[Bulletins 235 to 245 constitute the Report for 1915. In binding, pages i-xvi at the end of this bulletin should be detached and placed before Bulletin 235 which begins with page 1]

Maine Agricultural Experiment Station

BULLETIN 245 **DECEMBER, 1915**

ABSTRACTS OF PAPERS NOT INCLUDED IN BULLETINS, FINANCES, METEOROLOGY, INDEX

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*Absent on leave.

BULLETIN 245.

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1915 BUT NOT INCLUDED IN THE BULLETINS.

A complete list of all the publications issued by and from the Station in 1915 are given on pages xii to xiv of the introduction to this Report. The following pages contain abstracts of the papers issued during the year that are not included in the Bulletins or Official Inspections for the year.

RELATION OF SIMULTANEOUS OVULATION TO THE PRODUCTION OF DOUBLE-YOLKED EGGS*.

(1) Double-yolked eggs with normal separate yolks may have all the egg envelopes common to the two yolks, or they may have some separate and some common envelopes.

(2) They may be classified with reasonable accuracy into three groups:

Type I.—Double-yolked eggs having the entire set of egg envelopes common to the two yolks.

Type II.—Double-yolked eggs having separate chalaziferous layers but all or part of the thick albumen common to the two yolks.

Type III.—Double-yolked eggs in which the yolks have entirely separate thick albumen envelopes but a common egg membrane and shell.

(3) Of the eggs studied 16.03 per cent belonged to type I, 70.99 per cent to type II, and 12.98 per cent to type III.

(4) A large series of double-yolked eggs show all gradations within and between these groups.

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*This is an abstract of a paper by Maynie R. Curtis, having the same title and published in Journal of Agricultural Research, Vol. III, pp. 375-386. Pl. XLVI-LII. 1915.

(5) The most probable interpretation of this phenomenon is that the two components unite at any level of the oviduct from the funnel mouth to the isthmus ring.

(6) The conclusion that the union of the component eggs occurs *indiscriminately* at all levels of the oviduct is strongly supported by the fact that the percentage of eggs of each type closely proportional to the percentage of the portion of the duct in which the union of two eggs would give double-yolked eggs of that type.

(7) In 36.44 per cent of the double-yolked eggs the ovulations which furnished the two yolks must have been separated by an abnormally short interval, since a normal egg had been laid on the preceding day.

(8) An examination of the egg structure, however, shows that the two yolks have passed the entire length of the duct together in only 16.28 per cent of the cases in which the ovulations are known to have been usually rapid.

(9) While a heightened rate of fecundity may result in the production of an egg of any of the three types, 68.75 per cent of the eggs of type III are single eggs. It seems probable that many of them have resulted from the delay of the first egg in the oviduct.

(10) The ovary of each pullet which had just laid a double-yolked egg as her first egg contained two normal separate follicles which had separate blood supplies. In these cases, however, the doubling of the egg had occurred near the end of the albumen-secreting region.

(11) In a case in which there was evidence from the structure of the egg that the two yolks had passed the entire length of the oviduct together the two follicles were also quite distinct, with separate blood supplies.

(12) This, together with the fact that in only a small percentage of double-yolked eggs is there any evidence of simultaneous ovulation, indicates that the fusion of follicles and a resulting common blood supply is by no means the usual cause for the production of a double-yolked egg.

(13) A simple normal follicle furnished the yolk with two germ disks; hence, the fusion of the oöcytes (if this was the origin of the two germ disks) must have occurred before the formation of the follicle.

STUDIES ON THE PHYSIOLOGY OF REPRODUCTION IN THE DOMESTIC FOWL. XII.

On an Abnormality of the Oviduct and Its Effect upon Reproduction.*

This paper describes a case of congenital obstruction of the oviduct, of unusual character.

The bird was a year and a half old Rhode Island Red hen which had been killed for meat. She was well grown and in good flesh. When the body cavity was opened it was found full of membrane covered eggs. They represented every possible stage of absorption from a normal membrane shelled egg to collapsed empty egg membranes. Some of the eggs and empty membranes were free in the body cavity. Others were walled off in pockets either singly or in aggregates. There was one large mass (twice the size of a hen's egg) of empty tightly packed egg membranes. At the time of examination 15 absorbing eggs and a very large number of empty membranes were found. Eleven of the 15 eggs had evidently been normal eggs although many of them contained a homogeneous mixture of yolk and albumen at the time examined. Four were double eggs. That is, one egg enclosed within another. One of the four was made up of a series of four concentric eggs. The inner egg being a small "witch" or "cock" egg.

The ovary of this bird was in the same condition as the ovary of any laying bird. It had a normal series of enlarging yolks and resorbing follicles. The oviduct as far as the posterior end of the isthmus or egg membrane secreting portion was also in the normal laying condition. At the posterior end of the isthmus the duct ended blindly, although the ligament which suspends the duct from the body wall continued normally to the end of the body cavity. There was no shell gland or vagina. The only opening to the duct was the funnel mouth.

It was evident that this bird was in the midst of a normal period of reproduction and was producing eggs in a normal manner as far as her oviduct allowed. The membrane shelled eggs then backed into the body cavity from whence they were

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*This is an abstract of a paper by Maynie R. Curtis, having the same title and published in Biological Bulletin, Vol. XXVIII, pp. 154-163. Pl. I. & II. 1915.

being absorbed at a rapid rate. The occurrence of double eggs shows that one egg did not always get out of the duct in time to make way for the succeeding egg. The occurrence of the egg composed of four concentric eggs suggests that the direction of the movements of the egg must have been considerably disturbed so that this egg passed up and down the duct several times before it was discharged into the body cavity. The condition of the internal organs of the bird indicates that the physiological processes of digestion, absorption and secretion were not seriously disturbed.

The forward end of the oviduct or egg tube arises very early in the development of the chick embryo. The tube then grows backward until it reaches the region of the vent. The most probable explanation for the occurrence of the oviduct found in the case described is that in early embryonic development (probably on the sixth or seventh day of incubation) the backward growth of the oviduct stopped permanently while the differentiation of the part already formed continued in the normal manner.

As in other cases where the passage of the egg is prevented the sex organs passed through their normal reproductive cycles; the oviduct functioned as far as the point where the passage was interrupted; the eggs were then returned to the body cavity and resorbed. The number of eggs and empty egg membranes found in this fowl which was apparently in a perfectly normal physical condition show that a bird may possess very great power of resorption of its own eggs.

ON THE REFRACTIVE INDEX OF THE SERUM IN A GUINEA-CHICKEN HYBRID.*

This is a record of certain results regarding the refractive index of the blood serum of a genus-hybrid produced from the mating Cornish Indian Game ♂ × Guinea Fowl ♀.

Our results show that (1) there is a definite, characteristic, and permanent difference between the refractive index of the serum of the fowl and that of the guinea; and (2) that in the hybrid the guinea parent is dominant in respect of the physico-

*This is an abstract of a paper by Raymond Pearl and John W. Gowen, having the same title and published in Proceedings of the Society for Exper. Biology and Medicine. Vol. XII, p. 48, 1915.

chemical constitution of the blood as measured by the refractive index. Some figures on the point follow:

Source of Blood.	*nD*
Fowl (*Gallus* sp.)	1.34537
(Mean of data from 10 birds of different hereditary constitutions)	
Guinea (*Numida meleagris*)	1.34184
(Mean from 6 birds)	
Hybrid (*Gallus* ♂ × *Numida* ♀)	1.34179

FITTING LOGARITHMIC CURVES BY THE METHOD OF MOMENTS.*

The use of logarithmic curves in the analysis of various kinds of biological and agricultural data is rapidly becoming widespread and general. It was first shown by Lewenz and Pearson that the growth of children followed a logarithmic curve. Pearl demonstrated that the phenomena of growth and differentiation in Ceratophyllum also followed a logarithmic curve. Donaldson and Hatai in a series of papers dealing with the growth and quantitative relations of the whole organism and its various parts in the white rat and the frog have shown that the same law holds for growth in those forms.

