# Observations on the Physiology of Seed Development in Staphylea.

By

J. Arthur Harris.
Carnegie Institution of Washington. Cold Spring Harbor, Long Island, U. S. A.

With 1 figure in the text.

## I. Introductory remarks.

In most species of plants an ovule which does not receive a sperm ceases its development. Beyond this, we can hardly venture in a discussion of the causes which determine whether an ovule shall develop into a seed. Goebel in his "Organographie der Pflanzen" has frankly pointed out our almost complete ignorance of these matters, and I believe that most broadly informed botanists would agree with his statements. Yet the problem of the factors which determine the fate of an ovule seems to be of considerable interest, and definite knowledge perhaps of practical importance as well.

The logical method of approaching the problem seems to be to make a beginning somewhere, it does not matter much where, and to get quantitative approximations of the influence of individual factors until finally researches of a monographic character can be undertaken.

In a study of the factors influencing the length of the pod in *Staphylea*.[1]) I have had occasion to determine the correlation between the number of seeds per locule and the position of the fruit on the inflorescence and between the number of seeds per locule and the number of fruits per inflorescence for a single series of 2059 pods of *Staphylea trifolia* from the Missouri Botanical

[1]) Harris, J. Arthur, The Influence of the Seed upon the Size of the Fruit in *Staphylea*. (Bot. Gaz. In Press.)

Garden. In another place, the relationship between the characters of the inflorescence and the number of ovules has been discussed.[1])

In both of these papers the problems of fertility and fecundity were quite subsidiary, but the results were hardly what I had expected, and it seems desirable to present here the results of a study of three large series of data with special reference to the problem of the factors influencing the development of the seed.

The tables of data and the constants included here are almost without exception published for the first time, but the three series of material — all from the North American Tract of the Missouri Botanical Garden — have been utilized for other relationships in the two papers cited above. Hence it is unnecessary to discuss material or methods[2]) in detail.

## II. **Number of pods per inflorescence and fertility and fecundity.**

Given a species in which the inflorescence produces fruits from only a small proportion of the flowers which it bears, and in which the fruits, in their turn, mature only a small percentage of their ovules into seeds, it seems of considerable physiological interest to ascertain whether the inflorescences bearing a large number of fruits are more (or less) able to mature their ovules into seeds than those having a smaller number. Has the competion of several fruits for the plastic material available for a particuliar inflorescence the effect of lessening the chances of the ovules of a fruit developing into seeds? Or, on the other hand, are the inflorescences with more than the average number of pods so much more vigorous that their fruits also mature a larger number of seeds?

We have an interesting suggestion along this line in the work of Waldron[3]) on oats. He found that the correlation between the number of grains per head and the mean weight of the grains was strongly negative, i. e. the heaviest grains were produced by the smallest heads. In the case of *Celastrus*, however, there is no trustworthy indication[4]) of an interdependence between the number of flowers formed per inflorescence and the number of seeds maturing per fruit, or between the number of fruits matured per inflorescence

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[1]) Harris, J. Arthur, Further Observations on the Selective Elimination of Ovaries in *Staphylea*. (Zeitschr. f. ind. Abst. u. Vererbungsl. In press.)

[2]) The familar biometric methods have been employed in the analysis of the data. The means and standard devinations are omitted, since they have no direct bearing on the problems discussed. Sheppard's correction was not used.

[3]) Waldron, L. R., A Suggestion on Concerning Heavy and Light Seed Grain. (Ann. Nat. Vol. XLIV. 1910. p. 48—56.)

[4]) Harris, J. Arthur, Correlation in the Inflorescence of *Celastrus scondens*. (Ann. Report. Mo. Bot. Gard. Vol. XX. 1909. p. 116—122.)

and the number of seeds matured per fruit. Further data along these lines are much needed.[1])

We now take up the data available for *Staphylea*. As a basis of comparison for the correlations for number of fruits per inflorescence and number of seeds per locule I have determined the same relationship for number of ovules per locule.

To avoid the criticism so often urged against biometricians, that they obscure biological relationships by massing data, we again work with the individual shrubs for the 1906 collection. The data for the correlation between number of fruits per inflorescence and number of ovules per locule are given in Table I and those for the correlation between number of pods per inflorescence and number of seeds per locule in Table II. These are combination tables, comprising twenty individual correlation tables each. Data for $r_{nf}$ are unnecessary, for this correlation can be calculated from the data for $r_{no}$ and $r_{ns}$[2]) provided $\sigma_f$ be known.[3])

Table 1 gives the correlation coefficients.

These constants are of so low an order that it has seemed idle to calculate the sixty individual probable errors. As in another paper on *Staphylea*, I have used the approximation $E_r = .04$. If we demand that a correlation constant shall deviate from 0 by at least 2.5 times its probable error to be considered trustworthy, it is clear that all values between $+ .100$ and $- .100$ must be looked upon as of questionable signifiance.

Applying this criterion, we note that for $r_{no}$ thirteen of the twenty values fall within the limits of $\pm .100$, and four exceed it so slightly that no significance is to be attached to them. Two constants are of a magnitude about four times our approximation to the probable error, and one, namely that for plant 28, is about eight to ten times its probable error. Surely no one would venture

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[1]) Unfortunately, in *Staphylea* we cannot determine the relationship between the number of flowers produced per inflorescence and the fertilty characters. Morphogenetically, it would be interesting to know whether the inflorescences which produce a high number of flowers have fruits with relatively large (or small) numbers of ovules. From unpublished work, we know that there is sometimes a correlation between the number of fruits which an annual produces and the characteristics of these fruits, but as yet our knowledge of these matters is limited.

[2]) It is hardly necessary at this time to note that the biometrician designates the coefficient of correlation by $r$ and the two characters between which the correlation is to be determined by the subscript letters. Thus, $r_{no}$ is to be read "the correlation between the number of pods and the number of ovules per locule".

The characters considered in this paper are:

number of fruits per inflorescence $= n$,
position of fruits on the inflorescence axis, numbered from the proximal to the distal end $= p$,
number of ovules per locule $= o$,
number of seeds per locule $= s$,
number of ovules failing to develop per locule $= f$.

[3]) Data for $\sigma_f$ are not published here since the correlations between the number of ovules failing to develop are not considered in great detail. They may be published in another connection later.

to attach much weight to these constants if he had any regard to their probable errors.

Taking next $r_{ns}$, we find that eighteen out of twenty differ from zero by less than .100, and that the two others only slightly exceed this limit.

