VIII. *Mathematical Contributions to the Theory of Evolution.*—IX. *On the Principle of Homotyposis and its Relation to Heredity, to the Variability of the Individual, and to that of the Race. Part* I.—*Homotyposis in the Vegetable Kingdom.*

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CONTENTS.

I. INTRODUCTORY.

(1.) THE present paper endeavours to deal with a problem upon which I have long been occupied, adopting the widest basis compatible with the time and means at my disposal. In the first place, I have often been impressed with the small reduction in variability which can be produced by selection. The offspring of a single parent while diverging in character, possibly very widely from the average character of the race, will still have a variability in that character only slightly reduced, say at most 10 per cent. below the racial variability. Even if we select the ancestry for an indefinite number of generations, the offspring will have a variability upwards of 89 per cent. of that of the original race.* Now this capacity in the parent for producing variable offspring must be in some manner related to the degree of resemblance in those offspring. We have thus the two fundamental divisions of our subject:

(i.) What is the ratio of individual to racial variability?

(ii.) How is the variability in the individual related to inheritance within the race?

I must endeavour to explain my meaning a little more fully and clearly. The individual puts forth a number of like organs, corpuscles in the blood, petals of the flower, leaves of the trees, scales on the wing. These may or may not be divided up into differentiated groups. Special forms of leaves occur in the neighbourhood of the fruit; florets may be differentiated according to their position on the flower, scales

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* "On the Law of Ancestral Heredity," 'Roy. Soc. Proc.,' vol. 62, p. 400.

according to their position on the wing; there may be two or more classes of blood-corpuscles. But if we take organs which are like, and so far as we can judge undifferentiated, there is still a difference between them. The individual in putting forth what I may perhaps term "undifferentiated like organs,"* does so with a certain measure of variability. I am not concerned at present with the source of this variability. It may be due to the individual environment, to the physique of the individual, or to some inherent or bathmic tendency in the individual due to its ancestral history. All I am concerned with at present is, that the undifferentiated like organs of an individual possess a certain variability, and that this variability is somewhat less than that of all like organs in the race. If, however, the variability were entirely due to *external* circumstances attending growth, we should hardly expect to find leaves gathered from different branches and on different sides of a tree more alike to each other than to leaves of other trees of the same race. But this is indeed the case; there is a considerable correlation among the undifferentiated like organs of an individual notwithstanding the small reduction on racial variability. Among the trees and plants considered in this paper we have data enough to enable us to determine whether, say, a hundred leaves placed before us were gathered from a single tree, or collected at random from a number of trees. Here, of course, I mean by to "determine" to state the odds for or against these two assumptions.

Just as we can find by the methods already discussed in earlier memoirs of this series, the degree of correlation between brothers and the variability of an array of brothers due to the same parentage, so we can determine the correlation, *i.e.*, the degree of resemblance between the undifferentiated like organs of the individual and the degree of variability within the individual. This determination is the answer to our first fundamental problem, that of the ratio of individual to racial variability. But turning to the process of reproduction, the offspring depend upon the parental germs, and it would thus seem that the degree of resemblance between offspring

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* [I am fully conscious of *verbal* difficulty in the phrase "undifferentiated like organs," but I believe that the distinction between the differentiated and the undifferentiated is quite clear either from the standpoint of observation or from that of the frequency distribution itself. Differentiation, whether due to function, position on the individual, season of production, &c., is usually connected with one or two well-marked dominating factors; it is statistically discoverable by testing the frequency distribution for heterogeneity. On the other hand, variability in "undifferentiated like organs" is not to be associated with any one or two dominating factors which can be isolated; it is due to that combination of many small causes, inherent and environmental, which leads to what is familiar in both theory and observation as a homogeneous *chance* distribution. A diversity due to differentiation and a variability due to chance are quite distinct things. The one is the result of dominating factors which can be isolated and described; the other of a great number of small factors, varying from organ to organ, and incapable of being defined or specified. Indeed, upon each dominating factor of differentiation is superposed such a chance variability. Of course all things which differ even by chance variation are in a certain sense differentiated. But the term differentiation is throughout this paper reserved for the differences which arise, not from a multiplicity of small causes, but from dominating and usually easily recognisable single influences.—*July*, 1901.]

must depend on the variability of the sperm cells and the ova which may each be fairly considered as "undifferentiated like organs." Here again we are not compelled to assert that much or little is due to environment and little or much is due to inherent ancestral influence. All we assume is that such causes as produce the likeness between leaves of the same tree, or florets on the same flower, produce the likeness between spermatozoa or ova of the same individual, and that on this likeness the ultimate resemblance of offspring from the same parent depends. We have then to investigate how the quantitative resemblance between offspring of the same parents is related to the quantitative resemblance between the undifferentiated like organs in the individual; and then we must test on as wide a range of data as possible this theoretical relationship.

Now the reader will perceive at once that if we can throw back the resemblance of offspring of the same parents upon the resemblance between the undifferentiated like organs of the individual, we shall have largely simplified the whole problem of inheritance. Inheritance will not be a peculiar feature of the reproductive cells. One frog, let us say, differs from another in that it produces blood corpuscles more or less alike and unlike those of another frog. In the simplest forms of reproduction, budding and parthenogenesis, the offspring will not be absolutely alike, for buds and ova are undifferentiated like organs, and such organs have only a limited degree of resemblance. If this view be correct, variability is not a peculiarity of sexual reproduction, it is something peculiar to the production of undifferentiated like organs in the individual, and the problems of heredity must largely turn on how the resemblance between such organs is modified, if modified at all, by the conditions of nurture, growth, and environment generally. Our discussion of the subject will naturally break up into the following divisions:

(*a*.) On the theoretical relationship between the correlation of offspring and the correlation of undifferentiated like organs in the individual.

(*b*.) A determination of the correlation of undifferentiated like organs for as wide a range of life as possible.

The present paper deals only with variation and correlation in the vegetable kingdom, but the data for variation and correlation in the animal kingdom are being collected at the same time.

(*c*.) A comparison of the degree to which the results obtained from (*b*) satisfies the observed values of fraternal correlation already found when we use the relation determined in (*a*).

II. THEORETICAL DISCUSSION OF THE RELATION OF FRATERNAL CORRELATION TO THE CORRELATION OF UNDIFFERENTIATED LIKE ORGANS.

(2.) Let z be the deviation from the mean of the general population of any individual with regard to any character. Let us suppose z to depend upon certain characters in the spermatozoon and certain characters in the ovum from which the individual has developed. These characters cannot of course be determined, still less measured, but we have no reason to doubt their existence. In the particular spermatozoon from which the individual has developed, let them have deviations $x_1, x_2, x_3 \ldots$ from their mean values for all the spermatozoa of the race, and let $y_1, y_2, y_3 \ldots$ be the corresponding deviations for the ovum characters. Then

$$z = f(x_1, x_2, x_3 \ldots y_1, y_2, y_3 \ldots)$$

where f is a quite unknown function.

The mean of the z-character will, however, correspond to the mean values of the spermatozoon and ovum characters, and if we suppose the variation of these characters small as compared with their mean value, we assume as usual for such deviations:

$$z = \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \ldots + \beta_1 y_1 + \beta_2 y_2 + \beta_3 y_3 + \ldots \quad \text{(i.)},$$

where the α's and β's are independent of the x's and y's, and define the male and female inheritance.

Now let σ be the standard deviation of the character z in the population; σ_q the standard deviation of x_q, σ'_q of y_q. Let r_{pq} be the correlation of x_p and x_q, r'_{pq} of y_p and y_q. Then we will suppose that there is no selection of particular ova by particular spermatozoa, or that x_p and y_q are not correlated. Then if n = number of individuals in the population:

$$\sigma^2 = \frac{S(z^2)}{n} = \Sigma\alpha_p^2 \frac{S(x_p^2)}{n} + 2\Sigma(\alpha_p\alpha_q)\frac{S(x_px_q)}{n} + \Sigma\beta_p^2\frac{S(y_p^2)}{n} + 2\Sigma(\beta_p\beta_q)\frac{S(y_py_q)}{n},$$

where S is the sum for all individuals of any x or y for constant subscript, and Σ is the sum of α and β for every possible subscript. This follows by simple squaring and remembering that $S(x_p y_q) = 0$. We thus reach:

$$\sigma^2 = \Sigma(\alpha_p^2\sigma_p^2) + \Sigma(\beta_p^2\sigma'^2_p) + 2\Sigma(\alpha_p\alpha_q\sigma_p\sigma_q r_{pq}) + 2\Sigma(\beta_p\beta_q\sigma'_p\sigma'_q r'_{pq}). \quad \text{(ii.)}.$$

Now let us consider the correlation of two individuals due to the spermatozoa and ova put forth by the same two individuals. Let z_1 and z_2 be the values of their characters, and x', x'', y', y'' represent the fundamental characters in the two spermatozoa, and two ova on which they depend.

Then we have

$$z_1 = \Sigma(\alpha_p x'_p) + \Sigma(\beta_p y'_p)$$
$$z_2 = \Sigma(\alpha_p x''_p) + \Sigma(\beta_p y''_p).$$

Now let us multiply z_1 by z_2 and sum for every fraternal pair; then if R be the fraternal correlation we have, since one set of brethren will have the same standard deviation as the other, if they be taken of the same sex,

$$S(z_1 \times z_2) = n \times \sigma \times \sigma \times R,$$

where n is the total number of pairs of brethren.

Hence

$$n \times \sigma^2 \times R = \Sigma(\alpha_p^2 (x'_p x''_p)) + \Sigma(\alpha_p \alpha_q S(x'_p x''_q + x''_p x'_q)) + \Sigma(\beta_p^2 S(y'_p y''_p)) + \Sigma(\beta_p \beta_q S(y'_p y''_q + y''_p y'_q))$$

with the same notation as before and the same assumption as to no selective process between the female and male reproductive cells.

Now x'_p, x''_p are undifferentiated like organs put forth by an individual. If ρ_{pp} be the correlation of such :

$$S(x'_p x''_p) = n\sigma_p^2 \rho_{pp},$$

Similarly

$$S(y'_p y''_p) = n\sigma'^2_p \rho'_{pp}.$$

In the next place we should have *all* pairs of brothers :

$$S(x'_p x''_q) = S(x''_p x'_q) = \sigma_p \sigma_q \rho_{pq},$$

$$S(y'_p y''_q) = S(y''_p y'_q) = \sigma'_p \sigma'_q \rho'_{pq}.$$

We thus deduce

$$\sigma^2 \times R = \Sigma(\alpha_p^2 \sigma_p^2 \rho_{pp}) + \Sigma(\beta_p^2 \sigma'^2_p \rho'_{pp}) + 2\Sigma(\alpha_p \alpha_q \sigma_p \sigma_q \rho_{pq}) + 2\Sigma(\beta_p \beta_q \sigma'_p \sigma'_q \rho'_{pq}) \quad . \quad . \quad . \quad . \quad . \quad \text{(iii.)}.$$

Now if the degree of resemblance between undifferentiated like organs vary largely from organ to organ, we could proceed no further with this investigation. We should have shown that there was a relation, namely (iii.) between the R and the ρ's, but as the characters in the spermatozoa and ova are unknown and unmeasurable, we could not proceed further. On the other hand, if the correlation between undifferentiated like organs is approximately constant, then we may replace correlation coefficients like ρ_{pp} and ρ'_{pq} by their *mean* value ρ, say.

We have next to consider such correlations as ρ_{pq} or ρ'_{pq}. These are the two correlations between two different characters in two spermatozoa or ova from the same individual. Such correlations must vanish (i.) if there be no organic correlation between characters of the same spermatozoon or ovum, (ii.) if there be no correlation between the reproductive cells put forth by the same individual. In other words, ρ_{pq} must contain ρ and r_{pq} as factors, and since if these two correlations are perfect ρ_{pq} must be perfect, it is a reasonable hypothesis to assume

$$\rho_{pq} = \rho \times r_{pq} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(iv.)}.$$

This, it will be seen, is identical in form with the result I have supposed to hold for cross-heredity,* and which appears to be approximately true for that case. We shall consider later statistics bearing on this result.

Assuming accordingly that (iv.) holds, we find from (iii.)

$$\begin{aligned}\sigma^2 \times \mathrm{R} &= \rho\{\Sigma\,(\alpha_p{}^2\sigma_p{}^2) + \Sigma\,(\beta_p{}^2\sigma'_p{}^2) + 2\Sigma\,(\alpha_p\alpha_q\sigma_p\sigma_q r_{pq}) + 2\Sigma\,(\beta_p\beta_q\sigma'_p\sigma'_q r'_{pq})\} \\ &= \rho \times \sigma^2 \text{ by (ii.)}.\end{aligned}$$

Hence we conclude that

$$\mathrm{R} = \rho \quad \text{. . . . . (v.).}$$

Or: *The correlation between brothers will be equal to the mean correlation between the undifferentiated like organs put forth by an individual.*

Now, if this result be true, it is very remarkable and very fundamental. We should hardly expect it to be absolutely true, for it is very unlikely that the coefficient of correlation between undifferentiated like organs is the same whatever the organs may be. This equality may rather be spoken of as belonging to an ideal theoretical vital state approaching the actual state, perhaps, as BOYLE'S Law or the perfect fluid approach phenomena observed in physical nature. What we should expect would be a general approximation between the values of R and ρ, and a tendency to equality when large series are averaged. This is the point which we shall investigate in the sixth section of this paper, after placing before the reader in the fourth section a fairly wide† range of actual statistics.

It will be seen at once that if (v.) represents an approximate or average truth of living nature, then the problem of inheritance is to a large extent the same as the problem of variability in the individual. We have not answered, of course, even in part, the problem of why two brothers resemble each other, but we see that it is part of a much more general problem having nothing to do with sexual reproduction. It is one with the problem of the likeness in leaves of the same tree, or the likeness in scales on the same spot of a moth's wing. It brings the problem of heredity into closer touch with the problem of variability. When we ascertain the sources of variation in the individual, then we shall have light on the problem of fraternal resemblance.

III. ON THE VARIABILITY AND CORRELATION OF UNDIFFERENTIATED LIKE ORGANS IN THE INDIVIDUAL.

(3.) I must frankly admit that I have collected my material from the standpoint of the mathematical statistician and not of the trained field naturalist. I have sought things which were easy to count and measure, and endeavoured to avoid "differentia-

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* "The Law of Ancestral Heredity," 'Roy. Soc. Proc.,' vol. 62, p. 411.

† Not wide when we regard the natural range of living forms, but from the standpoint of the labour that has been spent on the collection.

tion" only by the roughest tests and by largely untrained powers of observation. I have examined my material to see if it gave obvious signs of heterogeneity in the tabulated bulk. I have examined my individuals and their organs for obvious outward signs of differentiation. But I have not studied the morphological evolution of the organs considered, or questioned whether the parts counted were all due to the same source. Hence it is quite possible that the botanist may reject at once some of my series. What I have endeavoured to do is to take as wide a range of as different organs as possible in different types of life and trust to the bulk of my statistics to give me a substantially accurate average value of ρ to compare with the values of R we have determined on other occasions. At the same time the material here presented does not by any means exhibit all the trials made; we often enough at the first attempt did not get a suitable character to measure or count, or again the individuals collected were occasionally insufficient. Nothing, however, has been omitted which was unfavourable to the conclusions ultimately drawn. Thus the *Nigella Hispanica* statistics have been retained, although there is not the slightest doubt of a very considerable differentiation in the flowers growing at different parts of the plant.

When such a differentiation takes place the result will generally be a great reduction in the correlation; for "like" organs on the same individual, say A and a if differentiated, will really be less closely related to each other than to B and b respectively, the corresponding organs in a second individual. On the other hand a heterogeneity of material, say a mixture of two different local races, will tend as a rule to raise the correlation,* for it generally amounts to compounding two very like correlation surfaces with the mean of one approximately shifted along the regression line of the second. If we bear these two opposing influences in mind, differentiation tending to reduce, heterogeneity to increase the actual degree of correlation of undifferentiated like organs, it will not seem incompatible with an actual approximate constancy of such correlation to find a fairly wide range of values in our statistics. We set them forth as the first rough attempt to appreciate the resemblance of like parts within the individual. To the specialist in the future must be left the work of selecting, with special knowledge, truly homogeneous material and absolutely undifferentiated characters, and thus obtaining the required correlation to a much higher degree of accuracy.

(4.) It remains to explain the process by which the correlation was deduced. Let us take as an illustration beech-leaves. One hundred trees fairly of the same age and belonging to the same district, were selected, and twenty-six leaves specified by the letters of the alphabet were gathered from each of these. The leaves were gathered so far as possible all round the outside of the tree, roughly about the same height from the ground, and scattered over different parts of the individual boughs. Thus each tree was supposed to be individualised by twenty-six leaves. The veins on these leaves were then counted, and varied for beech-leaves in general between ten and twenty-two.

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* See 'Phil. Trans.,' A, vol. 192, p. 277.

All the possible pairs were now taken, *i.e.*, $\frac{1}{2}(26 \times 25) = 325$ in number, and entered on a correlation table in the usual manner, the two variables being the number of veins in the first leaf and the number of veins in the second leaf. But as either member of the pair might be a "first" leaf, the table so formed was rendered symmetrical by starting with either leaf in the pair as first or second. Thus a single tree led to 650 entries in the correlation table, or with 100 trees there were 65,000 entries. This large number must not lead the reader to overweight the importance of the constants calculated upon it. There were only 100 trees leading to 32,500 pairs of leaves, each pair coming from the same tree. I should have much preferred a thousand trees, but the great labour of collecting, counting, and calculating precluded any such number. In many cases also it would have been practically impossible to have obtained 100 individuals growing under fairly like environment. For example, I only succeeded in approximating to 100 Spanish chestnuts from one district and near one age. When I took a second hundred, gathered from several districts, partly old trees and partly others of a pollard growth of fifteen to twenty years, I found the heterogeneity at once increased the correlation (see below, p. 301). In many cases, of course, it was impossible to obtain twenty-six undifferentiated like organs from the same individual. In these cases the pairs were formed in the same manner, but in some series the total number due to each individual varied very considerably, and accordingly the work of verifying the tables was much increased. When but few pairs could be obtained from each individual, we have sometimes increased the number of individuals dealt with up to a couple of hundred. But the labour of dealing even with a hundred individuals is often—for example, in the case of mushrooms and onions—very serious. Had it not been for the generous help of a number not only of willing but of competent collectors and calculators, the material here dealt with would have taken not eighteen months but years of my own unaided efforts.

The calculation of the means, standard deviations, probable errors, and correlations of each table was carried out in the manner sufficiently discussed in earlier papers of this series.* The symmetry of the tables leads to slight simplifications in calculating the product moment which will readily suggest themselves to the reader, and of course only a single mean and standard deviation is required for each table. Tests for the accuracy of the last two constants are at once provided in the case in which the same number of organs are taken from each individual, for their values must be identical with those obtained for the whole series of organs entered only once and not for each possible pair.

(5.) The quantitative measurement of the degree of resemblance between undifferentiated-like organs being, so far as I am aware, a quite novel branch of investigation, I venture, with some hesitation, to introduce certain terms to describe oft-

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* See especially Memoir III., 'Phil. Trans.,' A, vol. 187, pp. 253–318, and Memoir IV., 'Phil. Trans.,' A, vol. 191, pp. 229–311.

recurring ideas. I shall call undifferentiated like organs *homotypes*, indicating that they are types produced by the same mould or individual. Thus two leaves of the same tree, or two blood-corpuscles from the same frog are *homotypes*; their resemblance will be homotypic, and the character by which their resemblance is quantitatively measured will be the *homotypic* character. I shall speak of *homotypic* correlation and distinguish it from *organic* correlation—although, of course, the former is in a certain sense organic. By organic correlation I refer to the correlation between two different characters in the same organ; by homotypic correlation to the correlation between the same or different characters in a pair of homotypes. If the same character, then the correlation is *direct homotypic correlation*; if different characters, then the correlation is *cross homotypic correlation*. Lastly, the principle that homotypes are correlated, *i.e.*, that variation within the individual is less than that of the race, or that undifferentiated like organs have a certain degree of resemblance, I shall speak of as *homotyposis*. Thus homotyposis denotes not only likeness of the homotypes, but that this likeness has probably definite quantitative limits. If my view be correct, heredity is only a special case of homotyposis, any multiplication of cells is homotypical, and denotes a given degree of variation and a given degree of likeness. This does not "explain" heredity, but shows it merely as a phase of a much wider natural process.

IV. ACTUAL DATA.

SECTION I.—*Leaves of Trees.*

(6.) The leaves of trees provide material for fairly easy computation without measurement. Thus we may count the veins on the leaf or the leaflets on the compound leaf, and ascertain the degree of resemblance between leaves of the same tree. The variation is, however, in some cases very considerable, and the labour of forming the tables involving thousands of entries very great. Still the leaf-series are some of my best, and considered as a whole, perhaps the most satisfactory.

(7.) A. *Ash* (Fraxinus excelsior). *Number of* Pinnæ *on Leaf.*—My first series (i.) consists of 26 leaves taken from each of 109 trees by Dr. ALICE LEE or myself. The trees were nearly all large old trees, growing on the commons of Great and Little Hampden, Buckinghamshire. The leaves were taken as far as possible from a variety of branches all round the tree, and from different points on these branches. The labour of tabling and deducing the constants is due to Dr. LEE. The number of pairs = 70,850.

My second series (ii.) consist of 26 leaves taken from each of 120 trees by Miss C D. FAWCETT, B.Sc. These trees, many of which were young trees growing in the hedgerows, were taken in the neighbourhood of Lyme Regis in Dorsetshire. The same rules as to gathering were observed. Dr. LEE again undertook the labour of tabling and the deduction of the constants. The number of pairs = 78,000.

My third series consists of 26 leaves from each of 100 trees in Monmouthshire, young trees being included, but the same rules as to gathering being observed. The whole of the labour of gathering, counting and deducing the constants is due to Miss MILDRED E. BARWELL, of Girton College.*

The general numerical results are given in the table below :—

Resemblance of Ash Leaves from same Tree.

Series.	Number.			Mean No. of leaflets.	S. D. of leaflets.	Correlation.
	Trees.	Leaves.	Pairs.			
Buckinghamshire	109	2834	70850	10·1295 ± ·0214	1·6891 ± ·0151	·3743 [± ·0109]†
Dorsetshire . .	120	3120	78000	9·7260 ± ·0239	1·9759 ± ·0169	·3964 [± ·0102]
Monmouthshire .	100	2600	65000	9·8766 ± ·0265	2·0058 ± ·0188	·4047 [± ·0111]
Mean of series .	—	—	—	9·9107	1·8903	·3918

Thus a total of 329 trees, giving 8,554 compound leaves counted and yielding 213,850 pairs on the symmetrical tables, were dealt with in all.

It will be seen at once that the mean number of *pinnæ* to the leaf, and their variability differs considerably with the locality, the age and the environment of the tree, but the correlation of leaves from the same tree is fairly alike for the three series, and almost identical with the theoretical value ·4000 given by the Law of Ancestral Heredity for the degree of resemblance between pairs of brothers.

