent. of total.	Per cent. for the 5-year period 1919-1923.
8.0– 9.9 per cent.	47	17.4	26.1
10.0–11.9 per cent.	67	24.8	23.2
12.0 and above	150	55.9	41.1
7.9 per cent. and below	5	1.9	9.6
Total	269	100.0	100.0

The summary shows that our 8 per cent. requirement is being very strictly complied with; that from 60 to 80 per cent. of samples examined contained 10 per cent. or more of fat; and that in over one-half, the fat content was 12 per cent. or over; and that, as compared with the preceeding five years, there is a considerable decrease in samples containing less than 10 per cent. of fat and an increase in those containing 12 per cent. or more.

Meat Products.

All the meat products examined were submitted by the Dairy and Food Commissioner to be tested for preservatives, excess or undeclared starchy material or undeclared color.

Table V. Hamburg Steak Containing Sulphites.

D. C. No.		Sampled at	Sulphur dioxide (SO_2), mgms. per kilo.
28217	*Bridgeport,*	Boston Public Market	382.0
28220		Helbig's Market	801.0
28221		Chicago Market	113.0
28233		W. Auch	329.0
28224		Washington Public Market	1016.0
28611	*Bristol,*	Valentines' Market	269.0
28612		The National Meat Market	2323.0
28613		Public Market	2212.0
28614	*East Hartford,*	Aronson's Market	708.0
28437	*Naugatuck,*	Adolph Reiter	142.0
28438		The People's Market	373.0
28426	*New Haven,*	The Congress Public Market.	1993.0
28234	*Norwalk,*	Fowler's Market	171.0
28237	*Norwich,*	Wysod's Market	346.0
28240		Grunville Public Market	1794.0
28601		Self-Service Market	505.0
28609	*Plainville,*	V. G. Manello	640.0
28228	*Stamford,*	Saltzman's Market	4364.0
28227		Capitol Market	274.0
28430	*Wallingford,*	Samuel Lev	2312.0
28423	*Waterbury,*	Fulton Market	979.0
28441	*Willimantic,*	William Laramie	636.0

Hamburg Steak.

Sixty-two samples were examined and twenty-two were found to contain sulphites, the use of which is illegal under the general provisions of the food law and in violation of a specific State regulation.[1]

[1] Regulation 51.

Samples in which sulphites were found are given in Table V.

FRANKFURTS.

Thirty-four samples were submitted, fifteen of which contained undeclared, or excess of, starch or undeclared color. A summary of these samples is given in Table VI.

Two samples of casings were examined for color but none was found.

TABLE VI. FRANKFURTS CONTAINING EXCESS OF STARCH, OR ARTIFICIAL COLOR, OR BOTH.

D. C. No.	Dealer	Manufacturer	Remarks
	Bethel.		
28205	Bethel Provision Co.....	Own make........	Excess starch.
28206	Bethel Provision Co.....	Own make........	Excess starch.
	Bridgeport.		
29204	Thos. McNamara & Sons, Inc.	Own make........	Excess starch.
	Hartford.		
28062	Independent Packing Co.	....	Color undeclared.
28071	Eastern Provision Co...	Independent Packing Co.........	Starch and color undeclared.
28072	Grote & Weigel........	....	Color undeclared.
28073	Hartford Center Factory	....	Color undeclared.
	New Britain.		
28435	Adam Ostrowski.......	Own make........	Starch undeclared
	New Haven		
29205	Columbia Market......	T. J. McNamara & Sons, Bridgeport	Excess starch.
	Norwich.		
28238	Norwich Provision Co...	Own make........	Excess starch.
	Stamford.		
28409	Klein & Gmahle.........	Own make........	Excess starch.
	Waterbury.		
28212	Kramer Bros...........	Sachenhauser,	Excess starch.
28422	Fulton Market.........	Own make........	Color undeclared.
28424	John Hullstrunk........	Own make........	Excess starch; color undeclared.
	Willimantic.		
28443	Liberty Cash Market...	Capitol Beef Co., Boston, Mass...	Starch undeclared.

PORK SAUSAGE.

According to a State regulation, pork sausage may contain cereal or other starchy material provided it is declared upon the label or signs displayed and provided the amount does not exceed 2 per cent.

Fifteen samples of pork sausage were examined and none found in violation of these provisions.

MILK AND MILK PRODUCTS.

MARKET MILK.

Four hundred and seventy-three official samples of milk have been examined for the Dairy and Food Commissioner. This number is much smaller than for some years past due to the increased amount of testing done by licensed operators attached to the Commissioner's office. The tests required of the Station are thereby reduced to such as are necessary for checking purposes.

Two hundred and fifty-seven unofficial samples have been analyzed for the Commissioner; and also one hundred and sixty-eight for producers or consumers. The total from all sources is eight hundred and ninety-eight.

The four hundred and seventy-three official samples may be classified on the basis of the analyses, as follows:

	No. of samples	Per cent.
Not found adulterated..........	232	49.0
Adulterated by watering.........	26	5.5
Adulterated by skimming.........	23	4.9
Adulterated by reason of being sub-standard in solids and solids-not-fat................	71	15.0
in solids and fat..............	9	1.9
in solids, fat and solids-not-fat...	112	23.7
	473	100.00

Roughly, 50 per cent. were not found adulterated, 10 per cent. were watered or skimmed, and 40 per cent. were sub-standard in two or more of the items fat, solids, and non-fat solids.

Adulterated samples, other than sub-standard, are summarized in Table VII.

TABLE VII. ADULTERATED MILK.

No.	Dealer	Solids	Fat	No.	Dealer	Solids	Fat
	Containing Added Water				**Containing Added Water**—*Continued.*		
	Cornwall Bridge.				*Somers.*		
27344	Jacob Lorch........	10.39	2.8	27849	Max Levitt........	9.48	2.9
				28100	Max Levitt........	9.30	3.0
	Glastonbury.						
28079	John Alekson.......	11.61	4.3		*Thompsonville.*		
28080	John Alekson.......	12.03	4.5	29398	Thomas Bostick....	10.59	3.3
				29399	Thomas Bostick....	10.54	3.3
	Litchfield.						
27776	B. O. Blakeslee.....	10.79	3.3		*Torrington.*		
	Newtown.			28992	T. Semkman.......	11.42	4.1
27817	Samuel Steinfelt....	9.90	3.0				
27818	Samuel Steinfelt....	9.71	2.8				
27819	Samuel Steinfelt....	10.39	3.2		*Watertown.*		
	Niantic.			28316	Tom Dubesky.......	10.07	3.1
				28317	Tom Dubesky.......	10.22	3.1
27812	Harry Morton......	10.60	3.5	28318	Tom Dubesky.......	10.19	3.1
29281	J. H. Perkins.......	9.63	2.5				
29284	Harry Morton......	10.34	3.2				
29285	Harry Morton......	10.09	3.3		*West Cheshire.*		
				27773	Howard E. Ives.....	10.09	3.3
	No. Branford.			27775	Howard E. Ives.....	10.59	3.3
29850	E. L. Cole.........	10.56	3.2				
	Rockfall.				*West Cornwall.*		
27762	Joe Misiok.........	11.42	3.7	27347	Chester Turkowitz..	10.23	2.9
27763	Joe Misiok.........	11.69	4.0	27800	Wm. Livingston....	10.60	3.1

EVAPORATED MILK AND SWEETENED EVAPORATED MILK.

Nine samples of evaporated milk and sweetened evaporated milk, six of which were submitted by the Dairy and Food Commissioner, have been examined and are summarized in Table VIII.

Evaporated milk should contain[1] not less than 7.8 per cent. of fat, 25.5 per cent. of solids and the sum of the percentages of fat and solids should be not less than 33.7.

Sweetened evaporated milk should contain[2] not less than 8 per cent. of fat and not less than 28 per cent. of milk solids. The sweetened products were examined for fat only.

[1] F. I. D. 189.
[2] Circ. 136.

TABLE VII. ADULTERATED MILK—*Concluded.*

No.	Dealer	Solids	Fat	No.	Dealer	Solids	Fat
	Skimmed Milk				**Skimmed Milk**—*Continued.*		
	Danbury.				*Norwich Town.*		
29777	Wm.MountianLunch	10.71	2.0				
29778	Depot Lunch.......	11.24	2.8	29643	Isadore Michon.....	11.15	2.5
29782	Groveland Lunch...	10.49	2.2	29646	H. R. Gardner......	9.78	1.8
	Hawleyville.				*Putnam.*		
28744	Alex Murin........	10.73	2.3	27409	Daniel J. Weeks....	11.21	2.7
				27412	John E. Tachariadis.	10.76	2.3
	Madison.			27413	Miller & Duffy.....	11.12	2.6
28715	New York Lunch...	10.57	2.1	27427	Miller & Duffy.....	10.63	2.0
	Mystic.				*Warehouse Point.*		
28703	Central Lunch......	9.15	0.7	29260	S. Wolcott Bissell...	12.06	3.0
28704	C. R. Worth.......	10.10	1.5				
	New London.				*Westerly, R. I.*		
				28701	White House Lunch.	11.26	2.5
28132	Crocker House Restaurant.........	11.29	2.8		*West Haven.*		
28133	Far East Restaurant.	9.93	1.4	27790	G. D. Shaw........	11.65	2.7
	Norwich.						
27433	James Hayes.......	10.30	2.0		*Willimantic.*		
27840	Fern's Restaurant...	11.51	2.6	27439	T. F. Shea.........	11.04	2.0
27846	Preston Pub. Market.	11.20	2.6	27445	A. Krug...........	9.76	1.4

TABLE VIII. ANALYSES OF EVAPORATED AND SWEETENED EVAPORATED MILK.

No.	Brand or Manufacturer	Fat	Solids	Fat + Solids
	EVAPORATED MILK.	%	%	%
646	Libby, McNeil and Libby........	8.22	26.65	34.87
647	" " " "	8.25	26.61	34.86
319	H. D. Lee Mercantile Co., *Lee*... Waterbury, Conn............	7.82	26.29	34.11
D. C. 28078	Sheffield Condensed Milk Co., New York............	7.94	25.87	33.81
D. C. 28077	Sheffield Condensed Milk Co., New York............	7.91	25.85	33.76
D. C. 28245	The Borden Co., New York......	7.95	26.24	34.18
D. C. 28246	Rogers Milk Corp., New York *Freshpak.*	8.03	25.90	33.93
	SWEETENED EVAPORATED MILK.			
D. C. 28075	Sheffield Farm Milk Co.,New York	8.23	.....	....
D. C. 28076	" " " "	8.24	.....	....

All of the evaporated milks met the requirements of the standard and the sweetened products conformed to the standard for fat.

CREAM.

Four samples of cream and sour cream were examined for fat. They were sampled by the Dairy and Food Commissioner and found to contain from 21 to 38.5 per cent. of fat. Samples were Nos. **28401, 17009, 29314** and **29151.**

CHOCOLATE-MILK.

One sample of this product was examined. It was sold by the Sagalou Farm, Branford.

Analysis:

Solids 16.0 per cent.; ash 0.76 per cent.; fat 3.21 per cent.; protein (factor 6.25) 3.06 per cent.; casein (approx.), 1.78 per cent.; sugar (by difference), 7.19 per cent.

BUTTERMILK[1]

Fermented milks are of two kinds viz., (1) that in which the fermentation produces only lactic acid and (2) those in which both lactic acid and alcohol are formed. Lactic acid is produced by the action of lactic-acid-forming bacteria while alcohol is formed by the action of certain types of yeasts although bacteria may be, in part, responsible.

Buttermilk is an example of the first named type of fermentation, *i. e.*, that in which lactic acid is the chief, or only, product of fermentation. As originally made, it was the sour milk left in the churn after the removal of butter. Now, however, commercial buttermilk is largely made from sour skimmed milk by inoculation with a "starter" (lactic acid bacteria), incubating at the proper temperature and finally breaking up the loppered milk by agitating until a uniform liquid or emulsion is obtained. Whole milk (*i.e.* unskimmed milk), may also be thus treated.

The second type of fermentation includes products containing both lactic acid and alcohol in varying proportions. Broadly there are two classes in this group viz., (a) where the acid predominates and (b) where the alcohol is the most conspicuous product. These two classes are determined by the kinds of yeasts or bacteria present and also by the temperature of incubation.

Yoghurt may be cited as an example of that class in which lactic acid predominates over the alcohol; and Kumiss made from mare's milk, and Kephir, the corresponding product made from cow's milk, are examples of products in which alcohol predominates.

In order to see whether fermented milks, as now found in trade, conform to the characteristics just stated for the several types,

[1] References consulted:
Heineman. Milk. 1921.
Rogers. U. S. Dept. Agr., Bureau Animal Industry. Circ. 171, 1911; Bull. 319, 1916.

three samples were secured in New Haven and two in Hartford. All of these were of the buttermilk type and sold as such. No specially cultured milks of the Yoghurt or Kephir classes have been secured.

The five samples of buttermilk were examined as follows:

	21956	**21981**	**21980**	**27246** (Churned)	**27247**
Water	90.38%	83.01%	91.06%	93.41%	90.48%
Ash	0.88	0.72	0.76	0.57	0.76
Protein	3.58	3.20	3.22	2.40	3.47
Fat	0.54	8.73	0.46	0.39	0.64
Sugar (calc.)	4.62	4.34	4.50	3.23	4.65
Alcohol	trace?	trace?	trace?	trace?	none?

All of these products except **21981** are made from skimmed milk.

As to alcohol our results obtained in the usual way, showed very inconsiderable amounts, the actual figures ranging from 0.03 to 0.10 per cent. Without further tests to positively identify alcohol, its presence may be questioned; however, one authority on this subject observes that while pure cultures of lactic acid bacteria produce only lactic acid, cultures in which other organisms may be present do produce small amounts of other related acids and sometimes *traces* of alcohol. At any rate, the statements made in the literature by authorities to the effect that the product generally known as buttermilk, contains no alcohol or not more than traces thereof, is substantiated by the analyses here given.

As to how much alcohol may occur in products of the second type of fermentation, Kumiss and Kephir may be cited. Recorded analyses show that Kumiss contains from 2.5 to 3.0 per cent. while Kephir contains from 0.6 to 0.75 per cent. No analyses of Yoghurt were found, but since it belongs to the class which is not conspicuous for alcohol it is reasonable to expect that it contains less of that constituent than Kumiss or Kephir.

HUMAN MILK.

Nineteen samples of breast milk, submitted chiefly by associations of Visiting Nurses and by physicians, have been examined. As in the case of cows' milk, wide variations occur in the compositions of different portions of milk of this type as noted in a previous bulletin.[1] The uncertainty of conclusions based upon analyses of samples which do not fairly represent the entire secretion is pointed out to those submitting samples of this kind.

Analyses of the samples submitted are given in Table IX.

[1] Conn. Exp. Sta. Bull. 227, p 255.

TABLE IX. ANALYSES OF HUMAN MILK.

No.	Solids	Protein (N. x 6.38)	Fat	Sugar	Ash
	%	%	%	%	%
21978	11.84	1.30	3.0	7.3	0.24
22245	11.84	1.36	3.4	6.84	0.24
22252	12.37	1.05	3.8	7.33	0.19
22253	11.63	1.45	2.8	7.07	0.31
22254	10.57	1.30	2.7	6.30	0.27
22346	15.53	1.58	6.4	7.28	0.27
22434	10.97	1.00	3.0	6.78	0.19
22516	11.28	1.00	2.8	7.22	0.26
22701	17.60	1.25	9.0	7.11	0.24
22853	16.76	1.13	8.8	6.63	0.20
22994	12.10	1.28	3.4	7.19	0.23
23179	13.14	1.23	4.8	6.89	0.22
23180	11.56	1.19	3.4	6.77	0.20
23181	13.52	1.87	4.6	6.81	0.24
23220	12.08	1.37	3.0	7.52	0.19
23369	12.47	1.40	3.8	7.03	0.24
23385	.....	....	5.4	....	....
914	11.95	1.03	3.4	7.41	0.11
274	.....	1.35	6.2	....	....

SPICES.

GROUND NUTMEG AND SAGE.

Nutmeg is the dried seed of *Myristica fragrans* Houtt., deprived of its testa, with or without a thin coating of lime (CaO). It contains not less than 25 per cent. of non-volatile ether extract, not more than 10 per cent. of crude fiber, not more than 5 per cent. of total ash, nor more than 0.5 per cent. of ash insoluble in hydrochloric acid.[1]

Sage is the dried leaf of *Salva officinalis* L. It contains not less than 1 per cent. of volatile ether extract, not more than 25 per cent of crude fiber, not more than 10 per cent. of total ash, nor more than 1 per cent. of ash insoluble in hydrochloric acid[2].

Eight samples of ground nutmeg and nine samples of sage were collected by the Station agent.

In all cases the requirements of the standard were fully met. Analyses are given in Table X.

[1] Circ. 136.
[2] Ibid.

TABLE X. ANALYSES OF NUTMEG AND SAGE.

No.	Brand or Manufacturer	Ether non-vol.	Extract vol.	Crude fiber	Total ash	Ash insol. in acid.
		%	%	%	%	%
	NUTMEG.					
410	Austin, Nichols & Co. Inc., N. Y. *Sunbeam*..........	32.41	....	3.04	4.10	0.09
428	Bennett, Simpson & Co., N.Y	30.89	....	3.53	2.41	0.03
450	James Butler Inc., N. Y.....	34.50	....	2.85	1.98	0.05
405	Great Atlantic & Pacific Tea Co....................	35.99	....	2.55	3.09	0.07
453	Chas. G. Lincoln & Co., Inc. Hartford, *Capitol Mills*...	36.25	....	2.98	2.52	0.05
423	Grand Union Tea Co., Brooklyn..............	32.96	....	3.15	3.37	0.05
418	E. R. Durkee, Elmhurst, L.I.	37.53	....	2.38	2.02	0.02
447	Frances H. Leggett & Co., N. Y. *Premier*...........	35.89	....	2.83	2.58	0.03
	SAGE.					
427	Bennett, Simpson & Co., N.Y.	....	1.87	14.88	6.87	0.52
449	James Butler, N. Y. *Peerless*.	....	2.14	17.65	6.18	0.33
416	E. R. Durkee & Co., Elmhurst, L. I.............	....	1.88	16.68	6.11	0.22
402	E. R. Durkee & Co., Elmhurst, L. I.............	....	1.84	14.28	8.04	0.42
429	B. Fischer & Co. Inc., N. Y.	....	1.86	15.18	6.92	0.46
422	Grand Union Tea Co., Brooklyn..............	....	1.73	14.83	7.75	0.72
406	Great Atlantic & Pacific Tea Co....................	....	2.23	18.80	6.28	0.32
448	Frances H. Leggett & Co., *Premier*...............	....	1.70	14.88	7.00	0.34
421	Williams & Carleton Co., Hartford...............	....	1.93	16.63	6.40	0.55

SYRUPS.

MAPLE SYRUP.

Six samples collected by inspectors of the Dairy and Food Commissioner's office were examined.

The product should contain not more than 35 per cent. of water and not more than 2.5 per cent. of ash[1].

All samples conformed to the standard, except **28765**, which contained an excess of water but otherwise appeared to be a genuine maple product. This sample had fermented slightly when examined.

Analyses are given in Table XI.

[1] Circ. 136.

TABLE XI. ANALYSES OF MAPLE SYRUP.

D. C. No.		Water %	Ash %	Lead No. %
28648	Great Atlantic & Pacific Tea Co.	32.20	0.55	1.32
28641	Rigney & Co., Brooklyn, *Colonial*	34.05	0.52	1.22
28758	Seaman Bros., N. Y., *White Rose*	33.36	0.50	1.26
28775	Welch Bros., Burlington, Vt., *Green Mountain Boy*	32.43	0.59	1.33
28755	R. C. Williams & Co., N. Y., *Royal Scarlet*	32.76	0.59	1.29
28765	No label	41.00	0.60	1.44

One sample **22945** submitted by a purchaser, was found to contain 33 per cent. of water and 0.66 per cent. of ash.

MOLASSES.

Twenty samples representing eleven brands were examined, all except two brands being analyzed in duplicate.

In all cases the limit of moisture set by the standard, viz., 25 per cent., is exceeded but the excesses are generally not greater than 10 per cent. of the standard. In two cases the ash exceeds the limit of 5 per cent., indicating a second or third molasses type. Sulphur dioxide was declared in all but two brands. One of these, **28773,** was declared to contain no sulphur dioxide and none was found; in **28645** and a duplicate, **30235,** no declaration of sulphur dioxide was made and only doubtful traces were found.

Analyses are given in Table XII.

HONEY.

An unofficial sample of strained honey, **28204,** submitted by the Dairy and Food Commissioner, was found to contain 20.58 per cent. of moisture (dried in vacuum at 60-65°C), 0.10 per cent. of ash and 1.55 per cent. of sucrose, and to be within the limits of composition for pure honey.

TEA[1].

Analyses of twelve samples of tea including well-known commercial brands and some typical grades are given in Table XIII. Description of the samples includes comments upon quality and cup characteristics as judged by expert tea tasters. Although quality and character of infusion cannot be interpreted in terms of exact chemical constituents this comparative data is, nevertheless, of considerable interest. These analyses also supplement work previously done[2] in this laboratory upon certain standard and market teas.

[1] Samples and data upon quality and cup characteristics were furnished through the courtesy of Mr. Ukers, editor of the Tea and Coffee Trade Journal, New York.

[2] Conn. Exp. Sta., Bull. 210, 1918.

TABLE XII. ANALYSES OF MOLASSES.

D. C. No.	Brand	Moisture %	Ash %
28760	*Amolco.* The American Molasses Co., New York	27.10	3.23
28762	*Belle Rose.* New Orleans Coffee Co., Ltd., New Orleans, La	26.70	2.39
29934	*Belle Rose.* New Orleans Coffee Co., Ltd., New Orleans, La	27.00	2.74
28784	*Brer Rabbit* (Gold label). Penick & Ford, New Orleans, La	26.00	4.05
29243	*Brer Rabbit* (Gold label). Penick & Ford, New Orleans, La	27.10	4.08
28785	*Brer Rabbit* (Green label). Penick & Ford, New Orleans, La	26.00	4.96
29242	*Brer Rabbit* (Green label). Penick & Ford, New Orleans, La	26.90	5.73
28790	*Cherry Grove.* Alexander Molasses Co., Chicago, Ill	25.20	7.24
29942	*Cherry Grove.* Alexander Molasses Co., Chicago, Ill	26.40	7.13
28644	*Dunbar's Old Fashioned.* Dunbar Molasses & Syrup Co., New Orleans, La	27.90	4.83
29904	*Dunbar's Old Fashioned.* Dunbar Molasses & Syrup Co., New Orleans, La	27.80	5.17
28645	*Dunbar's Pure Sugar House.* Dunbar Molasses & Syrup Co., New Orleans, La	27.30	2.89
30235	*Dunbar's Pure Sugar House.* Dunbar Molasses & Syrup Co., New Orleans, La	27.60	3.08
28759	*Giltedge.* W. Wirt Wickes & Son, New York	27.10	3.35
29241	*Giltedge.* W. Wirt Wickes & Son, New York	27.10	3.62
28773	*Grandma's.* Boston Molasses Co., Boston, Mass.	30.00	1.07
29943	*Grandma's.* Boston Molasses Co., Boston, Mass.	27.90	1.49
28751	*Moro.* The Southern Molasses Co., New York	25.09	7.47
29952	*Moro.* The Southern Molasses Co., New York	27.10	7.52
29244	*Rosemere.* The American Molasses Co., New York	26.00	3.92

TABLE XIII. ANALYSES OF TEA.

No.	Brand of Tea and Cup Characteristics	H_2O	Total Ash	Ash insol. in acid	Total Nitrogen	Fiber	Ether Extract	Hot Water Extract	Caffeine		Tannin
									Grav.	From N	
		%	%	%	%	%	%	%	%	%	%
76	*Typical Java.* Consists of Orange Pekoe and Pekoe leaf of good manufacture selected from a number of better known Java Tea Estates producing medium to fine qualities. Combines in leaf and liquor the grades of Java most favored in the United States and is thoroughly typical of the mass of good medium tea produced on that Island......	8.09	5.53	0.01	3.74	9.72	1.19	41.30	2.96	2.86	7.88
77	*Typical Black China.* Composite of North China teas of the better qualities used principally in the United States. Represents all characteristics of this class of black China tea. Lower grades of this type, as well as very choice teas used only in small quantities, have not been included in this composite sample..........	8.18	5.60	0.28	3.56	9.78	1.28	38.60	2.49	2.38	5.17
78	*Typical Ceylon.* Composed of medium and high grown teas from Ceylon Estates, Pekoe and Orange Pekoe leaf, and represents a typical Ceylon tea as regards flavor, strength and color of liquor......................	8.06	5.27	0.13	4.16	9.05	1.71	40.10	3.23	3.09	9.28
79	*Typical India.* Composite of Orange Pekoes and Pekoes produced in Darjeeling, Assam, Sylhet, Cachar and Dooars districts. Assam comprises about 40 per cent. of the mixture. Represents average North Indian production and exhibits qualities of strength, color and flavor of liquor characteristic of the growth of that section..................	8.24	5.83	0.19	4.02	10.08	1.51	39.20	3.44	3.33	7.97
45	*Salada Orange Pekoe Blend.* Composed of Orange Pekoe leaf. Liquor flavory, light in color and bright. Cup character indicates chief component to be high grown Ceylon probably mixed with better class Javas...	7.48	5.17	0.07	4.10	4.08	1.67	40.50	2.99	2.94	10.68

TABLE XIII. ANALYSES OF TEA—*Concluded.*

No.	Brand of Tea and Cup Characteristics	H_2O	Total Ash	Ash insol. in acid	Total Nitrogen	Fiber	Ether Extract	Hot Water Extract	Caffeine		Tannin
									Grav.	From N.	
		%	%	%	%	%	%	%	%	%	%
46	*Lipton Yellow Label Orange Pekoe.* Described as "choicest blend of Ceylon and India tea of Orange Pekoe and other selected grades." A good medium tea with bright infusion and a liquor well balanced between Ceylon and India................................	7.50	5.06	0.09	4.15	9.28	2.01	36.90	2.97	2.89	9.89
47	*Chase and Sanborn Orange Pekoe Blend.* Consists principally of Orange Pekoe leaf of very good quality. Predominating characteristic is of a high grown Ceylon with a touch of Darjeeling flavor. Liquor light and flavory.............................	7.52	4.97	0.03	4.10	9.40	2.31	41.10	2.83	2.77	8.93
48	*Tetley's Orange Pekoe.* Blend of Orange Pekoe and Pekoe leaf. Good medium quality and apparently consists chiefly of Ceylon and Java teas........................	8.05	5.36	0.07	3.95	9.54	1.45	40.70	3.02	2.94	8.76
49	*White Rose Ceylon.* Straight Ceylon composed of Pekoes, medium and low grades. Liquor colory, of good strength with little flavor. A good household tea of medium quality..	8.19	5.14	0.04	4.17	9.72	1.91	39.60	3.49	3.30	8.67
50	*"Royal Garden" Orange Pekoe Ceylon-India.* The liquor indicates a blend of good medium quality, chiefly Ceylon and India with a trace of China flavor..................	7.83	5.33	0.24	3.94	9.97	2.70	38.00	2.89	2.81	7.44
51	*"Thea-Nectar" Orange Pekoe.* Composed chiefly of Indian Orange Pekoe leaf. Liquor is of good strength and deep color. Flavor distinctly "Assamy"..................	8.23	5.68	0.10	3.97	10.32	1.36	38.80	3.47	3.31	7.71
74	*"Tree" Tea Formosa Oolong.* Straight Formosa of about "Superior" grade. A typical early summer medium fired Formosa of good quality............................	8.66	5.78	0.54	3.66	11.16	2.56	40.50	2.90	2.74	11.38

Vinegar.

Thirty-nine samples were examined for the Dairy and Food Commissioner of which four were adulterated.

Three of the four adulterated samples were made by Silver and Kushmann, Waterbury, and one by J. A. Silver Bottling Works also in Waterbury.

Twenty-six samples have been submitted by individuals, representing mostly the product of farm manufacture.

Miscellaneous Foods, Etc.

The usual number of miscellaneous foods have been submitted by health officers, town officials or private individuals, either directly or through the office of the Dairy and Food Commissioner, to be examined for poisons or other injurious substances. The materials, forty-two in number, are listed as follows:

Table XIV. Foods Examined for Poisons, Etc.

No.	Name of Food	Remarks
961	Baking Powder	Available carbon dioxide 13.9 per cent. Required by standard 12 per cent.
681	Cakes	Copper, arsenic and lead found in quantity.
22231 } **22232** }	Cakes, bran	No evidence of poison found.
22344	Candy	No alkaloidal or metallic poisons found.
22343	Candy	No alkaloidal or metallic poisons found.
22592	Candy	No evidence of poison found.
22447	Candy	No volatile, alkaloidal or metallic poisons detected.
D.C.29465	Candy	No narcotic drugs found.
D.C.29986	Cider, sweet	Labeled 1–10 per cent. benzoate of soda. No alcohol was found and no injurious substance was detected.
22698	Cider	Alcohol 3.3 per cent; no heavy metals found.
22218	Cider	Dark color due evidently to oxidation of iron and combination with tannin absorbed from the barrel.
289	Cider	Alcohol 7.8 per cent.; had been preserved with "anti-ferment"
962 } **963** }	Coffee	No chicory, cereal products or other adulterants found.
D.C.29451	Macaroni Sauce	No evidence of spoilage.
D.C.27909	Malic acid	Used in making soft drinks. Showed characteristics of racemic malic acid.
22511 } **22512** }	Milk	Corrosive sublimate (mercuric chloride found.)
22191 } **D.C.27249** }	Milk, malted	Nothing found to suggest probable cause of illness. Rats fed on sample six days developed no unfavorable symptoms.

Table XIV—Foods Examined for Poisons, Etc.—*Concluded.*

No.	Name of Food	Remarks
22517	Mushrooms	Not positively identified. Appeared to be of edible type.
23083	Pickles	No alum or heavy metals found.
D.C.29452	Sardines	Unfit for food.
28117	Soda, cherry	No poisons detected.
22707	Vinegar	No poisons detected.
22628	Water	No poisons detected.
23022	Water, sugar, salt	No evidence of mercury or arsenic found.
22607	Water, medicinal	Not substantially different from ordinary drinking water.
21944	Wine, wild cherry (made without removal of pits)	Contained 4.7 mgms. hydrocyanic acid per 100cc.
22825	Wine, wild cherry (same as **21959**, 5 mos. later)	Contained 5.4 mgms. hydrocyanic acid per 100 cc.
21959	Wine, wild cherry (made after removal of pits)	Contained 1 mgm. hydrocyanic acid per 100 cc.

D. C. **27915** and **27908,** crown caps, D. C. No. **27907,** ginger ale were submitted to determine, if possible, the source of an oily taste in the ginger ale. Examination revealed no explanation of the off-taste about which complaint was made.

Arsenic was found in 5 cases of dog poisoning; and of two fowls examined, arsenic was found in one.

II. DRUGS.

The work on drugs for the past year includes the usual examinations of drugs recognized in the Pharmacopoeia and National Formulary, and of proprietary and miscellaneous products. In addition, a study has been made of variations in the amounts of medicament in pills and tablets, samples having been obtained chiefly from the stocks of dispensing physicians. A few preparations obtained on prescriptions have also been examined.

A classification of the products examined is as follows:

	No. of samples
Tablets and pills	92
Prescriptions	8
U. S. P. and N. F. drugs	25
Toilet preparations	18
Proprietary remedies, etc	10
Miscellaneous	14
Total	167

Practically all of the samples in the three first named groups were submitted by the Dairy and Food Commissioner. Ninety-two samples of tablets and pills are reported here, but analyses of about forty more could not be completed for discussion in this report and will, therefore, be made a part of our work for the coming year. Such products present many analytical difficulties and the work consumes much time.

Tablets, Pills, Etc.

The ninety-two samples in this group represent one hundred and four items of medicament which were declared in definite quantities and which have been checked by direct determinations. In some instances constituents have been determined which were not declared as to quantity; and in other cases medicaments declared were not determined because of inadequate methods for reliable analyses.

The samples collected consisted of from twenty-five to one hundred tablets depending upon the nature of the medicaments and the analyses required. Individual weights of a representative number of tablets were taken, after which they were ground to a uniform powder, and the medicaments determined in percentage amounts of the ground sample. Maximum, minimum and average amounts of medicament were then calculated in terms of grains per tablet.

WEIGHT VARIATIONS.

Variations in weights of tablets and pills are due, in part, to the mechanical limitations of manufacturing processes. Much improvement has been made in this direction in recent years and compressed tablets, at least, can be made with a surprising degree of uniformity. In the case of pills coated with saccharated lime, or similar preparations, the weight of the coating may considerably exceed that of the medicament enclosed and, hence, if it were possible or practicable to examine the medicament apart from the coatings, less variation might be shown than appears when calculations are based on analyses of the ground pills as a whole.

The complete data on weight variations for the samples examined are given in Table XV.

The distribution of samples on the basis of total variations in weight is shown in the following summary:

Variation from	No. of samples	Per cent. of total number
0 to 4.99 per cent.	15	16.3
5 to 9.99 "	36	39.1
10 to 14.99 "	22	24.0
15 to 19.99 "	13	14.1
20 to 29.99 "	4	4.3
Over 30 "	2	2.2
Total	92	100.0

It is of interest to compare these results with similar data given in a previous report of this laboratory[1] which cites also the experience of Kebler. The results by Kebler were of about the same date as our earlier analyses; our recent results show a substantial improvement in this particular.

[1] Conn. Exp. Sta. Bull. 200, p. 188.

Table XV. Variations in Weight of Tablets.

No.	Drug and Manufacturer	Weight of tablet, mgms. Min.	Max.	Avg.	Total variation Mgms.	Per cent. of avg.
29960	Acetanilid Comp. (Acetasal) (Daggett & Miller)	316.0	346.0	335.0	30.0	9.0
29212	Acetanilid Comp. No. 1 (Direct Sales Co.)	358.0	423.5	397.3	65.5	16.5
29238	Acetanilid Tablets (DirectSales)	343.0	366.0	356.9	23.0	6.4
29209	Acetanilid Sodium Comp. (Maltbie Chem. Co.)	382.0	404.0	391.0	22.0	5.6
29962	Acetanilid Tablets (Salcelol) (Stoddard Co.)	338.0	364.0	353.0	26.0	7.4
29975	Acetanilid Tablets (Tilden Co.)	409.5	499.0	465.5	89.5	19.2
30208	Acetphenetidin (Direct Sales Co.)	403.0	432.0	416.0	29.0	7.0
29249	Acetphenetidin Tablets (Tailby-Nason)	408.0	446.5	430.0	38.5	9.0
30220	Acetphenetidin Tablets (Mfr?)	351.0	395.0	384.0	44.0	11.5
29959	Aspirin (Abbott Lab.)	400.5	425.0	411.5	24.5	6.0
29234	Aspirin (A. D. S.)	338.5	414.0	386.4	75.5	19.5
29929	Aspirin (A. D. S.)	371.0	432.0	399.7	61.0	15.3
29939	Aspirin (Bayer Co.)	378.5	423.0	401.7	44.5	11.1
29930	Aspirin (Brewer & Co.)	401.0	462.0	430.0	61.0	14.2
29240	Aspirin (Buffington, Inc.)	387.5	406.0	398.0	18.5	4.6
29938	Aspirin (De Pill Co.)	375.0	399.5	388.5	24.5	6.3
29237	Aspirin (Direct Sales Co.)	412.5	431.0	420.7	18.5	4.4
30207	Aspirin (Direct Sales Co.)	396.5	417.0	406.7	20.5	5.0
30217	Aspirin (Drug Products Co.)	387.0	423.0	401.6	36.0	9.0
29935	Aspirin (Fraser)	345.0	371.0	360.6	26.0	7.2
29906	Aspirin (Mfr?)	358.0	398.0	379.0	40.0	10.6
29941	Aspirin (Harvey Co.)	403.0	421.0	409.0	18.0	4.4
29950	Aspirin (Harvey Co.)	378.0	389.6	382.5	11.6	3.0
29940	Aspirin (Lee & Osgood)	380.5	423.0	399.0	42.5	10.7
29933	Aspirin (Lehn & Fink)	381.5	412.5	401.4	31.0	7.7
29944	Aspirin (Mulford Co.)	356.5	381.0	371.1	24.5	6.6
29218	Aspirin (National Drug Co.)	396.0	407.0	403.0	11.0	2.7
29239	Aspirin (National Drug Co.)	394.0	449.0	416.8	55.0	13.2
29928	Aspirin (Squibb)	354.0	378.5	362.8	24.5	6.8
29966	Aspirin (Surgeons and Physicians Supply Co.)	403.5	417.5	410.5	14.0	3.4
29210	Aspirin (Tailby-Nason)	353.0	384.0	365.4	31.0	8.5
29926	Aspirin (United Drug Co.)	359.0	405.0	380.0	46.0	12.1
30202	Aspirin (The Upjohn Co.)	460.0	493.0	471.3	33.0	7.0
29945	Aspirin (Wyeth)	356.0	390.0	380.0	34.0	8.9
29215	Aspirin (Yates D. & C. Co.)	383.5	435.5	421.4	52.0	12.3
29901	Aspirin (Yates D. & C. Co.)	387.0	466.0	431.1	79.0	18.3
29912	Aspirin (Yates D. & C. Co.)	443.0	470.5	459.0	27.5	6.0
940	Blaud's Iron Pills (United Drug Co.)	366.5	429.5	397.0	63.0	15.9
30206	Calcium, Iodized (Direct Sales Co.)	64.5	80.1	74.5	15.6	20.9
29229	Calcium Sulphide Pills (Upjohn Co.)	136.0	152.0	143.0	16.0	11.2
29230	Calcidin (Abbott Laby.)	124.3	139.9	130.9	15.6	11.9

TABLE XV. VARIATIONS IN WEIGHT OF TABLETS—*Continued.*

No.	Drug and Manufacturer	Weight of tablet, mgms. Min.	Max.	Avg.	Total variation Mgms.	Per cent. of avg.
29222 30223	Calomel (Yates D. & C. Co.)	90.0	96.0	92.3	6.0	6.5
29991	Calomel (Mfr?)	114.0	126.5	121.0	12.5	10.3
29919	Corrosive Sublimate (Davis, Rose Co.)	978.0	1009.0	991.1	31.0	3.1
30227	Corrosive Sublimate (Davis, Rose Co.)	921.5	1011.0	964.4	89.5	9.3
30228	Corrosive Sublimate (Morgenstern & Co.)	925.0	1045.0	993.0	120.0	12.1
29219	Coryza No. 2 (G. S. Stoddard & Co..)	157.2	187.3	176.9	30.1	17.0
30209	Hexamethylenamine (Direct Sales Co.)	317.0	331.0	323.6	14.0	4.3
29226	Hexamethylenetetramine (Buffington, Inc.)	312.5	324.0	322.4	11.5	3.6
30212	Hex-Iodine Lozenges (Daggett & Miller)	950.9	980.3	965.5	29.4	3.0
29908	Hydrastin - Strychnine Trit. (Smith Pharmacal Co.)	75.3	89.4	80.9	14.1	17.4
29228	Migraine Tablets (Nat. Drug Co.)	414.0	469.5	435.5	55.5	12.7
29225	Migraine Tablets (Tailby-Nason)	220.0	236.5	226.0	16.5	7.3
29932	Morphine Sulphate (Hypoderm.) (John Weyth & Bros.)	15.5	18.0	16.6	2.5	15.1
29247	Nitroglycerine Tablets (Nat. Drug. Co.)	34.9	40.0	37.5	5.1	13.6
29213	Phenolphthalein Tablets (Direct Sales Co.)	148.0	168.5	162.9	20.5	12.6
29915	Quinine Sulphate (Harvey Co.)	230.0	270.5	253.5	40.5	16.0
29924	Quinine Sulphate (Standard Laby.)	245.5	261.0	253.2	15.5	6.1
29246	Quinine Sulphate (Nat. Drug Co.)	288.0	307.0	299.0	19.0	6.4
30203	Quinine Sulphate (Yates D. & C. Co.)	319.0	368.0	350.0	49.0	14.0
29910	Sedative Pills No. 3 (G. F. Harvey Co.)	390.8	499.3	432.0	108.5	25.1
29953	Sodium Bromide (A. D. S.)	370.0	412.0	392.5	42.0	10.7
29978	Sodium Bromide (Tailby-Nason)	640.0	658.0	650.0	18.0	2.8
29236	Triple Bromides (Tailby-Nason)	495.5	516.5	506.2	21.0	4.1
29961	Sodium Salicylate (Daggett & Miller)	507.0	531.0	518.0	24.0	4.6
30214	Sodium Salicylate (Daggett & Miller)	397.0	419.0	406.7	22.0	5.4
29214	Sodium Salicylate (Direct Sales Co.)	416.0	448.5	436.0	32.5	7.5
29221	Sodium Salicylate (Direct Sales Co.)	437.5	470.0	454.2	32.5	7.2
29951	Sodium Salicylate (Harvey Co.)	320.0	413.0	373.3	93.0	24.9

TABLE XV. VARIATIONS IN WEIGHT OF TABLETS—*Concluded.*

No.	Drug and Manufacturer	Weight of tablet, mgms. Min.	Max.	Avg.	Total variation Mgms.	Per cent. of avg.
29208	Sodium Salicylate (Rheumatic Tablets) (Maltbie Chem. Co.)	798.0	831.5	813.6	33.5	4.1
29931	Sodium Salicylate (Haberle Drug Co.)	388.0	430.0	416.6	42.0	10.1
29923	Sodium Salicylate (Standard Laby.)	454.0	519.5	485.8	65.5	13.5
29920	Sodium Salicylate (Strasenburg Co.)	433.0	464.5	452.7	31.5	7.0
29248	Sodium Salicylate (Syracuse Pharmacal Co.)	381.0	404.0	392.1	23.0	5.9
29248D	Duplicate of 29248 (Syracuse Pharmacal Co.)	380.0	398.0	390.0	18.0	4.6
29235	Sodium Salicylate Comp. (Tailby-Nason)	398.5	434.0	414.0	35.5	8.6
29903	Sodium Salicylate (Tailby-Nason.)	385.0	425.5	412.7	40.5	9.8
29967	Sodium Salicylate (Tailby-Nason)	366.0	390.0	381.3	24.0	6.3
29946	Sodium Salicylate (Yates D. & C. Co.)	449.0	485.5	463.1	36.5	7.9
30211	Sodium Salicylate (Yates D. & C. Co.)	434.5	486.5	455.3	52.0	11.4
29914	Strontium Salicylate (Daggett & Miller)	500.0	535.0	509.0	35.0	6.9
29905	Strontium Salicylate (Tailby-Nason)	425.0	457.0	441.0	32.0	7.3
29969	Strychnine Sulphate (A. D. S.)	165.0	188.0	178.1	23.0	12.9
29216	Strychnine Sulphate (Daggett & Miller Co.)	103.0	117.0	108.3	14.0	12.9
29216D	Duplicate of 29216 (Daggett & Miller Co.)	103.5	114.5	111.0	11.0	9.9
29900	Strychnine Sulphate (Glen Pharmacal Co.)	73.0	85.5	78.7	12.5	15.9
30219	Strychnine Sulphate (The Harvey Co.)	32.0	38.0	34.6	6.0	17.3
29211	Strychnine Sulphate (Nat. Drug Co.)	73.0	88.0	82.2	15.0	18.2
30210	Strychnine Sulphate (Yates D. & C. Co.)	40.0	49.5	43.0	9.5	22.1
29916	Thyroid (Desiccated) Tablets (Harvey Co.)	396.5	547.5	496.2	151.0	30.4
29989	Thyroid (Desiccated) Tablets (Harvey Co.)	366.0	512.0	409.2	146.0	35.7
29911	Valerian Compound (Tailby-Nason)	428.3	460.4	446.1	32.1	7.2

Variation of	Per cent. of samples examined by Kebler	Connecticut 1917	Connecticut 1924
Less than 10 per cent.	43	44	55
More than 10 " "	57	56	45
More than 15 " "	28	26	21
More than 20 " "	9	10	7

VARIATIONS IN MEDICAMENT.

