******A THESIS.******

******Correlation of the Tree Characters of Apples******

Submitted by

Ray Gordon Voorhorst.

To the Michigan Agricultural College

as part requirement for the

Master of Science Degree.

****** June 1917.******

******A THESIS.******

*****Compilation of the Tree Characters of Willows******

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THESIS

******Foreword******

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INTRODUCTION.

The fruit characters of the apple have been much more extensively studied and more fully described than have the tree characters. Perhaps this has been so because the fruit is more accessible at all times. Especially was this the method practiced by the earlier pomologists. A few words sufficed to describe the tree and then a lengthy description of the fruit followed. But, at present, one sees a marked tendency to devote more time to a description of the tree characters. This is a forward step in the identification of varieties. The tree characters may constitute a part of the identity of the variety just as truly as do the fruit characters. However, it is commonly understood that the vegetative characters are more affected by environmental factors, than are the reproductive parts. The question then naturally arises, "Can the tree characters be depended upon in the identification of a variety?"

OBJECT OF THE PROBLEM.

The object of this investigation has been to determine: (1) Whether there is any correlation between similar characters of trees of the same variety; (2) Whether there is any correlation between similar characters of trees which have been supposed to be of the same pomological group; and, (3) Whether the correlations have been due to external factors rather than to internal factors. That is, "Is environment sufficiently strong to overcome heredity in the vegetative parts of the plant, or does heredity manifest itself?"

MATERIALS AND METHODS.

This investigation was conducted in the dwarf apple orchard of the Michigan Agricultural College, E. Lansing, Michigan. Some thirty-eight varieties of apples grow in this orchard. Originally each variety was represented by three trees, but through death and removal many varieties are represented now by one or two trees only. About two-thirds of the trees are on Paradise roots, the remainder are on Doucin roots. Material for this investigation came from both of these sources. In the data, Doucin will always be made of the source of the [illegible], whether it was Paradise or Doucin. The Paradise trees stand ten feet apart while the Doucin trees were planted fifteen feet apart.

The trees are approximately ten years old. A portion of them are thrifty; others, mention of which is to follow, are decidedly unthrifty. The soil is a heavy clay loam. The writer thinks that it is due to the condition of a part of this soil that some of the trees are in so unthrifty a condition. An irregular circular area some four or five rods in diameter, which forms the highest point in the orchard— although the whole orchard does not vary more than two feet in elevation — seems to be underlaid with an impervious subsoil. While the orchard has been almost continuously in sod, no considerable extent of sod grows at this point, the ground being sparsely covered with small weed growth, mostly dandelion at this time.

Of the material used in this investigation, the varieties, Winter Banana and Mother were almost certainly affected and perhaps the varieties Sutton and Jonathan were also affected by this poor soil area. Owing to the poor growth made on this area it was sometimes difficult for the writer to obtain from the tree even the small amount of material with which he worked.

The varieties selected were eleven in number, namely: Esopus Spitzenburg, Jonathan, Mother, and Red Canada representing the Jonathan Group; Fall Pippin, Maiden Blush, and Winter Banana representing the Fall Pippin Group; Fameuse and McIntosh representing the Fameuse Group; and, Hubbardston and Sutton * representing the King Group.

In addition to these eleven varieties representing four pomological groups the writer also studied some twenty other varieties for purposes of comparison and may include the data therefrom at times.

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*The writer is aware that in placing Sutton with Hubbardston he is not following the arrangement of groups given by Hedrick in Bulletin 275 N.Y. State Station, which has been his guide. But Beach, in the "Apples of New York," states that some believe Sutton to be a seedling of Hubbardston.

The material studied consisted: (1) in the new growth of shoots, the measurements being taken from a point on the southwest side of the tree and continuing around to the east until the desired number of twigs had been measured. In some cases this included practically all the twigs, the tree having but few more than twenty-five, the number of twigs used; and, (2) in the leaves. The limitations of time prevented the consideration of other characters.

The method followed in studying the new growth was as follows: Measurement was made of the distance from the last annual ring to the tip of the shoot. The measurement was made in inches with a yard-stick reading to the nearest half-inch. The inches were changed into their equivalents in millimeters before the computations were made. The diameter of the twig or shoot was measured at a distance of two inches above the last annual ring, the vernier calipers being used and measurements reading to the nearest tenth of a millimeter. This is the method Shaw followed in measuring diameters.

In measuring the leaf two methods were used. (1) The length and the greatest transverse diameter of the blade were measured. (2) The length of the blade and the length of the petiole were measured. In these measurements the millimeter scale was used.

The leaves were taken from a point near or just below the middle of the current season's growth, as suggested by Shaw.[1]

The methods used for the determination of the different constants are those used by the Farm Crops Department of the Michigan Agricultural College. The formulas for these procedures are:-

$$\text{Correction } (C) = \frac{\Sigma f\,(v - G)}{N}$$

$$\text{Mean } (M) = G \pm C$$

Standard Deviation (σ) $= \sqrt{\dfrac{\Sigma f\,(V - G)^2 - C\,\Sigma(V - G)}{N - 1}}$

Probable Error of Mean (E_M) = $\pm .6745 \dfrac{\sigma}{\sqrt{N}}$

Probable Error Of Standard Deviation (E_σ) = $\pm .6745 \dfrac{\sigma}{\sqrt{2N}}$

Coefficient of Correlation (r) = $\dfrac{\dfrac{\Sigma p}{N} - C_1 C_2}{\sigma_1 \sigma_2}$

Probable Error of Coefficient Of Correlation (E_r) =

$$\pm \frac{.6745\,(1 - r^2)}{\sqrt{N}}$$

The symbols used are those used by Bailey and Gilbert[2]. n = number, v = value, M = Mean, G = guess at mean, c = M—G, Σ = sum of, σ = standard deviation, f = frequency, E = probable error.

The calculations were all checked by another person than the one who made them.

PRESENTATION OF DATA.

Owing to a scarcity of material at the time the collection of data was made, the number of individuals in each case is extremely small,— too small, in fact, to admit of any degree of accuracy in results. Twenty-five shoots from each tree were used and the number of leaves from each variety ranges from sixteen to twenty-four.

The following characters were studied: length of new growths (shoots), diameter of new growth, length of leaf blade (not including tip), greatest transverse diameter of leaf blade, and length of petiole of leaf.

Before presenting the data on correlations it has been thought that it might make for clearness to present the tables which vary in the characters on them. It is to be hoped that the reader can get at the meaning of the tables without a presentation of a graphic chart. The trees of a single variety are first discussed. The size of a class was 50 millimeters.

Length of Branches.

Tompkins---One tree only was studied. The range in classes was from 700 to 8[illegible] millimeters. The constants for this character were as shown in Table 1.

Table 1. Showing Variations in Length of New Growth of Tompkins.

One unit = one millimeter.

	Tree No. 1.	Tree No.2.	Tree No.3.
Number	[illegible]5	------	-----
Mode	7[illegible]	------	-----
Mean	744	------	-----
P.E. of Mean	± 14.61244	------	------
Standard Deviation	108.[illegible]1	------	-----
P.E. of Stand. Dev.	± 10.[illegible]	------	-----
Coefficient of Var.	14.[illegible]	------	-----
P.E. of Coef. of Var.	±.[illegible]7	------	-----

Jonathan---Two trees were studied. The range in classes was 270 - 8[illegible] millimeters, and 300 - 800 millimeters in trees 1 and 3 respectively. The constants for this character were as shown in Table 2.

Table 2. Showing Variations in Length of New Growth of Jonathan.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	25	----	2[illegible]
Mode	550	----	5[illegible]
Mean	480	----	516
P.E. of mean	± 17.60604	----	± 17.[illegible]
Standard Deviation	130.51161	----	127.[illegible]

P.E. of Stand. Dev.	± [illegible]	------	± [illegible]
Coef. of Var.	37.1[illegible]	------	[illegible]
P.E. of Coef. of Var.	± 1.[illegible]	------	± 1.[illegible]

In this case an increase in the mean was accompanied by a decrease in the standard deviation and in the coefficient of variability.

Cotton--- Three trees were studied. The range in classes was: 170 – 570 mm., 300 – 750 mm., and 300 – 900 mm. in trees 1, 2, and 3 respectively. The constants for the character of length are shown in Table 6.

Table 6. Changes in Variations in Length of New Growth of Cotton.

The unit = one millimeter.

	Tree No. 1.	Tree No. 2.	Tree No. 3.
Number	[illegible]	[illegible]	[illegible]
Mode	[illegible]	[illegible]	[illegible]
Mean	[illegible]	[illegible]	[illegible]
P.E. of mean	± 7.[illegible]	± 14.[illegible]	± 16.1[illegible]
Stand. Dev.	57.3777	110.[illegible]7	1[illegible]
P.E. of Stand. Dev.	± 5.[illegible]	± 10.[illegible]	± 1[illegible]
Coef. of Var.	[illegible]	[illegible]	[illegible].7118
P.E. of Coef. of Var.	± 1.[illegible]	± 1.[illegible]	± 1.[illegible]71

We find here that the increase in mean of both of the other trees is accompanied by an increase in standard deviation in both these trees over the first tree. But when the other two trees are themselves compared we find that the standard deviation decreases with the increase of the mean. The tree making the greatest increase in the mean has the lowest coefficient of variability. The tree having the smallest mean is second in variability, and the tree ranking second in mean is highest in variability.

[illegible] ([illegible])--- Three trees were studied. The range in classes was: 300 – 1050 mm., 450 – [illegible] mm., [illegible] mm. in trees 1, 2, and 3 respectively. The constants for the character of length are shown in Table 4.

Table 4. [illegible] Variation in Length of the Culm of [illegible].

One unit = one millimeter.

	Tree No. 1.	Tree No. 2.	Tree No. 3.
Number	[illegible]	[illegible]	[illegible]
Mode	[illegible]	700	[illegible]
Mean	70[illegible]	71[illegible]	[illegible]
P.E. of Mean	± [illegible]	± [illegible]	± [illegible]
Standard Deviation	[illegible]	[illegible]	[illegible]
P.E. of Stand. Dev.	± [illegible]	± [illegible]	± [illegible]
Coeff. of Var.	[illegible]	[illegible]	[illegible]
P.E. of Coeff. of Var.	± [illegible]	± [illegible]	± [illegible]

The tree having the lowest mode and mean has also the lowest standard deviation and lowest coefficient of variability. The tree having [illegible] mode and mean is [illegible] standard deviation and [illegible] in coefficient of variability. The tree [illegible] in mode and mean is intermediate in standard deviation and coefficient of variability.

<u>[illegible]</u>--- Three trees were studied. The range in classes was [illegible] - 7[illegible] mm., [illegible] mm., and [illegible] mm. in trees 1, 2, and 3 respectively. The constants for the character of length are shown in Table 5.

Table 5. Showing Variation in Length of the Culm of [illegible].

One unit = one millimeter.

	Tree No. 1.	Tree No. 2.	Tree No. 3.
Number	[illegible]	[illegible]	[illegible]
Mode	[illegible]	[illegible]	[illegible]
Mean	[illegible]	[illegible]	[illegible]

P.E. of Mean	± [illegible]	± [illegible]	± [illegible]
Standard Deviation	[illegible]	[illegible]	[illegible]
P.E. of Stand. Dev.	± [illegible]	± [illegible]	± [illegible]
Coef. of Var.	[illegible]	[illegible]	[illegible]
P.E. of Coef. of Var.	± [illegible]	± 1.1062	± [illegible]

The tree lowest in mean is lowest in standard deviation and intermediate in variability. The second in mean is intermediate in standard deviation and lowest in variability. The tree highest in mean is highest in standard deviation and in coefficient of variability.

<u>Maiden Blush</u>(Foreign Stock)---Three trees were studied. The range in classes was: 450-750 m.m., 450-850mm., and 450 - 850mm. in trees 1,2, and 3 respectively. The constants for this character are shown in Table 3.

Table 3. Showing Variation in Length of New Growth of Maiden Blush.

The unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	[illegible]	[illegible]	[illegible]
Mode	800	700	750
Mean.	578	[illegible]	[illegible]
P.E. of Mean	± [illegible]	± [illegible]	± [illegible]
Standard Deviation	[illegible]	[illegible]	[illegible]
P.E. of Stand. Dev.	± [illegible]	± [illegible]	± [illegible]
Coef. of Var.	[illegible]	[illegible]	[illegible]
P.E. of Coef. of Var.	± [illegible]	± [illegible]	± [illegible]

The tree lowest in mean is lowest in standard deviation, and also lowest in coefficient of variability. The second in mean is highest in standard deviation and highest in variability. The tree highest in mean is intermediate in both standard deviation and in variability.

Winter Banana---Two trees were studied. The range of classes was: 151-470mm., and 100-[illegible]00mm. in trees 1 and 2 respectively. The constants for the character of length are shown in Table 7.

Table 7. Showing Variations in Length of New Growth of Winter Banana.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	[illegible]	27	--------
Mode	[illegible]	7[illegible]	--------
Mean	73[illegible]	[illegible]	--------
P.E.of mean	± [illegible]	± 17.[illegible]	--------
Standard Deviation	1[illegible].[illegible]7	1[illegible].[illegible]	--------
P.E.of Stand. Dev.	± .[illegible]	± .[illegible]	--------
Coef. of Var.	[illegible].[illegible]	1[illegible].[illegible]	--------
P.E.of Coef. of Var.	± 1.[illegible]	± 1.[illegible]	--------

The tree 1 most in mean is lowest in standard deviation and in coefficient of variability.

Fameuse ([illegible])----Three trees were studied. The range of classes was: [illegible]-800mm., [illegible]-1000mm., and [illegible]-[illegible]mm. in trees 1, 2, and 3 respectively. The constants for the character of length are shown in Table 8.