The following is the actual distribution of the frequency of the leaflets :—

Number of Pinnæ on Leaves.

Series.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Total.
Buckingh'shire	3	0	16	21	201	67	879	156	1140	68	257	9	17	0	2834
Dorsetshire. .	4	0	84	30	396	115	959	228	911	72	280	11	29	1	3120
Monmouthshire	1	5	42	24	279	55	836	143	896	83	216	6	13	1	2600
Total . .	8	5	142	75	876	237	2674	527	2947	223	753	26	59	2	8554

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* This was a remarkably satisfactory piece of work, carried through from the collecting of the raw material down to the calculation of the constants, the statistical methods having to be mastered and applied during the course of the investigation.

† In determining the probable errors of the correlation coefficients, there is some question as to whether we should use the number of individuals, which seems too small, the number of pairs, which seems too large, or the number of individual organs dealt with. I have used the latter, but enclose the probable errors in brackets to mark the doubt.

It will be remarked at once that the leaves with an even number of leaflets are relatively infrequent; there is usually a single leaflet at the end of the compound leaf. I was able at Hampden, however, to obtain leaves illustrating almost the whole evolution of this single leaflet. Sometimes this leaflet had the slightest division at its point; this division was found in most stages of double tongued leaflet down to a complete double leaf, which would be reckoned as two *pinnæ*. In the same way the centre leaflet was found slightly trisected, three tongued and finally a triple leaflet scarcely distinguishable from the usual single leaf at the end and the two nearest side leaflets. Very occasionally the double leaflet seemed to give one side leaflet and the final leaflet. Of course, all these anomalies were rare and had to be sought for, but they would form in themselves a suggestive study.

The Dorsetshire series gives 9 *pinnæ* instead of 11 as the mode, and 7 are more frequent than 13. This latter result is also true for the Monmouthshire series, which again has nothing like the same preponderance on its modal 11 as the Buckinghamshire series. I take it that the greater variability of both Dorsetshire and Monmouthshire series, together with their greater relative proportion of compound leaves with 9 and 7 *pinnæ*, is due to those series containing a much larger proportion than the Buckinghamshire series of small trees.

For ashes in general, I think, we may safely take 10 as the average (but *not the modal*) number of *pinnæ*, the standard deviation is 1·9 *pinnæ*, and the leaf resemblance is measured by a correlation of ·4.

If we compare racial and individual variabilities we have:

Series.	S. D.	S. D. of array.	Coefficient of variation.	Percentage variability.
Buckinghamshire . .	1·6891	1·5663	15·46	92·73
Dorsetshire	1·9759	1·8140	18·65	91·81
Monmouthshire . .	2·0058	1·8342	18·57	91·44
Mean . . .	1·8903	1·7382	17·56	91·99

Thus 92 per cent. of the total racial variability of this character of the ash is to be found in the individual tree, and here, as in all our other series, it is impossible to assert that variation is a result of sexual reproduction; it is clearly an essential factor of the individual growth. I conclude with the actual tables of data for the three series.

TABLE I.—(i.) Buckinghamshire Ashes.

Number of Pinnæ on First Leaf.

Number of Pinnæ on Second Leaf.

	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Totals.
3	6	0	6	6	15	0	6	0	33	3	—	—	—	—	75
4	0	0	0	0	0	0	0	0	0	0	—	—	—	—	0
5	6	0	18	16	74	14	155	18	94	3	2	—	—	—	400
6	6	0	16	24	96	25	213	29	113	3	0	—	—	—	525
7	15	0	74	96	716	211	2168	235	1385	34	87	0	4	—	5025
8	0	0	14	25	211	50	732	82	485	17	56	0	3	—	1675
9	6	0	155	213	2168	732	8970	1305	7361	278	756	11	20	—	21975
10	0	0	18	29	235	82	1305	278	1648	69	213	6	17	—	3900
11	33	0	94	113	1385	485	7361	1648	13558	838	2825	57	103	—	28500
12	3	0	3	3	34	17	278	69	838	90	326	19	20	—	1700
13	—	—	2	0	87	56	756	213	2825	326	1896	88	176	—	6425
14	—	—	—	—	0	0	11	6	57	19	88	16	28	—	225
15	—	—	—	—	4	3	20	17	103	20	176	28	54	—	425
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Totals	75	0	400	525	5025	1675	21975	3900	28500	1700	6425	225	425	0	70850

TABLE II.—(ii.) Dorsetshire Ashes.

Number of Pinnæ on First Leaf.

Number of Pinnæ on Second Leaf.

	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Totals.
3	2	0	2	0	23	1	37	2	24	5	4	—	—	—	100
4	0	0	0	0	0	0	0	0	0	0	0	—	—	—	0
5	2	0	170	36	506	129	786	108	324	6	28	3	2	—	2100
6	0	0	36	22	114	39	245	62	186	11	31	0	4	—	750
7	23	0	506	114	2298	465	3726	641	1816	83	210	6	12	—	9900
8	1	0	129	39	465	454	782	338	536	31	88	2	10	—	2875
9	37	0	786	245	3726	782	9428	1662	6172	308	793	13	23	—	23975
10	2	0	108	62	641	338	1662	820	1554	103	360	9	40	1	5700
11	24	0	324	186	1816	536	6172	1554	8806	676	2421	62	192	6	22775
12	5	0	6	11	83	31	308	103	676	114	417	16	28	2	1800
13	4	0	28	31	210	88	793	360	2421	417	2276	120	238	14	7000
14	—	—	3	0	6	2	13	9	62	16	120	10	34	0	275
15	—	—	2	4	12	10	23	40	192	28	238	34	140	2	725
16	—	—	—	—	—	—	—	1	6	2	14	0	2	0	25
Totals...	100	0	2100	750	9900	2875	23975	5700	22775	1800	7000	275	725	25	78000

TABLE III.—(iii.) Monmouthshire Ashes.

Number of Pinnæ on First Leaf.

Number of Pinnæ on Second Leaf.

	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Totals.
3	—	—	4	2	9	1	8	0	1	—	—	—	—	—	25
4	—	2	0	5	19	3	66	8	21	1	—	—	—	—	125
5	4	0	34	18	208	36	366	47	269	24	38	6	—	—	1050
6	2	5	18	10	106	21	251	32	138	2	15	0	—	—	600
7	9	19	208	106	1450	280	2594	283	1593	132	277	9	14	1	6975
8	1	3	36	21	280	60	464	86	365	19	38	1	1	0	1375
9	8	66	366	251	2594	464	8022	1227	6468	430	950	24	28	2	20900
10	0	8	47	32	283	86	1227	222	1344	94	216	2	13	1	3575
11	1	21	269	138	1593	365	6468	1344	9292	841	1924	46	93	5	22400
12	—	1	24	2	132	19	430	94	841	138	366	12	16	0	2075
13	—	—	38	15	277	38	950	216	1924	366	1388	45	131	12	5400
14	—	—	6	0	9	1	24	2	46	12	45	2	3	0	150
15	—	—	—	—	14	1	28	13	93	16	131	3	22	4	325
16	—	—	—	—	1	0	2	1	5	0	12	0	4	0	25
Totals...	25	125	1050	600	6975	1375	20900	3575	22400	2075	5400	150	325	25	65000

(8.) B. *Spanish Chestnut* (Castanea vulgaris). *Veins in the Leaf.*—A character which at first sight appears easy to determine is the number of veins running from the main rib to the edge of a leaf. The leaves of many trees, however, will on examination be found quite unsuitable, the veining being far too complex, too much indeed of a network. Among fairly practicable leaves are those of the beech and the Spanish chestnut. Here two fundamental difficulties occur : (i.) near the tip of the leaf the number of veins becomes rather difficult to register. In the case of the beech by holding the leaf in various lights or even using a lens, it was possible to be fairly sure of the separate veins. In the case of the chestnut, the total number of veins is so great that the addition or omission of a single vein is hardly likely on the average to lead to any serious error. (ii.) The occasional branching or bifurcation of the vein formed a difficulty, especially if it occurred near the edge of the leaf. If the bifurcation occurred close up to the main rib of the leaf, the vein system was counted as two ; if close to the edge of the leaf as one ; intermediate bifurcations had to be left to the judgment of the recorder, having regard to the general appearance of the leaf and its system of subsidiary veining. The doubtful cases were not very many, and occurred more frequently with the chestnut than with the beech leaves. In neither case was the main rib or vein included in the total number for the leaf, the record was of the side veins flowing from this. The numbers right and left in the beech leaf were found to be far more nearly equal than in the case of the chestnut, which thus possessed considerably greater asymmetry. In these cases as in those of the ash, the leaves were gathered at random round the tree, and at random on the branches, care being, however, taken in the case of the chestnut to avoid leaves in the neighbourhood of the fruit.*

Series (i.). *Hampden Spanish Chestnuts.*

I had hoped to get records for 26 leaves from each of 100 trees from the splendid chestnut avenue at Hampden House, but it provided records for some 60 trees only. These I owe to Miss LINA ECKENSTEIN. I was able to add by diligent search about 25 additional trees from the same neighbourhood. All these were large forest trees of splendid growth. In order to make the number up to 100, some 15 additional trees were added, these being all large old trees from other neighbourhoods. I look upon this series as a fairly homogeneous one, representing the degree of resemblance between leaves on fully developed forest trees. The counting of the veins on this series was undertaken by Miss C. D. FAWCETT, B.Sc., and the tabulating and numerical reduction by Dr. LEE. Both these processes involved an immense amount of labour, in fact days and days of careful and fatiguing work.

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* The leaves were all gathered in the autumn, towards the fall.

Number of Veins on Second Leaf.

	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.
20	—	—	—	—	1	0	1	0	0	1	2	7	1	1	0	2	0	4
21	—	—	—	—	0	1	2	1	2	1	2	2	0	2	6	5	1	3
22	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	1	2	1	1	2	3	9	10	5	5	12	7	7
25	0	1	0	0	1	0	2	1	2	1	6	4	4	0	6	10	7	8
26	1	2	0	0	2	2	2	3	4	6	9	9	5	6	9	17	4	10
27	0	1	0	0	1	1	3	8	4	11	16	17	21	29	37	26	24	20
28	0	2	0	0	1	2	4	4	4	11	25	12	7	26	25	32	13	27
29	1	1	0	0	2	1	6	11	11	12	36	23	19	29	31	42	23	32
30	2	2	0	0	3	6	9	16	25	36	38	53	43	66	68	100	61	73
31	7	2	0	0	9	4	9	17	12	23	53	56	51	56	67	93	61	89
32	1	0	0	0	10	4	5	21	7	19	43	51	66	59	76	99	73	74
33	1	2	0	0	5	0	6	29	26	29	66	56	59	92	95	133	104	101
34	0	6	0	0	5	6	9	37	25	31	68	67	76	95	124	156	158	158
35	2	5	0	0	12	10	17	26	32	42	100	93	99	133	156	174	174	180
36	0	1	0	0	7	7	4	24	13	23	61	61	73	104	158	174	222	233
37	4	3	0	0	7	8	10	20	27	32	73	89	74	101	158	180	233	242
38	0	3	0	0	11	8	9	18	27	45	88	77	107	125	171	221	252	267
39	2	3	0	0	9	9	11	21	26	32	69	79	74	111	155	208	244	250
40	0	7	0	0	6	8	12	31	31	44	86	70	98	124	183	197	251	256
41	0	1	0	0	6	6	7	9	13	19	44	44	75	51	113	137	189	196
42	1	1	0	0	5	9	6	20	19	23	53	46	52	87	131	146	240	249
43	0	2	0	0	5	0	3	11	6	8	27	29	56	42	95	87	140	136
44	0	1	0	0	2	4	0	5	7	8	30	26	34	34	87	74	140	134
45	1	1	0	0	7	1	6	7	9	7	18	27	38	34	67	60	85	105
46	0	3	0	0	3	1	1	2	6	3	11	16	33	33	52	56	84	74
47	1	0	0	0	4	0	4	4	5	4	9	16	13	12	43	35	58	44
48	—	—	—	—	1	0	0	1	1	0	5	9	13	17	48	32	63	62
49	—	—	—	—	—	0	0	0	2	2	4	9	9	5	15	13	15	28
50	—	—	—	—	—	0	0	0	0	0	0	8	7	3	16	7	25	27
51	—	—	—	—	—	0	0	0	0	0	0	2	4	2	6	7	16	11
52	—	—	—	—	—	1	0	0	1	0	3	5	2	2	14	6	22	16
53	—	—	—	—	—	—	—	0	0	0	0	1	0	1	3	2	3	0
54	—	—	—	—	—	—	—	2	2	0	2	2	2	13	5	7	8	9
55	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
57	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
58	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	25	50	0	0	125	100	150	350	350	475	1050	1075	1225	1500	2225	2550	3000	3125

Table IV.—Hampden Chestnut Trees.

Number of Veins on First Leaf.

6.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.
0	4	0	2	0	0	1	0	0	1	0	1	—	—	—	—	—
1	3	3	3	7	1	1	2	1	1	3	0	—	—	—	—	—
0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	—
0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	—
7	7	11	9	6	6	5	5	2	7	3	4	1	—	—	—	—
7	8	8	9	8	6	9	0	4	1	1	0	0	0	0	0	1
4	10	9	11	12	7	6	3	0	6	1	4	0	0	0	0	0
24	20	18	21	31	9	20	11	5	7	2	4	1	0	0	0	0
13	27	27	26	31	13	19	6	7	9	6	5	1	2	0	0	1
23	32	45	32	44	19	23	8	8	7	3	4	0	2	0	0	0
61	73	88	69	86	44	53	27	30	18	11	9	5	4	0	0	3
61	89	77	79	70	44	46	29	26	27	16	16	9	9	8	2	5
73	74	107	74	98	75	52	56	34	38	33	13	13	9	7	4	2
04	101	125	111	124	51	87	42	34	34	33	12	17	5	3	2	2
58	158	171	155	183	113	131	95	87	67	52	43	48	15	16	6	14
74	180	221	208	197	137	146	87	74	60	56	35	32	13	7	7	6
22	233	252	244	251	189	240	140	140	85	84	58	63	15	25	16	22
33	242	267	250	256	196	249	136	134	105	74	44	62	28	27	11	16
52	267	292	328	307	240	288	181	172	129	103	65	72	34	40	15	20
44	250	328	346	344	315	343	233	181	189	144	118	117	36	50	30	24
51	256	307	344	396	367	393	311	277	280	219	162	163	67	77	49	75
89	196	240	315	367	312	326	252	246	264	175	175	132	43	46	29	26
40	249	288	343	393	326	378	300	299	256	207	174	145	64	74	34	57
40	136	181	233	311	252	300	276	262	282	255	215	176	103	89	71	72
40	134	172	181	277	246	299	262	226	277	237	233	172	96	101	56	64
85	105	129	189	280	264	256	282	277	284	309	251	200	149	146	56	87
84	74	103	144	219	175	207	255	237	309	342	256	258	158	146	99	120
58	44	65	118	162	175	174	215	233	251	256	224	203	104	96	81	75
63	62	72	117	163	132	145	176	172	200	258	203	230	128	131	106	114
15	28	34	36	67	43	64	103	96	149	158	104	128	80	96	61	85
25	27	40	50	77	46	74	89	101	146	146	96	131	96	122	67	92
16	11	15	30	49	29	34	71	56	56	99	81	106	61	67	42	67
22	16	20	24	75	26	57	72	64	87	120	75	114	85	92	67	80
3	0	5	10	17	9	19	26	23	32	38	32	25	25	34	24	24
8	9	5	14	26	8	16	26	27	35	47	36	33	23	39	20	18
—	—	—	—	5	0	4	14	4	7	10	7	5	5	2	6	7
—	—	—	—	4	0	0	7	1	1	11	8	9	6	3	11	11
—	—	—	—	4	0	4	12	4	7	7	5	3	4	2	3	5
—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0
—	—	—	—	3	0	6	15	6	11	6	3	1	6	4	0	5
00	3125	3725	4125	4950	3875	4475	3825	3550	3725	3525	2775	2675	1475	1550	975	1200

52.	53.	54.	55.	56.	57.	58.	59.	Totals.
—	—	—	—	—	—	—	—	25
—	—	—	—	—	—	—	—	50
—	—	—	—	—	—	—	—	0
—	—	—	—	—	—	—	—	0
—	—	—	—	—	—	—	—	125
1	—	—	—	—	—	—	—	100
0	—	—	—	—	—	—	—	150
0	0	2	—	—	—	—	—	350
1	0	2	—	—	—	—	—	350
0	0	0	—	—	—	—	—	475
3	0	2	—	—	—	—	—	1050
5	1	2	—	—	—	—	—	1075
2	0	2	—	—	—	—	—	1225
2	1	13	—	—	—	—	—	1500
14	3	5	—	—	—	—	—	2225
6	2	7	—	—	—	—	—	2550
22	3	8	—	—	—	—	—	3000
16	0	9	—	—	—	—	—	3125
20	5	5	—	—	—	—	—	3725
24	10	14	—	—	—	—	—	4125
75	17	26	5	4	4	0	3	4950
26	9	8	0	0	0	0	0	3875
57	19	16	4	0	4	0	6	4475
72	26	26	14	7	12	0	15	3825
64	23	27	4	1	4	0	6	3550
87	32	35	7	1	7	0	11	3725
120	38	47	10	11	7	0	6	3525
75	32	36	7	8	5	0	3	2775
114	25	33	5	9	3	0	1	2675
85	25	23	5	6	4	0	6	1475
92	34	39	2	3	2	0	4	1550
67	24	20	6	11	3	0	0	975
80	24	18	7	11	5	0	5	1200
24	4	11	2	4	1	0	0	375
18	11	18	7	9	4	0	1	475
7	2	7	2	6	4	0	3	100
11	4	9	6	6	3	0	0	100
5	1	4	4	3	0	0	3	75
0	0	0	0	0	0	0	0	0
5	0	1	3	0	3	0	2	75
1200	375	475	100	100	75	0	75	65000

Number of Veins on Second Leaf.

	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.
19	—	—	—	1	1	2	1	2	4	2	5	3	1	0	0	0	1	0
20	—	—	—	0	0	0	0	1	0	0	1	1	1	3	1	8	0	1
21	—	—	—	0	1	0	0	0	1	0	3	0	1	5	2	3	4	2
22	1	0	0	0	1	2	2	3	5	3	10	8	4	1	5	1	2	0
23	1	0	1	1	0	2	2	3	9	2	9	9	6	13	8	6	7	7
24	2	0	0	2	2	4	4	8	16	14	14	13	9	5	7	10	8	5
25	1	0	0	2	2	4	4	5	10	11	20	20	21	12	20	19	11	10
26	2	1	0	3	3	8	5	4	20	18	26	19	15	11	17	19	12	10
27	4	0	1	5	9	16	10	20	36	30	55	47	40	39	41	47	36	33
28	2	0	0	3	2	14	11	18	30	22	41	28	36	22	38	36	39	20
29	5	1	3	10	9	14	20	26	55	41	70	65	65	55	75	78	79	51
30	3	1	0	8	9	13	20	19	47	28	65	54	63	56	76	77	57	64
31	1	1	1	4	6	9	21	15	40	36	65	63	50	62	89	96	82	73
32	0	3	5	1	13	5	12	11	39	22	55	56	62	88	103	111	100	92
33	0	1	2	5	8	7	20	17	41	38	75	76	89	103	94	121	119	113
34	0	8	3	1	6	10	19	19	47	36	78	77	96	111	121	194	160	164
35	1	0	4	2	7	8	11	12	36	39	79	57	82	100	119	160	158	171
36	0	1	2	0	7	5	10	10	33	20	51	64	73	92	113	164	171	206
37	0	1	2	0	5	2	6	8	17	18	41	40	59	84	98	137	175	196
38	0	3	1	0	1	1	7	8	23	16	42	48	61	88	102	171	154	240
39	1	1	0	1	3	8	7	12	26	27	44	56	70	72	113	132	178	220
40	0	3	0	0	3	6	6	13	18	20	40	55	69	85	117	166	190	252
41	0	0	0	0	0	1	1	2	5	6	26	22	42	51	61	98	123	183
42	1	0	0	1	1	4	5	4	11	9	27	33	29	47	55	77	104	164
43	—	—	—	—	0	2	11	2	3	9	26	30	53	45	70	86	124	136
44	—	—	—	—	1	2	6	3	2	4	13	27	29	23	52	60	81	135
45	—	—	—	—	—	0	2	2	0	0	6	14	14	11	24	27	42	80
46	—	—	—	—	—	0	2	1	0	1	5	18	13	14	21	29	46	87
47	—	—	—	—	—	1	0	1	1	1	4	8	3	17	6	21	23	44
48	—	—	—	—	—	—	—	1	0	2	4	6	9	10	19	15	20	44
49	—	—	—	—	—	—	—	—	—	—	—	0	3	9	11	7	14	27
50	—	—	—	—	—	—	—	—	—	—	—	2	2	9	9	3	9	7
51	—	—	—	—	—	—	—	—	—	—	—	0	1	0	1	1	5	8
52	—	—	—	—	—	—	—	—	—	—	—	2	2	1	3	5	7	15
53	—	—	—	—	—	—	—	—	—	—	—	3	1	3	3	5	3	12
54	—	—	—	—	—	—	—	—	—	—	—	1	1	2	6	1	2	6
55	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	1	0	2
56	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	1	4	6
57	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	4	0	8
58	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	3	0	6
59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
61	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	25	25	25	50	100	150	225	250	575	475	1000	1025	1175	1350	1700	2200	2350	2900

eries (ii.). TABLE V.—Mixed Set Spanish Chestnut Leaves.

Number of Veins on First Leaf.