Other biological phenomena than growth follow a logarithmic law. Pearl, in a case of regulation of the shape of abnormal eggs, and later Curtis for normal eggs, have shown that the changes in size and shape of successively laid eggs are graduated with a logarithmic curve. Work now in progress in the Biological Laboratory, Maine Experiment Station, of which only a preliminary notice has yet been published, shows that generally the change in milk flow with age in dairy cattle is logarithmic. Several years ago Holtsmark pointed out that the relation between the number of food units required and the milk yields of different animals was logarithmic.

From this incomplete review of the literature recording the use of logarithmic curves in biological and agricultural investigations it is clear that the workers in these fields will, as time

*This is an abstract of a paper by John Rice Miner, having the same title and published in the Journal of Agricultural Research, Vol. III, pp. 411-423. 1915.

goes on, have increasing need to be able to handle these curves easily and critically.

Up to the present time the only available method of fitting logarithmic curves was that of least squares. Several years ago Pearl and McPheters published a set of tables intended to lighten materially the labor of fitting such curves by the least-squares method. For a long time, however, the writer has felt that it would be highly desirable to bring this class of curves into the general system of curve fitting worked out by Pearson and known as the "method of moments." The theory of the method is extremely simple, involving as it does only the assumption that if we equate the area and moments of a theoretical curve to the area and moments of a series of observations we shall get a reasonable fit of the curve to the observations. Experience with the method in the hands of different workers in England and America has abundantly demonstrated that this assumption is entirely justified in the fact.

In the papers cited, and in others also, Pearson has given the equations for the calculation of the constants from the moments in the case of (*a*) skew frequency curves in general, (*b*) sine curves, (*c*) parabolas of all orders, (*d*) the point binomial, (*e*) hypergeometrical series, etc. There has been lacking, however, the determination of the equations connecting moments and constants for the general family of logarithmic curves of the type.

$$y=a+bx+cx^2+d\log(x+q)$$

and its modifications. The necessary equations are given in the paper here abstracted.

INTERPOLATION AS A MEANS OF APPROXIMATION TO THE GAMMA FUNCTION FOR HIGH VALUES OF *n**

This paper is purely mathematical in subject matter and interest. The question discussed is whether a degree of approximation, sufficient for statistical purposes, to the value of log gamma *n* can be had by interpolating in a table of log factorial *n*.

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*This is an abstract of a paper by Raymond Pearl, having the same title and published in Science N. S. Vol. XLI, pp 506-507.

It is shown that the interpolation method, when third differences are used, gives values slightly better than those by Forsyth's method when $n = 25$. For $n = 75$ or more the interpolation method using only second differences gives an approximation sufficiently close for all practical statistical purposes. As to the labor involved, there is no great amount of choice between Forsyth's and the interpolation method, but on the whole there appears to be a distinct, if small, advantage in favor of the interpolation.

MENDELIAN INHERITANCE OF FECUNDITY IN THE DOMESTIC FOWL, AND AVERAGE FLOCK PRODUCTION.*

In this paper it is shown that:

1. There is a marked difference in average egg production per bird of Barred Plymouth Rock pullets of the Maine Station strain at the present time as compared with what obtained during the period of simple mass-selection for this character. This is seen in Table I.

TABLE I.

MONTHLY DISTRIBUTION OF MEAN EGG PRODUCTION PER BIRD UNDER DIFFERENT BREEDING SYSTEMS

Month	Weighted Mean Under Mass Selection	Best Comparable Year to 1913-14 of Similar-sized Flocks Under Mass Selection (1905-06 100-bird Pens)	Best Month in Any Year of Mass Selection, Any Size Flock	Year 1913-14
November...	4.63	5.38	6.45 (1904-05, 100-bird flock)	*10.76*
December...	8.91	9.91	12.02 (1901-02, only 48 birds in small flocks)	*14.19*
January....	11.71	13.27	15.21 (1901-02, only 48 birds in small flocks)	*13.88*
February....	10.87	13.39	14.46 (1905-06, 50-bird flocks)	*13.37*
March.....	16.11	17.33	18.29 (1905-06, 50-bird flocks)	*19.22*
April.....	15.85	16.48	18.50 (1901-02, only 48 birds in small flocks)	*18.44*
May.....	13.92	———	17.02 (1902-03, 147 birds in small flocks)	*16.88*
June.....	12.46	13.47	16.88 (1901-02, only 48 birds in small flocks)	*14.56*
July.....	10.87	10.49	14.90 (1901-02, only 48 birds in small flocks)	*14.52*

*This is an abstract of a paper by Raymond Pearl, having the same title and published in American Naturalist, Vol. XLIX, pp. 306-317, 1915.

2. This difference is in the direction of a substantially higher mean production at the present time, when tested on flocks of large size.

3. The increase in flock average productivity is most pronounced in respect to winter production, which is the laying cycle to which especial attention has been given in the breeding.

4. The cause of this increase in flock productivity appears, with a degree of probability which is very high and amounts nearly to certainty, to be that the method of breeding the stock now followed is more closely in accord with the mode of inheritance of fecundity than was the simple mass-selection practised in the earlier period.

5. The result announced in earlier papers that high fecundity is a sex-linked character, for which the female is heterozygous, has been confirmed by practical poultrymen in their breeding operations.

STUDIES ON THE PHYSIOLOGY OF REPRODUCTION IN THE DOMESTIC FOWL.

XIII. On the Failure of Extract of Pituitary Body (Anterior Lobe) to Activate the Resting Ovary.

From the evidence presented in this paper it appears to be clearly established that the substance of the anterior lobe of the pituitary body of the cow, when injected into the abdominal cavity of hens in which the ovary is in a completely resting condition, does not cause an activation of the ovary, in the sense of inducing ovulation at an earlier date than that at which it would normally occur.

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*This is an abstract of a paper by Raymond Pearl and Frank M. Surface, having the same title and published in Journal of Biological Chemistry, Vol. XXI, pp. 95-101. 1915.

FREQUENCY OF OCCURRENCE OF TUMORS IN THE DOMESTIC FOWL.*

The purpose of the present paper is to record the data on the frequency of occurrence of tumors in the domestic fowl which have been collected during eight years' routine autopsy work at the Maine Agricultural Experiment Station.

The chief points brought out by an analysis of these data are as follows:

(1) Of the 880 birds autopsied 79, or 8.96 per cent, had tumors. That is, there were 90 cases of tumors per 1,000 birds.

(2) There was no significant difference in frequency of occurrence of tumors between birds which died from natural causes and apparently normal birds which were killed.

(3) There is a significant positive correlation between age and the occurrence of tumors. Only 7.37 per cent of the birds under 2 1-4 years had tumors, while neoplasms were present in 19.17 per cent of those that were over that age.

(4) In birds with tumors which died from natural causes, the tumors were directly or indirectly the probable cause of death in from one-third to one-half the cases.

(5) There was a decided tendency for the association of hypertrophied (apparently due to cell infiltration) liver, spleen, or kidney with the presence of tumors in other organs.

(6) Death often resulted from internal hemorrhage from the tumor, the underlying tissue, or the hypertrophied liver or spleen.

(7) The tumors can be classified into cystic and tissue tumors; 22.78 per cent of the tumors were of cystic and 74.68 per cent of solid-tissue structure. There were two cases of tissue tumors to which cysts were attached.

(8) In the females[1] the organs most frequently affected were the genital organs; 37.76 per cent of all the tumors being in the ovary and 18.36 per cent in the oviduct and oviduct ligament.

(9) In most cases the tumors were confined to one organ. In 15 cases, however, the tumor had evidently undergone metastasis, since tumors of similar nature occurred in from two to four organs.