Table 8. Showing Variation in Length of New Growth of Fameuse.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	[illegible]	27	[illegible]
Mode	6[illegible]	[illegible]	6[illegible]
Mean	6[illegible]	[illegible]	[illegible]
P.E. of mean	± 1[illegible].[illegible]	± 1[illegible].[illegible]	± 17.[illegible]
Standard Dev.	11[illegible].[illegible]71[illegible]	11[illegible].[illegible]	1[illegible].[illegible]7

P.E. of Stand. Dev.	± [illegible]	± [illegible].7[illegible]	± [illegible]
Coef. of Var.	17.[illegible]	[illegible]	[illegible].7[illegible]
P.E. of Coef. of Var.	± 1.[illegible]	± [illegible]	± [illegible]

The tree lowest in mode and mean is intermediate in standard deviation and highest in coefficient of variability. The tree second in mean is lowest in both standard deviation and in the coefficient of variability. The tree highest in mean was also highest in standard deviation but intermediate in coefficient of variation.

<u>McIntosh.</u> (Foreign Stock)-----Three trees were studied. The range in classes was: [illegible]-1070 mm., [illegible]-970 mm., and [illegible]-970 mm. in trees 1, 2, and 3 respectively. The constants for the character of length are shown in Table 9.

Table 9. Showing Variation in Length of New Growth of McIntosh.

The unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	[illegible]	[illegible]	[illegible]
Mode	800	850	700
Mean	8[illegible]	[illegible]	[illegible]
P.E. of Mean	± [illegible]	± [illegible]	± [illegible]7
Stand. Dev.	1[illegible]	1[illegible]	[illegible]
P.E. of Stand. Dev.	± [illegible]	± [illegible]	± [illegible]
Coef. of Var.	[illegible]	[illegible]	[illegible]
P.E. of Coef. of Var.	± 1.[illegible]	± 1.[illegible]	± 1.77[illegible]

Here we find the tree lowest in mean to be lowest in standard deviation and intermediate in coefficient of variability. The tree second in mean was highest in both standard deviation and in coefficient of variability. The tree highest in mean was intermediate in standard deviation and lowest in coefficient of variability.

<u>Hubbardston.</u> Two trees were studied. The range in classes was: [illegible]-700 mm. and [illegible]-[illegible] mm. in trees 1 and 2 respectively. The constants for the character of length are shown in Table 10.

Table 10. Showing Variations in Length of New Growth of [illegible].

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	------	[illegible]	[illegible]
Mode	------	[illegible]	[illegible]
Mean	------	[illegible]	[illegible]
P.E. of Mean	-------	±17.[illegible]	±17.[illegible]
Stand. Dev.	------	[illegible]	[illegible]
P.E. of Stand. Dev.	------	±[illegible]	±[illegible]
Coef. of Var.	-------	[illegible]	[illegible]
P.E. of Coef. of Var.	------	± 1.[illegible]	± 1.[illegible]7

The tree lowest in mean was lowest in standard deviation and highest in coefficient of variability.

__Sutton.__ One tree was studied. The range in increase was: [illegible] mm. in this one tree. The constants for the character of length are found in Table 11.

Table 11. Showing Variations in Length of New Growth of Sutton,

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	----	----	[illegible]
Mode	----	----	[illegible]
Mean	----	----	[illegible]
P.E. of Mean	----	----	± [illegible]
Stand. Dev.	----	----	[illegible]
P.E. of Stand. Dev.	----	----	± [illegible]
Coef. of Var.	----	----	[illegible]
P.E. of Coef. of Var.	----	----	± [illegible]

One tree admits of no comparison. However we might say that the tree had a high mean and a low standard deviation, and a low coefficient of variability when compared with other varieties.

Diameter of New Growth.

As previously explained, the measurements for this character were taken at the end of the [illegible] above the last annual ring. The next seven tables will deal with this character. The size of a class was .5 millimeters.

<u>Esopus.</u> ---One tree only was studied. The range in classes was 4.[illegible] - 8.0 millimeters for this tree. The constants for the character of diameter are shown in Table 12.

Table 12. Showing Variation in Diameter of New Growth of Esopus.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	[illegible]	-----	----
Mode	5.5	-----	-----
Mean	6.1	-----	-----
P.E. of Mean	± .11700	-----	-----
Standard Deviation	.9[illegible]	-----	-----
P.E. of Stand. of Var.	± .1[illegible]	-----	-----
Coef. of Var.	15.516	-----	-----
P.E. of Coef. of Var.	± .08080	-----	-----

While the mean is rather high here the standard deviation is not great and the coefficient of variation is low.

<u>Jonathan.</u> Two trees were studied. The range in classes was: 3.0-6.0 mm. and 3.5-7.0 mm. in trees 1 and 3 respectively. The constants for the character of diameter are shown in Table 13.

Table 13. Showing Variations in Diameter of New Growth of Jonathan.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	25	-----	25
Mode	4.5	-----	5.0
Mean	4.6	------	4.9

P.E. of Mean	± .10117[illegible]	-----	±.11[illegible]
Stand. Dev.	.7[illegible]	-----	.8[illegible]
P.E. of Stand. Dev.	± .07[illegible]	-----	±.08171
Coef. of Var.	17.[illegible]71	-----	18.[illegible]
P.E. of Coef. of Var.	±1.17[illegible]	-----	±1.17[illegible]2

We see in this case, that, with an increase in the mode and mean, we likewise have an increase in the standard deviation and in the coefficient of variability.

Mother. ----Three trees were studied. The range of classes was: [illegible] mm.,-[illegible] mm., 4.5-7.0 mm., and 4.5-[illegible].0 mm. in trees 1,2, and 3 respectively. The constants of the character of diameter are shown in Table 14.

Table 14. Showing Variations in Diameter of [illegible] Crown of Mother.

Class unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	[illegible]	[illegible]	[illegible]
Mode	4.0	5.5	5.5
Mean	4.[illegible]8	5.24	6.10
P.E. of Mean	± .07710[illegible]	± .06[illegible]8	± .180[illegible]
Stand. Dev.	.[illegible]710[illegible]	.88[illegible]	1.118[illegible]
P.E. of Stand. Dev.	± .0[illegible]45[illegible]	± .0[illegible]7	± .108[illegible]
Coef. of Var.	12.[illegible]710	13.8[illegible]	18.[illegible]
P.E. of Coef. of Var.	± .7[illegible]070	± .77[illegible]	± 1.1[illegible]010

Here we find as the mode and the mean increase, the standard deviation likewise increases. But there is a very slight decrease in the coefficient of variability of the tree intermediate in mean. It is somewhat lower than the tree having the lowest mean. The tree having the highest mean has also the highest standard deviation and the highest coefficient of variability.

[illegible] (Poorin Stock)---- Three trees were studied.

The range in classes was: 4.0-[illegible] mm., 7.0- 11.[illegible] mm., and [illegible] mm. in trees 1,2, and 3 respectively.

The constants for the character of diameter are shown in Table 17.

Table 17. Showing Variation in Diameter of New Growth of Red Canada.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	[illegible]	[illegible]	[illegible]
Mode	[illegible]-7.0	7.0	7.0
Mean	7.[illegible]	7.3	7.[illegible]
P.E. of Mean	± .1[illegible]7	± .[illegible]787	± .1[illegible]
Stand. Dev.	1.[illegible]7	1.7[illegible]	.[illegible]
P.E. of Stand. Dev.	± .10711	± .1880[illegible]	± .[illegible]8
Coef. of Var.	1[illegible].1810	23.1804	18.0[illegible]7
P.E. of Coef. of Var.	± 1.[illegible]804	± 1.[illegible]	± .8028[illegible]

The tree having the lowest mode and mean here ranks intermediate in standard deviation and in coefficient of variability. The tree which has the intermediate mean ranks lowest in standard deviation and in coefficient of variability, as well. The tree which has the highest standard deviation and highest mean also has the highest coefficient of variability.

Fall Pippin. -----Three trees were studied. The range in classes was:4.7-8.5 mm., 5.0- 10.5 mm.,and 5.0-10.0 mm. in trees 1,2, and 3 respectively. The constants for the character of diameter are shown in Table 18.

Table 18. Showing Variation in Diameter of New Growth of Fall Pippin.

One unit= one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	[illegible]	[illegible]	[illegible]
Mode	8.0	[illegible]	[illegible]
Mean	8.7[illegible]	8.[illegible]	8.74
P.E. of Mean	± .1[illegible]	± .1[illegible]	± .1[illegible]
Stand. Dev.	1.10135	1.[illegible]	1.40771
P.E. of Stand. Dev.	± .08845	± .11785	± .10[illegible]
Coef. of Var.	17.57[illegible]1	16.1[illegible]	[illegible]
P.E. of Coef. of Var.	± .67877	± 1.1[illegible]	± 1.0[illegible]

The tree lowest in mean is lowest in standard deviation, and in coefficient of variability. The tree intermediate in mean is highest in standard deviation and in coefficient of variability. The tree highest in mean is intermediate in standard deviation and in coefficient of variability.

Maiden Birch (T[illegible] Stock)--- Three trees were studied. The range in classes was: 3.5-6.0 mm., 4.0-8.5 mm., and 5.5-7.5 mm. in trees 1, 2, and 3 respectively. The constants for the character of diameter are shown in Table 17.

Table 17. Tree-to-tree Variation of Diameter of New Growth of Maiden Birch.

Class value = .5 millimeter.

	Tree No. 1.	Tree No. 2.	Tree No. 3.
Number	25	25	25
Mode	[illegible].0	5.0	[illegible].0
Mean	4.6[illegible]	5.28	5.74
P.E. of Mean	± .08161	± .11073	± .146[illegible]
Stand. Dev.	.60150	.84011	1.1[illegible]
P.E. of Stand. Dev.	± .05[illegible]	± .08[illegible]	± .10[illegible]
Coef. of Var.	13.00[illegible]	16.0207	19.[illegible]
P.E. of Coef. of Var.	± .[illegible]470	± 1.0047	± 1.2656[illegible]

We find here [illegible] agreement. An increase in mean is accompanied by an increase in standard deviation and in coefficient of variability.

Winter Banana--- Two trees were studied. The range in classes was: 4.5-[illegible].0 mm., and 4.0-7.0 mm. in trees 1 and 2 respectively. The constants for the character of diameter are shown in Table 18.

Table 18. Tree-to-tree Variation in Diameter of New Growth of Winter Banana.

Class value = .5 millimeter.

	Tree No. 1.	Tree No. 2.	Tree No. 3.
Number	[illegible]	25	----
Mode	7.	[illegible].0	----
Mean	6.24	[illegible].12	----

P.E. of Mean	± [illegible]	± [illegible]	-----
Stand. Dev.	[illegible]	[illegible]	-----
P.E. of Stand. Dev.	± [illegible]	± [illegible]	-----
Coef. of Var.	[illegible].3748	[illegible]	-----
P.E. of Coef. of Var.	± [illegible]	± [illegible]	-----

These two trees have almost identical means, standard deviations, and coefficients of variability. The standard deviations increase with the increase in mean and there is a slight decrease in the coefficient of variability with the increase in mean.

<u>Tamerse</u> (Pumpkin Stock)---- Three trees were studied. The range of classes was 4.5-7.0 mm., 4.0 - [illegible] mm., and 4.5- [illegible] mm. in trees 1, 2, and 3 respectively. The constants for the character of diameter are shown in Table 16.

Table 16. Showing Variations ~~to~~ in Diameter of New Growth of Tamerse.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No. 3.
Number	25	25	25
Mode	5.0	[illegible]	[illegible]
Mean	5.78	[illegible]	[illegible]
P.E. of Mean	± .08107	± .06408	± .14518
Stand. Dev.	.88191	.80702	1.06810
P.E. of Stand. Dev.	± .06704	± [illegible]	± .10474
Coef. of Var.	15.2546	13.7751	18.6377
P.E. of Coef. of Var.	± .75018	± [illegible]	± 1.20464

There is a lack of uniformity in this case. The tree ranking lowest in mean is intermediate in standard deviation and in coefficient of variability. The tree which is intermediate in mean is lowest in standard deviation and in coefficient of variability. The tree having the highest mean also has the highest standard deviation and the highest coefficient of variability.

McIntosh. ([illegible] Stock)----- Three trees were studied. The range in classes was: 4.5 - 11.0 mm., 4.0 - [illegible] mm., and 4.5 - 10.5 mm. in trees 1, 2, and 3 respectively. The constants of the character of diameter are shown in Table 20.

Table 20. Showing Variation of Diameter of New Growth of McIntosh.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	25	25	25
Mode	7.0	7.0	7.0
Mean	7.08	6.9	6.56
P.E. of Mean	± .2[illegible]06	± .1[illegible]75	± .13[illegible]
Stand. Dev.	1.89616	1.42887	1.4[illegible]772
P.E. of Stand Dev.	± .17915	± .13330	± .14[illegible]
Coef. of Var.	26.8020	20.7008	22.4075
P.E. of Coef. of Var.	±1.92044	± 1.38016	± 1.47[illegible]

In this case we find an increase in mean accompanied by an increase in standard deviation. But the tree having lowest in mean is intermediate in coefficient of variability. The tree having the highest mean has also the highest standard deviation and the highest coefficient of variability.

Hubbardston -----Two trees were studied. The range in classes was: 3.5 - 5.5 mm, and 3.5 - 7.5 mm. respectively in trees 2 and 3. The constants for the character studied are shown in Table 21.

Table 21. Showing Variation ~~of~~ in Diameter of New Growth of Hubbardston.

One unit = one millimeter.

	Tree No.1.	Tree No.2.	Tree No.3.
Number	-----	25	25
Mode	-----	4.5	5.0
Mean	-----	4.72	5.02
P.E. of Mean	-----	± .06278	± .1[illegible]
Stand. Dev.	------	.[illegible]	.[illegible]

P.E. of Stand. Dev.	----------	± .0[illegible]	± .0[illegible]
Coef. of Var.	----------	10.[illegible]	18.[illegible]
P.E. of Coef. of Var.	----------	± .[illegible]	± 1.[illegible]7

The results [illegible] for these two trees. An increase in mode and mean is accompanied by an increase in standard deviation and the coefficient of variability.

Sutton. -----One tree only was studied. The range in classes was: 4.0 - 9.0 mm for this tree. The constants for the character of diameter are shown in Table [illegible].

Table [illegible]. Showing Variation in Diameter of New Growth of Sutton.

One unit = one millimeter.