36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.
0	0	0	1	0	0	1	—	—	—	—	—	—	—	—	—
1	1	3	1	3	0	0	—	—	—	—	—	—	—	—	—
2	2	1	0	0	0	0	—	—	—	—	—	—	—	—	—
0	0	0	1	0	0	1	—	—	—	—	—	—	—	—	—
7	5	1	3	3	0	1	0	1	—	—	—	—	—	—	—
5	2	1	8	6	1	4	2	2	0	0	1	—	—	—	—
10	6	7	7	6	1	5	11	6	2	2	0	—	—	—	—
10	8	8	12	13	2	4	2	3	2	1	1	1	—	—	—
33	17	23	26	18	5	11	3	2	0	0	1	0	—	—	—
20	18	16	27	20	6	9	9	4	0	1	1	2	—	—	—
51	41	42	44	40	26	27	26	13	6	5	4	4	—	—	—
64	40	48	56	55	22	33	30	27	14	18	8	6	0	2	0
73	59	61	70	69	42	29	53	29	14	13	3	9	3	2	1
92	84	88	72	85	51	47	45	23	11	14	17	10	9	9	0
113	98	102	113	117	61	55	70	52	24	21	6	19	11	9	1
164	137	171	132	166	98	77	86	60	27	29	21	15	7	3	1
171	175	154	178	190	123	104	124	81	42	46	23	20	14	9	5
206	196	240	220	252	183	164	136	135	80	87	44	44	27	7	8
196	166	229	213	255	205	149	181	132	95	84	41	44	20	15	6
240	229	266	268	331	258	260	250	206	154	138	75	87	61	41	17
220	213	268	266	354	291	261	261	255	153	154	89	81	58	20	12
252	255	331	354	382	353	294	329	293	202	171	106	88	80	39	19
183	205	258	291	353	382	310	351	276	214	207	142	107	96	43	34
164	149	260	261	294	310	304	348	335	271	252	191	146	104	76	37
136	181	250	261	329	351	348	354	334	260	232	183	143	122	85	56
135	132	206	255	293	276	335	334	416	311	339	255	219	171	131	54
80	95	154	153	202	214	271	260	311	274	271	220	213	166	121	52
87	84	138	154	171	207	252	232	339	271	290	246	210	170	135	70
44	41	75	89	106	142	191	183	255	220	246	238	194	173	140	79
44	44	87	81	88	107	146	143	219	213	210	194	164	190	150	56
27	20	61	58	80	96	104	122	171	166	170	173	190	162	172	95
7	15	41	20	39	43	76	85	131	121	135	140	150	172	128	79
8	6	17	12	19	34	37	56	54	52	70	79	56	95	79	42
15	14	19	20	24	26	42	53	53	62	76	117	87	113	120	72
12	10	22	8	18	23	31	29	43	35	50	66	28	61	52	49
6	6	12	2	8	21	21	22	49	24	45	45	37	57	45	44
2	3	6	2	3	8	13	9	23	22	23	33	13	26	18	28
6	4	6	7	6	10	10	9	16	23	10	35	16	26	23	16
8	8	2	1	0	10	11	5	1	14	5	20	6	17	9	12
6	6	1	2	0	12	10	12	11	14	7	22	13	13	15	5
—	—	—	1	2	0	1	0	8	2	2	3	1	1	1	0
—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0
—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0
—	—	—	—	—	—	1	0	6	5	1	7	2	0	1	0
2900	2775	3675	3750	4400	4000	4050	4225	4375	3400	3425	2850	2425	2225	1700	950

51.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	Totals.
—	—	—	—	—	—	—	—	—	—	—	—	25
—	—	—	—	—	—	—	—	—	—	—	—	25
—	—	—	—	—	—	—	—	—	—	—	—	25
—	—	—	—	—	—	—	—	—	—	—	—	50
—	—	—	—	—	—	—	—	—	—	—	—	100
—	—	—	—	—	—	—	—	—	—	—	—	150
—	—	—	—	—	—	—	—	—	—	—	—	225
—	—	—	—	—	—	—	—	—	—	—	—	250
—	—	—	—	—	—	—	—	—	—	—	—	575
—	—	—	—	—	—	—	—	—	—	—	—	475
—	—	—	—	—	—	—	—	—	—	—	—	1000
0	2	3	1	—	—	—	—	—	—	—	—	1025
1	2	1	1	—	—	—	—	—	—	—	—	1175
0	1	3	2	0	0	0	1	—	—	—	—	1350
1	3	3	6	0	0	0	0	—	—	—	—	1700
1	5	5	1	1	1	4	3	—	—	—	—	2200
5	7	3	2	0	4	0	0	—	—	—	—	2350
8	15	12	6	2	6	8	6	—	—	—	—	2900
6	14	10	6	3	4	8	6	—	—	—	—	2775
17	19	22	12	6	6	2	1	—	—	—	—	3675
12	20	8	2	2	7	1	2	1	—	—	—	3750
19	24	18	8	3	6	0	0	2	—	—	—	4400
34	26	23	21	8	10	10	12	0	—	—	—	4000
37	42	31	21	13	10	11	10	1	0	0	1	4050
56	53	29	22	9	9	5	12	0	0	0	0	4225
54	53	43	49	23	16	1	11	8	0	0	6	4375
52	62	35	24	22	23	14	14	2	0	0	5	3400
70	76	50	45	23	10	5	7	2	0	0	1	3425
79	117	66	45	33	35	20	22	3	0	0	7	2850
56	87	28	37	13	16	6	13	1	0	0	2	2425
95	113	61	57	26	26	17	13	1	0	0	0	2225
79	120	52	45	18	23	9	15	1	0	0	1	1700
42	72	49	44	28	16	12	5	0	0	0	0	950
72	92	58	38	20	25	16	18	0	0	0	0	1200
49	58	50	50	35	15	20	16	1	0	0	0	800
44	38	50	24	26	8	12	9	1	0	0	0	625
28	20	35	26	10	7	12	5	1	0	0	1	350
16	25	15	8	7	4	6	6	0	0	0	1	300
12	16	20	12	12	6	14	12	—	—	—	—	225
5	18	16	9	5	6	12	6	—	—	—	—	225
0	0	1	1	1	0	—	—	—	—	—	—	25
0	0	0	0	0	0	—	—	—	—	—	—	0
0	0	0	0	0	0	—	—	—	—	—	—	0
0	0	0	0	1	1	—	—	—	—	—	—	25
950	1200	800	625	350	300	225	225	25	0	0	25	67600

62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	25	25	25	50	100	150	225	250	575	475	1000	1025	1175	1350	1700	2200	2350	2900

—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	
—	—	—	—	—	—	1	0	6	5	1	7	2	0	1	0	
2900	2775	3675	3750	4400	4000	4050	4225	4375	3400	3425	2850	2425	2225	1700	950	12

0	0	0	0	0	0	—	—	—	—	—	—	0
0	0	0	0	1	1	—	—	—	—	—	—	25
950	1200	800	625	350	300	225	225	25	0	0	25	67600

Series (ii.). *Mixed Spanish Chestnuts.*

My second series consists of 26 leaves from each of 104 trees. These were gathered in a variety of neighbourhoods. Many of these were young trees. In the case of nearly 50 sets, the trees were pollards from old stumps with about 15 years' growth; some of the others were from fine old trees, and as a result we have many districts and many ages combined. I have to thank Miss C. D. FAWCETT for sets from the neighbourhood of Hampstead, Miss GRACE LEE for sets from that of St. Albans, Miss CHARLES for sets from the neighbourhood of Dorking, while about half the series was gathered by Mr. ROBERT J. PARKER from his chestnut woods at Haslemere. The counting of the veins was undertaken by Miss M. NOTCUTT, while the tabulation and numerical reduction are the work of Dr. W. R. MACDONELL. The series being mixed, the variability is higher than that of the first series and thus the labour spent on it was even greater.

The following table gives the general results:—

Resemblance of Spanish Chestnut Leaves from same Tree.

Series.	Number.			Mean number of veins.	S. D. of veins.	Correlation.
	Trees.	Leaves.	Pairs.			
Hampden .	100	2600	65,000	41·0735 ± ·0775	5·8780 ± ·0550	·4655[± ·0104]
Mixed . .	104	2704	67,600	41·2145 ± ·0840	6·4780 ± ·0594	·5913[± ·0084]
Mean . .	—	—	—	41·1440	6·1780	·5284

We note at once that the mean number of veins for the forest trees and for the mixed group is sensibly the same. On the other hand, the variability and the correlation differ very considerably. The latter is sensibly higher than the ·4 obtained for the leaflets of the ash. I should be inclined to consider that the heterogeneity of the mixed series is at the bottom of the difference between the two series, but there cannot, I think, be any doubt of the greater resemblance of chestnut leaves for this character than of ash leaves in the number of *pinnæ*.

The actual distribution of veins in the 5304 leaves examined was as follows:—

No. of veins.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.
1st series	—	1	2	0	0	5	4	6	14	14	19	42	43	49	60
2nd series	1	1	1	2	4	6	9	10	23	19	40	41	47	54	68
Total	1	2	3	2	4	11	13	16	37	33	59	83	90	103	128

No. of veins.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.
1st series.	89	102	120	125	149	165	198	155	179	153	142	149	141	111	107
2nd series	88	94	116	111	147	150	176	160	162	169	175	136	137	114	97
Total	177	196	236	236	296	315	374	315	341	322	317	285	278	225	204

No. of veins.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	Total.
1st series.	59	62	39	48	15	19	4	4	3	0	3	—	—	—	2600
2nd series	89	68	38	48	32	25	14	12	9	9	1	0	0	1	2704
Total	148	130	77	96	47	44	18	16	12	9	4	0	0	1	5304

The total gives a fairly smooth series with the mode at 40, and a secondary mode at 42. In the forest trees we have the same result as in the total, but in the mixed group the secondary mode is at 44, and almost equally important with the primary. The influence of symmetry makes itself felt in the preponderance of the even numbers, although not in such a marked degree as in the case of the ash, where the counting of the final leaflet gave, of course, preponderance to the odd numbers.

For the Spanish chestnut we may accordingly take 41 veins as the average, 40 as the modal number to the leaf; 6·2 as the S.D. of the veins; and ·5 (slightly weighting the homogeneous series) as the degree of resemblance between the leaves of the same tree.

It remains to consider the comparative individual and racial variabilities :—

Series.	S. D.	S. D. of array.	Coefficient of variation.	Percentage variability.
Hampden	5·8780	5·2024	14·31	88·51
Mixed	6·4780	5·2242	15·72	80·65
Mean	6·1780	5·2133	15·01	84·58

We see that the variability of the chestnut leaf as measured by the coefficient of variation is somewhat less than that of the ash. The individual as compared with the racial variability is also somewhat less than in the case of the ash, but the individual exhibits still some 85 per cent. of the racial variability. Tables IV. and V. give the data for the chestnut series.

(9.) C. *Beech* (Fagus sylvatica). *Number of Veins on the Leaf.*—I have here only one series of 26 leaves from each of 100 trees. These were gathered and counted by Mrs. KARL PEARSON and myself in the neighbourhood of Great Hampden. The trees were in part fine isolated specimens growing on the commons, but as there were not sufficient of these we were compelled to gather from the somewhat smaller trees abounding in the beechwoods of this part of Buckinghamshire. The leaves were gathered about 4 to 5 feet from the ground on the outside of the tree.* The tabulation of the results and the calculation of the constants are again the work of Dr. LEE.

Hampden Beech Leaves.

Number.			Mean number of veins.	S.D. of veins.	Correlation of pairs.
Trees.	Leaves.	Pairs.			
100	2600	65,000	16·1062 ± ·0230	1·7351 ± ·0162	·5699 [± ·0087]

Distribution of Number of Veins.

Number of veins...	10	11	12	13	14	15	16	17	18	19	20	21	22	Total.
Frequency	1	7	34	110	318	479	595	516	307	181	36	15	1	2600

Individual and Racial Variation.

S.D.	S.D. of array.	Coefficient of variation.	Percentage variability.
1·7351	1·4258	10·77	82·17

Accordingly, we see that the modal value of the beech leaf veins is 16, which is very near the mean, 16·11. The standard deviation about 1·7, and the degree of resemblance among its leaves ·57 Measured by its coefficient of variation, it is the least variable of the trees so far dealt with, and the leaves of the same tree more closely resemble each other. Notwithstanding its relatively small variability, the individual on an average exhibits about 82 per cent. of the racial variability.

The table of reduced data is given below.

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* I did not observe among the leaves gathered anything of the differentiation indicated by Professor MACLEOD between "licht- en schadernbladen." The material, so far as this character (number of veins) goes, seemed singularly homogeneous and of small variability.

TABLE VI.—Hampden Beech Trees.

Number of Veins on First Leaf.

Number of Veins on Second Leaf.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	Totals.
10	0	2	7	7	6	3	—	—	—	—	—	—	—	25
11	2	8	35	45	59	23	3	—	—	—	—	—	—	175
12	7	35	92	145	261	156	92	47	15	—	—	—	—	850
13	7	45	145	394	836	689	387	199	46	1	1	—	—	2750
14	6	59	261	836	2124	2021	1616	723	243	54	4	3	—	7950
15	3	23	156	689	2021	3256	3122	1856	605	221	20	3	—	11975
16	—	3	92	387	1616	3122	4576	3205	1380	437	51	6	—	14875
17	—	—	47	199	723	1856	3205	3914	1928	860	120	46	2	12900
18	—	—	15	46	243	605	1380	1928	1882	1278	213	80	5	7675
19	—	—	—	1	54	221	437	860	1278	1248	282	137	7	4525
20	—	—	—	1	4	20	51	120	213	282	138	64	7	900
21	—	—	—	—	3	3	6	46	80	137	64	32	4	375
22	—	—	—	—	—	—	—	2	5	7	7	4	0	25
Totals	25	175	850	2750	7950	11975	14875	12900	7675	4525	900	375	25	65000

(10.) D. *Holly* (Ilex Aquifolium). *Number of Prickles on the Leaf.*—This character seemed an easy one so far as mere counting goes, although the leaves were troublesome to gather. The leaves were gathered, so far as possible, all round the tree or bush, about the height at which cattle would browse, and from the outside of the bush. Internal and high branches (often differentiated by being almost prickleless) were to be avoided. Flowering trees, and, above all, leaves near the flowering buds or fruit were to be rejected. These conditions could only be approximately followed in practice when a large number of trees had to be dealt with from one neighbourhood, and these series, I fancy, allow more to the personal equation of the gatherer than is wholly satisfactory.

Series (i.). *Somersetshire Hollies.*

I owe this series of 26 leaves from each of 100 trees to Miss AGNES FRY. Of these trees, 56 were hedge-row hollies, and 44 wood trees or bushes growing in moist places.* The counting of the prickles was in some part undertaken by Mr. MACLEOD,

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* Miss FRY writes to me: "The texture of the leaves seems rather different,—the wood hollies are much less stout and harsh and more often have few prickles. In fact, I rather wonder if *shade* does not affect the number. In the few cases where hedge-row hollies have very few prickles the leaves come from the inside of the bush. I have carefully avoided the neighbourhood of berries,—and what is more difficult of flower buds. But the holly has two flowers, one with abortive pistil and one with abortive stamens. The latter I suppose would drop away and leave no trace of their presence. But, on the whole, I have avoided flower and berry-bearing bushes—it is easy to find bushes without either. And, so far as my observation goes, I am not convinced that the neighbourhood of flowers or the top of the tree causes modification . . . . It is very difficult to keep to a standard of counting for the tip, but I have tried to do so. Doubtless the hollies too are of rather different ages, but I have avoided patriarchal trees, though doubtful if this makes much difference in this case." It will be seen that in this point, as in others, much had to be left to the judgment of a careful observer.

but for more than three-quarters of the trees by Miss Fry herself. The labour of tabulation and the deduction of the constants was undertaken by Dr. Lee.

Series (ii.). *Dorsetshire Hollies.*

This series of 26 leaves from each of 100 trees was gathered and counted by Miss C. D. Fawcett, B.Sc. It differs in several important respects from Miss Fry's series. As it came from the neighbourhood of the sea, by Lyme Regis, we might expect a considerable difference of environment; the trees were chiefly hedgerow trees. They show, however, a *lower* mean number of prickles than the Somersetshire series, which embraced a large element of wood trees. I think the series is less homogeneous than the Somersetshire series. In particular, Tree 91 contributes the almost abnormal series of 24 leaves with 1 and 2 leaves with 2 prickles. The lump at the end of the frequency distribution is practically due to this one tree. I do not feel able to reject it entirely, but I give the numerical constants as determined with and without it. I take it that of the two observers the personal equation of one tended rather to emphasise the need for a mathematically "random selection" of trees, and the personal equation of the other to emphasise the importance of a botanically "homogeneous group" of trees. The result has been the increase of correlation and variability in the first, and their decrease in the second case. Probably their mean is not far from the truth. It is noteworthy that the ash trees from Dorsetshire and Monmouthshire, although exhibiting a like substantial difference of environment, were far more alike.

The tabulation and reduction of this series is also due to Dr. Lee. I now summarise the results as before:—

Resemblance of Holly Leaves from the same Tree.

Series.	Number.			Mean number of prickles.	S. D. of prickles.	Correlation.
	Trees.	Leaves.	Pairs.			
Somersetshire (i.)	100	2600	65,000	15·2935 ± ·0379	2·8655 ± ·0268	·3648 [± ·0115]
Dorsetshire (ii.)*a*.	100	2600	65,000	13·4373 ± ·0497	3·7595 ± ·0352	·6423 [± ·0078]
„ (ii.)*b*.	99	2574	64,350	13·5622 ± ·0474	3·5661 ± ·0335	·5985 [± ·0085]
Mean (i.) and (ii.)*a*	—	—	—	14·3654	3·3125	·5035
Mean (i.) and (ii.)*b*	—	—	—	14·4278	3·2158	·4816

(ii.)*b* is the Dorsetshire series, excluding tree (91).

In round numbers accordingly the number of prickles on the holly leaf is 14·4, the standard deviation 3·3 prickles, and the degree of resemblance ·5. The holly thus falls between our results for the ash and the chestnut, one series approaching our Buckinghamshire ashes, the other the group of mixed Spanish chestnuts, being somewhat in excess of the Buckinghamshire beeches.

The actual frequency of prickles is given by :—

Series.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Somersetshire (i.) . . .	1	2	2	3	6	6	10	8	10	24	43	74	135	276
Dorsetshire (ii.)*a* . . .	0	40	21	14	18	27	31	45	62	84	86	152	219	336
,, (ii.)*b* . . .	0	16	19	14	18	27	31	45	62	84	86	152	219	336
Total (i.) and (ii.)*a* .	1	42	23	17	24	33	41	53	72	108	129	226	354	612
Total (i.) and (ii.)*b* .	1	18	21	17	24	33	41	53	72	108	129	226	354	612

Series.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	Total.
Somersetshire (i.) . . .	335	417	407	328	235	122	79	44	22	6	3	1	1	2600
Dorsetshire (ii.)*a* . . .	350	337	311	217	128	70	31	12	8	1	0	0	0	2600
,, (ii.)*b* . . .	350	337	311	217	128	70	31	12	8	1	0	0	0	2574
Total (i.) and (ii.)*a* .	685	754	718	545	363	192	110	56	30	7	3	1	1	5200
Total (i.) and (ii.)*b* .	685	754	718	545	363	192	110	56	30	7	3	1	1	5174

The series is thus seen to be fairly uniform, the mode corresponding in the total result as well as the Somersetshire series to 15 prickles, while that of the Dorsetshire series is at 14, an even number of prickles. The holly leaf has clearly not the marked symmetry of ash or chestnut leaves. Thus, 16 prickles in the Somersetshire series are almost as frequent as 15, or since there is almost always a prickle at the tip, asymmetrical leaves must be very nearly as frequent as symmetrical.

Lastly, turning to the comparison of racial and individual variabilities, we have the table :—

Series.	S. D.	S. D. of array.	Coefficient of variation.	Percentage variability.
Somersetshire (i.) . .	2·8655	2·6680	18·74	93·12
Dorsetshire (ii.)*a* . .	3·7595	2·8815	27·98	76·65
,, (ii.)*b* . .	3·5661	2·8282	26·29	80·11
Mean (i.) and (ii.)*a*	3·3125	2·7747	23·36	84·88
Mean (i.) and (ii.)*b*.	3·2158	2·7482	22·52	86·61

Here again we see how great is the variability within the individual. Looking upon Tree (91) as so largely biasing the complete Dorsetshire series that we must exclude it, we see that the individual possesses 80 to 90 per cent. of the variability of the race. The variability of the offspring of the individual will, of course, be larger still, even if we had merely uniparental reproduction. Thus we have still further evidence, if more were necessary, that variability is not a factor dependent upon sexual reproduction. For this character of the prickles it will be seen that the holly leaf is more variable than those of the ash, chestnut, or beech. The following are the fundamental tables of data :—

TABLE VII.—Somersetshire Hollies.

Number of Prickles on First Leaf.

Number of Prickles on Second Leaf.

	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	Totals.
0	—	1	0	0	1	0	3	0	1	2	2	0	1	3	2	3	4	0	2	—	—	—	—	—	—	—	—	25
1	1	0	1	2	1	0	3	0	1	2	4	0	2	7	4	5	8	3	3	2	1	—	—	—	—	—	—	50
2	0	1	0	2	0	1	0	1	2	1	2	0	3	10	5	5	5	7	2	2	1	—	—	—	—	—	—	50
3	0	2	2	2	1	0	1	0	0	3	6	3	7	10	6	8	10	6	2	4	2	—	—	—	—	—	—	75
4	1	1	0	1	0	3	5	2	6	8	14	18	17	17	12	17	12	5	7	2	1	1	—	—	—	—	—	150
5	0	0	1	0	3	8	4	1	8	7	8	22	12	28	18	18	3	8	1	0	0	0	—	—	—	—	—	150
6	3	3	0	1	5	4	8	1	4	17	14	13	19	29	26	39	28	16	15	3	2	0	—	—	—	—	—	250
7	0	0	1	0	2	1	1	2	4	6	12	10	17	27	22	22	24	17	15	10	6	1	—	—	—	—	—	200
8	1	1	2	0	6	8	4	4	6	10	21	21	23	36	31	34	16	16	8	2	0	0	—	—	—	—	—	250
9	2	2	1	3	8	7	17	6	10	22	47	45	78	65	80	76	53	38	21	11	4	3	0	0	0	0	1	600
10	2	4	2	6	14	8	14	12	21	47	70	95	139	166	146	120	101	43	28	22	8	4	3	0	0	0	0	1075
11	0	0	0	3	18	22	13	10	21	45	95	162	237	327	286	212	167	125	52	32	11	8	2	0	1	0	1	1850
12	1	2	3	7	17	12	19	17	23	78	139	237	410	533	532	498	327	237	160	58	34	16	6	1	4	0	4	3375
13	3	7	10	10	17	28	29	27	36	65	166	327	533	1184	1199	1181	947	562	280	141	76	44	20	4	0	0	4	6900
14	2	4	5	6	12	18	26	22	31	80	146	286	532	1199	1360	1471	1325	885	491	237	112	78	36	4	2	0	5	8375
15	3	5	5	8	17	18	39	22	34	76	120	212	498	1181	1471	1970	1811	1343	738	415	225	135	65	8	4	2	0	10425
16	4	8	5	10	12	3	28	24	16	53	101	167	327	947	1325	1811	1832	1459	950	517	294	169	80	20	5	5	3	10175
17	0	3	7	6	5	8	16	17	16	38	43	125	237	562	885	1343	1459	1334	1026	512	272	175	71	18	12	7	3	8200
18	2	3	2	2	7	1	15	15	8	21	28	52	160	280	491	738	950	1026	944	484	324	185	76	33	20	6	2	5875
19	—	2	2	4	2	0	3	10	2	11	22	32	58	141	237	415	517	512	484	232	202	98	40	17	5	1	1	3050
20	—	1	1	2	1	0	2	6	0	4	8	11	34	76	112	225	294	272	324	202	186	99	78	24	11	1	1	1975
21	—	—	—	—	1	0	0	1	0	3	4	8	16	44	78	135	169	175	185	98	99	32	34	12	5	1	—	1100
22	—	—	—	—	—	—	—	—	—	0	3	2	6	20	36	65	80	71	76	40	78	34	24	8	5	2	—	550
23	—	—	—	—	—	—	—	—	—	0	0	0	1	4	4	8	20	18	33	17	24	12	8	0	1	—	—	150
24	—	—	—	—	—	—	—	—	—	0	0	1	4	0	2	4	5	12	20	5	11	5	5	1	0	—	—	75
25	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	2	5	7	6	1	1	1	2	—	—	—	—	25
26	—	—	—	—	—	—	—	—	—	1	0	1	4	4	5	0	3	3	2	1	1	—	—	—	—	—	—	25
Totals	25	50	50	75	150	150	250	200	250	600	1075	1850	3375	6900	8375	10425	10175	8200	5875	3050	1975	1100	550	150	75	25	25	65000

TABLE VIII.—Dorsetshire Hollies.