Of the values for $r_{nf}$, fourteen fall below our limit of trustworthiness, five exceed it by not more than .063, and a single individual, again plant 28, shows a more substantial correlation.[1])

Notwithstanding the low values of the coefficients with regard to their probable errors, there may still be some significance in these constants. Suppose the real relationship between the characters to be 0; we would then not expect to find correlations of 0 when we calculated the coefficients upon the basis of three hundred locules, but results falling above or below this value by an amount due to the probable error of random sampling. This is precisely the condition observed; some have the positive and some the negative sign. Now by comparing the number of cases in which the values fall above and below 0, we may be able to get some idea of the sign, at least, of the correlation in a population of individuals.

For $r_{no}$ nine of the coefficients have the positive and eleven the negative sign. In a series of only twenty individuals one could not expect a more nearly even division. The positive constants average .1305 while the negative ones give a mean correlation of —.0718. If we omit the high value for plant 28, the positive values average .1022. The mean for the twenty series, having regard to signs, is +.0192. But the standard deviation of the coefficients = .1226, about, and $.67449\ \sigma_r = \sqrt{20} = .0185$. The mean is, therefore, $A_r = .0192 \pm .0185$, and we conclude that so far as our data go there is no evidence in favor of any relationship between the number of fruits per inflorescence and the number of ovules per locule.

Consider $r_{ns}$. Of the twenty, four are positive as compared with sixteen negative, while if actually $r = 0$ and the results were due to random sampling, we should expect 10 and 10. Observation differs from theory by six cases. For the probable error, we have $.6745 \sqrt{20 \times .5 \times .5} = 1.51$, and $6 \pm 1.51$ is perhaps significant. The mean of the four positive coefficients is .0399 and that for the sixteen negative —.0598; for the whole twenty individuals $A = —.03987$. By the brute force method, $\sigma_r = .0530$ and $E_A = .00799$. Now an average correlation of $-.0399 \pm .0080$ may be significant, but with such low values throughout any cautious statistician would hesitate in attaching much significance to them.

The constants for $r_{nf}$ need not be discussed in detail. Since the constants for $r_{no}$ are about equally divided between positive and negative while those for $r_{ns}$ are preponderatingly negative,

[1]) Naturally the suggestion of an arithmetical blunder in the case of this individual will occur to the reader, but I have been unable to find any slip in the work.

we expect $r_{nf}$ to be positive in most cases, and find one fourth only to be negative.

Table 1.

| Shrub | $r_{no}$ Number of Fruits and Number of Ovules | $r_{ns}$ Number of Fruits and Number of Seeds | $r_{nf}$ Number of Fruits and Number of Ovules Failing |
|---|---|---|---|
| 11 | —.093 | .035 | .000 |
| 12 | .131 | .060 | .055 |
| 13 | —.075 | —.090 | .022 |
| 14 | —.053 | —.082 | .103 |
| 15 | —.041 | —.042 | —.009 |
| 16 | —.012 | —.054 | .025 |
| 17 | .173 | —.031 | .159 |
| 18 | .178 | —.001 | .069 |
| 19 | .038 | —.058 | .066 |
| 20 | —.111 | —.056 | —.029 |
| 21 | .010 | —.024 | .025 |
| 22 | —.061 | —.138 | .105 |
| 23 | —.081 | .003 | —.060 |
| 24 | —.017 | —.062 | .006 |
| 25 | .096 | .062 | .005 |
| 26 | —.138 | —.067 | —.044 |
| 27 | —.108 | —.007 | —.075 |
| 28 | .357 | —.035 | .243 |
| 29 | .093 | —.083 | .127 |
| 30 | .097 | —.128 | .163 |

For all the pods collected for each year, we have:

Number per Inflorescence and Ovules per Locule:

1906, Table III, $r = .0391 \pm .0086$, $r/E_r = 4.6$.
1908, Table IV, $r = .0633 \pm .0061$, $r/E_r = 10.4$.
1909, Table V, $r = -.0539 \pm .0085$, $r/E_r = 6.3$.

Number per Inflorescence and Seeds per Locule:

1906, Table VI, $r = -.0474 \pm .0086$, $r/E_r = 5.5$.
1908, Table VII, $r = -.0494 \pm .0061$, $r/E_r = 8.1$.
1909, Table VIII, $r = .0626 \pm .0085$, $r/E_r = 7.4$.

Judged by the probable errors these constants might, taken individually, be regarded as statistically significant. We must note, however, that:

a) We have taken the number which gives the lowest possible probable error, and that if we used the number of fruits instead of the number of locules, the probable errors would be nearly doubled.

b) When very high or very low correlation coefficients are in hand, too great stress cannot be laid upon the probable errors.

c) The numerical values are too low to be of any practical biological significance, and positive and negative coefficients occur for both relationships.

## Table I.

Combination Table showing the correlation between Number of Fruits per Inflorescence and Number of Ovules per Locule for twenty Individual Shrubs.