	Tree No. 1.	Tree No. 2.	Tree No. 3.
Number	----	----	15
Mode	----	----	6.0
Mean	----	----	6.[illegible]
P.E. of Mean	----	----	± .17083
Stand. Dev.	----	----	1.[illegible]
P.E. of Stand. Dev.	----	----	± .1[illegible]
Coef. of Var.	----	----	20.[illegible]
P.E. of Coef. of Var.	----	----	± 1.[illegible]7

All that can be said here is that this tree has a high mean, a high standard deviation and a high coefficient of variability.

Discussion of the Variation in Length and in Diameter of the New Growth of All of the Varieties.

In studying the mean, the standard deviation and the coefficient of variability we learn these facts: The general summation for length is, that [illegible] highest mean, we find five highest standard deviation, three intermediate and one that had the lowest standard deviation among the highest mean. Of the six trees having intermediate mean length [illegible] were lowest. Of the nine trees having the lowest mean length the first seven lowest in standard deviation, one intermediate, and one highest. Considering now the coefficient of variability we find: Of the nine trees highest in mean, three were also highest in coefficient of variability, two were intermediate and four were lowest. Of the six trees intermediate in mean length, four were the highest in the coefficient of variability and two were lowest. Of the nine trees having the lowest mean length, three were lowest, three were intermediate, and three were highest in coefficient of variability.

Now to consider the diameters, of the growths, we find these results: Of the nine trees having the highest mean, the first eight having the highest standard deviation and one intermediate in this character. Of the six trees having intermediate mean diameters, the first three intermediate, two lowest and one highest in standard deviation. Of the nine trees having lowest diameters, the first seven having the lowest, and two intermediate standard deviations. Then the coefficient of variation is the character studied in [illegible]. Of the nine trees having the highest mean, seven had the highest, one the intermediate and one the lowest coefficient of variation. Of the six trees intermediate in mean diameter, one was highest, one was intermediate, and three were lowest in coefficient of variation. Of the nine trees having the lowest mean diameter, four were lowest, four were intermediate and one was highest in coefficient of variation.

If we take the statement of Fincher[6], as quoted by Tower*, that, " The coefficient of variability is not of great importance to students in biology, he, (Fincher) being of the opinion that the coefficient of variability does not express the actual facts facts as accurately as does the standard deviation," and frame our conclusions thereby — we find, that in general, the tree highest in mean length of new growth and in mean diameter of new growth is also highest in standard deviation; and that the tree lowest in these characters is also lowest in standard deviation.

[illegible]

Having considered the variations in the length and in the diameter of the new shoots, we will now proceed to a study of the variations in the length and transverse diameter of the leaf blades and of the variations in the length of the petioles of the leaves. It was unfortunate that the leaves were taken collectively from all the trees of a variety instead of having taken data from each individual tree. Thus, as the material has been so gathered, it has been necessary to compare one variety with another, with no chance of comparing the individuals within the variety. It should be mentioned that these comparisons of the leaves of one tree of a variety with those of another tree, or trees, of the same variety, could not have been made for it would have been of assistance to us in our comparison of the trees included within a variety. As the matter stands the comparison of one individual tree with another of the same variety has been confined wholly to a study of the characters of length and diameter of the new growth of shoots. Comparisons will be made, however, between the leaves of one variety and those of other varieties. Our first study will be a comparison of the length of the leaf blades and the transverse (widest) diameter of the leaf blades. Later, we will study the variations in blade length and petiole length.

In the study of blade length and transverse diameter of the blade, the size of the class is five millimeters. The mid-classes are multiples of five (5). Leaf, or blade, length and diameter can be studied most advantageously in the same table, thus economizing space. The table which follows shows the variations in length and transverse diameter of leaf.

[illegible].

Sixteen individuals were studied. The range of the classes for length was: 30-70 millimeters; for diameter, 40-[illegible] millimeters. The constants for these characters are shown in Table [illegible].

Table [illegible]. Showing Variations in Length and in Transverse Diameter of the Leaf Blade of [illegible].

The unit = one millimeter.

	Length	Diameter.
Number	16	16
Mode	60	45

	Length	Diameter.
Mean	61.[illegible]	[illegible]
P.E. of Mean	± .[illegible]	± .7[illegible]
Standard Deviation	4.[illegible]7	[illegible]
P.E. of Stand. Dev.	± .[illegible]	± .[illegible]
Coef. of Var.	[illegible]	[illegible]
P.E. of Coef. of Var.	----	-----

JONATHAN.

Twenty-one individuals were studied. The range of classes was: for length, 43 – 75 mm, for diameter, [illegible] – [illegible] millimeters. The constants for these characters are shown in Table 24.

Table 24. Showing Variations in Length and in Transverse Diameter of the Leaf Blade of Jonathan.

One unit = one millimeter.

	Length	Diameter.
Number	[illegible]	[illegible]
Mode	[illegible]	[illegible]
Mean	61.[illegible]	[illegible]
P.E. of Mean	± .[illegible]	± .7[illegible]
Stand. Dev.	[illegible]	[illegible]
P. E. of Stand. Dev.	± .[illegible]	± .[illegible]
Coef. of Var.	[illegible]	11.7[illegible]
P.E. of Coef. of Var.	------	-------

[illegible].

Seventeen individuals were studied. The range of classes was: for length, [illegible]–[illegible] millimeters; for diameter, [illegible]–[illegible] millimeters. The constants for these characters are shown in Table 25.

Table 25. Showing Variations in Length and in Transverse Diameter of the Leaf Blade of [illegible].

One unit = one millimeter.

	Length	Diameter.
Number	17	17
Mode	73	[illegible]
Mean	73.[illegible]	17.[illegible]
P.E. of Mean	± .[illegible]	± .[illegible]
Stand. Dev.	[illegible]	[illegible].007
P.E. of Stand. Dev.	± .[illegible]	± .[illegible]
Coef. of Var.	7.014	[illegible].7[illegible]
P.E. of Coef. of Var.	------	--------

PEI CHWAN [illegible]

Twenty-two individuals were studied. The range of variation was: for length, 50-70 millimeters; for diameter, [illegible] - [illegible] millimeters. The constants for these characters are given in Table 26.

Table 26. Showing Variations in Length and in Transverse Diameter of the Leaf Plate of Pei Chwan.

The unit = one millimeter.

	Length	Diameter
Number	22	[illegible]
Mode	65	[illegible]
Mean	61.[illegible]	[illegible]
P.E. of Mean	± .11[illegible]	± .[illegible]
Stand. Dev.	[illegible].007	[illegible]
P.E. of Stand. Dev.	± .[illegible]	± .[illegible]
Coef. of Var.	[illegible].7[illegible]	1[illegible].[illegible]7[illegible]
P.E. of Coef. of Var.	------	------

Tali Ping-in-Chow[illegible].
TAN [illegible].

Thirty-three individuals were studied. The range of variation was; for length, 70-100 millimeters; for diameter, [illegible] mm. The constants for these characters are given in Table 27.

Table 27. Showing Variations in Length and in Transverse Diameter of the Leaf Plate of Tali [illegible].

The unit = one millimeter.

	Length.	Diameter.
Number	[illegible]	[illegible]
Mode	[illegible]	[illegible]
Mean	[illegible]	[illegible]
P.E. of Mean	± [illegible]	± [illegible]
Stand. Dev.	[illegible]	[illegible]
P.E. of Stand. Dev.	± [illegible]	± .7[illegible]
Coef. of Var.	[illegible]	[illegible]
P.E. of Coef. of Var.	-----	-----

MAIDEN PLUSH. ([illegible])

[illegible] individuals were measured. The range of the classes was: for length, [illegible] millimeters; for diameter, [illegible]. The constants for these characters are shown in Table 28.

Class unit = one millimeter.

Table 28. Showing Variations in the Length and Transverse Diameter of the Leaf Tissue of Maiden Plush.

	Length	Diameter
Number	[illegible]	[illegible]
Mode	[illegible]	[illegible]
Mean	[illegible]	77.127
P.E. of Mean	± [illegible]	± [illegible]
Stand. Dev.	[illegible]	[illegible]
P.E. of Stand. Dev.	± [illegible]	± [illegible]
Coef. of Var.	[illegible]	[illegible]
P.E. of Coef. of Var.	-----	-----

[illegible]

[illegible] individuals were measured. The range of the classes was: for length, [illegible] millimeters; for diameter, [illegible]-7 millimeters. The constants for these characters are shown in Table [illegible].

Table [illegible]. Showing Variations in the Length and the Transverse Diameter of the Leaf Tissue of [illegible].

Class unit = one millimeter.

	Length	Diameter.
Number	[illegible]	18
Mode	[illegible]	[illegible]
Mean	73.[illegible]	[illegible]7.[illegible]
P.E. of Mean	± 1.[illegible]	± 1.0[illegible]
Stand. Dev.	7.[illegible]	[illegible]
P.E. of Stand. Dev.	± .[illegible]	± .[illegible]
Coef. of Var.	[illegible]	[illegible]
P.E. of Coef. of Var.	----	----

[illegible] Group.

[illegible]. ([illegible]) ——Twenty-four individuals were studied. The range in classes was: for length, [illegible] - [illegible] millimeters; for diameter, [illegible] - [illegible] millimeters. The constants for these characters are shown in Table 50.

Table 50. The [illegible] Variations in the Length and in the Transverse Diameter of the [illegible] of [illegible].

Class [illegible] = [illegible] millimeter.

	Length	Diameter.
Number	[illegible]	[illegible]
Mode	7[illegible] & [illegible]	[illegible]
Mean	7[illegible].[illegible]	[illegible]
P.E. of Mean	±1.[illegible]	± .[illegible]
Stand. Dev.	[illegible]	[illegible]
P.E. of Stand. Dev.	± .77[illegible]	± .[illegible]
Coef. of Var.	[illegible]	[illegible]
P.E. of Coef. of Var.	------	------

[illegible].

Thirty-[illegible] individuals were studied. The range in classes was: for length, [illegible]-80 millimeters; for diameter, [illegible]-[illegible] mm. The constants for [illegible] are shown in Table 51.

Table 51. The [illegible] Variations in the Length and in the Transverse Diameter of the [illegible] of [illegible].

Class [illegible] = [illegible] millimeters.

	Length.	Diameter.
Number	[illegible]	[illegible]
Mode	70, 80, 85.	[illegible], [illegible]0.
Mean	[illegible]	[illegible]
P.E. of Mean	± 1.[illegible]	± .[illegible]1
Stand. Dev.	[illegible]	[illegible]
P.E. of Stand. Dev.	± .[illegible]	± [illegible]
Coef. of Var.	1[illegible]	[illegible]
P.E. of Coef. of Var.	-----	------

Wine Group.

HUBBARDSTON.----Thirty-two individuals were studied. The range in classes was: for length, [illegible] - [illegible]0 millimeters; for diameter, 40-70 millimeters. The constants for the characters are shown in Table 32.

Table 32. Showing Variations in the Length and Transverse Diameter of the Leaf Blade of Hubbardston.

One unit = one millimeter.

	Length	Diameter.
Number	22	22
Mode	80	50 and 5[illegible]
Mean	72.955	5[illegible].[illegible]06
P.E. of Mean	± 1.146	± 1.0[illegible]1
Stand. Dev.	7.967	7.102
P.E. of Stand Dev.	± .7[illegible]	± .761
Coef. of Var.	13.[illegible]40	11.[illegible]05
P.E. of Coef. of Var.	=====	=====

SUTTON.---Sixteen individuals were studied. The range in classes was: for length, 60 - 85 millimeters; for diameter, 45 - 65 mm. The constants for these characters are shown in Table 33.

Table 33. Showing Variation in the Length and in the Transverse Diameter of the Leaf Blade of Sutton.

One unit = one millimeter.

	Length	Diameter
Number	16	16
Mode	7[illegible] [illegible]	[illegible]
Mean	7[illegible].5	54.032
P.E. of Mean	± 1.506	± 1.076
Stand. Dev.	7.746	6.[illegible]
P.E. of Stand. Dev.	± .[illegible]	± .761
Coef. of Var.	10.[illegible]	11.[illegible]
P.E. of Coef. of Var.	-------- -	--------

Discussion of the Variation in the Length and in the Diameter of the Leaf Blade.

Owing to the fact that the leaves were gathered promiscuously from all the trees representing the variety, no comparison of the above mentioned characters between trees of the same variety could be made. Our efforts will therefore be confined to a discussion of the variation found in trees representing a pomological group.

In the Jonathan Group we study Esopus, Jonathan, Mother, and Red Canada.--The last named having grown on Doucin Stock whereas the others grew on Paradise Stock, might be thought to differ in its leaf characters from the others. A study of the tables however, fails to verify this belief. For purposes of comparison we have concluded it best to compare the various constants, one at a time. For the length character we learn these facts: The modes for the varieties Esopus, Jonathan, Red

Canada, and Mother representing the Jonathan Group, are; 6[illegible] mm. 60mm., 6[illegible] mm., and 7[illegible] mm. respectively. Attention is called to the fact that the three first are near together in mode while the last shows a much higher mode. The means for length of leaves in these trees in the order named are: 5[illegible].3125 mm., 61.0 mm., 61.50 mm., and 73.75 mm. respectively. Of course we would expect the means to resemble, somewhat, the modes and they do.

For the standard deviation for length we find these results: For the trees in the order named; 4.6885 mm., 6.822 mm., 5.067 mm., and 5.286 mm. respectively. The standard deviation for the last named variety, namely; Mother, is low when its mean length is considered. When the coefficient of variability is considered, we find these results: 8.3728, 11.035, 8.782, and 7.084 respectively. We find the leaves of the variety "Mother" to be the least variable.

In conclusion we may say that in the constants for the length character of the leaf blade, the varieties Esopus, Jonathan and Red Canada stand close together while Mother is quite alone in these characters.

In considering the same constants for diameter in the varieties of this same group, we find results as follows: Mode; 4[illegible] mm., 4[illegible] mm., 60 mm., and 5[illegible] mm. respectively for Esopus, Jonathan, Red Canada, and Mother.
Red Canada in this case, shows a greater divergence from the

first two than does Mother. Of course, we expect the means to be quite similar. The means were [illegible] mm., [illegible] mm., [illegible].373 mm., and 37.552 mm. respectively. Red Canada again joins its group and Mother moves further away. The standard deviations were: 4.6135 mm., 5.527 mm., 6.311 mm., and 5.007 mm. respectively. Red Canada shows the greatest deviation and Esopus the least for this character. But the coefficient of variability may tell another story.