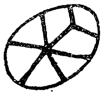
Number of Prickles on First Leaf.

Number of Prickles on Second Leaf.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	Totals.
1	590 [38]	105 [57]	36	19	40	35	8	41	15	19	27	43	14	4	3	1	—	—	—	—	—	—	—	1000 [400]
2	105 [57]	74 [72]	49	31	51	37	24	55	29	13	13	24	11	5	3	1	—	—	—	—	—	—	—	525 [475]
3	36	49	20	17	31	26	14	34	15	13	19	33	15	8	10	5	2	2	1	—	—	—	—	350
4	19	31	17	16	46	36	60	53	43	23	21	24	18	16	11	4	5	3	3	0	1	—	—	450
5	40	51	31	46	68	54	91	70	47	30	25	59	32	13	18	0	0	0	0	0	0	—	—	675
6	35	37	26	36	54	40	75	93	75	72	52	70	36	28	18	10	8	3	2	2	2	1	—	775
7	8	24	14	60	91	75	142	144	129	71	69	71	67	53	41	29	18	6	3	5	4	1	—	1125
8	41	55	34	53	70	93	144	188	203	132	156	129	87	64	37	38	16	2	3	3	2	0	—	1550
9	15	29	15	43	47	75	129	203	220	176	224	185	199	173	148	115	59	24	15	4	2	0	—	2100
10	19	13	13	23	30	72	71	132	176	180	268	268	296	205	156	113	54	27	21	8	4	1	—	2150
11	27	13	19	21	25	52	69	156	224	268	404	526	581	453	382	285	127	90	45	18	9	6	—	3800
12	43	24	33	24	59	70	71	129	185	268	526	784	1039	755	625	456	199	104	48	19	8	6	—	5475
13	14	11	15	18	32	36	67	87	199	296	581	1039	1822	1497	1234	725	391	196	80	40	11	6	3	8400
14	4	5	8	16	13	28	53	64	173	205	453	755	1497	1594	1393	1129	685	385	163	74	21	24	8	8750
15	3	3	10	11	18	18	41	37	148	156	382	625	1234	1393	1462	1223	814	480	223	90	32	17	5	8425
16	1	1	5	4	0	10	29	38	115	113	285	456	725	1129	1223	1432	1025	582	348	147	52	51	4	7775
17	—	—	2	5	0	8	18	16	59	54	127	199	391	685	814	1025	910	574	307	157	56	17	1	5425
18	—	—	2	3	0	3	6	2	24	27	90	104	196	385	480	582	574	340	222	99	35	24	2	3200
19	—	—	1	3	0	2	3	3	15	21	45	48	80	163	223	348	307	222	136	70	33	26	1	1750
20	—	—	—	0	0	2	5	3	4	8	18	19	40	74	90	147	157	99	70	22	13	4	0	775
21	—	—	—	1	0	2	4	2	2	4	9	8	11	21	32	52	56	35	33	13	6	9	0	300
22	—	—	—	—	—	1	1	0	0	1	6	6	6	24	17	51	17	24	26	4	9	6	1	200
23	—	—	—	—	—	—	—	—	—	—	—	—	3	8	5	4	1	2	1	0	0	1	—	25
Totals	1000 [400]	525 [475]	350	450	675	775	1125	1550	2100	2150	3800	5475	8400	8750	8425	7775	5425	3200	1750	775	300	200	25	65000 [64350]

The lower numbers in brackets give the results when Tree 91 is excluded.

SECTION II.—*Seed Vessels of Flowers.* A. *Poppies.*

(11.) Having dealt with several characters in a variety of trees, I thought it desirable to deal with a single character in a variety of races in a very different branch of the vegetable kingdom. After consultation with my colleague, Professor F. O. Oliver, the stigmatic bands on the seed capsules of poppies were selected, and they have proved an easily recorded character, which could be considered for a variety of races. Here again there was some diversity in the method of collection. The rules given being (i.) that the bands were to be counted at the periphery of the capsule and not at the centre; thus  was counted as 7, not 6, bands; and (ii.) every possible bud on the plant was to be counted. The work went on from spring to autumn of the year 1899; it was impossible to collect, dry, and preserve for counting all the wild poppies gathered as soon as they had ceased flowering. Thus some poppies were taken when they had completely done flowering, others with flowers on them, and others with many buds. Few, I think, would be included which had not formed all their buds. In my own series, I counted the bands on every capsule, in every flower, and in nearly every bud, opening the bud and using a microscope when necessary. The labour of this was very great, and was not carried out by all my helpers. I doubt, indeed, whether any advantage was derived from it, except in so far as there may be correlation between the number of stigmatic bands and the early or late development of the seed-vessel.

(12.) The following series were obtained :—

Series (i.). *Buckinghamshire Wild Poppy* (Papaver Rhœas).—I gathered 200 specimens from as wide a range as possible—roadside, field-hedgerow, and cornfield—avoiding *Papaver dubium*, and counting every set of stigmatic bands right down to the smallest bud I could manage. These specimens were gathered on the very top of the Chilterns; the soil and climate is not a very favourable one, and my mean number of buds was a small one. I myself tabled the data and calculated the constants.

Series (ii.). *Buckinghamshire Wild Poppy* (Papaver Rhœas).—Miss C. D. Fawcett gathered 236 poppy plants on the southern slope of the Chilterns, towards their foot. They came nearly all from a single cornfield, and thus their environment was much more uniform, and the climate more favourable than in Series (i.). It is quite possible that these poppies were largely the offspring of a comparatively few poppies, as they were gathered from a small area. Dr. Lee tabled the data and calculated the constants.

Series (iii.). *Somersetshire Wild Poppy* (Papaver Rhœas).—The bulk of this series were gathered by Miss Agnes Fry in the Quantocks, but being rather a short series, 86 plants, I added to it several other short series, 42 plants in all, gathered and counted by various less active helpers. Thus the series is really an omnibus series, although mainly from the Quantocks. Dr. LEE tabulated the data and calculated the constants.

My other two series are of the Shirley Poppy, a well-known and beautiful garden variety.

Series (iv.). *Chelsea Shirley Poppy.*—These plants were grown by my colleague, Professor F. O. OLIVER, in his garden at Chelsea. The plants had scarcely been thinned, and so, being very crowded, grew tall, and with few buds on the plant. The plants were taken up and forwarded to me by rail, but being delayed in transit suffered a great deal, so that a good many capsules were broken off, or could not be counted. These circumstances account for the smallness of the number of pairs obtained from each plant. Professor OLIVER kindly came and assisted me in the counting. The data were tabulated and reduced by myself.

Series (v.). *Buckinghamshire Shirley Poppy.*—These plants were grown at Hampden Farm House, and covered a large border. They were extremely healthy, large plants, and I have counted as many as 120 capsules on a single plant! The plants were taken up singly as they had done flowering and the bands counted. The labour of counting was severe, as there were 4443 capsules on 176 plants as compared with 1020 capsules on 325 Chelsea poppies. The tabulation involved the entry of 197,478 pairs, perhaps the largest number we have yet dealt with in a single correlation table; this and the determination of the constants is the work of Dr. LEE.

The reader will notice that the investigations on poppies differ largely from those on the leaves of trees. In the latter case, 26 leaves were taken at random from the trees and the character on each measured. In the former case, every available capsule was dealt with. These, of course, are not *all* the capsules put forth by the plant, and the proportion of these two sets would vary considerably from one series to another, approaching fairly close to equality in my wild poppies from the top of the Chilterns, and differing very considerably in the Shirley poppies from Chelsea. In the leaves of the trees no tree was weighted by its size or vigour; in the case of a vigorous poppy, however, it may contribute ten times as many pairs to our table as a feeble plant. There is a good deal to be said for both methods of dealing with the problem, and even for a third method to which I shall refer immediately. If we pick up two leaves at random and wish to consider the probability that they belong to one tree, we ought certainly to allow for the larger number of pairs of leaves on the larger trees; if we wish to discover to what extent two randomly chosen men have characters like to those of brothers, we ought certainly to allow for the large families, even if we do not deal with every possible pair of brothers in those families. These two different methods of dealing with resemblance due either to the production of like organs by the individual or to heredity must be carefully borne in mind. In dealing with Mr. GALTON's data for stature[*] I have taken every possible pair of

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[*] 'Phil. Trans.,' A, vol. 187, pp. 253–318.

brothers; in my own measurements of 1000 families I have taken only two brothers from each family. We cannot *a priori* expect the results to come out exactly the same. Indeed, we might *a priori* expect the latter method to give rather higher results than the former, for it introduces more individual families, and if we tabulated all the brothers of one family only or all the like organs of one organism, we should find nothing but a spurious correlation growing indefinitely small as the number of brothers or organs was indefinitely increased.* Thus I anticipated that the Hampden Shirleys would give a lower correlation than the Chelsea Shirleys, the wild poppies from the top of the Chilterns a higher value than those from the bottom, &c.

As our series of poppy plants were in no case very large, it was impossible to directly test this result by taking only a single pair from each plant, even if it had been possible after the counting and marking to select a pair of capsules at random. I accordingly adopted a third or intermediate method. Miss FAWCETT had recorded her capsules under the letters *a*, *b*, *c*, &c., and not grouped them directly under the number of the stigmatic bands. Accordingly, it was possible to take *a* with *b*, *c* with *d*, *e* with *f*, &c., and thus repeat no single capsules, but get a number of pairs sensibly taken at random. Thus large and vigorous plants will give more pairs than feeble ones, and yet much fewer than if we take every possible pair. This series will be referred to as Series (ii.)^{bis}. Its general result confirms the anticipation referred to above. It will be noticed that nothing of this kind can be done in the case of leaves of trees, where we cannot gather *every* leaf. One great advantage of the 26 leaves from every tree is the means it provides of testing the accuracy of the lengthy process of tabulation and calculation. Each leaf is used 25 times, and thus the mean and standard-deviation of the total number of pairs ought to be the same as those of the total series of leaves (say, 2600 for 100 trees). This valuable method of verification is lost when we do not take the same number of like organs from each individual. It then becomes of considerable interest to ascertain how far the mean and variability of the total number of organs observed are identical with the mean and variability of the total number of pairs of organs observed. This comparison is made in Series (v.)^{bis}, the mean and variability of the 4443 capsules being compared with those of the corresponding 197,478 pairs. The whole of the tabulation and arithmetic involved in Series (ii.)^{bis} is mine, but Series (v.)^{bis} is again due to Dr. LEE.

I now proceed to sum up the results obtained from the above seven series.

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* I worked out the theory of this some time ago, and may publish it on another occasion.

Resemblance of Poppy Capsules from the same Plant.

Series.	Number of			Mean number of bands.	S. D. of bands.	Correlation.
	Plants.	Capsules.	Pairs.*			
Wild poppy (i.) . (top of Chilterns)	200	1305	11,026	10·0443 ± ·0331	1·7704 ± ·0234	·5620 [± ·0128]
Wild poppy (ii.) . (southern slope of Chilterns)	236	2343	25,160	9·9055 ± ·0210	1·5087 ± ·0149	·3997 [± ·0117]
Wild poppy (ii.)$^{\text{bis}}$ (no capsule repeated)	236	2268	2,268	9·8444 ± ·0211	1·4878 ± ·0149	·4452 [± ·0114]
Wild poppy (iii.) . (Quantocks)	127	1324	19,790	8·7733 ± ·0270	1·4553 ± ·0191	·5333 [± ·0133]
Shirley poppy (iv.) (Chelsea)	325	1020	2,756	12·3679 ± ·0355	1·6803 ± ·0251	·6149 [± ·0131]
Shirley poppy (v.) (Hampden)	176	4443	197,478	12·6103 ± ·0191	1·8853 ± ·0135	·5238 [± ·0073]
Mean (i.), (ii.), (iii.)	563	4972	55,976	9·5744	1·5781	·4983
Mean (iv.), (v.) .	501	5463	200,234	12·4891	1·7828	·5693
Mean (i.) to (v.) .	1064	10,435	256,210	[10·6524]	[1·6600]	·5267

Now this table contains a good deal of interest. Upwards of a thousand poppy plants were dealt with, involving the counting of the bands on more than ten thousand capsules, and the entry of more than a quarter of a million of pairs in the correlation tables. We see at once that the mean and variability of the Shirley poppy differ so widely from those of the wild poppy, that it is idle to group these species for these characters together. It is interesting to note, however, that both in the number of bands and in the variability the Hampden poppies, whether wild or Shirley, stand at the top of their respective series. With regard to the wild poppy, I probably gathered from a wider area with a greater variety of environment than was the case in Series (ii.) or (iii.). That mine were gathered from much poorer soil is evidenced by my plants having on an average only 6 capsules, while the Quantocks and southern Chiltern poppies had about 10 capsules. The difference is possibly even greater than these numbers indicate, for I counted every bud I possibly could. The two Chiltern series do not differ much in the mean number of bands, but the difference of variability is very significant. I should take it to be a very fair measure of the relative range of environment in the two cases. When we turn to the Shirley series the difference is almost too great for any comparison. While the Hampden series had some twenty-five capsules, on an average, to the plant, the Chelsea series numbered

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* The reader must bear in mind that this column gives the number of pairs of the symmetrical tables below, or *twice* the number of independent pairs.

only about three! In fact, besides being extremely crowded a process of selection had gone on in the transit. From examination of the uninjured plants, I think that five capsules a plant would be more than the average of these poppies before packing, and that at least one to two capsules per plant were destroyed on the journey. Accordingly, I do not consider that much weight should be given to the results of this series, but I felt bound to include it as I have included all the series dealt with, even when I hold them to be really unsuited to the present investigation. If we consider the two methods of dealing with Series (ii.), *i.e.*, that of including all possible pairs, and that of including pairs in which no capsule was repeated, we find that no very sensible change is made in the mean or variation, but a rather greater increase in the correlation than might have been anticipated. I think this is largely due to unconscious selection in the choice of pairs, *i.e.*, we took the records for (*a*) and (*b*), (*c*) and (*d*), &c., as our pairs; it is quite possible that in recording the capsules successive letters would correspond to capsules gathered from the same part of the plant, and so the members of the pair would be subject to the same or somewhat similar conditions of nutriment, light and warmth during development. Valuable investigations have yet to be made on the relative degree of resemblance of leaves or seed-vessels coming at random from the same tree or plant, and coming from the same branch or shoot. The effects of position on the individual undoubtedly produces some differentiation, and all we can hope to do at present is to get round numbers approximately describing the degree of resemblance of these *theoretically* undifferentiated like organs.

If we exclude the Chelsea series, we have for the

Wild poppy	·4983
Shirley poppy	·5238
Mean	·5110

For the four series of trees we have

Ash	·3918
Chestnut	·5284
Holly	·5035
Beech	·5699
Mean	·4984

So far as the seed-vessels of poppies and the leaves of trees are concerned we have a degree of resemblance in undifferentiated like organs which approximates to the value ·5.

It will be as well to put together the frequency distributions of the capsules as we have done in the case of the trees:—

Wild Poppies (*Papaver Rhœas*). Frequency of Stigmatic Bands.

Series.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Totals.
Chilterns (i.) . . .	2	17	86	182	255	272	260	130	67	25	9	—	1305
Chilterns (ii.) . . .	1	13	103	304	571	634	428	198	56	26	6	3	2343
Quantocks (iii.) . .	17	61	189	358	316	227	96	39	20	1	—	—	1324
Total . . .	20	91	378	844	1142	1133	784	367	143	52	15	—	4972

Shirley Poppies. Frequency of Stigmatic Bands.

Series.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	Totals.
Chelsea (i.). .	0	1	1	4	40	95	167	245	202	145	86	26	7	1	0	1020
Hampden (ii.)	1	11	32	56	148	363	628	925	954	709	397	155	51	12	1	4443
Total .	1	12	33	60	188	458	795	1170	1156	854	483	181	58	13	1	5463

These distributions appear to be uniform although asymmetrical, and they give no obvious sign of a mixture. The mode is 10 for the Chilterns series and 8 for the Quantocks series, while the Shirley poppies give 12 for Chelsea and 13 for Hampden.

It remains to tabulate the several results obtained for variation. These are given in the following table. We see at once that the general effect of weighting the capsules with the number of pairs on the plant has the effect of increasing the mean and reducing the variability; in other words, the plants with most capsules on and leading to most pairs, are those with the greatest number of stigmatic bands. We have some evidence accordingly that the most vigorous plants exhibit most bands on the capsules:—

Individual and Racial Variability.

Series.	Stigmatic bands.		Coefficient of variation.	S. D. of array.	Percentage variability.
	Mean.	S. D.			
Wild Poppy.					
(i.) from pairs	10·0443	1·7704	17·6259	1·4644	82·71
,, ,, capsules	9·9318	1·7684	17·8052	—	—
(ii.) from pairs	9·9055	1·5087	15·2309	1·3829	91·66
,, ,, capsules	9·8288	1·5007	15·2677	—	—
,, pairs without repetition of capsules	9·8444	1·4878	15·1132	1·3322	89·54
(iii.) from pairs	8·7733	1·4553	16·5878	1·2311	84·59
,, ,, capsules	8·7236	1·5402	17·6556	—	—
Mean from pairs	9·5744	1·5781	16·4809	1·3661	86·32
Mean from capsules . . .	9·4947	1·6031	16·9095	—	—
Shirley Poppy.					
(iv.) from pairs	12·3679	1·6803	13·5860	1·3251	78·86
,, ,, capsules	12·3873	1·7326	13·9869	—	—
(v.) from pairs	12·6103	1·8853	14·9505	1·6060	85·18
,, ,, capsules	12·5091	1·8977	15·1705	—	—
Mean from pairs	12·4891	1·7828	14·2682	1·4655	82·02
Mean from capsules . . .	12·4482	1·8151	14·5787	—	—
Total mean from pairs . .	—	—	15·5962	1·4019	84·60
Total mean from capsules .	—	—	15·9772	—	—

But we might well have expected a good deal more evidence of this. The differences of the means calculated from capsules and pairs is not very great, and in two out of three series of the wild poppies the variability as deduced from pairs is very slightly greater than (sensibly equal to) that deduced from capsules. The mean values of the coefficient of variation, as calculated from pairs and from capsules, are in close agreement. The only sensible deviation is that of the Quantocks series, and this arises from the large difference in the standard deviations of the two methods. The work has been carefully revised, but no error discovered.

Generally for the coefficient of variation we have—

Ash	17·56
Spanish chestnut	15·05
Beech	10·77
Holly	23·36
Mean . .	16·67

Wild poppy	16·91
Shirley poppy	14·58
Mean . .	15·98

So that the variability of both may be expressed in round numbers as 16. It is clearly not a constant for the whole vegetable kingdom, but 16 enables us to form some rough appreciation of the plasticity of vegetable forms, and may be compared with values obtained from other series later.

Comparing again the ratio of the racial and individual variabilities, we see that the latter reaches, on an average, over 85 per cent. of the former, the minimum value being 79 and the maximum 91. It is difficult to test this point directly, for the very simple reason that a single plant will, as a rule, have very few flowers; and upon small numbers it is impossible to test satisfactorily the full variability of the plant. The probable error becomes enormous if we have only four or five capsules to determine the standard deviation from. The method adopted has been that which arises in the treatment of parental inheritance; all the offspring of parents of a given stature are clubbed together and form an array. This array has a certain variability, and this variability is taken to be that of a single family of offspring having parents of the given stature. It would clearly be impossible to find the variability inside the family from numbers such as occur in a single human family. To some extent we can verify the assumptions thus made. Thus I took the wild poppy with the largest number of capsules I had come across, and determined their variability; there were 36 such capsules, and the standard deviation was 1·4519. I then took two of the most prolific Shirley poppies which had 126 and 85 capsules on them, and their variabilities were given by standard deviations of 1·3290 and 1·5889, *i.e.*, a mean of 1·4589. These are actually in excess of the standard deviations of the arrays, namely, 1·3661 and 1·4019 of the two series of poppies! I think we may accordingly take the latter as a reasonable measure of the possible variation of the individual.

TABLE IX.—Wild Poppy (Chilterns' Top) Series (i.).

Number of Stigmatic Bands on First Capsule.

Number of Stigmatic Bands on Second Capsule.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	Totals.
5	0	8	4	—	—	—	—	—	—	—	—	12
6	8	38	46	23	11	5	2	—	—	—	—	133
7	4	46	184	163	146	78	31	8	1	—	—	661
8	—	23	163	390	398	279	111	75	32	4	—	1475
9	—	11	146	398	554	415	250	161	68	9	5	2017
10	—	5	78	279	415	514	520	240	112	27	10	2200
11	—	2	31	111	250	520	770	366	160	52	9	2271
12	—	—	8	75	161	240	366	252	178	35	12	1327
13	—	—	1	32	68	112	160	178	92	23	11	677
14	—	—	—	4	9	27	52	35	23	28	12	190
15	—	—	—	—	5	10	9	12	11	12	4	63
Totals	12	133	661	1475	2017	2200	2271	1327	677	190	63	11026

TABLE X.—Wild Poppy (Chilterns' Base) Series (ii.).

Number of Stigmatic Bands on First Capsule.

Number of Stigmatic Bands on Second Capsule.

	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Totals.
5	0	1	2	1	2	1	4	—	—	—	—	—	11
6	1	4	40	25	19	10	9	1	1	—	—	—	110
7	2	40	184	289	228	145	48	20	4	1	—	—	961
8	1	25	289	822	964	563	283	105	20	8	—	—	3080
9	2	19	228	964	1868	1633	855	353	78	32	5	4	6041
10	1	10	145	563	1633	2106	1469	682	151	60	17	8	6845
11	4	9	48	283	855	1469	1220	585	154	63	20	13	4723
12	—	1	20	105	353	682	585	336	134	54	14	14	2298
13	—	1	4	20	78	151	154	134	52	44	17	7	662
14	—	—	1	8	32	60	63	54	44	26	8	1	297
15	—	—	—	—	5	17	20	14	17	8	2	1	84
16	—	—	—	—	4	8	13	14	7	1	1	0	48
Totals	11	110	961	3080	6041	6845	4723	2298	662	297	84	48	25160

TABLE XI.—Wild Poppies (Chilterns' Base) (ii.)$^{\text{bis}}$.

(No repetition of any individual capsule.)

Number of Stigmatic Bands on First Capsule.

Number of Stigmatic Bands on Second Capsule.