In addition to variations in medicament caused by the limitations of weight control, other factors enter into consideration, such as the purity of the basic drugs used, the mixing of them, and finally the limits of reasonable error in analysis. The manufacturer must be presumed to have determined that the drugs he uses conform to the limits of purity prescribed by the U. S. Pharmacopoeia or National Formulary, or, in case of drugs not recognized therein, to a degree of purity established by reliable analyses, and to have based the claims for his finished product accordingly. Approved analytical methods[1] are available for many of the medicaments ordinarily encountered in products of this type; but conclusions must be drawn cautiously in case of methods, the limitations of which are not sufficiently established.

Table XVI gives maximum and average variations in medicament in terms of grains per tablet and in percentages referred, in both cases, to the quantities of drugs declared to be present. A study of the tabulation shows that the maximum variation from the dosage claimed has been a shortage in sixty-one items and an overage in forty items; in other words the —and +variations have been about 6:4. In more than one-half of the items determined, the variation in dosage between the lightest and heaviest tablets or pills was within 10 per cent. of the dosage declared; in over three-fourths of the items this range was less than 15 per cent.; and in nearly seven-eighths of the items the range did not exceed 20 per cent.

If the average variation from claimed dosage is considered, the comparison is, naturally, somewhat better. Thus we find that the average variation from the stated dose is less than 10 per cent. in about four-fifths (79.8 per cent.), of the items determined; in about two-thirds (65.4 per cent.) of the items the variation does not exceed 5 per cent.

These conclusions are best shown in tabular form as follows:

Variations from	Maximum variation Items determined	Maximum variation Per cent.	Average variation Items determined	Average variation Per cent.
0 to 4.99 per cent.	24	23.8	68	65.4
5 to 9.99 " "	31	30.7	15	14.4
10 to 14.99 " "	24	23.7	8	7.7
15 to 19.99 " "	8	7.9	5	4.8
20 to 29.99 " "	11	10.9	6	5.8
30 upward " "	3*	3.0	2*	1.9
Totals	101	100.0	104	100.0

*Includes one item (in **29960**) which is obviously a mistake in labelling.

Again we may refer to a similar summary[2] revised to a basis comparable with the above tabulation. The comparison as regards maximum variation from claim is as follows:

[1] Methods of the A. O. A. C. and of the U. S. Pharmacopoeia have been followed wherever possible.

[2] Conn. Exp. Sta. Bull. 200 (1917).

Variations from	1917 Items determined	1917 Per cent.	1924 Items determined	1924 Per cent.
0 to 4.99 per cent.	25	16.2	24	23.8
5 to 9.99 " "	45	29.2	31	30.7
10 to 14.99 " "	41	26.6	24	23.7
15 to 19.99 " "	21	13.6	8	7.9
20 to 29.99 " "	10	6.5	11	10.9
30 upward, " "	12	7.9	3	3.0
Totals	154	100.0	101	100.0

Since an improvement has been shown in the matter of uniformity of weight of tablets as compared with our previous inspection, less variation in medicament would, therefore, be anticipated at this time. The above comparison shows that such is the case. About 55 per cent. of the determinations made were within 10 per cent. of the quantity of drug declared as compared with 45 per cent. showing a like range in 1917. Twenty-two per cent. of the individual items determined varied from the stated dose by 15 per cent. or more while the corresponding figures in our previous inspection is twenty-eight per cent. The improvement in uniformity of medicament parallels rather closely the increase in uniformity of tablet weights.

TABLE XVI. VARIATIONS IN MEDICAMENT IN TABLETS, ETC.

No.	Drug	Claim, grains	Maximum variation, grains	Maximum variation, per cent.	Average variation, grains	Average variation, per cent.
29960	Acetanilid	2.6	−0.4	−15.4	−0.2	−7.7
29975		5.0	+0.6	+12.0	+0.2	+4.0
29238		5.0	−0.4	−8.0	−0.2	−4.0
29209		2.5	±0.1	±4.0	±0.0	±0.0
29212		2.0	−0.3	−15.0	−0.1	−5.0
29962		2.5	±0.1	±4.0	±0.0	±0.0
29228		2.5	−0.4	−16.0	−0.3	−12.0
29225		2.0	+0.1	+5.0	±0.0	±0.0
29235		2.5	±0.1	±4.0	±0.0	±0.0
29249	Acetphenetidin	5.0	±0.2	±4.0	±0.0	±0.0
30208		5.0	+0.6	+12.0	+0.3	+6.0
30220		5.0	−0.6	−12.0	−0.2	−4.0
29941	Aspirin	5.0	+0.3	+6.0	+0.1	+2.0
29950		5.0	+0.2	+4.0	+0.1	+2.0
29944		5.0	−0.3	−6.0	−0.1	−2.0
29940		5.0	+0.3	+6.0	±0.0	±0.0
29938		5.0	−0.3	−6.0	−0.1	−2.0
29939		5.0	−0.3	−6.0	±0.0	±0.0
29935		5.0	−0.7	−14.0	−0.5	−10.0
29933		5.0	+0.3	+6.0	+0.1	+2.0
29930		5.0	−0.4	−8.0	±0.0	±0.0
29929		5.0	+0.7	−14.0	+0.2	+4.0
29234		5.0	−0.7	−14.0	−0.1	−2.0
29928		5.0	−0.3	−6.0	−0.2	−4.0
29926		5.0	−0.6	−12.0	−0.3	−6.0

TABLE XVI. VARIATIONS IN MEDICAMENT IN TABLETS, ETC.—*Continued*

No.	Drug	Claim grains	Maximum variation grains	Maximum variation per cent.	Average variation grains	Average variation per cent.
29945	Aspirin.	5.0	−0.3	−6.0	±0.0	±0.0
29959		5.0	−0.4	−8.0	−0.3	−6.0
29901		5.0	+0.7	+14.0	+0.3	+6.0
29912		5.0	−0.2	−4.0	±0.0	±0.0
29215		5.0	−0.4	−8.0	±0.0	±0.0
29906		5.0	−0.5	−10.0	−0.3	−6.0
29210		5.0	+0.3	+6.0	+0.1	+2.0
29218		5.0	−0.2	−4.0	−0.1	−2.0
29239		5.0	+0.6	+12.0	+0.2	+4.0
29237		5.0	±0.1	±2.0	±0.0	±0.0
29240		5.0	−0.2	−4.0	−0.1	−2.0
30207		5.0	±0.1	±2.0	±0.0	±0.0
30202		5.0	−0.3	−6.0	−0.2	−4.0
29966		5.0	−0.2	−4.0	−0.1	−2.0
30217		5.0	+0.4	+8.0	+0.1	+2.0
29911	Barbital.	0.25	. . . . . .	. . . . . .	−0.01	−4.0
940	Blaud's Pills (Ferrous Sulphate)	1.0	+0.2	+20.0	+0.1	+10.0
29236	Bromide, Ammonium	2.5	+0.1	+4.0	±0.0	±0.0
29236	Bromide, Potassium.	2.5	+0.3	+12.0	+0.2	+8.0
29219		0.167	. . . . . .	. . . . . .	−0.006	−3.6
29978	Bromide, Sodium. . . .	10.0	−0.4	−4.0	−0.2	−2.0
29953		5.0	±0.3	±6.0	±0.0	±0.0
29236		2.5	−0.1	−4.0	±0.0	±0.0
29209	Caffeine.	0.5	±0.0	±0.0	±0.0	±0.0
29228		0.25	−0.02	−8.0	−0.01	−4.0
29225		0.25	±0.01	±4.0	±0.00	±0.0
29235		0.25	−0.02	−8.0	−0.01	−4.0
29960	Caffeine citrate.	0.13	+0.12	+92.3	+0.11	+84.6
29212		0.50	±0.00	±0.0	±0.00	±0.0
29230	Calcidin.	0.15	+0.05	+33.3	+0.03	+20.0
29229	Calcium sulphide . . .	1.0	−0.1	−10.0	±0.0	±0.0
29222	Calomel (Mercurous chloride). . . .	0.10	+0.02	+20.0	+0.01	+10.0
30223						
29991		0.25	+0.02	+8.0	+0.01	+4.0
29219	Camphor.	0.25	. . . . . .	. . . . . .	−0.05	−20.0
29212	Camphor Monobromate	0.5	+0.1	+20.0	±0.0	±0.0
29225		0.5	±0.0	±0.0	±0.0	±0.0
30228	Corrosive Sublimate (Mercuric chloride)	7.3	+0.7	+9.6	+0.3	+4.1
30227		6.9	+0.4	+5.8	±0.0	±0.0
29919		6.9	+0.8	+12.0	+0.6	+8.8
29226	Hexamethylenetetramine.	5.0	−0.2	−4.0	−0.1	−2.0
30209		5.0	−0.2	−4.0	−0.1	−2.0
29228	Morphine Sulphate. .	0.05	±0.00	±0.00	±0.00	±0.0
29932		0.125	+0.015	+12.00	+0.005	+4.0
29247	Nitroglycerine.	0.01	±0.0	±0.0	±0.0	±0.0
29213	Phenolphthalein. . . .	2.0	+0.3	+15.0	+0.2	+10.0
29915	Quinine Sulphate . . .	2.0	+0.2	+10.0	+0.1	+5.0
29924		2.0	−0.2	−10.0	−0.1	−5.0
29246		2.0	−0.3	−15.0	−0.2	−10.0
30203		2.0	+0.3	+15.0	+0.2	+10.0
29209	Sodium Bicarbonate.	2.5	−0.4	−16.0	−0.4	−16.0
29228		1.0	+0.1	+10.0	±0.0	±0.0

TABLE XVI. VARIATIONS IN MEDICAMENT IN TABLETS, ETC.—*Concluded*

No.	Drug	Claim grains	Maximum variation grains	Maximum variation per cent.	Average variation grains	Average variation per cent.
29208	Sodium Bicarbonate.	2.5	+0.1	+4.0	±0.0	±0.0
29235		1.0	−0.1	−10.0	±0.0	±0.0
29228	Sodium Salicylate. . .	1.75	−0.34	−19.4	−0.27	−15.4
29967		5.0	−0.4	−8.0	−0.3	−6.0
29903		5.0	−0.5	−10.0	−0.2	−4.0
29214		5.0	−0.4	−8.0	−0.2	−4.0
29221		5.0	+0.2	+4.0	+0.1	+2.0
29920		5.0	−0.3	−6.0	−0.1	−2.0
29923		5.0	−0.6	−12.0	−0.2	−4.0
29931		5.0	+0.3	+6.0	+0.2	+4.0
29946		5.0	−0.3	−6.0	−0.2	−4.0
29951		5.0	−1.0	−20.0	−0.3	−6.0
29961		5.0	±0.1	±2.0	±0.0	±0.0
29235		1.75	+0.17	+9.7	+0.08	+4.6
29208		7.5	−0.3	−4.0	−0.1	−1.3
30214		5.0	−1.4	−28.0	−1.3	−26.0
29248		5.0	−1.2	−24.0	−1.1	−22.0
29248D		5.0	−1.2	−24.0	−1.1	−22.0
30211		5.0	+0.5	+10.00	+0.2	+4.0
29914	Strontium Salicylate.	5.0	−0.5	−10.0	−0.4	−8.0
29905		5.0	±0.2	±4.0	±0.0	±0.0
29211	Strychnine Sulphate.	0.033	+0.007	+21.0	+0.005	+15.1
29969		0.033	+0.004	+12.0	+0.002	+6.0
29900		0.017	+0.004	+23.5	+0.003	+17.6
29216		0.017	+0.008	+47.1	+0.006	+35.3
29216D		0.017	+0.005	+29.4	+0.005	+29.4
30210		0.033	+0.006	+18.2	+0.001	+3.0
30219		0.017	−0.004	−23.5	−0.003	−17.6

COMMENTS ON ANALYSES.

Table XVII gives the analytical data obtained upon the tablets and pills examined, ninety-two in number. In general, the plan adopted for judging the products was to designate as "satisfactory" the tablets or pills in which the average quantity of medicament equaled the quantity claimed, and in which the variation in medicament, as calculated for the lightest and heaviest units, did not exceed 10 per cent. of the claimed dose. Tablets or pills in which the average quantity of medicament was found to be within 10 per cent. of the quantity claimed were "passed." In a few instances where the quantity of medicament was very small, or where it could not be determined with the exactness desired, the latter designation was used with somewhat more tolerance. This plan is not ideal, but it is based upon the belief that some distinction should be made between those products which show a conspicuous degree of uniformity and those which do not, and, furthermore, that the average dose should equal the declared dose, and that variations should be+ and —in about equal magnitude. It is recognized that a tolerance which may be perfectly fair as applied to aspirin tablets, for example, may be very irrational when applied to hypodermic tablets. This is a subject which needs further consideration. The kind and amount of drug involved and the effects likely to result from an overdose must be taken into account in determining the magnitude of reasonable tolerances.

Particular comment is due with respect to a number of analyses listed in Table XVII. **29960.** *Acetasal.* This product shows about twice the quantity of caffeine citrate indicated by the label; in other words, our results show about 2.5 per cent. caffeine instead of 2.5 per cent. caffeine citrate. This is evidently an error in labelling. In our previous inspection a product of similar name and made by the same manufacturer was declared to contain 2.5 per cent. caffeine.

29228. *Migraine Tablets No. 8.* The deficiency in sodium salicylate exceeded 10 per cent. but other ingredients were substantially correct and the tablets were passed.

29209. *Acetanilid Sodium Compound.* This was correct in the main ingredients and the deficiency in sodium bicarbonate was passed.

29248 and **29248 D.** *Sodium Salicylate.* These samples were low in sodium salicylate but both were from the same stock. No other sample of this manufacturer was found among the physicians visited.

29216 and **29216 D.** *Strychnine sulphate.* Both these samples contained excesses of medicament but both were from the same source. No other samples of strychnine sulphate of this make were found among the physicians visited.

To summarize, it may be said that of 92 samples, representing thirty-three manufacturers (2 samples were of unknown make), 29 were satisfactory and 57 were passed. Six varied from claim by considerable amounts. These were Acetasal, **29960** (with the comment noted), sodium salicylate, **30214,** strychnine sulphate, **29216** and **29216 D,** and sodium salicylate, **29248** and **29248 D.**

Prescriptions.

ARSENOUS ACID.

29965. Sample of arsenous acid, bought on prescription, H. F. Ruby and Co., Hartford. Required not less than 0.975 per cent. of arsenous oxide, As_2O_3; found 0.46 per cent. A second sample from the same source showed 0.41 per cent. Both samples were less than ½ strength.

30233. Sample obtained on prescription calling for solution of arsenous acid, Victor W. Schmelzer, Meriden. The preparation was found to be Fowler's solution, and not a solution of arsenous acid.

Both these preparations contain the same limits for arsenous oxide (A_2O_3), viz., 0.975 to 1.025 per cent. and the sample obtained conformed substantially to these limits. It was not, however, the article called for.

HYDROCHLORIC ACID.

29206. Sample of hydrochloric acid, dilute, bought on prescription, R. J. Keefe, Windsor Locks. Required not less than 9.5 per cent. hydrochloric acid; found 9.64 per cent.

Prescription satisfactory.

PHOSPHORIC ACID.

30232. Sample of phosphoric acid, dilute, bought on prescription, Broderick and Curtin, Meriden. Required not less than 9.5 nor more than 10.5 per cent. of phosphoric acid; found 9.4 per cent.

Prescription passed.

POTASSIUM IODIDE.

Three samples were purchased on a prescription calling for 3.5 drachms of potassium iodide and sufficient distilled water to make 1 fluid ounce. Such a solution should contain 45.5 grams of potassium iodide in 100 cc. of solution, assuming 99 per cent. purity for the potassium iodide used.

29987. Purchased of A. C. Roby, Unionville. Potassium iodide found, 46.37 grams per 100 cc.

Solution satisfactory.

30224. Purchased of J. W. Sears, New Haven. Potassium iodide found, 44.78 grams per 100 cc.

Solution passed.

30231. Purchased of F. E. Wilson, Rockville. Potassium iodide found, 46.71 grams per 100 cc.

Solution satisfactory.

29974. This solution had leaked in transit and was not examined.

Table XVII. Analyses of Medicinal Tablets, Etc.

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist	Medicament: Declared, grains per tablet	Found, grains: Min.	Found, grains: Max.	Found, grains: Avg.	Remarks	D. C. No.
29960	Acetanilid Compound (Acetasal) (Daggett & Miller Co.)	M. J. Dowd: Thompsonville						
	Acetanilid 50%		2.6	2.2	2.5	2.4		29960
	Caffeine citrate 2.5%		0.13	0.24	0.25	0.24		
	Sodium salicylate		....	0.50	0.5	0.5		
	Sodium bicarbonate		....	0.7	0.8	0.7	Excess caffeine citrate.	
29212	Acetanilid Comp. No. 1 (Direct Sales Co.)	F. J. Mann: Southington						
	Acetanilid		2.0	1.7	2.0	1.9		29212
	Camphor monobromate		0.5	0.5	0.6	0.5		
	Caffeine citrate		0.5	0.5	0.5	0.5	Pass	
29238	Acetanilid Tablets (Direct Sales Co.)	N. Hibbard: Danielson.						
	Acetanilid		5.0	4.6	4.9	4.8	Pass	29238
29209	Acetanilid Sodium Comp. (Maltbie Chem. Co.)	H. F. King: Windsor.						
	Acetanilid		2.5	2.4	2.6	2.5		29209
	Sodium bicarbonate		2.5	2.1	2.2	2.1		
	Caffeine		0.5	0.5	0.5	0.5		
	Tinct. Gelsemium		....	....	....	....	Pass (Low in Sod. Bicarbonate)	
29962	Acetanilid Tablets[1] (G. S. Stoddard & Co.)	M. J. Dowd: Thompsonville.						
	Acetanilid		2.5	2.4	2.6	2.5	Satisfactory	29962
29975	Acetanilid Tablets (Tilden Co.)	J. A. Coogan: Windsor Locks.						
	Acetanilid		5.0	4.6	5.6	5.2	Pass	29975
30208	Acetphenetidin (Direct Sales Co.)	H. F. Moore: Bethel.	5.0	5.2	5.6	5.3	Satisfactory	30208
29249	Acetphenetidin Tablets(Tailby-Nason Co)	R. M. Griswold: Kensington.						29249
	Acetphenetidin		5.0	4.8	5.2	5.0	Satisfactory	
30220	Acetphenetidin (Mfr?)	L. C. Heidger: Stratford.	5.0	4.4	5.0	4.8	Pass	30220
29959	Aspirin (Abbott Lab.)	T. J. Luby: Hartford.						29959
	Aspirin		5.0	4.6	4.8	4.7	Pass	
29234	Aspirin (American Druggists' Syndicate)	F. P. Clason: Hartford.						
	Aspirin		5.0	4.3	5.3	4.9	Pass	29234
29929	Aspirin (American Druggists' Syndicate)	Woodward Drug Co: Middletown						
	Aspirin		5.0	4.9	5.7	5.2	Pass	29929
29939	Aspirin (Bayer Co.)	Plaisted Drug Store: So. Norwalk.						
	Aspirin		5.0	4.7	5.2	5.0	Satisfactory	29939
29930	Aspirin (Brewer & Co.)	L. Peisner's Park View Pharmacy: Middletown.						
	Aspirin		5.0	4.6	5.3	5.0	Pass	29930
29240	Aspirin (Buffington, Inc.)	K. T. Phillips: Putnam.						
	Aspirin		5.0	4.8	5.0	4.9	Pass	29240
29938	Aspirin (De Pill Co.)	W. H. Jones' Drug Store: Stamford						
	Aspirin		5.0	4.7	5.0	4.9	Pass	29938
29237	Aspirin (Direct Sales Co.)	N. Hibbard: Danielson.						
	Aspirin		5.0	4.9	5.1	5.0	Satisfactory	29237
30207	Aspirin (Direct Sales Co.)	H. F. Moore: Bethel.						
	Aspirin		5.0	4.9	5.1	5.0	Satisfactory	30207
30217	Aspirin (Drug Products Co.)	L. C. Heidger: Stratford.						
	Aspirin		5.0	5.0	5.4	5.1	Satisfactory	30217
29935	Aspirin (Fraser)	Leverty's Drug Store: Bridgeport.						
	Aspirin		5.0	4.3	4.6	4.5	Pass	29935

[1] Salcelol.

Table XVII. Analyses of Medicinal Tablets, Etc.

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist	Medicament: Declared, grains per tablet	Found, grains: Min.	Found, grains: Max.	Found, grains: Avg.	Remarks	D. C. No.
29906	Aspirin (Mfr?)	E. L. Pratt: Winsted.						
	Aspirin		5.0	4.5	5.0	4.7	Pass	29906
29941	Aspirin (G. F. Harvey Co.)	N. P. Lewis: Norwich						
	Aspirin		5.0	5.0	5.3	5.1	Satisfactory	29941
29950	Aspirin (G. F. Harvey Co.)	P. A. Park: Bristol.						
	Aspirin		5.0	5.0	5.2	5.1	Satisfactory	29950
29940	Aspirin (Lee & Osgood Co.)	The Lee & Osgood Co: Norwich.						
	Aspirin		5.0	4.8	5.3	5.0	Satisfactory	29940
29933	Aspirin (Lehn & Fink)	Misentis Drug Store: Middletown.						
	Aspirin		5.0	4.9	5.3	5.1	Satisfactory	29933
29944	Aspirin (H. K. Mulford Co.)	Sisk's Drug Store: Norwich.						
	Aspirin		5.0	4.7	5.1	4.9	Pass	29944
29218	Aspirin (National Drug Co.)	T. F. Rockwell: Rockville.						
	Aspirin		5.0	4.8	4.9	4.9	Pass	29218
29239	Aspirin (National Drug Co.)	K. T. Phillips: Putnam.						
	Aspirin		5.0	4.9	5.6	5.2	Pass	29239
29928	Aspirin (Squibb)	The Gladding Drug Co: Hartford.						
	Aspirin		5.0	4.7	4.9	4.8	Pass	29928
29966	Aspirin (Surgeons' and Physicians' Supply Co.)	E. O. Elmer: Hartford.						
	Aspirin		5.0	4.8	4.9	4.9	Pass	29966
29210	Aspirin (Tailby-Nason Co.)	A. P. Pratt: Windsor.						
	Aspirin		5.0	4.9	5.3	5.1	Satisfactory	29210
29926	Aspirin (United Drug Co.)	Liggett Drug Co: Hartford.						
	Aspirin		5.0	4.4	5.0	4.7	Pass	29926
30202	Aspirin (The Upjohn Co.)	Geo. D. Wight: Bethel.						
	Aspirin		5.0	4.7	5.1	4.8	Pass	30202
29945	Aspirin (John Wyeth & Bros)	Branford Pharmacy: Branford.						
	Aspirin		5.0	4.7	5.1	5.0	Satisfactory	29945
29215	Aspirin (Yates Drug & Chemical Co.)	J. E. Brainard: Wallingford.						
	Aspirin		5.0	4.6	5.2	5.0	Pass	29215
29901	Aspirin (Yates Drug & Chemical Co.)	A. J. Goodwin: Kensington.						
	Aspirin		5.0	4.8	5.7	5.3	Pass	29901
29912	Aspirin (Yates Drug & Chemical Co.)	G. W. Eddy: Collinsville.						
	Aspirin		5.0	4.8	5.1	5.0	Satisfactory	29912
940[1]	Blaud's Iron Pills (United Drug Co.)							
	Ferrous Carbonate		1.0	1.0	1.2	1.1	Satisfactory	940[1]
30206	Calcium, Iodized (Direct Sales Co.)	J. L. Pons: Bridgeport.						
	Total iodine		....	....	....	0.05		30206
	Avail. iodine		....	....	....	0.003	No standard for comparison	
29229	Calcium Sulphide Pills (Upjohn Co.)	J. H. Desmarais: Bristol.						
	Calcium Sulphide		1.0	0.9	1.0	1.0	Satisfactory	29229
29230	Calcidin (Abbott Laby.)	E. R. Storrs: Hartford.						
	Avail. iodine		0.15[2]	0.18	0.20	0.18	Pass	29230
29222 } 30223 }	Calomel (Yates Drug & Chemical Co.)	E. H. Metcalf: Rockville						
	Mercurous chloride		0.10	0.11	0.12	0.11	Satisfactory	{ 29222 { 30223
29991	Calomel (Smith Pharmacal Co.)	W. E. Hills: Naugatuck						
	Mercurous chloride		0.25	0.24	0.27	0.26	Satisfactory	29991
29919	Corrosive Sublimate (Davis, Rose & Co.)	The Valley Pharmacy: Collinsville						
	Mercuric chloride		6.9[3]	7.4	7.7	7.5	Satisfactory	29919

[1] Station Sample.

[2] Claim, 1 grain calcidin, contains 15% avail. iodine.

[3] Not less than 0.45 gm. not more than 0.55 gm. = 6.9—8.5 grains.

Table XVII. Analyses of Medicinal Tablets, Etc.

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist	Medicament: Declared, grains per tablet	Found, grains: Min.	Found, grains: Max.	Found, grains: Avg.	Remarks	D.C. No.
30227	Corrosive Sublimate (Davis, Rose & Co.)	The Congress Pharmacy: New Haven.						
	Mercuric chloride		6.9 [1]	6.6	7.3	6.9	Satisfactory	30227
30228	Corrosive Sublimate (Morgenstern & Co.)	M. Epstein: New Haven.						
	Mercuric chloride		7.3	7.0	8.0	7.6	Pass	30228
29219	Coryza No. 2 (G. S. Stoddard & Co.)	T. F. Rockwell: Rockville.						
	Potass. bromide		0.167	....	....	0.161		29219
	Camphor		0.25	....	....	0.20		
	Quinine, strychnine and atropine		0.111 [2]	....	....	0.097 [3]		
	Salicylic acid		....	....	....	0.03		
	Acetanilid		....	....	....	0.10		
	Acetphenetidin		....	....	....	0.005?	Pass	
30209	Hexamethylenamine (Direct Sales Co.)	H. F. Moore: Bethel.						
	Hexamethylenamine		5.0	4.8	5.0	4.9	Pass	30209
29226	Hexamethylenamine (Buffington, Inc.)	R. A. Richardson: Bristol.						
	Hexamethylenamine		5.0	4.8	4.9	4.9	Pass	29226
30212	Hex-Iodine Lozenges (Daggett & Miller Co.)	D. R. Howland: Stratford.						
	Hexamethylenetetramine		....	....	....	10.52 [4]		30212
	Iodine		....	....	....	0.17 [4]		
	Ash		....	....	....	2.41 [4]		
	Sugar		....	....	....	80.00 [4]		
	Menthol and undetermined		....	....	....	6.90 [4]	Pass	
29908	Hydrastin-Strychnine Trit. (Smith Pharmacal Co.)	E. R. Kelsey: Winsted.						
	Hydrastine and strychnine, as total alkaloids		0.010 [2]	....	....	0.008 [3]	Pass	29908
29228	Migraine Tablets No. 8 (Nat. Drug Co.)	F. M. Hamblin: Bristol.						
	Acetanilid		2.5	2.1	2.4	2.2		29228
	Morphine sulphate		0.05	0.05	0.05	0.05		
	Sodium salicylate		1.75	1.41	1.60	1.48		
	Caffeine		0.25	0.23	0.26	0.24		
	Sodium bicarbonate		1.0	1.0	1.1	1.0		
	Capsicum		0.05	....	....	....	Pass (Low in sodium salicylate)	
29225	Migraine Tablets (Tailby-Nason Co.)	R. A. Richardson: Bristol.						
	Acetanilid		2.0	2.0	2.1	2.0		29225
	Caffeine		0.25	0.24	0.26	0.25		
	Camphor monobromate		0.5	0.5	0.5	0.5	Satisfactory	
29932	Morphine Sulphate (Hypoderm.) (John Wyeth & Bros.)	J. E. Loveland: Middletown.						
	Morphine sulphate		0.125	0.120	0.140	0.130	Pass	29932
29247	Nitroglycerine Tablets (Nat. Drug Co.)	T. C. Hodgson: Berlin.						
	Nitroglycerine		0.01	0.01	0.01	0.01	Satisfactory	29247
29213	Phenolphthalein Tablets (Direct Sales Co.)	F. J. Mann: Southington.						
	Phenolphthalein		2.0	2.0	2.3	2.2	Pass	29213
29915	Quinine Sulphate (G. F. Harvey Co.)	R. B. Cox: Collinsville.						
	Quinine sulphate		2.0	1.9	2.2	2.1	Pass	29915
29924	Quinine Sulphate (Standard Laby.)	C. T. Baldwin: Derby.						
	Quinine sulphate		2.0	1.8	1.9	1.9	Pass	29924

[1] Not less than 0.45 gm. nor more than 0.55 gm. = 6.9 − 8.5 grains.
[2] Calc. for mixed alkaloids.
[3] Mixed alkaloids.
[4] Percentages. Claimed to contain hexamethylenetetramine and iodine.

TABLE XVII. ANALYSES OF MEDICINAL TABLETS, ETC.

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist	Medicament: Declared, grains per tablet	Medicament: Found, grains: Min.	Medicament: Found, grains: Max.	Medicament: Found, grains: Avg.	Remarks	D. C. No.
29246	Quinine Sulphate (National Drug Co.)	T. C. Hodgson: Berlin.						
	Quinine sulphate		2.0	1.7	1.9	1.8	Pass	**29246**
30203	Quinine Sulphate (Yates Drug & Chemical Co.)	J. D. Eggleston: Meriden.						
	Quinine sulphate		2.0	2.0	2.3	2.2	Pass	**30203**
29910	Sedative Pills No. 3 (G. F. Harvey Co.)	R. V. Sanderson: Winsted.						
	Camphor, asafoetida and valerian		....	....	....	....	Pass (Camphor and asafoetida present, amount not determined	**29910**
29953	Sodium Bromide (Am. Drug. Syndicate)	Devita Pharmacy: New Haven.						
	Sodium bromide		5.0	4.7	5.3	5.0	Pass	**29953**
29978	Sodium Bromide (Tailby-Nason Co.)	H. Boyd: So. Manchester.						
	Sodium bromide		10.0	9.6	9.9	9.8	Pass	**29978**
29236	Triple Bromides (Tailby-Nason Co.)	G. T. Lamarche: Putnam						
	Potassium bromide		2.5	2.6	2.8	2.7		**29236**
	Sodium bromide		2.5	2.4	2.5	2.5		
	Ammonium bromide		2.5	2.5	2.6	2.5	Pass	
29961	Sodium Salicylate (Daggett & Miller Co.)	M. J. Dowd: Thompsonville.						
	Sodium salicylate		5.0	4.9	5.1	5.0	Satisfactory	**29961**
30214	Sodium Salicylate (Daggett & Miller Co.)	D. R. Howland: Stratford.						
	Sodium salicylate		5.0	3.6	3.8	3.7	Low	**30214**
29214	Sodium Salicylate (Direct Sales Co.)	F. J. Mann: Southington.						
	Sodium salicylate		5.0	4.6	4.9	4.8	Pass	**29214**
29221	Sodium Salicylate (Direct Sales Co.)	E. H. Metcalf: Rockville.						
	Sodium salicylate		5.0	4.9	5.2	5.1	Satisfactory	**29221**
29951	Sodium Salicylate (G. F. Harvey Co.)	P. A. Park: Bristol.						
	Sodium salicylate		5.0	4.0	5.2	4.7	Pass	**29951**
29208	Sodium Salicylate (Rheumatic Tablets) (Maltbie Chem. Co.)	H. F. King: Windsor.						
	Sodium salicylate		7.5	7.2	7.5	7.4		**29208**
	Sodium bicarbonate		2.5	2.5	2.6	2.5		
	Wine colchicum seed		....	....	....	....	Pass	
29931	Sodium Salicylate (Haberle Drug Co.)	H. L. Burr: Middletown						
	Sodium salicylate		5.0	4.8	5.3	5.2	Satisfactory	**29931**
29923	Sodium Salicylate (Standard Laby.)	C. T. Baldwin: Derby.						
	Sodium salicylate		5.0	4.4	5.1	4.8	Pass	**29923**
29920	Sodium Salicylate (R. J. Strasenburg Co.)	E. P. Dunne: Unionville.						
	Sodium salicylate		5.0	4.7	5.0	4.9	Pass	**29920**
29248	Sodium Salicylate (Syracuse Pharmacal Co.)	R. M. Griswold: Kensington.						
	Sodium salicylate		5.0	3.8	4.0	3.9	Low	**29248**
29248 D	Duplicate of **29248** (Syracuse Pharmacal Co.)	R. M. Griswold: Kensington.						
	Sodium salicylate		5.0	3.8	4.0	3.9	Low	**29248D**
29235	Sodium Salicylate Comp. (Tailby-Nason Co.)	G. T. Lamarche: Putnam.						**29235**
	Acetanilid		2.5	2.4	2.6	2.5		
	Caffeine		0.25	0.23	0.25	0.24		
	Sodium salicylate		1.75	1.76	1.92	1.83		
	Sodium bicarbonate		1.0	0.9	1.0	1.0	Satisfactory	

Table XVII. Analyses of Medicinal Tablets, Etc.

D. C. No.	Drug and Manufacturer	Stock of Doctor or Druggist	Medicament: Declared, grains per tablet	Medicament: Found, grains: Min.	Max.	Avg.	Remarks	D. C. No.
29903	Sodium Salicylate (Tailby-Nason Co.)... Sodium salicylate	E. G. Reade: Watertown.	5.0	4.5	5.0	4.8	Pass	**29903**
29967	Sodium Salicylate (Tailby-Nason Co.)... Sodium salicylate	E. O. Elmer: Hartford.	5.0	4.6	4.8	4.7	Pass	**29967**
29946	Sodium Salicylate (Yates Drug & Chemcal Co.) Sodium salicylate	A. S. McQueen: Branford.	5.0	4.7	5.1	4.8	Pass	**29946**
30211	Sodium Salicylate (Yates Drug & Chemical Co.) Sodium salicylate	H. D. Lockwood: Meriden.	5.0	4.9	5.5	5.2	Pass	**30211**
29914	Strontium Salicylate (Daggett & Miller Co.) Strontium salicylate	R. B. Cox: Collinsville.	5.0	4.5	4.8	4.6	Pass	**29914**
29905	Strontium Salicylate (Tailby-Nason Co.) Strontium salicylate	E. L. Pratt: Winsted.	5.0	4.8	5.2	5.0	Satisfactory	**29905**
29969	Strychnine Sulphate (A. D. S.) Strychnine sulphate 1/30	Ebbs Drug Co.: Waterbury.	0.033	0.032	0.037	0.035	Pass	**29969**
29216	Strychnine Sulphate (Daggett & Miller Co.) Strychnine sulphate 1/60	I. E. Brainard: Wallingford.	0.017	0.022	0.025	0.023	Excess strychnine sulphate	**29216**
29216 D	Duplicate of **29216** (Daggett & Miller Co.) Strychnine sulphate 1/60	I. E. Brainard: Wallingford.	0.017	0.020	0.022	0.022	Excess strychnine sulphate	**29216D**
29900	Strychnine Sulphate (Glen Pharmacal Co.) Strychnine sulphate 1/60	R. M. Griswold: Kensington.	0.017	0.018	0.021	0.020	Pass	**29900**
30219	Strychnine Sulphate (The G. F. Harvey Co.) Strychnine sulphate 1/60	L. C. Heidger: Stratford.	0.017	0.013	0.015	0.014	Pass	**30219**
29211	Strychnine Sulphate (Nat. Drug Co.) Strychnine sulphate 1/30	A. P. Pratt: Windsor.	0.033	0.033	0.040	0.038	Pass	**29211**
30210	Strychnine Sulphate (Yates Drug & Chemical Co.) Strychnine sulphate 1/30	H. DeF. Lockwood: Meriden.	0.033	0.031	0.039	0.034	Pass	**30210**
29916	Thyroid (Desiccated) Tablets (G. F. Harvey Co.) Equivalent to 10 grains fresh thyroid. Iodine in thyroid combination	R. B. Cox: Collinsville.	0.0034[1]	0.0037	0.0050	0.0046	Satisfactory	**29916**
29989	Thyroid (Desiccated) Tablets (G. F. Harvey Co.) Same as **29916**	R. B. Cox: Collinsville.	0.0034[1]	0.0032	0.0046	0.0037	Satisfactory	**29989**
29911	Valerian Compound (Tailby-Nason Co.)	R. V. Sanderson: Winsted.						**29911**
	Barbital		0.25	....	....	0.24		
	Valerian		....	....	....	....		
	Hyoscyamus		....	....	....	....		
	Asafoetida		....	....	....	....	Pass (asafoetida present; valerian and hyoscyamus not identified	

[1] Ten grains fresh thyroid = 2 grains dry. Dry thyroid contains not less than 0.17 nor more than 0.23 per cent. iodine in thyroid combinations = 0.0034 to 0.0046 grain.