| Shrub | 4 | 5 | | | | | | 6 | | | | | | | | | 7 | | | | | | | | | | 8 | | | | | | | | | |
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| | 3 | 1 | 3 | 4 | 5 | 6 | 8 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 12 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | — | — | 1 | — | 1 | — | — | — | 2 | 12 | 6 | 6 | 10 | — | — | — | — | 5 | 15 | 13 | 6 | 3 | — | — | — | — | — | 15 | 33 | 16 | 40 | 35 | 21 | — | — | — |
| 12 | — | — | 1 | 1 | — | — | 1 | — | 5 | 3 | 1 | — | 4 | 1 | — | — | — | 10 | 25 | 13 | 5 | 10 | 4 | — | 1 | — | — | — | 32 | 76 | 36 | 12 | 35 | 16 | — | 20 |
| 13 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | 3 | 3 | — | — | — | — | — | — | — | 1 | 14 | 32 | 24 | 7 | — | — | — | — |
| 14 | — | — | 1 | 1 | 2 | 1 | — | 16 | 33 | 15 | 10 | 3 | — | — | — | — | 36 | 62 | 22 | 31 | 10 | — | — | — | — | — | — | 14 | 12 | 10 | 17 | 4 | — | — | — | — |
| 15 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | 1 | 1 | 5 | 1 | — | — | — | — | — | — | 1 | 8 | 11 | 19 | 1 | — | 3 | — | — |
| 16 | — | — | 3 | 2 | 1 | — | — | 2 | 3 | 2 | 9 | 1 | — | 2 | — | — | 1 | 12 | 10 | 2 | 4 | — | 3 | — | — | — | — | 14 | 53 | 48 | 45 | 23 | — | 19 | — | — |
| 17 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 | 3 | — | 2 | — | — | — | — | — | 1 | 17 | 20 | 10 | 3 | 8 | — | — | — | — |
| 18 | — | — | 1 | — | — | — | — | 1 | 5 | 2 | 1 | — | — | — | — | — | 3 | 19 | 14 | 14 | 1 | — | — | — | — | — | — | 14 | 73 | 43 | 85 | 16 | — | — | — | — |
| 19 | — | — | — | 1 | — | — | — | 2 | 4 | 3 | — | — | — | — | — | — | 9 | 17 | 11 | — | 4 | — | — | — | — | — | — | 40 | 114 | 39 | 10 | 13 | — | — | — | — |
| 20 | 1 | — | 1 | 1 | 1 | — | — | — | — | 3 | 3 | — | — | — | 1 | — | — | 5 | 13 | 9 | 1 | 6 | — | 6 | — | — | — | 2 | 53 | 71 | 32 | 15 | 15 | — | 15 | — |
| 21 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | 4 | 2 | 2 | — | — | — | — | — | — | — | 40 | 96 | 69 | 13 | 14 | — | — | — | — |
| 22 | — | — | — | 1 | — | — | — | — | — | 2 | — | — | 2 | 1 | — | — | 3 | 1 | — | — | 1 | — | 3 | — | — | — | — | 34 | 68 | 29 | 26 | 33 | 39 | 40 | — | — |
| 23 | — | — | — | — | — | — | — | 6 | 14 | 8 | 3 | 5 | — | — | — | — | 24 | 26 | 29 | 19 | 11 | — | — | — | — | — | — | 24 | 62 | 44 | 23 | 2 | — | — | — | — |
| 24 | — | — | — | — | — | — | — | — | 4 | 2 | 4 | — | — | — | — | — | 7 | 8 | 8 | 20 | 11 | — | — | — | — | — | — | 14 | 40 | 35 | 47 | 33 | — | — | — | — |
| 25 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 6 | 1 | 7 | 11 | — | — | — | — | — |
| 26 | — | — | — | — | — | — | — | 4 | 9 | 16 | 7 | 2 | — | — | — | — | 9 | 26 | 39 | 18 | 11 | — | — | — | — | — | — | 17 | 60 | 50 | 19 | 5 | — | — | — | — |
| 27 | — | — | — | — | — | — | — | — | 1 | 1 | — | 1 | — | — | — | — | — | 1 | 5 | — | 4 | — | — | — | — | — | — | 7 | 30 | 52 | 15 | 39 | 10 | — | — | — |
| 28 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 2 | 1 | — | — | — | — | — | — | — | — | 19 | 16 | 19 | — | 5 | 2 | — | — | — |
| 29 | — | — | — | — | — | — | — | 7 | 16 | 4 | 12 | — | — | 6 | — | 4 | 23 | 26 | 6 | 22 | — | — | 9 | — | — | 10 | — | 12 | 30 | 26 | 55 | — | — | 9 | — | — |
| 30 | — | — | — | — | — | — | — | 12 | 8 | 32 | 31 | 11 | — | — | — | — | 19 | 17 | 54 | 24 | 30 | — | — | — | — | — | — | 5 | 2 | 22 | 17 | 16 | — | — | — | — |

| Shrub | 9 | | | | | | | | | | 10 | | | | | | | | | 11 | | | | | | | 12 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 2 | 3 | 4 | 5 | 6 | 8 |
| 11 | — | 6 | 11 | 4 | 22 | 21 | 7 | — | — | — | 3 | 2 | 1 | 8 | 4 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 12 | — | — | 5 | 12 | 6 | 1 | 11 | 2 | — | 8 | — | 1 | 3 | 4 | — | 3 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 13 | — | 1 | 19 | 39 | 28 | 13 | — | — | — | — | 10 | 20 | 57 | 20 | 16 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — |
| 14 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 15 | — | 3 | 20 | 28 | 30 | 7 | — | 10 | — | — | 1 | 29 | 59 | 30 | 7 | — | 7 | — | — | — | 4 | 19 | 5 | 2 | — | 3 | 1 | — | 2 | 1 | — | 1 |
| 16 | — | 1 | 14 | 9 | 2 | 8 | — | — | — | — | — | 2 | 1 | 3 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — |
| 17 | 2 | 27 | 32 | 39 | 3 | 18 | — | — | — | — | 9 | 25 | 38 | 9 | 24 | — | — | — | — | — | — | 6 | — | 2 | — | — | 1 | 1 | — | — | — | — |
| 18 | — | — | 1 | 1 | 4 | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 19 | — | 2 | 17 | 6 | 3 | 1 | — | — | — | — | 1 | 1 | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 20 | — | 3 | 8 | 19 | 11 | 1 | — | — | 4 | — | 1 | 4 | 13 | 4 | 1 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 21 | — | 11 | 16 | 22 | — | 2 | — | — | — | — | 2 | 1 | 3 | — | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 22 | — | 4 | 3 | 4 | 4 | 2 | 1 | 4 | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 23 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 24 | — | 3 | 19 | 13 | 16 | 10 | — | — | — | — | — | 1 | 2 | 3 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 25 | — | 12 | 5 | 6 | 6 | 5 | — | — | — | — | 22 | 35 | 43 | 57 | 42 | — | 24 | — | — | — | — | 2 | 4 | 1 | 3 | — | 2 | 5 | — | — | 1 | — |
| 26 | — | — | 4 | 3 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 27 | — | 12 | 21 | 23 | 12 | 19 | 6 | — | — | — | 11 | 10 | 3 | 3 | 9 | 5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 28 | — | 15 | 23 | 48 | 9 | 6 | 3 | — | — | — | 16 | 22 | 37 | 19 | 7 | 29 | — | — | — | 2 | — | 3 | 2 | — | 8 | — | — | — | — | — | — | — |
| 29 | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 30 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

Table II.