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*This is an abstract of a paper by Maynie R. Curtis, having the same title and published in Journal of Agricultural Research, Vol. V, pp. 397-404. 1915.

[1]Autopsies were made on too few males to yield reliable data.

SEVENTEEN YEARS SELECTION OF A CHARACTER SHOWING SEX-LINKED MENDELIAN INHERITANCE.*

In 1898 there was begun at the Maine Agricultural Experiment Station an experiment in breeding Barred Plymouth Rock fowls, having for its purpose the improvement by selection of the character winter egg production. This investigation has continued to the present time.

The experiment has fallen into three divisions or periods: viz., (1) the period from 1898 to 1907, (2) the period from 1908 to 1912, and finally (3) the period from 1912 to date. Detailed reports on the methods of breeding in operation have been published elsewhere.† For purposes of clear orientation in the present discussion it will be well here briefly to review the facts as to the methods of breeding used in each of the periods. With these facts definitely in mind we may then proceed to an examination of the results.

1. *The Period from 1898 to 1907.*—During this period the breeding followed the plan outlined at the beginning by Woods and Gowell. Essentially it consisted of the following elements.

1. Trap-nest record of the performance of each individual female.
2. Selection as breeders of all females which laid more than a definite number of eggs (150) in the first laying year.
3. Selection as breeders of males whose dams had laid more than another definite number of eggs (200).
4. The indiscriminate mass breeding, *without* individual pedigrees, of all individuals selected as described under 2 and 3, and, in consequence,

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*This is an abstract of a paper by Raymond Pearl, having the same title and published in American Naturalist, Vol. XLIX, pp. 595-608, 1915.

†Cf. particularly Woods, C. D., and Gowell, G. M., U. S. Dept. Agr. Bur. Anim. Ind. Bulletin 90, 1906, pp. 42; Pearl, R., and Surface, F. M., *Ibid.* Bulletin 110, Part I, 1909, pp. 80; Pearl, Me. Agr. Expt. Stat. Ann. Rept., 1911, pp. 113-176; and Pearl, *Jour. Exp. Zool.*, Vol. 13, 1912, pp. 153-268.

5. *No test of the progeny* of particular matings with respect to their laying ability.

This may be designated as the *period of mass selection.*

2. *The Period from 1908 to 1912.*—For reasons which have been fully set forth elsewhere[3] it was decided not to continue the breeding along the same plan after 1907. The new plan, put into operation first in the breeding season of 1908, was calculated primarily to furnish definite information regarding the mode of inheritance of the character winter egg production. It involved essentially the following items:

1. Trap-nest record of the performance of each individual female.
2. The selection of both males and females was made on a *double* basis, including in addition to the individual's own performance as in the earlier plan, also the idea of progeny performance. In practice this worked out *for hens* in the following way; Plans were made to see whether there could be formed by selection and propagated three distinct strains of winter egg producers, namely, high, mediocre and low. This involved, *on the individual performance side,* the separate selection in the first years of *three* classes of females as breeders: (*a*) good winter producers, with records before March 1 of above 30 eggs; (*b*) mediocre winter producers, with records below 30 eggs: and (*c*) poor winter producers, which laid no eggs before March 1. The division at 30 eggs was, after the first year, merely a nominal one in the selection of *high* producers. Actually only birds were used in the *a* class whose records materially exceeded 30 eggs, running up to over 100 eggs in some cases.

   The *progeny performance* idea was carried out in two ways in the breeding. In the first place, no female was selected for the *high* winter production breeding pens, for example, unless, in addition to her own high winter record, all her sisters and her dam were high producers. In the second place, of all females fulfilling the above qualification only those were bred a

[3]Pearl and Surface, *loc. cit.*

second time whose progeny from the first year's mating had proven to be all high producers. Similar types of selection were followed by the mediocre and low lines, except that segregating families were put in the mediocre class.

3. The selection of males was along essentially the same lines, with only such difference as is involved in the fact that the male makes no performance record himself. Males were put into the breeding pen the first time on the basis of the records of their dams, on the one hand, and of their sisters, on the other hand. Those whose progeny proved that they were transmitting the character to which selection was being made were used a second or even third time as breeders.
4. Complete individual pedigrees, whereby each offspring individual's parentage, both male and female, was known.
5. The records of production of the progeny of each mating separately recorded and studied as a unit.

It will be noted that there are but two essential differences between the plan in this period and that followed in the earlier one. These are: first and most important, that in this second period the principle of *progeny testing* was introduced into the scheme of breeding. The second difference was that selection was carried on for low production as well as for high, which had not been previously done. A third difference is apparently found in the fact that in this second period of selection the winter record rather than the yearly record is made the basis of selection. This is in no way an essential difference.

As a result of the studies made in this period on the plan of breeding outlined the mode of inheritance of the character winter production was definitely determined, and has been confirmed by subsequent work.[1] The character was shown to be Mendelian in its genetic behavior, depending upon two factors, one of which is sex-linked.

3. *The Period from 1912 to Date.*—The only difference in the mode of breeding the stock of Barred Plymouth Rocks in

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[1]Pearl, 1912, *loc. cit.*, also AMER. NAT., Vol. XLIX, 1915, pp. 306-317, and Curtis and Pearl, *Jour. Exp. Zoology*, Vol. 19, 1915, pp. 45-59.

this period, as compared with the preceding one, is found in the fact that during this last period *all selections for low and mediocre production have been dropped.* The breeding for high production alone continues, with only such differences in the details of manipulation of the breeding stock as would naturally follow a definite knowledge of the mode of inheritance of the character, and of the gametic constitution of particular individuals with reference to that character. As a matter of fact, all low-producing lines were dropped at the end of the laying year 1911-12. Certain of the mediocre lines were continued a year longer. In the laying flock of 1913-14 there were no birds which had been bred for anything other than high production, so far as the breeder's deliberate intention went.

The results of this seventeen year selection period are set forth in Table I.

TABLE I

MEAN WINTER PRODUCTION PER BIRD OF THE BARRED PLYMOUTH ROCK FLOCKS FROM 1899 TO 1915

Laying Year	Mean Winter Production of All Birds	No. of Birds Making Winter Records	Mean Winter Production of All Birds Selected for *High* Production	Mean Winter Production of All Birds Selected for *Low* Production
1899-1900	41.03 eggs	70	–	–
1900-1901	37.88 "	85	–	–
1901-1902	45.23 "	48	–	–
1902-1903	26.01 "	147	–	–
1903-1904	26.55 "	254	–	–
1904-1905	35.04 "	515	–	–
1905-1906	40.65 "	635	–	–
1906-1907	22.44 "	635	–	–
1907-1908	19.93 "	780	–	–
1908-1909	26.69 "	359	54.16	22.06
1909-1910	31.76 "	247	47.57	25.05
1910-1911	30.49 "	264	50.58	17.00
1911-1912	35.93 "	232	57.42	16.43
1912-1913	43.01 "	182	52.61	–
1913-1914	52.20 "	192	52.20	–
1914-1915	45.89 "	179	45.89	–
Totals and means	35.05 "	4,842	51.49	20.14

The data of this table are shown graphically in Fig. 63.

From the table and diagrams the following results appear:

1. The number of individuals involved in this experiment, on each one of which exact trap-nest records have been kept, is large, amounting nearly to five thousand. This number is large enough to lead to conclusions which are trustworthy.