Drugs Not Purchased on Prescription.

BORIC ACID.

Boric acid of the purity prescribed by the U. S. Pharmacopoeia contains, in the dried powder, not less than 99.5 per cent. of boric acid, H_3BO_3.

29224. Sample purchased at Wilson Pharmacy, Willimantic, (Brewer and Co. product). It contained 99.04 per cent. of boric acid.

Sample passed.

29223. Sample purchased of C. DeVillers, Willimantic. (20 Mule Team brand). It contained 99.0 per cent. of boric acid.

Sample passed.

CALCIUM HYDROXIDE SOLUTION

Lime water should contain not less than 0.14 per cent. of calcium hydroxide $Ca(OH)_2$.

Samples examined are listed in the following summary.

Analyses of Lime Water.

D. C. No.		Druggist	Calcium hydroxide $Ca(LH)_2$ found %
29918	*Collinsville*	Valley Pharmacy..........	0.17
30226	*New Haven*	State Pharmacy..........	0.17
30225		J. P. Gillespie & Co..........	0.16
30234	*Wallingford*	Moran's Drug Store:.....	0.17
30236	*Waterbury*	Apothecaries Hall Co......	0.02
29947	*Winsted*	The Case Drug Store.....	0.17

Sample **30236** deficient in lime.

CALOMEL.

One sample purchased by the Station agent, **953**, Merck's product, was found to contain 99.8 per cent. of mercurous chloride. The U. S. Pharmacopoeia requires not less than 99.6 per cent.

Sample satisfactory.

MONOBROMATED CAMPHOR.

No assay for this product is given in the U. S. Pharmacopoeia although certain specifications for it are defined.

29981. Sample purchased of John J. Cronin, Middletown, Merck's. Assayed by the tentative method[1] it was found to closely approximate 100 per cent. monobromated camphor.

Sample satisfactory.

[1] J. A. O. A. C.

SOLUTION OF CITRATE OF MAGNESIA.

27877. This preparation was made and distributed by A. K. Shupis, Stamford. It contained 1.07 gms. of magnesium oxide (MgO) per 100 cc., whereas the U. S. Pharmacopoeia requires not less than 1.5 gms. per 100 cc.

Sample below standard.

COLLODION.

This preparation unless otherwise specified, should be of the contractile type and contain not less than 5.1 per cent. of pyroxylin.

29988. Sample purchased of J. G. McNamara, Collinsville. It contained 5.75 per cent. of pyroxylin and otherwise conformed to the specifications for collodion except for a faint acidity and the probable presence of amyl acetate, the odor of which was apparent on evaporation.

Sample passed.

SYRUP OF FERROUS IODIDE

This preparation should contain not less than 4.75 nor more than 5.25 per cent. of ferrous iodide, FeI_2.

29949. Sample purchased at Claxton's Drug Store, Torrington. It contained 5.25 per cent. of ferrous iodide.

Sample satisfactory.

TINCTURE OF IODINE.

This preparation should contain not less than 6.5 nor more than 7.5 grams of iodine, and not less than 4.5 nor more than 5.5 grams of potassium iodide per 100 cc.

29921. Sample purchased at the Thompsonville Drug Co., Thompsonville. It contained 6.55 grams of iodine and 4.56 grams of potassium iodide per 100 cc.

Sample satisfactory.

29207. Sample purchased at the Bridge Pharmacy, Windsor Locks. It contained 6.95 grams of iodine and 5.07 grams of potassium iodide in 100 cc.

Sample satisfactory.

30230. Sample purchased at the Powell Drug Co., East Hartford. It contained 6.70 grams of iodine and 4.63 grams of potassium iodide, per 100 cc.

Sample satisfactory.

ESSENCE OF PEPPERMINT.

This preparation should contain 10 per cent. by volume of oil of peppermint.

The samples examined are summarized as follows:

No.		Druggist	Peppermint oil, per cent.
30248	*Putnam*	J. A. P. Gagne	4.0
30247		G. N. Lemaitre	11.3
30400	*Torrington*	South End Pharmacy	9.5
30401		Park Pharmacy	13.9
30402		Claxton's Pharmacy	10.9
29948	*Winsted*	City Pharmacy	7.7
29948D		City Pharmacy	10.7
30249		Albert Decsi	12.4

Two samples **30248** and **29948** were deficient in peppermint oil. A second sample of one of these, **29948D**, was of required strength.

SWEET OIL.

29922. Sweet Oil, Pleasant St. Pharmacy, Thompsonville. No oil other than olive oil should be dispensed as sweet oil. This sample responded to the tests for genuine olive oil.

Sample passed.

Toilet Preparations.

These products have been examined chiefly in accordance with Section 2679 of the General Statutes which prohibits the use of wood alcohol in the compounding of any toilet lotion.

Eleven samples of hair tonic, three of bay rum and two of witch hazel were examined but no wood alcohol was detected.

Two samples of hair tonic, **29972** and **22973**, sold by E. J. Mangini of Waterbury have no declaration of the percentage of alcohol present. They contained 45 and 57 per cent. respectively.

Wild Root Hair Tonic, **29963,** Wildroot Co., Inc., sold by A. Seidman, Hartford, contained 23 milligrams of arsenic per 100 cc.

Another preparation containing arsenic was brought to our attention by a purchaser. This was an original bottle labelled KDX Dandruff Exterminator, **22704**, Koken Companies, St. Louis. The preparation was found to be a dilute, alkaline, alcoholic solution containing 93 milligrams of arsenic (As) per 100 cc. of solution, with a salicylate and glycerin. Other medicaments, if present, not identified.

Medical and other literature contain conflicting data upon the effects of arsenic. Its external application may develop pustules, vesicles and erysipelatoid inflammation of the skin[1]; but it is further noted that many forms of skin disease, such as chronic eczema, are treated with arsenic with beneficial results[2]. Absorption takes place to some extent through the intact skin so that poisoning may result from the external use of arsenical cosmetics;[3]

[1] Cushny. *Pharmacology and Therapeutics*, p. 595.
[2] Ibid, p. 602.
[3] Sollmann. *Manual of Pharmacology*, p. 737.

but improved nutrition of the skin and hair is said to be effected by external and internal treatment with arsenic.[1] Another authority[2] cites instances of poisoning, particularly the death of a child following the application of an arsenical ointment for scalp eruption. "Arsenic pock"[3] is a term used to designate arsenical ulcers of the hands in the case of color workers and others engaged in handling arsenical materials.

There appears to be no question that arsenic constitutes a potential source of injury and that its indiscriminate use in toilet lotions and hair tonics is attended with danger.

27244. *Boncilla Clasmic Pack.* Crown Chemical Co., Indianapolis, Ind. Sample submitted by a purchaser through the office of the Dairy and Food Commissioner.

Loss on drying at 100° C. (chiefly moisture), 48.30 per cent., organic and volatile 4.09 per cent., ash 47.61 per cent. Silica, iron, aluminum and manganese considerable, calcium magnesium and sodium small amount, carbonate and sulphate small amount, phosphate trace, organic extractives negligible amount, no vesicating principles found, glycerine present, arsenic not detected.

The preparation consists essentially of perfumed clay (iron-aluminum silicate), glycerine and water with a little calcium carbonate. The composition is quite typical of so-called beauty clays.

27245. *Cold Cream.* Brand not known. Submitted by a purchaser who used it in conjunction with beauty clay, **27244,** and suffered irritation of the skin.

The cream was almost completely soluble in ether and besides the fatty base and perfume nothing was found. No vesicating principles or arsenic were detected.

Proprietary Remedies, etc.

22530 A. *Sun and Moon Sacred Anointing Oil.* Prepared by A. W. Lowrie, Inc., Hartford. Recommended for external or internal use. Sample submitted by the Commissioner of Public Health through the office of the Dairy and Food Commissioner. The preparation consisted of yellow, limped oil with a small layer of brown solution containing some sediment. The odor of methyl salicylate was apparent and the reaction was slightly acid to litmus.

Partial analysis:

Moisture and volatile at 100°C., 10.48 per cent.; residue at 100°C (largely oil), 89.52 per cent.; ash trace; alcohol by weight 1.91 per cent.; salicylate present; alkaloids none found; refraction of oil at 25° C 62.2° (butyro-refractometer scale); iodine No. of oil 64; Halphen test on oil negative. Oil almost completely saponifiable.

[1] Sollmann. *Manual of Pharmacology*, p. 742.
[2] Peterson, Haines and Webster. *Legal Medicine and Toxicology*, p. 218.
[3] Kober and Hayhurst. *Industrial Health.*

The examination shows that the medicine consists substantially of a fixed oil, methyl salicylate and a small amount of vegetable extractive material in dilute alcohol.

22530 B. *Sun and Moon Sacred Ointment.* This is another sacred remedy of the same manufacturer.

Partial analysis:

Moisture and volatile at 100°C 8.27 per cent.; residue at 100° C (fatty base) 91.73 per cent.; ash trace; salicylate present; alkaloids not found; menthol none found. Fat largely unsaponifiable; fluorescent in ether solution.

The ointment consists of a fatty base (probably petrolatum), a little saponifiable fat or oil with methyl salicylate as the chief or only active ingredient.

The remedy is proclaimed by the manufacturer as "A food for the body to destroy disease" and is further claimed to contain "vibrations of life from the radio-activity of electricity magnetism, electrons and atoms." This meaningless jumble of scientific terms serves to introduce the element of mystery upon which the "patent medicine" man generally depends for the appeal of his wares. In this instance the mystery is fortified with alleged sacredness.

29450. *Nature's Vital Food.* Manufactured by A. S. Maine, Westerly, R. I. Sample submitted by Dr. Osborne, Health Commissioner, through the office of the Dairy and Food Commissioner.

The label on the bottle says, in part, that this remedy is a special preparation of 32 kinds of roots, herbs, barks and gums; that it is a *blood purifier* the use of which *makes possible the cure* of thousands of the most virulent cases of cancer, etc. This implies that the remedy effects such cures. On reading the literature which goes with the package however, it appears that this medicine is used as a tonic to fit the patient for the Main's special cancer treatment which consists, apparently, of drawing out the cancer by means of plasters. On the reverse side of the label appears the claim that the remedy is a preventive of cancers, tumors, syphilis, and a number of other diseases. On the carton it says, in part: "An internal medicine for all aliments of the human body—removing the cause of your disease, thereby rendering a permanent cure.

The preparation is a dark brown liquid with some sediment, acid to litmus, and having a disagreeable odor.

Analysis was made as follows:

Water and volatile at 100°C 98.82 per cent.; solids 1.18 per cent.; ash 0.27 per cent.; iron, calcium, magnesium sodium, potassium, sulphate and phosphate present; chloride trace; zinc trace (?); anthraquinone derivatives present; bitter and pungent principles present; asafoetida, rhubarb, gentian and capsicum indicated; aloes not found; benzoic acid present, (0.04%); salicylic and citric acids not found; hypophosphites, antipyrin, acetphenetiden, acetanilid, pyramidon, iodine and alcohol not found; alkaloids none or trace.

The examination shows that the preparation is an aqueous solution of vegetable extractives consisting wholly, or in part, of vegetable cathartics with bitter and pungent principles; and containing a small amount of benzoic acid and some vegetable tissue.

The mineral constituents are insignificant, as shown by the small amount of ash, and are only such as are generally present in the ash of vegetable matter.

The labeling of this product is an example of misbranding at its worst.

21850. *Volta.* Prepared and distributed by the Volta Company of America, Inc., Philadelphia, Pa. Sample purchased by the Station agent at Wood's Drug Store, New Haven.

Analysis:

Free sulphur 86.74 per cent;. aluminum oxide 3.20 per cent.; iron oxide 0.74 per cent.; phosphate trace; carbonate, borate, chloride and soluble sulphate none found; alkaloids none found; starch none; methyl salicylate present.

The analyses indicates that the preparation is essentially a mixture of sulphur, iron and aluminum oxides, with methyl salicylate and possibly some other aromatic substance.

The product is not labeled as a cure or a remedy, but states that it is adapted to the treatment of rheumatism, sciatica, etc.

21851. *Erbjus.* Prepared by the Erbjus Remedy Co., Bridgeport, Conn. Sample purchased by the Station agent at Wood's Drug Store, New Haven. A tonic "made with herb juice and glycerine. Non-alcoholic, for stomach, kidney, liver, rheumatism and bowels."

Analysis showed the following composition:

Water (in vacuo at 60° C), 84.80 per cent.; ash 0.53 per cent.; glycerine 10.74 per cent.; sugar, as dextrose, 1.75 per cent.; salicylic acid 0.43 per cent; undetermined 1.75 per cent. Qualitative tests showed the presence of salicylic acid, anthraquinone derivatives, glycerine, sugar and citrates(?) No other medicaments were detected. Alkaloids and aloes not found. Manganese was present in the ash but other ash constituents were not investigated.

The preparation appears from the analysis to be a solution of vegetable cathartics and bitters in glycerine and water. No curative claims for the article are made.

21847. *Dr. Edward's Olive Tablets.* The Olive Tablet Co., Columbus, Ohio. A substitute for calomel. Sample purchased by the Station agent at York Pharmacy, New Haven.

These are olive-green, sugar coated pills averaging in weight a little less than 3 grains each.

Examination and partial analysis:

Qualitative tests showed the presence of aloes; ginger, sugar, calcium (large amount), and iron. Starch, alkaloids, jalap and mercury not detected. Quantitative determinations showed moisture and volatile at 100°C. 5.86 per cent.; ash (chiefly calcium carbonate), 13.93 per cent; petroleum ether extract non-volatile at 100° C. 1.15 per cent.

The tablets contain aloes and ginger as the essential medicaments.[1]

30216. *Dakol.* The Dakol Co., New Haven. Samples by the Dairy and Food Commissioner. This is a nasal cream.

Examination:

Qualitative tests showed the base to consist largely of saponifiable fat with menthol and creosote or guiacol indicated. (The odor of creosote was apparent in one of the factions but tests for it were negative).

23367. *Ovelmo Blood Tonic and Restorative,* Ovelmo Co., Fort Wayne, Ind. Sample submitted by a purchaser. Red tablets, average weight 0.681 gram. Not labelled as a cure.

Analysis:

Moisture 4.00 per cent.; ash 37.43 per cent.; insol. ash, talc. etc., 2.90 per cent.; iron and aluminum oxides 8.25 per cent.; calcium oxide 9.62 per cent.; magnesium oxide 1.10 per cent.; sodium oxide 4.27 per cent.; potassium oxide 0.35 per cent.; sulphur trioxide 6.39 per cent.; phosphorus pentoxide 0.10; chlorine 0.15 per cent; carbon dioxide present, not determined; nitrogen 0.38 per cent; sugar 35.59 per cent; starch 6.80 per cent; cellulose (fiber) 3.71 per cent; ether extract 1.83 per cent; emodin-like substance present; alkolaids none found.

The tablets consist substantially of ferrous sulphate, bicarbonate of soda, carbonates of lime and magnesia, sugar, starch, a small amount of emodin-like substances (vegetable cathartics), and other vegetable extractives. No alkaloids were found.

23368. *Ovelmo Digestive Tablets.* Ovelmo Co., Fort Wayne, Ind. Sample submitted by a purchaser. Black tablets, average weight 0.347 grams. Not labelled as a cure.

Analysis:

Moisture 6.75 per cent.; ash 38.35 per cent.; insol. ash 2.30 per cent.; iron and aluminum oxides 2.25 per cent.; calcium oxide 9.25 per cent.; magnesium oxide 9.64 per cent; sodium oxide 6.23 per cent; potassium oxide 0.45 per cent; phosphorus pentoxide 0.40 per cent; chlorine 0.40 per cent; carbon dioxide present, amount not determined; sulphur trioxide none; nitrogen 0.35 per cent; sugars 25.02 per cent; starch 10.80 per cent; cellulose (fiber) 5.19 per cent; ether extract 1.48 per cent.; emodin-like substances indicated; charcoal present; alkaloids none found; diastase and pepsin not tested for.

These tablets consist of, or contain, bicarbonate of soda, carbonates of lime and magnesia, starch, sugar and charcoal. Emodin-like substances are indicated, and digestive ferments may be present.

[1] See also Conn. Exp. Sta. Report for 1914, p 310.

Both these Ovelmo products were purchased on the mail order plan and were being used by the purchaser to cure eczema. In the literature of the American Medical Association we find reference to an "Ovelmo Company" of Fort Wayne which did a mail order business in preparations for the cure of skin diseases until Federal interference finally disrupted the organization. Whether the old concern has been revived under new management, or whether the similarity of name, methods and purposes of the present company is merely a coincidence we cannot say. At any rate, we advised the purchaser of these remedies to consult his physician or a specialist in skin diseases.

D. C. 30221. *Mineral Water.* Luippold Mineral Water Co., Inc., Bridgeport, Conn. This is a carbonated water and analysis was made after carbon dioxide had been largely removed. Results are expressed as milligrams per liter.

Analysis:

Total solids at 100°C. 8970; after ignition 6870; silica 14.5; iron and aluminum oxides (largely ferrous iron), 30; potassium oxide 60; sodium oxide 2176.9; magnesium oxide 586.4; calcium oxide 1010; strontium oxide trace?;maganese oxide 15; chloride (Cl), 4345; sulphate (SO_3), 446; phosphate (P_2O_5), none; carbon dioxide present.

The water contains chiefly chlorides of sodium, megnesium and calcium with smaller amounts of other mineral salts. It is a natural mineral water, carbonated.

Collateral advertising stressed curative features of the product and was objectionable as were certain claims made on the label itself. A representative of the company, in conference with the Dairy and Food Commissioner, advised that the advertisement cited was the only one of its kind that had appeared and that it would not be repeated; and that the label had already been revised.

Miscellaneous Drugs.

Miscellaneous drugs and chemicals for identification or other examination have been submitted, chiefly by health or other public officials, and are summarized in Table XVIII.

TABLE XVIII. MISCELLANEOUS DRUGS ETC.

No.	Name of drug, etc.	Remarks.
D. C. 29464	Alcohol	No wood alcohol found. Trace of diethylphthalate present.
28223 } 22824 }	Ampules of silver nitrate.	Tested for acidity. Faint acidity was demonstrated but no evidence that it was sufficient in kind or amount to cause injury when applied to the eyes, was obtained.
639	Boric acid	Found to be 98.6 per cent. pure.
506	Hank's Chemical (fire extinguisher)	About 99 per cent. bicarbonate of soda colored with iron salt.
D. C. 29425	Medicine. (Prescription).	Prescription called for ammonium and potassium bromides, aromatic spirits of ammonia, camphor and water. Total bromides calculated 9.4 gms. per 100 cc, found 8.7 gms. Ammonia and camphor present. Medicaments substantially as called for.
22374	Medicine	A syrupy solution containing iron and vegetable cathartics. No other medicaments detected.
D. C. 29419	Medicine	Found: Alcohol 7.8 per cent., sodium bromide 12.28 per cent., glycerine 22.46 per cent. phenolphthaline present, pepsin indicated, iron, potassium and phosphates traces, alkaloids and arsenic none found. Medicine consists of a sedative, laxative, pepsin, alcohol, glycerine and water.
D. C. 28618	Preserving Powder F.L.P.	Consists substantially of salt and chili saltpeter. (Nitrate of soda.)
D. C. 28074	B. Salt	Consists essentially of salt and nitrate of soda or saltpeter and red pepper.
D. C. 28779	Preservaline	Contains 93.27 per cent. of sodium sulphite. No borax.
22347	Sodium hydroxide solution	Found to be 1.126 stronger than tenth normal.
22591	Stain for poultry feathers	Appeared to be commercial turpentine, or turpentine and a light oil.
143	Unknown substance	Identified as plaster of Paris (calcium sulphate).

BABCOCK GLASSWARE, ETC.

The following is a summary of Babcock glassware checked during the year. Lactometers and thermometers were compared with certified instruments for the Dairy and Food Commissioner.

	Total	Broken in transit	Accurate	Inaccurate
Cream	585	3	537	45
Milk test bottles	2707	29	2652	21
Pipettes	556	20	533	3
Acid measures	1	0	1	0
Lactometers	17	0	17	0
Therometers	8	0	8	0
Totals	3869	52	3748	69

BULLETIN 268 MARCH 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

REPORT ON INSPECTION OF COMMERCIAL FEEDING STUFFS

1924

E. M. BAILEY

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

March, 1925.

The Wilson H. Lee Co.

CONTENTS.

THE NEW LAW RELATING TO FEEDING STUFFS.

A law relating to Concentrated Commercial Feeding Stuffs was passed by the General Assembly, session of 1925, and is now in force. Rules and regulations for enforcement of the law will be issued, as provided in the act, but the essential provisions as they differ from the old law may be here noted. Copies of the law may be obtained from this Station upon request.

"Concentrated Commercial Feeding Stuffs" defined. Section 1 of the law defines the term "concentrated commercial feeding stuffs" in substantially the same way that it is defined in the old law; and with the same exemptions. Scratch grains are classed as concentrated feeds.

Labelling. Section 2 defines how concentrated commercial feeding stuffs shall be labelled. The label must declare (1) the number of net pounds of feed in the package; (2) the name, brand or trade mark under which the article is sold; (3) the name and address of the manufacturer or importer; (4) a statement of the minimum percentages of (a) crude protein, (b) crude fat, and (c) the maximum percentage of crude fiber; and (5) in case of feeds composed of two or more ingredients, the name of each ingredient contained therein.

Registration and registration fee. Section 3 requires the annual registration of concentrated commercial feeding stuffs and a registration fee of fifteen dollars ($15.00) for each brand. Registration is to be made with the Connecticut Agricultural Experiment Station on or before September 1, 1925, and annually thereafter.

Duties of Manufacturers. Manufacturers, jobbers or individuals shipping feeds into Connecticut will be expected to register their brands and pay the necessary fees thereon. Connecticut dealers should assure themselves that the brands they handle are properly registered. In case the manufacturer or jobber outside the State neglects or refuses to register, the dealer who handles such feeds will be held responsible for such registration and registration fee.

Dealers within the State who mix their own brands are responsible for the registration and proper labelling thereof.

Cottonseed Meal. Cottonseed meal registered as required by the fertilizer law is not exempt from registration also under the feed law if sold for feeding purposes.

Meaning of "Brand". It is held that a distinct brand name or a distinct guaranty constitutes a distinct brand.

Affixing Tags. The use of wire or any metal in affixing tags is prohibited by law.

Commercial Feeding Stuffs.

E. M. Bailey.*

RÔLE OF THE NUTRIENTS.

Water. Air dry feeding stuffs, whether concentrates or roughage, still contain some moisture which cannot be seen or felt. The amount of such moisture averages not far from ten per cent. While not a nutrient in the ordinary sense, water is essential to the animal; but since it is obtained in abundance from sources other than the feed, its presence therein is not of importance. Excessive amounts, however, jeopardize the keeping qualities of a feed and automatically reduce the percentage of the more desirable ingredients.

Ash. The importance of mineral constituents in feeds is emphasized by the fact that animals fed upon rations deprived largely or entirely of ash constituents generally die sooner than animals which have been given no food at all. Given stock mineral matter in addition to that obtained in the daily ration is an old and familiar practice among experienced stockmen who have long "salted their cattle" with common salt (sodium chloride), the commercial grades of which contain small and varying amounts of other minerals, such as calcium, magnesium, iron and phosphorus and sulphur. Recent studies in nutrition have shown some of the specific needs which minerals satisfy in the vital processes. Thus big neck in calves, colts and lambs, and hairlessness in pigs are now attributed to iodine deficiency in the feed; and defective skeletal formation in growing animals is due either to a lack of calcium and phosphorous or to an absence of the necessary agency to make the proper utilization of these minerals possible, for it has been shown that without what has been called the fourth, or antirachitic, vitamine which is present in cod liver oil and in green plant tissues, calcium and phosphorus cannot be properly assimilated.

Protein. This nutrient group is estimated by determining the amount of nitrogen which a feed contains and multiplying that amount by the factor 6.25 on the assumption that proteins uniformly contain 16 per cent. of nitrogen. While this method of estimation is not strictly accurate it is as close an approximation as it is generally possible or practicable to get. From protein the body repairs waste, builds new tissue and, to a lesser extent, derives heat and energy. It was formerly thought that all proteins were adequate for all these processes, but it is a comparatively

*Analyses are chiefly by Messrs. Nolan and Mathis; inspection and sampling by Mr. Churchill; and compilation largely by Miss Bacon.

recent contribution to our knowledge that they are not. Protein is a complex substance made up of nineteen separate parts called amino acids. Proteins which contain some of all the various amino acids are called "complete" proteins; those in which one or more amino acids are lacking are called "incomplete". Undoubtedly all these separate parts play some rôle in vital processes; more particularly we know that tryptophane and lysine are essential to a normal rate of growth. The proteins of cereal grains are relatively low in the two amino acids just mentioned while proteins of animal origin, such as milk, meat, and eggs, are rich in these two substances; thus the logic of supplementing grain rations with skimmed milk or tankage is apparent. Grain mixtures alone may suffice if fed in sufficient quantity but it may happen that the energy requirements of the animal will become satisfied by non-protein constituents of the ration and its appetite fail before enough of the necessary amino acids has been acquired.

Knowledge of digestible nutrients and nutritive rations are not the final criteria by which rations are to be adjusted. The right kind and quality of protein must be supplied.

Crude Fiber. By this term is meant the coarser and more woody tissue characteristic of all forms of roughage and present in the outer coats of cereal and other fodder grains. It belongs to the carbohydrate group and is, in part, digested by ruminant animals. Its chief value lies in its mechanical effect in the intestinal tract.

Nitrogen-free Extract. In this class are included the relatively more digestible carbohydrates of the starch and sugar types. Their principal rôle in nutrition is to supply heat and energy, but they have also the power of sparing protein, by which is meant that when fed together with protein they reduce the amount of the latter food required. An excess of this carbohydrate group over the immediate needs of the body can be transformed into fat and stored in the body tissue.

The term "carbohydrate" as applied to a feeding stuff properly means "crude fiber" and "nitrogen-free extract" combined. Nitrogen-free extract is obtained by deducting from 100 per cent. the sum of the percentages of moisture, ash, protein, fiber and fat (ether extract).

Fat (Ether Extract). Fats, like the carbohydrates, furnish energy to the body and like them also, but to a lesser extent, spare protein. As energy producers their value is 2.25 times greater than that of either carbohydrate or protein. This ether-soluble material is in all cases crude fat, by which we understand that non-fatty substances like chlorophyll and coloring matter may be included therein.

Accessory Nutritive Factors. In this class are included the vitamines. There is not likely to be a deficiency of the vitamines A, B and C in rations of domestic animals; and they will not lack

the antirachitic vitamine if green fodder or properly cured leguminous hay is supplied. The beneficial influence of sunlight upon the growth and development of animals has also been strikingly demonstrated, and it may be classed with the vitamines as an accessory nutritive factor.

Digestible Nutrients.

Coefficients of digestibility for some common commercial concentrates are given in the following table.

TABLE I. COEFFICIENTS OF DIGESTIBILITY OF FEEDING STUFFS[1]

Feed.	Average dry matter, lbs. per hundred.	Coefficient of digestibility.			
		Protein.	Fiber.	Nitrogen free extract.	Fat.
Cottonseed Meal	92.2	84	37	75	95
Cottonseed Feed	91.7	58	45	61	90
Linseed Meal (Old Process)	90.9	89	57	78	89
Wheat Bran	89.9	78	31	72	68
Wheat Middlings	89.6	77	30	78	88
Wheat Feed	89.9	77	36	76	87
Rye Feed	88.5	80	..	88	90
Buckwheat Middlings	88.0	87	32	86	83
Oat Feed	93.5	75	42	46	78
Oat Middlings	93.1	80	49	85	93
Corn Gluten Feed	91.3	85	76	88	85
Corn Gluten Meal	90.9	85	55	90	93
Hominy Feed	89.9	66	76	90	91
Brewers' Grains	92.5	81	49	57	89
Dried Beet Pulp	91.8	52	83	83	..

CLASSIFICATION OF SAMPLES.

Commercial feeding stuffs and other fodder materials examined during the past year may be summarized as follows:

Official samples drawn by the Station agent	200
Samples submitted by purchasers or drawn by the Station agent upon request	63
Samples examined in connection with experimental work at the Storrs Station	91
Total	354

INSPECTION OF 1924.

Two hundred official samples were drawn by the Station agent during November and December, 1924. These samples and those

[1] Henry and Morrison: Feeds and Feeding, 18th Ed.

submitted by, or at the request of, purchasers are discussed in this report.

Samples secured for inspection purposes may be classified as follows:

Cottonseed Products	8	Proprietary Horse Feeds	3
Linseed Products	6	" Stock "	21
Wheat Products	38	" Dairy "	37
Rye Products	1	" Hog "	1
Maize Products	17	" Poultry "	38
Brewers' and Distillers' Products	4	Beef Scrap	20
Dried Beet Pulp	6	Total	200

Remarks on Analyses.

(*Analyses in Table II, pages 505-526.*)

Definitions of feeding stuffs here quoted are those adopted by the Association of Feed Control Officials.

COTTONSEED MEAL.

41.12 Per cent. Protein Cottonseed Meal, Choice Quality, must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow. free from excess of lint, and must contain at least 41.12 per cent. crude protein, equivalent to 8 per cent. of ammonia.

Cottonseed meal not fulfilling the above requirements as to color, odor, or texture, shall be branded Off Quality.

38.56 Per cent. Protein Cottonseed Meal, Prime Quality, must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 38.56 per cent. crude protein, equivalent to 7.5 per cent. of ammonia.

Cottonseed meal not fulfilling the above requirements as to color, odor or texture, shall be branded Off Quality.

36 Per Cent. Protein Cottonseed Meal, Good Quality, must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, free from excess lint and must contain at least 36 per cent. crude protein, equivalent to 7 per cent. of ammonia.

Cottonseed Meal not fulfilling the above requirements as to color, odor or texture, shall be branded Off Quality.

Seven samples were examined two of which viz., Dixie, **778**, and Neal's Choice, **749**, were deficient by large amounts. Dixie, guaranteed 41.12 per cent. of protein and not over 10 per cent. of fiber was found to contain 33.75 per cent. of protein and 13.88 per cent. of fiber. Analysis of the duplicate which was left with the dealer by our agent, No. **1419**, showed 34.88 per cent. of protein. In the case of Neal's Choice, **749**, the guaranty called for 43 per cent. protein and not more than 10 per cent. of fiber whereas 34.38 per cent. of protein and 13.93 per cent. of fiber were found. This stock was resampled, No. **1361**, and showed a protein content of 33.88 per cent. These deficiencies are unusual; the products were, in fact, cottonseed feeds.

The other samples met the guaranties in all respects.

COTTONSEED FEED.

Cottonseed Feed is a mixture of cottonseed meal and cottonseed hulls containing less than 36 per cent. protein.

One sample, Danish, **728**, fully met the guaranty.

LINSEED MEAL.

Linseed Cake or *Meal* is oil cake or meal made from flaxseed, provided that the final product shall contain less than 6 per cent. of weed seeds and other foreign materials, and provided further that no portion of the stated 6 per cent. of weed seeds and other foreign materials shall be deliberately added.

Old Process Oil Meal, Old Process Linseed Meal is oil meal as defined or linseed meal as defined produced by crushing, cooking and hydraulic pressure.

The six samples examined substantially met or exceeded the guaranties in all respects. The average protein content was 32.57 per cent. which is a little higher than was found a year ago. The prices quoted ranged from $53.00 to $60.00 and averaged $57.67.

WHEAT BRAN.

Wheat Bran is the coarse outer covering of the wheat kernel as separated from cleaned and scoured wheat in the usual process of commercial milling.

Eleven samples were examined all of which satisfied the guaranties for protein and for fat. Fiber guaranties, where given, were not exceeded. The average protein found, 15.71 per cent., exceeded the average guaranteed by about 1.5 per cent., and the average fat content, 5.27 per cent. exceeded the average guaranty by about the same amount.

WHEAT MIDDLINGS.

Standard Middlings consists mostly of fine particles of bran, germ and very little of the fibrous offal obtained from the "tail of the mill." This product must be obtained in the usual commercial process of milling and shall not contain more than 9.5 per cent. crude fiber.

Flour Middlings shall consist of standard middlings and red dog flour combined in the proportion obtained in the usual process of milling and shall not contain more than 6.0 per cent. crude fiber.

Red Dog Flour consists of a mixture of low-grade flour, fine particles of bran and the fibrous offal from the "tail of the mill" and shall not contain more than 4.0 per cent. crude fiber.

Brown Shorts (*Red Shorts*) consists mostly of the fine particles of bran, germ and very little of the fibrous offal obtained from the "tail of the mill". This product must be obtained in the usual commercial process of milling.

Gray Shorts (*Gray Middlings* or *Total Shorts*) consists of the fine particles of the outer bran, the inner bran or bee-wing bran, the germ and the offal or fibrous materials obtained from the "tail of the mill". This product must be obtained in the usual process of commercial milling.

White Shorts or *White Middlings* consists of a small portion of the fine bran particles and the germ and a large portion of the fibrous offal obtained from the "tail of the mill." This product must be obtained in the usual process of flour milling.

Sixteen samples were analyzed and all conformed to the guaranties for protein and for fat; fiber guaranties, so far as given, were not exceeded. The fiber content found did not reach 8 per cent. in any case and the average of all samples was but slightly over 6 per cent. The average protein found, 17.1 per cent., exceeds the average guaranty by 1.5 per cent. and the average fat found, 5.50 per cent., exceeded the guaranty by about 1 per cent. The average price quoted was $37.18.

MIXED FEED.

Wheat Mixed Feed (*Mill Run Wheat Feed*) consists of pure wheat bran and the gray or total shorts or flour middlings combined in the proportions obtained in the usual process of commercial millings.

Of eleven samples of mixed feed no single sample exceeded 8.50 per cent. of fiber while the average for all was 7.23 per cent. The tentative limit of fiber in mixed feed is 8.50 per cent. Protein found exceeded that guaranteed in all cases and there were no deficiencies in fat. The average of prices quoted was $43.55.

RYE PRODUCTS.

Rye Middlings or *Rye Feed* is the by-product obtained from the manufacture of ordinary "100 per cent." rye flour from cleaned and scoured rye grain.

The single sample examined fully met the guaranty.

CORN GLUTEN FEED.

Corn Gluten Feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germs by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

The four samples analyzed fully satisfied their guaranties. The average protein found, 25.11 per cent., exceeded the average guaranty by about 2 per cent. The average of prices quoted was $50.25.

CORN GLUTEN MEAL.

Corn Gluten Meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran, by the processes employed in the manufacture of cornstarch and glucose. It may or may not contain corn solubles.

One sample was examined. It showed a slight protein deficiency (0.31 per cent.), but the guaranty for fat was exceeded.

HOMINY FEED.

Hominy Feed, *Hominy Meal* or *Hominy Chop* is the kiln-dried mixture of the mill run bran coating, the mill run germ, with or without a partial extraction of the oil and a part of the starchy portion of the white corn kernel obtained in the manufacture of hominy, hominy grits and corn meal by the degerminating process.

Twelve samples were examined all of which met or exceeded their guaranties for protein and fat and none of which exceeded the limits for fiber. The average of prices quoted was $50.75.

BREWERS' AND DISTILLERS' PRODUCTS.

Brewers' Dried Grains are the properly dried residue from cereals obtained in the manufacture of beer.

Distillers' Dried Grains are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors. The product shall bear the designation indicating the cereal predominating.

Four products of this class were examined and all met or exceeded their guaranties.

DRIED BEET PULP.

Dried Beet Pulp is the dried residue from sugar beets which have been cleaned and freed from crowns, leaves and sand, and which have been extracted in the process of manufacturing sugar.

Three samples conformed substantially to the guaranties. The other three, two of which were imported stock, bore no statement of composition. The average of prices quoted was $46.17.

PROPRIETARY MIXED FEEDS.

Horse Feed.

Three samples of horse feeds were analysed all of which conformed to their guaranties.

Dairy Feed.

In this group are included those feeds sold as dairy feeds and dairy rations. Their protein content generally varies between 20 and 25 per cent. with the extreme variation of about 17 to 27 per cent. Fat is guaranteed at from 4 to 6 per cent. and the maximum for fiber is about 10 per cent. The averages for 29 samples examined were protein 22.6, fiber 8.7, and fat 5.4 per cent. Prices quoted varied generally between $50 and $55, range for the extremes being $42 to $59 with an average of about $52.

Of the 29 samples there were only four deficiencies in protein which exceeded 1 per cent.; only three deficiencies in fat were greater than 0.25 per cent. and only one exceeded 0.50 per cent.; and there were no significant excesses of fiber. The protein guaranty of Nobotheration Dairy Ration, **754**, has been revised in view of the deficiency found.

Stock Feed.

Feeds of this class contain from 8 to 12 per cent. of protein. The average protein found in the 19 samples examined was about 10 per cent. No deficiencies in protein were found. There was one excess of fiber and four fat deficiencies, three of which were more than 0.5 per cent. In all nineteen samples were analyzed. The formula for Nobotheration Stock Feed, **762,** we are advised has been changed to meet the fat deficiency shown. New tags were furnished the dealer by the manufacturers of Pennant Stock Feed to revise the fat guaranty.

Hog Feed and Calf Feed.

One hog feed and two calf feeds were analyzed. All substantially met their guaranties.

Poultry Feeds.

Fifty-eight samples of poultry feeds, twenty of which were meat scraps, were analyzed. Of the poultry feeds there were only three shortages in protein and only one, **845,** which exceeded 1 per cent. Fiber guaranties so far as they were given, were exceeded in only one sample and there were no deficiencies in fat.

Among the samples of beef scrap there were three deficiencies in protein only two of which, **871** and **852**, were considerable. There were no shortages in fat; generally the guaranty for fat was largely exceeded.

SUMMARY OF DEFICIENCIES.