Combination Table showing the Correlation between Number of Fruits per Inflorescence and Number of Seeds per Locule for twenty individual Shrubs.

| Shrub | 0 | | | | | | | | | | | 1 | | | | | | | | | | 2 | | | | | | | | | | | 3 | | | | | | | | | | 4 | | | | | | 5 | | | | | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 2 | 3 | 4 | 5 | 6 | 8 | 2 | 3 | 4 | 5 | 6 | 6 |
| 11 | — | 12 | 30 | 26 | 48 | 40 | 20 | — | — | — | — | 11 | 22 | 18 | 30 | 28 | 18 | — | — | — | — | — | 1 | 2 | 3 | 9 | 3 | 4 | — | — | — | — | — | — | 1 | 3 | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 12 | — | — | 30 | 68 | 33 | 11 | 35 | 15 | — | 14 | — | — | 21 | 43 | 19 | 6 | 23 | 8 | — | 10 | — | — | — | 3 | 4 | 5 | 1 | 5 | 1 | — | 2 | — | — | — | 4 | 2 | — | — | — | — | 4 | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — |
| 13 | — | 3 | 22 | 50 | 37 | 17 | — | — | — | — | — | 3 | 19 | 50 | 31 | 9 | | — | — | — | | — | 4 | 9 | 20 | 4 | 5 | — | — | — | — | — | 1 | 3 | 9 | 2 | 3 | — | — | — | — | — | 1 | 1 | 1 | 1 | 2 | — | — | — | 2 | — | — | — |
| 14 | — | 27 | 55 | 26 | 34 | 9 | — | — | — | — | — | 27 | 39 | 16 | 19 | 6 | — | — | — | — | — | — | 9 | 13 | 6 | 6 | 2 | — | — | — | — | — | 2 | — | — | 1 | 1 | — | — | — | — | — | 1 | 1 | — | — | — | — | — | — | — | — | — | — |
| 15 | — | 4 | 34 | 73 | 51 | 11 | — | 15 | — | — | — | 1 | 19 | 41 | 30 | 5 | — | 6 | — | — | — | — | — | 8 | 5 | 9 | 1 | — | 3 | — | — | — | — | 2 | 1 | — | 1 | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — |
| 16 | — | 9 | 42 | 44 | 35 | 21 | — | 14 | — | — | — | 6 | 37 | 24 | 22 | 10 | — | 9 | — | — | — | — | 2 | 6 | 3 | 4 | 3 | — | 1 | — | — | — | 1 | 2 | 1 | 2 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 17 | 2 | 27 | 45 | 48 | 7 | 33 | — | — | — | — | — | 21 | 27 | 37 | 5 | 17 | — | — | — | — | — | 1 | 6 | 7 | 10 | 2 | 3 | — | — | — | — | — | — | 2 | 1 | — | 1 | — | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — |
| 18 | — | 9 | 58 | 38 | 57 | 10 | — | — | — | — | — | 8 | 30 | 16 | 41 | 5 | — | — | — | — | — | — | — | 9 | 4 | 7 | 2 | — | — | — | — | — | 1 | 2 | 1 | — | 1 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — |
| 19 | — | 27 | 85 | 36 | 8 | 12 | — | — | — | — | — | 25 | 57 | 21 | 5 | 6 | — | — | — | — | — | — | 1 | 9 | 2 | 1 | | — | — | — | — | — | — | 2 | 1 | 1 | — | — | — | — | — | — | 1 | — | — | — | — | — | — | — | — | — | — | — |
| 20 | — | 3 | 30 | 53 | 19 | 8 | 11 | — | 10 | — | — | — | 31 | 36 | 21 | 4 | 7 | — | 14 | — | — | — | 3 | 3 | 19 | 15 | 5 | 2 | — | 2 | — | — | — | 3 | 9 | 5 | 1 | 1 | — | 1 | — | — | — | 2 | 2 | — | — | — | — | 3 | 1 | — | — | — |
| 21 | — | 7 | 29 | 23 | 5 | — | — | — | — | — | — | 20 | 34 | 36 | 3 | 10 | — | — | — | — | — | — | 15 | 31 | 20 | 1 | 5 | | — | — | — | — | 6 | 14 | 11 | 4 | 1 | — | — | — | — | — | 3 | 9 | 5 | 1 | 2 | — | 3 | — | 1 | 1 | — | — |
| 22 | — | 19 | 28 | 18 | 15 | 20 | 21 | 23 | — | — | — | 12 | 29 | 11 | 5 | 14 | 16 | 19 | — | — | — | — | 5 | 9 | 5 | 8 | 1 | 4 | 5 | — | — | — | 3 | 6 | 2 | 1 | — | 1 | 1 | — | — | — | 3 | — | — | 1 | 1 | — | — | — | — | — | — | — |
| 23 | — | 30 | 53 | 45 | 23 | 9 | — | — | — | — | — | 19 | 39 | 32 | 17 | 7 | — | — | — | — | — | — | 4 | 8 | 4 | 5 | 2 | — | — | — | — | — | 1 | 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 24 | — | 11 | 29 | 33 | 43 | 27 | — | — | — | — | — | 7 | 25 | 17 | 31 | 14 | — | — | — | — | — | — | 3 | 13 | 9 | 11 | 11 | — | — | — | — | — | 2 | 5 | — | 4 | 2 | — | — | — | — | — | 1 | — | 1 | 1 | — | — | — | — | — | — | — | — |
| 25 | — | 24 | 21 | 22 | 38 | 23 | — | 10 | — | — | — | 14 | 17 | 24 | 22 | 19 | — | 9 | — | — | — | — | 3 | 7 | 6 | 11 | 4 | — | 3 | — | — | — | — | 2 | 6 | 4 | 2 | — | 1 | — | — | — | 1 | — | 2 | — | — | 1 | — | 1 | — | — | 2 | 1 |
| 26 | — | 15 | 53 | 58 | 26 | 10 | — | — | — | — | — | 12 | 35 | 41 | 15 | 5 | — | — | — | — | — | — | — | 7 | 5 | 4 | 3 | — | — | — | — | — | 1 | 4 | 4 | — | — | — | — | — | — | — | 1 | — | — | — | — | — | 1 | — | — | — | — | — |
| 27 | — | 16 | 36 | 45 | 11 | 38 | 10 | — | — | — | — | 8 | 23 | 29 | 15 | 29 | 9 | — | — | — | — | — | 4 | 4 | 8 | 2 | 5 | 1 | — | — | — | — | 1 | — | 1 | 2 | — | 1 | — | — | — | — | 1 | — | — | — | — | — | — | — | 1 | — | — | — |
| 28 | — | 23 | 30 | 50 | 13 | 12 | 18 | — | — | — | — | 20 | 22 | 36 | 16 | 6 | 12 | | — | — | — | — | 5 | 10 | 15 | — | — | 9 | — | — | — | — | 6 | 1 | 5 | 1 | — | 3 | — | — | — | — | — | — | 2 | — | — | — | — | — | — | — | — | — |
| 29 | — | 16 | 40 | 17 | 50 | — | — | 14 | — | — | 21 | 16 | 19 | 10 | 25 | — | — | 10 | — | — | 9 | — | 9 | 8 | 6 | 9 | — | — | — | — | — | 4 | 1 | 3 | 2 | 5 | — | — | — | — | — | 2 | — | 2 | 1 | 1 | — | — | — | — | — | — | — | — |
| 30 | — | 17 | 11 | 54 | 38 | 32 | — | — | — | — | — | 8 | 11 | 43 | 27 | 17 | — | — | — | — | — | — | 8 | 4 | 10 | 7 | 7 | — | — | — | — | — | 3 | 1 | 1 | — | 1 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