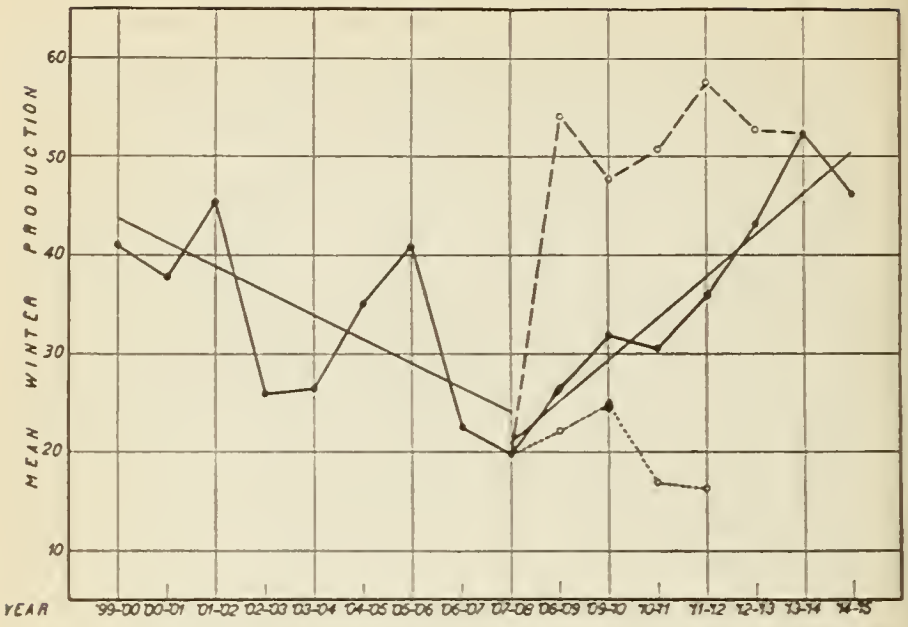

FIG. 1. Graph showing the course of mean winter egg production between the years 1899 and 1915. The solid lines and circles give the total flock means. The two straight lines, fitted by the method of least squares to the observed flock means, have the equations $y=43.655-2.181x$, $y=17.070+4.148x$. The open circles and broken (dash) line give the means of the lines selected for high winter production between the years 1908 and 1915. The dotted line and open circles give the mean winter production of the lines selected for low production between the years 1908 and 1912.

2. From the beginning of the experiment through the laying year 1907-08 the general trend of mean production was downward, with minor fluctuations from year to year. In other words during the period in which the system of breeding was mass selection for high production without progeny test there was no change of the mean in the direction of the selection. The fluctuations in mean production during this period were, in the main, due probably to two sets of causes: (*a*) environmental differences in different years acting at one point or another in the life history of the birds; (*b*) random fluctuations in the genetic constitution of the male birds used as breeders in successive years, brought about because of the ignorance of the breeder, in the absence of any individual progeny testing plan, of the ability of any particular male to transmit high fecundity to his daughters.

3. Since the laying year 1907-08 there has been a steady increase in mean winter production for the whole flock, except for the years 1910-11 and 1914-15. In the former year the decline in the mean is slight, and is probably due to unfavorable environmental influences. In 1914-15 the decline is certainly due to such causes.

4. That selection on a progeny test basis was effective is demonstrated not only by the general flock averages, but also by the fact that it was possible to propagate separately high and low producing strains. The high producing strains differed widely from the low producing in mean winter production. Taking the average for seven years in the case of the high, and four years in the case of the low, it appears that the mean winter production of the high producing strains was approximately two and a half times that of the low producing strains. At the end of the laying year 1911-12 the low producing lines were dropped. In the next year (breeding season of 1913) no birds were bred which were known to belong to segregating lines. Of course some were included which proved afterwards to have been segregating, but this fact could not, in any such case, have been told in advance from the records in hand.

A SYSTEM OF RECORDING TYPES OF MATING IN EXPERIMENTAL BREEDING OPERATIONS.*

This paper is of interest only to the experimentalist. It describes a uniform and comprehensive method of describing numerically the different forms of pedigrees which arise in Mendelian work.

MEASUREMENT OF THE WINTER CYCLE IN THE EGG PRODUCTION OF DOMESTIC FOWL.*†

In this paper quantitative evidence is presented which shows, with flocks of poultry having average hatching dates falling somewhere within the month of April, that—

*This is an abstract of a paper by Raymond Pearl, having the same title and published in Science N. S. Vol. XLII, pp. 383-386, 1915.

*†This is an abstract of a paper by Raymond Pearl, having the same title and published in Journal of Agricultural Research, Vol. V, pp. 429-437. 1915.

(1) The correlation between the egg production to March 1 of the pullet year as one variable and the egg production up to the time when the individual is 300 days of age as the second variable is extremely high.

(2) The mean production to March 1 is, in general, higher than the mean production to 300 days of age.

(3) The production to March 1 is a relatively less variable measure (as indicated by the coefficient of variation) than the production to 300 days of age.

(4) The conclusion that the 300-day production would be a better measure of the winter cycle of fecundity than the production to March 1 is not warranted by the facts. Whatever superiority there is of one of these measures over the other is entirely in favor of the production to March 1. We may therefore conclude that the use, in the writer's investigations on fecundity, of the record of egg production to March 1 of the pullet year as a measure of the winter cycle of production is fully justified by a critical examination of the facts. The justification for the employment of the winter cycle of production as an index of innate fecundity capacity or ability is a distinct and separate problem which has been discussed at length in earlier papers.

TWO CLOVER APHIDS.*

Aphis brevis Sanderson (Long-beaked clover aphid).

In the vicinity of Orono, Me., the leaves of the hawthorn (*Crataegus* spp.) in June are commonly twisted into dark-purple swollen curls and are inhabited by an aphid the fall migrants of which were described by Prof. Sanderson as *Aphis brevis*. This insect takes flight from hawthorn during June and early July and returns late in the season before producing the sexual generation. I have taken the fall migrants on cultivated plum (*Prunus* spp.), but yet have made no spring collections from that host. In June and July, 1906, I collected apparently the same species from the twigs and terminal leaf curls of the Japan quince (*Cydonia japonica*).

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*This is an abstract of a paper with the same title, by Edith M. Patch, published in the Journal of Agricultural Research, Dept. of Agriculture, Washington, D. C., Vol. III, No. 5, Feb. 15, 1915, pp. 431-433, with 3 figures.

I undertook some transfer tests during the summer of 1912, and found that *Aphis brevis* accepted both alsike and other clover (*Trifolium* spp.). Migrants placed on alsike and white clover produced nymphs that fed with apparent satisfaction on the test plants. The potted white clover was, however, more easily managed in the laboratory, so it was selected for the main rearings. The transfer was made on June 14. The migrants fed on the clover, and their abdomens became distended. At this time the head, thorax, and cornicles were black, and abdomens olive green, with distinct black lateral dots. By June 21 their abundant progeny were established on both stem and runner. The nymphs at first were pale and pellucid, with rosy head and prothorax. By June 24 this generation had matured, but did not begin to reproduce for a day or two.

Aphis bakeri Cowen (Short-beaked clover aphid).

About the middle of August, 1914, large numbers of an aphid from *Trifolium pratense* were taken by Mr. George Newman at Orono, Maine. This species is distinct from the one just discussed, and yet they resemble each other enough so that both species have sometimes been listed under the same name. The fact that both species are found on hawthorn in the spring and migrate to clover in the summer may be partly responsible for this confusion.

The habitat of the short-beaked clover aphid on clover seemed to be the ventral side of the leaf and the stem near the ground. The colonies were frequently covered by "ant sheds," as well as sometimes extending for a short distance underground.

This species is smaller, more slender and graceful than the long-beaked clover aphid. Joint V of the antenna is noticeably shorter than IV and is without sensoria, except the usual distal one, in the summer winged viviparous female. The stigma is rather narrow and the distal end acute. The beak hardly reaches the second coxa and frequently falls considerably short of it. The prothoracic and abdominal lateral tubercles are prominent, but very slender. Both species have the cornicles and cauda very short.

THE POND-LILY APHID AS A PLUM PEST.*

One of our best-known aphids common upon various water plants is *Rhopalosiphum nymphaeae* (Linn.). This has received considerable attention as a "semi-aquatic" species which on account of the waxgland areas of its body appears to be particularly adapted to a life in moist localities and to suffer no inconvenience from contact with water while feeding on aquatic plants.