In Table III are summarized deficiencies as shown by the inspection this year. Shortages in protein of less than one per cent. and in fat of less than one-fourth of one per cent., and excesses in fiber of less than one per cent. are not included. It shows that of the two hundred samples examined eighteen, or 9 per cent., have failed to meet guaranties in one or more particulars. The law prohibiting the use of wire in affixing tags has been violated in three instances.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred					
			Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	OIL SEED PRODUCTS.							
	Cottonseed Meal.							
737	Paramount. Ashcraft-Wilkinson Co., Atlanta, Ga.	*Hazardville:* Amos D. Bridges Sons	6.50	5.79	36.00	12.95	30.56	8.20
		Guaranty			36.00	14.00		5.50
868[1]	Steerboy. S. P. Davis, Little Rock, Ark.	*New Milford:* Geo. T. Soule	5.95	7.52	43.25	5.88	29.10	8.30
		Guaranty			43.00	10.00		6.00
775	Bull. Humphreys-Godwin Co., Memphis, Tenn.	*Norwich:* Norwich Grain Co.	5.55	5.39	44.88	9.60	27.55	7.03
		Guaranty			43.00	10.00		5.00
778	Dixie. Humphreys-Godwin Co., Memphis, Tenn.	*Norwich:* Yantic Grain & Products Co.	6.70	5.89	33.75	13.88	33.00	6.78
		Guaranty			41.12	10.00		5.00
821	Lovit. L. B. Lovitt & Co., Memphis, Tenn	*Granby:* E. H. Rollins	6.20	6.15	41.19	9.98	27.78	8.70
		Guaranty			41.00	10.00		6.00
749	"Neal's Choice." L. B. Lovitt & Co., Memphis, Tenn	*Guilford:* Fred C. Morse	7.48	5.47	34.38	13.93	32.69	6.05
		Guaranty			43.00	10.00		6.00
713	"Thirty Six Brand". L. B. Lovitt & Co., Memphis, Tenn	*Plantsville:* C. A. Cowles	6.83	5.72	37.00	12.55	31.05	6.85
		Guaranty			36.00	14.00		5.00
		Average of guaranty			**40.45**	**11.14**		**5.50**
		Average of analyses	**6.46**	**5.99**	**38.64**	**11.30**	**30.19**	**7.42**
		Average digestible			**32.5**	**4.2**	**22.7**	**7.0**
	Cottonseed Feed.							
728	Danish. Humphreys-Godwin Co., Memphis, Tenn	*Thompsonville:* Geo. S. Phelps	8.18	6.14	37.00	12.85	29.48	6.35
		Guaranty			36.00	15.00		5.00

[1] Wire tags.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
			Pounds per Hundred					
	OIL SEED PRODUCTS—*Concluded.*							
	Linseed Meal, Old Process.							
710	Alinco. American Linseed Co., N.Y.	*Plantsville:* C. A. Cowles	7.58	6.08	31.44	7.90	38.55	8.45
		Guaranty	.....	.....	32.00	.....	.....	5.00
739	Amco. American Milling Co., Peoria, Ill.	*Hazardville:* Amos D. Bridges' Sons	9.80	5.64	31.25	9.20	37.61	6.50
		Guaranty	.....	.....	30.00	.....	.....	5.00
872	Pure. Archer-Daniels Midland Co., Minneapolis, Minn.	*New Milford:* Geo. E. Ackley Co.	9.15	4.72	35.50	7.73	36.57	6.33
		Guaranty	.....	.....	34.00	.....	.....	6.00
864	Pure. Kellogg & Miller, Amsterdam, N. Y.	*Waterbury:* Spencer Grain Co.	7.65	5.67	31.63	7.55	40.40	7.10
		Guaranty	.....	.....	32.00	.....	.....	4.70
724	Kelloggs. Spencer Kellogg Co., Buffalo, N. Y.	*Thompsonville:* Geo. S. Phelps	8.70	5.26	34.94	8.23	36.52	6.35
		Guaranty	.....	.....	34.00	.....	.....	5.00
822	Argentine. Mann Bros. Co., Buffalo, N. Y.	*Granby:* E. H. Rollins	9.85	5.74	30.63	7.70	39.13	6.95
		Guaranty	.....	.....	31.00	10.00	.....	6.00
		Average guaranty	.....	.....	**32.17**	**10.00**	.....	**5.28**
		Average of analyses	**8.79**	**5.52**	**32.57**	**8.05**	**38.12**	**6.95**
		Average digestible	.....	.....	**29.0**	**4.6**	**29.7**	**6.2**
	WHEAT PRODUCTS.							
	Wheat Bran.							
722	Dominion Flour Mills Co., Montreal, Canada	*New Britain:* Stanley Svea Grain & Coal Co.	9.13	5.70	16.00	9.10	54.59	5.48
		Guaranty	.....	.....	15.00	.....	.....	3.50

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
			Pounds per Hundred					
	WHEAT PRODUCTS—*Continued.*							
	Wheat Bran—Concluded.							
817 [2]	Wm. Hamilton & Son, Inc., Honeoye Falls, N. Y.	*Derby:* Peterson-Hendee Co.	9.63	6.29	15.00	8.25	56.45	4.38
		Guaranty	.....	.....	13.25	11.60	.....	2.90
708 [2]	Choice. Hecker-Jones-Jewell Milling Co., New York City	*Plantsville:* C. A. Cowles	9.30	6.42	15.06	9.70	54.12	5.40
		Guaranty	.....	.....	13.00	14.00	.....	3.50
794	Lakewood's. Lake of the Woods Milling Co., Montreal, Canada	*Willimantic:* Boston Grain Co.	8.90	5.68	14.38	10.60	54.99	5.45
		Guaranty	.....	.....	15.00	.....	.....	3.50
699	Niagara. Niagara Falls Milling Co., Niagara Falls, N. Y.	*Meriden:* H. Grulick	9.78	6.54	16.25	9.50	52.55	5.38
		Guaranty	.....	.....	15.00	.....	.....	3.50
800	Northwestern Consolidated Milling Co., Minneapolis, Minn.	*Stafford Springs:* Stafford Granary	9.85	6.26	16.13	9.20	53.53	5.03
		Guaranty	.....	.....	13.00	.....	.....	4.00
702 [2]	Pillsbury's. Pillsbury Flour Mills, Buffalo, N. Y.	*West Cheshire:* G. W. Thorpe	10.00	6.21	15.38	10.15	52.63	5.63
		Guaranty	.....	.....	14.00	.....	.....	4.00
764	Golden Loaf. Tennant & Hoyt Co., Lake City, Minn.	*Yantic:* Yantic Grain & Products Co.	9.65	5.64	15.88	8.55	55.00	5.28
		Guaranty	.....	.....	14.00	.....	.....	4.00
854	Eagle. Vannatter & Ham, Ltd., Toronto, Canada	*Branford:* S. V. Osborn	8.83	5.75	15.81	8.93	54.95	5.73
		Guaranty	.....	.....	15.00	11.00	.....	4.00
736 [2]	Gold Medal. Washburn-Crosby Co., Minneapolis, Minn.	*Hazardville:* Amos D. Bridges' Sons	10.10	5.86	15.88	8.78	54.05	5.33
		Guaranty	.....	.....	14.00	.....	.....	4.00
741 [2]	The Wilson Flour Mills, Wilson, Kansas	*Rockville:* Rockville Grain & Coal Co.	9.30	6.81	17.00	10.08	51.91	4.90
		Guaranty	.....	.....	14.50	11.00	.....	3.50
		Average guaranty	.....	.....	**14.16**	**11.90**	.....	**3.67**
		Average of analyses	**9.50**	**6.11**	**15.71**	**9.35**	**54.06**	**5.27**
		Average digestible	.....	.....	**12.3**	**2.9**	**38.9**	**3.6**

[2] With screenings.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	WHEAT PRODUCTS—*Continued.*							
	Wheat Middlings.							
753	Central Milling Co., Wilson, N. Y....	*New London:* P. Schwartz Co	9.95	3.58	17.75	4.68	58.29	5.75
		Guaranty			15.00			3.50
748	Dominion Flour Mills, Montreal, Canada	*Guilford:* Fred C. Morse	9.63	4.33	17.56	6.95	55.20	6.33
		Guaranty			16.00			5.00
712 [2]	The Fairchild Milling Co., Cleveland, Ohio	*Plantsville:* C. A. Cowles	10.95	3.14	15.63	4.48	61.55	4.25
		Guaranty			15.00	8.00		3.50
694	Jas. Goldie Co., Ltd., Toronto, Ontario	*Wallingford:* A. E. Hall	10.58	4.60	17.50	7.53	53.69	6.10
		Guaranty			17.00	8.00		6.00
863 [2]	H. Hecker-Jones-Jewell Milling Co., New York City	*Waterbury:* Spencer Grain Co.	9.65	4.96	16.38	7.60	56.41	5.00
		Guaranty			14.00	9.50		5.00
833	Lakewood's. Lake of the Woods Milling Co., Montreal, Canada	*Southport:* C. Buckingham & Co	10.88	3.97	16.88	5.65	56.72	5.90
		Guaranty			16.00			5.00
795 [2]	Rex. Maple Leaf Milling Co., Toronto, Canada	*Willimantic:* Willimantic Grain Co	8.78	4.25	17.38	6.90	56.96	5.73
		Guaranty			16.00			5.00
816 [2]	Niagara. Niagara Falls Milling Co., Niagara Falls, N. Y	*Derby:* Peterson-Hendee Co	9.80	5.32	17.75	7.10	54.35	5.68
		Guaranty			15.50			4.00
745 [2]	Ogilvie Flour Mills, Fort William, Canada	*Rockville:* Rockville Grain & Coal Co.	8.48	3.56	17.00	7.08	58.68	5.20
		Guaranty			15.00			4.00
686 [2]	Pillsbury's. Pillsbury Flour Mills, Buffalo, N. Y	*Hamden:* I. W. Beers	11.05	3.05	17.25	3.50	60.25	4.90
		Guaranty			15.00			4.00

[2] With screenings.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	WHEAT PRODUCTS—*Continued.*							
	Wheat Middlings—Concluded.							
865	Pillsbury's XXX Daisy. Pillsbury Mills, Minneapolis, Minn.	*Danbury:* H. E. Meeker	10.35	2.39	17.69	1.40	63.77	4.40
		Guaranty			16.00			4.00
752 [2]	Bell Cow. Quaker Oats Co., Saskatoon, Canada	New London: P. Schwartz Co	10.65	4.24	17.38	6.10	55.38	6.25
		Guaranty			16.00	8.00		4.00
811	Red Wing. Red Wing Milling Co., Red Wing, Minn	*Middletown:* Meech & Stoddard, Inc.	8.85	5.16	17.38	7.70	55.46	5.45
		Guaranty			15.00			5.10
819 [2]	Black Hawk. Robin Hood Mills, Calgary, Canada	*Ansonia:* Ansonia Flour & Grain Co.	8.80	4.09	17.00	7.10	57.56	5.45
		Guaranty			17.00			4.50
750 [2]	Gold Medal. Washburn-Crosby Co., Minneapolis, Minn	*New London:* New London Grain Co	10.45	4.77	16.56	7.25	55.07	5.90
		Guaranty			15.00			4.00
799 [2]	Pioneer. Western Canada Flour Mills, Winnipeg, Canada	*So. Coventry:* E. W. Latimer	10.50	4.03	17.19	6.08	56.50	5.70
		Guaranty			16.00			4.50
		Average guaranty			**15.59**	**8.38**		**4.44**
		Average of analyses	**9.96**	**4.09**	**17.14**	**6.07**	**57.24**	**5.50**
		Average digestible			**13.2**	**1.8**	**44.6**	**4.8**
	Wheat Feed (Mixed Feed)							
866	Wingold. Bay State Milling Co., Winona, Minn	*Danbury:* F. C. Benjamin	10.40	4.54	17.13	5.55	57.45	4.93
		Guaranty			15.60			4.10
744	Boston. Duluth Superior Milling Co., Duluth, Minn	*Rockville:* Rockville Grain & Coal Co.	8.48	5.27	16.50	8.40	55.62	5.73
		Guaranty			15.00			4.00
788	Durum. Duluth Superior Milling Co., Duluth, Minn	*Putnam:* F. M. Cole	8.38	4.48	16.75	8.50	56.61	5.28
		Guaranty			15.00			5.00

[2] With screenings.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred					
			Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	WHEAT PRODUCTS—*Concluded.*							
	Wheat Feed (Mixed Feed)—Concluded.							
882	Boston. Duluth Superior Milling Co., Duluth, Minn.	*Bloomfield:* Bloomfield Farmers' Exchg.	9.65	5.23	16.00	7.95	55.69	5.48
		Guaranty			15.00			4.00
707	Gold Mine. H. H. King Flour Mills, Minneapolis, Minn.	*Plantsville:* C. A. Cowles	8.98	5.05	16.25	7.85	56.29	5.58
		Guaranty			15.00			4.50
805	Redwing. Meech & Stoddard, Middletown, Conn.	*Hartford:* Meech Grain Co	9.30	5.14	16.75	7.68	55.70	5.43
		Guaranty			15.00			4.50
826	Pennant Quality. National Milling Co., Toledo, Ohio	*Farmington:* Winchell Smith Grist Mill	8.38	3.97	16.38	7.13	58.54	5.60
		Guaranty			15.00			3.75
823 [2]	Pillsbury's. Pillsbury Mills, Minneapolis, Minn.	*Granby:* E. H. Rollins	10.10	4.17	17.88	5.90	57.17	4.78
		Guaranty			15.00			4.00
733	Occident. Russell Miller Milling Co., Minneapolis, Minn.	*Suffield:* Spencer Bros	9.78	5.09	16.69	7.25	55.29	5.90
		Guaranty			15.50			4.50
786 [2]	Dakota. State Mill & Elevator Co., Grand Forks, No. Dakota	*Danielson:* Dayville Grain & Coal Co.	7.78	5.13	16.31	8.03	56.87	5.88
		Guaranty			15.10			5.30
874 [2]	Gold Medal. Washburn-Crosby Co., Minneapolis, Minn.	*Torrington:* F. L. Wadhams & Sons	10.35	4.25	15.38	5.33	60.31	4.38
		Guaranty			16.00			4.00
		Average guaranty			**15.20**			**4.33**
		Average of analyses	**9.23**	**4.76**	**16.55**	**7.23**	**56.87**	**5.36**
		Average digestible			**12.7**	**2.6**	**43.2**	**4.7**

[2] With screenings.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred					
			Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	RYE PRODUCTS.							
810 [2]	Feed. Boutwell Milling & Grain Co., Troy, N. Y.	*Middletown:* Meech & Stoddard, Inc.	10.85	3.69	14.38	4.45	63.43	3.20
		Guaranty			13.00			3.00
	MAIZE PRODUCTS.							
	Corn Gluten Feed.							
880	American Maize Products Co., New York City	*Bloomfield:* Bloomfield Farmers' Exchg.	7.90	4.18	24.50	6.33	54.44	2.65
		Guaranty			23.00			1.50
855	Buffalo. Corn Products Refining Co., New York City	*Branford:* S. V. Osborn	9.25	5.32	24.50	6.35	51.48	3.10
		Guaranty			23.00			2.00
751	Douglas. Penick & Ford Ltd., Cedar Rapids, Iowa	*New London:* P. Schwartz Co	8.15	7.07	28.13	7.43	46.24	2.98
		Guaranty			23.00			1.00
704	Staley's. A. E. Staley Mfg. Co., Decatur, Ill	*West Cheshire:* G. W. Thorpe	8.38	4.44	23.31	6.58	54.29	3.00
		Guaranty			23.00			1.00
		Average guaranty			**23.00**			**1.38**
		Average of analyses	**8.42**	**5.25**	**25.11**	**6.67**	**51.62**	**2.93**
		Average digestible			**21.3**	**5.1**	**45.4**	**2.5**
	Corn Gluten Meal.							
777	Diamond. Corn Products Refining Co., New York City	*Norwich:* Yantic Grain & Products Co.	7.93	1.35	39.69	2.98	44.85	3.20
		Guaranty			40.00			1.00

[2] With screenings.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	MAIZE PRODUCTS—*Continued.*							
	Hominy Feed.							
757	Aunt Jemima Mills Co., St. Joseph, Mo.	*Mystic:* Yantic Grain Co.	9.70	2.62	11.13	5.15	60.37	11.03
		Guaranty	....	....	10.00	....	....	5.00
721	Paragon. C. M. Cox, Boston, Mass.	*Bristol:* Bristol Grain & Supply Co	9.30	3.45	11.13	4.68	63.84	7.60
		Guaranty	....	....	10.00	7.00	....	6.00
884	Ideal. Elevator Milling Co., Springfield, Mass.	*Seymour:* Seymour Grain & Coal Co.	8.78	3.25	11.88	4.88	62.73	8.48
		Guaranty	....	....	10.00	6.00	....	7.00
837	Emco. Evans Milling Co., Indianapolis, Ind.	*Norwalk:* Francis H. Leggett & Co.	10.13	2.57	11.00	3.85	66.15	6.30
		Guaranty	....	....	10.00	7.00	....	5.00
695	B.C. Kellogg Company, Battle Creek, Mich	*Wallingford:* A. E. Hall	9.73	2.66	11.25	4.70	64.58	7.08
		Guaranty	....	....	10.00	5.00	....	6.00
783	Sonny South. Louisville Milling Co., Louisville, Ky.	*Moosup:* T. E. Main & Sons Co.	8.13	2.53	11.06	4.68	65.65	7.95
		Guaranty	....	....	10.00	6.00	....	7.00
742	Bufceco. Maple Flake Mills, Chicago, Ill.	*Rockville:* Rockville Grain & Coal Co.	10.05	2.58	11.00	3.63	67.59	5.15
		Guaranty	....	....	10.00	6.00	....	5.00
720	Choice Steam Cooked. Miner-Hillard Milling Co., Wilkes-Barre, Pa.	*Bristol:* Bristol Grain & Supply Co	9.25	2.36	10.50	4.05	69.36	4.48
		Guaranty	....	....	10.00	5.00	....	4.00
779	Mystic. Mystic Mills, Sioux City, Iowa	*Norwich:* Yantic Grain & Products Co.	9.05	2.22	10.94	4.60	66.36	6.83
		Guaranty	....	....	8.50	5.00	....	4.00
701[1]	The Patent Cereals Co., Geneva, N. Y.	*Meriden:* H. Grulich	10.35	2.68	11.00	4.70	65.54	5.73
		Guaranty	....	....	10.00	5.00	....	5.00

[1] Wire tags.

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	MAIZE PRODUCTS—*Concluded.*							
	Hominy Feed—Concluded.							
688	Burt's. Postum Cereal Co., Inc., Battle Creek, Mich	*Hamden:* I. W. Beers	10.40	2.57	11.25	4.08	65.42	6.28
		Guaranty	....	....	10.00	....	....	6.00
725	Yellow. Quaker Oats Co., Chicago, Ill.	*Thompsonville:* Geo. S. Phelps	9.20	2.34	10.63	4.28	68.12	5.43
		Guaranty	....	....	10.50	....	....	5.00
		Average guaranty	....	....	**9.92**	**5.78**	....	**5.42**
		Average of analyses	**9.51**	**2.65**	**11.06**	**4.44**	**65.48**	**6.86**
		Average digestible	....	....	**7.3**	**3.4**	**58.9**	**6.2**
	BREWERS' AND DISTILLERS' PRODUCTS.							
867	Dried Brewers' Grains. Atlantic Export Co., New York City	*New Milford:* Geo. T. Soule	5.40	3.49	25.00	13.33	45.28	7.50
		Guaranty	....	....	25.00	14.00	....	6.00
781	Corn Distillers' Grain. Canada Industrial Alcohol Co., Corbyville, Ont	*Norwich:* Yantic Grain & Products Co.	3.18	2.67	31.31	10.48	41.51	10.85
		Guaranty	....	....	30.00	....	....	3.00
738	Brewers' Dried Grains. St. Albans Grain Co., St. Albans, Vt.	*Hazardville:* Amos D. Bridges' Sons	6.70	3.56	23.19	13.10	45.95	7.50
		Guaranty	....	....	21.00	16.00	....	5.00
714	Ricomalt. Waterloo Distilling Co., Waterloo, N. Y	*Plantsville:* C. A. Cowles	4.20	3.60	31.00	9.68	39.59	11.93
		Guaranty	....	....	28.00	....	....	10.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred					
			Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	DRIED BEET PULP.							
842	Dutch Dried. Chr. de Vries, Rotterdam	*Stamford:* Francis H. Leggett & Co.	6.88	4.74	7.75	17.73	61.92	0.98
		Guaranty						
698	The Larrowe Milling Co., Detroit, Mich	*Wallingford:* A. E. Hall	10.40	2.74	8.25	17.63	60.18	0.80
		Guaranty			8.00	20.00		0.50
877	Martiners Grain Co., New York City	*Winsted:* E. Manchester & Sons	7.05	3.35	8.94	18.20	61.48	0.98
		Guaranty						
719	Michigan Sugar Co., Saginaw, Mich	*Plainville:* W. S. Eaton	6.43	3.04	8.38	18.95	62.50	0.70
		Guaranty			8.00	20.00		0.50
771	The Scholl Co., Newark, N. J.	*Colchester:* Meech & Brown Grain Co.	7.10	3.53	9.13	20.25	58.84	1.15
		Guaranty			7.00	20.00		0.25
692	Manufacturer Unknown	*North Haven:* W. L. Thorpe	8.58	3.22	9.13	19.78	57.79	1.50
		Guaranty						
		Average guaranty			**7.67**	**20.00**		**0.42**
		Average of analyses	**7.74**	**3.44**	**8.60**	**18.76**	**60.44**	**1.02**
		Average digestible			**4.5**	**15.6**	**50.2**	
	PROPRIETARY MIXED FEEDS.							
	Horse Feed.							
808	Diamond. Dwight Hamlin, Pittsburgh, Pa.	*Hartford:* Meech Grain Co	7.50	5.56	8.88	9.00	65.43	3.63
		Guaranty			9.00			1.50

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred					
			Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Horse Feed—Concluded.							
807	Imperial Steam Cooked. Imperial Grain & Milling Co., Toledo, Ohio	*Hartford:* Meech Grain Co	8.98	2.47	9.88	5.83	67.99	4.85
		Guaranty			9.50			4.00
726	Schumacher Sugared Feed. Quaker Oats Co., Chicago, Ill.	*Thompsonville:* Geo. S. Phelps	9.15	5.20	10.19	10.63	60.68	4.15
		Guaranty			10.00			3.25
		Average guaranty			**9.50**			**2.92**
		Average of analyses	**8.54**	**4.41**	**9.65**	**8.49**	**64.70**	**4.21**
	Dairy Feed.							
802	Advanced Registry. Arcady Farms Milling Co., Chicago, Ill	*Stafford Springs:* Dennis Grain Mill	8.08	4.88	25.56	9.70	45.73	6.05
		Guaranty			25.00			5.00
803	Peerless. Arcady Farms Milling Co., Chicago, Ill.	*Stafford Springs:* Dennis Grain Mill	7.35	7.16	21.25	12.45	46.46	5.33
		Guaranty			20.00			4.00
801	Wonder Dairy Feed. Arcady Farms Milling Co., Chicago, Ill.	*Stafford Springs:* Dennis Grain Mill	8.63	5.38	24.25	9.65	46.84	5.25
		Guaranty			24.00			5.00
735	Success Dairy Ration. Amos D. Bridges' Sons, Hazardville, Conn.	*Hazardville:* Amos D. Bridges' Sons	8.90	4.44	21.38	8.70	51.15	5.43
		Guaranty			20.00			5.20
754	Nobotheration Dairy Ration. C. W. Campbell Co., Westerly, R. I.	*Mystic:* J. L. Manning	9.95	4.17	20.44	5.90	54.76	4.78
		Guaranty			22.00			5.00
705	Unicorn Dairy Ration. Chapin & Co., Chicago, Ill.	*West Cheshire:* G. W. Thorpe	8.05	6.31	24.25	8.58	46.93	5.88
		Guaranty			24.00	10.00		5.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Dairy Feed—Continued.							
706	Dairy Ration. C. A. Cowles, Plantsville, Conn.	*Plantsville:* C. A. Cowles	8.13	6.35	27.13	8.33	43.58	6.48
		Guaranty	....	....	24.00	....	....	5.00
691	Wirthmore Balanced Ration. C. M. Cox Co., Boston, Mass.	*North Haven:* W. L. Thorpe	9.25	6.39	25.38	8.90	43.85	6.23
		Guaranty	....	....	25.00	....	....	5.50
785	Wirthmore Dairy Feed. C. M. Cox Co., Boston, Mass.	*Danielson:* Quinebaug Mills	8.85	4.05	22.25	7.00	54.07	3.78
		Guaranty	....	....	20.00	....	....	5.00
847	Basic Dairy Ration. R. G. Davis & Sons, New Haven, Conn.	*Glenbrook:* Davis-Scofield Co.	9.98	5.83	20.00	7.68	51.68	4.83
		Guaranty	....	....	20.00	....	....	5.00
873	Litchfield Dairy Ration. R. G. Davis & Sons, New Haven, Conn.	*Torrington:* Litchfield Coop. Assoc.	8.93	5.98	20.06	8.23	51.85	4.95
		Guaranty	....	....	20.00	9.00	....	5.00
730	Fulpail Dairy Ration. Eastern States Farmers' Exchange, Springfield, Mass.	*West Suffield:* Hugh E. Stratton	9.28	7.20	21.00	9.23	48.06	5.23
		Guaranty	....	....	20.00	9.00	....	4.00
729	Milkmore Dairy Ration. Eastern States Farmers' Exchange, Springfield, Mass.	*West Suffield:* Hugh E. Stratton	9.08	6.05	24.88	8.73	45.13	6.13
		Guaranty	....	....	24.00	9.00	....	4.00
709	Elmore Milk Grains. Elmore Milling Co., Oneonta, N. Y.	*Plantsville:* C. A. Cowles	8.10	6.35	25.56	8.40	46.06	5.53
		Guaranty	....	....	25.00	11.00	....	6.00
697	Lancaster 20% Dairy Feed. John W. Eshelman & Sons, Lancaster, Pa.	*Wallingford:* A. E. Hall	9.93	6.75	19.25	10.40	49.54	4.13
		Guaranty	....	....	20.00	....	....	4.00
787	Advance Dairy Feed. Grain Marketing Co., Chicago, Ill.	*Danielson:* Dayville Grain & Coal Co.	8.98	7.93	17.31	10.05	49.53	6.20
		Guaranty	....	....	16.00	....	....	5.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Dairy Feed—Continued.							
774	Grandin's 24% Balanced Dairy Ration. D. H. Grandin Mill Co., Jamestown, N. Y.	*Norwich:* Norwich Grain Co.	8.63	5.25	23.00	8.23	49.81	5.08
		Guaranty	....	....	24.00	....	....	5.00
796	Grandin's Twin Six Dairy Feed. D. H. Grandin's Mill Co., Jamestown, N.Y.	*Willimantic:* Willimantic Grain Co.	9.08	5.82	21.75	7.68	50.57	5.10
		Guaranty	....	....	22.00	....	....	5.00
839	Algrane Milk Feed. The H-O Cereal Co., Inc., Buffalo, N. Y.	*So. Norwalk:* Roodner Feed Co.	8.58	5.57	17.13	10.88	54.01	3.83
		Guaranty	....	....	16.00	15.00	....	4.00
746	Beatsall Milk Grains. Kasco Mills, Waverly, N. Y.	*Guilford:* Fred C. Morse	8.85	6.16	24.38	8.03	47.03	5.55
		Guaranty	....	....	22.00	....	....	4.50
747	Kasco Mormilk Dairy Ration. Kasco Mills, Waverly, N. Y.	*Guilford:* Fred C. Morse	8.40	5.40	27.06	8.18	44.98	5.98
		Guaranty	....	....	25.00	....	....	5.00
711	Larro Feed Ready Ration. Larrowe Milling Co., Detroit, Mich.	*Plantsville:* C. A. Cowles	8.63	5.76	21.00	10.98	49.08	4.55
		Guaranty	....	....	20.00	....	....	4.00
838	Nabob Dairy Feed. Francis H. Leggett & Co., Stamford, Conn.	*Norwalk:* Francis H. Leggett & Co.	8.85	8.09	19.56	9.55	49.60	4.35
		Guaranty	....	....	20.00	....	....	4.00
875	Red Star Dairy Feed. E. Manchester & Sons, Winsted, Conn.	*Winsted:* E. Manchester & Sons	8.10	5.70	22.75	7.03	49.87	6.55
		Guaranty	....	....	23.00	....	....	4.00
743	Bull Brand Dairy Ration. Maritime Milling Co., Buffalo, N. Y.	*Rockville:* Rockville Grain & Coal Co.	9.23	6.53	22.50	10.48	45.01	6.25
		Guaranty	....	....	24.00	....	....	6.00
768	Red Wing Junior Dairy Ration. Meech & Stoddard, Inc., Middletown, Conn.	*Colchester:* Meech & Brown Grain Co.	8.18	5.47	19.25	7.75	53.92	5.43
		Guaranty	....	....	20.00	....	....	5.00
769	Red Wing Special Dairy Ration. Meech & Stoddard, Inc., Middletown, Conn.	*Colchester:* Meech & Brown Grain Co.	7.90	4.84	23.38	7.75	49.73	6.40
		Guaranty	....	....	24.00	....	....	6.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Dairy Feed—Concluded.							
789	Oswego 20% Dairy Feed. Ontanio	*Putnam:* Bosworth Bros	7.70	5.52	20.13	10.98	50.09	5.58
	Milling Co., Oswego, N. Y.	Guaranty	.....	.....	20.00	.....	.....	5.00
766	Uncle John's 24% Cream Pot Ration.	*Colchester:* David Shea	8.05	5.80	21.63	7.45	51.14	5.93
	Ontanio Milling Co., Oswego, N. Y.	Guaranty	.....	.....	24.00	.....	.....	5.50
862	Stevens 44 Sweetened Dairy Ration.	*Waterbury:* Spencer Grain Co.	8.85	7.68	23.38	7.83	47.33	4.93
	Park & Pollard Co., Boston, Mass.	Guaranty	.....	.....	24.00	.....	.....	5.00
687	Pillsbury's 24% Dairy Feed. Pillsbury	*Hamden:* I. W. Beers	9.50	7.68	22.81	8.70	45.71	5.60
	Flour Mills Co., Minneapolis, Minn.	Guaranty	.....	.....	24.00	.....	.....	4.50
827	Burt's Dairy Feed. Postum Cereal Co.,	*Farmington:* Winchell Smith Grist Mill	7.70	4.58	24.06	6.85	51.78	5.03
	Battle Creek, Mich	Guaranty	.....	.....	24.00	.....	.....	5.00
814	Purina 24% Cow Chow Feed. Ralston	*Middletown:* H. G. Wadhams	9.73	6.12	25.94	10.68	42.65	4.88
	Purina Co., St. Louis, Mo	Guaranty	.....	.....	24.00	.....	.....	4.30
834	Red Brand Dairy Feed. Tioga Mill &	*Southport:* C. Buckingham & Co	8.98	7.00	25.69	8.13	44.42	5.78
	Elevator Co., Waverly, N. Y.	Guaranty	.....	.....	24.00	10.00	.....	4.50
825	Mill Streams Boomerang Dairy Feed.	*Farmington:* Winchell Smith Grist Mill	8.98	5.53	24.19	6.03	49.54	5.73
	Winchell Smith Grist Mill, Farmington, Conn	Guaranty	.....	.....	24.00	.....	.....	6.00
758	Big Y Dairy Ration. Yantic Grain &	*Mystic:* Yantic Grain Co.	9.03	4.35	26.63	7.28	47.31	5.40
	Products Co., Norwich, Conn.	Guaranty	.....	.....	25.00	10.00	.....	5.00
759	Uncas Dairy Feed. Yantic Grain &	*Mystic:* Yantic Grain Co.	8.43	5.18	20.00	8.65	51.81	5.93
	Products Co., Norwich, Conn.	Guaranty	.....	.....	20.00	.....	.....	5.00
		Average guaranty	.....	.....	**22.22**	**10.38**	.....	**4.86**
		Average of analyses	**8.73**	**5.93**	**22.60**	**8.68**	**48.65**	**5.41**

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Stock Feed.							
797	Pennant Brand Stock Feed. E. W.	*So. Coventry:* E. W. Latimer	8.35	4.10	10.38	9.95	61.59	5.63
	Bailey & Co., Swanton, Vt	Guaranty	.....	.....	10.00	10.00	.....	6.50
790	Parex Stock Feed. Bosworth Bros.,	*Putnam:* Bosworth Bros	7.88	4.64	9.25	10.60	63.18	4.45
	Putnam, Conn	Guaranty	.....	.....	9.00	.....	.....	3.00
762	Nobotheration Stock Feed. C. W.	*Westerly:* C. W. Campbell Co.	9.18	3.70	13.13	7.45	62.81	3.73
	Campbell Co., Westerly, R. I.	Guaranty	.....	.....	10.00	.....	.....	5.00
767	Fortune Stock Feed. Coles Co., Middletown, Conn	*Colchester:* David Shea	7.50	3.75	9.25	11.28	63.27	4.95
		Guaranty	.....	.....	9.00	11.00	.....	5.00
784	Charlestock Feed. C. M. Cox Co., Boston, Mass	*Danielson:* Quinebaug Mills	7.50	5.70	10.94	12.63	57.45	5.78
		Guaranty	.....	.....	9.00	14.00	.....	4.00
734	Wirthmore Stock Feed. C. M. Cox Co.,	*Suffield:* Spencer Bros	8.78	3.78	10.13	9.13	61.63	6.55
	Boston, Mass	Guaranty	.....	.....	9.00	.....	.....	4.00
848	Davis Stock Feed. R. G. Davis & Sons,	*Glenbrook:* Davis-Scofield Co	9.43	4.47	10.63	12.48	60.16	2.83
	New Haven, Conn.	Guaranty	.....	.....	10.50	.....	.....	4.00
715	Flory's Special Stock Feed. Flory	*Plantsville:* C. A. Cowles	7.03	4.97	8.75	15.24	60.53	3.48
	Milling Co., Bangor, Penn.	Guaranty	.....	.....	8.00	14.00	.....	3.00
772	Grandin's Stock Feed. D. H. Grandin	*Norwich:* Norwich Grain Co.	7.80	3.50	9.13	9.18	65.49	4.90
	Mill Co., Jamestown, N. Y	Guaranty	.....	.....	9.00	.....	.....	5.00
755	New England Stock Feed. H-O Cereal	*Mystic:* J. L. Manning	8.25	4.45	12.00	9.80	61.07	4.43
	Co., Buffalo, N. Y	Guaranty	.....	.....	9.50	.....	.....	4.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Stock Feed—Concluded.							
835	Nabob Stock Feed. Francis H. Leggett & Co., Norwalk, Conn	*Norwalk:* Francis H. Leggett & Co.	9.10	4.40	10.38	11.75	61.79	2.58
		Guaranty	....	....	10.00	....	....	3.00
770	Red Wing Stock Feed. Meech & Stoddard Co., Middletown, Conn.	*Colchester:* Meech & Brown Grain Co	7.95	3.71	10.25	10.03	63.51	4.55
		Guaranty	....	....	9.00	....	....	3.00
727	Fidelity Stock Feed. Nowak Milling Corp., Buffalo, N. Y.	*Thompsonville:* Geo. S. Phelps	7.98	5.06	8.56	11.93	63.02	3.45
		Guaranty	....	....	8.00	....	....	3.00
791	Park & Pollard Co. Stock Feed. Park & Pollard Co., Boston, Mass.	*Putnam:* Bosworth Bros	8.73	7.21	9.94	7.25	61.74	5.13
		Guaranty	....	....	8.00	....	....	2.50
853	Burt's Stock Feed. Postum Cereal Co., Inc., Battle Creek, Mich	*Branford:* S. V. Osborn	9.10	3.90	9.44	8.03	64.60	4.93
		Guaranty	....	....	9.00	9.50	....	4.00
830	Schumacker Feed. Quaker Oats Co., Chicago, Ill.	*Stratford:* Z. C. Ingersoll	7.98	4.74	10.75	10.88	62.05	3.60
		Guaranty	....	....	10.00	....	....	3.25
831	White Star Stock Feed. Quaker Oats Co., Chicago, Ill.	*Bridgeport:* Samp Mortar Mills	8.65	4.27	8.13	12.63	63.29	3.03
		Guaranty	....	....	9.00	....	....	3.00
718	Syragold Stock Feed. Syracuse Milling Co., Syracuse, N. Y.	*Plainville:* W. S. Eaton	9.13	4.44	9.13	11.23	62.72	3.35
		Guaranty	....	....	9.00	....	....	3.00
793	Red Tag Big Y Stock Feed. Yantic Grain & Products Co., Norwich, Conn.	*Willimantic:* Boston Grain Co	8.10	4.35	12.00	10.45	59.92	5.18
		Guaranty	....	....	9.00	....	....	4.00
		Average guaranty			**9.16**	**11.70**		**3.80**
		Average of analyses	**8.34**	**4.48**	**10.11**	**10.63**	**62.10**	**4.34**