## Table III, 1906.
Number per Inflorescence.

| Ovules per Locule. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | — | — | 1 | — | — | — | — | — | — | — | — | — | 1 |
| 5 | — | — | 8 | 7 | 5 | 1 | — | 1 | — | — | — | — | 22 |
| 6 | — | 50 | 106 | 105 | 87 | 29 | 16 | 10 | 1 | — | — | — | 408 |
| 7 | — | 137 | 245 | 261 | 195 | 102 | 19 | 19 | 6 | 1 | — | 4 | 995 |
| 8 | 1 | 296 | 817 | 709 | 537 | 281 | 122 | 87 | 15 | 20 | — | 10 | 2907 |
| 9 | 2 | 100 | 218 | 276 | 157 | 115 | 28 | 16 | 4 | 8 | — | 22 | 924 |
| 10 | — | 77 | 153 | 260 | 164 | 112 | 38 | 31 | 1 | 1 | — | — | 837 |
| 11 | — | 2 | 6 | 33 | 9 | 7 | 8 | 3 | — | — | — | — | 68 |
| 12 | — | 4 | 6 | 2 | 1 | 1 | — | 1 | — | — | — | — | 15 |
| Totals | 3 | 666 | 1560 | 1653 | 1155 | 648 | 231 | 168 | 27 | 30 | — | 36 | 6177 |

## Table IV, 1908.
Number per Inflorescence.

| Ovules per Locule. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 17 | 23 | 40 | 16 | — | — | — | — | — | 96 |
| 5 | 49 | 58 | 42 | 21 | 5 | 2 | — | — | — | 177 |
| 6 | 700 | 618 | 475 | 263 | 105 | 55 | 19 | — | 19 | 2254 |
| 7 | 456 | 521 | 463 | 281 | 123 | 53 | 24 | — | 5 | 1926 |
| 8 | 1610 | 1682 | 1387 | 842 | 305 | 226 | 139 | 2 | 3 | 6196 |
| 9 | 216 | 194 | 219 | 125 | 38 | 17 | 16 | 3 | — | 828 |
| 10 | 135 | 120 | 133 | 126 | 54 | 9 | 15 | 12 | — | 604 |
| 11 | 6 | — | 3 | 6 | 1 | — | — | 1 | — | 17 |
| 12 | — | — | 1 | — | — | — | — | — | — | 1 |
| Totals | 3189 | 3216 | 2763 | 1680 | 631 | 362 | 213 | 18 | 27 | 12099 |

## Table, V, 1909.
Number per Inflorescence.

| Ovules per Locule. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1 | — | — | — | — | — | — | 1 | — | — | — | 2 |
| 5 | 3 | 4 | 5 | 4 | 1 | — | 2 | 6 | — | — | — | 25 |
| 6 | 92 | 215 | 239 | 161 | 90 | 22 | 83 | 68 | — | — | 7 | 977 |
| 7 | 98 | 204 | 274 | 181 | 81 | 27 | 73 | 43 | — | — | 4 | 985 |
| 8 | 228 | 635 | 757 | 623 | 319 | 196 | 161 | 90 | 18 | — | 22 | 3049 |
| 9 | 46 | 115 | 180 | 115 | 75 | 35 | 27 | 9 | 7 | — | — | 609 |
| 10 | 66 | 131 | 173 | 104 | 60 | 46 | 8 | 2 | 2 | — | — | 592 |
| 11 | — | 4 | 1 | — | — | 1 | — | — | — | — | — | 6 |
| 12 | — | — | — | — | 1 | — | — | — | — | — | — | 1 |
| Totals | 534 | 1308 | 1629 | 1188 | 627 | 327 | 354 | 219 | 27 | — | 33 | 6246 |

## Table VI, 1906.
### Number per Inflorescence.

| Seeds per Locule. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | 299 | 761 | 827 | 591 | 343 | 115 | 91 | 10 | 14 | — | 21 | 3074 |
| 1 | — | 238 | 556 | 581 | 399 | 217 | 85 | 61 | 14 | 10 | — | 9 | 2170 |
| 2 | 1 | 82 | 170 | 164 | 120 | 63 | 25 | 13 | 2 | 2 | — | 4 | 646 |
| 3 | — | 29 | 54 | 60 | 37 | 17 | 6 | 2 | 1 | 4 | — | 2 | 212 |
| 4 | — | 14 | 15 | 16 | 7 | 5 | — | 1 | — | — | — | — | 58 |
| 5 | — | 4 | 4 | 5 | 1 | 2 | — | — | — | — | — | — | 16 |
| 6 | — | — | — | — | — | 1 | — | — | — | — | — | — | 1 |
| Totals | 3 | 666 | 1560 | 1653 | 1155 | 648 | 231 | 168 | 27 | 30 | — | 36 | 6177 |

## Table VII, 1908.
### Number per Inflorescence.

| Seeds per Locule. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1268 | 1371 | 1281 | 743 | 286 | 164 | 92 | 13 | 14 | 5232 |
| 1 | 1121 | 1157 | 984 | 596 | 218 | 118 | 69 | 2 | 10 | 4275 |
| 2 | 517 | 458 | 334 | 234 | 87 | 60 | 33 | 2 | 3 | 1728 |
| 3 | 181 | 163 | 111 | 80 | 28 | 16 | 13 | — | — | 592 |
| 4 | 66 | 47 | 40 | 18 | 8 | 4 | 6 | 1 | — | 190 |
| 5 | 27 | 13 | 9 | 8 | 4 | — | — | — | — | 61 |
| 6 | 5 | 5 | 4 | — | — | — | — | — | — | 14 |
| 7 | 3 | 2 | — | 1 | — | — | — | — | — | 6 |
| 8 | — | — | — | — | — | — | — | — | — | — |
| 9 | 1 | — | — | — | — | — | — | — | — | 1 |
| Totals | 3189 | 3216 | 2763 | 1680 | 631 | 362 | 213 | 18 | 27 | 12099 |