One of the most troublesome of our plum aphids in Maine is a species inhabiting the shoots and the ventral surface of the leaves, ordinarily without causing curl or similar deformation of the leaf, but exhibiting a dangerous tendency to feed also upon the young fruit itself as well as tapping the fruit stems.

After watching this plum aphid several years and wondering where its summer home might be (for it is a migratory species, leaving the plum in June) it was noticed that there were apparently no structural characters to separate this from the common pond-lily aphid, *R. nymphaeae*.

In view of this the "migration test" was made this spring by placing the spring migrants (alate viviparous forms) from plum upon water plantain, *Alisma Plantago-aquatica*; arrow-head, *Sagittaria latifolia*; and cat-tail flag, *Typha latifolia*; which had been potted and kept under laboratory control. These three plants are on the approved dietary of *R. nymphaeae* and the plum migrants accepted them all readily, and the progeny of the plum migrants are perfectly content with the habitat given them.

Thus the life cycle of the ancient aphid is found to include a residence upon the plum, migrating thence to water plants for the summer and returning to the plum in the fall for the deposition of the over-wintering egg which provides for its spring generations upon that tree.

Biosteres rhagoletis Richmond, sp. n., A Parasite of *Rhagoletis pomonella* Walsh.†

During the summer of 1913 the writer was engaged in studying blueberry insects in Washington County, Maine. A maggot

*This is an abstract of a paper with the same title, by Edith M. Patch, published in Science, N. S., Vol. XLII, No. 1074, page 164, July 30, 1915.

†This is an abstract of a paper with the same title, by William C. Woods, published in The Canadian Entomologist, Vol. XLVII, pp. 293-295, with 3 figures.

was found infesting the berries, which when bred proved to be *Rhagoletis pomonella* Walsh, the apple maggot or railroad worm (Journal of Economic Entomology, 1914, Vol. VII, pp. 398-399). There were also obtained from larvae of this species collected at Cherryfield, Maine, in August and September, 1913, twenty-one specimens of a parasite, which emerged from puparia kept under laboratory conditions, at various dates between February 25 and April 21, 1914.

No parasite has been recorded from *Rhagoletis pomonella* Walsh, previous to this time.

The species belongs to the family *Braconidae* and to the subfamily *Opiinae*. In this same group are placed many of the parasites, including one of this genus, which are recorded by Silvestri as bred from various fruit-flies (Bulletin 3, Hawaii Board of Agrculture and Forestry, 1914.)

Specimens of this species were swept on the blueberry barrens of Washington County last summer, where apparently they had considerably reduced the number of the maggots as compared with the preceding season. Specimens of the Cherryfield parasites were submitted to Mr. E. A. Richmond, of Cornell University, who determined it as a new species.

EFFECT OF TEMPERATURE ON GERMINATION AND GROWTH OF THE COMMON POTATO-SCAB ORGANISM.*

The object of this study was to determine as closely as possible the optimum, maximum and minimum temperatures for the growth of the common potato scab organism in artificial cultures, also the effects of variations in temperature upon the germination of the so-called "gonidia" which it produces in the fruiting stage upon such cultures. The organism under consideration is what has been known since 1892 as *Oospora scabies* Thaxter and which Lutman and Cunningham have recently

*This is an abstract of a paper with the same title by Michael Shapovalov published in the Journal of Agricultural Research, Vol. IV, No. 2, pp. 129-134, May 15, 1915.

pronounced as identical with *Actinomyces chromogenus* Gasperini.

In making the germination tests the ordinary agar hanging-block used in studying the growth of bacteria was employed, using beef extract agar without salt. The maximum temperature for germination and growth is apparently slightly below 41° C. Germination is most rapid between 35° and 40.5° with little difference at temperatures between these points. Below this the time for germination gradually increases so that 10° C. it takes 15 or more times as long as at 35°. The largest percentage of germination is usually secured at from 30° to 37° C. Apparently the minimum temperature for germination lies somewhere near 5° C.

Exposure to cold weather, several degrees below zero centigrade, does not always kill the parasite. The organisms in cultures on cooked potato cylinders withstand low temperature better than those in beef broth cultures.

While temperatures from 35° to 40° C. are most favorable for the germination of the gonidia, they are unfavorable for long-continued growth of the organism, although at 35° a stimulating effect was produced at first. Below 20° C. growth is very much retarded and slow. The maximum temperature for growth is about 40.5°, the optimum 25° to 30°, and the minimum about 5° C.

Abnormal growths or involution forms were observed in the cultures but apparently these were produced as the result of variation in the composition of the culture media employed and were not caused by unfavorable temperatures.

METEOROLOGICAL OBSERVATIONS.

For many years the meteorological apparatus was located in the Experiment Station building and the observations were made by members of the Station Staff. June 1, 1911, the meteorological apparatus was removed to Wingate Hall and the observations are in charge of Mr. James S. Stevens, professor of physics in the University of Maine.

In September, 1914, the meteorological apparatus was again moved to Auburt Hall, the present headquarters of the physics department.

The instruments used were at Lat. 44° 54′ 2″ N. Lon. 64° 40′ 5″ W. Elevation 135 feet.

The instruments used are the same as those used in preceding years, and include: Maximum and minimum thermometers; rain gauge; self-recording anemometer; vane; and barometers. The observations at Orono now form an almost unbroken record of forty-seven years.

Meteorological Summary for 1915.

Observations Made at the University of Maine.

1915.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Average.	Total.
Highest temperature	52	64	60	73	77	87	89	89	89	76	62	54	. . . .	. .
Lowest temperature	21	8	6	20	25	31	49	36	30	27	19	4	. . .	. .
Mean temperature	23 9	28 7	30 2	45 4	51 5	62 7	65 7	66 5	62 1	50 8	38.2	28.8	16.21	
Mean temperature in 47 years	16 4	12 3	30 1	40 1	55 7	60 8	65 8	66 0	60.0	50 9	38.3	24 1	42.73	.
Total precipitation in inches	2 49	3 56	0 31	3 28	4 97	2 47	6 67	4 67	1 19	2 62	3 04	3.57	. . . .	38.87
Mean precipitation in 47 years	3 99	3 51	4 11	20 5	3 56	3 39							42.67	
Number of days with precipitation of .01 or more	9	10	2	11	11	12	13	13	1	7	11	10		113
Snow fall in inches	9 1	14 0	0 5	13 0								12.5		49 1
Mean snow fall in 47 years	21 69	21 36	15 00	5 62	0 18					0 70	7 03	15 96	87 34	
Number of clear days	14	13	16	13	13	14	14	15	22	19	11	13	. .	177
Number of fair days	8	6	7	3	8	8	9	5	1	4	6	2	. . .	67
Number of cloudy days	9	9	8	14	10	8	8	11	7	8	13	16	. . .	121
Total movement of wind in miles	3573	3909	6980	1761	4763	3268	3130	2689	3708	3688	1789	3866		18224

REPORT OF THE TREASURER.

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts are audited by the State Auditor and the Hatch Fund and Adams Fund accounts are also audited by the Office of Experiment Stations acting for the United States Secretary of Agriculture in accordance with Federal Law.

The income of the Station from public sources for the year that ended June 30, 1915, was:

U. S. Government, Hatch Fund appropriation...	$15,000 00
U. S. Government, Adams Fund appropriation...	15,000 00
State of Maine, Animal Husbandry investigation appropriation	5,000 00
State of Maine, Aroostook Farm investigation ...	5,000 00

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experiment farms is used to meet the expenses of investigations. The printing which costs about $4,500 is paid for by an appropriation to the University.

All of the disbursements except for printing and the sheep husbandry experiment are given in the tables that follow on the two succeeding pages. The sheep husbandry expenditures were labor $182.55, seeds, plants and sundry supplies $100.22, feeding stuffs $483.59 and live stock $750.99, making a total of $1,517.35.

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1915.