	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Totals.
5	—	—	—	—	1	—	—	—	—	—	—	—	1
6	—	2	5	1	1	0	3	—	—	—	—	—	12
7	—	5	24	28	19	13	1	1	—	—	—	—	91
8	—	1	28	80	79	73	24	8	2	—	—	—	295
9	1	1	19	79	202	140	74	25	5	4	—	—	550
10	—	0	13	73	140	198	127	50	10	7	1	—	619
11	—	3	1	24	74	127	112	59	10	6	0	2	418
12	—	—	1	8	25	50	59	32	13	5	2	0	195
13	—	—	—	2	5	10	10	13	10	3	1	0	54
14	—	—	—	—	4	7	6	5	3	0	0	0	25
15	—	—	—	—	—	1	0	2	1	0	0	1	5
16	—	—	—	—	—	—	2	0	0	0	1	0	3
Totals	1	12	91	295	550	619	418	195	54	25	5	3	2268

TABLE XII.—Wild Poppy (Quantocks) Series (iii.).

Number of Stigmatic Bands on First Capsule.

Number of Stigmatic Bands on Second Capsule.

	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	Totals.
5	14	41	31	22	16	7	4	0	1	0	136
6	41	170	299	202	93	40	9	0	9	0	863
7	31	299	922	895	375	113	22	2	7	0	2666
8	22	202	895	1716	1312	687	178	22	11	0	5045
9	16	93	375	1312	1590	1275	337	43	19	0	5060
10	7	40	113	687	1275	1234	406	92	52	0	3906
11	4	9	22	178	337	406	308	138	51	1	1454
12	0	0	2	22	43	92	138	102	37	1	437
13	1	9	7	11	19	52	51	37	26	4	217
14	0	0	0	0	0	0	1	1	4	0	6
Totals...	136	863	2666	5045	5060	3906	1454	437	217	6	19790

TABLE XIII.—Shirley Poppies (Chelsea) Series (iv.).

Number of Stigmatic Bands on First Capsule.

Number of Stigmatic Bands on Second Capsule.

	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	Totals.
6	—	—	1	—	—	—	—	—	—	—	—	—	—	1
7	—	—	0	0	1	—	—	—	—	—	—	—	—	1
8	1	0	0	0	2	0	0	3	—	—	—	—	—	6
9	—	0	0	20	37	29	15	9	—	—	—	—	—	110
10	—	1	2	37	88	64	39	19	4	1	—	—	—	255
11	—	—	0	29	64	140	138	70	19	4	1	—	—	465
12	—	—	0	15	39	138	196	154	68	25	2	—	—	637
13	—	—	3	9	19	70	154	174	105	55	8	—	—	597
14	—	—	—	—	4	19	68	105	112	63	17	2	1	391
15	—	—	—	—	1	4	25	55	63	52	16	4	0	220
16	—	—	—	—	—	1	2	8	17	16	4	4	1	53
17	—	—	—	—	—	—	—	—	2	4	4	6	1	17
18	—	—	—	—	—	—	—	—	1	0	1	1	0	3
Totals	1	1	6	110	255	465	637	597	391	220	53	17	3	2756

TABLE XIV.—Shirley Poppies (Hampden) Series (v.).

Number of Stigmatic Bands on First Capsule.

Number of Stigmatic Bands on Second Capsule.

	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	Totals.
5	0	10	19	10	4	3	8	4	5	—	—	—	—	—	—	63
6	10	90	190	101	51	42	80	40	50	—	—	—	—	—	—	654
7	19	190	354	208	122	140	308	194	145	7	—	—	—	—	—	1687
8	10	101	208	114	181	251	365	335	238	112	44	11	—	—	—	1970
9	4	51	122	181	762	1144	1085	721	390	119	50	16	—	—	—	4645
10	3	42	140	251	1144	2858	3943	3357	1948	698	249	86	15	7	—	14741
11	8	80	308	365	1085	3943	7444	6401	5327	2305	758	200	54	2	—	28280
12	4	40	194	335	721	3357	6401	10574	9095	5129	2234	715	179	49	—	39027
13	5	50	145	238	390	1948	5327	9095	11198	8494	4008	1321	303	57	—	42579
14	—	—	7	112	119	698	2305	5129	8494	9388	5569	2151	594	144	2	34712
15	—	—	—	44	50	249	758	2234	4008	5569	3664	1717	513	115	2	18923
16	—	—	—	11	16	86	200	715	1321	2151	1717	792	325	97	1	7432
17	—	—	—	—	—	15	54	179	303	594	513	325	160	58	4	2205
18	—	—	—	—	—	7	2	49	57	144	115	97	58	20	1	550
19	—	—	—	—	—	—	—	—	—	2	2	1	4	1	0	10
Totals ...	63	654	1687	1970	4645	14741	28280	39027	42579	34712	18923	7432	2205	550	10	197478

(13.) C. *Nigella Hispanica.*—Besides the poppy capsules, Professor OLIVER had suggested to me that it would be possible to count the segmentation of the seed vessel in the cases of Nigella and Mallow. I accordingly procured from Messrs. VEITCH, of Slough, upwards of a hundred plants of *Nigella Hispanica.* Meanwhile, Professor OLIVER sent me a list of some he had counted himself, and pointed out that there was a substantial differentiation between the seed vessels on the main stem and those on the side shoots. It was quite clear on examination that these seed vessels were not undifferentiated like organs, the number of segments in a seed vessel on the side shoots being much more like the number on a similar vessel on a separate plant than like those of a main-shoot capsule on the same plant. Further, although I do not know the history of these special plants, they were probably from highly selected seed and in a very unstable condition. Whereas in the examination of many thousand poppy capsules I only found one remarkable abnormal case,* abnormalities in the case of *Nigella Hispanica* abounded and rendered the counting of the segmentation very difficult. Double and treble capsules were found in every state of union up to complete fusion, and with every variety of deformity, such as the tips of one capsule growing through the sides of a second capsule. Thus the material was by no means suited to my present purpose. However, as I had the material it seemed worth while testing the influence of differentiation in reducing correlation. Accordingly I made no attempt to separate top from side capsules,† and formed the following table in the manner sufficiently indicated in the preceding pages:—

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[*] A double capsule on one stem. It contained only a few seeds. These Professor F. O. OLIVER kindly sowed for me this year; there resulted two plants with a very few poor flowers, but the abnormality was not perpetuated, and the capsules rotted off without giving seed.

[†] If the top capsules only had been taken I should often have had only one on a plant.

TABLE XV.—Segmentation of *Nigella Hispanica*.

Number of Segments in First Seed Vessel.

Number of Segments in Second Seed Vessel.

	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	Totals.
2	—	—	—	5	2	3	—	—	—	—	—	—	—	—	—	—	—	—	—	10
3	—	—	—	1	1	0	4	0	0	0	0	1	—	—	—	—	—	—	—	7
4	—	—	—	2	5	4	6	1	1	0	0	0	0	0	1	—	—	—	—	20
5	5	1	2	64	58	55	101	13	1	0	2	1	0	0	0	—	—	—	—	303
6	2	1	5	58	60	76	168	25	9	2	6	0	0	0	0	—	—	—	—	412
7	3	0	4	55	76	88	240	41	7	10	9	0	0	0	1	—	—	—	—	534
8	—	4	6	101	168	240	866	107	28	15	11	4	0	0	2	—	—	—	—	1552
9	—	0	1	13	25	41	107	14	9	3	9	0	0	0	0	0	0	0	1	223
10	—	0	1	1	9	7	28	9	0	1	1	0	0	0	1	0	0	0	1	59
11	—	0	0	0	2	10	15	3	1	0	3	0	0	0	1	—	—	—	—	35
12	—	0	0	2	6	9	11	9	1	3	2	—	—	—	—	—	—	—	—	43
13	—	1	0	1	0	0	4	0	0	0	—	—	—	—	—	—	—	—	—	6
14	—	—	0	0	0	0	0	0	0	0	—	—	—	—	—	—	—	—	—	0
15	—	—	0	0	0	0	0	0	0	0	—	—	—	—	—	—	—	—	—	0
16	—	—	1	0	0	1	2	0	1	1	—	—	—	—	—	—	—	—	—	6
17	—	—	—	—	—	—	—	0	0	—	—	—	—	—	—	—	—	—	—	0
18	—	—	—	—	—	—	—	0	0	—	—	—	—	—	—	—	—	—	—	0
19	—	—	—	—	—	—	—	0	0	—	—	—	—	—	—	—	—	—	—	0
20	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	2
Totals...	10	7	20	303	412	534	1552	223	59	35	43	6	0	0	6	0	0	0	2	3212

While the modal value is conspicuously 8, the mean value is 7·4639. This is due to the second modal value of 5 on the side shoots. The standard deviation is 1·4893, and the correlation ·1899. It will be seen at once how the result fully confirmed my expectation, that the degree of resemblance between capsules on the same plant would be largely reduced, owing to the existence of differentiation. The actual distribution of capsules in 210 plants was as follows :—

Number of Segments.

	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	Total.
Frequency. . .	1	1	5	75	108	133	420	61	19	10	8	2	0	0	1	0	0	0	1	845

Thus on an average there were four seed vessels to a plant. The mean and standard deviation found directly from the capsules are 7·5101 and 1·4559 respectively. These are in substantial agreement with the above results found for pairs. They do not confirm the conclusion based upon the data for poppies, namely that if we work with pairs we shall raise the mean and lower the variability. The fact is that vigour seems to work in opposite directions with this plant and the poppy ; with the latter it means many capsules with a high number of stigmatic bands, but with the former it means many side shoots with the differentiated capsules with few segmentations. Such capsules of course decrease the mean and raise the variability.

The coefficient of variation is 19·385, sensibly greater than that of the wild poppy, but below that of the holly leaf. The standard deviation of an array is 1·4622, or the variability of the individual 98·18 per cent. of that of the race. The plant with the greatest number of seed vessels on had only 11, and these gave a standard deviation of 1·6188, greater than that of the whole race ! But of course this is subject to a very large probable error ; it suffices to emphasise, however, how the source of variation is to be sought within the individual, and is not a mere result of sexual reproduction.

The following table sums up the results obtained for *Nigella Hispanica* :—

	Number of			Mean.	S. D.	Coefficient of variation.	S. D. of array.	Percentage variation.	Correlation.
	Plants.	Capsules.	Pairs.						
Pairs. .	210	845	3212	7·4639	1·4893	—	1·4622	98·18	·1899
Capsules				7·5101	1·4559	19·385	—	—	—

(14.) D. *Mallow* (Malva Rotundifolia).—I had given up the idea of the ordinary wild mallow (*Malva sylvestris*) owing to the few plants to be found in the neighbourhood of Hampden, as well as on account of the immense number of seed vessels on the plants to be counted. But one day an inspection of my potato-patch revealed the whole ground covered with low plants of *Malva Rotundifolia.*[*] On inquiry I found that a cottage had recently stood on the site, and that the cottagers kept in their herb-bed a small clump of this plant for the preparation of a local ointment of high repute. When the cottage was removed the mallow had spread over the whole patch, I believe very little by seed, but largely by stolons. This seemed to provide excellent material ready to hand, and from it we can draw some conclusions as to the influence of such a division on the degree of resemblance of like parts. It will be remembered that DARWIN,[†] in experimenting on *Origanum vulgare*, found that cross-fertilisation of flowers on plants which had separate roots, but had spread by stolons from the same individual, presented no advantage over self-fertilisation, and he concluded that this arose from the fact that the plants were really one and the same individual so far as such processes were concerned. If this were so in the case of my mallow, we ought to find a great reduction in the relationship of undifferentiated like organs. Two points struck me at the outset—the small variability in the segmentation of the seed vessels and the low mean value (13·7) compared with that (15) given in botanical works. I was able to collect 127 plants; of these, 76 had more than 26 capsules, some many more, and of these I took 26 only; 51 plants had fewer than 26 capsules, and although I took buds in every stage of development I could not make up my number to this, often only obtaining 10, or even fewer. As the potatoes were being removed the mallows had to be taken up before the seeds were ripe, and the seed-vessels artificially dried. The counting of the segments proved a very laborious task. To Miss M. NOTCUTT I owe a considerable portion of the counting. The buds and small seed vessels requiring a lens or small microscope were counted by Dr. LEE, Mr. RADFORD SHARPE, and myself. I am responsible for the tabulation of the data and for all the numerical calculations.

The 127 plants gave rise to 57,740 pairs distributed thus:—

TABLE XVI.—*Malva Rotundifolia.*

Number of Segments in the First Seed-vessel.

Number of Segments in the Second Seed-vessel.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	Totals.
10	10	24	60	78	89	36	5	—	—	—	302
11	24	64	202	270	185	57	7	—	—	—	809
12	60	202	850	1802	1905	637	95	1	—	—	5552
13	78	270	1802	5036	6195	2409	324	8	0	5	16127
14	89	185	1905	6195	9760	4293	653	13	0	10	23103
15	36	57	637	2409	4293	2428	386	5	0	8	10259
16	5	7	95	324	653	386	60	2	0	2	1534
17	—	—	1	8	13	5	2	—	—	—	29
18	—	—	—	0	0	0	0	—	—	—	0
19	—	—	—	5	10	8	2	—	—	—	25
Totals	302	809	5552	16127	23103	10259	1534	29	0	25	57740

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[*] Misnamed "marsh mallow" throughout this district of Buckinghamshire.

[†] 'Cross and Self-fertilisation in Plants,' 3rd edition, p. 94

The following table gives the chief numerical results :—

Malva Rotundifolia.

	Number of			Mean.	S. D.	Coefficient of variation.	S. D. of array.	Per-centage variation.	Correla-tion.
	Plants.	Capsules.	Pairs.						
Pairs. .	127	2568	57740	13·7000 ± ·0139	1·0407 ± ·0098	—	1·0232	98·32	·1827 ± [·0129]
Capsules				13·6632	1·0652	7·7961	—	—	—

The actual distribution of frequency of the capsules was :—

No. of segments.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	Total.
Frequency . .	18	41	263	736	994	445	68	2	0	1	2568

These results amply bear out my *a priori* conclusions.

The degree of resemblance of like parts has been very largely reduced. The variability (7·7961) is smaller than any we have yet come across, and the variability of the individual differs under 2 per cent. from that of the race. All these conclusions are compatible with the decreased individuality which may be expected to exist among the members of a group to a large extent propagated by stolons and not from seed.

Although in the majority of cases (76 out of 127) I took the same number of seed capsules (26) from the plant, still the influence of the plants with fewer capsules is quite marked; we see that weighting with the number of pairs lowers the variation and raises the mean, in other words, the large vigorous plants have more segmentation and less variability. The distribution of segmental frequency is fairly uniform, and shows a marked mode at 14 segments, not the 15 of the usual statement.

SECTION III.—*Members of Whorls.*

(15.) *Woodruff* (Asperula odorata).—I must confess that there is divergence between the standpoints of the botanist and of the statistician. To the latter a character is good or bad according as it affords facilities for fairly easy measurement or enumeration. He has first to seek such characters as a *sine quâ non*, and then inquire how far they occur in undifferentiated like organs. On the other hand, the biologist will readily provide a list of such characters in plant or animal life, and not one of them be available for measurement or counting. I had long fixed my eye on the members of the whorls of the woodruff. They were so fascinatingly easy to collect and count; they exhibited such a moderate amount of variation, and one felt sure the collecting, counting, tabulating, and calculating could all be done in the inside of a week; and the impulse to such a light task after the elaborate work on the earlier series was very great. Professor F. O. OLIVER and others warned me that the members of the whorls were differentiated in their origin* and also in their position on the stem, and that such a series was unsuited to illustrate the degree of resemblance between undifferentiated like organs. However, the task seemed, comparatively speaking, so easy that I felt I would undertake it, if only to compare with the *Nigella Hispanica*, and ascertain in another case how differentiation does weaken the degree of resemblance of like parts. I accordingly collected 201 single sprays of woodruff† well distributed along about a mile of lane on the bank of a hedgerow facing south. These were gathered at Great Hampden, Buckinghamshire. In counting the members on the whorls I soon found evidences of differentiation in position, the whorls towards the top of the spray having, as a rule, fewer members than those lower down. The following is the table of frequency of different pairs of whorls :—

TABLE XVII.—Woodruff. Great Hampden.

Number of Members on First Whorl.

Number of Members on Second Whorl.	4.	5.	6.	7.	8.	9.	10.	Totals.
4	8	8	41	7	1	—	—	65
5	8	32	273	126	91	4	—	534
6	41	273	2376	1363	1150	41	4	5248
7	7	126	1363	1216	953	34	3	3702
8	1	91	1150	953	1284	54	2	3535
9	—	4	41	34	54	4	—	137
10	—	—	4	3	2	—	—	9
Totals ...	65	534	5248	3702	3535	137	9	13230

I now give the numerical statement of the constants deduced from the above table and the frequency distribution of the whorls :—

---

* Some of the members of the whorls are true leaves and others modified stipules.

† They were broken off as close to the ground as possible; they included all parts branching off above ground, but the forked sprays were only few in number.

Woodruff.

	Number of			Mean.	S. D.	Coefficient of variation.	S.D. of array.	Percentage variation.	Correlation.
	Sprays.	Whorls.	Pairs.						
Pairs ...	201	1465	13230	6·7978 ± ·0164	·9318 ± ·0116	—	·9177	98·49	·1733 [± ·0171]
Whorls				6·9010	·9291	13·4631	—	—	—

The frequency distribution of the 1465 whorls was :—

Number of	4.	5.	6.	7.	8.	9.	10.	Total.
Frequency . . .	6	40	537	410	455	16	1	1465

The double modes 6 and 8 are brought out by the above distribution, and this is evidence either of differentiation or of a tendency to an even number of members. Contrary to the usual rule, the mean number of members is reduced when we take pairs, indicating that when we take a spray with many whorls—such as occasionally arises from forking—the number of members in the whorls are reduced, and since the variation is also very slightly increased (as in *Nigella*), they are spread out over a greater range.

The great reduction in the correlation, the value of which is only ·1733, shows how unsuited the material was for the purposes of the present investigation. At the same time the ratio of the individual to the racial variability reaches the very high value of 98·5 ! We have selected a character to test individuality on, which exhibits differences which are largely racial, and not peculiar to the individual plant.

SECTION IV.—*Ferns.*

(16.) In choosing ferns for considering the resemblance between undifferentiated like organs I had in view not only the comparative ease of counting (as compared, for example, with the segmentation of mallow), but the fact which students of the fern strongly impressed upon me that it was peculiarly subject to its environment. One great authority went so far as to assert that the presence or absence of *sori* on an individual hartstongue depended *solely* on the environment and not at all on the individuality of the plant. While hardly prepared to accept to the full such a statement (for I had already learned in a variety of types of the existence of individuality in a marked manner apart from the influence of environment), I anticipated in accordance with it a fairly high correlation of undifferentiated like organs, and this has, indeed, turned out to be the case.

(17.) *Somersetshire Hartstongue* (Scolopendrium vulgare).—I owe the counting of the *sori* on 8 to 12 fronds of each of 101 hartstongue ferns to Miss AGNES FRY. It was not always possible to obtain the full suggested number of 10 fronds. In a few cases Miss FRY also counted more than 10. But the ferns with fewer than 10 are not many, and the distribution of the fronds is sensibly identical with that of the pairs of fronds. The number of *sori* was often very large, running up to 180; the grouping of the leaves was accordingly arranged in units of 10 *sori*, and, to save fractionising in the table, these groups were taken 0—9·5, 9·5—19·5, 19·5—29·5, &c. The grouping on the basis of Miss FRY's record was carried out by Mr. LESLIE BRAMLEY-MOORE. With regard to the counting of the *sori*, all the sterile as well as the fertile markings were included. Fronds with no markings were included; one plant, the only one found, with absolutely no markings on any of the fronds was excluded, and to this I shall recur immediately. It was difficult to procure ten perfect fronds; many of those gathered were found to be more or less torn; in many cases the loss of *sori* was easily ascertained; in others an estimate had to be formed. Such estimates were made, however, in only forty-four cases out of more than 1,000 fronds, and in the majority of these cases it meant the addition of very few *sori*, and a possible error in the estimate of still fewer. Sometimes one or two *sori* may have been missed at the tip, where the small markings are indistinct, but the errors due to this source, as well as to the occasional error of a unit or two in counting such a large number are well under the unit of grouping of ten *sori* finally selected. The environment of the series was not quite uniform, some thirty-three coming from a stream bed and the remainder from a park glade. The plants varied considerably in age, but the necessity of procuring eight to twelve fronds was probably effective in excluding any quite young ferns. The absence or presence of *sori* on the frond was not directly associated with its age or size. Miss FRY has recorded a number of large and medium fronds with no *sori*, and some of the fronds recorded as young have occasionally a very considerable number of *sori* (as many as ninety-five on one at least). Still, a glance at the table on p. 330 shows that the fronds with zero *sori* form in same way an anomalous group; they give a hump in the frequency distribution in a manner somewhat similar to that due to barren wives in fertility-frequency curves.* Dr. LEE having tabulated the *sori*, and calculated the constants on the basis of including all fronds with zero number of *sori*, I went through Miss FRY's data again and excluded, not all the entries in the first row and column of Miss LEE's table, but only such of them as arose from the fronds with no *sori*. The result was a great smoothing of the table, a raising of the mean, and a lowering of the variability; but *no appreciable effect whatever was made on the degree of resemblance of like organs*, although I

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* See 'The Chances of Death and other Studies in Evolution,' vol. 1, essay on "Reproductive Selection," and diagram.

threw out upwards of 1212 pairs! This was hardly to be anticipated, but may certainly give us confidence in the substantial validity of the numerical result reached. This result is clearly independent of any extraneous source hindering the production of any *sori* at all on the frond. About a third of the ferns in the series (31 in 101) had one or more fronds in ten without *sori* at all, the total number of fronds without *sori* being seventy-six. The following table gives the chief numerical constants :—

Hartstongue Fern.

	Number of			Mean number of *sori*.	S. D.	Coefficient of variation.	S. D. of array.	Percentage variation.	Correlation.
	Plants.	Fronds.	Pairs.						
Fronds without *sori* included .	101	1024	9384	73·7398 ± ·7419	35·1967 ± ·5246	47·7310	27·3136	77·60	·6307 [± ·0127]
Fronds without *sori* excluded .	101	948	8172	74·3948 ± ·5246	31·2176 ± ·4836	41·9640	24·2358	77·64	·6303 [± ·0132]

The following is the actual distribution of pairs, which in this case is very nearly proportional to the distribution of fronds :—

Number of *sori*.	0–9·5.	9·5–19·5.	19·5–29·5.	29·5–39·5.	39·5–49·5.	49·5–59·5.	59·5–69·5.	69·5–79·5.	79·5–89·5.	89·5–99·5.	99·5–109·5.	109·5–119·5.	119·5–129·5.	129·5–139·5.	139·5–149·5.	149·5–159·5.	159·5–169·5.	169·5–179·5.	179·5–189·5.	Totals.
Fronds without *sori* included .	838	254	352	727	783	886	979	1040	887	908	717	446	277	191	27	18	27	18	9	9384
Fronds without *sori* excluded	103	211	294	634	716	829	925	1004	856	893	709	439	276	184	27	18	27	18	9	8172

We see from the last table how the "hump" disappears from the frequency distribution when we exclude the fronds without *sori*. The double mode indicates at least considerable flatness at the top of the distribution, and may possibly mark some heterogeneity of material. I am inclined, however, to think that the great variability (about forty-two even when the fronds without *sori* are excluded) is fully accounted for by the sensitiveness of the fern in the matter of *sori* to very slight differences of environment. I look upon the high resemblance of like parts here as having been intensified by this cause ; upon an inherent individuality we have superposed an individuality due partially, perhaps, to age, but largely to small differences of immediate environment. Although the variation in the race is so large, and the degree of individuality so great, the ratio of individual to racial variability is still 78 per cent. Thus while the variability of the hartstongue (as far as *sori* is concerned) is double that of the very variable holly, and almost thrice that of the poppy, still the percentage variability of the two latter species is to that of the former only as about 85 to 78. Thus in the most variable and most individual species we have yet come across, we still find the variation within the individual is more than three-fourths of the entire variation of the race. In view of facts like this, it seems impossible to maintain the position taken up by Mr. ADAM SEDGWICK, that variation is the outcome of bi-sexual reproduction. The source of variation exists within the individual and is extensively active without the occurrence of any form of mating whatever.