## Table VIII, 1909.
### Number per Inflorescence.

| Seeds per Locule. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 253 | 635 | 826 | 561 | 301 | 140 | 143 | 87 | 12 | — | 18 | 2976 |
| 1 | 188 | 478 | 577 | 428 | 218 | 104 | 114 | 87 | 11 | — | 7 | 2212 |
| 2 | 67 | 134 | 158 | 131 | 82 | 56 | 59 | 34 | 3 | — | 6 | 730 |
| 3 | 16 | 47 | 52 | 40 | 21 | 20 | 28 | 9 | 1 | — | 2 | 236 |
| 4 | 7 | 11 | 10 | 23 | 5 | 5 | 5 | 2 | — | — | — | 68 |
| 5 | 3 | 2 | 5 | 3 | — | — | 5 | — | — | — | — | 18 |
| 6 | — | 1 | 1 | 2 | — | 2 | — | — | — | — | — | 6 |
| Totals | 534 | 1308 | 1629 | 1188 | 627 | 327 | 354 | 219 | 27 | — | 33 | 6246 |

Although neither *o* nor *s* seem to be very dependent upon the number of fruits borne on the inflorescence, it is conceivable that the proportion of the ovules which develop into seeds may show a somewhat more sensible dependence upon the number of fruits among which available plastic material must be divided. To determine this point we simply classify the fruits according to the number produced on their inflorescence, compute the total number of ovules formed and the total number which develop to maturity, and calculate the ratio of the number of ovules formed to the number of seeds developing. This is the coefficient of fecundity.[1])

Combining the collections for the three years to avoid the extreme irregularity due to low frequencies of the larger inflorescences, we have these results:

| Number per Inflorescence | Total Ovules | Total Seeds | Coefficient of Fecundity |
|---|---|---|---|
| 1 | 28126 | 3572 | .1270 |
| 2 | 39713 | 4371 | .1101 |
| 3 | 46254 | 4472 | .0967 |
| 4 | 35848 | 3530 | .0985 |
| 5 | 19174 | 1776 | .0926 |
| 6 | 10822 | 1040 | .0961 |
| 7 | 6243 | 712 | .1140 |
| 8 | 3131 | 297 | .0949 |
| 9 | 614 | 57 | .0928 |
| Totals | 189923 | 19827 | .1044 |

Fruits which occur alone, or with only one other, on an inflorescence seem to be slightly more fecund than those in concurrence with a number of others.

There is, therefore, a slight relationship between the number of fruits per inflorescence and the proportional number of seeds developing per locule, and of such a nature that as the number of fruits per inflorescence increases, the relative number of seeds developing decreases. Physiologists would probably have predicted this, but the intensity of the relationship is lower than would generally have been expected.

## III. Position of pods inflorescence and fertility and fecundity.

The position of a fruit on the inflorescence axis might be considered of significance in determining the number of seeds which reach maturity.

Data for the correlation between the position of the pod on the inflorescence and the number of seeds developing per locule

[1]) See Biometrika. Vol. VII. 1910. p. 309—310.

for the twenty shrubs of the 1906 series are presented in the combination Table IX. Table 2 gives the constants.

For $r_{ps}$ fifteen of the coefficients are negative in sign. Only two deviate more than $\pm .100$ from 0, and the greatest is .128. So far as the magnitude of the individual constants is concerned, there is little reason to suspect a correlation between $p$ and $s$.

Table IX.

Combination Table showing the Correlation between the Position of the Fruit on the inflorescence and the number of Seeds per Locule for twenty individual Shrubs.

| Shrub | 0 | | | | | 1 | | | | | 2 | | | | | 3 | | | | 4 | | | | 5 | | | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| 11 | 73 | 65 | 34 | 4 | — | 60 | 43 | 20 | 4 | — | 14 | 5 | 2 | 1 | — | 3 | 1 | 1 | — | — | — | — | — | — | — | — | — |
| 12 | 118 | 70 | 14 | 4 | – | 72 | 46 | 10 | 2 | — | 11 | 10 | — | — | — | 10 | – | — | — | 2 | – | — | — | — | — | — | — |
| 13 | 60 | 52 | 15 | 2 | — | 68 | 33 | 9 | 2 | — | 27 | 11 | 3 | 1 | — | 14 | 4 | — | — | 4 | 1 | — | 1 | 1 | 1 | — | — |
| 14 | 77 | 60 | 14 | — | — | 60 | 39 | 8 | — | – | 21 | 10 | 5 | — | — | 3 | 1 | — | — | 1 | 1 | — | — | — | — | — | — |
| 15 | 85 | 65 | 34 | 2 | 2 | 49 | 34 | 18 | 1 | — | 11 | 9 | 5 | — | 1 | 2 | 2 | — | — | — | 1 | — | – | — | — | — | — |
| 16 | 88 | 54 | 18 | 4 | 1 | 50 | 41 | 14 | 1 | 2 | 11 | 2 | 5 | 1 | — | 4 | 2 | 2 | — | — | — | — | — | — | — | — | — |
| 17 | 92 | 57 | 13 | — | — | 68 | 29 | 10 | — | — | 16 | 10 | 3 | — | — | 3 | — | 1 | — | 1 | – | — | — | — | — | — | — |
| 18 | 70 | 74 | 28 | — | - | 38 | 42 | 20 | — | — | 7 | 8 | 7 | — | — | 2 | 1 | 2 | — | — | 1 | — | – | — | — | — | — |
| 19 | 88 | 61 | 17 | 2 | — | 45 | 50 | 18 | 1 | — | 8 | 2 | 3 | — | — | 2 | 1 | 1 | — | 1 | — | — | — | — | — | — | — |
| 20 | 75 | 43 | 15 | 1 | – | 52 | 40 | 19 | 2 | — | 29 | 13 | 6 | 1 | — | 7 | 6 | 5 | 2 | 4 | — | – | — | 4 | — | — | — |
| 21 | 21 | 22 | 14 | 7 | — | 34 | 43 | 18 | 8 | — | 36 | 20 | 12 | 4 | — | 10 | 16 | 5 | 5 | 10 | 5 | 5 | – | 3 | 2 | — | — |
| 22 | 75 | 49 | 19 | 1 | – | 61 | 27 | 16 | 2 | — | 19 | 10 | 8 | — | — | 8 | 4 | 2 | – | 2 | 3 | — | — | — | — | — | — |
| 23 | 91 | 56 | 13 | — | — | 65 | 35 | 14 | — | — | 13 | 7 | 3 | — | — | 2 | 1 | — | – | — | – | — | — | — | — | — | — |
| 24 | 78 | 44 | 18 | 3 | — | 53 | 27 | 12 | 2 | – | 30 | 12 | 5 | — | — | 9 | 1 | 3 | — | 1 | — | 1 | 1 | — | – | — | — |
| 25 | 60 | 44 | 30 | 4 | – | 48 | 39 | 16 | 2 | — | 16 | 12 | 4 | 2 | — | 7 | 5 | 3 | — | 3 | 1 | — | — | 1 | 1 | 1 | 1 |
| 26 | 78 | 48 | 27 | 7 | 2 | 58 | 33 | 13 | 3 | 1 | 8 | 7 | 2 | 2 | — | 4 | 5 | — | — | 1 | — | – | — | 1 | – | — | — |
| 27 | 74 | 59 | 19 | 4 | — | 68 | 30 | 13 | 2 | - | 13 | 7 | 4 | — | — | 5 | — | — | — | 1 | – | — | – | 1 | — | — | — |
| 28 | 86 | 46 | 10 | 4 | — | 64 | 36 | 8 | 4 | — | 25 | 12 | 2 | — | — | 9 | 5 | 1 | 1 | 2 | – | — | — | — | — | — | — |
| 29 | 77 | 52 | 24 | 5 | – | 51 | 23 | 12 | 3 | — | 22 | 11 | 3 | — | — | 6 | 4 | 2 | 1 | – | 3 | 1 | – | — | — | — | — |
| 30 | 67 | 55 | 28 | 2 | — | 45 | 43 | 17 | 1 | — | 18 | 12 | 6 | — | — | 5 | 1 | — | — | — | — | — | – | — | — | — | — |