DISBURSEMENTS.

Receipts.	Hatch fund.	Adams fund.	Animal husbandry investigations.
Salaries	$5,537 01	$11,049 60	$4,722 74
Labor	3,664 04	33 03	
Publications	113 87		
Postage and stationery	717 20	144 72	56 75
Freight and express	139 05	99 58	2 28
Heat, light and power	158 75	168 00	
Chemical and laboratory supplies	180 29	269 74	21 42
Seeds, plants and sundry supplies	325 06	246 04	35 63
Fertilizers	1,375 36		
Feeding stuffs	1,018 96	1,769 08	
Library	619 07	89 84	2 00
Tools, machinery and appliances	211 36	58 81	
Furniture and fixtures	93 12	34 50	
Scientific apparatus and specimens	16 20	200 09	3 71
Live stock	4 50		
Traveling expenses	353 30	511 49	155 47
Contingent expenses	20 00		
Buildings	452 86	334 48	
Total	$15,000 00	$15,000 00	$5,000 00

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1915—Concluded.

DISBURSEMENTS.

Receipts.	Aroostook farm.	General account.	Inspection analysis.
Salaries	$970 00	$4,135 54	$10,441 78
Labor	3,352 87	2,705 31	.....
Publications	.....	10 40	.....
Postage and stationery	46 39	91 16	263 18
Freight and express	46 99	526 51	157 85
Heat, light and power	211 64	256 63	164 67
Chemical and laboratory supplies	577 16	402 62	926 79
Seeds, plants and sundry supplies	219 53	979 04	.....
Fertilizers	1,869 29	24 00	.....
Feeding stuffs	585 79	321 97	.....
Library	.....	10 70	.....
Tools, implements and machinery	966 57	96 48	.....
Furniture and fixtures	4 53	2 04	153 60
Scientific apparatus	.....	11 85	.....
Live stock	70 00	650 00	.....
Traveling expenses	276 25	163 50	173 68
Contingent expenses	221 70	205 89	7 20
Buildings	468 59	129 41	.....
Total	$9,887 30	$10,723 05	$12,288 75

INDEX.

Index to Reports for the Years 1911 to 1915, and to Bulletins 235 to 245 Inclusive.

In each reference the first two figures indicate the year. Thus, '15, 291, indicates page 291 of the report for 1915.

THIRTY-FIRST ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE

1915

STATE OF MAINE

1916

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

Organization January to June, 1915.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY,	*President*
DIRECTOR CHARLES D. WOODS,	*Secretary*
CHARLES L. JONES, Corinna,	*Committee of Board of Trustees*
FREELAND JONES, Bangor,	*Committee of Board of Trustees*
WILLIAM A. MARTIN, Houlton,	*Committee of Board of Trustees*
WILLIAM T. GUPTILL, Topsham,	*Commissioner of Agriculture*
EUGENE H. LIBBY, Auburn,	*State Grange*
HOWARD L. KEYSER, Greene,	*State Pomological Society*
FRANK S. ADAMS, Bowdoinham,	*State Dairymen's Association*
LEONARD C. HOLSTON, Cornish,	*Maine Livestock Breeders' Association*
WILLIAM G. HUNTON, Readfield,	*Maine Seed Improvement Association*

AND THE HEADS AND ASSOCIATES OF STATION DEPARTMENTS, AND THE DEAN OF THE COLLEGE OF AGRICULTURE.

THE STATION STAFF.

ADMINISTRATION	CHARLES D. WOODS, Sc. D.,	*Director*
	BLANCHE F. POOLER,	*Clerk*
	GEM M. COOMBS,	*Stenographer*
	JANIE L. FAYLE,	*Stenographer*
BIOLOGY	RAYMOND PEARL, PH. D.,	*Biologist*
	FRANK M. SURFACE, PH. D.,	*Biologist*
	MAYNIE R. CURTIS, PH. D.,	*Assistant*
	JACOB ZINN, AGR. D.,	*Assistant*
	JOHN W. GOWEN, B. S.,	*Assistant*
	JOHN RICE MINER, B. A.,	*Computer*
	HAZEL F. MARINER, B. A.,	*Clerk*
CHEMISTRY	JAMES M. BARTLETT, M. S.,	*Chemist*
	HERMAN H. HANSON, M. S.	*Associate*
	EDWARD E. SAWYER, B. S.,	*Assistant*
	ELMER R. TOBEY, B. S.,	*Assistant*
	HOYT D. LUCAS, B. S.,	*Assistant*
	HARRY C. ALEXANDER,	*Laboratory Assistant*
ENTOMOLOGY	EDITH M. PATCH, PH. D.,	*Entomologist*
	ALICE W. AVERILL,	*Laboratory Assistant*
PLANT PATHOLOGY	WARNER J. MORSE, PH. D.,	*Pathologist*
	MICHAEL SHAPOVALOV, M. S.,	*Assistant*
	VERNON FOLSOM,	*Laboratory Assistant*
AROOSTOOK FARM	GUY A. BAKER	*Superintendent*
HIGHMOOR FARM	WELLINGTON SINCLAIR,	*Superintendent*
ROYDEN L. HAMMOND,		*Seed Analyst and Photographer*
CHARLES C. INMAN,		*Assistant*

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

Organization July to December, 1915.

THE STATION COUNCIL.

PRESIDENT ROBERT J. ALEY, *President*
DIRECTOR CHARLES D. WOODS, *Secretary*
CHARLES L. JONES, Corinna,
FREELAND JONES, Bangor,
WILLIAM A. MARTIN, Houlton, } *Committee of Board of Trustees*
WILLIAM T. GUPTILL, Topsham, *Commissioner of Agriculture*
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	MICHAEL SHAPOVALOV, M. S.	*Assistant*
	DONALD S. CLARK,	*Laboratory Assistant*
AROOSTOOK FARM	JACOB ZINN, AGR. D.,	*Assistant Biologist*
	C. HARRY WHITE,	*Scientific Aid*
	GUY A. BAKER	*Superintendent*
HIGHMOOR FARM	WELLINGTON SINCLAIR,	*Superintendent*
	WALTER E. CURTIS,	*Scientific Aid*
ROYDEN L. HAMMOND,		*Seed Analyst and Photographer*
CHARLES C. INMAN,		*Assistant*

*Absent on leave.

The publications of this Station will be sent free to any address in Maine. All requests should be sent to

Agricultural Experiment Station,

Orono, Maine.

CONTENTS.

ANNOUNCEMENTS.

Establishment of the Station.

The Maine Fertilizer Control and Agricultural Experiment Station, established by Act of the Legislature approved March 3, 1885, began its work in April of that year in quarters furnished by the College. After the Station had existed for two years, Congress passed what is known as the Hatch Act, establishing agricultural experiment stations in every state. This grant was accepted by the Maine Legislature by an Act approved March 16, 1887, which established the Maine Agricultural Experiment Station as a department of the University. The reorganization was effected in June, 1887, but work was not begun until February 16, 1888. In 1906 Congress passed the Adams Act for the further endowment of the stations established under the Hatch Act.

The purpose of the experiment stations is defined in the Act of Congress establishing them as follows:

"It shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantage of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manure, natural and artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories."

The work that the Experiment Station can undertake from the Adams Act fund is more restricted and can "be applied only to paying the necessary expenses for conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective states and territories."

Investigations.

The Station continues to restrict its work to a few important lines, believing that it is better for the agriculture of the State to study thoroughly a few problems than to spread over the whole field of agricultural science. It has continued to improve its facilities and segregate its work in such a way as to make it an effective agency for research in agriculture. Prominent among the lines of investigation are studies upon the food of man and animals, the diseases of plants and animals, breeding of plants and animals, orchard and field experiments, poultry investigations, and entomological research.