I place here the table for the distribution of *sori* in pairs of fronds. The numbers in brackets are those which must replace the unbracketed numbers, if fronds without *sori* be excluded.

TABLE XVIII.—Hartstongue

Number of Sori *on First Frond.*

Number fo Sori *on Second Frond of Pair.*

	0–9·5.	9·5–19·5.	19·5–29·5.	29·5–39·5.	39·5–49·5.	49·5–59·5.	59·5–69·5.	69·5–79·5.	79·5–89·5.	89·5–99·5.	99·5–109·5.	109·5–119·5.	119·5–129·5.	129·5–139·5.	139·5–149·5.	149·5–159·5.	159·5–169·5.	169·5–179·5.	179·5–189·5.	Totals.
0 – 9·5	272 (14)	47 (4)	70 (12)	111 (18)	88 (21)	65 (8)	65 (11)	37 (1)	35 (4)	18 (3)	10 (2)	7 (0)	1 (0)	12 (5)	—	—	—	—	—	838 (103)
9·5– 19·5	47 (4)	20	40	44	30	27	17	6	12	7	2	0	2	0	—	—	—	—	—	254 (211)
19·5– 29·5	70 (12)	40	32	61	36	38	28	11	18	13	5	0	0	0	—	—	—	—	—	352 (294)
29·5– 39·5	111 (18)	44	61	134	134	74	68	46	29	17	5	0	1	3	—	—	—	—	—	727 (634)
39·5– 49·5	88 (21)	30	36	134	146	112	79	68	39	27	11	7	5	0	0	1	0	—	—	783 (716)
49·5– 59·5	65 (8)	27	38	74	112	116	136	127	76	49	41	10	8	7	0	0	0	—	—	886 (829)
59·5– 69·5	65 (11)	17	28	68	79	136	152	173	109	89	31	12	3	6	1	4	3	2	1	979 (925)
69·5– 79·5	37 (1)	6	11	46	68	127	173	206	145	124	64	16	9	3	1	4	0	0	0	1040 (1004)
79·5– 89·5	35 (4)	12	18	29	39	76	109	145	122	133	113	29	13	10	3	1	0	0	0	887 (856)
89·5– 99·5	18 (3)	7	13	17	27	49	89	124	133	190	130	69	32	9	1	0	0	0	0	908 (893)
99·5–109·5	10 (2)	2	5	5	11	41	31	64	113	130	168	79	40	11	7	0	0	0	0	717 (709)
109·5–119·5	7 (0)	0	0	0	7	10	12	16	29	69	79	90	81	34	5	1	3	2	1	446 (439)
119·5–129·5	1 (0)	2	0	1	5	8	3	9	13	32	40	81	38	39	5	0	0	0	0	277 (276)
129·5–139·5	12 (5)	0	0	3	0	7	6	3	10	9	11	34	39	46	4	1	3	2	1	191 (184)
139·5–149·5	—	—	—	—	0	0	1	1	3	1	7	5	5	4	0	0	0	0	0	27 (27)
149·5–159·5	—	—	—	—	1	0	4	4	1	0	0	1	0	1	0	0	3	2	1	18 (18)
159·5–169·5	—	—	—	—	0	0	3	0	0	0	0	3	0	3	0	3	6	6	3	27 (27)
169·5–179·5	—	—	—	—	—	—	2	0	0	0	0	2	0	2	0	2	6	2	2	18 (18)
179·5–189·5	—	—	—	—	—	—	1	0	0	0	0	1	0	1	0	1	3	2	0	9 (9)
Totals. .	838 (103)	254 (211)	352 (294)	727 (634)	783 (716)	886 (829)	979 (925)	1040 (1004)	887 (856)	908 (893)	717 (709)	446 (439)	277 (276)	191 (184)	27 (27)	18 (18)	27 (27)	18 (18)	9 (9)	9384 (8172)

(18.) B. *Somersetshire Ceterach* (Ceterach officinarum).—Some time after I had tried in vain to count any characters in bracken, I had a letter from Miss AGNES FRY saying that she thought it just possible that the lobes on the fronds of ceterach might be counted. The chief difficulty, of course, was the indefinite character of the lobes near the tip—a difficulty which had rendered the lobes in bracken impossible. The rather indefinite tip is here of greater consequence than in the hartstongue or the chestnut leaf, for the total number of lobes is comparatively small. In some samples Miss FRY sent me, however, I agreed fairly closely with her estimates, and although the tip must form a difficulty,* we settled that an attempt should be made to include ceterach in the present series. Miss FRY accordingly counted 9 to 11 fronds on each of 99 plants. It was necessary to take plants of very different ages, and even if ceterach be not so sensible to its environment as hartstongue, it is quite possible that part of the correlation observed is due to similarity of age. The absolute agreement of the result obtained with that for hartstongue is one of the most striking things in the whole collection of data. Considering the difficulty of the tip in ceterach and the sensibility of the *sori* of hartstongue to environment, it may be a chance agreement, but it is certainly one that gives ground for pause, and suggests further investigations of the degree of resemblance between like organs in ferns. The tabulation of the data and the calculation of the constants are again due to Dr. LEE.

Ceterach.

Number of			Mean No. of lobes.	S. D.	Coefficient of variation	S. D. of array.	Percentage variation.	Correlation.
Plants.	Fronds.	Pairs.						
99	999	9098	23·1677 ± ·0902	4·2278 ± ·0638	18·2485	3·2795	77·57	·6311[± ·0128]

The distribution of frequency of the fronds is almost the same as that of the pairs, since the attempt was made to take 10 fronds; actually 80 plants had 10, 14 had 11, and 5 only 9 fronds.

Frequency from Pairs.

No. of lobes .	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Frequency .	55	73	146	229	375	418	584	575	811	726	800	805

No. of lobes .	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	Total.
Frequency .	863	679	668	386	288	215	184	91	37	45	27	0	9	0	9	9098

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* Miss FRY writes: "It is very difficult to keep to a standard of counting for the tip, but I have tried to do so."

TABLE XIX.—Ceterach, Somersetshire.

Number of Lobes in First Frond.

Number of Lobes in Second Frond.

	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	Totals.
13	2	4	5	7	5	8	7	5	7	4	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55
14	4	2	8	10	7	11	11	10	5	3	2	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	73
15	5	8	10	9	15	14	21	19	17	9	6	7	2	0	2	1	1	—	—	—	—	—	—	—	—	—	—	146
16	7	10	9	10	21	25	31	28	23	26	21	7	7	2	2	0	0	—	—	—	—	—	—	—	—	—	—	229
17	5	7	15	21	22	45	59	47	48	32	27	18	11	8	6	2	2	—	—	—	—	—	—	—	—	—	—	375
18	8	11	14	25	45	42	65	53	55	35	25	13	8	12	3	1	1	2	—	—	—	—	—	—	—	—	—	418
19	7	11	21	31	59	65	80	77	65	61	47	18	27	6	7	1	1	0	—	—	—	—	—	—	—	—	—	584
20	5	10	19	28	47	53	77	54	62	54	44	26	28	25	27	8	2	4	2	—	—	—	—	—	—	—	—	575
21	7	5	17	23	48	55	65	62	90	103	87	63	63	38	44	19	10	5	3	3	1	—	—	—	—	—	—	811
22	4	3	9	26	32	35	61	54	103	84	83	71	64	44	29	12	7	2	1	1	1	—	—	—	—	—	—	726
23	0	2	6	21	27	25	47	44	87	83	82	96	87	69	65	27	17	10	4	1	0	—	—	—	—	—	—	800
24	1	0	7	7	18	13	18	26	63	71	96	136	104	95	73	30	15	11	14	4	2	1	—	—	—	—	—	805
25	—	—	2	7	11	8	27	28	63	64	87	104	132	96	92	50	43	16	20	6	4	3	—	—	—	—	—	863
26	—	—	0	2	8	12	6	25	38	44	69	95	96	82	95	43	28	15	14	4	2	1	—	—	—	—	—	679
27	—	—	2	2	6	3	7	27	44	29	65	73	92	95	76	53	27	28	25	10	1	2	0	0	1	—	—	668
28	—	—	1	0	2	1	1	8	19	12	27	30	50	43	53	28	37	38	22	5	7	2	0	0	0	—	—	386
29	—	—	1	0	2	1	1	2	10	7	17	15	43	28	27	37	36	17	22	13	4	3	0	0	2	—	—	288
30	—	—	—	—	—	2	0	4	5	2	10	11	16	15	28	38	17	26	19	6	9	6	0	0	1	—	—	215
31	—	—	—	—	—	—	—	2	3	1	4	14	20	14	25	22	22	19	8	11	3	7	6	0	1	0	2	184
32	—	—	—	—	—	—	—	—	3	1	1	4	6	4	10	5	13	6	11	8	1	7	6	0	3	0	2	91
33	—	—	—	—	—	—	—	—	1	1	0	2	4	2	1	7	4	9	3	1	0	2	0	0	0	0	0	37
34	—	—	—	—	—	—	—	—	—	—	—	1	3	1	2	2	3	6	7	7	2	2	6	0	1	0	2	45
35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	6	6	0	6	6	0	0	0	3	27
36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	—	—	—	—	0
37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	2	1	1	3	0	1	0	—	—	—	—	9
38	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	—	—	—	—	0
39	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	0	2	3	—	—	—	—	9
Totals	55	73	146	229	375	418	584	575	811	726	800	805	863	679	668	386	288	215	184	91	37	45	27	0	9	0	9	9098

It will be seen at once that while in the case of ceterach the variability has fallen to less than half that of the hartstongue—being close to that of the *Nigella Hispanica* and less than that of holly—still the measure of the individuality, *i.e.*, the degree of sameness in like organs, is to the limit of accuracy defined by its probable error identical with that of hartstongue. Considering the difficulties arising from environment, difference of age, and from standards of reckoning, this agreement is remarkable. It seems to me that the basis of the identity, the bulk of the agreement, must have other sources than a balance between the resemblances produced in undifferentiated like organs by such diverse causes as environment on the one hand and age on the other acting upon the individual plants. I hope that further investigations upon ferns may be forthcoming. Table XIX. contains the classified data for ceterach.

SECTION V.—*Onions* (Allium cepa), *Great Hampden.*

(19.) The veins in the successive tunics of onions occurred to me as a possible character for computation, no differentiation of the number of veins with the position of the tunic being discoverable. The number of tunics on which the veins were countable was about six, but the process of counting itself was for more than one reason a most trying one. As there were so few "like organs" to each individual, it was needful to deal with at least 200. I accordingly purchased about 250 English onions; these were in three groups, and came from as many cottage gardens. Their average horizontal diameter was about 2 inches, and they appeared very uniform in character. It is quite possible, however, that there may be some heterogeneity introduced into the series by this mixture of onions from different sources, but I did not at the time see my way to obtaining the whole series from one homogeneous sowing.* The entire work of counting and calculating on 200 of these onions was most valiantly undertaken by Dr. LEE.† Each onion was cut through horizontally; the tunics then came easily apart, and these were held up to the light, and the number of veins, ranging from 18 to 54, then counted and recorded. The following table contains the chief numerical constants:—

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* The onions were purchased at an auction following a harvest festival; the great bulk of them had formed a large chancel crucifix constructed of two different species from one cottage garden. The English onions from this crucifix formed a most homogeneous group, having been already selected for uniformity of size and appearance. I supplemented these by the purchase of two other smaller "offerings," closely resembling them.

† If any of my readers wish to appreciate the purely *physical* difficulties of the task, they should try the effect of slicing and counting four or five onions, and they will, I think, be inclined, as I soon was, to give up the task in despair.

English Onion.

Number of			Mean No. of veins.	S. D.	Coefficient of variation.	S. D. of array.	Percentage variation.	Correlation.
Plants.	Tunics.	Pairs.						
200	1085	4924	29·8725 ± ·1066	5·2060 ± ·0754	17·4274	4·1222	79·18	·6108 [± ·0128]

The actual number of tunics with veins countable was made up as follows: 121 onions with 6, 44 with 5, 34 with 4, and 1 with only 3 available tunics. It will be seen that the onion has a degree of resemblance in its undifferentiated-like organs closely resembling that of the Chelsea Shirley poppies, of the Dorsetshire hollies (without No. 91), or the mixed Spanish chestnuts, and somewhat less than that found for the two series of ferns. Its variability approaches closely that of the wild poppy. On the whole it fits well into our series of results, the somewhat high value of the correlation approaching those of several sets, the homogeneity of which is not entirely above suspicion. The accompanying table gives the classified data from which the constants were deduced.

SECTION VI.—*Leguminous Plants.*

(20.) I had at an early stage considered that the counting of seeds in the pods of leguminous plants would be a very easy manner of testing the intensity of homotypic correlation. But as the number of seeds fully developed would depend on the extent to which the flower had been fertilised, it seemed to me, after further thinking about the problem, that unless I counted all the abortive as well as the fully developed seeds, I should find the factor of homotyposis weakened by the external chances upon which I thought cross-fertilisation must depend, and which I feared would have nothing in the main to do with the individuality of the plant. I made some attempts to count all abortive as well as fully developed seeds in certain species, but I found the task not only very laborious, but my estimates doubtful. Examining for another purpose DARWIN'S 'Cross- and Self-Fertilisation of Plants.' I was struck by the fact that he did not hesitate for the purpose of comparing their vigour to count the seeds of plants living in *the open and all alike subject to free visitation from insects and bees.* He distinctly states (3rd Edn., p. 115) that "the difference in the number of the contained seeds* must depend upon the constitution of the plants." This view of the matter impressed me without entirely removing my earlier doubts. Given a number of plants living under the like conditions, and with a superabundant visitation from insects, there would be ample and equal chance of fertilisation for all

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* DARWIN in all cases appears to have calculated the good or fully developed seed.

TABLE XX.—Engli

Number of

Number of Veins in Second Tunic.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.
18	—	—	2	1	0	2	2	2	0	—	—	—	—	—	—	—
19	—	—	0	0	0	1	1	2	3	1	2	—	—	—	—	—
20	2	0	4	4	3	3	3	6	5	0	0	1	—	—	—	—
21	1	0	4	6	2	5	9	14	7	7	0	1	5	0	2	1
22	0	0	3	2	2	6	17	16	23	15	15	10	6	4	2	1
23	2	1	3	5	6	8	18	27	27	16	13	14	10	3	3	0
24	2	1	3	9	17	18	14	34	29	23	20	15	10	5	2	3
25	2	2	6	14	16	27	34	32	63	30	23	23	17	12	9	2
26	—	3	5	7	23	27	29	63	64	62	48	51	31	21	15	16
27	—	1	0	7	15	16	23	30	62	52	37	45	30	33	18	15
28	—	2	0	0	15	13	20	23	48	37	52	40	33	20	17	12
29	—	—	1	1	10	14	15	23	51	45	40	86	28	33	15	13
30	—	—	—	5	6	10	10	17	31	30	33	28	40	23	27	17
31	—	—	—	0	4	3	5	12	21	33	20	33	23	20	13	16
32	—	—	—	2	2	3	2	9	15	18	17	15	27	13	14	4
33	—	—	—	1	1	0	3	2	16	15	12	13	17	16	4	22
34	—	—	—	0	0	3	0	6	9	18	10	13	20	11	24	11
35	—	—	—	2	1	2	2	7	10	16	10	9	19	8	23	10
36	—	—	—	0	1	0	1	0	2	10	11	11	13	12	15	17
37	—	—	—	0	0	1	0	1	3	8	8	8	12	6	6	10
38	—	—	—	0	0	1	0	1	1	2	6	2	4	4	7	15
39	—	—	—	1	0	1	0	1	1	3	0	2	3	3	6	10
40	—	—	—	0	0	0	0	0	0	0	1	0	4	3	3	5
41	—	—	—	0	0	0	0	0	0	0	1	2	0	1	1	2
42	—	—	—	0	0	0	0	0	0	3	0	2	4	0	1	2
43	—	—	—	1	0	0	0	1	0	1	0	0	0	0	0	2
44	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
46	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
47	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
48	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
49	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
51	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
52	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
53	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
54	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	9	10	31	68	124	164	208	329	491	445	379	424	356	251	227	207

–English Onion. Great Hampden.

umber of Veins in First Tunic. [*To*

33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	0	2	0	0	0	1	0	0	0	1	—	—	—	—	—	—	—	—	—	—
1	0	1	1	0	0	0	0	0	0	0	—	—	—	—	—	—	—	—	—	—
0	3	2	0	1	1	1	0	0	0	0	—	—	—	—	—	—	—	—	—	—
3	0	2	1	0	0	0	0	0	0	0	—	—	—	—	—	—	—	—	—	—
2	6	7	0	1	1	1	0	0	0	1	—	—	—	—	—	—	—	—	—	—
16	9	10	2	3	1	1	0	0	0	0	—	—	—	—	—	—	—	—	—	—
15	18	16	10	8	2	3	0	0	3	1	—	—	—	—	—	—	—	—	—	—
12	10	10	11	8	6	0	1	1	0	0	—	—	—	—	—	—	—	—	—	—
13	13	9	11	8	2	2	0	2	2	0	—	—	—	—	—	—	—	—	—	—
17	20	19	13	12	4	3	4	0	4	0	—	—	—	—	—	—	—	—	—	—
16	11	8	12	6	4	3	3	1	0	0	—	—	—	—	—	—	—	—	—	—
4	24	23	15	6	7	6	3	1	1	0	—	—	—	—	—	—	—	—	—	—
22	11	10	17	10	15	10	5	2	2	2	1	—	—	—	—	—	—	—	—	—
11	20	15	8	12	8	4	3	2	3	1	2	2	0	0	0	0	0	0	0	0
10	15	12	14	12	13	4	2	0	2	2	0	0	0	0	0	0	0	0	0	0
17	8	14	10	12	15	9	2	8	9	4	1	0	1	0	0	0	1	0	0	0
10	12	12	12	14	14	4	8	3	8	2	0	0	0	0	0	0	0	0	0	0
15	8	13	15	14	14	13	7	6	7	7	3	1	0	0	0	0	0	0	0	0
10	4	4	9	4	13	4	3	2	9	3	1	0	0	0	0	0	0	0	0	0
5	3	2	2	8	7	3	2	2	2	0	1	0	0	0	0	0	0	0	0	0
2	2	0	8	3	6	2	2	4	2	2	3	0	2	0	0	0	2	0	0	0
2	3	2	9	8	7	9	2	2	4	1	1	0	0	0	0	0	0	0	0	0
2	1	2	4	2	7	3	0	2	1	2	1	0	0	0	0	0	0	0	0	0
1	2	0	1	0	3	1	1	3	1	1	0	1	1	0	0	0	1	0	0	0
—	2	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
—	0	0	1	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0	0	0
—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
—	0	0	1	0	0	0	0	2	0	0	1	0	1	0	0	0	0	0	0	0
—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
—	2	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
207	207	195	187	152	152	87	48	45	60	30	18	5	5	0	0	0	5	0	0	0

52.	53.	54.	Totals.
—	—	—	9
—	—	—	10
—	—	—	31
—	—	—	68
—	—	—	124
—	—	—	164
—	—	—	208
—	—	—	329
—	—	—	491
—	—	—	445
—	—	—	379
—	—	—	424
—	—	—	356
—	—	—	251
—	—	—	227
—	—	—	207
0	0	2	207
0	0	0	195
0	0	0	187
0	0	0	152
0	0	1	152
0	0	0	87
0	0	0	48
0	0	0	45
0	0	0	60
0	0	0	30
0	0	1	18
0	0	1	5
0	0	0	5
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	5
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	5
0	0	5	4924

of them, and excess or defect from the average number of fertile seeds would depend only on the constitution of the individual plant. It would seem accordingly that in the case of cross-fertilisation ample visitation was a *sine quâ non*, and this led me to select broom in the first place.

Broom (Cytisus Scoparius), *Danby Dale*.—We collected 10 pods from each of 120 broom bushes. These were growing within some quarter of a mile of each other, on the roadside at Botton, towards the head of Danby Dale, Yorkshire.

I roughly estimated that if abortive seeds were to be included, 16 would be about the modal number of ovules; the actual average of fully developed seeds in 1200 pods was 9·6425, with a modal value at 9, so that some 6 to 7 seeds failed of fertilisation on the average in each pod. The following is the frequency distribution of the seeds in the pods:—

No. of seeds.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	Total.
Frequency .	8	15	29	47	54	77	98	126	136	134	103	100	98	67	48	33	17	5	4	1	1200

I came across no pods with an entire absence of seeds, although such may exist. I refer to this because the reader might think that such were discarded. The distribution is fairly regular, but it is clear that the variation is very large, the distribution being very flat topped. As in nearly all the cases that I have dealt with in this memoir, it is markedly skew. I reserve, however, for the present the full consideration of variation in the vegetable world, as my data extend far beyond the material considered in this paper, which is limited to the cases in which the homotypic correlation has also been worked out—a far more laborious enquiry. I would only remark that among plants and trees I know of nothing approximating even to the "normal law," and that in many cases we appear to have mixtures of local races hardly yet differentiated by the botanist.

The following table gives the constants for broom:—

Broom. Seeds in Pods.

Number of			Mean No. of seeds.	S. D. of seeds.	Coefficient of variation.	S. D. of array.	Percentage variation.	Correlation.
Plants.	Pods.	Pairs.						
120	1200	10,800	9·6425 ± ·0691	3·54655 ± ·0488	36·7804	3·22595	90·96	·4155 [± ·0161]

The actual distribution of pairs is given in the table on the following page. It will be seen that some of the arrays are rather irregular, but in its results I look upon broom to be as satisfactory as any material I have dealt with. In the first place, the table fully bears out the conclusion drawn from the simple frequency

TABLE XXI.—Broom. Danby Dale.

Number of Seeds in First Pod.