The coefficients of variability were: 10.2478, 11.715, 12.373, and 8.783 respectively. This is as we expected. Esopus, Jonathan, and Red Canada are more variable than Mother. A characteristic of Mother has been to consistently hold to a low coefficient of variability. Esopus, Jonathan, and Red Canada show a close resemblance to each other while Mother, while placed in this group, has never shown so close a resemblance. Especially do Esopus and Jonathan resemble each other. Red Canada, being on Doucin roots, may be altered somewhat.

A discussion of the Fall Pippin Group.

Of this group, Maiden Blush was on Doucin roots, while Winter Banana was probably modified somewhat by its poor habitat. As in the preceeding case, the constants for the length and for the diameter will be taken up in order, for Fall Pippin, Maiden Blush, and Winter Banana.

But when we consider that one of the trees showed a variability in branches similar to this variability in leaf diameter we may yet find an explanation for this behavior.

The coefficients of variability are: 11.877, 9.012, and 14.443 respectively. Maiden Blush consistently holds a low place in all the constants. Fall Pippin is rather consistent, but the radical departure in standard deviation of diameter has raised its coefficient of variability considerably.

Discussion of the Fameuse Group, represented by Fameuse and McIntosh. The modes for length were: (75 and 80) mm., and (50-60-65 mm.). The means for length were: 75.728 mm. and 59.100 mm. The standard deviations were: 8.0[illegible]5 mm. and 9.[illegible] mm. Fameuse with greater length mean has a lower standard deviation consequently McIntosh has a larger coefficient of variability, that for Fameuse being 10.644 and for McIntosh 15.6[illegible].

The constants for diameter of leaf blade in this group were: Modes [illegible] and (45 and 50); Means, [illegible].147 and 4[illegible] mm. standard deviations; [illegible] and [illegible] mm. The coefficients of variability were 11.[illegible] and 13.611.

The constants for length in these two varieties are widely separated, but the constants for diameter more nearly resemble one another.

Discussion of the Vine Group, represented by [illegible] and Sutton. The constants for length of blade were: Modes 80 and (77 and 80) mm., Means 72.[illegible] mm. and 72.[illegible] mm. coefficient of variability, 10.[illegible] and 11.[illegible] and for standard deviations; 7.[illegible]87 mm. and 7746 mm. respectively.

The constants for diameter of blade were: Modes (75 and 80) and 77 mm. respectively. Means were [illegible].363 mm. and [illegible].082 mm. Standard deviations, 7.[illegible] mm. and 6.[illegible] mm. the coefficients of variability being 11.[illegible] and 11.[illegible]. We take this opportunity to call attention to the very close resemblance in both length and diameter characters of the leaf as found in these two varieties. We are firmly of the belief that these two varieties belong to the same pomological group. Later (in the discussion of blade and petiole lengths) we shall find this assumption strengthened by the results shown there.

[illegible]

[illegible]

[illegible]

[illegible] millimeters; [illegible] length, [illegible]. [illegible]. The [illegible]

Jonathan Creek.

[illegible]

[illegible] measurements was: [illegible] , [illegible] , [illegible] length, 11. - [illegible] millimeters. The constants [illegible] these [illegible] Table 8.

Table 8.-- [illegible]

[illegible]

[illegible] = [illegible].

	Blade	Petiole
Number	18	18
Range	[illegible]	[illegible]
Mean	[illegible].17	[illegible]
P.E. of Mean	± [illegible]	± [illegible]
Stand. Dev.	[illegible]	1.7[illegible]
P.E. of Stand. Dev.	± [illegible]	± .[illegible]
Coeff. of Var.	7.[illegible]	[illegible]
P.E. of Coeff. of Var.	[illegible]	[illegible]

[illegible] The [illegible] was: [illegible] of blade, [illegible]7-7[illegible] millimeters; [illegible] length, 11. - [illegible] millimeters. The constants [illegible] in Table 9.

Table [illegible]. Showing Variation [illegible] Blade and [illegible] of [illegible] of Jonathan.

Class unit = [illegible].

	Blade	Petiole
Number	[illegible]	1[illegible]
Mode	[illegible]	[illegible].[illegible]
Mean	[illegible]	[illegible]
P. E. of Mean	± .[illegible]	± .[illegible]
Stand. Dev.	[illegible]	[illegible]
P. E. of Stand. Dev.	± .[illegible]	± .[illegible]
Coef. of Var.	[illegible]	1[illegible]
P. E. of Coef. of Var.	-----	-----

[illegible].

The range [illegible] classes was: for length of blade, [illegible], for petiole length, 11.[illegible] – [illegible] millimeters. The constants for these characters are shown in Table [illegible].

Table [illegible]. Showing Variations in Length of Blade and Length of Petiole of [illegible].

Class unit = [illegible] millimeter.

	Blade	Petiole
Number	[illegible]	[illegible]
Mode	[illegible]	[illegible]
Mean	7[illegible].7[illegible]	[illegible].
P. E. of Mean	± .[illegible]	± .[illegible]7
Stand. Dev.	[illegible]	[illegible]
P. E. of Stand. Dev.	± .[illegible]	± .[illegible]
Coef. of Var.	[illegible]	[illegible]
P. E. of Coef. of Var.	-----	-----

[illegible] --- The range in classes was: for length of blade, [illegible]7-7[illegible] millimeters; for length of petiole, [illegible] millimeters. The constants for these characters are shown in Table [illegible]7.

Table 37. [illegible] Variations in [illegible] Blade and [illegible] of [illegible] Tetaud.

[illegible] = one [illegible].

	Blade	Petiole
Number	13	13
Mode	8[illegible]	1[illegible].[illegible]
Mean	8[illegible].7[illegible]	[illegible]
P.E. of mean	± .[illegible]	± .[illegible]
Stand. Dev.	[illegible].[illegible]74	1.77[illegible]
P.E. of Stand. Dev.	± .4[illegible]3	± .[illegible]11
Coef. of Var.	6.00[illegible]	[illegible].741
P.E. of Coef. of Var.	-----	-----

Fall Pippin Group.

FALL PIPPIN. The range in classes was: for length of blade, [illegible] - [illegible] millimeters; for petiole length, [illegible]0.7 - 24.8 millimeters. The constants for these characters are shown in Table 38.

Table 38. [illegible] Variations in Length of Blade and in Length of Petiole of Fall Pippin.

[illegible] = one millimeter.

	Blade	Petiole
Number	13	13
Mode	81	[illegible].5
Mean	[illegible].875	[illegible]
P.E. of mean	± 1.[illegible]	± .[illegible]
Stand. Dev.	[illegible]	1.[illegible]
P.E. of Stand. Dev.	± 1.[illegible]	± .1[illegible]
Coef. of Var.	10.[illegible]	8.7[illegible]
P.E. of Coef. of Var.	-----	-----

MAIDEN BLUSH. ([illegible])

The range in classes was: for length of blade, [illegible] mm. for petiole length, 10.[illegible] millimeters. The constants for these characters are shown in Table 39.

Table [illegible]. Showing Variations in [illegible] of [illegible] and in Length of [illegible] of [illegible] Finch.

[illegible] = one [illegible].

	[illegible]	[illegible]
Number	18	[illegible]8
Mode	[illegible]	[illegible]
Mean	71.[illegible]	[illegible]
P.E. of Mean	±1.0[illegible]	± .1[illegible]1
Stand. Dev.	6.0[illegible]	.9[illegible]7
P.E. of Stand. Dev.	± .721	± .[illegible]
Coef. of Var.	8.411	[illegible].017
P.E. of Coef. of Var.	-----	-----

[illegible]---- The [illegible] in classes was: for length of [illegible], [illegible] millimeters; for [illegible] length, [illegible] mm. The constants for these characters are found in Table [illegible].

Table [illegible]. Showing Variations in the Length of [illegible] and in the Length of [illegible] of [illegible].

[illegible] = one millimeter.

	[illegible]	[illegible]
Number	18	18
Mode	7[illegible] and [illegible]	[illegible] and [illegible]
Mean	77.06[illegible]	[illegible].073
P.E. of Mean	±1.[illegible]	± .[illegible]
Stand. Dev.	8.1[illegible]	[illegible].30[illegible]
P.E. of Stand. Dev.	± .7[illegible]	± .[illegible]8
Coef. of Var.	8.0[illegible]8	1[illegible].1[illegible]
P.E. of Coef. of Var.	-----	-----

[illegible] GROUP.

[illegible].([illegible]) The range in classes was: for length of [illegible], 6[illegible]-[illegible] millimeters; for [illegible] length, 1[illegible].[illegible]- [illegible] mm. The constants for these characters are shown in Table [illegible].

Table [illegible]. Showing Variations in Length of [illegible] and in [illegible] Length of [illegible].

[illegible] = [illegible].

	Flank	Petiole
Number	16	16
Mode	61-70-7[illegible]	[illegible]
Mean	73.1[illegible]	[illegible]
P.E. of Mean	± 1.[illegible]7	± .[illegible]
Stand. Dev.	[illegible]	[illegible]
P.E. of Stand. Dev.	± 1.[illegible]	± .[illegible]8
Coef. of Var.	11.[illegible]	1[illegible]
P.E. of Coef. of Var.	-----	-----

McINTOSH (Spucin Stock)

The range in classes was: for length of flank, [illegible] millimeters; for petiole length, [illegible] millimeters. The constants for this character are shown in Table 42.

Table 42. Showing Variations in Length of Flank and in Length of Petiole of McINTOSH.

One unit = one millimeter.

	Flank	Petiole
Number	16	16
Mode	77	24.5
Mean	83.375	[illegible].175
P.E. of Mean	±1.[illegible]1	± .[illegible]40
Stand. Dev.	8.700	[illegible]
P.E. of Stand. Dev.	±1.137	± .[illegible]4
Coef. of Var.	10.[illegible]70	11.160
P.E. of Coef. of Var.	----	-----

Wing Group/,.

<u>HUTCHINSON</u>. The range in classes was: for length of flank, 70-87 millimeters; for length of petiole, [illegible] mm. The constants for these characters are shown in Table 43.

Table 43. Showing Variations in Length of Flank and in Length of Petiole of H[illegible].

One unit = one millimeter.

[illegible].

In the [illegible] County, the petioles have [illegible] and [illegible] for [illegible] and McIntosh, respectively. [illegible].

The [illegible] County [illegible] of [illegible] and [illegible], respectively. [illegible] we would say.

In conclusion, it seems that there is a fair degree of correlation in these characters of the apple leaf. A [illegible] to be [illegible] in this paper will, we believe however, more accurately determine the degree of correlation in all characters, both branches and leaves.

-----Correlation of the new growth and leaf characters-------

In order to be able to tell how closely one character is associated with another it is very necessary that we resort to the use of correlation tables. We will now proceed to this study, taking up in order, the characters of length and diameter of the new growth ; length and diameter of the leaf blades; and leaf blade and petiole lengths.

We will now take up the new growth correlations. Without further mention the leaf blade characters and petiole characters will follow in order at the conclusion of this part.

[illegible]. Tree No.1.

V	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	f
150														
200														
250														
300														
350														
400														
450														
500					1									1
550														
600				1		1			1					3
650						2								2
700					2	2	1							5
750							2	1	1					4
800					1	1			1					3
850							1	1	2	1				5
900											1			1
950										1				1
				1	4	6	4	2	5	2	1			25

FIG. 1.----Correlation [illegible] length and diameter of [illegible] Tree No.1. [illegible] subject, diameter rela-tive; r = .[illegible] ± .0757.

[illegible]----- For the characters [illegible] a fair correlation. [illegible] tables showing variation in length and in diameter [illegible] this tree to be the lowest (14.8) of all the trees in the coefficient of variability for the length character, while the coefficient of variability for diameter ~~is~~ (15.8) is near the average for all the trees. See Tables I and II.

JONATHAN. Tree No.1.

V	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	f
150														
200														
250	1													1
300		1												1
350	1	2	1											4
400		2	2											4
450		1	1											2
500			2	1	1									4
550					4									4
600				2										2
650				1										1
700					1									1
750														
800							1							1
850														
900														
950														
	2	6	6	4	6		1							25

FIG. 2.---- Correlation between length and diameter of new growth of Jonathan, Tree No.1. Length subject, diameter relative, r =.8077 ± .0462

<u>Length and diameter of new growth</u>---- This is a very good correlation. From the tables of variation we find that this tree has a high coefficient of variability for length (27.2) and above the average coefficient of variability for diameter (17.[illegible]) See Tables 1 and 10.

JONATHAN Tree No.2.

V														f
150														
200														
250														
300		1												1
350		2												2
400			1	1										2
450			5	1										6
500				1	3									4
550				1	4									5
600						2								2
650														
700														
750					1									1
800								1	1					2
850														
900														
950														
		3	6	4	8	2		1	1					25

FIG.3.---- Correlation between length and diameter of new growth of Jonathan, Tree No.2. Length subject, diameter relative; r= .1700 ± .0[illegible]

Length and diameter of new growth---- This coefficient of correlation is exceeded by only one other in all the studies of the characters of the tree. From the variation tables we find here, too, that the coefficient of variability for length ([illegible].1) is [illegible] for that character and the coefficient of variability for diameter ([illegible]) is also one of the highest. See Tables [illegible].

[illegible] TREE NO.1.

V	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	f
150		2	2											4
200		1	1		3									5
250			2	3	2									7
300				2	2	1								5
350					1									1
400														
450														
500														
550														
600														
650														
700														
750														
800														
850														
900														
950														
		3	8	5	8	1								25

FIG. 4. ---Correlation between length and diameter of new growth of Jonathan, Tree No.1. Length subject, diameter relative; r = [illegible] ±.0500

Length and diameter of new growth.— [illegible] have, [illegible], one of the poorest conditions so that was found [illegible] in the study of the length and diameter characters of new growth. Although the mean length of new growth was far below the average for the variety, being less than one half the figure for each of the other two trees, yet its coefficient of variability was high (34.0). The mean diameter for the new growth of this tree was much less than that for the other two trees, but the coefficient of variability was low. See Tables 6 and 11.