The Legislature of 1913 provided for investigations by the Station in animal husbandry which make Chapter 141 of the Public Laws for 1913. The following quoted from the act outlines the purpose of the act. "The Maine Agricultural Experiment Station in addition to the investigations now conducted by it, shall conduct scientific investigations in animal husbandry, including experiments and observations on dairy cattle and other domestic animals. Said investigations shall be carried out under control of the director of the Maine Agricultural Experiment Station. There shall be appropriated annually from the State Treasury the sum of five thousand dollars to be paid to the Maine Agricultural Experiment Station and the same shall be expended by the director of said Station in executing the provisions of this act."

Inspections.

Up to the close of the year 1913 it had been the duty of the Director of the Station to execute the laws regulating the sale of agricultural seeds, apples, commercial feeding stuffs, commercial fertilizers, drugs, foods, fungicides and insecticides, and the testing of the graduated glassware used by creameries. Beginning with January 1914 the purely executive part of these

laws is handled by the Commissioner of Agriculture. It is still the duty of the Director of the Station to make the analytical examination of the samples collected by the Commissioner and to publish the results of the analyses. The cost of the inspections is borne by fees and by a State appropriation.

Offices and Laboratories.

The offices, laboratories and poultry plant of the Maine Agricultural Experiment Station are at the University of Maine, Orono. Orono is the freight, express, post, telegraph and telephone address for the offices and laboratories.

Visitors to the Station will find it convenient to leave the steam cars at Bangor or Old Town, as the railway station at Orono is a mile from the University. Bangor and Old Town trolley cars pass through the campus. They pass the railway station in Bangor 5 minutes after the hour and half hour, and the railway station in Old Town, 20 minutes after and 10 minutes before the hour.

Aroostook Farm.

By action of the Legislatures of 1913 and 1915 a farm was purchased in Aroostook County for scientific investigations in agriculture to be under "the general supervision, management, and control" of the Maine Agricultural Experiment Station. The farm is in the town of Presque Isle, about two miles south of the village, on the main road to Houlton. The Bangor and Aroostook railroad crosses the farm. A flag station, "Aroostook Farm," makes it easily accessible by rail.

The farm contains about 275 acres, about half of which is cleared. The eight room house provides an office, and home for the farm superintendent. The large barn affords storage for hay and grain and has a large potato storage house in the basement.

Highmoor Farm.

The State Legislature of 1909 purchased a farm upon which the Maine Agricultural Experiment Station "shall conduct scientific investigations in orcharding, corn, and other farm

crops." The farm is situated in the counties of Kennebec and Androscoggin, largely in the town of Monmouth. It is on the Farmington Branch of the Maine Central Railroad, two miles from Leeds Junction. A flag station, "Highmoor," is on the farm.

The farm contains 225 acres, about 200 of which are in orchards, fields, and pastures. There are in the neighborhood of 3,000 apple trees upon the place which have been set from 20 to 30 years. Fields that are not in orchards are well adapted to experiments with corn, potatoes, and similar general farm crops. The house has two stories with a large wing, and contains about 15 rooms. It is well arranged for the Station offices and for the home of the farm superintendent. The barns are large, affording storage for hay and grain. The basement affords limited storage for apples, potatoes and roots.

The Aim of the Station.

Every citizen of Maine concerned in agriculture has the right to apply to the Station for any assistance that comes within its province. It is the wish of the Trustees and Station Council that the Station be as widely useful as its resources will permit.

In addition to its work of investigation, the Station is prepared to make chemical analyses of fertilizers, feeding stuffs, dairy products and other agricultural materials; to test seeds and creamery glassware; to identify grasses, weeds, injurious fungi and insects, etc.; and to give information on agricultural matters of interest and advantage to the citizens of the State.

All work proper to the Experiment Station and of public benefit will be done without charge. Work for the private use of individuals is charged for at the actual cost to the Station. The Station offers to do this work only as a matter of accommodation. Under no condition will the Station undertake analyses, the results of which cannot be published, if they prove of general interest.

Publications.

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station and in scientific journals, both foreign and domestic. The bulletins for the year make up the annual report. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and are bound in with the annual report as an appendix thereto. Miscellaneous publications consisting of newspaper notices of bulletins, newspaper bulletins and circulars which are not paged consecutively and for the most part are not included in the annual report are issued during the year.

All the bulletins issued by the Station are sent to the members of the staffs of other Stations and the U. S. Department of Agriculture who ask for them, to all newspapers in Maine, to libraries and to agricultural exchanges. Bulletins which have to do with general agriculture and the Official Inspections which bear upon the feeding stuffs, fertilizer and seed inspections are sent to a general mailing list composed chiefly of farmers within the State. The publications having to do with the food and drug inspection are sent to a special list including all dealers in Maine and other citizens who request them. The annual report is sent to directors of experiment stations and to libraries. Copies of all publications are sent to the newspapers within the State and to those on the exchange list outside of the State.

BULLETINS ISSUED IN 1915.

No. 235. Studies on Oat Breeding. II—Selection Within Pure Lines. 40 pages, 2 illustrations.
No. 236. Field Experiments in 1914. 24 pages.
No. 237. The Assumption of Male Secondary Characters by a Cow With Cystic Degeneration of the Ovaries. 16 pages, 10 illustrations.
No. 238. Leafhoppers of Maine. 80 pages, 25 illustrations.
No. 239. Studies on Bean Breeding. I. Standard Types of Yellow Eye Beans. 16 pages, 9 illustrations.
No. 240. Apple Spraying Experiments in 1914. 20 pages.
No. 241. Woolly Aphid of Elm and Juneberry. 8 pages, 2 illustrations.
No. 242. Pink and Green Aphid of Potato. 20 pages, 3 illustrations.

No. 243. Further Data on the Measurement of Inbreeding. 24 pages, 6 illustrations.
No. 244. Blueberry Insects of Maine. 40 pages, 7 illustrations.
No. 245. Finances, Meteorology, Index, Abstracts of Papers Not in the Bulletins. 36 pages.

OFFICIAL INSPECTIONS ISSUED IN 1915.

No. 66. Opened Shell-fish. 8 pages.
No. 67. Milk and Cream. 20 pages.
No. 68. Fungicide and Insecticide Inspection. 28 pages.
No. 69. Cream and Milk. 12 pages.
No. 70. Vinegar. 12 pages.
No. 71. Cream and Milk. 20 pages.
No. 72. Feeding Stuffs Inspection. 96 pages.
No. 73. Seed Inspection. 28 pages.
No. 74. Fertilizer Inspection. 60 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1915.

No. 504. Abstract Bulletin 237. 7 pages.
No. 505. Special Report to Commissioner of Agriculture for 1914. 39 pages.
No. 506. Station Publications. 1 page.
No. 507. List of Available Publications. 4 pages.
No. 508. Abstract Bulletin 237. 4 pages.
No. 509. Experiments at Highmoor Farm in 1915. 8 pages.
No. 510. Suggestion of Breeding Yellow Eye Beans of Standard Type. 4 pages.
No. 511. Abstract Bulletin 240. 7 pages.
No. 512. Cooperative Experiments. 2 pages.
No. 513. Abstract Bulletin 238. 7 pages.
No. 514. Experiments at Aroostook Farm in 1915. 8 pages.
No. 515. Poultry Management at the Maine Station (Revised) 98 pages.
No. 516. Surplus Stock of Seed Oats at Aroostook Farm. 1 page.
No. 517. Surplus Stock of Seed Oats at Highmoor Farm. 1 page.
No. 518. Cultural Methods with Oats used by the Station. 8 pages.
No. 519. Report of Progress on Animals Husbandry Investigations in 1915. 27 pages.
No. 520. Growing Crops Without Potash in 1916. 16 pages.
No. 521. Potatoes without Potash (placard). 1 page.

BIOLOGY PUBLICATIONS 1915.