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Hog Feed, Etc.							
700	Purina Pig Chow. Purina Mills, St. Louis, Mo	*Meriden:* H. Grulich	9.83	8.56	21.50	7.05	48.13	4.93
		Guaranty	....	....	20.00	....	....	3.20
815	Purina Calf Chow. Purina Mills, St. Louis, Mo	*Middletown:* H. G. Wadhams	9.93	3.88	26.69	3.18	52.02	4.30
		Guaranty	....	....	27.00	....	....	3.20
809	Blatchford's Calf Meal. Blatchford Calf Meal Co., Waukegan, Ill.	*Middletown:* Meech & Stoddard, Inc.	10.05	6.38	24.38	5.85	47.81	5.53
		Guaranty	....	....	24.00	....	....	5.00
	Poultry Feed.							
846	Buttermilk Laying Mash. Basic Feeds Co., Lockport, Ill.	*Stamford:* W. L. Crabb	8.18	5.25	21.13	4.98	54.73	5.73
		Guaranty	....	....	18.00	5.00	....	5.00
792	Parex Dry Mash. Bosworth Bros., Putnam, Conn	*Putnam:* Bosworth Bros	8.85	5.98	18.94	6.28	54.37	5.58
		Guaranty	....	....	18.00	....	....	4.50
832	Buckingham's Dry Mash. C. Buckingham & Co., Southport, Conn.	*Southport:* C. Buckingham & Co	9.48	7.35	20.00	4.55	52.92	5.70
		Guaranty	....	....	19.00	....	....	5.00
760	Ego Dry Mash. C. W. Campbell Co., Westerly, R. I.	*Westerly:* C. W. Campbell Co.	8.48	8.41	22.25	7.83	47.10	5.93
		Guaranty	....	....	18.00	....	....	2.00
765	Fortune Egg Mash with Buttermilk. Coles Co., Middletown, Conn.	*Colchester:* David Shea	7.58	11.07	21.31	5.68	49.01	5.35
		Guaranty	....	....	17.00	....	....	3.50
878	Laying Mash. C. A. Cowles, Plantsville, Conn	*Plantsville:* C. A. Cowles	8.10	9.34	17.63	6.78	53.12	5.03
		Guaranty	....	....	18.00	....	....	4.00
879	Cowles' Meato Mash. C. A. Cowles, Plantsville, Conn.	*Plantsville:* C. A. Cowles	8.98	4.87	22.00	5.48	53.59	5.08
		Guaranty	....	....	22.00	....	....	5.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feed—Continued.							
703	Wirthmore Buttermilk Mash Feed. C. M. Cox Co., Boston, Mass.	*West Cheshire:* G. W. Thorpe	8.43	12.34	21.75	6.03	45.05	6.40
		Guaranty			20.00			4.00
861	C-B Mash. The Crittenden Benham Co., New Haven, Conn.	*New Haven:* The Crittenden Benham Co.	7.30	11.41	18.94	6.05	49.65	6.65
		Guaranty			18.00			5.00
836	Crosby's Growing Feed. Crosby Milling Co., Brattleboro, Vt.	*Norwalk:* Francis H. Leggett & Co.	9.88	8.42	18.75	4.83	52.97	5.15
		Guaranty			15.00	4.50		4.50
849	Davis Buttermilk Mash Feed. R. G. Davis & Sons, New Haven, Conn.	*Glenbrook:* Davis-Scofield Co.	8.90	6.89	18.25	6.13	54.00	5.83
		Guaranty			18.00			5.00
731	Egg Mash, Open Formula. Eastern States Farmers' Exchange, Springfield, Mass.	*West Suffield:* Hugh E. Stratton	9.60	5.71	19.88	5.43	53.95	5.43
		Guaranty			20.00			3.50
840	Eshelman's Laying Mash. John W. Eshelman & Sons, Lancaster, Pa.	*So. Norwalk:* Roodner Feed Co.	9.28	9.05	21.75	5.18	48.19	6.55
		Guaranty			20.00			5.00
881	Flory's Superior Egg Mash. Flory Milling Co., Bangor, Penn.	*Bloomfield:* Bloomfield Farmers' Exchg.	8.63	9.69	20.88	7.88	47.57	5.35
		Guaranty			20.00			5.50
773	Grandin's Poultry Dry Mash with Buttermilk. D. H. Grandin's Mill Co., Jamestown, N. Y.	*Norwich:* Norwich Grain Co.	8.50	12.25	20.56	5.43	48.01	5.25
		Guaranty			20.00			3.00
723	Red Comb Egg Mash. Hales & Hunter Co., Chicago, Ill.	*New Britain:* Stanley Svea Grain & Coal Co	8.80	8.45	20.06	4.83	52.21	5.65
		Guaranty			20.00			4.50
841	Premier Laying Mash. Francis H. Leggett & Co., Stamford, Conn.	*Stamford:* Francis H. Leggett & Co.	9.70	7.47	22.06	5.00	49.19	6.58
		Guaranty			20.00			5.00
876	Storrs Egg Mash. E. Manchester & Sons, Winsted, Conn.	*Winsted:* E. Manchester & Sons	7.85	9.03	19.63	5.23	51.91	6.35
		Guaranty			18.00			4.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feed—Continued.							
845	Armour's Cak-Cak Laying Mash. Maple Flake Mills, Chicago, Ill.	*Stamford:* W. L. Crabb	9.75	8.61	18.75	3.50	54.99	4.40
		Guaranty			20.00			3.00
844	Iroquois Laying Mash. Maple Flake Mills, Chicago, Ill.	*Stamford:* W. L. Crabb	8.63	8.50	20.56	6.43	49.08	6.80
		Guaranty			20.00			5.00
843	Bull Brand Laying Mash. Maritime Milling Co., Buffalo, N. Y.	*Stamford:* W. L. Crabb	8.88	8.75	20.63	7.03	48.71	6.00
		Guaranty			20.00			5.00
806	Red Wing Dry Mash. Meech & Stoddard, Inc., Middletown, Conn.	*Hartford:* Meech Grain Co.	8.40	8.46	18.75	6.40	52.49	5.50
		Guaranty			17.00			5.50
856	Bonnie Booster with Buttermilk. Park & Pollard Co., Boston, Mass.	*New Haven:* R. G. Davis & Sons	9.93	5.38	15.25	2.93	63.23	3.28
		Guaranty			12.00			3.00
818	Lay or Bust Dry Mash. Park & Pollard Co., Boston, Mass.	*Ansonia:* Ansonia Flour & Grain Co.	9.73	6.74	18.13	5.38	55.49	4.53
		Guaranty			18.00			1.50
885	Platco Laying Mash. Frank S. Platt Co., New Haven, Conn.	*New Haven:* Frank S. Platt Co.	7.78	10.22	20.75	6.68	48.84	5.73
		Guaranty			18.94			5.38
858	Pratt's Baby Chick Food. Pratt Food Co., Philadelphia, Pa.	*New Haven:* R. G. Davis & Sons	8.70	8.54	13.00	2.55	63.16	4.05
		Guaranty			11.50			3.50
860	Purina Chicken Chowder. Purina Mills, St. Louis, Mo.	*New Haven:* The Crittenden Benham Co.	8.45	8.22	20.06	6.23	52.11	4.93
		Guaranty			18.00			4.00
857	Ful-O-Pep Chick Starter. Quaker Oats Co., Chicago, Ill.	*New Haven:* R. G. Davis & Sons	7.75	8.76	17.38	4.90	55.01	6.20
		Guaranty			15.00	6.50		5.00
859	Ful-O-Pep Egg Mash. Quaker Oats Co., Chicago, Ill.	*New Haven:* R. G. Davis & Sons	7.73	9.23	20.44	6.98	49.89	5.73
		Guaranty			20.00			4.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feed—Continued.							
829	Quisenberry Quality "Big 4" Mash. Quisenberry Feed Mfg. Co., Buffalo, N. Y.	*Farmington:* Winchell Smith Grist Mill	8.88	6.19	17.88	8.15	54.27	4.63
		Guaranty			17.00	6.00		4.00
828	Quisenberry Quality Buttermilk Laying Mash. Quisenberry Feed Mfg. Co., Buffalo, N. Y.	*Farmington:* Winchell Smith Grist Mill	9.70	6.34	19.88	5.63	53.80	4.65
		Guaranty			18.00			4.00
689	Vitality Egg Mash. Rosenbaum Bros., Chicago, Ill.	*Hamden:* I. W. Beers	9.40	9.30	20.56	5.65	49.54	5.55
		Guaranty			20.00	7.00		4.00
883	S. G. Home Made Milk Mash. The Seymour Grain & Coal Co., Seymour, Conn.	*Seymour:* Seymour Grain & Coal Co.	8.90	7.49	18.06	6.58	53.69	5.28
		Guaranty			18.00	9.00		4.50
824	Mill Streams Lightnin Laying Mash. Winchell Smith Grist Mill, Farmington, Conn	*Farmington:* Winchell Smith Grist Mill	9.80	8.86	19.75	5.68	51.31	4.60
		Guaranty			16.00			3.00
716	Syragold Egg Mash. Syracuse Milling Co., Syracuse, N. Y	*Plainville:* W. S. Eaton	8.65	7.73	19.94	7.05	51.56	5.07
		Guaranty			18.00			3.00
820	Syragold Egg Mash. Syracuse Milling Co., Syracuse, N. Y	*Granby:* E. H. Rollins	8.70	7.27	20.00	7.30	51.83	4.90
		Guaranty			18.00			3.00
693	Egatine. Tioga Mill & Elevator Co., Waverly, N. Y.	*North Haven:* W. L. Thorpe	9.03	8.28	26.44	4.68	45.09	6.48
		Guaranty			23.00			2.50
763	Big Y Laying Mash. Yantic Grain & Products Co., Norwich, Conn.	*Yantic:* Yantic Grain & Products Co.	9.25	8.33	21.13	6.43	49.18	5.68
		Guaranty			20.00			4.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feeds—Continued (Beef Scrap.)							
851	Big 50 Meat & Bone Scrap. American Agricultural Chemical Co., N. Y.	*New Canaan:* C. H. Fairty Co.	5.05	24.82	53.94	2.36		13.83
		Guaranty			50.00			6.00
871	Protox Meat & Bone Scrap. American Agricultural Chemical Co., N. Y.	*New Milford:* Geo. E. Ackley Co.	5.03	23.64	51.94	3.14		16.25
		Guaranty			55.00			6.00
756	Beach Soap Co., Lawrence, Mass.	*Mystic:* J. L. Manning	6.10	33.24	43.13	1.90	3.20	12.43
		Guaranty			35.00			10.00
690	Cooked Meat Scrap for Poultry. Conn. Fat Rendering & Fertilizer Corp., New Haven, Conn.	*Hamden:* I. W. Beers	6.75	29.06	50.00	2.70	1.44	10.05
		Guaranty			40.00			8.00
696	Frisbie's Poultry Feed Animal Products. L. T. Frisbie Co., New Haven, Conn.	*Wallingford:* A. E. Hall	6.03	33.03	44.75	2.10	0.69	13.40
		Guaranty			40.00			8.00
870	Frisbie's Poultry Feed. The L. T. Frisbie Co., New Haven, Conn.	*New Milford:* Geo. T. Soule	6.20	28.76	49.38	2.83		12.83
		Guaranty			50.00			8.00
813	Greene's Poultry Scraps. Green Chicken Feed Co., Marblehead, Mass.	*Middletown:* Meech & Stoddard, Inc.	4.35	44.80	32.13	8.24		10.48
		Guaranty			25.00			5.00
804	Cooked Meat & Bone Scraps. A. G. Markham & Co., Springfield, Mass.	*Stafford Springs:* Dennis Grain Mill	7.58	33.63	47.56	2.80		8.43
		Guaranty			40.00			8.00
780	Marsh's Pure Ground Scraps for Poultry. Geo. E. Marsh Co., Lynn, Mass	*Norwich:* Yantic Grain & Products Co.	5.00	31.48	45.25	4.67		13.60
		Guaranty			40.00			8.00
850	High Grade Meat and Bone Scraps. Martin & Maurer, Harrison, N. J.	*New Canaan:* C. H. Fairty Co.	5.88	27.06	51.38	3.20		12.48
		Guaranty			50.00			10.00

TABLE II. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1924.

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.)	Ether Extract (Crude fat)
	PROPRIETARY MIXED FEEDS—*Cont.*							
	Poultry Feeds—Concluded. (*Beef Scrap.*)							
798	Blue Seal Meat Scraps. New England	*So. Coventry:* E. W. Latimer	5.90	27.28	52.63	2.31		11.88
	By-Products Corp., Lawrence, Mass.	Guaranty	....	....	50.00	3.00	....	5.00
717	White Seal Meat Scraps. New England	*Plainville:* W. S. Eaton	5.80	36.93	40.94	0.90	2.03	13.40
	By-Products Corp., Lawrence, Mass.	Guaranty	....	....	40.00	4.00	....	5.00
761	Pawtucket Rendering Co., Pawtucket,	*Westerly:* C. W. Campbell Co.	5.18	32.52	50.00	4.15		8.15
	R. I.	Guaranty	....	....	40.00	....		8.00
740 [1]	Rauh's Meato. E. Rauh & Sons Animal	*Hazardville:* Amos D. Bridges' Sons	4.55	5.75	76.25	0.40	....	13.05
	Feed Co., Indianapolis, Ind.	Guaranty	....	....	75.00	1.00	....	6.00
852	Swift-Sure Ground Beef Scrap for	*East Haven:* F. A. Forbes	4.98	29.82	52.13	2.94		10.13
	Poultry. M. L. Shoemaker & Co.,		....	....	55.00	....		10.00
	Philadelphia, Pa.	Guaranty						
732	Cooked Meat and Bone Scraps. Springfield Rendering Co., Springfield,	*Suffield:* Spencer Bros.	7.18	30.30	51.25	1.80	0.94	8.53
	Mass.	Guaranty	....	....	40.00	....	....	8.00
812	Meat Scrap for Poultry. John T. Stan-	*Middletown:* Meech & Stoddard, Inc.	6.10	28.90	43.88	8.19		12.93
	ley Co., New York, N. Y.	Guaranty	....	....	40.00	....		10.00
869	Vico High Protein Meat Scraps. Van	*New Milford:* Geo. T. Soule	7.18	18.47	58.69	....	3.11	12.55
	Iderstine Co., Long Island City, N.Y.	Guaranty	....	....	55.00	....	....	5.00
776	Royal Worcester Beef Scrap. Worces-	*Norwich:* Norwich Grain Co.	7.30	28.89	48.25	5.31		10.25
	ter Rendering Co., Auburn, Mass.	Guaranty	....	....	40.00	....		8.00
782	Royal Worcester Special Meat Scrap.	*Jewett City:* Red Wing Feed Store	6.28	21.78	56.13	2.71		13.10
	Worcester Rendering Co., Auburn,	Guaranty	....	....	50.00	....		8.00

[1] Wire tags.

TABLE III. FEEDS NOT CONFORMING TO GUARANTIES OR OTHERWISE ILLEGAL.

Station No.	Manufacturer and Brand	Protein Deficiency	Fat Deficiency	Fiber Excess	Remarks
	COTTONSEED MEAL.	%	%	%	
868	Steerboy. S. P. Davis, Little Rock, Ark.	....	....	....	Wire tags, illegal.
778	Dixie. Humphreys-Godwin Co., Memphis, Tenn.	7.37	....	3.88	....
749	Neal's Choice. L. B. Lovitt & Co., Memphis, Tenn.	8.62	....	3.93	....
	HOMINY FEED.				
701	The Patent Cereals Co., Geneva, N. Y.	....	....	....	Wire tags, illegal.
	DAIRY FEED				
754	Nobotheration Dairy Ration. C. W. Campbell Co., Westerly, R. I.	1.56	....	....	....
785	Wirthmore 20 Protein Dairy Feed. C. M. Cox Co., Boston, Mass.	....	1.22	....	....
709	Elmore Milk Grains. Elmore Milling Co., Oneonta, N. Y.	....	0.47	....	....
743	Bull Brand Dairy Ration. Maritime Milling Co., Buffalo, N. Y.	1.50	....	....	....
766	Uncle John's 24% Cream Pot Ration. Ontanio Milling Co., Oswego, N. Y.	2.37	....	....	....
687	Pillsbury's 24% Dairy Feed. Pillsbury Flour Mills Co., Minneapolis, Minn.	1.19	....	....	....
825	Mill Streams Boomerang Dairy Feed. Winchell Smith Grist Mill, Farmington, Conn.	....	0.27	....	....
	STOCK FEED.				
797	Pennant Brand Stock Feed. E. W. Bailey & Co., Swanton, Vt.	....	0.87	....	....
762	Nobotheration Stock Feed. C. W. Campbell Co., Westerly, R. I.	....	1.27	....	....
848	Davis Stock Feed. R. G. Davis & Sons, New Haven, Conn.	....	1.17	....	....
715	Flory's Special Stock Feed. Flory Milling Co., Bangor, Penn.	....	....	1.24	....
835	Nabob Stock Feed. Francis H. Leggett & Co., Norwalk, Conn	....	0.42	....	....

Table III. Feeds Not Conforming to Guaranties or Otherwise Illegal.

Station No.	Manufacturer and Brand	Protein Deficiency	Fat Deficiency	Fiber Excess	Remarks
		%	%	%	
	Poultry Feeds.				
845	Armour's Cak-Cak Laying Mash. Maple Flake Mills, Chicago, Ill.	1.25	....	....	....
829	Quisenberry Quality "Big 4" Mash. Quisenberry Feed Mfg. Co., Buffalo, N. Y.	....	....	2.15	....
	Beef Scrap.				
871	Protox Meat & Bone Scrap. American Agricultural Chemical Co., New York City	3.06	....	....	....
740	Rauh's Meato. E. Rauh & Sons Animal Feed Co., Indianapolis, Ind.	....	....	....	Wire tags, illegal.
852	Swift-Sure Ground Beef Scrap for Poultry. M. L. Shoemaker & Co., Philadelphia, Pa.	2.87	....	....	....

Over the five-year period 1920 to 1924 inclusive, from 8 to 12 per cent. of samples examined have been found deficient in individual years. The combined data for this period shows that of 864 samples analyzed 83 have been deficient in one or more of the three items, protein, fat and fiber, which is 9.6 per cent. of the total. In other words 90.4 per cent. of the samples examined have substantially met their guaranties. The distribution of these deficiencies is shown in Table IV.

Table IV. Summary and Distribution of Deficiencies for Five Year Period, 1920 to 1924 Inclusive.

	No. Samples	No. Deficient
Cottonseed Meal	60	9
Cottonseed Feed	4	1
Linseed Meal	27	0
Wheat Bran	70	1
Wheat Feed	42	1
Wheat Middlings	80	2
Rye Products	9	0
Wheat and Rye	1	0
Buckwheat	2	0
Oat Products	4	0
Corn Gluten Feed	25	1
Corn Gluten Meal	3	0
Corn Meal	4	0
Hominy Feed	58	11
Distillers' and Brewers' Grains	15	3
Dried Beet Pulp	25	0
Proprietary Feeds (including Poultry Feeds)	429	53
Miscellaneous:		
Peanut Oil Meal	1	1
Cocoanut Oil Meal	1	0
Corn Flakes	1	0
Red Dog Flour	3	0
Total	864	83

MISCELLANEOUS SAMPLES.

In Table V are included samples submitted by purchasers or others interested. Most of these have required only partial or complete fodder analyses; but in a few cases examinations were made for poisons.

Table V. Analyses of Feeding Stuffs Submitted by Individuals.

Station No.	Material	Submitted by	Pounds per Hundred: Water	Ash	Protein (Nx6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.	Ether Extract (Crude fat).	Remarks
	Corn Products.								
23162	Buffalo Gluten Feed "A"	*Granby:* P. J. Rogers	....	....	24.56	....	....	....	
23163	Buffalo Gluten Feed "B"	P. J. Rogers	....	....	25.63	....	....	....	
	Oat Products.								
898	Canada Oats No. 44	*Cromwell:* Edmund Peterson	9.40	3.34	11.00	9.18	61.60	5.48	
900	Ground Oats No. 38—40	Edmund Peterson	10.15	2.99	11.50	9.65	60.56	5.15	
1183	Ground Oats	*Berlin:* D. B. Hubbard, Jr.	1.97	....	12.31	9.13	....	....	
	Wheat Products.								
897	Red Wheat	*Cromwell:* Edmund Peterson	10.83	1.78	12.38	2.20	70.86	1.95	
901	Gold Medal Wheat Bran	Edmund Peterson	10.10	6.04	16.00	8.90	53.71	5.25	
902	H. Wheat Middlings	Edmund Peterson	10.28	4.90	15.88	8.30	55.09	5.55	
	Proprietary Mixed Feeds.								
	Dairy Feeds and Rations.								
23366	Dairy Feed	*Hazardville:* Amos D. Bridges' Sons	....	....	20.94	....	....	....	
599	Dairy Ration	*Plantsville:* C. A. Cowles	8.10	5.74	26.56	9.18	44.03	6.70	
23005	Big Y Dairy Ration	*Norwich:* S. C. Beebe	....	....	26.94	....	....	....	
22808	Dairy Ration Home Mixture	*Hazardville:* Amos D. Bridges' Sons	9.56	....	20.75	....	....	5.21	
22838	Fulpail Dairy Ration No. 1	*Thomaston:* Nils Swanson	....	....	21.75	....	....	....	
22839	Fulpail Dairy Ration No. 2	Nils Swanson	....	....	23.81	....	....	....	
22836	Fulpail 20% Eastern States Ration	*Norwich:* Walter T. Clark	....	....	21.63	....	....	....	Guaranty; protein 20%.
22835	Milkmore 24% Eastern States Ration	Walter T. Clark	....	....	25.75	....	....	....	Guaranty; protein 24%.
176	Red Wing Junior Dairy Ration	*Middletown:* Meech & Stoddard, Inc.	....	....	18.94	....	....	....	
177	Red Wing Special Dairy Ration	Meech & Stoddard, Inc.	....	....	22.63	....	....	....	
935	Red Wing Special Dairy Ration	*Middlefield:* Lyman Farm	....	....	20.88	....	....	6.20	Guaranty; protein 24.00, fat 6.00, fiber 9.00%.
932	Uncle John's 24% Cream Pot Ration	Lyman Farm	....	....	23.75	....	....	6.45	Guaranty; protein 24.00, fat 5.5, fiber 9.00%.
22828	Uncle John's 24% Cream Pot Dairy Ration	*Middletown:* The Coles Company	....	....	23.19	....	....	....	Guaranty; protein 24%.
23284	Wadfeeco Dairy Ration	*New Haven:* S. C. Salmon	....	....	25.00	....	....	....	Guaranty; protein 24.00, fat 5.00, fiber 7.00%.
	Poultry Feeds.								
23004	Big Y Laying Mash	*Norwich:* S. C. Beebe	....	....	22.19	....	....	....	
22912	Big Y Laying Mash	The Yantic Grain & Products Co.	....	....	22.06	....	....	....	Guaranty; protein 20.00, fat 4.00%.
22683	Eastern States Egg Mash	*Gaylordsville:* Miss H. M. Bamwell	6.16	4.91	21.75	6.58	55.50	5.10	Guaranty; protein 22.00, fat 3.5 fiber, 7.00%.
22684	Eastern States Egg Mash	Miss H. M. Bamwell	6.14	5.12	22.56	6.59	54.43	5.16	Guaranty; protein 22.00, fat 3.5, fiber 7.00%.
22837	Egg Mash 22% Eastern States Ration	*Norwich:* Walter T. Clark	....	....	23.06	....	....	....	Guaranty; protein 22.00%.
934	Laying Mash	*Meriden:* Reliable Grain & Feed Co.	6.20	13.32	25.75	5.50	41.73	7.50	
895	Cracked Corn	*Cromwell:* Edmund Peterson	12.50	1.03	9.00	1.78	72.39	3.30	
899	Frisbie Meat and Bone Scraps	Edmund Peterson	6.30	31.41	45.88	....	2.11	14.30	Guaranty; protein 40.00, fat 8%.
23272	Beef Scrap	*Middletown:* Middlesex Refining Co.	....	....	56.50	....	....	....	
294	Bran A-1	*Cromwell:* Edmund Peterson	....	....	15.31	....	....	....	

TABLE V. ANALYSES OF FEEDING STUFFS SUBMITTED BY INDIVIDUALS.

Station No.	Material	Submitted by	Pounds per Hundred						Remarks
			Water	Ash	Protein (Nx6.25)	Fiber	Nitrogen-free Extract (Starch, gum etc.)	Ether Extract (Crude fat).	
	PROPRIETARY MIXED FEEDS—*Concluded.*								
	Poultry Feeds—Concluded.								
295	Middlings A-2	Edmund Peterson	....	....	16.81	....	....	....	
296	Corn Meal A-3	Edmund Peterson	....	....	10.31	....	....	....	
297	Beef Scrap A-4	Edmund Peterson	....	....	50.31	....	....	....	
298	Dry Ground Fish A-5	Edmund Peterson	....	....	31.94	....	....	....	
202	Chick Feed	*Waterbury:* F. E. Liebreich	....	....	20.44	....	....	....	
23207	Skim Milk Curd	*Bridgeport:* The Mitchell Dairy Co.	68.96	2.73	24.50	....	....	0.54	
22809	Scratch Feed	*Plainville:* Kosenko Bros. Poultry Farm	10.67	....	11.31	....	....	3.50	
22810	Mash	Kosenko Bros. Poultry Farm	8.58	....	22.06	....	....	5.62	
	MISCELLANEOUS.								
22757	Ground Oats	*New Haven:* Station Agent, stock of R. G. Davis	11.35	3.05	13.38	6.29	60.98	4.95	
22758	Ground Oats	Station Agent, stock of Crittenden Benham Co.	11.75	3.11	14.31	7.88	58.57	4.38	
22759	Ground Oats	*Thompsonville:* Station agent, stock of Geo. S. Phelps & Co.	10.81	3.31	12.38	8.96	59.30	5.24	
22760	Ground Oats	*Hartford:* Station agent, stock of Meech Grain Co.	11.41	3.13	13.06	7.40	60.48	4.52	
22761	Ground Oats	*Guilford:* Station agent, stock of Fred C. Morse	11.59	3.01	12.88	7.51	61.04	3.97	
22762	Ground Oats	*Middlefield:* Station agent, stock of Middlefield Grain & Coal Co.	10.81	3.24	12.56	8.68	60.37	4.34	
22763	Ground Oats	*Middletown:* Station agent, stock of Meech & Stoddard, Inc.	11.45	3.15	12.13	8.24	60.55	4.48	
23469	Feed	*Yantic:* Morris Pearson	....	....	23.88	....	....	....	
22998	Wheat Bran	*Bridgeport:* Bridgeport Ice Delivery Co	....	....	16.13	....	....	....	
22999	Brewers' Grains	Bridgeport Ice Delivery Co.	....	....	22.94	....	....	....	
23000	Oats & Barley	Bridgeport Ice Delivery Co.	....	....	14.00	....	....	....	
1111	Full Cream Milk Powder	*Stratford:* Samuel Wallace	....	....	....	....	....	27.80	
460	Bran	*Middletown:* Station agent, stock of Meech & Stoddard, Inc.	10.58	6.22	14.44	10.00	53.14	5.62	
461	Cottonseed Meal	Station agent, stock of Meech & Stoddard, Inc	8.70	5.77	36.44	12.73	30.28	6.08	
462	Corn Meal	Station agent, stock of Meech & Stoddard, Inc	13.44	1.56	9.50	2.43	69.09	3.98	
463	Experimental Ration	Station agent, stock of Meech & Stoddard, Inc	11.43	4.08	17.75	7.43	54.25	5.06	
936	Feed	*Warehouse Point:* Edward Potwine	....	....	20.25	....	....	....	
22519	Feed	*Storrs:* Dept. of Animal Husbandry	6.72	0.66	9.38	0.45	81.99	0.80	
42	Feed	*Norwich:* H. F. Segelkers	....	....	17.44	....	....	....	
23003	Dry Buttermilk	*Simsbury:* Robert Darling	....	....	31.77	....	....	3.98	
333	Mash	*Bridgeport:* Homeland Grocery Store	9.67	7.38	21.38	5.32	50.00	6.25	
896	Corn Meal	*Cromwell:* Edmund Peterson	11.18	1.74	10.25	3.18	69.10	4.55	
1015	Corn	*Orange:* Howard Treat	18.00	....	....	....	....	....	

TABLE V. ANALYSES OF FEEDING STUFFS

SUBMITTED BY INDIVIDUALS.

Station No.	Material	Submitted by	Pounds per Hundred: Water	Ash	Protein (Nx6.25)	Fiber	Nitrogen-free Extract (Starch, gum, etc.	Ether Extract (Crude fat).	Remarks
	MISCELLANEOUS—*Concluded.*								
1191	Eastern States Mash	*Bolton:* J. W. Phelps	....	....	....	....	....	....	Composed of wheat, corn and oat products with meat scraps all in substantial proportions.
1195	Ground Oats	*New Haven:* Crittenden Benham Co.	....	....	....	....	....	....	Chiefly oats, trace corn and wheat; no rye found.
1196	Corn Meal	*New Haven:* Crittenden Benham Co.	....	....	....	....	....	....	As claimed; slight contamination with oats, wheat and buckwheat.
23286	Poultry Mash	*South Glastonbury:* Harry W. Ferry	....	....	....	....	....	....	No evidence of mouldy or smutted grains.
515	Hopper Mash	*Seymour:* L. H. Smyth	....	....	....	....	....	....	No poisons detected.

BULLETIN 269 AUGUST, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

Perithecia of Thielavia basicola Zopf in Culture And The Stimulation of their Production by Extracts from other Fungi

---

FLORENCE A. McCORMICK

BOTANICAL DEPARTMENT

The Wilson H. Lee Co.

Perithecia of Thielavia basicola Zopf in Culture and the Stimulation of their Production by Extracts from other Fungi.

By

Florence A. McCormick.

During a disease survey of tobacco in the summer of 1920, *Thielavia basicola* Zopf was found to be unusually abundant, the heavy rains in the early part of the season favoring its development. Perithecia were plentiful and, in some cases, they were found to be deeply embedded in the tissues of the host. It, therefore, seemed worth while to attempt to establish more definitely the connection of the ascospore stage with the chlamydospores and endoconidia, all three spore forms being known by the name *Thielavia basicola* Zopf, since Peglion, in 1900, (19) has given the only published record of perithecia in artificial culture. Aside from its scientific interest, it is of economic value to know whether there are two fungi or only one, possessing all spore forms, parasitic on its agricultural hosts. *Thielavia basicola* Zopf is a well known parasite, chiefly serious on tobacco, the violet and many of the Leguminosae. Johnson mentions thirty-nine hosts compiled by previous investigators and gives sixty-six additional ones.

Historical.

The literature cited below concerns, in the main, the perithecia commonly assumed to be the perfect stage of the fungus producing chlamydospores and endoconidia known as *Thielavia basicola* Zopf and is only a small part of the mass of publications bearing chiefly on the economic problems connected with that fungus.

In 1850 Berkeley and Broome (2) found the chlamydospores at the base of stems of peas and *Nemophila auriculata* and gave the fungus the name of *Torula basicola* n. s. In 1876 Zopf (33) published an article in which he described a fungus growing on *Senecio elegans* L. in the Botanical Garden of Berlin and he recognized the chlamydospores as identical with those described and figured by Berkeley and Broome. In addition to the chlamydospores, he described endoconidia, ascospores and spermatia. The last spore form has not been observed by other workers and Zopf himself omitted it from a later publication. Due to the association of perithecia with the chlamydospores and endoconidia, Zopf, in his publication of 1876, changed the name, *Torula basicola*, given by Berkeley and Broome, to *Thielavia basicola* and placed the fungus in the Perisporiaceae. Since the date of that publication the fungus bearing chlamydospores and endoconidia, noted above, has also been known as *Thielavia basicola* Zopf and the perithecia occasionally found with them have been considered the perfect stage of that fungus. In August, 1876, Sorokin (30) announced the finding of a new fungus on the roots of *Cochlearia armoracia.* He described the chlamydospores, but, not recognizing them as belonging to the fungus found by Berkeley and Broome twenty-six years before, nor knowing of Zopf's discovery, named the fungus *Helminthosporium fragile* sp. n. Saccardo lists the fungus in three different places and under as many different names. He retains the name for the chlamydospore stage given by Berkeley and Broome (23), but he changed the name *Helminthosporium fragile* Sorok., given by Sorokin, to *Clasterosporium fragile* (Sorok.) Sacc. (24). He also gives a description of *Thielavia basicola* Zopf (22), including in it perithecia along with the other spore forms.

In his paper of 1891, Zopf (34) gives a detailed account of a new disease of lupines which he found to be due to *Thielavia basicola.* He did not make cultures but, since perithecia were again found associated with chlamydospores and endoconidia, he still considered the fungus undoubtedly an ascomycete and retained the name *Thielavia basicola.* This opinion has been generally accepted although the relationship of perithecia to endoconidia and chlamydospores has not been considered completely established, since perithecia are not obtained in artificial cultures and only infrequently found in nature. In classification of fungi, however, *Thielavia basicola* Zopf is invariably placed with the ascomycetes, on the supposition that chlamydospores, endoconidia and perithecia belong to the same fungus, and taxonomists agree that it is closely related to the Aspergillaceae.

Previous to the report from this Station in 1921 (14), Peglion (19) is the only person who had obtained perithecia in a culture. He found perithecia only once, these occurring after he moistened a three year old culture on potato plugs with a 6% tartaric acid solution. A week later he discovered that perithecia had developed. Prof. Thaxter, 1891, (31), who found this fungus on violet roots and who was the first to report its presence in America, did not find perithecia and he has never been fully convinced of their relationship to the other two spore forms. Sorauer (29), 1895, does not question the relationship. Oudemans (18) considers *Thielavia basicola* Zopf as belonging to the Perisporiaceae and he illustrates only a mature perithecium, a mature ascus and a young ascogonium, omitting any reference to the asexual spores. Cappelluti-Altomare (4) found perithecia associated with chlamydospores on tobacco roots. Aderhold (1) failed to obtain perithecia in his cultures and did not find them in plants infected with that fungus. In discussing perithecia Clinton, 1906, (5) says, "So far as our own observations go we could not positively assert their relationship to the other spore forms of the root rot fungus, but from their presence and the observations of others there seems to be no reason for doubting this relationship." In his report of the following year Dr. Clinton (6) further says "During the past year and a half the fungus has been under observation in cultures with various media in an attempt to develop the ascospore stage. This has not been obtained, though the fungus was grown on tobacco roots on which this stage occurs in nature in Connecticut. Fresh tobacco roots containing the fungus were sent to Professor Thaxter, who tried to isolate the ascospores by the Barber method and obtain cultures directly from them—our cultures having come originally from the endospores, or possibly from the chlamydospores—but he was not successful in obtaining such cultures. Professor Thaxter has, on the other hand, a culture of another species of *Thielavia* which forms ascospores, but never the endospores and chlamydospores. These facts possibly may indicate that the ascospore stage has no relationship to our fungus, and that it occurs on the tobacco roots as a parasite of the fungus rather than as a stage of it." Duggar (8) says, "The association of the ascosporous stage with the others and the apparent continuity of mycelium are believed to show genetic connection." Gilbert (12) also accepts this hypothesis and states that he was fortunate to obtain a perithecium attached to the same hypha which bore an endoconidiophore, but that he never saw an ascus. Foex (10) and Reddick (21) found violets infected with *Thielavia basicola* Zopf and accepted the relationship of perithecia with the other spore forms. Johnson (15) considers association of the perithecia with chlamydospores in nature as an evidence of their relationship. Peters (20), who did not obtain perithecia in his cultures and only once found them in his investigations in the field, questions their connection with the chlamydospores and endoconidia.

Ferraris (9) distinguishes the asexual stage from the ascospore stage, applying the name *Thielaviopsis basicola* (Berk.) Ferraris to the fungus which bears the chlamydospores and endoconidia and the name *Thielavia basicola* Zopf to the ascospore stage, not, however, implying two distinct fungi. To simplify the nomenclature in this paper the writer is following hereafter the terminology of Ferraris for these different stages.

Experiments With a Conidum-Chlamydospore Culture.

In August, 1920, a culture of *Thielaviopsis basicola* (Berk.) Ferraris, culture No. 396, was isolated from tobacco roots in which there were large numbers of perithecia associated with chlamydospores. Pieces of the infected roots were thoroughly washed in running water, followed by sterilized water, and put on oat agar containing some tobacco leaf extract. An endoconidium-chlamydospore culture was obtained, but no perithecia were produced.

Peglion's result indicated that nutrition might be a factor in the development of perithecia. Repeated efforts were made, therefore, to induce the formation of perithecia by the use of various kinds of media, by the provision of an excess of food, by slow starvation and, finally, by partial starvation followed by an abundance of food.

It was thought that tobacco extract might be a favorable food, and agar was made with it, alone and in combination with other substances. Sterilized tobacco seedlings were used alone and made up with agar and soil. Stock agars were made with ground peas, beans, oats, corn, peanuts, carrots, potatoes and beef extract. These media were used alone and also in combination with other nutrients, such as glucose and yeast, and a series of cultures, grading from slightly acid to slightly alkaline, was also tried. Plugs of carrot, potato, pineapple and pea pods gave an excellent growth of the fungus, but orange and lemon plugs gave little or no growth. Transfers from luxuriant cultures to water agar were made, with the hope that a change from an abundance of food to a negligible quantity might be effective, and transfers were also made from one highly nutritive medium to another equally so, but of a different kind. With some cultures gelatine was substituted for agar. The results of these tests were strictly negative, not a single culture showed a development of perithecia. Eighteen cultures on various media in protected test tubes, were planted outdoors in the spring and were left throughout the summer to see if the natural temperature of the soil might be a factor. Here again the results were entirely negative.

Perithecia in Culture.

In view of the negative results of the nutrition experiments it seemed worth while to determine whether or not perithecia of *Thielavia basicola* Zopf were the product of sexual strains. It was the intention of the writer to secure during the summer of 1921 as large a number of strains as possible for the purpose of making mixed cultures, but work on tobacco wildfire prevented making such collections. No other culture in addition to culture 396 was procured until later in the summer when some violet plants, heavily infected with chlamydospores of *Thielaviopsis basicola* (Berk.) Ferraris and perithecia of *Thielavia basicola* Zopf, were sent to Dr. Clinton from a greenhouse near Hartford. The writer visited the greenhouse and secured fresh material for culturing.

On August 9th pieces of these roots were cultured like the tobacco roots from which culture 396 was obtained, put into four Petri dishes and given the culture number 1351. On August 15th a slight growth of *Thielaviopsis basicola* was perceptible and transfers were made to three tubes of pea meal agar and three tubes of carrot agar. Two days later additional transfers were made to seven tubes of carrot agar. Nothing further was done with these cultures until October 6th. On that date one of the transfers made on pea meal agar, August 15th, showed chlamydospores, endoconidia and perithecia. This tube was so contaminated with bacteria that, although sixteen transfers to tubes and two to Petri dishes were made, only a feeble growth was obtained. Subsequent transfers failed to restore it and the culture was finally lost. Of the seven transfers made on carrot agar, August 17th, one showed perithecia as well as chlamydospores and endoconidia and the remaining six had only chlamdospores and endoconidia. The growth of these six cultures was feeble on account of bacterial contamination and they, too, were finally lost. The culture containing perithecia along with the two asexual spores was also contaminated with bacteria and a fungus, still undetermined, but repeated culturing freed it from bacteria and later from the fungus.

There can be no doubt that culture 1351, obtained from the violet, is the fungus commonly known as *Thielavia basicola* Zopf. As stated above, Professor Thaxter (31), in 1891, announced the finding of this fungus on violets in Connecticut. In regard to perithecia he makes the following statement: "Zopf describes an ascosporic condition on which the genus *Thielavia* is founded, which has not been observed by the writer except as a parasite on other fungi (species of Isaria)." Foex (10) also found *Thielavia basicola* on violets and he gives a description of the disease and figures chlamydospores and perithecia with ascospores. In regard to the relationship of perithecia with the other spore forms he says: "Toutefois, il est hors de doute, après les observations de Zopf, que ces conceptacles appartiement bien au champignon qui constitue des endoconidies et des chlamydospores." In his paper on violet diseases Reddick (21) says: "The ascosporic stage, mentioned above, does not seem to play a particularly important role in the life cycle of this organism. If it were commonly developed it would seem reasonably certain that the numerous workers in this country and abroad would have seen and recorded its occurrence more frequently." Reddick's illustrations of infected violet plants agree well with Fig. 1, Plate XXXVII. The plants were considerably stunted and had comparatively small, yellowish leaves. In some cases the root system was almost entirely decayed, only a few lateral roots remained and the cortex of the main root was almost disintegrated, in places exposing the network of xylem.

Sections of some diseased violet roots, collected from the greenhouse mentioned above, showed numerous chlamydospores borne internally in the cortex as well as in the xylem, medullary rays and pith. Fig. 3, Pl. XXXVII, taken from such a root, also shows sclerotial masses of mycelium completely filling some of the cells. The chlamydospores shown in this figure are identical with those found in tobacco. Endoconidia from the violet are also like those in the culture isolated from the second host. In addition to Brierley's description (3) of endoconidia, Gilbert (12) has also described both spore forms and it is not necessary to repeat them here.

Perithecia, however, are not so well known. Some features noted by previous observers may here be re-emphasized and additional ones given. Perithecia have been found by the writer in roots of tobacco (Pl. XXXVII, Fig. 6), the pea (Pl. XXXVII, Fig. 5), the violet (Pl. XXXVII, Figs. 2 and 4) and recently of Antirrhinum. Sections have been made of the first three infected roots mentioned and the perithecia found in their tissues are alike in all. They are found chiefly in the cortex, but they are also located on the surface lying among masses of chlamydospores and no tissue of the root is entirely free from their invasion. The description of them as seen in culture, however, applies only to those isolated from the violet as no culture of them has been secured from any other host. In culture the perithecia of *Thielavia basicola* Zopf are globular or nearly so, but in nature the pressure of the surrounding cells of the host may make them some what elongated, one dimension occasionally being nearly twice as great as the other. The cells of the tightly twisted and intertwined hyphae, composing the enveloping sheath, vary in size so as to make the perithecium "rough" as Gilbert described it. The enveloping sheath is hyaline or slightly tinted. At maturity the perithecium looks black which is due to the very dark brown color of the ascospores lying within. There is no sign of an opening of any kind so that it may be considered a true cleistocarp. The asci are exceedingly fragile and by the time the ascospores are mature they have disintegrated leaving the ascospores free in the perithecial cavity. Asci, however, can be seen and obtained intact by gently pressing the cover glass over a nearly mature perithecium. If the ascospores are mature the ascus will invariably be ruptured. The asci are hyaline, nearly egg-shaped and contain eight ascospores. (Pl. XXXVIII, Fig. 23.)

The size of the perithecium has been commonly given as 80 to 100μ. The writer has found this size rather large. In the sections of the tobacco and pea roots the perithecia measure about the same, the maximum size of those measured in tobacco being 72μ and those of the pea 66μ. In the violet roots the perithecia were somewhat larger, the maximum dimension reaching as high as 99μ which, however, is exceptional even in this host. The larger size of the perithecia in the violet roots may possibly be due to greenhouse conditions. In culture, perithecia, which it is recalled were isolated from the violet, average about the same in size as those found in tobacco and pea roots.

The ascospores are small, dark brown and lenticular with one end blunt, from which germination occurs. In mass they appear black. The relatively large oil drop is the conspicuous feature of the cell contents. In the roots of the violet, tobacco and pea, as well as those in culture 1351, the general size is 10 to 13μ by 4.5 to 6.5μ.