[illegible] Tree No.2.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	F
150														
200														
250														
300					1									1
350														
400				2		1								3
450						4								4
500					1	1	1							3
550						2	3							5
600						2	2							4
650							1	1	1					3
700														
750									2					2
800														
850														
900														
950														
				2	2	10	7	1	3					25

FIG. 8.----Correlation between length and diameter of new growth of [illegible], Tree No.2. Length subject, diameter relative; r = .7028 ± .0[illegible]

Length and diameter of new growth.---- The correlation here is a little below the average for these characters. We find that the tree has a good coefficient of variability for length (30.6) but that it is low in the coefficient of variability for diameter (13.7) Since length is variable and diameter is more constant we would expect a lower correlation. See Tables 8 and 14.

V	3.[illegible]	[illegible]	4.[illegible]	4.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.[illegible]	7.[illegible]	[illegible]	[illegible]	[illegible]	f
150														
200														
250														
300					1									1
350				1		1								2
400					1	3								4
450					1		2							3
500					1	1	1							3
550						3	1							4
600								1						1
650									1					1
700									1	1	1			3
750										2				2
800													1	1
850														
900														
950														
				1	4	8	4	1	2	3	1		1	25

FIG. 6. Correlation between length and diameter of new growth of Nether, Tree No.3. Length subject, diameter relative; r = .9570 ± .0[illegible]

<u>Length and diameter of new growth</u>.-----This, again, is a very good correlation being among the highest obtained. Our variation tables show us that this tree made practically as good growth in length as the tree of the same variety making the best growth, [illegible] millimeters compared to [illegible] millimeters; that the coefficient of variability for length was very high (23.7) and that the new growth diameter was the greatest of the three trees, (4.42, 5.24, and 6.1[illegible] mm. respectively). The coefficient of variability of diameter was high, being 18.[illegible]%.

See Tables [illegible] and 14.

TSU. CANADA. Tree No.1.

V	4.6	4.7	5.6	5.7	6.6	6.7	7.6	7.7	8.6	8.7	9.6	9.7	10.6	10.7	11.6	11.5	f
450																	
500	1	1															2
550		1															1
600			1														1
650		1	2														3
700		1		1													2
750			1			1											2
800				1	1	2											4
850			1		1		1										3
900							1										1
950						1											1
1000								1									1
1050									1								1
1100																	
1150																	
1200																	
	1	4	5	2	2	4	2	1	1								22

FIG. 7.---- Correlation between the length and diameter of new growth of Tsu. Canada, Tree No.1. Length subject, diameter relative; r = .8807 ± .0307.

Length and diameter of new growth.----Here we have a good correlation. The mean length of new growth in this tree was 738 millimeters, the greatest for any of the three trees, the others being 712 and 674 millimeters respectively. But the variability was not as great as it was for another tree, (Tree No.2.); being (16.6) for this tree and (2?.?) for Tree No.2. The mean diameter of new growth was the least in this tree and its coefficient of variability was not as great as for tree No.2. (See Tables 4 and 10.)

[illegible] Tree No.2.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
450				1	1													2
500					1													1
550							[illegible]	1										4
600						1												1
650								1	1									[illegible]
700									1	2	1	1						5
750						1		2										[illegible]
800									1	2								[illegible]
850																		
900																		
950												1						1
1000																		
1050																1		1
1100																	1	1
1150																		
1200																	1	1
				1	2	3	2	[illegible]	[illegible]	4	[illegible]	2				1	3	[illegible]

FIG. 5.--[illegible] Tree No.2. [illegible]

r = .3708 ± .0010.

Length and diameter of new growth.--This tree represents the best combination of all the trees, in the new growth characters. It is not the tree that has the highest mean length growth, falling [illegible] of Tree No.1. in this respect. But the coefficient of variability for length was far above any of the others of the variety, and was among the highest of any of the varieties studied, being [illegible]. The tree had the greatest diameter of new growth for the variety and the coefficient of variability for diameter of new growth was [illegible], the highest for the variety. See Tables [illegible] and [illegible].

[illegible] Tree No. [illegible].

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
450																	
500			1			1											2
550					2	1											3
600						2	1										3
650						2	2	2									6
700							1	2									3
750									2	1							3
800							1										1
850							1	1			1						3
900											1						1
950																	
1000																	
1050																	
1100																	
1150																	
1200																	
			1		2	6	6	5	2	1	2						25

FIG.6.--- [illegible] length and diameter of new growth of [illegible], Tree No. [illegible]. Length subject, diameter relative; r = .7316 ± .0[illegible]7.

[illegible]---The [illegible] is the lowest [illegible] of the variety. The mean for length ([illegible] mm) is the lowest [illegible] three trees. The coefficient of variability for length ([illegible]) is also the lowest. The mean for diameter (7.15) is intermediate, but the coefficient of variability for the diameter is also the lowest of the [illegible] of the variety. [illegible] Tables 4 and 13.

[illegible] Tree No.1.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
350															
400			1		[illegible]	1	1								5
450				1		[illegible]									[illegible]
500						3	2								[illegible]
550					1	1	1								3
600									3	1					[illegible]
650								1	1	1					[illegible]
700									1						1
750											1				1
800															
850															
900															
950															
			1	1	3	7	4	1	5	2	1				25

FIG. 10.--- Correlation between length and diameter of new growth of Fall Pippin, Tree No.1. Length subject, diameter relative; r = .[illegible] ± .0474.

Length and diameter of new growth.---The correlation expressed above is very good, altho' it is the lowest for the three trees of the variety, Fall Pippin. An inspection of Table 16 shows that the new growth has the least mean length and likewise the least mean diameter; that the coefficient of variability for length (19.1) is intermediate and the coefficient of variability for diameter is considerably lower than that for the other two trees, these being 18.1% and [illegible]% respectively. See Tables 5 and 16.

TALL TRIUMPH. Tree No.2.

V	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	f
350																
400																
450				1	1											2
500					2	2	2									6
550					1	1										2
600						1	1		1							3
650						1		1	1	1						4
700							1	1	1	1	1					5
750									1	1						2
800																
850															1	1
				1	4	5	4	2	4	3	1				1	25

FIG.11.---Correlation between length and diameter of new growth of Tall Triumph, Tree No.2. For length subject, diameter relative; r = .8107 ± .0480

Length and diameter of new growth.--- This tree is intermediate in its coefficient of ~~ef~~ correlation, the coefficient being very good. The mean length (6.6cm.) is the same as for the tree highest in coefficient of correlation within the variety. The coefficient of variability for length (17.5) is the lowest of any tree within the variety. The mean diameter (620) is the highest but the coefficient of variability (16.1) for this character is only intermediate in value.

See Tables 9 and 16.

[illegible]. Tree No.3.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
350	1													1
400			1											1
450					1									1
500					1		1							[illegible]
550				1	2		1							4
600				2	2	3								7
650						1	1							[illegible]
700								1	1					2
750								1					1	[illegible]
800									1		1			[illegible]
850													1	1
900														
950														
	1	0	1	3	6	4	[illegible]	2	2	0	1	0	2	25

FIG. 13.---[illegible] length and diameter of new growth of [illegible], Tree No.3. Length subject, diameter relative; r = .[illegible]67 ± .0[illegible].

Length and diameter of new growth.---- The correlation coefficient here is the [illegible] for the variety and is a very good correlation [illegible] with any variety. The mean length (610 mm.) is the same as that for tree No.2, but the coefficient (26.2) for this character is the [illegible] in the [illegible], as is the coefficient of variability for diameter (20.9) the mean diameter being 6.7± [illegible] which is a little lower than that for tree No.2.

See Table [illegible] and Fig. 13.

[illegible] TREE No.1.

V	[illegible]	4.	4.5	[illegible]	[illegible]	[illegible]	[illegible]	7.[illegible]	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
350	1															1
400																
450		1	1													2
500		2	1	3												6
550		1														1
600			3	4	1											8
650				1	1											2
700					1	3										4
750					1											1
800																
850																
900																
950																
	1	4	5	8	4	3										25

FIG.16---Correlation between length and diameter of one year growth of [illegible], Tree No.1. Length subject, diameter relative; r = .7776 ± .0[illegible].

Length and diameter of one year growth.---The correlation we have here is fair but is the lowest within the variety. The mean length (575mm.) is intermediate but near the lowest length (572 mm.) and it is lowest in coefficient of variability (16.[illegible]) for this character when comparison, with the other trees of the variety, is made. The mean diameter (4.[illegible]mm.) is the lowest for the variety as is also the coefficient of variability (1[illegible].[illegible]) for this character. See Tables 6 and 17.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
[illegible]																
400																
450		2	1													[illegible]
500			1	1												2
550		1	1	1												3
600			2		1											[illegible]
650				2												2
700				1	2	1										4
750					1	1	1									3
800						2										2
850						1	1	1								[illegible]
900																
950																
		3	5	5	4	5	2	1								25

FIG. 1[illegible].----Correlation [illegible] new growth of [illegible] Flush. Tree No.2. [illegible], [illegible]; r = .[illegible]4 ± .0[illegible].

[illegible] and [illegible]----The above correlation is [illegible] for the variety. The mean length (3[illegible] mm.) and the mean diameter (5.[illegible] mm.) are also intermediate for the variety. The coefficient of variability for the length character is 26.8, the highest for the variety, the others being 18.8 and 1[illegible] respectively. The coefficient of variability for diameter is 16 which is intermediate as regards the other two.

See Tables 6 and 17.

[illegible], Tree No.3.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
350										
400										
450	1	1	1							3
500										
550			1	2	1					4
600				3						3
650				1						1
700					1				1	2
750					1	2	[illegible]	1		6
800						1	2		1	4
850								1	1	2
	1	1	2	6	3	3	[illegible]	2	3	[illegible]5

FIG. 1[illegible]. [illegible] growth of [illegible], Tree No.3. [illegible] subject, [illegible] relative; r = .[illegible]7[illegible] ± .0[illegible].

[illegible]---The above correlation [illegible] variety. [illegible], [illegible] length (3[illegible] mm.), the [illegible] (3.74 mm.), and the coefficient of [illegible] (20.3) are the highest [illegible] variety; the coefficient of [illegible] length was 16, the highest coefficient having [illegible] No.7. [illegible] Tables 6 and 17.

[illegible], [illegible] No. 1.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	F
350											
400											
450		1									1
500	1	1	1								3
550	1										1
600	1	1	1								[illegible]
650			[illegible]								[illegible]
700			1								[illegible]
750											
800			1	[illegible]	1						[illegible]
850				1						1	[illegible]
900					1				1		[illegible]
950						1	1	1		[illegible]	[illegible]
	5	5	7	5	[illegible]	1	1	1	[illegible]	[illegible]	25

FIG. 13. [illegible] length and diameter of [illegible] growth of [illegible] Tarara Tree No. 1. Length subject, diameter relative; r = .77[illegible] ± .0[illegible].

[illegible] ------ This tree shows a very [illegible] of [illegible] above the average for the eleven varieties. Compared with the other tree of the variety [illegible] Tarara, we find that it has a higher mean length (7[illegible] mm. against 67[illegible] mm. for Tree No. 2.) a [illegible] diameter (6.[illegible] mm. against 6.1[illegible] mm.) a higher coefficient of variability for length ([illegible] against 13.7) and the same coefficient of variability for diameter, namely; 13.[illegible]7 and [illegible].

[illegible] Table 7 [illegible].

[illegible], Tree No.2.

V	[illegible]	4.	[illegible]	[illegible]	[illegible]	[illegible]	5.	7.	7.	[illegible]	8.	[illegible]	[illegible]	[illegible]	100	f
350																
400		1														1
450			1													1
500																
550			1	2												[illegible]
600				3			1									[illegible]
650				1	1			1								[illegible]
700				1	3	1	2					1				7
750							1									1
800							1	1			1					3
850									1	1						2
900										1						1
950																
		1	2	3	3	1	7	[illegible]	1	2	1	1				25

FIG. 17.----Correlation [illegible] length and diameter of new growth of [illegible], Tree No.2. Length [illegible], diameter [illegible]; r = .[illegible] ± .[illegible].

Length and diameter of new growth----- We see that this is only a fair correlation where these characters of the tree are concerned. Discussion of the characters under Tree No.1. for this variety will suffice largely for explanation here. It might be added that the greater difference between the coefficients of variation for length and diameter respectively, in Tree No.2. as compared with Tree No.1 will account for the lower correlation. See Tables 7 and 12.

Fameuse([illegible]) Tree No.1.

V	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	f
300																
350																
400		1														1
450		1														1
500																
550			2													2
600			3	1												4
650			3		3											6
700			1	1	2		1									5
750					1											1
800					3											3
850					1											1
900							1									1
950																
1000																
		2	9	2	10		2									25

FIG. 18.----Correlation between length and diameter of new growth of Fameuse, Tree No.1. Length subject, diameter relative; r =.7[illegible]87 ± .[illegible]13.

Length and diameter of new growth-----A fairly good correlation is found in this case. One tree of the Fameuse variety falls much lower in correlation coefficient, while the third tree is considerably higher. The mean for length is intermediate, being 666 mm. as against 635 mm. and 61[illegible] mm. for the other two trees. The mean diameter is likewise intermediate being 5.56 mm. as against 5.06 mm. and 5.82 mm. The coefficients of variability for each character are found to be the lowest found in the three trees. They are 17.3 for length and 12.[illegible] for diameter. See Tables 8 and 19.

FAMEUSE (Doucin Stock) Tree No.2.

V	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	f
300			1													1
350		1	1													2
400	1	1														2
450		2	1													3
500	1		1													2
550	1	2	1	1		1										6
600				3												3
650			1	2												3
700				1		1										2
750																
800					1											1
900																
950																
1000																
	3	6	6	7	1	2										25

FIG. 19. Correlation between length and diameter of new growth of Fameuse, Tree No.2. Length subject, diameter relative; r = .5701 $\pm$ .0611.

Length and diameter of new growth---This is the poorest correlation we have found in our study of new growth characters. Mean length and mean diameter (536 mm and 5.06 mm. respectively) are each far below the same means in the two other trees, these being 666 mm. and 688 mm. for length; and 5.56 mm. and 5.82 mm. for diameter. The coefficient of variability is highest for length and very low in diameter. This makes a poor correlation. See Tables 8 and 19.