Number of Seeds in Second Pod.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	Totals.
1	8	10	9	4	2	7	9	9	5	5	3	1	—	—	—	—	—	—	—	—	72
2	10	8	20	24	11	17	13	6	7	8	5	2	1	2	0	1	—	—	—	—	135
3	9	20	34	49	25	34	16	22	18	15	9	6	4	0	0	0	—	—	—	—	261
4	4	24	49	52	39	52	37	33	40	39	19	11	11	11	1	1	—	—	—	—	423
5	2	11	25	39	40	53	60	41	61	53	37	25	16	13	4	5	0	1	—	—	486
6	7	17	34	52	53	64	63	77	89	76	50	42	33	21	7	7	1	0	—	—	693
7	9	13	16	37	60	63	88	97	116	103	84	63	52	35	25	14	4	3	—	—	882
8	9	6	22	33	41	77	97	144	133	141	106	97	106	64	36	14	8	0	—	—	1134
9	5	7	18	40	61	89	116	133	146	136	125	97	86	67	47	27	18	4	2	—	1224
10	5	8	15	39	53	76	103	141	136	148	122	107	96	68	38	28	17	3	2	1	1206
11	3	5	9	19	37	50	84	106	125	122	88	77	91	51	32	20	7	0	0	1	927
12	1	2	6	11	25	42	63	97	97	107	77	88	107	72	47	31	14	8	4	1	900
13	—	1	4	11	16	33	52	106	86	96	91	107	82	76	61	37	16	4	3	0	882
14	—	2	0	11	13	21	35	64	67	68	51	72	76	32	39	35	13	2	1	1	603
15	—	0	0	1	4	7	25	36	47	38	32	47	61	39	40	28	17	4	4	2	432
16	—	1	0	1	5	7	14	14	27	28	20	31	37	35	28	20	16	5	6	2	297
17	—	—	—	—	0	1	4	8	18	17	7	14	16	13	17	16	10	4	7	1	153
18	—	—	—	—	1	0	3	0	4	3	0	8	4	2	4	5	4	2	5	0	45
19	—	—	—	—	—	—	—	—	2	2	0	4	3	1	4	6	7	5	2	—	36
20	—	—	—	—	—	—	—	—	—	1	1	1	0	1	2	2	1	0	—	—	9
Totals...	72	135	261	423	486	693	882	1134	1224	1206	927	900	882	603	432	297	153	45	36	9	10800

distribution of the high degree of variability in the broom pod. We have so far reached nothing but the *sori* on the Hartstongue fern with anything like such a high coefficient of variation. We might expect, if Mr. ADAM SEDGEWICK'S view were correct and great variation meant small intensity of heredity, that homotyposis, of which heredity is only a special case, would also be small if variation were large. But we find nothing of the kind. The resemblance of undifferentiated like organs reaches the value ·4155, fully equal to that of the *pinnæ* of the ash, which have less than half the variability of broom pods. This value is close also to the ·4000 given by the Ancestral Law of Heredity for the degree of resemblance between brothers. In the next place this normal behaviour as to the degree of resemblance of like organs is associated with a variability in the individual which amounts to upwards of 90 per cent. of the racial variability. It is impossible to form standard deviations for groups of 10, but if the reader will reduce any array of the above table to the number 10, rejecting all fractions of unity, he will obtain quite fair samples of what I actually found in the case of individual pods. I think we may feel fairly confident that the variability of a race is not in inverse proportion to either its heredity or its homotyposis.

It will be seen that broom, so far as it goes, supports the view held by DARWIN that the number of ripe seeds is a measure of individual constitution. At the same time the question of self-fertilisation arises. Would completely self-fertilised plants exhibit full homotyposis? May not outside influences—wind, shaking due to visits of insects or other causes of a random character—be also needful for the ripening of the seeds even in the case of self-fertilisation? Again, can we always suppose that a plentiful visitation will take place in the case of all cross-fertilised plants? I must confess that the value for the homotyposis found in the case of broom did not suffice to remove all my doubts as to any character depending on fertilisation being a suitable one for the determination of the intensity of homotyposis. The subject, however, is one of such great interest that it deserves an independent and fuller treatment than can be provided here.*

V. CROSS-HOMOTYPIC CORRELATION.

(21.) *Mushroom* (Agaricus campestris).—A more complete study was now made of two species—the mushroom and the ivy. We found some difficulty in discovering two easily measurable or countable characters in one organ, neither of which was largely influenced by the growth of the organ or the age of the organism. In selecting an organ in the mushroom, I was guided by the desire to take a simple organism, and an organ upon which fertilisation had no influence. The gill of the mushroom seemed to satisfy to some extent these conditions. Had we been able to grow our own mushrooms we might have succeeded in taking them all at the same stage of

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* This has been to some extent provided in an Appendix to this memoir, added since its completion.

development, and our results would in this case have been more homogeneous and thus more satisfactory. But simply gathering them in the fields we could only make a very rough approximation to uniformity in age or development. We aimed at a condition in which the underskin had disappeared and the gills had lost all signs of a crease or notch. Dr. LEE and I collected more than 100 mushrooms in the Great and Little Hampdens. With the assistance of my wife we cut 10 gills out of each of these, distributed, as far as the condition of the mushroom would allow, uniformly round the axis. These gills were then placed on ruled paper, the horizontal lines of which served to mark the maximum length of the gill. This was marked by two fine needle-pricks, one at either end. Two further needle-pricks were now made at the points farthest removed from this length line, one on the upper and one on the lower contour of the gill. Thus by drawing through the four needle points lines parallel and perpendicular to the paper-ruling we obtained a rectangle approximately circumscribing the gill. The length and breadth of this rectangle are what I shall term the length and breadth of the gill. At first I endeavoured to take these measurements by the use of a micrometer microscope, but this method was very laborious, and gave an apparent exactness wholly out of keeping with the somewhat rough and ready manipulation of the gill. Even when the gill itself was placed under the microscope the gill length could only be placed parallel to the spider wires by a somewhat vague appreciation, and the upper boundary of the gill was under the lens rather less definite than without it. Accordingly we resorted to the needle-pricks and the ruling by fine lines of the above-mentioned rectangle. I determined, after various trials with engraved glass scales, &c., the length and breadth of these rectangles by the use of a pair of proportional compasses, set to multiply by ten, and an ordinary millimetre scale. I was thus able to get readings to ·01 of a millimetre, which agreed well on repetition. As the millimetre itself was afterwards adopted as the unit of grouping, I do not think the errors of manipulation will seriously affect our results. The needle-prick method enabled us to deal with the mushrooms quite fresh and reserve the measuring till another season.* Dr. LEE found what we may term the *gill-index*, *i.e.*, the ratio of length to breadth for the 1070 gills, by aid of a FULLER's slide rule. We had thus three characters to deal with—length, breadth, and index. Of these we considered that the first two would undoubtedly be largely influenced by the stage of development of the mushroom, but we hoped that the index (like, for example, the cephalic index of children over two years of age) would not be much influenced by the growth factor. On the other hand, the correlation of lengths of gills or the correlation of breadths of gills from the same mushroom would of course be influenced by growth as well as

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* In all such systems of mass-measurement, the method adopted has to be chosen with due regard to time and eyesight. The actual measurement of the gills occupied me about ten full days, the microscopic method would have taken about four times the time, even if my eyes would allow of such continuous working and the mushrooms could have been preserved fresh.

by individuality. Thus we should find the degree of resemblance between two gills of the same mushroom, when measured by length or breadth, to be influenced not only by the individuality of the mushroom, but by the stage of its growth, and accordingly likely to exceed, and possibly considerably exceed, the value about ·5, which we have determined in several other cases.*

In order to make a more complete study of the influence of stages of growth on the degree of resemblance of undifferentiated like organs, Dr. LEE with her characteristic energy undertook the five needful tables.

They are the following :—

(i.) Organic correlation of the length and breadth of the same gill.
(ii.) Homotypic correlation of the lengths of two gills of the same mushroom.
(iii.) Homotypic correlation of the breadths of two gills of the same mushroom.
(iv.) Cross homotypic correlation of the length of one, and the breadth of a second gill of the same mushroom.
(v.) Homotypic correlation of the indices of two gills of the same mushroom.

Of these tables the cross homotypic correlation between length and breadth is a very laborious business, offering no means of readily testing the accuracy of the entries until the whole table is completed and its columns and rows added up. Ultimately the frequency distributions (as given by row or column marked totals) for the lengths and breadths in tables (ii.), (iii.), and (iv.), ought to be $n - 1$ times the frequency distributions of lengths and breadths as given by the like row and column in the organic correlation table (i.), n being the number of organs measured in each individual; in our case this is ten.

I begin by considering the results obtained for the degree of resemblance of gill-indices, *i.e.*, Table (v.) referred to above. The following were the results obtained :—

Mushroom. Gill Indices.

Number of			Mean index.	S. D.	Coefficient of variation.	S. D. of array.	Percentage variation.	Correlation.
Mushrooms.	Gills.	Pairs.						
107	1070	9630	2·8695 ± ·0108	·5246 ± ·0076	18·2819	·4385	83·58	·5490 [± ·0144]

The frequency distribution of the gills was the following :—

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* The absurdity of disregarding the growth-factor may be realised if we consider how much the degree of resemblance in brethren would be increased if we took pairs of brothers, differing, say, by less than two years, and these pairs were scattered at all ages from four to twenty !

Gill Index.

	1·4995–1·5995.	1·5995–1·6995.	1·6995–1·7995.	1·7995–1·8995.	1·8995–1·9995.	1·9995–2·0995.	2·0995–2·1995.	2·1995–2·2995.	2·2995–2·3995.	2·3995–2·4995.	2·4995–2·5995.	2·5995–2·6995.	2·6995–2·7995.	2·7995–2·8995.	2·8995–2·9995.
Frequency .	1	1	4	7	13	18	30	39	55	78	101	90	100	93	73

	2·9995–3·0995.	3·0995–3·1995.	3·1995–3·2995.	3·2995–3·3995.	3·3995–3·4995.	3·4995–3·5995.	3·5995–3·6995.	3·6995–3·7995.	3·7995–3·8995.	3·8995–3·9995.	3·9995–4·0995.	4·0995–4·1995.	4·1995–4·2995.	4·2995–4·3995.	4·3995–4·4995.
Frequency .	66	62	39	43	31	43	15	20	10	9	1	8	3	3	4

	4·4995–4·5995.	4·5995–4·6995.	4·6995–4·7995.	4·7995–4·8995.	4·8995–4·9995.	4·9995–5·0995.	5·0995–5·1995.	5·1995–5·2995.	5·2995–5·3995.	5·3995–5·4995.	5·4995–5·5995.	5·5995–5·6995.	Total.
Frequency .	0	3	1	2	0	1	0	1	0	1	0	1	1070

This distribution is rather irregular and may suggest heterogeneity; the tail is somewhat inordinately extended. But the numerical constants given in the table above are quite comparable with the best of our other series, and are rather better than I had anticipated *a priori*, for I expected the diverse stages of growth would influence the index as well as the absolute measures. It would be of great interest to repeat the series on an artificially grown bed of mushrooms, taking each at the same stage.

It will be seen that the mushroom, with degree of resemblance of like organs about that of the Spanish chestnut, has a variability comparable with that of the ash. The variation of the individual is even in such a comparatively simple organism more than 80 p.c. of that of the race. It will thus be clear that the mushroom takes, so far as our present investigation is concerned, no special place apart in the vegetable world, but quantitatively is comparable with highly developed organisms like trees. The accompanying table, Table XXII., gives the data for the measurement of the gills.

I now turn to the relationships of the absolute measurements, which, as I have noted, we have good grounds for believing are much affected by growth.

The numerical constants are summed up in the following table, the dimensions being given in millimetres:—

Index of Second Gill.

	1·5495.	1·6495.	1·7495.	1·8495.	1·9495.	2·0495.	2·1495.	2·2495.	2·3495.	2·4495.	2·5495
1·5495	—	—	—	—	1	1	0	2	1	1	0
1·6495	—	—	1	2	1	2	2	1	0	0	0
1·7495	—	1	2	2	7	6	10	5	1	2	0
1·8495	—	2	2	8	5	12	9	6	5	4	5
1·9495	1	1	7	5	14	18	16	11	20	7	5
2·0495	1	2	6	12	18	10	26	25	21	9	12
2·1495	0	2	10	9	16	26	20	35	35	26	29
2·2495	2	1	5	6	11	25	35	40	42	28	44
2·3495	1	0	1	5	20	21	35	42	48	68	72
2·4495	1	0	2	4	7	9	26	28	68	68	102
2·5495	0	0	0	5	5	12	29	44	72	102	124
2·6495	2	0	0	2	4	3	8	28	47	75	124
2·7495	1	0	0	2	3	6	16	32	44	62	104
2·8495	—	—	—	0	0	1	12	15	29	79	90
2·9495	—	—	—	0	1	1	7	8	15	38	47
3·0495	—	—	—	0	3	2	5	6	15	46	50
3·1495	—	—	—	0	0	0	2	7	6	27	32
3·2495	—	—	—	0	0	1	3	6	5	13	17
3·3495	—	—	—	0	1	0	2	1	7	13	15
3·4495	—	—	—	1	0	3	4	3	4	7	11
3·5495	—	—	—	—	—	1	2	3	3	12	9
3·6495	—	—	—	—	—	0	0	0	1	3	5
3·7495	—	—	—	—	—	2	1	3	2	6	3
3·8495	—	—	—	—	—	—	—	—	1	0	1
3·9495	—	—	—	—	—	—	—	—	1	3	4
4·0495	—	—	—	—	—	—	—	—	0	0	0
4·1495	—	—	—	—	—	—	—	—	0	2	3
4·2495	—	—	—	—	—	—	—	—	0	0	0
4·3495	—	—	—	—	—	—	—	—	1	1	0
4·4495	—	—	—	—	—	—	—	—	1	0	0
4·5495	—	—	—	—	—	—	—	—	—	—	0
4·6495	—	—	—	—	—	—	—	—	—	—	0
4·7495	—	—	—	—	—	—	—	—	—	—	0
4·8495	—	—	—	—	—	—	—	—	—	—	0
4·9495	—	—	—	—	—	—	—	—	—	—	0
5·0495	—	—	—	—	—	—	—	—	—	—	0
5·1495	—	—	—	—	—	—	—	—	—	—	0
5·2495	—	—	—	—	—	—	—	—	—	—	0
5·3495	—	—	—	—	—	—	—	—	—	—	0
5·4495	—	—	—	—	—	—	—	—	—	—	1
5·5495	—	—	—	—	—	—	—	—	—	—	—
5·6495	—	—	—	—	—	—	—	—	—	—	—
Totals...	9	9	36	63	117	162	270	351	495	702	909

TABLE XXII.—Mushroom Gill-

Index of First Gill.

2·5495.	2·6495.	2·7495.	2·8495.	2·9495.	3·0495.	3·1495.	3·2495.	3·3495.	3·4495.	3·5495.	3·6495.
0	2	1	—	—	—	—	—	—	—	—	—
0	0	0	—	—	—	—	—	—	—	—	—
0	0	0	—	—	—	—	—	—	—	—	—
5	2	2	0	0	0	0	0	0	1	—	—
5	4	3	0	1	3	0	0	1	0	—	—
12	3	6	1	1	2	0	1	0	3	1	0
29	8	16	12	7	5	2	3	2	4	2	0
44	28	32	15	8	6	7	6	1	3	3	0
72	47	44	29	15	15	6	5	7	4	3	1
102	75	62	79	38	46	27	13	13	7	12	3
124	124	104	90	47	50	32	17	15	11	9	5
124	138	100	84	50	42	36	17	10	4	11	1
104	100	112	96	78	54	69	29	23	18	24	3
90	84	96	98	74	63	60	26	34	16	23	9
47	50	78	74	58	56	50	27	43	22	44	10
50	42	54	63	56	44	55	32	25	20	29	16
32	36	69	60	50	55	48	31	40	26	22	12
17	17	29	26	27	32	31	18	20	23	20	13
15	10	23	34	43	25	40	20	28	22	42	13
11	4	18	16	22	20	26	23	22	22	16	7
9	11	24	23	44	29	22	20	42	16	58	15
5	1	3	9	10	16	12	13	13	7	15	4
3	2	13	9	13	10	8	21	12	12	23	10
1	4	1	3	5	5	5	10	9	10	7	4
4	7	3	3	2	7	7	4	6	5	2	2
0	0	0	0	0	2	0	1	0	2	2	0
3	2	1	2	2	4	1	2	4	6	11	1
0	0	0	2	0	0	0	4	0	3	2	0
0	2	1	5	0	0	6	2	4	0	0	3
0	4	2	2	1	3	0	1	2	4	2	2
0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	0	3	0	2	3	3	2	3	0
0	0	0	0	0	0	1	0	1	1	0	0
0	0	1	1	1	0	1	1	3	2	1	1
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	1	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	1	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0
1	2	1	1	1	0	1	0	1	1	0	0
—	—	—	—	—	—	0	0	0	0	0	0
—	—	—	—	—	—	1	1	1	0	0	0
909	810	900	837	657	594	558	351	387	279	387	135

m Gill-indices.

Gill.

495.	3·7495.	3·8495.	3·9495.	4·0495.	4·1495.	4·2495.	4·3495.	4·4495.	4·5495.	4·6495.	4·7495.	4·8495.
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
0	2	—	—	—	—	—	—	—	—	—	—	—
0	1	—	—	—	—	—	—	—	—	—	—	—
0	3	—	—	—	—	—	—	—	—	—	—	—
1	2	1	1	0	0	0	1	1	—	—	—	—
3	6	0	3	0	2	0	1	0	—	—	—	—
5	3	1	4	0	3	0	0	0	0	0	0	0
1	2	4	7	0	2	0	2	4	0	1	0	0
3	13	1	3	0	1	0	1	2	0	1	0	1
9	9	3	3	0	2	2	5	2	0	0	0	1
0	13	5	2	0	2	0	0	1	0	3	0	1
6	10	5	7	2	4	0	0	3	0	0	0	0
2	8	5	7	0	1	0	6	0	0	2	1	1
3	21	10	4	1	2	4	2	1	0	3	0	1
3	12	9	6	0	4	0	4	2	0	3	1	3
7	12	10	5	2	6	3	0	4	0	2	1	2
5	23	7	2	2	11	2	0	2	0	3	0	1
4	10	4	2	0	1	0	3	2	0	0	0	1
0	10	7	1	0	2	6	0	2	0	1	0	1
4	7	4	2	0	6	3	0	1	0	1	0	1
2	1	2	2	0	5	1	0	3	0	2	2	1
0	0	0	0	0	1	0	0	1	0	0	0	0
1	2	6	5	1	12	4	0	1	0	0	0	0
0	6	3	1	0	4	2	0	0	0	0	0	0
3	0	0	0	0	0	0	2	0	0	0	0	0
2	2	1	3	1	1	0	0	2	0	0	0	2
0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	2	0	0	0	0	0	0	0	1	1
0	0	0	2	0	0	0	0	0	0	1	0	0
1	1	1	1	0	0	0	0	2	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	2	0	0	0	0	0	0	1	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	2	0	0	0	0	0	0	1	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	2	0	0	0	0	0	0	1	1	0
5	180	90	81	9	72	27	27	36	0	27	9	18

4·8495.	4·9495.	5·0495.	5·1495.	5·2495.	5·3495.	5·4495.	5·5495.	5·6495.	Totals.
—	—	—	—	—	—	—	—	—	9
—	—	—	—	—	—	—	—	—	9
—	—	—	—	—	—	—	—	—	36
—	—	—	—	—	—	—	—	—	63
—	—	—	—	—	—	—	—	—	117
—	—	—	—	—	—	—	—	—	162
—	—	—	—	—	—	—	—	—	270
—	—	—	—	—	—	—	—	—	351
—	—	—	—	—	—	—	—	—	495
—	—	—	—	—	—	—	—	—	702
0	0	0	0	0	0	1	—	—	909
0	0	0	0	0	0	2	—	—	810
1	0	0	0	0	0	1	—	—	900
1	0	0	0	0	0	1	—	—	837
1	0	0	0	0	0	1	—	—	657
0	0	0	0	0	0	0	—	—	594
1	0	1	0	1	0	1	0	1	558
1	0	0	0	0	0	0	0	1	351
3	0	1	0	1	0	1	0	1	387
2	0	1	0	1	0	1	0	0	279
1	0	0	0	0	0	0	0	0	387
1	0	0	0	0	0	0	0	0	135
1	0	0	0	0	0	0	0	0	180
1	0	0	0	0	0	0	0	0	90
1	0	2	0	2	0	0	0	2	81
0	0	0	0	0	0	0	0	0	9
0	0	0	0	0	0	0	0	0	72
0	0	0	0	0	0	0	0	0	27
0	0	0	0	0	0	0	0	0	27
2	0	0	0	0	0	0	0	0	36
0	0	0	0	0	0	0	0	0	0
1	0	1	0	1	0	0	0	1	27
0	0	1	0	1	0	0	0	1	9
0	0	0	0	0	0	0	0	0	18
0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	1	9
0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	1	9
0	0	0	0	0	—	—	—	—	0
0	0	0	0	0	—	—	—	—	9
0	0	0	0	0	—	—	—	—	0
0	0	1	0	1	—	—	—	—	9
18	0	9	0	9	0	9	0	9	9630

[illegible]	—	—	—	—	—	—	—	—	—	—	—
5·6495	—	—	—	—	—	—	—	—	—	—	—
Totals…	9	9	36	63	117	162	270	351	495	702	909

N

—	—	—	—	—	—	1	1	1	0	0	0
909	810	900	837	657	594	558	351	387	279	387	135

N.B.—1·5495 denotes the group formed of all indices from 1·4995 to 1·5995, or since the ratio, length/breadth, was

0	0	0	2	0	0	0	0	0	0	1	1	0
5	180	90	81	9	72	27	27	36	0	27	9	18

adth, was formed to three decimal places, all values of the index from 1·500 to 1·599 inclusive.

0	0	1	0	1	—	—	—	—	9
18	0	9	0	9	0	9	0	9	9630

Absolute Dimensions of Mushroom Gills.

Character.	Mean.	S. D.	Coefficient of variation.	S. D. of array.	Percentage variation.	Direct homotypic correlation.
Length. .	19·1847 ± ·0831	4·0282 ± ·0587	20·9969	2·0510	50·92	·8607 [± ·0053]
Breadth .	6·8529 ± ·0331	1·6047 ± ·0234	23·4164	1·0859	67·67	·7363 [± ·0094]

Cross-correlations.

Length and breadth, organic . .	·7000 ± ·0105
Length and breadth, homotypic .	·6275[± ·0125]

The results here given seem to be of considerable suggestiveness. While the two means and standard deviations differ very considerably, the coefficients of variation for the length and breadth of the gill are approximately equal, and in addition very high. This is precisely what we might expect when dealing with a series of organisms in various stages of growth. Further, the variability of the individual as compared with that of the race is reduced immensely below the 80 to 90 per cent. with which our previous investigations have made us familiar. This might again be anticipated as a result of heterogeneity in the stage of growth. The organic correlation of length and breadth, as well as the homotypic correlations of the same two characters, both direct and cross, are all very high, and the latter are much beyond what we might legitimately put to the credit of the pure homotyposis factor. It seems, therefore, somewhat hazardous to consider how far they satisfy the relationship suggested in the introductory part of this paper. The direct homotypic correlations for length and breadth are not approximately equal as we might expect; this suggests that growth may be a somewhat more marked factor in the length than the breadth of the gill. If we take the product of direct homotypic correlation with the organic correlation, this ought, on our hypothesis, to give us roughly the cross-homotypic correlation. We have the following results :—

Product of direct homotypic length correlation with organic length-breadth correlation . . . . = ·6025.
Product of direct homotypic breadth correlation with organic length-breadth correlation . . . . = ·5154.
Product of mean of direct homotypic breadth and length correlation with organic length-breadth correlation . . . . = ·5590.