The ascogonium begins as a small lateral branch attached at right angles to the main hypha. The early stages, in gross appearance, apparently do not differ essentially from the figures given by Fraser and Chambers (11) for *Aspergillus herbariorum* and by Dale (7) for *Aspergillus repens* de Bary, although loose coils were not observed in this fungus. No attempt has been made to study the nuclear behavior and all the drawings of these stages, given here (Pl. XXXVIII, Figs. 11-22) were made from living material. The coil early becomes compact and additional hyphae soon bud out from the primary coil, thereby concealing it. The entire process takes place very quickly, as perithecia, apparently mature, can be seen along the sides of the tube eight days after the transfer has been made. Where observed, the early stages gave no indication of more than one hypha being involved in the ascogonial coil.

Possible Factors Inducing the Formation of Perithecia.

Having obtained perithecia in this accidental way the question arose as to the factors which brought forth their appearance. It was first thought that this might be a specialized form growing on this particular lot of violets. More violets were procured from the same greenhouse and cultures were made from individual plants. Ten additional cultures were isolated from as many different plants, but while all produced endoconidia and chlamydospores, none formed perithecia. If, then, culture 1351 were a unique strain it could not be general throughout the plants in the greenhouse, but one might expect to obtain perithecia from one-spore cultures of its endoconidia and chlamydospores. For the purpose of investigating this point one-endoconidium cultures were made. The spores were plated in stiff agar and the single germinating spores were transferred to tubes.

One-Conidium Cultures.

Of the 260 one-endoconidium cultures that were isolated from culture 1351 all showed a luxuriant development of endoconidia and chlamydospores, but no perithecia were found in them. This result apparently gave the solution as to the cause of the non-appearance of perithecia in some of the first transfers made from culture 1351. In an attempt to obtain transfers free from bacteria and the associated fungus an effort was made to touch the mycelium very lightly with the needle in order to carry over only endoconidia. For a time it was thought that perithecia were completely lost, but later it was found that transfers which included some of the mycelium always produced perithecia.

In isolating the germinating endoconidia it was noted that they vary somewhat in shape from the elongated narrow type with straight ends to short almost egg-shaped ones. The one-spore cultures were made from as many different types as possible, but the subsequent growth was alike in all.

Although no one-endoconidium cultures developed perithecia it seemed possible that culturing two or more together might lead to their production. To facilitate the process of culturing, transfers from several tubes were frequently put into one tube so that while all the 260 cultures were used only 151 mixed cultures were made. In case perithecia developed in a tube containing transfers from more than two tubes the cultures producing them could be readily separated. No perithecia were in any of these tubes.

Chlamydospore Cultures.

For the same reason chlamydospore cultures were also isolated from culture 1351. They are, however, much more difficult to secure than endoconidium cultures, but by treating them with pepsin good germination was obtained. Pieces of culture, three or four weeks old, were thoroughly washed, since the numerous endoconidia, which are everywhere present in cultures, germinate so rapidly as to easily contaminate the chlamydospore cultures. Chlamydospores cling tenaciously together in chains and frequently more than one chlamydospore in a chain will germinate. In such cases the entire chain was transferred to a tube with the intention of accurately making single spore cultures in case perithecia were found in any of the tubes. Ninety chlamydospore cultures were included in the twenty mixed cultures made, each tube containing transfers from four or five cultures, but in none of these twenty tubes were perithecia produced. It was the intention to make an extensive series of plantings of one-endoconidium cultures with chlamydospore cultures, but investigations with the asco stage made this seem unnecessary and comparatively few were made. In no case did these produce ascospores but both asexual spores.

Investigations with the Ascospore Stage.

In studying the young stages of the ascogonium an effort was made to ascertain the relation of the ascogonial hypha to the mycelium which bears endoconidia and chlamydospores, since as noted above, culture 1351 is a mixed culture bearing all three spore forms. As the figures of *Aspergillus* also show, there was no indication here of hyphae from two different mycelia being concerned in the ascogonial coil. With the hope of getting a clearer view of the individual threads and also of being able to get cultures from them, small pieces of mycelium were cultured on clear agar with the idea that possibly an ascogonial hypha might become sufficiently separated so that it could be cut free from contaminating endoconidia, chlamydospores or the mycelium which bears them. All such attempts failed and one-ascospore cultures seemed to be the only method of getting accurate evidence of the relationship of the perithecia to the endoconidia and chlamydospores.

The Germination of Ascospores. Endoconidia are produced in such numbers that it is also necessary to free perithecia from them in order to procure pure ascopore cultures, for they germinate so readily that they contaminate the smaller and more slowly germinating ascospores. Pieces of culture, containing many perithecia, were thoroughly washed under a strong flow of tap water and finally in sterilized water. It was often necessary to tease away the endoconidia with sterilized needles.

Various methods, recommended for inducing germination of other ascospores, were tried without success. However, in the writer's experience the germination of ascospores of *Thielavia basicola* is very low, so this may be the cause of the failure. The first germination was obtained in a van Tieghem cell containing a trace of pepsin in the drop of water. All subsequent cultures were made by crushing the washed perithecia in a tube containing beef broth, a trace of pepsin and a minute particle of thymol. A better method, probably, would be to filter the solution containing pepsin through a Berkefeld filter, thus making thymol unnecessary. After about half an hour loops of the broth were transferred to melted beef agar which contained about 3% agar. A very clear agar is essential on account of the small size of the ascospores. Germination begins to appear in about five days. The open Petri dish was examined under the microscope and germinating ascospores transferred with a sterile needle to a suitable medium, in this case pea meal agar. By this method forty-two one-ascospore cultures were obtained. The germination of these spores was obtained only when pepsin was used and it was not determined whether or not they will germinate without it. The sole aim was to procure germination and no consideration was given to factors bringing it about. It is quite possible that freezing may be an aid to germination of the ascospores and the age of the spores may also be important. The best germination was secured with spores taken from cultures six weeks or two months old.

As previously stated the ascospore germinates at the blunt end (Pl. XXXVIII, Fig. 1) and the writer has not found more than one germ tube connected with a spore. Next to the spore coat, the germ tube has a one-sided bulbous enlargement and variation in diameter with considerable curling is characteristic of the older as well as the younger hyphae (Pl. XXXVIII, Figs. 9, 10). Especially in the early stages the cells are practically filled with a fine granular content (Pl.XXXVIII, Figs. 1-8). Growth is comparatively slow and although small test tubes were used it was several days before the delicate hyphae could be detected growing up on the sides of the tube and along the edge of the medium. The mycelium is white and on pea meal agar seldom shows the slightest tendency to become cottony, neither does it make a felt-like growth as does *Thielaviopsis basicola*. The hyphae grow sparsely over the surface and down into the interior of the medium.

None of the forty-two one-ascospore cultures produced either chlamydospores or endoconidia and although they have been in culture more than two years they have produced only perithecia and these usually developed sparingly and sometimes not at all. While there may be some difference of growth in the media commonly used for fungi, there has never been the least indication of even the rudiments of chlamydospores or endoconidia. Pea meal agar is the stock medium used and, while the growth on it is usually so delicate as to be readily overlooked, it seems to be a satisfactory one for this fungus, as all the forty-two cultures are still in good condition. The fungus also grows well on corn meal, prune, oat, potato, carrot and bean meal agars. However, there is often a difference in growth of cultures made at the same time and on the same agar. The factor, or factors, bringing about this condition have not been ascertained. With the above media in only a few cultures was there any approach to a cottony mycelium and, while the mycelium was abundant, it still remained delicate, being, in comparison with other fungi, very inconspicuous.

Mixed Cultures of Thielavia basicola Zopf and Thielaviopsis basicola (Berk.) Ferraris

The fact that none of the one-ascospore cultures produced either endoconidia or chlamydospores suggested that the ascospore cultures might be sexually related to the endoconidium-chlamydospore strains without, however, producing any asexual spores. With this idea in mind each of three one-ascospore cultures was cultured with eighty-one one-endoconidium cultures, from culture 1351, and with three *Thielaviopsis basicola* from tobacco, four from violet and one from garden peas. Perithecia were abundantly produced in all. Usually within six days immature perithecia could be detected in the tube placed under the microscope and in eight days almost mature perithecia could be seen with a hand lens. The remaining thirty-nine perithecial cultures were cultured with the eight cultures isolated from tobacco, violet and pea and they were also stimulated to produce an abundance of perithecia.

These results seemed to indicate that production of perithecia in this fungus was due to different sexual strains. However, it was early noted that there was a tendency to form perithecia in the one-ascospore cultures even though they were not cultured with the endoconidium-chlamydospore strains. In such cases perithecia were slower in making their appearance and increased in number as the culture grew older. Furthermore the forty-two cultures varied somewhat in this ability of forming perithecia when cultured alone and there was often a difference in cultures of the same strain made at the same time and on the same medium. In no case, however, did a single culture alone produce perithecia as quickly or as abundantly as when grown with endoconidium-chlamydospore cultures. The factors which cause this difference in production of perithecia have not been ascertained. In autoclaves in which steam is in contact with the tubes a little more moisture at times collects in some tubes than in others, so it was thought that possibly the rigidity of the medium might be a factor. Cultures were made on media containing different concentrations of agar, but these gave no definite results, perithecial formation not being increased in any of them. A few cultures on oat agar, made in the usual way, formed a ring of perithecia along the upper edge of the medium, but these were not general throughout the tube and not always obtained. Possibly a slow drying combined with a favorable medium might be a factor. Occasionally transfers taken from an old dried culture make a more luxuriant growth and form more perithecia than those from newer cultures. For the experiments made on the production of perithecia an ascosporic culture, No. 1603, which alone seldom forms perithecia, was used.

Mixed Cultures of Thielavia basicola Zopf and Other Fungi.

The writer is indebted to Prof. Thaxter for the suggestion of culturing *Thielavia basicola* Zopf with other fungi to see if the reaction with them is similar to that with *Thielaviopsis basicola* (Berk.) Ferraris.

First of all, however, *Thielavia basicola*, culture 1603, the strain which alone rarely produces perithecia, was cultured with the remaining forty-one strains of *Thielavia basicola*, but there was no additional stimulation in growth or perithecial formation. In this respect the results differ from those obtained by Miss Wineland (32) who found that two one-ascospore cultures of *Fusarium moniliforme*, grown together, stimulate the production of perithecia.

Other fungi were then tried. The same *Thielavia basicola* culture, No. 1603, was cultured with 120 strains and species, embracing 43 genera, belonging to Phycomycetes, Ascomycetes, Basidiomycetes and Fungi Imperfecti. In all the tests pea meal agar was used and in each case a transfer from one culture of *Thielavia basicola* was put into a tube with that from one other fungus. Many of the fungi grew so rapidly as to bury the delicate more slowly growing *Thielavia basicola* and no evidence of its mycelium could be detected, but in others both species survived in the fully mature culture.

As a result of these experiments it was found that *Thielavia basicola* Zopf produces abundant perithecia when it is cultured with *Cladosporium fulvum*, *Aspergillus umbrosus*, a strain of *Aspergillus glaucus*, *Eurotium amstelodami* and in a less degree with *Fusicladium pirinum*. In all cases the perithecia produced in these mixed cultures are exactly alike in every respect to those obtained in the original culture isolated from violet and no trace of chlamydospores or endoconidia was found in them.

It seems probable that if various other media were used or change of cultural conditions tried that other fungi might react in this same way.

It is interesting that results vary with different species of the same genus. While perithecia of *Thielavia basicola* were abundantly produced when that fungus was cultured with *Cladosporium fulvum*, isolated from tomato leaf by the writer, three *Cladosporium* cultures received from Dr. C. L. Shear, two of which were isolated from cranberry and one from blueberry, were unsuccessful. *Aspergillus umbrosus*, kindly determined by Drs. Charles Thom and Margaret Church, was obtained from peach preserves and *Aspergillus glaucus* strain and *Eurotium amstelodami* were received from the same investigators. Eight additional cultures of Aspergillus, received from them and nine others of the same genus, received from Dr. D. H. Linder, as well as one other species from this laboratory, had no effect in stimulating the production of perithecia. *Thielaviopsis paradoxa* has a striking resemblance to *Thielaviopsis basicola*, but two cultures received from Dr. J. P. Martin, Honolulu, and one isolated from banana stalk by the writer, were also unsuccessful. Two cultures of *Isaria*, received from Dr. F. J. Pritchard, had no effect in increasing the number of perithecia.

Results, similar to those given above, are recorded by Heald and Pool (13) who found that *Melanospora pampeana* responded in the production of perithecia when grown with *Fusarium moniliforme*, *Basisporium gallarum* and to a smaller extent with *Fusarium culmorum*. Their description of a one-ascospore culture of *Melanospora pampeana* as showing a "scanty scarcely distinguishable, white mycelium" might apply equally as well to the one-ascospore cultures of *Thielavia basicola* Zopf. However, in their one-ascospore culture or in transplants from it they never found perithecia, while on the other hand the one-ascospore cultures of *Thielavia basicola* Zopf spasmodically produce some perithecia when grown alone on an ordinary culture medium. In opposition to the results of Heald and Pool the writer so far has not been able to get a response of perithecia of *Thielavia basicola* on cultures of other fungi that have been heated in the autoclave or boiled in the open for twenty minutes.

Molliard (16), (17) found that *Ascobolus* produces perithecia when a bacterium is present in the culture and Sartory announced a similar association necessary for the production of ascospores in a yeast (25) and of perithecia in an Aspergillus (26), (27), (28).

The writer's experiments have been sufficiently repeated to demonstrate that *Thielavia basicola* Zopf, though possessing to some degree the ability to form perithecia when cultured alone, is greatly stimulated in the production of these structures when cultured in association with *Thielaviopsis basicola* (Berk.) Ferraris, *Cladosporium fulvum*, *Aspergillus umbrosus*, *Aspergillus* of the *glaucus* group, *Eurotium amstelodami* and *Fusicladimu pirinum*.

Since *Thielavia basicola* Zopf does not form either the chlamydospores or endoconidia of *Thielaviopsis basicola* (Berk.) Ferraris, and since perithecial formation is stimualted equally well by other fungi, there seems to be no real justification for considering *Thielavia basicola* the perfect stage of *Thielaviopsis basicola*. Although the frequent association of these two fungi in nature and the fact that their relationship has long been accepted in literature make one reluctant to consider them as two distinct species, yet the cultural evidence is a strong argument in favor of such a view.

The Influence of Extracts upon Production of Perithecia.

The observations made upon the influence of extracts of some fungi upon production of perithecia are recent, but the experiments have been repeated a sufficient number of times to make them seem worthy of being recorded here. Cultures of several fungi were barely covered with water and allowed to stand about twenty-four hours. The liquid was filtered through paper and then through a Berkefeld filter, thus avoiding sterilization by heat; for, as already stated, cultures of the various fungi, which in living condition stimulate the production of perithecia, after heating, no longer have this stimulating effect. In some cases the liquid only was used and in others the mat of mycelium was crushed in a mortar, squeezed through cheese cloth and the juice thus obtained also filtered with the extract. There is some indication that the latter method is the better one, but this point has not been fully determined. All the extracts from fresh fungi, so far tried, have been made with water only and sterilized by passing the liquid through a Berkefeld filter. Cultures of *Thielavia basicola* Zopf, No. 1603, were made in the usual way upon pea meal agar and some of the extract, prepared as above described, poured into the tube and allowed to flow over the transplant. In every case the fungus from which the extract was made was also grown upon pea meal agar to avoid conflicting results which might arise from the introduction of some other medium. Check cultures on pea meal agar alone were also made in every series.

Nine different extracts of *Thielaviopsis basicola* (Berk.) Ferraris were made and each one caused a marked stimulation both in growth and perithecial production, in the majority of cases fully equaling in numbers the perithecia formed in mixed cultures of the two living fungi. Following the use of extracts a stimulation in growth is noticeable within a few days, but the formation of perithecia is slower than when two living fungi are cultured together. However, in every series, the checks have no perithecia or only a few scattered ones, while the cultures treated with the extracts have produced them abundantly. The age of the fungus from which the extract is made, amount of water necessary for extracting and the optimum length of time required for extraction are probable factors which affect the number and rapidity of perithecial development.

Three different extracts were made from *Cladosporium fulvum* and one from *Aspergillus umbrosus*. In all cases these extracts also greatly stimulated growth and perithecial production. As when grown with the living fungi, *Thielavia basicola* produces no asexual spores when treated with any of the extracts so far used.

The effect of heat upon the extracts was tried both in the autoclave at twenty pounds pressure for twenty minutes and by boiling in the open for twenty minutes. Without exception both methods of heating have so far completely destroyed the stimulating power of the extract. Extracts from *Aspergillus* of the *glaucus* group, *Eurotium amstelodami* and *Fusicladium pirinum* have not yet been tried.

As stated above, *Thielaviopsis paradoxa*, in living condition, failed to stimulate the production of perithecia and it was also suggested that the failure with many fungi in living condition might be due to the smothering of the more delicate *Thielavia basicola*. If this is the situation, then, extracts from such luxuriant fungi might act as stimulants even though the living fungus gave no result. While one experiment is not sufficient to be conclusive it may be stated here that an extract made from *Thielaviopsis paradoxa* also greatly stimulated growth and perithecial formation. The case is the same with *Saccharomyces cerevisiae*. Cultures of yeast were made on pea meal agar and mixed cultures were made from them and *Thielavia basicola*. In each case the yeast completely covered the *Thielavia basicola* transplant before it had time to grow; but two different extracts made from fresh yeast cultures, stimulated growth and perithecial production. The stimulating factor in the yeast extract was also completely destroyed by heating.

To determine whether commercial extracts of fungi contained the stimulating factor, 1%, 2%, 4% and 6% water solutions of Taka-diastase were made and filtered through a Berkefeld filter. Cultures of *Thielavia basicola* were treated with these by the same method as with the preceding extracts. The resulting growth far surpassed that following the use of any other extract so far used. The mycelium became very abundant and made almost a felt-like growth. Later, perithecia developed. The type of growth following the addition of Taka-diastase differs so markedly from that in any medium or extract which has been tried that it suggests the presence of two factors, one an unusually potent stimulant for growth and another stimulating perithecial formation. See Plate XXXIX.

The nature of the factors in any of the extracts above considered, causing such a striking increase in growth and production of perithecia of *Thielavia basicola*, is beyond the scope of the problem at hand. The results with the mixed cultures of *Thielavia basicola* Zopf and of other fungi are an indication that this fungus should not be considered the perfect stage of *Thielaviopsis basicola* (Berk.) Ferraris any more than of the other fungi above noted. The results with extracts, here recorded, are an additional indication that *Thielavia basicola* is a distinct fungus and they are also an argument against any ideas of heterothallism that may have been connected with it.

Thielavia basicola Zopf has always been found associated with *Thielaviopsis basicola* (Berk.) Ferraris on the same hosts. Whether or not it is by itself parasitic on these hosts or, as has been suggested by Dr. Clinton, a parasite on *Thielaviopsis basicola*, is not yet determined. Inoculations of *Thielavia basicola* have been made on tobacco in the greenhouse as well as in the field without definite results. The biologic relationship of these two forms is not yet clear.

Summary.

Perithecia of *Thielavia basicola* Zopf have been secured in artificial culture.

Since the name *Thielavia basicola* was given by Zopf on account of the presence of perithecia, the fungus secured from their ascospores should be considered *Thielavia basicola* Zopf. This is the first report of its isolation in artificial culture.

Thielavia basicola Zopf has a tendency to produce perithecia when grown alone, but this is greatly stimulated when the fungus is grown with *Thielaviopsis basicola* (Berk.) Ferraris with which it is associated in nature.

It has been shown that *Thielavia basicola* Zopf is also stimulated to produce perithecia when it is grown with *Cladosporium fulvum*, *Aspergillus umbrosus*, *Aspergillus* of the *glaucus* group, *Eurotium amstelodami* Mangin, and to a certain extent with *Fusicladium pirinum*.

It has been shown that *Thielavia basicola* Zopf is likewise stimulated to produce perithecia when it is treated with water extracts obtained from *Thielaviopsis basicola* (Berk.) Ferraris, *Cladosporium fulvum*, *Aspergillus umbrosus*, *Thielaviopsis paradoxa*, *Saccharomyces cerevisiae* and also with a water solution of Taka-diastase.

The above evidence indicates that *Thielavia basicola* Zopf is not the ascospore stage of *Thielaviopsis basicola* (Berk.) Ferraris although the two forms are commonly associated.

Literature Cited.

1. **Aderhold, R.** Impfversucht mit *Thielavia basicola* Zopf. Arb. Biol. Adt. Land. Fortw. Kaiserl. Gesundh. 4: 463-5. 1905.
2. **Berkeley, M. J.** and **Broome, C. E.** Notices of British Fungi. Ann. Mag. Nat. Hist. II, 5: 461. 1850. pl. II, f. 4.
3. **Brierley, W. B.** The 'Endoconidia' of *Thielavia basicola* Zopf. Ann. Bot. 29: 483-493. 1915.
4. **Cappelluti-Altomare, G.** I semenzai del Tabacco e la *Thielavia basicola* Zopf. R. Inst. Scafati: 137-47. 1902.
5. **Clinton, G. P.** Report of the Botanist 1906. Conn. Agr. Exp. Sta. Rept. 1906: 342-368. 1907.
6. **Clinton, G. P.** Report of the Botanist 1907. Conn. Agr. Exp. Sta. Rept. 1907: 363-368. 1908.

7. **Dale, Elizabeth.** On the morphology and cytology of *Aspergillus repens* DeBary. Ann. Mycol. VII: 215-225. 1909.
8. **Duggar, B. M.** Fungous Diseases of Plants: 213. 1909.
9. **Ferraris, T.** Hyphales. Soc. Bot. Ital. Flora Ital. Crypt 1: 233. 1912.
10. **Foex, Et.** Maladie du pied de la violette. Ann. Ecole Nat. Agr. Montpelier, N. S., 10: 165-171. pl. 6. 1910.
11. **Fraser, H. C. I.** and **Chambers, H. S.** The Morphology of *Aspergillus herbariorum*. Ann. Mycol. 5:419-431. 1907.
12. **Gilbert, W. W.** The root-rot of tobacco caused by *Thielavia basicola*. U. S. Dept. Agr., Bur. Plant Ind. Bul. 158: 1-48. pls. I-IV. 1909.
13. **Heald, F. D.** and **Pool, Venus W.** The influence of chemical stimulation upon the production of perithecia by *Melanospora Pampeana* Speg. Agr. Exp. Sta. Rept. Univ. Neb. 22: 130-132. 1909.
14. **Jenkins, E. H.** Report of the Director. Conn. Agr. Exp. Sta.: 6. Oct. 31, 1921.
15. **Johnson, James.** Host Plants of *Thielavia basicola*. Jour. Agr. Res. 6: 289-300. 1916.
16. **Molliard, M.** Rôle des bacteries dans la production des peritheces des Ascobolus. Comp. Rend. 136: 899-901. 1903.
17. **Molliard, M.** Sur une condition qui favorise la production des peritheces chez les Ascobolus. Bull. Soc. Myc. de France XIX: 150-152. 1903.
18. **Oudemans, C. A. J. A.** Champignons dans Les Pays-Bas. Tab. II. Fig. 1. 1897.
19. **Peglion, V.** La moria delle piantine nei semenzai. Ricerche intorno ai mezzi di defesa. Staz. Sper. Agr. Ital. 33: 221-237. 1900.
20. **Peters, Leo.** The biology of *Thielavia basicola*. Mitteil. aus der Biol. Reichsanst. für Land-und Forstwirtschaft, Heft 21: 63-74. 1921.
21. **Reddick, D.** Diseases of the Violet. Mass. Hort. Soc. Trans. 1913: 85-102. 1913.
22. **Saccardo, P. A.** *Thielavia basicola* Zopf. Sacc. Syll. Fung. I: 39. 1882.
23. **Saccardo, P. A.** *Torula basicola* B. et Br. Sacc. Syll. Fung. 4: 257. 1886.
24. **Saccardo, P. A.** *Clasterosporium fragile* (Sorok) Sacc. Sacc. Syll. Fung. 4: 386. 1886.
25. **Sartory, A.** Sporulation d'une levure sous l'influence d'une bacterie. Compt. Rend. Soc. Biol. 72: 558-560. 1912.
26. **Sartory, A.** De l'influence d'une bacterie sur la production des peritheces chez un *Aspergillus*. Compt. Rend. Soc. Biol. 79: 174-175. March 4, 1916.
27. **Sartory, A.** Sporulation by symbiosis in fungi. Compt. Rend. Acad. Sci. 167: 302-305. 1918.
28. **Sartory, A.** Production of perithecia by an *Aspergillus* under the influence of a bacterium. Compt. Rend. Soc. Biol. 83: 1113-1114. 1920.
29. **Sorauer, P.** Ueber die Wurzelbräune der Cyclamen. Zeitschr. Pflanzenkr. 5: 18-20. 1895.
30. **Sorokin, N.** Ueber *Helminthosporium fragile* sp. n. Hedw. 15: 113. 1876.
31. **Thaxter, R.** Fungus in violet roots. Conn. Agr. Exp. Sta. Rept. 1891: 166-167. 1892.
32. **Wineland, Grace O.** An ascigerous stage and synonomy for *Fusarium moniliforme*. Jour. Agr. Res. XXVIII: 909-922.
33. **Zopf, W.** *Thielavia basicola* Zopf. Genus novum Perisporiacearum. Sitz. Bot. Ver. Prov. Brandenb. 18: 101-105. 1876.
34. **Zopf, W.** Ueber die Wurzelbräune der Lupinen, eine neue Pilzkrankheit. Zeitschr. Pflanzenkrank. I: 72-76. 1891.

Explanation of Plates.

Plate XXXVII.

Fig. 1. Violet plants infected with *Thielaviopsis basicola* (Berk.) Ferraris and *Thielavia basicola* Zopf.

Fig. 2. Part of section of infected violet root. p, perithecia of *Thielavia basicola*.

Fig. 3. Part of section of infected violet root showing sclerotial masses of hyphae and chlamydospores of *Thielaviopsis basicola*. Photographed by Mr. E. M. Stoddard.

Fig. 4. Part of section of infected violet root showing perithecia of *Thielavia basicola*.

Fig. 5. Part of section of infected pea root showing perithecia of *Thielava basicola*. Photographed by Mr. E. M. Stoddard.

Fig. 6. Part of section of infected tobacco root showing perithecia of *Thielavia basicola*. Photographed by Mr. E. M. Stoddard.

Plate XXXVIII.

Figs. 1–8. Germination of ascospores of *Thielavia basicola* Zopf. Figs. 1 and 6 magnification x 1,000; Figs. 2–5 and 7-8 mag. x 450.

Figs. 9 and 10. Hyphae of *Thielavia basicola* Zopf. x 600.

Figs. 11–22. Stages in the development of the perithecium of *Thielavia basicola* Zopf. Figs. 11–16, 18, 20–22, magnification x 1200. Figs 17 and 19 mag. x 1,000.

Fig. 23. An ascus of *Thielavia basicola* Zopf with ascospores. x 1,200.

PLATE XXXVII.

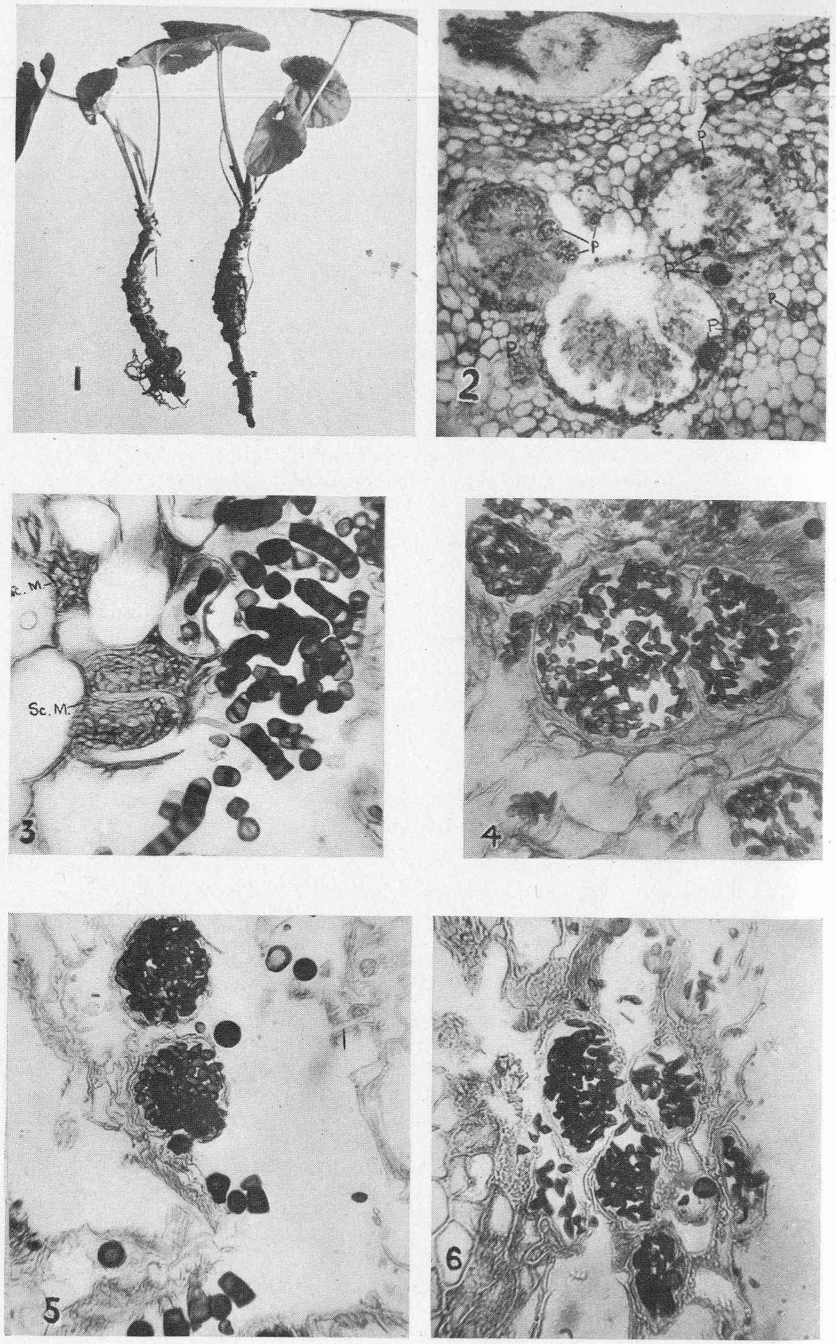


PLATE XXXVIII.

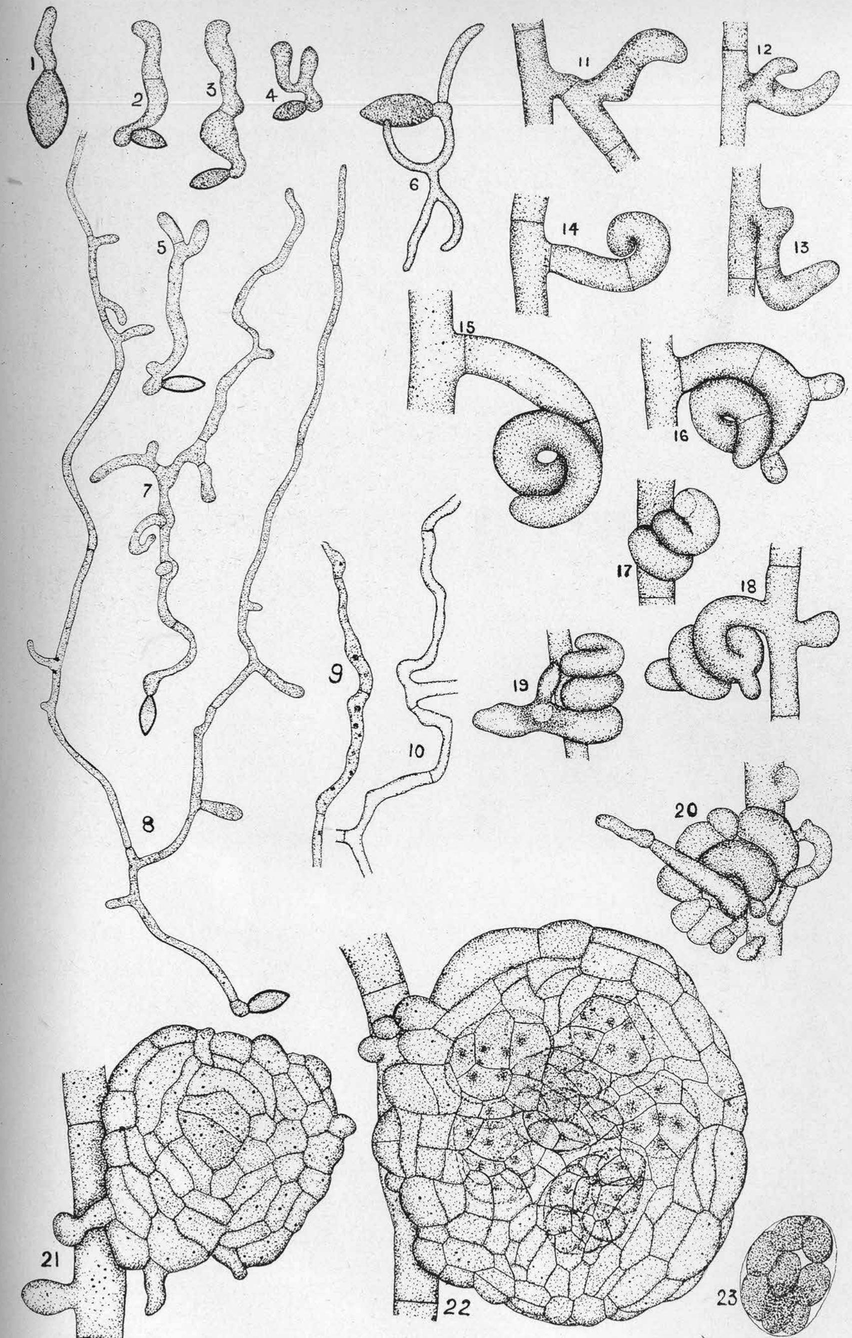
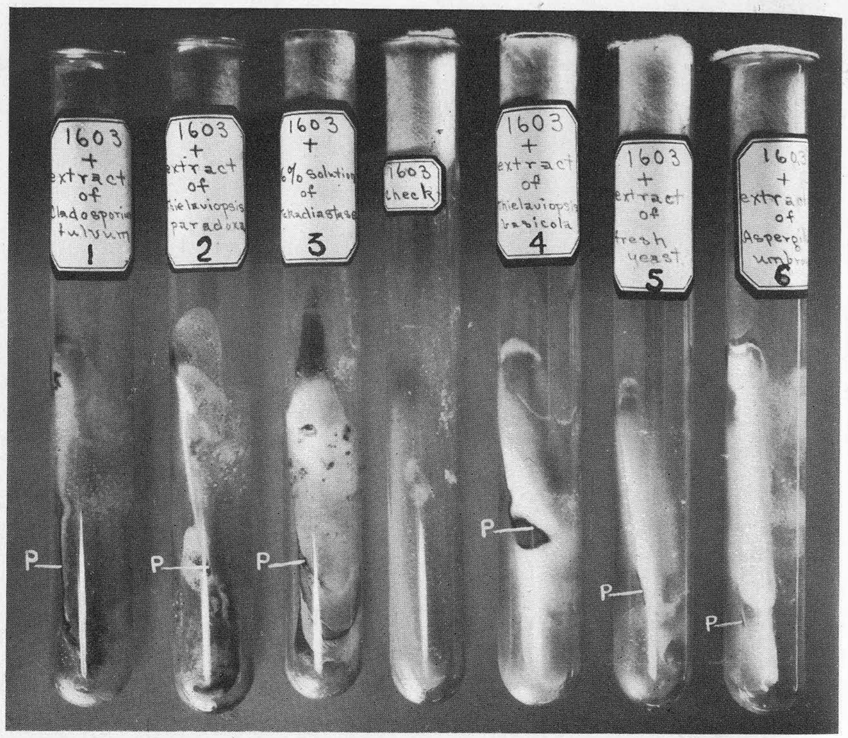


PLATE XXXIX.



Cultures of 1603 on pea meal agar. P, perithecia.

No. 1. Addition of a few drops of extract from *Cladosporium fulvum.*

No. 2. Addition of a few drops of extract from *Thielaviopsis paradoxa.*

No. 3. Addition of a few drops of 6% water solution of Taka-diastase.

Check. Pea meal agar alone.

No. 4. Addition of a few drops of extract from *Thielaviopsis basicola* (Berk.) Ferraris.

No. 5. Addition of a few drops of extract from *Saccharomyces Cerevisiae.*

No. 6. Addition of a few drops of extract from *Aspergillus umbrosus.*

Photographed by E. M. STODDARD.

INDEX

1924

The numerals marked T refer to pages of the report of the sub-station which immediately follow this report.

PAGE

Connecticut Agricultural Experiment Station
New Haven, Connecticut

Fertilizer Experiments
With
Tobacco

TOBACCO STATION
AT
WINDSOR

The Wilson H. Lee Co.

Fertilizer Experiments With Tobacco *

N. T. Nelson and P. J. Anderson

Nowhere in the world does tobacco receive so expensive a ration of fertilizer as in New England. About one-third of the entire cost of producing tobacco here is the fertilizer item. Aside from the heavy cost, consideration of the fertilizer problem is extremely important because its composition affects the quality as well as the yield of cigar leaf. Yet, despite its vital importance to the tobacco grower, the investigation of commercial fertilizers for tobacco has received very scant attention from the experiment stations of New England. In the annals of tobacco growing in the Connecticut Valley, extending back for more than a century, there are found records of only two sets of fertilizer experiments. These two classical experiments were conducted thirty years ago at about the same time by Goessmann[1] in Massachusetts and Jenkins[2] in Connecticut. Conditions have changed so much in the last thirty years, both in fertilizers and in tobacco growing, that a considerable part of the conclusions from these experiments may not be applicable to present times. There is need for a reworking of the whole field of commercial fertilizers for tobacco.

There have been numerous fertilizer tests for tobacco in other sections of the country, but the results are of little value to the Connecticut grower because the type of tobacco grown is not the same, the soil and climate are different and the New England system of continuous cropping is different from that followed in other sections.

* The fertilizer experiments at the tobacco station at Windsor, were begun in 1922 by Dr. G. H. Chapman, and carried out under his direction until his resignation August 1, 1923. From that time until April 1924, they were continued by C. M. Slagg, and after April 1, by Dr. N. T. Nelson, physiologist in charge. These changes of administration have been unfortunate for the continuity of the experiments and have resulted in considerable loss since the data were recorded in different ways and are not supplemented by actual knowledge of their progress on the part of the present administration.

Since a considerable mass of data has accumulated in the files it has seemed best to publish all of it that is of significance in order to have on record all that has been done. With some modifications and additions the experiments are being continued and it is hoped that the data obtained from them will be published annually in the future. The data on the experiments of 1922 and 1923 are taken entirely from the reports of Dr. Chapman and Mr. Slagg and the present writers wish to give to them all credit for the work done.

[1] Goessmann, C. A. On field experiments with tobacco in Massachusetts. Mass. Agric. Expt. Station. Bulletin **47**:1-31, 1897.

[2] Jenkins, E. H. Experiments in growing tobacco with different fertilizers. Conn. Agric. Expt. Station Report **16**:1-35, **17**:112-144, **18**:254-284, **19**:128-156, **20**:285-333, **21**:230-256 (1892-1897).

Limitations of available space and time to devote to it made it necessary to restrict the experiments at the beginning to an attempt to solve only a few of the problems involved. The experiments were divided into series as follows:

1. *Nitrogen series.* Comparison of different carriers of nitrogen.
2. *Phosphoric acid series.* Comparison of different quantities of phosphoric acid.
3. *Potash series.* Comparison of high grade sulfate of potash with double manure salt.
4. *Manure series.* Comparison of different kinds of manure.
5. *Fractional application series.* Comparison of fertilizer applied all at once with the same amount, or less, divided between several applications.
6. *Sulfur-chlorine-magnesium series.* The purpose of this experiment was to determine the effect of these elements on the tobacco.[1]

In the following pages each of these series is followed separately throughout the three years of the experiment.