And such a deviation as 5 plus to 15 minus from the expected 10 : 10 for signs is not very remarkable.

The average for the twenty constants is $-.0310 \pm .0088$, from which we see that the coefficient is only 3.89 times its probable error and hence hardly statistically trustworthy.

Comparing the average relationship between position and number of ovules per locule calculated for these same twenty individuals and published elsewhere, we find:

Position and Ovules, Mean $r = -.0733 \pm .0177$.
Position and Seeds, Mean $r = -.0310 \pm .0088$.
$.0423 \pm .0197$.

If any importance is to be attached to these constants, the number of ovules is more influenced by position on the inflorescence than the number of seeds developing. A priori, I would have expected the reverse, but we are treading entirely too near the danger line of chance errors to attribute much biological significance to our results.

Approaching the same problem from another side, we examine the correlation constants for position and number of ovules failing to develop into seeds for the twenty individuals of the 1906 series. They appear in Table 2.

These constants for $r_{pf}$ are equally divided between positive and negative. Only three deviate frome 0 more than $-.100$, and these only slightly. The average for the series is $-.0183 \pm .0109$. Obviously no significance whatever is to be attached to this value, and we must conclude that there is no evidence that the position of a fruit on its inflorescence has anything to do with the failure of ovules to develop into seeds.

Table 2.

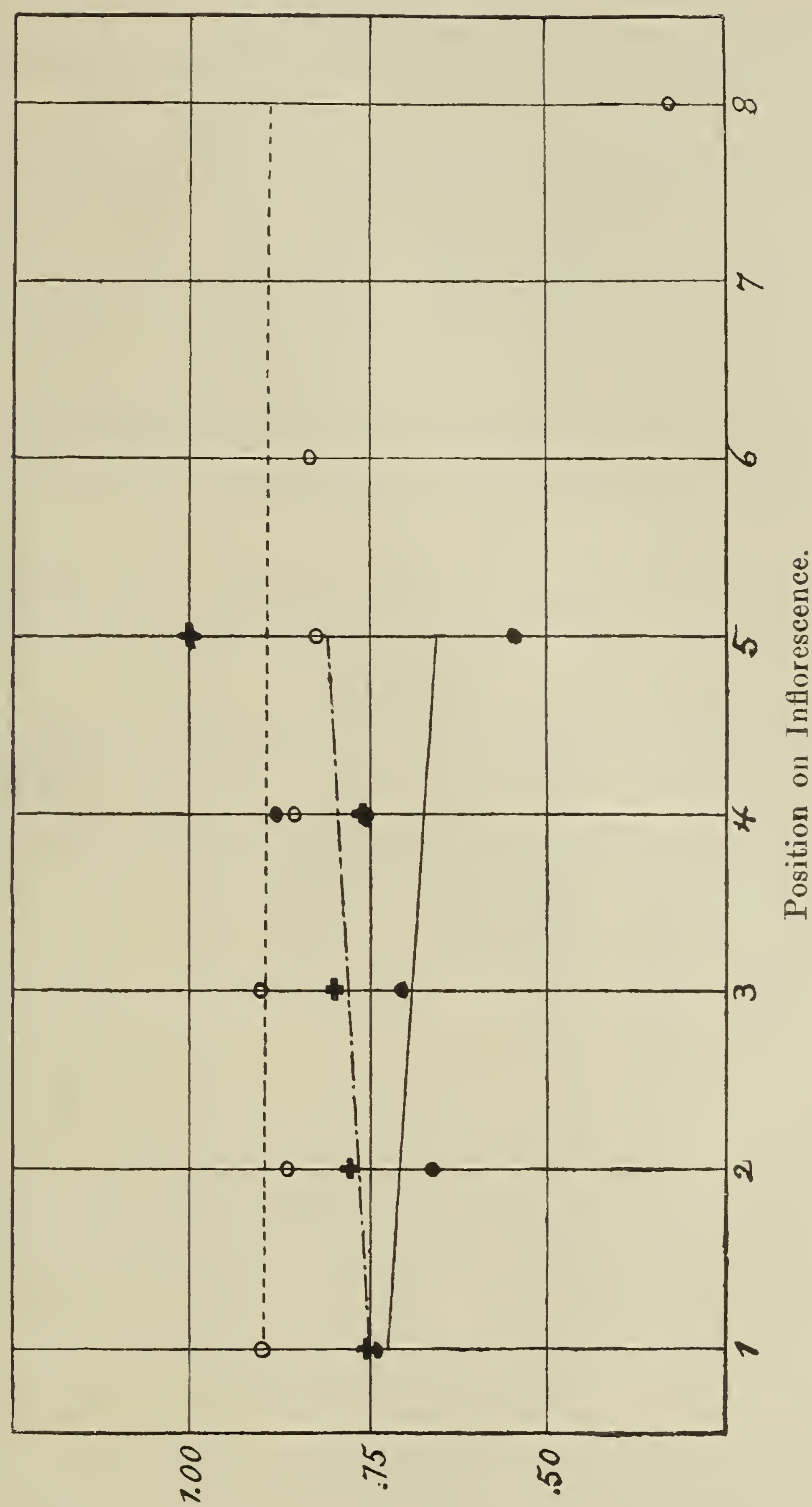
| Shrub. | $r_{ps}$ Position of Fruit and Number of Seeds. | $r_{pf}$ Position of Fruit and Number of Ovules Failing. |
|---|---|---|
| 11 | —.084 | .026 |
| 12 | —.088 | —.040 |
| 13 | —.128 | —.082 |
| 14 | —.048 | .041 |
| 15 | —.006 | .093 |
| 16 | —.058 | —.108 |
| 17 | —.018 | .013 |
| 18 | .091 | —.090 |
| 19 | .064 | .079 |
| 20 | .063 | —.165 |
| 21 | —.097 | —.000 |
| 22 | .005 | —.046 |
| 23 | .018 | .013 |
| 24 | —.006 | —.027 |
| 25 | —.009 | .026 |
| 26 | —.070 | —.092 |
| 27 | —.126 | —.146 |
| 28 | —.025 | .068 |
| 29 | —.017 | .036 |
| 30 | —.079 | .033 |

For $r_{ps}$ for the three general samples, we have:

1906, Table X, $r = -.0148 \pm .0086$.
1908, Table XI, $r = -.0077 \pm .0061$.
1909, Table XII, $r = +.0128 \pm .0085$.