FAMEUSE.(Doucin Stock) Tree No.3.

V	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	f
300																
350																
400																
450			1													1
500																
550		1	2													3
600		2	3	2	1											8
650					1											1
700		1														1
750				1	2	2										5
800							1									1
850						1	2									3
900									1							1
950										1						1
1000																
		4	6	3	4	3	3	0	1	1						25

FIG. 20.----Correlation between length and diameter of new growth of Fameuse, Tree No.3. Length subject, diameter relative; r = .8209 ± .0450.

<u>Length and diameter of new growth</u>---- Here again we have a very good correlation in these characters. Inspection of the tables show us that the new growth of this tree is highest in mean length and in mean diameter. The coefficients of variability for mean length (15.8) and for mean diameter (18.0) are seen to be nearly equal. We are surprised that the correlation is not greater than it is, such being the case.

See Tables 8 and 16.

McINTOSH (Tolman Stock) Tree No.1.

V	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	f
300																
350		1	1													2
400			1													1
450			1													1
500																
550		1		1	1		1									4
600				1	1											2
650							1									1
700							1	2								3
750						1										1
800					1		1	1		2						5
850									1							1
900													1			1
950															1	1
1000																
1050													1	1		2
		2	3	2	3	1	4	3	1	2			2	1	1	25

FIG. 21.---Correlation between length and diameter of new growth of McIntosh. Tree No.1. Length subject, diameter relative; r = .8700 ± .0033.

Length and diameter of new growth---In this case we find one of our highest correlations again. The mean length is practically as high as for the tree highest in this respect being [illegible] mm. against [illegible] mm. In mean diameter (7.03 mm. against [illegible] mm. and [illegible] mm.); in coefficient of variability for length ([illegible] against [illegible] and [illegible]) as well as in coefficient of variability for diameter ([illegible] against [illegible] and [illegible]) we find it to be first in order. (See Tables [illegible] and [illegible].)

McINTOSH ([illegible] Stock) Tree No. 2.

V	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
300																
350	1															1
400					1											1
450	1		1													2
500																
550																
600							2	1								3
650			1			2	1		1							5
700				1	1											2
750						1			1							2
800							1	1			1					3
850							1		1	1	1					4
900																
950										2						2
1000																
1050																
	2	0	2	1	[illegible]	[illegible]	[illegible]	2	3	[illegible]	2					25

FIG. 22.---Correlation between length and diameter of new growth of McIntosh, Tree No. 2. Length subject, diameter relative; r = .[illegible] ± .[illegible].

Length and diameter of new growth.--- The above is only a fair correlation for the new growth characters of length and diameter. In this case it is difficult to ascribe a cause for this "falling off" in correlation. The mean length and mean diameter are practically the same as for the previous tree which was so high in correlation. But we find our explanation in the coefficients of variability which, while not far apart, are both low, indicating less variability in the tree as compared to the other trees. In Tables [illegible] and [illegible]

V	4.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.0	f
300																
350		1														1
400		1	2													3
450		1														1
500			2	1												3
550			1	1	1		1									4
600																
650				1		1	1	1								4
700					1		3	1								5
750							1									1
800								1								1
850																
900																
950									1						1		2
1000																
1050																
		3	5	3	2	1	6	3	1					1		25

FIG. 23. ---Correlation between length and diameter of new growth of McIntosh, Tree No.3. Length subject, diameter relative; r = .[illegible]70 ± .0[illegible]8.

<u>Length and diameter of new growth</u>---- We find here a close agreement with Tree No.1 of this variety. The correlation coefficient for No.1 was .8500 ± .0[illegible]75 as compared to .[illegible]70 ± .0[illegible]. The mean lengths and mean diameters ([illegible] mm. against 610 mm., and 7.[illegible] mm. against 6.[illegible] mm.) for these characters, will be found to be a close proportion. Again the coefficients of variability for length and for diameter are in close proportion. e.g. 21.[illegible] : [illegible].6 :: [illegible].1 : 22.5.

See Tables C and [illegible].

V	0.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.5	[illegible]	[illegible]	[illegible]	f
300	1	2											3
350		2											2
400													
450			2										2
500		1		2									3
550			4										4
600			1	2	2								5
650			1		2								3
700					3								3
750													
850													
	1	5	8	4	7								25

FIG. 21. [illegible] growth of [illegible], Tree No.1. [illegible]; r = [illegible] ± [illegible]

[illegible] ---- A [illegible] correlation [illegible] the least [illegible] correlation. This [illegible] growth has [illegible] of correlation. [illegible] That is, [illegible] a [illegible] correlation. [illegible] Tables 15 [illegible].

TRANSCENDENT, TREE NO.2.

V	35	40	45	50	55	60	65	70	75	80	85	90	f
300													
350	1		1										2
400		1	1	1									3
450		1		1									2
500			5	2									7
550													
600			1	1									2
650				5	2		1						8
700						1							1
750													
800								1	1				2
	1	2	[illegible]	[illegible]	3	1	1	1	1				25

FIG. 55.——Correlation of shoot length and diameter of new growth of Transcendent Tree No.2. Length subject, diameter relative; r = .70[illegible] ± .0[illegible].

Identification [illegible].—— The coefficient of correlation differs but little from that of the other Transcendent tree; one being .6[illegible] ± .0[illegible] and the other .70[illegible] ± .0[illegible]. This second tree is lower in every constant with the exception of coefficient of variability for diameter, where it is somewhat greater. The two trees are practically identical, however. See Tables [illegible] and 21.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
300													
350													
400			1										1
450													
500		1				1							2
550			1	1	2								4
600					3	1	1						5
650						2	1						3
700								1	2	1		1	5
750						1		1	1		1		4
800									1				1
		1	2	1	5	5	2	2	4	1	1	1	25

FIG. 53.--- Correlation between length and diameter of new growth of Cotton, Tree No.3. Length subject, diameter relative; r = .7[illegible] ± .0377.

Length and diameter of new growth of Cotton.--- This is but a fair correlation when considering these characters in these trees. It is difficult to make any conclusions [illegible] [illegible] would be, [illegible] [illegible] were [illegible], that the low correlation is due to the low coefficient of variability for length. Such a condition usually produces such an effect. See Tables 11 and 12.

[illegible].

V	30	35	40	45	50	55	60	65	f
45									
50			1						1
55			3						3
60			1	4	2				7
65				2	2				4
70						1			1
75									
80									
85									
			5	6	4	1			16

FIG. 27--- [illegible] of the leaves of [illegible]. [illegible]; r = .[illegible]7 ± .0[illegible]1.

[illegible]ves.--- [illegible] [illegible], [illegible] [illegible] of [illegible] [illegible]. [illegible] have [illegible] [illegible] this [illegible]. [illegible] twenty-five [illegible] that, [illegible], [illegible] be [illegible] on the [illegible] coefficient, [illegible] five to twenty times its probable error. But it is [illegible] knowledge, that below twenty-five [illegible] [illegible] coefficient [illegible] [illegible] [illegible] probable [illegible] [illegible] have a value of [illegible] five [illegible] its probable error. [illegible] [illegible] that [illegible] [illegible]. In this [illegible] [illegible]. [illegible] Table [illegible].

[illegible].

V	[illegible]					f
45	1					1
50		1				1
55		1	1			2
60		1	7			8
65			3	3		6
70			1		2	[illegible]
75				1		1
80						
85						
	1	3	12	4	2	[illegible]

FIG. [illegible].---- [illegible] of Jonathan, [illegible]; r = .7[illegible]8 ± .07[illegible].

[illegible].---- The [illegible] Jonathan [illegible]. The [illegible]; [illegible] of [illegible] 61.[illegible] mm. [illegible] 47. [illegible]. The standard deviations are high, being 6.8[illegible] [illegible] and [illegible] for [illegible]. But the [illegible] of [illegible] are fairly high, consequently [illegible] coefficients of variability, [illegible] for length [illegible] 11.6[illegible] and [illegible] 11.71[illegible]. This [illegible] a correlation [illegible] has [illegible] correlation. [illegible] Table [illegible].

[illegible].

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33	f
[illegible]									
50									
55									
60					1				1
65									
70					1	3	1		5
75						3	4	2	9
80								1	1
85					1				1
					3	6	5	3	17

FIG. [illegible]---[illegible] leaves of [illegible], [illegible];

r = .[illegible] ± .[illegible].

[illegible]---The coefficient of correlation [illegible] is much lower than [illegible] little dependence can be put upon the results here shown. Attention is called to the fact that we have here only seventeen individuals. However this variety has been "erratic" in the behavior of all the characters studied. [illegible] our previous assumption, that, where we find low coefficient of variability we invariably find a low coefficient of correlation, is again sustained.

The coefficient of variability for length is 7.664 and for diameter it is 8.7318; also the coefficient for length is lower than that for diameter, which condition usually indicates a low coefficient of correlation. See Table 27.

[illegible].

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
4[illegible]									
[illegible]0					1				1
[illegible]				1	[illegible]	1			[illegible]
6[illegible]					1		[illegible]		[illegible]
65					1	1	4	2	[illegible]
7[illegible]								[illegible]	[illegible]
7[illegible]									
8[illegible]									
85									
				1	6	[illegible]	8	[illegible]	16

FIG. [illegible].--- Correlation between length and diameter of the leaves of [illegible] Canada. Length subject, diameter relative; r = .7278 ± .0876.

Length and diameter of leaves--- This is a fair degree of correlation for the leaf characters. The diameter ([illegible].2727 mm.) has a greater standard deviation ([illegible].3167 millimeters) than has the length (61.[illegible] millimeters) whose deviation is only 5.64[illegible] mm. Such being the case, the coefficient of variability for length is comparatively low(9.166) as against the higher coefficient (12.072) for diameter and, as usual, we find a reduced coefficient of correlation. See Table 26.

Table [illegible].

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
60										
65										
70	1	1	[illegible]							4
75			[illegible]	1						[illegible]
80			[illegible]	2	1					[illegible]
85				2	3					[illegible]
90						4				[illegible]
95									1	1
100					1					1
	1	1	6	5	6	4			1	[illegible]

FIG. [illegible].---The [illegible] between [illegible] and [illegible] of leaves of Tall Pippin. [illegible] subject, [illegible] relative; r = .8011 ± .0463.

[illegible]---Tall Pippin shows here, as it did in the [illegible] characters, a very [illegible] correlation for the above characters. The standard deviations for these characters are high [illegible], too, and the coefficients of variability being [illegible] and 11.877 for length and diameter respectively, the two coefficients of variability being high and close together [illegible] a good correlation.

[illegible] Table 27.

V	45	50	55	60	65	[illegible]	95	f
60		2						2
65		2	1	2				5
70			1	1	1			3
75			1	1	1			3
80				3				3
85								
90								
95								
100								
		4	3	7	2			16

FIG. 21.— [illegible] of leaves of [illegible]. Length subject, diameter relative; r = .5780 ± .1[illegible].

[illegible] ----The [illegible] in this [illegible] might be [illegible]. The standard deviations (3.[illegible] mm. and [illegible] mm.) are proportional to the mean length (70 mm.) and mean diameter ([illegible].157 mm.) but the coefficients of variability, while close together, are low being 5.7[illegible] for length and 5.012 for diameter. The results bear us out in our deduction that low coefficients of variability give us a low coefficient of correlation. See Table [illegible].

V	45	50	55	60	65	70	75	80	85	f
60	1									1
65		1								1
70	1		1	1						3
75		3		1						4
80			2	2			1			3
85				1	2	1				4
90										
95										
100										
	2	4	3	5	2	1	1			16

FIG. 56.---Correlation between length and diameter of leaves of Winter Banana. Length subject, diameter relative; r = .8206 ± .0570.

<u>Length and diameter of leaves</u>.--- In this variety the correlation is fairly good. The relation between the mean for length (73.235 mm.) and its standard deviation (7.0064 mm.) has [illegible] deviation (8.2344) giving it a coefficient of variability of 11.44 as against 9.571 for length. The great difference in these two coefficients is reflected in the correlation coefficient. See Table 26.

V	4[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
45									
50									
55									
60									
65		2							2
70		1	6	3					10
75			3	1					4
80			1	2	1				4
85				1	2				3
90									
95									
100								1	1
		3	10	7	3			1	24

FIG. 24.---Correlation between length and diameter of leaves of F[illegible]. Length subject, diameter relative; r = .[illegible] ± .0448.

Length and diameter of leaves.--- [illegible] show a very good correlation in these characters. The standard deviations for length and for diameter are proportional to the means for these characters. The coefficients of variability are high and close together; 10.8[illegible] for length and 11.[illegible] for diameter. This gives us a good correlation. The number of individuals used (24) being greater than in some other cases may have affected the result. See Table [illegible].

V	40	45	50	55	60	65	70	75	80	f
45	1	1								2
50	2	3								5
55		2	1							3
60		1	4							5
65			2	3						5
70										
75				1		1				2
80					1					1
85										
90										
95										
100										
	3	7	7	4	1	1				23

FIG. 37. ----Correlation between length and diameter of leaves of McIntosh. Length subject, diameter relative; $r = .8751 \pm .0378$.

Length and diameter of leaves.---- We find a higher coefficient of correlation for the leaf characters, than that shown before. The standard deviations are in about the same ratio to each other as are the means of length and diameter which they represent, the deviation for length being proportionally a little the higher. Each, however, is high and the coefficients of variability are as a consequence high, length being 13.05 and diameter being 12.0. Highest variabilities have given highest coefficient of correlation. See Table 31.

V	40	4[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70	f
55		1						1
60	1							1
65		2	1					3
70			3	2				5
75			2	2	1			6
80				2	3	1		6
85								
90							1	1
	1	3	6	6	4	1	1	22

FIG. [illegible].---- Correlation between length and diameter of leaves of [illegible]. Length subject, diameter relative; r = .[illegible] ± .0[illegible]7.

Length and diameter of leaves.---- These figures show [illegible] another very high correlation. The mean length has [illegible] deviation but the diameter [illegible] the variable giving the greater standard deviation for the [illegible]. The coefficients of variability are 1[illegible] for length and 1[illegible]4 for diameter. A greater number of individuals being used here, [illegible] to give us a better correlation. See Table [illegible].