Nitrogen Series

The tests in this series were designed to answer these questions:

1. Can all of the nitrogen be furnished to the plant from mineral carriers,—nitrate of soda, nitrate of potash and sulfate of ammonia?
2. Can one-half of the nitrogen be supplied from these mineral sources, the other half being from cottonseed meal and castor pomace?
3. Can one-half of the nitrogen be supplied to advantage in dry ground fish?
4. Can one-half of the nitrogen be supplied in tankage?

The advantage to be sought through the substitution of mineral for the organic sources of nitrogen is reduction in the cost of the fertilizer since the inorganic sources are only about one-half as expensive as the organic sources. In the case of fish, it was hoped also that there might be an improvement in the quality of the leaf. It is the general belief among tobacco growers that the use of inorganic sources of nitrogen produces tobacco of poor quality. In Dr. Jenkins' experiments it was found that where castor pomace was compared with a ration in which one-half of the nitrogen was supplied by pomace and one-half by nitrate of soda,[2] the latter formula did not produce tobacco of as good quality as where castor pomace alone was used, but the yield was increased. In his experiments he also found that the use of fish scrap as the *only* source of nitrogen reduced the yield but gave a superior quality. He did not try fish in combination with other sources of nitrogen.

[1] This series in cooperation with the Office of Tobacco Investigations, United States Department of Agriculture. Not reported on in this bulletin.

[2] Since the nitrate of soda was applied to the growing crop as a side dressing it is not possible to judge whether the results were due to mineral nitrogen or to fractional application.

The soil in the field on which the tests were made is Hartford sandy loam, and is fairly uniform in texture, drainage and fertility. It was laid out in plots of 1/40 acre, each containing four rows. Only three rows of each plot however, were harvested for the test because the fourth row was on the border and feeding from plots on each side of it treated in different ways. The whole series of seven plots was in triplicate making a total of twenty-one plots. All fertilizers were applied broadcast at one application about one week before setting. Rows were three feet four inches apart and the plants eighteen inches apart in the row. The variety of tobacco was Havana seed and all plots were set on the same day with plants as nearly uniform as could be obtained. The tobacco was primed in 1922 and 1923 but stalk cut in 1924.

After consultation with many growers in the Connecticut Valley and a careful study of previous field experiments, it was decided that a fertilizer containing approximately 260 lbs. ammonia; 225 lbs. phosphoric acid; and 240 lbs. potash to the acre would furnish ample quantities of these plant nutrients for an acre of tobacco. These amounts were considered as a basal ration in this experiment. Although such amounts of plant food materials are greatly in excess of that removed from the soil by the plant, farm practice in the Connecticut Valley has shown that the above quantities grow a good crop of tobacco. Accordingly, all the plots of this series received approximately the same number of pounds of the above plant nutrients per acre.

The fertilizer treatment of the seven plots was as follows:

Plot N1 Basal Ration. 1–7 of the Nitrogen in a Mineral or Inorganic Form (Sodium Nitrate). The Balance in Cottonseed Meal and Castor Pomace.

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal..........	2,100	172.2	60.9	31.5
Castor pomace...........	800	54.4	14.1	8.0
Nitrate of soda...........	200	37.6	.....	.....
Precipitated bone.........	300	.....	115.5	.....
Acid phosphate..........	200	.....	34.4	.....
Sulfate of potash.........	400	.....	.....	200.0
Total...............	4,000	264.2	224.9	239.5

Plot N2 One Half Nitrogen in Inorganic Carriers (Sodium Nitrate and Ammonium Sulfate*). The Balance of Nitrogen in Organic Carriers (Cottonseed Meal and Castor Pomace).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal.........	1,270	104.1	36.9	19.1
Castor pomace..........	410	27.9	7.4	4.1
Nitrate of soda...........	365	68.6	.....	.....
Sulfate of ammonia.......	260	65.0	.....	.....
Precipitated bone.........	375	.....	144.4	.....
Acid phosphate..........	213	.....	36.6	.....
Sulfate of potash........	433	.....	.....	216.5
Total...............	3,326	265.6	225.3	239.7

* These two materials used in amounts which theoretically would not change the soil reaction.

PLOT N3 ALL NITROGEN IN MINERAL CARRIERS (SODIUM NITRATE AND AMMONIUM SULFATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Sulfate of ammonia	550	137.5	.....	.....
Nitrate of soda	676	127.1	.....	.....
Precipitated bone	460	.....	177.1	.....
Acid phosphate	280	.....	48.2	.....
Sulfate of potash	479	.....	.....	239.5
Total	2,445	264.6	225.3	239.5

PLOT N4 ONE HALF NITROGEN IN MINERAL CARRIERS (POTASSIUM NITRATE AND AMMONIUM SULFATE*). THE BALANCE OF NITROGEN IN COTTONSEED MEAL AND CASTOR POMACE.

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,270	104.1	36.9	19.1
Castor pomace	410	27.9	7.4	4.1
Sulfate of ammonia	265	66.3	.....	.....
Nitrate of potash	435	65.3	.....	188.8
Precipitated bone	375	.....	144.4	.....
Acid phosphate	213	.....	36.6	.....
Sulfate of potash	55.5	.....	.....	27.8
Total	3,023.5	263.6	225.3	239.8

PLOT N5 ALL NITROGEN IN MINERAL CARRIERS (POTASSIUM NITRATE AND AMMONIUM SULFATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Sulfate of ammonia	724	178.0	.....	.....
Nitrate of potash	552	82.8	.....	239.6
Precipitated bone	460	.....	177.1	.....
Acid phosphate	280	.....	50.2	.....
Total	2,016	260.8	227.3	239.6

PLOT N6 ONE HALF NITROGEN FROM FISH, THE BALANCE FROM COTTONSEED MEAL AND SODIUM NITRATE (1-7 OF THE TOTAL NITROGEN IN THE NITRATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,150	94.3	33.4	17.3
Dry ground fish	1,250	130.5	95.0	.....
Nitrate of soda	200	37.6	.....	.....
Precipitated bone	200	.....	77.0	.....
Acid phosphate	115	.....	19.8	.....
Sulfate of potash	444	.....	.....	222.0
Total	3,359	262.4	225.2	239.3

* These two materials used in amounts which theoretically would not change the soil reaction.

PLOT N7 ONE HALF NITROGEN FROM FINE TANKAGE, THE BALANCE FROM COTTONSEED MEAL AND SODIUM NITRATE (1-7 THE TOTAL NITROGEN IN THE NITRATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,150	94.3	33.4	17.3
Tankage	1,359	130.46	108.7	.....
Nitrate of soda	200	37.6	.....	.....
Precipitated bone	180	.....	69.3	.....
Acid phosphate	80	.....	13.8	.....
Sulfate of potash	444	.....	.....	222.0
Total	3,413	262.4	210.7	239.3

From the above figures it is seen that the slight variation in the amounts of ammonia applied to the different plots is negligible. There is, however, a wide difference as to the type of substances used as nitrogen carriers. Plot N1 had one seventh of its nitrogen in mineral form; Plot N2, one half mineral nitrogen; Plot N3, all mineral nitrogen; Plot N4, one half mineral nitrogen; Plot N5, all mineral nitrogen; Plot N6, and Plot N7, one seventh mineral nitrogen. The amounts of potash and phosphoric acid added to the above plots was the same in all cases, approximately 240 pounds K_2O, and 225 pounds P_2O_5 per acre.

SEASON OF 1922

The average yield and quality of the triplicate plots in 1922 as recorded by Chapman is presented in Table I.

TABLE I. EFFECTS OF DIFFERENT SOURCES OF NITROGEN ON THE YIELD AND QUALITY OF PRIMED HAVANA—1922.

Plot No.	Lbs. ammonia per acre Mineral	Organic	Av. yield cured leaf, lbs. per acre	General Quality
N1....	37.6	226.6	1,396	Excellent
N2....	133.6	132.0	1,204	Fair
N3....	264.6	.....	1,456	Poor
N4....	131.6	132.0	1,360	Fairly good
N5....	260.8	.....	1,460	Excellent
N6....	37.6	224.8	1,382	Excellent
N7....	37.6	224.8	1,280	Good

A study of the above table shows that plots treated with all mineral nitrogen fertilizer had a tendency to give greater yields but poorer quality tobacco than plots receiving nitrogen of vegetable or animal origin. The quality of the tobacco on Plots N3 and N5, which received all the nitrogen in a mineral form, was so poor as to warrant an appraisal of fifteen cents a pound less than any other tobacco grown in this series. Not only was the tobacco of the first and second primings very poor, but the fourth was also of little character. The colors especially were poor, running almost entirely to a yellowish red, and not clean. Plots N1 and N6 were of the best quality and had a better finish than any of the others. The body, grain, texture, and color, were highly satisfactory on these two plots, but plots N3 and N5 produced tobacco of harsh texture, poor color, and too close a grain. Plot N7, on which tankage was used, while yielding a large percentage of desirable colors, gave a more of less dark greenish tobacco after fermentation.

The growth of the tabacco on all of the plots of the nitrogen series was very satisfactory as far as judged by measurements. Topping time showed that there was less than ten percent difference in the average height of plants on the different plots. No fixed growth difference as to height could be attributed to the different fertilizer treatments. Although not suffering in growth, there was one particularly noticeable variation on these plots in 1922. Those plots which were fertilized with a large percentage of nitrogen in the mineral form developed a marked *chlorosis*, apparently directly proportionate to the amount of mineral nitrogen present in the fertilizer. Chlorosis was noticed especially at the base of the plant on those plots supplied with large amounts of mineral nitrogen. On those plots where half the nitrogen was supplied in mineral form and a half from organic sources, chlorotic effects extended upward on the bottom five leaves. Chlorosis extended half way up the plant on the plots which had all the nitrogen applied in mineral form; eight and sometimes ten leaves were affected. This chlorosis was in every respect similar to that called "sand drown" by Dr. W. W. Garner of the United States Department of Agriculture. Immediately adjacent to the nitrogen plots was another series of plots to determine the effects of magnesium deficiency. These plots were specially treated to show the cause of sand drown and were run in cooperation with the United States Department of Agriculture. The chlorosis in the nitrogen plots was in every way similar to the chlorosis which accompanied magnesium starvation on the cooperative plots. For the season of 1922, at least, it was possible that the fertilizers high in mineral nitrogen did not supply adequate amounts of magnesium to fill the deficiency. The plots supplied with an abundance of organic nitrogen, on the other hand, did not develop chlorosis or "sand drown". Organic nitrogen carriers such as cottonseed meal apparently contain magnesium in amounts sufficient to meet the magnesium needs of the tobacco plant on an average Connecticut soil. The season of 1922 was very wet at times, and excessive leaching probably took place (which accentuated the effects). In a drier year, magnesium starvation probably would not follow the application of a heavy mineral nitrogen mixture. No chlorosis was noted in 1923.

Season of 1923.

In 1923 the nitrogen plots were the same as to location and treatment as they were in 1922. It was a much more favorable season, inclined to be dry, while 1922 was extremely wet. The tobacco was primed. Total weights of the triplicate plots were taken and figured to the acre basis as given in Table II. Each of the four primings was kept separate and a certain number of leaves taken from each for securing sorting data. All data (except total weights) are based on number of leaves. Burn tests were also made. Sorting results are recorded in the table.

In general the results seem inconsistent and no general tendency can be traced. As in the preceding year, the use of all mineral ammoniates resulted in the highest yields. The data on burn and percentage of high grades do not show that the quality was worse than where only one-seventh of the ammonia was from mineral sources. The fact that the burn was always best on the first priming is very apparent. Both dry ground fish and tankage appear to be superior to the basal ration in yield, percentage of higher grades and burn.

Season of 1924.

In 1924 the nitrogen plots were treated in the same manner as in 1923, being set with Havana seed on June 13 and 14, topped August 1 and 2, and harvested August 15 and 16.

Throughout the growing season no significant growth differences were observed between the different plots of the series. The tobacco on Plot N3 was slightly taller than that on the other plots but it also was more mature, being in full bloom when the others were only early and medium bloom at the date of topping. The average number of plants on the plots at harvest (about 160) indicates that the stand was practically uniform throughout the test.

The weather was extremely dry during both the growth and curing periods. The season was too dry for normal growth and a good cure. Scanty "damps" caused some difficulty in getting the crop in proper "case" until late in the fall. The tobacco was taken down in the middle of November and weights in the bundle were made November 28th, 1924.

In February, 1925, the tobacco was sorted by an experienced sorter, Mr. Frank Solkowski, and accurate weights were recorded on the different grades and lengths as indicated in tables III and IV.

TABLE II. SORTING DATA ON NITROGEN PLOTS FOR 1923.

Data taken by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
N 1	Basal ration 1–7 ammonia in minerals...........	1,768	564	1	28	....	....	....	70	30–25–24–18
				2	90	....	....	58	....	4– 6–12–10
				3	4	117	10	53	....	7– 6– 7– 9
				4	....	....	134	....	....	3– 5– 4– 3
				Total	122	117	144	111	70	
				%	21.63	20.74	25.54	19.68	12.41	Av. 11 secs.
N 2	½ ammonia in minerals (sulf. am. and nitr. soda)	1,795	535	1	77	....	....	39	35	37–31–28–39
				2	87	....	....	39	....	8–11– 9– 7
				3	49	78		15	....	5– 7– 7– 9
				4	....	6	110	....	....	1– 0– 2– 1
				Total	213	84	110	93	35	
				%	39.81	15.7	20.56	17.38	6.55	Av. 13 secs.
N 3	All ammonia in minerals (sulf. am. and nitr. soda)	1,857	567	1	46	....	....	63	46	20–27–15–33
				2	88	....	....	50	9	7– 6– 6– 5
				3	34	82	....	21	....	3– 5– 7– 9
				4	....	3	125	....	....	1– 0– 1– 2
				Total	168	85	125	134	55	
				%	29.63	14.99	22.05	23.63	9.7	Av. 9 secs.
N 4	½ ammonia in minerals (sulf. am. and nitr. potash)..................	1,789	543	1	24	....	....	40	90	67–42–59–53
				2	56	....	....	75	....	25– 7–32– 6
				3	15	90	....	34	....	7–14– 6– 7
				4	....	....	129	....	....	14–10–15–11
				Total	95	90	129	149	90	
				%	17.50	16.58	23.76	27.26	16.57	Av. 23 secs.

SORTING DATA ON NITROGEN PLOTS FOR 1923—*Continued.*

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
N 5	All ammonia in minerals (sulf. am. and nitr. potash).................	1,955	567	1	30	....	....	70	70	61–83–75–79
				2	81	....	....	52	....	9– 6– 7– 8
				3	20	85	....	40	....	8– 5– 6– 7
				4	....	4	115	....	....	3– 1– 2– 2
				Total	131	89	115	162	70	
				%	23.1	15.69	20.28	28.59	12.34	Av. 22 secs.
N 6	½ ammonia in fish.......	1,927	563	1	69	....	....	56	25	40–45–20–30
				2	82	....	....	50	....	37– 9–30– 7
				3	12	95	10	19	....	3–21–14– 6
				4	....	20	125	....	....	6–14– 7– 6
				Total	163	115	135	125	25	
				%	28.95	20.43	23.98	22.20	4.44	Av. 23 secs.
N 7	½ ammonia in tankage...	1,919	552	1	47	....	....	71	35	45–58–95–63
				2	74	....	....	53	....	13–11–15– 9
				3	30	92	3	20	....	7– 6– 7–13
				4	....	20	107	....	....	6– 3–11– 7
				Total	151	112	110	144	35	
				%	27.35	20.29	19.95	26.08	6.34	Av. 23 secs.

TABLE III. SORTING RESULTS FOR 1924 CROP. TOTAL WEIGHT OF GRADES AND LENGTHS IN OUNCES.

Plot No.	Fillers	Brokes	Tops	Darks				Seconds					Total
				18″	20″	22″	24″	16″	18″	20″	22″	24″	
N1......	31	63	24	26	63	55	3	5	21	36	15	1	343
N1*.....	45	122	68	10	34	59	8	0	5	15	17	2	385
N1**....	51	68	88	8	45	66	12	5	23	36	14	0	416
N2......	44	99	53	8	39	76	18	3	11	27	19	2	399
N2*.....	46	113	57	14	39	41	9	2	10	23	23	3	377
N2**....	45	62	56	13	49	64	6	4	23	48	15	4	389
N3......	32	97	36	14	60	89	9	0	11	27	13	0	388
N3*.....	49	123	117	0	16	31	6	0	3	23	25	3	396
N3**....	17	78	86	5	31	67	13	0	10	26	17	0	350
N4......	49	75	51	30	65	55	4	3	15	23	10	0	380
N4*.....	48	106	70	12	53	61	7	3	13	19	3	0	404
N4**....	55	76	99	13	53	63	14	2	14	28	10	0	427
N5......	44	106	82	20	61	30	2	0	4	9	4	0	362
N5*.....	32	168	83	4	14	29	7	0	1	8	6	0	352
N5**....	50	141	115	3	21	21	1	0	5	9	4	0	370
N6......	45	73	45	7	48	77	49	0	4	15	18	7	388
N6*.....	32	136	47	9	29	48	16	0	5	18	16	2	358
N6**....	68	131	51	9	36	28	2	0	11	29	22	7	394
N7......	58	149	60	7	35	36	6	0	10	17	23	3	404
N7*.....	74	127	95	3	14	22	9	0	8	21	32	10	415
N7**....	43	113	66	6	33	40	16	0	13	24	19	1	374

In the above table the brokes include poor quality tobacco (better than fillers) such as variegated, mixed, and off colors, also broken leaves and other damaged tobacco.

The tops include short darks, 16″ or less, and poor quality long darks. Leaves in the class called darks probably are not of wrapper quality but are of heavy body and dark color. No light or medium wrappers were found in sufficient amount to make separate weighings, therefore they are included in the seconds or the darks.

TABLE IV. SORTING RESULTS FOR 1924 CROP. PERCENTAGE OF GRADES.

Plot No.	Fillers %	Brokes %	Tops %	% of Darks				% of Lights					Total
				18″	20″	22″	24″	16″	18″	20″	22″	24″	
N1......	9	18	7	8	18	16	1	2	6	11	4	0	100
N1*.....	11	32	18	3	9	15	2	0	1	4	4	1	100
N1**....	12	16	21	2	11	16	3	1	6	9	3	0	100
Ave. %..	10.7	22.0	15.3	4.3	12.7	15.7	2.0	1.0	4.3	8.0	3.7	.3	100
N2......	11	25	13	2	10	19	4	1	3	7	5	0	100
N2*.....	12	30	15	4	9	11	2	1	3	6	6	1	100
N2**....	11	16	14	3	15	16	1	1	6	12	4	1	100
Ave. %..	11.3	23.7	14.0	3.0	11.4	15.3	2.3	1.0	4.0	8.3	5.0	.7	100
N3......	8	25	9	5	15	23	2	0	3	7	3	0	100
N3*.....	12	31	29	0	4	8	2	0	1	6	6	1	100
N3**....	5	22	25	1	9	19	4	0	3	7	5	0	100
Ave. %..	8.3	26.0	21.0	2.0	9.3	16.7	2.7	0.0	2.3	6.7	4.7	.3	100
N4......	13	20	13	8	17	14	1	1	4	6	3	0	100
N4*.....	12	26	17	3	13	15	2	1	3	5	3	0	100
N4**....	13	18	23	3	12	15	3	1	3	7	2	0	100
Ave. %..	12.7	21.3	17.6	4.7	14.0	14.7	2.0	1.0	3.3	6.0	2.7	0.0	100
N5......	12	29	23	6	17	8	0	0	1	3	1	0	100
N5*.....	11	47	24	1	4	8	2	0	0	2	1	0	100
N5**....	13	38	31	1	6	6	0	0	1	3	1	0	100
Ave. %..	12.0	38.0	26.0	2.7	9.0	7.3	0.7	0	0.7	2.6	1.0	0.0	100
N6......	12	19	12	2	12	20	12	0	1	4	4	2	100
N6*.....	9	38	13	3	8	14	4	0	1	5	4	1	100
N6**....	17	34	13	2	9	7	1	0	3	7	5	2	100
Ave. %..	12.7	30.3	12.7	2.3	9.7	13.6	5.7	0.0	1.7	5.3	4.3	1.7	100
N7......	14	37	15	2	9	9	1	0	3	4	5	1	100
N7*.....	18	30	23	1	3	5	2	0	2	5	8	3	100
N7**....	12	30	18	2	9	11	4	0	3	6	5	0	100
Ave. %..	14.7	32.3	18.7	1.7	7.0	8.3	2.3	0.0	2.7	5.0	6.0	1.3	100

The above results indicate that the use of inorganic compounds (such as ammonium sulfate and nitrates) as the only sources of applied ammonia tends to produce increased percentages of the lower grades of tobacco, included largely in the brokes and the tops. This is accompanied by a decrease in the percentage of the more desirable grades especially the seconds.

During sorting, samples were taken from the darks and the seconds which were pooled March 14, 1925, on the basis of color and general quality by Mr. Walter Edwards, official grader for the Connecticut Valley Tobacco Association. Applying 1923 prices, average prices per pound and per acre were computed. The price per pound of the different grades of tobacco grown on the different plots is given in Table V.

TABLE V. SCHEDULE OF PRICES PER POUND.

Plot	Price per lb. on basis of pooling and 1923 prices								
				Darks			Light seconds		
	Fil.	Tops	Brks.	16–18"	18–20"	20–30"	14–16"	16–18"	18–30"
N1	10	15	20	17	27	42½	30	45	72
N1*	10	15	20	17	27	42½	30	45	72
N1**	10	15	20	17	27	42½	30	45	72
N2	10	15	16	17	27	42½	25	37½	65
N2*	10	15	20	17	27	42½	30	45	72
N2**	10	15	20	17	27	42½	30	45	72
N3	10	15	16	17	27	42½	25	37½	65
N3*	10	15	16	17	27	42½	25	37½	65
N3**	10	15	20	17	27	42½	30	45	72
N4	10	15	16	17	27	42½	25	37½	65
N4*	10	15	20	17	27	42½	30	45	72
N4**	10	15	16	17	27	42½	25	37½	65
N5	10	12	16	15	20	35	25	37½	65
N5*	10	12	16	15	20	35	25	37½	65
N5**	10	12	16	15	20	35	25	37½	65
N6	10	15	20	17	27	42½	30	45	72
N6*	10	15	20	17	27	42½	30	45	72
N6**	10	15	20	17	27	42½	30	45	72
N7	10	15	16	17	27	42½	25	37½	65
N7*	10	15	20	17	27	42½	30	45	72
N7**	10	15	20	17	27	42½	30	45	72

Considering the percentage of the different grades as decimal parts of a pound and applying the pool prices, an average price per pound was figured for each plot. After deducting 11 cents per pound for sorting, sweating, storage and overhead (the Association charge for the 1923 crop) the net return per pound is presented in Table VI.

TABLE VI. SUMMARY OF RESULTS FOR 1924 ON NITROGEN PLOTS.

Plot No.	Treatment	Yield per acre in lbs.	Net price per lb.[1] (cents)	Net value of tobacco per acre	Fert. cost per acre	Net return per acre
N1	1/7 Min. N. (Nitr.	1,307	22.04	$288.06	.....	.....
N1*	Soda)	1,387	16.30	226.08	.....	.....
N1**		1,493	19.58	292.33	.....	.....
Ave.		1,396	19.31	268.82	$94.65	$174.17
N2	½ mineral N.	1,360	18.05	245.48	.....	.....
N2*	(Nitr. soda and	1,307	18.10	236.57	.....	.....
N2**	amm. sulf.)	1,387	22.43	311.10	.....	.....
Ave.		1,351	19.53	264.38	84.65	179.73
N3	All min. N. (Nitr.	1,387	18.31	253.96	.....	.....
N3*	soda and amm.	1,440	13.67	196.85	.....	.....
N3**	sulf.)	1,387	20.02	277.68	.....	.....
Ave.		1,405	17.33	242.83	69.56	173.27
*N4	½ Min. N. (Nitr.	1,333	15.18	203.46	.....	.....
N4*	pot. and amm.	1,440	16.56	238.46	.....	.....
N4**	sulfate)	1,467	15.26	223.25	.....	.....
Ave.		1,413	15.67	221.72	79.37	142.35
*N5	All min. N. (Nitr.	1,280	7.68	98.30	.....	.....
N5*	pot. and amm.	1,360	6.90	93.84	.....	.....
N5**	sulf.)	1,360	6.53	88.80	.....	.....
Ave.		1,333	7.04	93.65	62.15	31.50
N6	½ Nitrogen in D.	1,440	20.63	297.07	.....	.....
N6*	Gr. fish	1,413	17.42	246.14	.....	.....
N6**		1,360	17.05	231.88	.....	.....
Ave.		1,404	18.37	258.36	95.06	163.30
N7	½ Nitrogen in fine	1,413	13.22	186.80	.....	.....
N7*	tankage	1,440	16.63	239.47	.....	.....
N7**		1,440	21.47	309.17	.....	.....
Ave.		1,431	17.11	244.81	86.19	138.62

SUMMARY OF THREE YEARS EXPERIMENTS ON NITROGEN RATION.

In summarizing the results of the first three years of these tests, it must be kept in mind that the experiments are not yet complete and any tentative decisions drawn may be reversed by results of the experiments of 1925 or subsequent years. Also it must be remembered that only one of the three years was a normal tobacco year, viz., 1923. The season of 1922 was unusually wet while 1924 was abnormally dry. It is conceivable that the results in a normal year might be different.

[1] Ave. yield for 3 years.

*—Through a mistake which was not discovered until after the conclusion of these experiments plots N4 and N5 were treated with a low grade nitrate of potash (18% NH_3 and 12.76% K_2O) instead of a high grade (15% NH_3 and 43.4% K_2O) as was considered in working out the formula. The total amount of ammonia added to N4 was 275.6 lbs. and the potash was reduced to 106.5 lbs. per acre. Plot N5 likewise had the ammonia increased to 277.4 lbs. and the K_2O reduced to 70.4. It is quite certain this mistake also occurred in 1923. For this reason, the results obtained on these two plots in 1923 and 1924 are of doubtful significance.

Nevertheless with the preceding reservations in mind, let us see what tentative answer can be made to the questions proposed on page 4.

1. *Can all the nitrogen be supplied from mineral sources?* In answering this question it is best to disregard, for the reason previously stated, the plots on which nitrate of potash was used. Thus the question really is: Can all of the nitrogen be supplied from a mixture of nitrate of soda and sulfate of ammonia? This may be answered by comparing plots N1 (basal ration) with N3 (all nitrogen in sulfate of ammonia and nitrate of soda). The average yield of the N1 plots for the three years was 1,520 lbs. and for N3 was 1,573 lbs., showing thus a small increase in weight of cured leaves. In 1922 the quality of tobacco raised on N3 was rated poor as compared with N1 rated excellent. The sorting records for 1923 do not show that the N3 tobacco was inferior to N1. In 1924 the average price of the N1 tobacco was 2c. per pound higher than N3. When, however, this is balanced against the reduced cost of the fertilizer used on N3, the net return to the grower was only 90c. per acre less than where the more expensive fertilizer was used. However, since the quality was undoubtedly inferior during two out of the three years it would seem best for the grower to avoid the entire substitution of mineral sources of nitrogen and keep up the quality of the tobacco even though the immediate net return is no larger.

2. *Can one half of the nitrogen be supplied from sulfate of ammonia and nitrate of soda?* This question may be answered by comparing the records of the N1 plots with the N2 plots. The average yield on the N2 plots was 70 lbs. per acre less than the N1 plots for the three years. In 1922 the N2 tobacco was rated as "fair in quality" compared with N1 rated "excellent". On the other hand the sorting records of 1923 show somewhat better quality in N2 than in N1. The average price for the 1924 crop was practically the same for N1 and N2. The sorting records indicate about the same quality. The net return for the N2 tobacco was $5.56 per acre greater than for the N1 tobacco in 1924 because of the reduced price of the fertilizer. In answer to the question then we may say that the results during 3 years of tests indicate that mineral carriers of nitrogen may be used to advantage to supply one half of the ammonia.

3. *Can one half of the nitrogen be supplied to advantage in dry ground fish?* This may be answered by comparison of the records of the N1 and the N6 plots. The average yield of the N6 plots for the three years was 1,571 lbs. as compared with 1,520 lbs. for the N1 plots. In 1922 the quality of the two was rated the same. In 1923, N6 had more light wrappers, more seconds, fewer fillers and brokes and much longer fire-holding capacity than N1. In 1924 the average price of the N6 tobacco was about 1 cent less than N1 and the net return per acre after deducting the cost of the fertilizer was $10.87 less for the fish plots than for the basal ration plots. Since the favorable results of the first two years are contradicted by the third year's results it would seem best to delay a decision until after further tests. At least we can say that the fish ration compared very favorably with the basal and it was superior during two of the three years.

4. *Can one half of the nitrogen be supplied in tankage?* The answer is obtained by comparing the records of plots N7 with N1 during the three years. The average annual yield per acre of the N7 plots was 1,543 as compared with 1,520 for the N1 plots. In quality N7 was rated "good" in 1922 as compared with "excellent" for the N1 plots. The sorting records of 1923 show a higher percentage of light wrappers and seconds, a smaller percentage of fillers and brokes and a better fire-holding capacity on the N7 tobacco than the N1 plots. The situation is just reversed in 1924 when the average price per pound for the tankage tobacco was 2.2 cents less than N1 tobacco and the net return per acre was $35.55 less than where the basal ration was used. Here again, the results of the three years are contradictory and final decision must be reserved until after further trials have been made. The case does not seem quite as favorable for tankage, however, as for the substitution of fish.

Phosphoric Acid Series.

This series was begun in 1922 with the object of determining how much phosphoric acid should be used on tobacco. There is considerable difference of opinion on this point among tobacco growers. The only experiments dealing with this point on Connecticut Valley tobacco are those recorded by Jenkins which were conducted in co-operation with the United States Department of Agriculture.* In experiments on shade tobacco they found that by increasing the acre application of phosphoric acid from 210 to 310 pounds, the yield was increased by 25 pounds when precipitated bone was used, 55 pounds with double superphosphate and 88 pounds with acid phosphate. The burn and quality was good on all but best where precipitated bone was used to supply the extra hundred pounds of phosphoric acid. In another test, on broadleaf, they increased the phosphoric acid from 176 to 276 pounds by addition on successive plots of (1) acid phosphate (2) Thomas slag (3) double superphosphate and (4) precipitated bone. The addition of acid phosphate did not increase the yield, slag increased it by 108 lbs. per acre, double superphosphate by 144 lbs. and precipitated bone by 408 lbs. The burn was freer on the plots without added phosphoric acid but the leaf grown on added double super-

* Jenkins, E. H., Studies on the tobacco crop of Connecticut. Conn. Agric. Expt. Station, Bulletin 180:28–30. 1914.

phosphate and on precipitated bone had better quality than the others. From these data one would expect that there would be a distinct advantage in raising the amount of phosphoric acid to about 300 lbs. per acre.

At the Windsor station during 1922, '23 and '24 four plots in triplicate received varying amounts of phosphoric acid according to the following formulas. The amount of ammonia and potash was the same in all. The plots were on the same field as the nitrogen series during these years and all treatment throughout the season after the application of the fertilizer was the same for all plots.

PLOT P1. BASAL RATION 225 LBS. P_2O_5. SAME AS N1.

PLOT P2. BASAL RATION BUT WITHOUT ACID PHOSPHATE OR PRECIPITATED BONE. 75 LBS. P_2O_5.

Carrier Name	Pounds per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6	....	....
Sulf. potash........	400	....	....	200.0
Total..........	3,500	264.2	75.0	239.5

PLOT P3. 190.5 LBS. P_2O_5 IN PRECIPITATED BONE, COTTONSEED MEAL AND CASTOR POMACE.

Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6	....	....
Precipitated bone...	300	.....	115.5	.....
Sulfate potash......	400	.....	.....	200.0
Total..........	3,800	264.2	190.5	239.5

PLOT P4. 306 LBS. P_2O_5 IN PRECIPITATED BONE, COTTONSEED MEAL AND CASTOR POMACE.

Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6		
Precipitated bone...	600	.....	231.0	.....
Sulfate potash......	400	.....	.....	200.0
Total..........	4,100	264.2	306.0	239.5

During 1922 the plots were carefully watched for any signs of earlier maturity. The triplicate plots, P4, almost from the start showed a marked tendency to early ripening and the buds appeared on the plots of this series fully a week before the others. This plot, P4, had received a very high application, 306 lbs., of phosphoric acid per acre. On none of the other plots of this experiment (on which phosphoric acid was applied in amounts ranging from 75–225 lbs. to the acre) was there noted any such tendency to early maturity. All the tobacco was harvested at the same time in spite of the early maturity of the plants in plots P4. In the following table will be found the amounts of phosphoric acid applied per acre and the resulting yields with Chapman's notes as to quality.

TABLE VII. EFFECTS OF DIFFERENT AMOUNTS OF PHOSPHORIC ACID ON THE YIELD AND QUALITY OF PRIMED HAVANA—1922.

Plot No.	Pounds of P_2O_5 per acre	Yield of cured leaf lbs. per acre	General Quality
P1	225	1,419	Excellent
P2	75	1,425	Good—Greenish
P3	191	1,456	Excellent
P4	306	1,386	Poor—double colors

Within the limits of this experiment, varying the amounts of phosphoric acid had little effect on the yield. Only one treatment, P4 (with an excessively high application of phosphoric acid) showed any appreciable effect and this was on the quality rather than on the yield. The tobacco from P4 was inferior and showed many double colors, probably due to the fact that it was harvested over-ripe. The colors of P2 were inclined to be more green than the other plots but the tobacco was of fine quality otherwise.

In 1923 tests of plots P1–4 and replicates were conducted just as in 1922, the location of the plots and treatment being the same. The unfavorable effect of high application of P_2O_5 was apparently the same as in 1922 but the notes are scanty. The tobacco was primed. Records were taken from sample hands of leaves as in the case of the nitrogen series. Burn tests were made. Table VIII includes all records taken.

These data do not indicate that there has been a reduction in yield from omission of all mineral carriers of P_2O_5. The fire-holding capacity is strikingly best on the plot which received the least P_2O_5. In view of the fact that acid phosphate is believed to be detrimental to the burn of the leaf, it is puzzling to find that P1 which received acid phosphate had a longer fire-holding capacity than P3 or P4 which received no acid phosphate, and that P1 also had the highest yield.

During 1924 no wide differences in growth and maturity were observed. Plot P2 might possibly have been slower and Plot P4 more rapid in developing buds and flowers than the other plots of this series.

The tobacco was taken down, stripped, sorted and weighed at the same time as the nitrogen plots. The sorting results are given in Table IX.

TABLE VIII. SORTING DATA ON PHOSPHORIC ACID PLOTS FOR 1923.
Data taken by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves: Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	Fire-holding capacity (seconds)
P1	Basal ration, 225 lbs. P_2O_5.	1,919	544	1	30	....	....	50	50	53–61–49–60
				2	107	....	....	35	....	11– 9– 6– 7
				3	25	100	9	9	....	9– 6– 5– 7
				4	....	9	120	....	....	11–14–23–25
				Total	162	109	129	94	50	
				%	29.79	20.03	23.71	17.28	9.19	Av. 22 secs.
P2	Without acid phos. or ppt. bone. 75 lbs. P_2O_5	1,863	547	1	57	....	....	40	51	37–31–29–30
				2	95	....	....	40	....	65–51–67–11
				3	38	91	4	3	....	47–29– 8– 6
				4	....	8	120	....	....	21–16–14–20
				Total	190	99	124	83	51	
				%	34.66	18.15	22.68	15.18	9.33	Av. 30 secs.
P3	190½ lbs. P_2O_5, without acid phos.	1,826	550	1	93	....	....	32	30	40–20–41–33
				2	112	....	....	17	7	8– 5–15–11
				3	70	61	....	12	....	10– 8–13– 9
				4	....	30	85	1	....	16–13–11–14
				Total	275	91	85	62	37	
				%	50.00	16.55	15.46	11.27	6.72	Av. 17 secs.
P4	306 lbs. P_2O_5, without acid phos.	1,853	564	1	54	....	....	47	43	40–35–37–36
				2	116	....	....	28	....	12–20–17–20
				3	31	96	....	13	....	10– 9– 5– 7
				4	....	20	116	....	....	7–10–12–13
				Total	201	116	116	88	43	
				%	35.64	20.57	20.57	15.60	7.62	Av. 18 secs.

TABLE IX. SORTING RESULTS FOR 1924 CROP. PHOSPHORIC ACID PLOTS.
WEIGHT OF LEAVES IN EACH GRADE.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks 18"	20"	22"	24"	Oz. of Light Seconds 16"	18"	20"	22"	24"	Total
P1.......	43	113	66	12	40	92	38	0	13	24	21	2	464
P1*......	32	114	82	18	32	42	13	2	12	25	24	3	399
P1**.....	26	95	38	17	48	64	2	2	13	34	12	0	351
P2.......	45	128	79	4	29	42	9	0	3	16	18	2	375
P2*......	32	114	47	14	53	72	18	3	13	27	18	0	411
P2**.....	30	81	44	18	66	85	14	3	16	39	19	0	415
P3.......	35	113	56	7	32	76	23	2	8	24	37	5	418
P3*......	35	103	47	8	39	62	17	2	12	30	23	2	380
P3**.....	42	87	38	21	66	64	11	3	14	30	14	0	390
P4.......	40	160	92	5	18	34	10	0	3	13	17	0	392
P4*......	29	113	55	9	49	50	10	5	23	38	23	2	406
P4**.....	29	113	55	16	50	63	8	2	12	29	15	0	392

PERCENTAGE OF EACH GRADE AFTER SORTING

Plot No.	Fillers	Brokes	Tops	Darks 18"	20"	22"	24"	Light Seconds 16"	18"	20"	22"	24"	Total
P1.......	9	24	14	3	9	20	8	0	3	5	5	0	100
P1*......	8	28	21	5	8	10	3	1	3	6	6	1	100
P1**.....	7	27	11	5	14	18	1	1	4	9	3	0	100
Av. %...	8.0	26.3	15.4	4.3	10.3	16.0	4.0	.7	3.3	6.7	4.7	.3	100
P2.......	12	34	21	1	8	11	2	0	1	4	5	1	100
P2*......	8	28	11	3	13	18	4	1	3	7	4	0	100
P2**.....	7	19	10	4	16	22	3	1	4	9	5	0	100
Av. %...	9.0	27.0	14.0	2.7	12.3	17.0	3.0	.7	2.7	6.6	4.7	.3	100
P3.......	8	27	13	2	8	18	5	1	2	6	9	1	100
P3*......	9	27	13	2	10	16	4	1	3	8	6	1	100
P3**.....	11	22	10	5	17	16	3	1	3	8	3	0	100
Av. %...	9.3	25.3	12.0	3.0	11.8	16.8	4.0	1.0	2.8	7.3	6.0	.7	100
P4.......	10	41	23	2	5	9	2	0	1	3	4	0	100
P4*......	7	28	14	2	12	12	3	1	6	9	6	0	100
P4**.....	7	29	14	4	13	16	2	1	3	7	4	0	100
Av. %...	8.0	32.7	17.0	2.7	10.0	12.3	2.3	.7	3.3	6.3	4.7	0.0	100

Averaging the results given in the above table, the following comparisons can be made as to the effects of P_2O_5 on quality.

TABLE X—SUMMARY OF TABLE IX.

Plots	Pounds P_2O_5 Per Acre	Part Mineral P_2O_5	Fillers Average %	Brokes Average %	Tops Average %	Darks Average %	Seconds Average %
P1	225	2/3	8.0	26.3	15.4	34.6	15.7
P2	75	none	9.0	27.0	14.0	35.0	15.0
P3	191	7/12	9.3	25.3	12.0	35.6	17.8
P4	306	3/4	8.0	32.7	17.0	27.3	15.0

TABLE XI. SCHEDULE OF PRICES PER POUND.

Price per pound on basis of pooling, using 1923 prices.