How slender these relationships really are, may be best seen by expressing them in terms of regression. We have for the three straight line equations for position and number of seeds:

1906, $s = .7426 - .0167\, p$.
1908, $s = .8866 - .0098\, p$.
1909, $s = .7384 + .0159\, p$.




Explanation.

Diagramm I. Decrease in Number of Seeds per Locule associated with more distal position of fruits on inflorescence. The dots, circles and crosses show the empirical means; the lines are graduations of the data from the straight line equations. Solid dots and line = 1906; circles and dotted line = 1908 crosses and dot and dash line = 1909.

The means for the more distal positions carry little weight because of the smallness of the number upon which they are based.

## Table X, 1906.

Position:

| Seeds per Locule. | 1 | 2 | 3 | 4 | 5 | Totals. |
|---|---|---|---|---|---|---|
| 0 | 1533 | 1076 | 404 | 56 | 5 | 3074 |
| 1 | 1109 | 733 | 285 | 40 | 3 | 2170 |
| 2 | 355 | 190 | 88 | 12 | 1 | 646 |
| 3 | 115 | 60 | 28 | 9 | — | 212 |
| 4 | 33 | 16 | 7 | 2 | — | 58 |
| 5 | 11 | 4 | 1 | — | — | 16 |
| 6 | — | — | — | 1 | — | 1 |
| Totals | 3156 | 2079 | 813 | 120 | 9 | 6177 |

## Table XI, 1908.

Position:

| Seeds per Locule. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Totals. |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2674 | 1815 | 633 | 88 | 15 | 5 | — | 2 | 5232 |
| 1 | 2254 | 1474 | 463 | 67 | 11 | 5 | — | 1 | 4275 |
| 2 | 913 | 574 | 209 | 26 | 5 | 1 | — | — | 1728 |
| 3 | 301 | 195 | 84 | 9 | 2 | 1 | — | — | 592 |
| 4 | 104 | 64 | 18 | 4 | — | — | — | — | 190 |
| 5 | 27 | 23 | 11 | — | — | — | — | — | 61 |
| 6 | 12 | 1 | 1 | — | — | — | — | — | 14 |
| 7 | 2 | 2 | 1 | 1 | — | — | — | — | 6 |
| 8 | — | — | — | — | — | — | — | — | — |
| 9 | 1 | — | — | — | — | — | — | — | 1 |
| Totals | 6288 | 4148 | 1420 | 195 | 33 | 12 | — | 3 | 12099 |

## Table XII, 1909.

Position:

| Seeds per Locule. | 1 | 2 | 3 | 4 | 5 | Totals. |
|---|---|---|---|---|---|---|
| 0 | 1432 | 1141 | 361 | 42 | — | 2976 |
| 1 | 1042 | 854 | 275 | 38 | 3 | 2212 |
| 2 | 358 | 258 | 105 | 9 | — | 730 |
| 3 | 102 | 104 | 28 | 2 | — | 236 |
| 4 | 32 | 28 | 7 | 1 | — | 68 |
| 5 | 8 | 6 | 3 | 1 | — | 18 |
| 6 | 2 | 3 | 1 | — | — | 6 |
| Totals | 2976 | 2394 | 780 | 93 | 3 | 6246 |

Accordingly a difference of one node in the position of a fruit would be accompanied by no more change in the mean number of seeds than 1/100 to 2/100 seeds. This amount is so small that with no more than two thousand fruits, one cannot even be sure of the sign of the relationship. Diagram 1 shows by the slope of the lines and the plotted empirical means, how insignificant the correlation is.

The mean of the three regression coefficients is only —.0035 while for the regression of ovules on position as found in another place we have the average value —.0933. This result agrees with the conclusion drawn from the individuals of the 1906 collection, that the number of seeds developing is less dependent upon the position of the fruit on the inflorescence axis than is the number of ovules formed. I believe this result will be surprising to many botanists.

The same thing is made very clear by combining the three series of material and determining the coefficients of fecundity for the first five nodes of the inflorescences. We have:

| Position on Inflorescence | Total Ovules | Total Seeds | Coefficient of Fecundity |
|---|---|---|---|
| 1 | 97420 | 10224 | .1049 |
| 2 | 66504 | 6817 | .1025 |
| 3 | 23224 | 2469 | .1063 |
| 4 | 3094 | 345 | .1115 |
| 5 | 334 | 35 | .1048 |

## V. Summary and conclusions.

1. The foregoing pages contain the tabulated data and the results of analysis for three series comprising altogether over eight thousand fruits of *Staphylea trifolia*. The purpose of the work is to ascertain something concerning the internal factors influencing the development of the seed.

2. Much dogmatism prevails among biologists concerning the "explanation" of "fluctuating variability". It is frequently assumed that any variation polygon based upon "pure" material may be at once interpreted in terms of external environmental influences and internal differentiation.

3. Where an individual produces a series of organs which differ among themselves, it is generally assumed by biologists that differences in the vigor of individual branches or those due to "periodicity" will largely account for the "partial variability" observed. In some cases these factors probably have a considerable influence on the determination of the characters of the organs of an individual, but in the present material, the relative as well as the actual number of seeds developing seems to be very little

dependent upon either position on the inflorescence or number of fruits developing per inflorescence. There is a slight negative correlation for number of fruits and number of seeds developing, but position on the inflorescence seems to have no sensible influence on the capacity of the fruit for maturing its seeds.

4. The results set forth here, taken in connection with others to which reference has been made, show that fertility and fecundity are not always so easily influenced by the character of the inflorescence or by the position of the fruit on the inflorescence as might have been a priori expected. Only where we have large and diverse series of quantitative data for comparative study shall we be able to speak in general terms of the factors underlying the development of the ovules of an ovary into seeds.