V	40	45	50	55	60	65	70	f
55								
60		2						2
65		1	1					2
70			1	3				4
75			1	2	1			4
80				1	1			2
85						2		1
		3	3	6	2	2		16

FIG. 37.—Correlation between length and diameter of leaves of Cotton. Length subject, diameter relative; r = .[illegible]73 ± .[illegible].

Length and diameter of leaves.---- In this case we have a small number of individuals (16) but find a very good correlation of the characters studied. The standard deviations are small and are proportional to the length and mean diameter. The coefficients of variability stand close together being 10.68 for length and 11.8 for diameter. We now call attention to the close resemblance in every respect, of Cotton and Wild Cotton when both characters are considered. See Tables [illegible] and [illegible].

[illegible].

v	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
[illegible]									
50			1						1
[illegible]			3						3
[illegible]			1	4	2				7
65				2	2				4
70						1			1
75									
80									
[illegible]									
			5	6	4	1			16

FIG. 27--- [illegible] of the Leaves of [illegible]. [illegible], [illegible]; r = .[illegible]7 ± .0[illegible]1.

[illegible] ---- [illegible]

[illegible] have a [illegible]

[illegible]

[illegible].

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
45	1								1
50			1						1
55			1	1					2
60			1	7					8
65				3	3				6
70				1		2			[illegible]
75					1				1
80									
85									
	1		5	12	4	2			[illegible]

FIG. [illegible].---- [illegible] Jonathan, [illegible]; r = .7[illegible]8 ± .07[illegible].

[illegible] The [illegible] is a [illegible]. [illegible], Jonathan [illegible]. The [illegible]; [illegible] of [illegible] 71.[illegible] [illegible]. The [illegible] high, [illegible] 6.[illegible]. [illegible], [illegible] are [illegible] high, consequently [illegible] of [illegible], [illegible] 11.[illegible] 11.71[illegible]. This [illegible] correlation [illegible] has [illegible] consideration. [illegible] Table [illegible].

NUTMEG.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35	f
45									
50									
55									
60					1				1
65									
70					1	3	1		5
75						3	4	2	9
80								1	1
85					1				1
					3	6	5	3	17

FIG. 26.---[illegible] leaves of Mother, Length subject, diameter relative; r = .[illegible] ± .[illegible].

[illegible]---The coefficient of correlation [illegible] is so low here that the table is probably of very little significance [illegible] results here shown. Attention is called to the fact that we have here only seventeen individuals. However this variety has been "erratic" in the behavior of all the characters studied. Our previous assumption, that, where we find low coefficient of variability we invariably find a low coefficient of correlation, is again sustained.

The coefficient of variability for length is 7.004 and for diameter it is 3.7218; but the coefficient for length is lower than that for diameter, which condition usually indicates a low coefficient of correlation. See Table 27.

[illegible]

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
45									
50					1				1
55				1	[illegible]	1			[illegible]
60					1		[illegible]		[illegible]
65					1	1	4	[illegible]	9
70								[illegible]	[illegible]
75									
80									
85									
				1	6	[illegible]	8	5	16

FIG. 30.--- Correlation between length and diameter of the leaves of Red Canada. Length subject, diameter relative; r = .7278 ± .0676.

Length and diameter of leaves--- This is a fair degree of correlation for the leaf characters. The diameter (52.2727 mm.) has a greater standard deviation (6.3167 millimeters) than has the length (61.5009 millimeters) whose deviation is only 5.6455 mm. Such being the case, the coefficient of variability for length is comparatively low (9.166) as against the higher coefficient (12.072) for diameter and, as usual, we find a reduced coefficient of correlation. See Table 26.

T[illegible] [illegible].

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
60									
65									
70	1	1	[illegible]						4
75			[illegible]	1					[illegible]
80			[illegible]	2	1				[illegible]
85				2	5				[illegible]
90						4			[illegible]
95								1	1
100					1				1
	1	1	3	5	8	4		1	[illegible]3

FIG. [illegible].---[illegible] length and diameter of leaves of Tall Pippin. [illegible], [illegible] relative; r = .8[illegible] ± .0[illegible].

[illegible]---Tall Pippin shows here, as it did in the [illegible] characters, a very [illegible] correlation in the above characters. The standard deviations for these characters are high [illegible], too, and the coefficients of variability being 16.1[illegible] and 11.877 for length and diameter respectively, the two coefficients of variability being high and close together [illegible] a good correlation.

[illegible] Table 27.

V	45	50	55	60	65	70	75	80	85	f
60		2								2
65		2	1	2						5
70			1	1	1					3
75			1	1	1					3
80				3						3
85										
90										
95										
100										
		4	3	7	2					16

FIG. 3[illegible].-- [illegible] length and diameter of leaves of [illegible] Flush. Length subject, diameter relative; r = .77[illegible] ± .1[illegible].

Length and diameter of leaves.----The correlation in this case might be called fair but it is quite low. The standard deviations (6.[illegible] mm. and [illegible] mm.) are proportional to the mean length (70 mm.) and mean diameter (57.137 mm.) but the coefficients of variability, while close together, are low being 8.770 for length and 8.012 for diameter. The results bear us out in our assertion that low coefficients of variability give us a low coefficient of correlation. See Table 33.

V	47	50	5[illegible]	6[illegible]	6[illegible]	7[illegible]	7[illegible]	80	85	f
60	1									1
65		1								1
70	1		1	1						3
75		3		1						4
80			2	2			1			5
85				1	[illegible]	1				4
90										
95										
100										
	2	4	3	5	[illegible]	1	1			16

FIG. 33.—Correlation between length and diameter of leaves of Winter Banana. Length subject, diameter relative; r = .3803 ± .0350.

<u>Length and diameter of leaves</u>.— In this variety the correlation is fairly good. The relation between the mean for length (75.000 mm.) and its standard deviation (7.0364 mm.) has for mean and deviation (8.0846) giving it a coefficient of variability of 14.44 as against 9.371 for length. The great difference in these two coefficients is reflected in the correlation coefficient. See Table 26.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
45						
50						
55						
60						
65	2					2
70	1	6	3			10
75		[illegible]	1			4
80		1	2	1		4
85			1	2		3
90						
95						
100					1	1
	3	10	7	3	1	24

FIG. 24.---Correlation between length and diameter of leaves of [illegible]. Length subject, diameter relative, r = .8017 ± .0448.

Length and diameter of leaves.--- [illegible] very good correlation in these [illegible]. The standard deviations for length and for diameter are proportional to the means for these characters. The coefficients of variability are high and close together; 10.8[illegible] for length and 11.[illegible] for diameter. This gives us a good correlation. The number of individuals used (24) being greater than in some other cases may have affected the result. See Table 30.

V	40	45	50	55	60	65	70	75	80	f
45	1	1								2
50	2	3								5
55		2	1							3
60		1	4							5
65			2	3						5
70										
75				1		1				2
80					1					1
85										
90										
95										
100										
	3	7	7	4	1	1				23

FIG. 37. ----Correlation between length and diameter of leaves of McIntosh. Length subject, diameter relative; $r = .8751 \pm .0378$.

Length and diameter of leaves.--- We find no higher coefficients of correlation for the leaf characters, than that shown here. The standard deviations are in about the same ratio to each other as are the means of length and diameter which they represent, the deviation for length being proportionally a little the higher. Each, however, is high and the coefficients of variability are as a consequence high, length being 16.[illegible] and diameter being 15.[illegible]. Highest variabilities here give highest coefficient of correlation. See Table 51.

V	40	45	50	55	60	65	70	f
55		1						1
60	1							1
65		2	1					3
70			3	2				5
75			3	2	1			6
80				2	3	1		6
85								
90							1	1
	1	3	6	6	4	1	1	22

FIG. 36.--- Correlation between length and diameter of leaves of Hubbardston. Length subject, diameter relative; $r = .8[illegible] \pm .0[illegible]7$.

Length and diameter of leaves.--- These figures show another very good correlation. The mean length has a small deviation but the diameters are more variable giving us a greater standard deviation for the diameter. The coefficients of variability are 10.[illegible] for length and 15.24 for diameter. A greater number of individuals being used here, again seems to give us a better correlation. See Table 32.

V	40	45	50	55	60	65	70	f
55								
60		2						2
65		1	1					2
70			1	3				4
75			1	2	1			4
80				1	1			2
85						2		1
		3	3	6	2	2		16

FIG. 37.---Correlation between length and diameter of leaves of Dutton. Length subject, diameter relative; r = .8873 ± .0[illegible].

<u>Length and diameter of leaves</u>---- In this case we have a small number of individuals (16) but find a very good correlation of the characters studied. The standard deviations are small and are proportional to the length and mean diameter. The coefficients of variability stand close together being 10.88 for length and 11.8 for diameter. We now call attention to the close resemblance in every respect, of Dutton and Wellington when 10 characters are considered. (See Tables 33 and 34.)

[illegible]

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
[illegible]										
[illegible]										
70		1	1	[illegible]						4
75				[illegible]	1					[illegible]
80				[illegible]	2	1				[illegible]
[illegible]					2	3				5
[illegible]							4			[illegible]
[illegible]									1	1
100						1				1
		1	1	[illegible]	[illegible]	[illegible]	4		1	[illegible]

FIG. [illegible] [illegible] of Leaves of Tall [illegible] [illegible], [illegible] relative; r = .[illegible] ± .[illegible].

[illegible] Tall [illegible] shows here, as it did in the [illegible] characters, a very [illegible] for the above characters. The standard deviations for [illegible], too, [illegible] the coefficients of variability being [illegible] and [illegible].877 for length and [illegible] respectively, the two coefficients of variability [illegible] a [illegible] together [illegible] a good correlation.

[illegible] Table 27.

V	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35	f
60		2								2
65		2	1	2						5
70			1	1	1					3
75			1	1	1					3
80				3						3
[illegible]										
[illegible]										
[illegible]										
100										
		4	3	7	2					16

FIG. 32.— Correlation between length and diameter of leaves of [illegible] Plush. Length subject, diameter relative; $r = .5730 \pm .1[illegible]$.

Length and diameter of leaves.——The correlation in this case might be called fair but it is quite low. The standard deviations ([illegible].[illegible] mm. and [illegible].[illegible] mm.) are proportional to the mean length (76 mm.) and mean diameter (67.157 mm.) but the coefficients of variability, while close together, are low being 6.770 for length and 6.012 for diameter. The results bear us out in our assumption that low coefficients of variability give us a low coefficient of correlation. See Table 33.

V	47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	80	[illegible]	f
60	1									1
65		1								1
70	1		1	1						3
75		3		1						4
80			2	2			1			5
85				1	[illegible]	1				4
90										
95										
100										
	2	4	3	5	[illegible]	1	1			16

FIG. 33.---Correlation between length and diameter of leaves of Winter Banana. Length subject, diameter relative; r = .8806 ± .0350.

Length and diameter of leaves.— In this variety the correlation is fairly good. The relation between the mean for length (75.[illegible] mm.) and its standard deviation (7.0164 mm.) has the [illegible] deviation ([illegible]) giving it a coefficient of variability of 14.44 as against [illegible] for length. The great difference in these two coefficients is reflected in the correlation coefficient. See Table 26.

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
45										
50										
55										
60										
65			2							2
70			1	6	3					10
75				[illegible]	1					4
80				1	2	1				4
85					1	2				3
90										
95										
100									1	1
			3	10	7	3			1	24

FIG. 24.---Correlation between length and diameter of leaves of [illegible]. Length subject, diameter relative, r = .8117 ± .0448.

Length and diameter of leaves.--- [illegible] a very high correlation in these characters. The standard deviations for length and for diameter are proportional to the means for these characters. The coefficients of variability are high and close together; 10.84 for length and 11.06 for diameter. This gives us a high correlation. The number of individuals used (24) being greater than in some other cases may have affected the result. See Table 36.

V	40	45	50	55	60	65	70	75	80	f
45	1	1								2
50	2	3								5
55		2	1							3
60		1	4							5
65			2	3						5
70										
75				1		1				2
80					1					1
85										
90										
95										
100										
	3	7	7	4	1	1				23

FIG. 35. ----Correlation between length and diameter of leaves of McIntosh. Length subject, diameter relative; $r = .8751 \pm .0372$.

Length and diameter of leaves.---- We find no higher coefficient of correlation for the leaf characters, than that shown here now. The standard deviations are in about the same ratio to each other as are the means of length and diameter which they represent, the deviation for length being proportionally a little the higher. Each, however, is high and the coefficients of variability are as a consequence high, length being 13.65 and diameter being 12.8. High variabilities here give highest coefficient of correlation. See Table 31.

V	40	45	50	55	60	65	70	f
55		1						1
60	1							1
65		2	1					3
70			3	2				5
75			2	2	1			6
80				2	3	1		6
85								
90							1	1
	1	3	6	6	4	1	1	22

FIG. 38.--- Correlation between length and diameter of leaves of [illegible]. Length subject, diameter relative; r = .8142 ± .0407.

Length and diameter of leaves.--- These figures show us another very good correlation. The mean length has a standard deviation [illegible] the diameter [illegible] the variable giving us a greater standard deviation for this character. The coefficients of variability are 16.90 for length and 18.24 for diameter. A greater number of individuals being used here, again seems to give us a better correlation. See Table 38.

V	40	45	50	55	60	65	70	f
55								
60		2						2
65		1	1					2
70			1	3				4
75			1	2	1			4
80				1	1			2
85						2		1
		3	3	6	2	2		16

FIG. 37.---Correlation between length and diameter of leaves of Sutton. Length subject, diameter relative; r = .8078 ± .0707.

<u>Length and diameter of leaves</u>.---- In this case we have a small number of individuals (16) but find a very good correlation of the characters studied. The standard deviations are small and are proportional to mean length and mean diameter. The coefficients of variability stand close together being 10.88 for length and 11.8 for diameter. We now call attention to the close resemblance in every respect, of Sutton and Wellington when leaf characters are considered.

See Tables 53 and 54.

[illegible].

V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
54			1						1
57			2		1				3
60				1					1
63			3	2	1				6
66					3				3
69				1	1				2
72									
75									
78									
81									
84									
87									
			6	4	6				16

FIG. [illegible] --- Correlation between [illegible] length and [illegible] length of leaves of Tulips. [illegible]; r = .1775 ± .1615.