Plot	Filr.	Tops	Brks	Darks 16-18"	Darks 18-20"	Darks 20-30"	Seconds 14-16"	Seconds 16-18"	Seconds 18-30"
	¢	¢	¢	¢	¢	¢	¢	¢	¢
P1	10	15	18	17	27	42½	28	40	68
P1*	10	15	18	17	27	42½	28	40	68
P1**	10	15	18	17	27	42½	28	40	68
P2	10	15	20	17	27	42½	30	45	72
P2*	10	15	20	17	27	42½	30	45	72
P2**	10	15	20	17	27	42½	30	45	72
P3	10	15	18	17	27	42½	28	40	68
P3*	10	15	18	17	27	42½	28	40	68
P3**	10	15	20	17	27	42½	30	45	72
P4	10	15	16	17	27	42½	25	37½	65
P4*	10	15	16	17	27	42½	25	37½	65
P4**	10	15	16	17	27	42½	25	37½	65

The above schedule of prices is based on pool ratings by Mr. Walter Edwards and 1923 Pool prices. Average prices per pound of the tobacco grown on the different plots were computed on the same basis as the nitrogen plots. This is given in Table XII.

CONCLUSIONS FROM THREE YEARS DATA ON THE PHOSPHORIC ACID PLOTS

The most striking result of these experiments is the bad effect of increasing the phosphoric acid to 306 lbs. per acre. This is evidenced first by the reduced yield, the average being 31 pounds less than where no mineral phosphoric acid was used. In quality it was rated as "poor" in 1922 as compared with "excellent" for the P1 plot. The sorting data for 1923 show little difference in the tobacco taken from the different plots. In 1924, however, the quality was so poor that it was pooled at an average price of 4 cents per pound less than where no mineral phosphoric acid was added. The net return after deducting the cost of the fertilizer was $77.36 per acre less than where no mineral phosphoric acid was used.

TABLE XII. SUMMARY OF RESULTS FOR 1924 ON PHOSPHORIC ACID PLOTS.

Plot No.	Treatment	Yield per acre lbs. 1924	Yield per acre lbs. Ave. of 3 years	Net price per lb.[1]	Net value of tobacco per acre	Fert. cost	Net return
P1	225 lbs. P_2O_5 (2/3 mineral P_2O_5)	1,493	...	$19.16	$286.06	...	...
P1*		1,387	...	16.85	233.71	...	...
P1**		1,307	...	18.96	247.81	...	...
Ave.		1,396	1,610	18.32	255.86	$94.65	$161.21
P2	75 lbs. P_2O_5 (no mineral P_2O_5)	1,413	...	15.66	221.28	...	...
P2*		1,387	...	19.99	277.26	...	...
P2**		1,387	...	22.78	315.96	...	...
Ave.		1,396	1,561	19.48	271.50	85.15	186.35
P3	191 lbs P_2O_5 (7/12 mineral P_2O_5)	1,493	...	22.03	328.91	...	...
P3*		1,360	...	20.11	273.50	...	...
P3**		1,333	...	19.09	244.47	...	...
Ave.		1,395	1,559	20.41	282.29	92.65	189.64
P4	306 lbs. P_2O_5 (3/4 mineral P_2O_5)	1,387	...	11.31	156.87	...	...
P4*		1,333	...	18.49	246.47	...	...
P4**		1,333	...	16.81	224.08	...	...
Ave.		1,351	1,530	15.54	209.14	100.15	108.99

[1] Net price per pound after deducting 11 cents for sorting, packing, sweating and overhead.

These results are not in accord with those presented by Jenkins as discussed above. No explanation of the contradictory results will be attempted until the tests have been carried further.

The highest average yield for the three years was obtained where 225 lbs. of phosphoric acid were supplied by addition of both acid phosphate and precipitated bone to the organic carriers (P1) but the best quality was obtained on P3 where the acid phosphate was omitted but the P_2O_5 brought up to 191 lbs. by addition of precipitated bone. The latter also gave the highest net return per acre of all the phosphoric acid plots in 1924. The effect of omitting all carriers of mineral phosphoric acid was noticeable only by a slight reduction in quality.

Potash Series.

This series of experiments was begun in 1923 and continued through 1924 with three treatments in duplicate on the same field as the nitrogen and phosphoric acid series. The object of the tests was to compare the effect of supplying one half or all of the potash in double sulfate of potash magnesia instead of supplying it all in high grade sulfate of potash. The occurrence of "sand drown" during 1922 in the other plots previously mentioned suggested the advisability of supplying magnesia in the fertilizer ration. Since the cheapest and most convenient carrier of magnesia is the double manure salt, it has been most frequently used as the source of this element in fertilizer mixtures. It seemed advisable therefore to find out what effect its use would have on the yield and quality of the leaf.

Goessman, in the experiments in Massachusetts previously referred to, after three years of testing, sums up his conclusions in regard to it: "Our results with potash magnesia sulfate as main potash sources of a tobacco fertilizer are not encouraging". In rating the ten fertilizer formulas which were tried he places the two which contained double manure salt at the foot.

Jenkins, in the five year experiment at Poquonock, found that the plot treated with double manure salt gave a higher yield than the plots treated with any other carrier of potash. The quality of leaf, however, was not so good and the fire-holding capacity was less than all the rest except high grade sulfate which stood at the foot of the list although the yield was good. Thus he ranks double sulfate above high grade sulfate while Goessman does just the reverse.

In the face of these contradictory experimental results there appeared to be need of further tests. It was decided to compare plots where double manure salt was the only source with those in which high grade sulfate was the source and also with plots where the ration contained a mixture of the two carriers. The fertilizer ration of each of the plots is as follows:

Plot K1. All K_2O in Sulphate.

Carrier	Lbs. Carrier Per Acre	NH3	P_2O_5	K_2O
Cottonseed meal	2,100	172.2	60.9	51.5
Castor pomace	800	54.4	14.1	8.0
Nitrate of soda	200	37.6	....	....
Precipitated bone	300	....	115.5	....
Acid phosphate	200	....	34.4	....
Sulfate of potash	400	....	....	200.0
Total	4,000	264.2	224.9	239.5

Plot K2. All K_2O in Double Sulphate of Potash Magnesia.

Carrier	Lbs. Carrier Per Acre	NH3	P_2O_5	K_2O
Cottonseed meal	2,100	172.2	60.9	31.5
Castor pomace	800	54.4	14.1	8.0
Nitrate of soda	200	37.6	..	....
Precipitated bone	300	....	115.5	....
Acid phosphate	200	....	34.4	....
Double sulfate	800	....	....	208.0
Total	4,400	264.2	224.9	247.5

Plot K3. K_2O Divided between Sulfate and Double Sulfate.

Carrier	Lbs. Carrier Per Acre	NH3	P_2O_5	K_2O
Cottonseed meal	2,100	172.2	60.9	31.5
Castor pomace	800	54.4	14.1	8.0
Nitrate of soda	200	37.6	....	....
Precipitated bone	300	....	115.5	....
Acid phosphate	200	....	34.4	....
Sulfate of potash	200	....	....	100.0
Double sulfate	400	....	....	104.0
Total	4.200	264.2	224.9	243.5

No differences in growth during the season of 1923 were noted. Sorting data on the primed leaves as taken by Slagg are recorded in Table XIII.

During the first year of this experiment no appreciable effects were seen on the yield and quality of the tobacco. The percentages of the two top grades of plots K1, K2 and K3 were 48%, 51.4% and 50.3%, respectively.

The experiment was conducted during 1924 in the same manner as in 1923. The tobacco on the K2 plot was somewhat taller than on the other plots. Otherwise no differences in growth were noticed.

The tobacco was harvested, stripped, and sorted at the same time as the nitrogen plots. Table XIV gives the sorting data on the plots.

TABLE XIII. SORTING DATA ON POTASH SERIES.

Experiments of 1923 by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves: Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	Fire-holding capacity (seconds)
K1	All K_2O from H. G. sulfate 5.2 lbs. MgO per acre..	2,056	576	1	57	....	....	70	35	37–34–35–25
				2	74	....	....	74	....	7– 5– 6– 7
				3	38	94	....	....	....	5– 7– 4– 5
				4	....	14	120	....	....	7– 5– 7– 7
				Total	169	108	120	144	35	
				%	29.34	18.75	20.83	25.00	6.08	Av. 13 secs.
K2	All K_2O from Dbl. Sulf. 90.4 lbs. MgO per acre..	1,966	564	1	79	....	....	56	27	32–36–47–59
				2	76	....	....	61	....	19–30–11–24
				3	18	94	6	14	....	7– 9– 8–11
				4	....	13	110	....	....	
				Total	183	107	116	131	27	
				%	32.42	18.99	20.57	23.23	4.79	*Av. 25 secs.
K3	K_2O divided between the two. 45.2 lbs. MgO per acre.................	2,039	568	1	50	....	....	70	33	40–37–16–20
				2	97	....	....	43	....	5– 5– 6– 7
				3	12	107	16	....	....	4– 5– 3– 4
				4	....	20	120	....	....	4– 5– 7– 6
				Total	159	127	136	113	33	
				%	27.99	22.35	23.94	19.92	5.8	Av. 11 secs.

* Data on fire-holding capacity of the fourth priming for some unexplained reason was omitted. If this were recorded it would reduce the average slightly.

TABLE XIV. SORTING RESULTS FOR 1924 CROP ON THE POTASH PLOTS.

WEIGHT OF THE GRADES.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks 18″	20″	22″	24″	Oz. of Light Seconds 16″	18″	20″	22″	24″	Total
K1......	37	67	25	7	33	70	48	0	8	26	28	3	353
K1*.....	29	60	39	13	43	88	46	3	7	27	31	2	388
K2......	37	102	42	6	28	66	33	0	14	36	42	5	411
K2*.....	47	72	33	8	54	91	33	5	15	38	21	2	419
K3......	37	55	24	9	56	97	45	4	21	50	34	5	437
K3*.....	45	71	38	18	58	63	15	4	17	36	20	3	388
PERCENTAGE OF EACH GRADE AFTER SORTING.													
K1......	10	19	7	2	10	20	14	0	2	7	8	1	100
K1*.....	7	15	10	3	11	23	12	1	2	7	8	1	100
Av. %...	8.5	17.0	8.5	2.5	10.5	21.5	13.0	.5	2.0	7.0	8.0	1.0	100
K2......	9	25	10	1	7	16	8	0	4	9	10	1	100
K2*.....	11	17	8	2	13	24	8	1	3	9	4	0	100
Av. %...	10.0	21.5	9.0	1.5	10.0	20.0	8.0	.5	3.5	9.0	7.0	.5	100
K3......	8	13	6	2	13	22	10	1	5	11	8	1	100
K3*.....	12	18	10	5	15	16	4	1	4	9	5	1	100
Av. %...	10.0	15.5	8.0	3.5	14.0	19.0	7.0	1.0	4.5	10.0	6.5	1.0	100

No striking differences in quality were noted in the above plots. Samples were taken from these plots and graded in a manner similar to the other fertilizer plots. These pool ratings are given in Table XV.

TABLE XV. SCHEDULE OF PRICES PER POUND.

Plot	Price per pound on basis of pooling and 1923 prices.								
				Darks			Seconds		
	Filr.	Tops	Brks	16-18"	18-20"	20-30"	14-16"	16-18"	18-30"
K1	10	15	20	17	27	42½	30	45	72
K1*	10	15	20	17	27	42½	30	45	72
K2	10	15	20	17	27	42½	30	45	72
K2*	10	15	20	17	27	42½	30	45	72
K3	10	15	20	17	27	42½	30	45	72
K3*	10	15	20	17	27	42½	30	45	72

From the pooling data recorded in Table XV, it is apparent that there were no differences in quality between the different plots.

Regarding the percentage of the different grades as decimal parts of a pound and applying the corresponding pool prices, the average price per pound was figured for each plot, as given in Table XVI.

TABLE XVI. SUMMARY OF RESULTS FOR 1924 ON POTASH PLOTS.

Plot No.	Treatment	Yield per acre	Price per lb.[1]	Net value per acre	Fertilizer cost	Net return per acre
K1	Mineral potash	1333	$24.76	$330.00	....	....
K1*	all sulfate	1387	25.28	350.63	....	....
Ave.		1360	25.02	340.32	$94.65	$245.67
K2	Mineral potash	1413	24.86	351.27	....	....
K2*	all double sul-	1413	23.16	367.25	....	....
Ave.	fate.	1413	24.01	359.26	97.85	261.41
K3	Mineral potash	1467	27.70	406.36	....	....
K3*	½ sulfate, ½	1333	21.60	287.93	....	....
Ave.	dbl. sulfate.	1400	24.65	347.15	95.20	250.95

[1] Prices per pound after deducting 11 cents per pound for sorting, sweating, storage and overhead charges.

SUMMARY OF TWO YEARS' COMPARISON OF HIGH GRADE SULFATE WITH DOUBLE SULFATE OF POTASH.

During the two years of this experiment there has been no marked difference in the quality or quantity of the tobacco grown on the different plots. A somewhat larger yield in 1924 on the plots treated with double sulfate is offset by the smaller yield in 1923. Altogether there appears to be little choice between the three treatments. Apparently, if there were occasion to anticipate that the crop was going to suffer from magnesia hunger the double manure salt could be used to prevent it without serious impairment of the quality or yield of the tobacco. Ordinarily, however, magnesia hunger is not found where reasonably large amounts of organic fertilizers such as cottonseed meal or castor pomace are used. In this case, there would seem to be no advantage in using sulfate of potash magnesia and it has the disadvantage of adding to the bulk of fertilizer and of doubling the quantity of sulphuric acid introduced into the soil. Any conclusions based on experiments of only two years must necessarily be tentative, however.

FRACTIONAL APPLICATION SERIES.

This series was started in 1923 and continued during 1924. There was a double object of the tests (1) to see whether there was any increase in yield or quality above that obtained by the single broadcast application when some of the fertilizer was applied later during the growth of the plants and (2) to see whether a smaller amount applied fractionally would produce as good results as a larger amount applied all at once.

The basal mixture as in N1 was used on all plots, the only variation being in the amount and time of application. The treatments were as follows:

Plots H and H*. Total application 3,000 pounds; 1,400 broadcast, 400 in drill at time of setting, 400 after plants started, 400 at second hoeing, and 400 at later cultivation.

Plots I and I*. Total application 2,000 pounds. None of it broadcast, 400 in drill, 800 at first hoeing, 400 at second hoeing, 400 at later cultivation.

Plot J. 3,000 pounds broadcast. This to serve as a check on the above plots and on other plots where 4,000 pounds per acre was applied.

Between 500 and 600 leaves were taken from each plot when harvested and sorted by Slagg in 1923. Data are recorded in Table XVII.

These data show little difference in quality from the three treatments. Three thousand broadcast yielded over 100 pounds more leaf than 3,000 applied fractionally and about 150 lbs. more than 2,000 applied fractionally. There does not appear therefore to be any gain from fractional application as compared with the same amount broadcast and it is questionable whether the reduction in the cost of 2,000 lbs. of fertilizer as compared with 3,000 lbs. would counter-balance the 150 lbs. reduction in yield and the additional cost of labor for later applications.

During the growing season of 1924 it was noted that the growth was not quite so good on the I plots which received only one ton of fertilizer. The tobacco was topped, harvested, stripped and sorted at the same time as that on the nitrogen plots. The sorting records are presented in Table XVIII.

TABLE XVII—FRACTIONAL APPLICATION SERIES OF 1923.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves: Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	Fire-holding capacity (seconds)
H, H*	3,000 lbs. fractional......	1,866	531	1	13	....	....	14	84	20–25–10– 5
				2	57	....	....	84	....	5– 6– 9– 7
				3	11	123	....	10	....	3– 4– 5– 4
				4	....	10	125	....	....	4– 5–10– 7
				Total	81	133	125	108	84	
				%	15.26	25.04	23.54	20.34	15.82	Av. 8 secs.
I, I*	2,000 lbs. fractional......	1,827	588	1	21	....	....	60	78	30–25–26–35
				2	90	....	....	51	....	10–16– 6– 5
				3	38	107	....	....	....	4–13– 5– 6
				4	....	18	125	....	....	5– 7– 6–10
				Total	149	125	125	111	78	
				%	25.34	21.26	21.26	18.88	13.26	Av. 13 secs.
J	3,000 lbs. broadcast......	1,974	570	1	10	....	....	78	56	20–23–10–15
				2	100	....	....	34	....	5–10–28–10
				3	....	121	16	10	....	4– 6– 5– 7
				4	....	5	140	....	....	5– 6–11– 5
				Total	110	126	156	122	56	
				%	19.30	22.27	27.36	21.30	9.77	Av. 10 secs.

TABLE XVIII. SORTING RESULTS FOR 1924 CROP. FRACTIONAL APPLICATION PLOTS.

WEIGHT OF THE GRADES.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks 18″	20″	22″	24″	Oz. of Light Seconds 16″	18″	20″	22″	24″	Total
H.......	32	84	29	25	66	53	6	0	15	24	4	0	338
H*......	30	98	36	23	69	65	10	0	18	25	7	0	381
I........	39	122	83	40	60	19	0	3.	15	18	2	0	401
I*.......	48	56	49	31	34	6	0	1	7	11	1	0	244
J........	27	70	30	26	60	64	10	3	16	27	14	0	347

PERCENTAGE OF EACH GRADE AFTER SORTING.

Plot No.	Fillers	Brokes	Tops	18″	20″	22″	24″	16″	18″	20″	22″	24″	Total
H.......	10	25	9	7	19	16	2	0	4	7	1	0	100
H*......	8	26	9	6	18	17	3	0	5	6	2	0	100
Av. %...	9	25.5	9	6.5	18.5	16.5	2.5	0	4.5	6.7	1.5	0	100
I........	10	30	20	10	15	5	0	1	4	4	1	0	100
I........	20	23	20	13	14	3	0	0	3	4	0	0	100
Av. %...	15	26.5	20	11.5	14.5	4	0	.5	3.5	4	.5	0	100
J........	8	19	9	8	17	18	3	1	5	8	4	0	100

The samples selected during sorting were judged by Mr. Walter Edwards and on the basis of his pooling and prices for 1923 the following schedule of prices per pound for the different grades was fixed.

TABLE XIX. SCHEDULE OF PRICES PER POUND. FRACTIONAL APPLICATION PLOTS.

	Price per pound on basis of pooling and 1923 prices.								
				Darks			Seconds		
Plot	Filr.	Tops	Brks	16-18"	18-20"	20-30"	14-16"	16-18"	18-30"
H	10	15	20	17	27	42½	30	45	72
H*	10	15	20	17	27	42½	30	45	72
I	10	12	20	15	20	35	30	45	72
I*	10	15	16	17	27	42½	25	37½	65
J	10	12	20	15	20	35	30	45	72

The average price per pound for each plot based on the above and the net return per acre are given in Table XX.

TABLE XX. SUMMARY OF RESULTS FOR 1924 ON FRACTIONAL APPLICATION PLOTS.

No. Plot	Treatment	1923 yield per acre	Price per lb.*	Net value per acre	Fertilizer cost	Net return per acre
H	3,000 lbs. basal form-	1253	$17.88	$224.04		
H*	ula applied fraction-	1333	18.74	249.80		
Ave.	ally.	1293	18.31	236.92	$71.00	$165.92
I	2,000 lbs. basal form-	1200	10.36	124.32		
I*	ula applied fraction-	1227	8.68	106.50		
Ave.	ally.	1213	9.52	115.41	47.33	68.08
J	3,000 lbs. applied broadcast before setting.	1307	17.82	232.91	71.00	161.91

*Based on sorting percentages, grading by Mr. Walter Edwards, and pool prices for 1923 after deducting 11 cents per pound for sorting, packing, storage, etc.

SUMMARY OF FRACTIONAL APPLICATION SERIES.

The results of two years' tests show that when 3,000 lbs. of fertilizer are applied to the acre, there is no advantage either in quality or yield of the tobacco when the total amount is divided

between a number of applications. When the quantity of fertilizer applied was reduced, there was a reduction in yield and quality which more than counter-balanced the saving in the cost of fertilizer.

In order to see whether there was any profit in reducing the acre application from 4,000 to 3,000 lbs. per acre, we may compare Plot J with plots N1, P1 and K1 all of which received the same mixture as J but 1,000 more pounds of it. After deducting the cost of fertilizer we find that plot J netted a return of $161.91 to the grower in 1924, while plots N1 netted $174.17, plots P1, $161.21 and Plots K2, $245.67. From these figures it is apparent then that there was no gain from cutting down the fertilizer ration, but a strong probability of a loss. In this connection however, it should be kept in mind that the season of 1924 was very dry. A season characterized by more rainfall might show benefit from fractional application.

MANURE SERIES.

Concerning the value of stable manure for tobacco there is a wide difference of opinion among growers and dealers. Many would not use it even if it cost nothing. Probably the majority of farmers believe in using it, however, and would use more if it could be obtained. The ever increasing price of good manure makes it rather essential that we should find out experimentally just what its value is.

In the Massachusetts experiments previously mentioned, Goessman included plots in which manure at the rate of 10 tons per acre was the only fertilizer applied during two years. In his summary he concluded that the results were "encouraging but not sufficient in number to advise detailed discussion". In the Poquonock experiments, Jenkins treated one plot with 10-12 cords of manure per acre for four years and during two of the years added 500 lbs. of Swift-Sure Superphosphate. Although the yield was much below the average he attributed it to lack of a quickly available source of nitrogen and states that "the use of stable manure as an amendment as well as a fertilizer is necessary to get the best results".

An experiment was begun at the Windsor station in 1923 to test the value of manure as a supplement to commercial fertilizers and to compare cow manure with horse manure. Duplicate plots of one fourth of an acre were treated as follows:

M1—Two tons per acre of the basal ration.

M2—Ten tons of horse manure (New York) in addition to two tons of commercial.

M3—Ten tons of cow manure in addition to two tons of commercial.

The tobacco was stalk cut and one row of each plot weighed and sorted to get the data recorded in Table XXI.

TABLE XXI. MANURE SERIES OF 1923.

Plot	Treatment	Yield per acre	Percentage of grades				
			Light Wrapper	Medium Wrapper	Dark Wrapper	Seconds	Fillers and Brokes
M1	Com. Fertilizer	1540	35.05	9.11	19.76	25.77	10.31
M2	Horse Manure	1514	33.99	1.09	21.70	30.20	13.02
M3	Cow Manure	1928	33.04	12.98	27.85	19.21	6.92

These experiments are on too small a scale and preliminary in nature to warrant any conclusions as to the value of the different treatments.

BULLETIN OF IMMEDIATE INFORMATION No. 49 — JUNE 30, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

REGULATIONS FOR CARRYING OUT THE PROVISIONS OF THE LAW CONCERNING CONCENTRATED COMMERCIAL FEEDING STUFFS.

By the authority of Section 6 of the Act Concerning Concentrated Commercial Feeding Stuffs, Chapter 196, Public Acts of 1925, the following regulations have been adopted for carrying out the provisions of the act. The sections cited under each regulation refer to sections of the law wherein the term defined, or the clause interpreted, occurs.

WM. L. SLATE, JR.
Director of the Connecticut Agricultural Experiment Station.

THOMAS HOLT,
Dairy and Food Commissioner.

REGULATION 1. FEEDS NOT CLASSED AS CONCENTRATED COMMERCIAL FEEDING STUFFS.

(Section 1.)

It is held that the law exempts from classification as concentrated commercial feeding stuffs (1) roughages such as hays, straws, corn stover, ensilage and all materials containing over 60 per cent of water; (2) whole grains; (3) meals made from whole grains when not mixed with other materials or with each other; (4) feed ground from whole grains and sold directly from the manufacturer to the consumer; (5) feed ground from materials furnished by the consumer; or (6) feed mixed according to a formula furnished by the consumer, for his own use.

Regulation 2. Method of Labelling.

(Section 2.)

All concentrated commercial feeding stuffs must be labelled either by a statement printed on the bag or upon a properly attached tag; except that in the case of cottonseed meal sold for fertilizer, or of any concentrated feeding stuff sold in bulk, a certificate which shall contain the information otherwise required to appear upon the bag or upon the tag, may be issued by the dealer in lieu thereof.

The use of wire or any metal in affixing tags is prohibited by law.

Regulation 3. Form of Label.

(Section 2.)

The law requires a statement of (1) the net weight of the feed contained in the package; (2) the name, brand or trademark under which the feed is sold; (3) name and address of the manufacturer or importer; (4) the minimum percentages of (a) crude protein and (b) crude fat, and the maximum percentage of (c) crude fiber contained in the feed; and (5) the separate ingredients of which the feed is composed.

While the law requires only a statement of the items enumerated above no objection will be raised to more complete statements of chemical composition.

Regulation 4. Duties of Manufacturers, Jobbers and Dealers with Reference to Registration.

(Section 3.)

The law requires all concentrated commercial feeding stuffs to be registered with the Connecticut Agricultural Experiment Station on or before September 1st, 1925 and annually thereafter.

Manufacturers, jobbers or individuals shipping feeds into Connecticut will be expected to register their brands and pay the necessary fees thereon. Connecticut dealers should assure themselves that the brands they handle are properly registered. In case the manufacturer or jobber outside the State neglects or refuses to register, the dealer who handles such feeds will be held responsible for such registrations and registration fees.

Dealers within the State who mix their own brands are responsible for the registration and proper labelling thereof.

Regulation 5. Concerning Cottonseed Meal.

Cottonseed meal sold as a fertilizer is required to be registered under the terms of the fertilizer law; if sold also as a feeding stuff it is required also to be registered under the provisions of the feed law; if sold exclusively for one or the other of these purposes, it may be registered only under that law which applies.

Regulation 6. Definitions of Terms Used in the Law, and of Other Terms.

Person. The term "person" is accepted as defined in General Statutes, Chapter 128, Section 2448; it imports the singular or the plural as the case demands; and includes corporations, companies, societies and associations.

Importer. The term "importer" is defined in the Act.

Brand. It is held that a distinct brand name, or a distinct analysis, constitutes a distinct brand.

Nitrogen-free-extract. The term "nitrogen-free-extract" when used in a statement of chemical composition is held to mean that constituent group of substances represented by the percentage obtained when the sum of the percentages of moisture, ash, crude protein, crude fiber and crude fat is subtracted from 100 per cent.

Carbohydrates. The term "carbohydrates" is held to mean nitrogen-free-extract plus crude fiber.

Definitions for Feeding Stuffs. The definitions and standards for feeding stuffs as officially adopted from time to time by the Association of Feed Control Officials of the United States are accepted as official in carrying out the provisions of this law.

Regulation 7. Methods of Analysis.

(Section 2.)

The methods of analysis employed shall be those prescribed by the Association of Official Agricultural Chemists, wherever such methods have been adopted for the determinations desired.

REGULATION 8. "STOCK TONICS."

The law does not include those medicated products used as conditioners for stock and poultry, and which consist essentially of substances possessing, or claimed to possess, medicinal or condimental properties.

TEXT OF THE LAW

AN ACT CONCERNING CONCENTRATED COMMERCIAL FEEDING STUFFS.

(Chapter 196, Public Acts of 1925.)

Section 1. The term "concentrated commercial feeding stuffs" within the meaning of this act shall include linseed meals, cottonseed meals, pea meals, bean meals, cocoanut meals, gluten meals, gluten feeds, dried brewers' grains, dried distillers' grains, malt sprouts, dried beet pulp, hominy feeds, cerealine feeds, rice meals, alfalfa meals, oat feeds, corn and oat chop, corn and oat feeds, scratch feeds, digestor tankage, ground meat scraps, ground fish scraps, mixed feeds, provenders, bran, middlings and mixed feeds made wholly or in part from wheat, rye or buckwheat, and all materials of a similar nature intended for the feeding of domestic animals, including poultry; but shall not include hays, straws, corn stover, ensilage, whole grains or the unmixed meals made directly from the whole grains of wheat, rye, barley, oats, Indian corn, broom corn, rice, buckwheat and flaxseed, or feed ground from whole grain and sold directly from the manufacturer to the consumer.

Sec. 2. Each lot or parcel of concentrated commercial feeding stuffs sold, offered or exposed for sale shall have conspicuously affixed thereto a plainly printed statement certifying (1) the number of net pounds of feeding stuff contained therein, (2) the name, brand or trademark under which the article is sold, (3) the name and address of the manufacturer or importer, (4) a statement of the minimum percentages of (a) crude protein, and (b) crude fat, and (c) the maximum percentage of crude fiber contained in the feeding stuff, all constituents to be determined by the methods adopted by the Association of Official Agricultural Chemists of the United States and in force at the time, and, (5) in the case of feeds composed of two or more ingredients, the name of each ingredient contained therein; provided such statement shall not be affixed by wire or other metallic device, and provided, in the case of cottonseed meal which shall be sold for fertilizer or in the case of any concentrated feeding stuff sold in bulk, the dealer may issue, in lieu of the printed statement herein described, a certificate which shall contain the information required by this section.

Sec. 3. Before any concentrated commercial feeding stuff shall be sold or offered or exposed for sale in this state the person who shall cause it to be sold or offered or exposed for sale shall file with the Connecticut Agricultural Experiment Station, on or before September 1, 1925, and annually thereafter, two certified copies of the statement prescribed in section two of this act, on forms supplied by the Connecticut Agricultural Experiment Station, and shall pay a registration fee of fifteen dollars for each brand to be sold or offered or exposed for sale in this state. When any feeding stuff shall have been registered and the fee paid thereon, the director of said station shall issue a certificate of registration for such feed, and a list of the brands so registered shall be published annually in the station report. Fees so paid to said station shall be used toward defraying the expense of inspection. Whenever registration and payment as prescribed herein shall have been made on any brand of feeding stuff by any person, no other person shall be required to register such brand or to pay a registration fee thereon. The director may refuse registration of any feeding stuff, or may cancel any registration which shall have been made, if it shall appear or shall be found that all the provisions of this act have not been fulfilled, or if the feeding stuff shall bear any statement, design or device which shall be false or misleading as regard to materials of which it is composed. No feeding stuff on which registration shall have been refused or cancelled shall be permitted to be sold or offered or exposed for sale in this state.

Sec. 4. Every manufacturer, importer, agent or person selling or offering or exposing for sale any concentrated commercial feeding stuff in relation to which all the provisions of sections two and three of this act shall not have been complied with, shall be fined not more than one hundred dollars for the first offense and not more than two hundred dollars each subsequent offense.

Sec. 5. The Connecticut Agricultural Experiment Station may collect a sample, not exceeding two pounds in weight, for analysis, from any lot, parcel or package of concentrated commercial feeding stuff or unmixed meals, brans or middlings, which may be in the possession of any manufacturer, importer, agent or dealer, but such sample shall be taken in the presence of the parties in interest or their representatives, and taken from a number of parcels or packages which shall not be less than five per centum of the whole lot inspected, and shall be thoroughly mixed, divided into two samples, placed in glass vessels or other suitable containers, carefully sealed and a label placed on each stating the name or brand of the feeding stuff or material sampled, the name of the party from whose stock the sample was taken and the time and place of taking the same. Such label shall be signed by the station chemist or his deputy and one of such samples shall be retained by such chemist or his deputy and the other by the party whose stock shall have been sampled. Said station shall cause at least one sample of each brand of feeding stuff so collected to be analyzed annually by or under the direction of such chemist. Such analysis shall include a determination of crude fat, crude protein and crude fiber and any such other determination as may be advisable. Said station shall cause the analysis so made to be published in station bulletins, together with such additional information in relation to the character, composition and use thereof as may be of importance and shall issue the same annually or more frequently if advisable.

Sec. 6. The dairy and food commissioner and the director of the Connecticut Agricultural Experiment Station may make rules and regulations for carrying out the provisions of this act.

Sec. 7. The dairy and food commissioner shall enforce the provisions of this act and when evidence shall be submitted by the Connecticut Agricultural Experimental Station that any provision of this act shall have been violated, he shall make complaint to the prosecuting officer having jurisdiction thereof.

Sec. 8. The term "importer" shall include such persons as shall bring into or offer for sale within this state concentrated commercial feeding stuffs manufactured without this state.

Sec. 9. Sections 4774, 4775, 4777, 4778, 4779, 4780 and 4781 of the general statutes are repealed.

BULLETIN OF IMMEDIATE INFORMATION No. 50

JULY 15, 1925

Connecticut Agricultural Experiment Station

New Haven, Connecticut

REGULATIONS CONCERNING THE SHIPMENT OF NURSERY STOCK, AND THE NEW LAW

W. E. BRITTON, State Entomologist.

NURSERY CERTIFICATES.

The original certificate issued by the State Entomologist under Chapter 265, Public Acts of 1925, is to be kept in the nurseryman's possession, and is not to be attached to any package of nursery stock. It applies to the whole nursery which has been inspected and to such purchased stock as has been received from other nurseries under the certificate of a state or government officer. If any stock is received from outside the state unaccompanied by such a certificate, the State Entomologist should be notified at once so that it may be inspected.

An exact transcript of the certificate including number and date may be printed on labels or tags for shipping and must be attached to each package sent out of the nursery. An additional statement, made by the owner, that the stock has been fumigated will be required in many states. The law now requires that the inspection certificate be attached to every package shipped to points both within the State of Connecticut and outside. Please see that a copy always accompanies each sale whether shipped by freight, express, mail, automobile or whether carried away by the purchaser.

After the date of expiration, which is a part of each certificate, the document becomes invalid and should not be attached to any box, bale or package. The nurseryman has no right to change the date or any other portion of the certificate.

The improper use or abuse of a certificate will not be tolerated, and the certificate may be revoked for cause.

Duplicate copies of certificates for filing in other states will be furnished on request of the nurseryman.

DEALER'S PERMITS.

The original permit issued by the State Entomologist under Chapter 265, Public Acts of 1925, should be kept in the dealer's possession and is not to be attached to any package or shipment of nursery stock, though copies may be made for this purpose.

These may be typewritten or printed and a copy must go with each separate sale from stores, and with each shipment or package of nursery stock transported. This copy must be an exact transcript, and must include number, date of issue and of expiration. After the expiration date, the permit becomes invalid and should not be used. The dealer has no right to alter the date or any other portion of the permit. This permit may be revoked for improper use or abuse, and for not complying with the law.

Shipper's Permits.

The shipper's permit is issued to nurserymen in other states who file applications and duplicate signed copies of their state inspection certificates. The original permit should be kept, and a copy (typed or printed) together with a copy of the inspection certificate of the state in which the nursery is situated should accompany each shipment into Connecticut.

Package Certificates.

Occasionally individuals and firms not in the nursery business wish to ship a few trees or shrubs but cannot do so without inspection certificates. If such materials can be inspected by our men on their usual trips without extra travel and expense, this will be done on request, as an accommodation. Other inspections may be arranged by special appointment, or plants can be sent to the Station with address and postage for forwarding, and here they will be examined and sent along.

The U. S. Postal Laws and Regulations, Section 467, paragraph 2, governs the mailing of plants and plant products, and reads as follows:

"Nursery stock, including all field-grown florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plants and plant products for propagation, except field, vegetable and flower seeds, bedding plants and other herbaceous plants, bulbs and roots, may be admitted to the mails only when accompanied with a certificate from a State or Government inspector to the effect that the nursery or premises from which such nursery stock is shipped has been inspected within a year and found free from injurious insects, and plant diseases, and the parcel containing such nursery stock is plainly marked to show the nature of the contents and the name and address of the sender."

Such materials may be mailed without certificate to any Agricultural Experiment Station or to the United States Department of Agriculture. Florists' plants (not woody, field-grown) and vegetable or other annual herbaceous plants do not require certificates but must be plainly marked as to contents, origin and destination. Package certificates apply only to the contents of the packages on which they are placed, and the contents of which have been examined.

Quarantines.

Both state and Federal quarantines prohibit the movement of nursery stock and forest products from the area quarantined on account of gipsy and brown-tail moths to any point outside of that area, without inspection and certificate. Federal Inspectors will be stationed at convenient points to cover the quarantined area of the state. Applications for such inspections may be made to the nearest Federal Inspector or to the following:

Mr. D. M. Rogers, 408 Atlantic Avenue, Boston, Mass.
In charge of Federal gipsy moth quarantine inspection service.

Dr. W. E. Britton, State Entomologist, Agr. Exp. Sta., New Haven, Conn.
In charge of state gipsy moth quarantine inspection service.

THE NEW LAW PROVIDING FOR THE REGISTRATION AND INSPECTION OF NURSERIES

Chapter 265, Public Acts of 1925.

Section 1. Inspection and Shipment of Nursery Stock: The state entomologist or his deputies or assistants, shall, upon application, inspect at least once each year all nurseries at which woody field-grown trees and plants shall be grown for sale or shipment; may inspect any nursery stock when dug, before shipment or at destination; may inspect nurseries at any time for the purpose of controlling plant pests or to ascertain whether such pests exist in nurseries; may employ such deputies or assistants as he may deem necessary; may prescribe forms for registration, certificates and permits and may make rules and regulations regarding time and methods of inspection; may destroy or treat or order the destruction or treatment of, and prohibit the movement of, plants infested with dangerous pests; may co-operate with agents of the United States Department of Agriculture in the inspection of nurseries and control of plant pests; may, at reasonable times, enter any public or private grounds in performance of his duties under the provisions of this act. In case orders shall be issued for the destruction or treatment of infested plants, the owner, manager or agent of the nursery shall, within a reasonable time from the date of such order, destroy such plants as shall be ordered destroyed and make such treatment within the time specified in the order, or be subject to the penalty provided in section five of this act.

Sec. 2. All nurserymen shall register with the state entomologist each year, on or before July first, and make application for inspection, and furnish such data on such blanks as the state entomologist shall prescribe and furnish. In case a nurseryman shall fail to make such application on or before July first, he shall pay to the state entomologist the cost of such inspection. All firms, stores and individuals who shall sell but shall not grow nursery stock, shall be classed as dealers, and shall, each year, on or before March first, register with the state entomologist, giving the chief sources of their nursery stock and such data as he may require, on such forms as he may prescribe and furnish, and the state entomologist may issue a permit allowing such dealer to sell such nursery stock. Each nursery outside the state, before shipping nursery stock into the state, shall file with the state entomologist a copy of a valid inspection certificate and the state entomologist may issue a permit allowing such nursery to ship stock into the state. The state entomologist shall keep a record of all money received as costs for inspection, and such money shall be deposited with the state treasurer.

SEC. 3. The state entomologist shall issue to regular nurseries certificates, valid until the first day of August following the date of issue and covering the stock inspected and such other stock as shall have been received under valid certificates of inspection; may issue temporary permits covering certain portions thereof, and permits to dealers. All such certificates and permits may be revoked for cause. Nursery stock which shall not have been inspected or stock from a nursery not holding a valid certificate of inspection shall not be sold or transported, and transportation companies shall refuse to accept any shipment not bearing such certificate or some form of permit issued by the state entomologist, and all nurserymen shall furnish a certificate, and all dealers a permit, to accompany each package of stock sold or transported, but no provision of this act shall prevent or render liable any individual or firm who shall transport stock from his field or property to another field or property belonging to or operated by him, when such stock is not to be immediately sold or offered for sale and when such transportation shall not violate any established federal or state embargo or quarantine regulations.

SEC. 4. For the purposes of this act, any place at which hardy trees, shrubs and vines shall be propagated or grown out of doors for commercial purposes, shall be considered a nursery, and such stock shall be regarded as nursery stock; hardy herbaceous perennial plants, including strawberry plants, may be subject to the same provisions regarding inspection and pest control, if, in the opinion of said state entomologist, it shall seem desirable to control the movement of such plants. Florists' ordinary plants, unless woody and field-grown, shall not be included.

SEC. 5. Any person who shall interfere with the state entomologist or his deputy or assistant in the performance of his duties under the provisions of this act, or any person, firm or corporation who shall violate any of the provisions hereof, shall be fined not more than fifty dollars. Any person aggrieved by any order issued under the provisions of this act may appeal to the superior court, or to any judge thereof if said court shall not be in session, and said court or such judge may grant such relief or issue such order or judgment in the premises as to equity may appertain.

SEC. 6. Section 2119 of the general statutes is repealed.

Approved June 24, 1925.