In the numbered series of "Papers from the Biological Laboratory:"
75. Studies on the Physiology of Reproduction in the Domestic Fowl. XI. On the Relation of Simultaneous Ovulation to the Production of Double-Yolked Eggs. By Maynie R. Curtis, Journal of Agricultural Research, Vol. III, No. 5, pp. 375-385.

76. Studies on the Physiology of Reproduction in the Domestic Fowl. XII. On an Abnormality of the Oviduct and Its Effect upon Reproduction. By Maynie R. Curtis. Biol. Bulletin, Vol. XXVIII, No. 3, pp. 154-162.
77. On the Refractive Index of the Serum in a Guinea-Chicken Hybrid. By Raymond Pearl and John W. Gowen, Proc. Soc. Exp. Biol. & Med., Vol. XII, p. 48.
78. On the Fitting of Logarithmic Curves by the Method of Moments. By John Rice Miner. With an Introductory Statement on the Use of Logarithmic Curves in Biological and Agricultural Investigations by Raymond Pearl, Journal of Agricultural Research, Vol. III, pp. 411-423.
79. Studies on Oat Breeding. II. Selection within Pure Lines. By Frank M. Surface and Raymond Pearl, Maine Agricultural Experiment Station Annual Report for 1915, pp. 1-40.
80. Interpolation as a Means of Approximation to the Gamma Function for High Values of n. By Raymond Pearl, Science, N. S. Vol. XLI, No. 1057, pp. 506-507.
81. Mendelian Inheritance of Fecundity in the Domestic Fowl, and Average Flock Production. By Raymond Pearl, American Naturalist, Vol. XLIX, pp. 306-317.
82. Sex Studies. VII. On the Assumption of Male Secondary Characters by a Cow Affected with Cystic Degeneration of the Ovaries. By Raymond Pearl and Frank M. Surface, Maine Agricultural Experiment Station Annual Report for 1915, pp. 65-80.
83. Studies on the Physiology of Reproduction in the Domestic Fowl. XIII. On the Failure of Extract of Pituitary Body (Anterior Lobe) to Activate the Resting Ovary. By Raymond Pearl and Frank M. Surface, Journal of Biol. Chemistry, Vol. XXI, No. 1, pp. 95-101.
84. Studies on Bean Breeding. I. Standard Types of Yellow Eye Beans. By Raymond Pearl and Frank M. Surface, Maine Agricultural Experiment Station Annual Report for 1915, pp. 161-176.
85. Studies on Inbreeding. VI. Some Further Considerations Regarding Cousin and Related Kinds of Mating. By Raymond Pearl. American Naturalist, Vol. XLIX, pp. 570-575.
86. The Frequency of Occurrence of Tumors in the Domestic Fowl. By Maynie R. Curtis. Journal of Agricultural Research, Vol. V, No. 9, pp. 397-404.
87. Seventeen Years Selection of a Character Showing Sex Linked, Mendelian Inheritance. By Raymond Pearl. American Naturalist, Vol. XLIX, pp. 595-608.
88. A System of Recording Types of Mating in Experimental Breeding Operations. By Raymond Pearl. Science, N. S., Vol. XLII, pp. 383-386.

89. The Measurement of the Winter Cycle in the Egg Production of the Domestic Fowl. By Raymond Pearl. Journal of Agricultural Research, Vol. V., pp. 429-437.
90. On the Degree of Exactness of the Gamma Function Necessary in Curve Fitting. By Raymond Pearl. Science, N. S., Vol. XLII, pp. 833-834.
91. Studies on the Physiology of Reproduction in the Domestic Fowl. XIV. The Effect of Feeding Pituitary Substance and Corpus Luteum Substance on Egg Production and Growth. By Raymond Pearl. Journal Biol. Chemistry. In press.
92 Report of Progress on Animal Husbandry Investigations in 1915. By Raymond Pearl. Maine Agricultural Experiment Station Circular No. 519.

Papers published but not in the numbered series:

a. Brief Report of Progress on Animal Husbandry Investigations in 1914. By Raymond Pearl. Maine Agricultural Experiment Station Circular 503, pp. 1-11.
b. A Case of Assumption of Male Secondary Sex Characters by a Cow. By Raymond Pearl and Frank M. Surface. Science, N. S., Vol. XLI., pp. 615-616.
c. Growth and Variation in Maine. By Raymond Pearl and Frank M. Surface. Proc. Nat. Acad. Sci., Vol. I, pp. 222-226.
d. Dynamic Evolution. By Raymond Pearl. Journal of Heredity, Vol. VI, pp. 254-256.
e. Breeding for Sex. By Raymond Pearl. Hoard's Dairyman, Vol. L., p. 71.
f. The Publication of the Results of Investigations made in Experiment Stations in Technical Scientfic Journals. By Raymond Pearl. Science, N. S., Vol. XLII, pp. 518-522.
g. Further Data on the Measurement of Inbreeding. By Raymond Pearl. Maine Agricultural Experiment Station Bulletin 243, pp. 225-248.

ENTOMOLOGICAL PAPERS FROM THE MAINE AGRICULTURAL EXPERIMENT STATION, 1915.

Ent. 75. Pond-Lily Aphid as a Plum Pest. By Edith M. Patch. Science, Vol. XLII, No. 1074, p. 164, July 30, 1915.
Ent. 76. Two Clover Aphids. By Edith M. Patch. Journal of Agricultural Research, Vol. III, No. 5.
Ent. 78. Leafhoppers of Maine. By Herbert Osborn. Bul. 238. Me. Agr. Exp. Station.
Ent. 79. Woolly Aphid of Elm and Juneberry. By Edith M. Patch. Bul. 241. Me. Agr. Exp. Station.
Ent. 80. Boisteres rhagoletis Richmond, sp. n., a parasite of Rhagoletis pomonella, Walsh. By William C. Woods. Canadian Entomologist, Vol. XLVII, pp. 203-205.

Ent. 81. Pink and Green Aphid of Potato. By Edith M. Patch. Bul. 242. Me. Agr. Exp. Station.

Ent. 83. Blueberry Insects in Maine. By William C. Woods. Bul. 244. Me. Agr. Exp Station.

Changes in Members of Council.

In January, 1915, Mr. William T. Guptill, Topsham, was elected Commissioner of Agriculture in place of Mr. John A. Roberts of Norway.

At the annual meeting of the State Pomological Society in November, 1915, Wilson H. Conant, Buckfield, was elected as their representative on the Council in place of Mr. Howard L. Keyser of Greene.

Changes in Station Staff.

The Station counts itself as particularly fortunate in that it has been able to retain the services of the heads of the departments through so many years.

Mr. Bartlett has served the Station as Chemist continuously since 1885, Mr. Woods as Director since 1896, Miss Patch as Entomologist since 1904, Mr. Hanson as Associate Chemist since 1905, Mr. Morse as Plant Pathologist since 1907, Mr. Pearl as Biologist since 1908. Mr. Surface came to the Station as Associate Biologist in 1908. He was away with the Kentucky Experiment Station for two years but came back to this Station as biologist in 1913. It is only those who are familiar with the work of a Station that can appreciate the increased value that comes to a Station by having the continuous service of the heads of the departments. Such continuous service makes possible the carrying out of projects extending over long periods of time. While the Maine Station has an unusual staff in ability its marked success as a contributor to new facts underlying agricultural practice and as a high research institution is largely due to the continuity of effort possible only by the permanency of its staff.

April 1, Mr. Walter E. Curtis and Mr. C. Harold White were appointed Scientific Aids at the experiment farms.

June 1, Mr. Vernon Folsom resigned as Laboratory Assistant in Plant Pathology and Mr. Donald S. Clark was appointed in his stead.

July 1, Mr. John W. Gowen resigned as Assistant Biologist.

July 1, Mr. Hoyt D. Lucas resigned as Assistant Chemist and Mr. Walter H. Rogers was appointed in his stead.

Miss Janie L. Fayle, Stenographer, was absent on leave from August 1, and Miss Ella M. MacKenzie was employed in her stead.