[illegible]---- We have [illegible] of these characters. We believe that [illegible] condition [illegible] each [illegible] the variation was small [illegible] the coefficient of variability for each [illegible] is low, being 7.0[illegible] for length and [illegible] for [illegible]. Because of the fact that the coefficient of correlation is not five or ten times as great as its probable error, no [illegible] [illegible]----[illegible] Gilbert.

JONATHAN.

V	1[illegible].5	13.5	1[illegible].5	[illegible]	[illegible].5	[illegible].5	[illegible]3.5	[illegible].5	f
54									
57			1						1
60			1	1					2
63				4	2	1			7
66				1	1			1	3
69					1				1
72				1	1				2
75									
78									
81									
84									
87									
			2	7	5	1		1	16

FIG. 36.--- Correlation between blade length and petiole length of leaves of Jonathan. Blade length subject, petiole length relative; r = .[illegible]102 ± .1[illegible]26.

[illegible] --- No emphasis can be put upon these figures as the probable error is nearly one-half of the coefficient of correlation. The number of individuals is small.

See Table 35.

MOTHER.

V	14.5	16.5	18.5	20.5	22.5	24.5	26.5	28.5	f
54									
57									
60									
63									
66		1							1
69	1	1							2
72			3						3
75		1	2						3
78			1	1					2
81	1	1		2					4
84									
87	1								1
	3	4	6	3					16

FIG. 40. ----Correlation between blade length and petiole length of leaves of Mother. Blade length subject, petiole diameter relative. r = .4024 ± .1071.

Length of blade and length of petiole.------ The above is a fair correlation but no dependence can be placed on it. The blade length is again so nearly constant, that the deviation is low being 5.6091 mm. for a mean length of 75.75 mm. The petiole length is more variable, the standard deviation being 2 mm. for a mean petiole length of 18 mm. The coefficients of variability are: for blade length, 7.401; for petiole length 11.11. The blade length coefficient being low and the difference between them great, we look for a poor correlation. See Table 38.

V	14.5	16.5	18.5	20.5	22.5	24.5	26.5	28.5	f
54									
57				1	1				2
60					2				2
63			3		1				4
66			4	3					7
69									
72					1				1
75									
78									
81									
84									
87									
			7	4	5				16

FIG.41---Correlation between blade length and petiole length of leaves of Red Canada. Blade length subject, petiole length relative; $r = .2461 \pm .1584$.

Length of blade and petiole length---Such a correlation coefficient as the one above would seem to indicate that here we find little relation between blade length and petiole length. However, we must remember that the number of individuals was very small and consequently our results in this study of little significance. Because of so little variation in leaf length we get this low correlation since the standard deviation for diameter is here nearly normal. The coefficient of variability for length is 8.008 and for diameter 8.741, but no dependence can be placed on these. See Table 37.

V	18.5	20.5	22.5	24.5	26.5	28.5	30.5	32.5	f
63									
66									
69		1							1
72		1	1						2
75		1							1
78		1	1						2
81		1	2						3
84		1							1
87			1						1
90			1	1					2
93			1						1
96				1					1
99				1					1
		6	7	3					16

FIG. 42.--- Correlation between length of blade and panicle length of Fall Tillin. Blade length subject, panicle length relative; r = .60116 ± .0874.

Length of Blade and Length of Panicle-2-- Considering the fact that the characters now being studied have shown so little uniformity, the above correlation is a very good one. An examination of the tables shows us that the standard deviation for blade length (8.9580 for a blade length of 8.2875) is here about normal. (Normal ratio has been about 1:10) The panicle length and standard deviation are: Length 22.125 standard deviation 1.5-- Not so good as the other. See Table 12.

V	18.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	f
63		1							1
66	3	3							6
6?	1								1
72		2							2
7?		2							2
73	1	1							2
?1		2							2
?4									
?7									
?0									
?3									
?6									
?9									
	5	11							16

FIG. [illegible].---Correlation between blade length and petiole length of leaves of Maiden Blush. Blade length subject, petiole length relative; r = .0418 ± .1787.

Length of blade and length of petiole----Here again, we have a very poor correlation between blade length and petiole length. However in this case, we find a normal deviation for blade length, namely; 6.0418 mm. for mean blade length of 71.[illegible]. Rather it is [illegible] the [illegible] deviation for petiole length this being .9374 mm. for a mean petiole length of 1[illegible].875 mm.

The coefficient of blade length is normal or a little below but the same constant for petiole length is much reduced being 4.817. The result is a poor correlation but no dependence can be placed on these figures. See Table 3[illegible].

V	18.5	21.5	24.5	27.5	30.5	33.5	36.5	39.5	f
63		1							1
66									
69				1					1
72				2					2
75				1	2	1			4
78						1			1
81				1	2				3
84					1	2		1	4
87									
90									
93									
96									
99									
		1		5	5	4		1	16

FIG. 41.--- Correlation between blade length and petiole length of leaves of Winter Banana. Blade length subject, petiole length relative; r = .3[illegible] ± .0[illegible]7[illegible].

Length of blade and length of petiole.--- This is the highest coefficient of correlation that has been found, for these characters now being considered. The ratio of mean length of leaf blade to its standard deviation, in other words its coefficient of variability is about 1: 13 being normally 8 this being a little low for making the best correlation. The relation existing between the mean petiole length and its standard deviation is more nearly normal giving us a coefficient of variability, here, of 10.181. See Table 46.

FA[illegible]T.

V.	16.5	18.5	20.5	22.5	24.5	26.5	f
45							
48							
51							
54							
57							
60							
63							
66		1					1
69	2		1				3
72	1	1		1			3
75			2				2
78		1	2				3
81							
84		1				1	2
87					1		1
90							
93							
96							
99					1		1
	3	4	5	1	2	1	16

FIG. 17.--- [illegible] [illegible], [illegible] = .[illegible]7 ± .[illegible].

[illegible]. The [illegible] ([illegible]). [illegible] length is [illegible].[illegible]7 [illegible].

McINTOSH.

V	12.5	1[illegible].5	[illegible].5	[illegible]1.5	[illegible]4.5	[illegible].5	f
45			1				1
48							
51							
54					1		1
57		2	2				4
60				1	1		2
63				1			1
66				1	2		3
69					1		1
72							
75					1		1
78						1	1
81							
84						1	1
87							
90							
93							
96							
99							
		[illegible]	[illegible]	3	6	2	16

FIG. 46. Correlation between blade length and petiole length of leaves of McIntosh. Blade length subject, petiole length relative; r = .[illegible]16 ± .0[illegible].

Length of blade and length of petiole.--- A good correlation is found in this case. The standard deviations are about normal in each case and the coefficients of variability are high and close together, being 10.87 for blade length and 11.13 for petiole length. See Table 42.

V.	20.5	22.7	24.7	26.7	f
60	1				1
63	1				1
66		1			1
69		1			1
72					
75	1	2	1		4
78		1			1
81	1	1	2	1	5
84			1		1
87			1		1
	4	6	5	1	16

FIG. 47. Correlation between blade length and petiole length of leaves of [illegible]aston. Blade length subject, petiole length relative; r = .5377 ± .1146.

Length of blade and length of petiole.--- This is a fair correlation for these characters. The deviation of the blade length from the mean was greater than was the petiole deviation from its mean length. Differences in deviation give to a [illegible] [illegible] in the coefficients of variability (10.17 for blade length and 7.081 for petiole length) resulting in a lower degree of correlation. See Table 48.

[illegible].

V	[illegible].5	[illegible].5	24.[illegible]	[illegible].5	f
[illegible]					
6[illegible]		1			1
66					
6[illegible]	1	2	3		6
7[illegible]			1		1
7[illegible]	1		1		2
7[illegible]					
[illegible]1	1	2		1	4
8[illegible]					
87			1	1	2
	3	5	6	2	16

FIG. 18. ----[illegible] of Cotton. [illegible] subjects, [illegible] five; r = .[illegible] ± .1[illegible].

[illegible] ---- The [illegible] of [illegible] has not [illegible] five to [illegible] times as great as its probable error [illegible] the coefficient.

This statement is [illegible] by [illegible] and Gilbert in their [illegible] page 4[illegible].

Brief Discussion of the Correlation Studies.

It was found that, in general, the results obtained from the new growth studies were good, the figures being dependable and showing fair to very good correlations in practically all cases. In two instances only, was there a decidedly poor correlation one being that of the variety [illegible], the other, one of the [illegible] trees. This last case was explained as being, in all probability, due to a high degree of variability in new growth length with but very little variability in new growth diameter.

The results obtained in our study of blade length and blade diameter of the leaves, were fairly good but not as accurate as the study of the new growth.

In our study of the correlation between blade length and petiole length the results obtained were very unsatisfactory to the writer. We think that the explanation for these varying results may be found in the small number of individuals used, this being sixteen in all cases.

---------GENERAL SUMMARY.--------

The results of the foregoing data may be summarized in the following paragraphs.

-1- Data have been given for the variations and correlations in new growth (shoots) and in the leaves of [illegible] varieties of apples, representing [illegible] groups.

-2- Wide variations have been found to exist between trees of the same variety when grown under the same conditions, but, in general, trees within the variety usually show a reasonably close correlation of characters.

-3- It has been found, in the majority of cases, that an increase in length or in average in diameter is accompanied by a greater degree of variability.

-4- However, when a study of the correlation between length and diameter characters was made it was found that a high coefficient of variability for one character was usually accompanied by a correspondingly high coefficient of variability in the other character, the result being a high correlation for the two characters.

-5- The present investigation proves that external causes (environment) do influence the degree of correlation, for the trees within a variety were not all equally vigorous and these differences in vigor were reflected in the coefficients of correlation. In this connection Wilkinson [6] says, "The trees in sod showed uniformity in every organ and function of which note could be taken. The uniformity of the trees under tillage was in striking contrast. The effects of [illegible] of variety, age of tree, or cultural treatment and also [illegible] whether the trees are dwarf or standard stocks. Because of their shallow root system, dwarf trees are even more liable to injury [illegible] than standards."

-6- From the results obtained, the writer is led to believe that there is a correlation existing between varieties within a group as is shown in the case of [illegible], Jonathan, and [illegible] within the Jonathan Group, and of Hubbardston and [illegible] within the [illegible] Group, but that all varieties have not [illegible] been correctly placed in their groups as is the case of the variety "[illegible]" which bears but little resemblance to the other varieties in the Jonathan Group.

-7- From the results obtained the author believes that there is, in general, a very noticeable correlation between the [illegible] of the same variety; that varieties within the group, as often, or usually, show greater resemblance to each other, and lastly that the vigor of the plant [illegible] influences the correlation of its parts. Study of the individual trees of a variety show this almost conclusively.

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-3- Love, H.H. Studies of Variations in Plants. Cornell Agricultural Experiment Station Bulletin No.[illegible]7. p.37[illegible].

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[illegible]

[illegible]

Variety	
[illegible]	7[illegible]
Jonathan	[illegible]
	[illegible]
Mother	[illegible]
	[illegible]
	[illegible]
Red Canada	[illegible]
	71[illegible]
	[illegible]
Fall Pippin	[illegible]
	[illegible]
	[illegible]
Maiden Blush	[illegible]
	[illegible]
	87[illegible]
Winter Banana	7[illegible]
	[illegible]
Fameuse	[illegible]
	[illegible]
	[illegible]
McIntosh	[illegible]
	[illegible]
	[illegible]
Hubbardston	[illegible]
	[illegible]
Sutton	[illegible]

[illegible]

Variety.	M_L		σ_L		V_L
[illegible]	[illegible]	± .[illegible]	[illegible]	± .[illegible]	[illegible]
Jonathan	71.9	± .[illegible]	[illegible]	± -.864	[illegible]
[illegible]	73.[illegible]	± .[illegible]	[illegible]	± .[illegible]	7.[illegible]
[illegible]	82.[illegible]	± .912	[illegible].007	± .[illegible]	[illegible].70[illegible]
Fall Pippin	[illegible]	± 1.1[illegible]	[illegible]	± .801	10.1[illegible]
[illegible]	76.[illegible]	± 1.1[illegible]	[illegible]	± .[illegible]	11.606
Winter Banana	73.[illegible]	± [illegible].165	7.[illegible]	± -.[illegible]	[illegible].671
[illegible]	7[illegible]	± 1.10[illegible]	[illegible]	± .77[illegible]	10.[illegible]
McIntosh	[illegible].13	± 1.[illegible]	[illegible]	± .[illegible]	13.[illegible]
Hubbardston	73.[illegible]	± 1.[illegible]	7.[illegible]87	± .7[illegible]	[illegible]
[illegible]	7[illegible]	± 1.[illegible]6	7.7[illegible]	± .[illegible]	1[illegible].6[illegible]

[illegible]

	M_L		σ_L		V_L
[illegible]	[illegible]7	± .7[illegible]	[illegible]	± .[illegible]	7.[illegible]
Jonathan	[illegible]	± .[illegible]	[illegible]	± .[illegible]	[illegible]
[illegible]	7[illegible].7[illegible]	± .[illegible]	[illegible]	± .[illegible]	7.[illegible]
[illegible]	[illegible].75	± .[illegible]	[illegible]	± .[illegible]	[illegible]
Fall Pippin	[illegible].875	± 1.[illegible]	[illegible]	± 1.[illegible]	10.[illegible]
[illegible]	71.[illegible]	± 1.[illegible]	[illegible]	± .7[illegible]	[illegible]
Winter Banana	77.[illegible]	± 1.[illegible]	[illegible]	± .7[illegible]	[illegible]
[illegible]	7[illegible].1[illegible]	± 1.[illegible]7	[illegible]	± 1.[illegible]	11.[illegible]
McIntosh	[illegible].[illegible]75	± 1.[illegible]	[illegible].7[illegible]	± 1.1[illegible]7	13.8[illegible]
Hubbardston	7[illegible].75	± 1.[illegible]	7.7[illegible]7	± .[illegible]	1[illegible].17[illegible]
Sutton	7[illegible]	± 1.[illegible]	7.[illegible]	± .[illegible]	[illegible].7[illegible]

Notation:- M_L = Mean for Length.

σ_L = Standard Deviation for Length.

V_L = Coefficient of Variability for Length.

r = Coefficient of Correlation.