These numbers have to be compared with the cross homotypic length-breadth correlation, *i.e.*, with ·6275.

TABLE XXIII.—Mushroom. Length of Gill.

Length of First Gill.

Length of Second Gill.

Hundredths of millimetres.	899·5–999·5.	999·5–1099·5.	1099·5–1199·5.	1199·5–1299·5.	1299·5–1399·5.	1399·5–1499·5.	1499·5–1599·5.	1599·5–1699·5.	1699·5–1799·5.	1799·5–1899·5.	1899·5–1999·5.	1999·5–2099·5.	2099·5–2199·5.	2199·5–2299·5.	2299·5–2399·5.	2399·5–2499·5.	2499·5–2599·5.	2599·5–2699·5.	2699·5–2799·5.	2799·5–2899·5.	2899·5–2999·5.	2999·5–3099·5.	3099·5–3199·5.	3199·5–3299·5.	3299·5–3399·5.	3399·5–3499·5.	Totals.
899·5–999·5	—	1	8	2	6	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
999·5–1099·5	1	2	6	4	6	4	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27
1099·5–1199·6	8	6	68	30	37	29	8	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	189
1199·5–1299·5	2	4	30	22	32	41	23	15	7	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	180
1299·5–1399·5	6	6	37	32	78	93	52	26	10	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	342
1399·5–1499·5	1	4	29	41	93	172	141	76	43	21	15	7	3	2	—	—	—	—	—	—	—	—	—	—	—	—	648
1499·5–1599·5	—	4	8	23	52	141	146	183	91	36	11	5	6	4	1	—	—	—	—	—	—	—	—	—	—	—	711
1599·5–1699·5	—	—	3	15	26	76	183	236	180	94	59	17	15	4	1	—	—	—	—	—	—	—	—	—	—	—	909
1699·5–1799·5	—	—	—	7	10	43	91	180	250	214	140	43	41	11	9	0	2	1	0	0	2	—	—	—	—	—	1044
1799·5–1899·5	—	—	—	4	2	21	36	94	214	178	191	67	82	43	16	1	2	1	0	0	2	—	—	—	—	—	954
1899·5–1999·5	—	—	—	—	—	15	11	59	140	191	172	110	97	53	15	6	3	0	0	0	1	—	—	—	—	—	873
1999·5–2099·5	—	—	—	—	—	7	5	17	43	67	110	228	150	85	14	6	3	15	4	0	2	—	—	—	—	—	756
2099·5–2199·5	—	—	—	—	—	3	6	15	41	82	97	150	204	134	39	27	14	4	1	0	2	—	—	—	—	—	819
2199·5–2299·5	—	—	—	—	—	2	4	4	11	43	53	85	134	120	61	46	21	20	16	0	1	—	—	—	—	—	621
2299·5–2399·5	—	—	—	—	—	—	1	1	9	16	15	14	39	61	42	55	33	25	10	8	4	—	—	—	—	—	333
2399·5–2499·5	—	—	—	—	—	—	—	—	0	1	6	6	27	46	55	92	62	35	16	11	3	—	—	—	—	—	360
2499·5–2599·5	—	—	—	—	—	—	—	—	2	2	3	3	14	21	33	62	36	34	11	13	9	—	—	—	—	—	243
2599·5–2699·5	—	—	—	—	—	—	—	—	1	1	0	15	4	20	25	35	34	54	24	8	12	6	0	4	—	—	243
2699·5–2799·5	—	—	—	—	—	—	—	—	0	0	0	4	1	16	10	16	11	24	20	5	3	1	2	3	0	1	117
2799·5–2899·5	—	—	—	—	—	—	—	—	0	0	0	0	0	0	8	11	13	8	5	8	1	0	0	0	0	0	54
2899·5–2999·5	—	—	—	—	—	—	—	—	2	2	1	2	2	1	4	3	9	12	3	1	10	11	4	12	0	2	81
2999·5–3099·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	1	0	11	6	2	9	0	1	36
3099·5–3199·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2	0	4	2	2	6	0	2	18
3199·5–3299·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	3	0	12	9	6	8	0	3	45
3299·5–3399·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	—	—	0
3399·5–3499·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	2	1	2	3	—	—	9
Totals . . .	18	27	189	180	342	648	711	909	1044	954	873	756	819	621	333	360	243	243	117	54	81	36	18	45	0	9	9630

TABLE XXIV.—Mushroom. Breadth of Gill.

Breadth of First Gill.

Breadth of Second Gill.

Hundreths of millimetres.	299·5–349·5.	349·5–399·5.	399·5–449·5	449·5–499·5	499·5–549·5.	549·5–599·5.	599·5–649·5.	649·5–699·5.	699·5–749·5.	749·5–799·5.	799·5–849·5.	849·5–899·5.	899·5–949·5.	949·5–999·5.	999·5–1049·5.	1049·5–1099·5.	1099·5–1149·5.	1149·5–1199·5.	1199·5–1249·5.	1249·5–1299·5.	Totals.
299·5– 349·5	14	22	4	15	11	3	2	1	—	—	—	—	—	—	—	—	—	—	—	—	72
349·5– 399·5	22	32	22	32	25	15	8	3	2	1	—	—	—	—	—	—	—	—	—	—	162
399·5– 449·5	4	22	44	56	69	40	39	14	14	1	1	1	1	—	—	—	—	—	—	—	306
449·5– 499·5	15	32	56	70	88	67	60	24	29	7	5	5	2	2	4	0	2	—	—	—	468
499·5– 549·5	11	25	69	88	250	206	181	128	55	24	5	2	0	0	0	0	0	—	—	—	1044
549·5– 599·5	3	15	40	67	206	158	192	167	75	34	10	4	1	0	0	0	0	—	—	—	972
599·5– 649·5	2	8	39	60	181	192	252	243	129	56	23	11	6	5	4	2	2	—	—	—	1215
649·5– 699·5	1	3	14	24	128	167	243	286	197	92	68	26	10	6	0	4	0	—	—	—	1269
699·5– 749·5	—	2	14	29	55	75	129	197	164	155	108	49	18	11	2	0	0	—	—	—	1008
749·5– 799·5	—	1	1	7	24	34	56	92	155	176	157	59	33	14	12	5	1	0	0	1	828
799·5– 849·5	—	—	1	5	5	10	23	68	108	157	170	116	74	45	19	9	0	0	0	0	810
849·5– 899·5	—	—	1	5	2	4	11	26	49	59	116	82	55	46	30	16	1	0	0	1	504
899·5– 949·5	—	—	1	2	0	1	6	10	18	33	74	55	62	57	26	18	1	1	3	1	369
949·5– 999·5	—	—	—	2	0	0	5	6	11	14	45	46	57	28	22	19	2	1	3	0	261
999·5–1049·5	—	—	—	4	0	0	4	0	2	12	19	30	26	22	24	13	2	0	0	4	162
1049·5–1099·5	—	—	—	0	0	0	2	4	0	5	9	16	18	19	13	14	3	3	9	2	117
1099·5–1149·5	—	—	—	2	0	0	2	0	0	1	0	1	1	2	2	3	0	1	3	—	18
1149·5–1199·5	—	—	—	—	—	—	—	—	—	0	0	0	1	1	0	3	1	0	3	—	9
1199·5–1249·5	—	—	—	—	—	—	—	—	—	0	0	0	3	3	0	9	3	3	6	—	27
1249·5–1299·5	—	—	—	—	—	—	—	—	—	1	0	1	1	0	4	2	—	—	—	—	9
Totals. . .	72	162	306	468	1044	972	1215	1269	1008	828	810	504	369	261	162	117	18	9	27	9	9630

TABLE XXV.—Mushroom. Length and Breadth of Gill, Organic Correlation.

Length of Gill.

Breadth of Gill.

Hundredths of millimetres.	899·5– 999·5.	999·5– 1099·5.	1099·5– 1199·5.	1199·5– 1299·5.	1299·5– 1399·5.	1399·5– 1499·5.	1499·5– 1599·5.	1599·5– 1699·5.	1699·5– 1799·5.	1799·5– 1899·5.	1899·5– 1999·5.	1999·5– 2099·5.	2099·5– 2199·5.	2199·5– 2299·5.	2299·5– 2399·5.	2399·5– 2499·5.	2499·5– 2599·5.	2599·5– 2699·5.	2699·5– 2799·5.	2799·5– 2899·5.	2899·5– 2999·5.	2999·5– 3099·5.	3099·5– 3199·5.	3199·5– 3299·5.	3299·5– 3399·5.	3399·5– 3499·5.	Totals.
299·5– 349·5	1	0	4	0	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
349·5– 399·5	0	2	0	3	7	1	1	0	1	1	1	0	0	1	—	—	—	—	—	—	—	—	—	—	—	—	18
399·5– 449·5	0	1	2	3	5	5	7	3	1	3	1	0	2	1	—	—	—	—	—	—	—	—	—	—	—	—	34
449·5– 499·5	1	0	7	2	5	7	9	6	8	4	1	0	1	1	—	—	—	—	—	—	—	—	—	—	—	—	52
499·5– 549·5	—	—	6	5	2	16	16	22	17	17	10	2	2	1	—	—	—	—	—	—	—	—	—	—	—	—	116
549·5– 599·5	—	—	0	2	6	14	12	21	15	18	5	8	3	1	1	0	2	—	—	—	—	—	—	—	—	—	108
599·5– 649·5	—	—	1	2	6	11	13	20	25	18	16	4	7	2	2	2	1	3	1	0	1	—	—	—	—	—	135
649·5– 699·5	—	—	1	1	3	12	6	16	28	16	15	20	9	4	4	1	1	2	1	0	1	—	—	—	—	—	141
699·5– 749·5	—	—	—	1	3	3	6	5	10	21	17	14	10	9	3	5	3	1	1	0	0	—	—	—	—	—	112
749·5– 799·5	—	—	—	1	0	1	2	4	5	3	14	14	22	10	2	5	2	5	1	1	0	—	—	—	—	—	92
799·5– 849·5	—	—	—	—	—	1	5	2	3	2	11	13	16	11	9	8	3	2	1	2	0	0	0	1	—	—	90
849·5– 899·5	—	—	—	—	—	—	1	1	1	2	2	5	14	10	4	7	1	3	0	1	3	1	0	0	—	—	56
899·5– 949·5	—	—	—	—	—	—	—	0	1	1	2	2	3	5	8	5	5	5	1	1	1	0	0	1	—	—	41
949·5– 999·5	—	—	—	—	—	—	—	1	0	0	2	0	2	6	2	4	5	2	3	0	0	1	0	1	—	—	29
999·5–1049·5	—	—	—	—	—	—	—	—	1	0	0	0	0	4	1	2	3	2	2	0	0	0	2	0	0	1	18
1049·5–1099·5	—	—	—	—	—	—	—	—	—	—	—	2	0	3	0	1	1	1	1	1	2	0	0	1	—	—	13
1099·5–1149·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	0	0	0	0	0	1	0	0	—	—	2
1149·5–1199·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	0	0	0	0	0	—	—	1
1199·5–1249·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	1	1	0	1	—	—	3
1249·5–1299·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
Totals	2	3	21	20	38	72	79	101	116	106	97	84	91	69	37	40	27	27	13	6	9	4	2	5	0	1	1070

TABLE XXVI.—Mushroom. Length and Breadth of Gill, Homotypic Correlation.

Length of First Gill.

Breadth of Second Gill.

Hundredths of millimetres.	899·5–999·5.	999·5–1099·5.	1099·5–1199·5.	1199·5–1299·5.	1299·5–1399·5.	1399·5–1499·5.	1499·5–1599·5.	1599·5–1699·5.	1699·5–1799·5.	1799·5–1899·5.	1899·5–1999·5.	1999·5–2099·5.	2099·5–2199·5.	2199·5–2299·5.	2299·5–2399·5.	2399·5–2499·5.	2499·5–2599·5.	2599·5–2699·5.	2699·5–2799·5.	2799·5–2899·5.	2899·5–2999·5.	2999·5–3099·5.	3099·5–3199·5.	3199·5–3299·5.	3299·5–3399·5.	3399·5–3499·5.	Totals.
299·5– 349·5	3	4	22	9	10	8	7	6	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72
349·5– 399·5	4	7	24	10	31	24	17	10	7	8	4	2	6	5	3	—	—	—	—	—	—	—	—	—	—	—	162
399·5– 449·5	0	5	14	12	18	45	60	49	29	31	13	3	12	12	3	—	—	—	—	—	—	—	—	—	—	—	306
449·5– 499·5	3	5	41	20	64	55	72	55	40	38	24	8	21	12	10	—	—	—	—	—	—	—	—	—	—	—	468
499·5– 549·5	2	4	44	29	39	129	112	158	158	141	107	51	36	16	5	2	2	7	0	0	2	—	—	—	—	—	1044
549·5– 599·5	2	2	11	24	57	107	112	159	150	123	87	47	39	25	6	2	3	11	1	1	3	—	—	—	—	—	972
599·5– 649·5	2	0	19	34	53	107	127	179	197	142	115	78	52	25	15	15	8	35	4	4	4	—	—	—	—	—	1215
649·5– 699·5	1	0	10	24	41	86	81	149	195	175	136	140	104	60	17	8	12	14	4	4	8	—	—	—	—	—	1269
699·5– 749·5	1	0	4	17	27	53	55	64	108	124	120	104	127	82	23	41	21	16	6	10	5	—	—	—	—	—	1008
749·5– 799·5	—	—	—	1	2	10	27	39	71	56	88	136	162	92	32	42	23	14	16	7	3	1	2	3	0	1	828
799·5– 849·5	—	—	—	—	—	24	30	25	39	53	86	114	115	81	51	70	53	32	16	10	5	1	2	2	0	1	810
849·5– 899·5	—	—	—	—	—	—	7	11	22	30	47	33	69	70	51	60	43	22	14	5	7	1	4	6	0	2	504
899·5– 949·5	—	—	—	—	—	—	0	0	9	12	19	22	25	53	57	55	35	32	18	8	6	5	4	7	0	2	369
949·5– 999·5	—	—	—	—	—	—	2	2	8	12	13	14	26	42	35	35	19	22	12	2	7	3	2	4	0	1	261
999·5–1049·5	—	—	—	—	—	—	2	3	6	7	4	1	14	24	16	17	13	12	15	2	8	3	4	9	0	2	162
1049·5–1099·5	—	—	—	—	—	—	—	—	0	0	9	3	10	18	7	12	10	15	9	1	9	9	0	5	—	—	117
1099·5–1149·5	—	—	—	—	—	—	—	—	2	2	1	0	1	1	2	0	0	2	0	0	3	2	0	2	—	—	18
1149·5–1199·5	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	1	0	0	3	3	0	2	—	—	9
1199·5–1249·5	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	6	0	0	8	8	0	5	—	—	27
1249·5–1299·5	—	—	—	—	—	—	—	—	—	—	—	—	—	3	0	1	1	2	2	—	—	—	—	—	—	—	9
Totals . . .	18	27	189	180	342	648	711	909	1044	954	873	756	819	621	333	360	243	243	117	54	81	36	18	45	0	9	9630

It will be seen at once that they are sensibly too small (say, ·56 as compared with ·63). But having recognised the influence of heterogeneity in the growth stages of our material, the divergence is, I take it, of a magnitude rather to confirm than confute the hypothesis as to the relationship of direct and cross homotypic correlations. It must be remembered that we are dealing with *average* results. Our main proposition is that heredity is not a factor of life peculiar to sexual reproduction, but merely a phase of the larger factor, which we have termed homotyposis, or the tendency of the individual to put forth undifferentiated like organs with a certain degree of resemblance. Our subsidiary proposition is: that if the direct homotypic correlation oscillates about a certain mean value, and the cross homotypic correlation be the product of organic and direct homotypic correlations, then we should expect to find the average degree of resemblance of brethren equal to the average degree of resemblance of undifferentiated like organs in the individual.

All then I think we can safely say for the gills of mushrooms is that the relation of the direct and cross homotypic correlations is by no means such that it condemns our hypothesis, or enforces us to reject our subsidiary proposition. The difficulty lies in finding *adult* organisms with undifferentiated like organs with two characters in sufficient quantity, easily counted or measured, upon which the hypothesis can be tested. The investigation of the length and breadth of ivy leaves, to which we shall soon turn, suffers to some extent from the same defects as that for the gills of mushrooms.

Tables XXIII.–XXVI. contain the length-breadth data for the mushrooms. The frequency distributions for length and breadth are given in the last row and column of Table XXV. above, and exhibit in their irregularity something of the heterogeneity of growth to which I have referred. Of the two distributions, I consider that for the breadth as the more irregular and consequently the less satisfactory. It is, of course, harder to determine a definite breadth for the gill than a definite length, and I should be well content to compare the product of the homotypic length correlation and the organic length-breadth correlation, *i.e.*, ·6025, with the cross homotypic length-breadth correlation, *i.e.*, ·6275, as the best basis for our subsidiary proposition available from these measurements on mushrooms.

(22.) *Wild Ivy* (Hedera Helix).—This series was originally undertaken by Dr. E. WARREN, his object being to measure the degree of resemblance between ivy leaves on the same plant, using as his character the index, or ratio of length to maximum breadth. It was hoped that in this manner, the growth factor might be fairly well eliminated.

The figures (page 348) indicate how the breadth and length were determined by Dr. WARREN in leaves of somewhat different shape.

It will be seen that, as in the case of the gill of the mushroom, the breadth is taken as the maximum breadth between tangents to the contour parallel to the length, and these tangents do not necessarily go through points like a, a. Twenty-five leaves were taken from each of 42 plants by Dr. WARREN, in the neighbourhood of Canterbury,

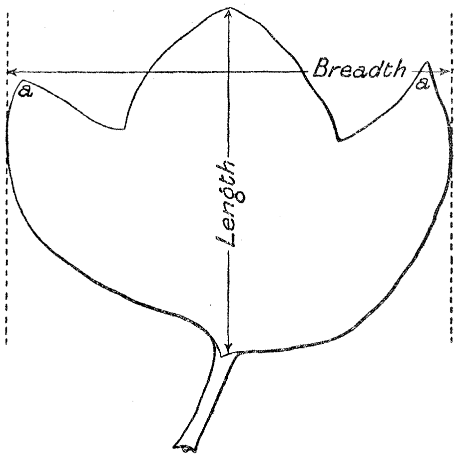
Table XXVII.—Ivy. Leaf Index.

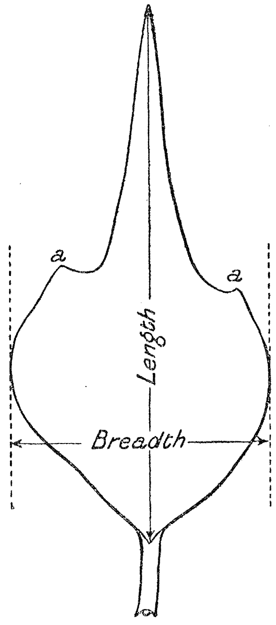
Index of First Leaf.

Index of Second Leaf.

Index.	·295–·395.	·395–·495.	·495–·595.	·595–·695.	·695–·795.	·795–·895.	·895–·995.	·995–1·095.	1·095–1·195.	1·195–1·295.	1·295–1·395.	1·395–1·495.	1·495–1·595.	1·595–1·695.	Totals.
·295– ·395	—	3	5	6	11	10	6	4	2	0	1	—	—	—	48
·395– ·495	3	8	14	31	55	71	36	12	5	3	0	2	—	—	240
·495– ·595	5	14	36	132	294	267	98	40	23	2	1	0	—	—	912
·595– ·695	6	31	132	1048	2186	1556	633	243	92	30	14	4	1	—	5976
·695– ·795	11	55	294	2186	5512	4728	2043	878	314	89	41	16	8	1	16176
·795– ·895	10	71	267	1556	4728	5536	3193	1420	578	195	102	40	12	4	17712
·895– ·995	6	36	98	633	2043	3193	2466	1182	459	190	101	41	12	4	10464
·995–1·095	4	12	40	243	878	1420	1182	628	303	130	68	39	15	6	4968
1·095–1·195	2	5	23	92	314	578	459	303	142	70	33	26	13	4	2064
1·195–1·295	0	3	2	30	89	195	190	130	70	36	17	2	4	0	768
1·295–1·395	1	0	1	14	41	102	101	68	33	17	4	1	1	0	384
1·395–1·495	—	2	0	4	16	40	41	39	26	2	1	12	5	4	192
1·495–1·595	—	—	—	1	8	12	12	15	13	4	1	5	0	1	72
1·595–1·695	—	—	—	—	1	4	4	6	4	0	0	4	1	0	24
Totals . . .	48	240	912	5976	16176	17712	10464	4968	2064	768	384	192	72	24	60000

and 25 leaves from each of 58 plants by me, in the neighbourhood of Great Hampden in Buckinghamshire. Care was taken to avoid the reproductive shoots with their larger uncut leaves. The Hampden plants were, I feel certain, a fairly homogeneous group, the plants were young runners up the trees, only a few feet in length. The Canterbury plants appear to have had a somewhat larger leaf, although in themselves an apparently homogeneous group.





It would undoubtedly have been better to have had the leaves collected by one person from one district; but until the leaves had all been measured and their indices found, I did not know of this difference between the two groups. It was very little noticeable in the table of index distribution, but became manifest to me when finding the homotypic correlation table of the absolute lengths, which I did in two sections, one for either group. The very considerable labour involved in measuring and determining the indices of 2500 leaves precluded a repetition of the work on more homogeneous material. The whole of this labour was undertaken by Dr. WARREN, who further formed the table and determined the correlation coefficient.*

I give in the following scheme the frequency distribution of the indices to show its uniformity.

Index.	·295–·395.	·395–·495.	·495–·595.	·595–·695.	·695–·795.	·795–·895.	·895–·995.	·995–1·095.	1·095–1·195.	1·195–1·295.	1·295–1·395.	1·395–1·495.	1·495–1·595.	1·595–1·695.	Total.
Frequency	2	10	38	249	674	738	436	207	86	32	16	8	3	1	2500

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* After measuring the gills of only 1070 mushrooms, I very fully appreciate Dr. WARREN'S task on the 2500 ivy leaves!

Of course the groupings here are large, but the distribution notwithstanding the mixture of material seems more regular than in some of our other series.

The following scheme gives the constants in the usual manner :

Leaf Index of Wild Ivy.

Number of			Mean index.	S. D.	Coefficient of variation.	S. D. of array.	Percentage variation.	Correlation.
Plants.	Leaves.	Pairs.						
100	2500	60,000	·8473 ± ·0020	·1506 ± ·0014	17·7735	·1449	96·21	·2726 [± ·0125]

It will be observed that the correlation is lower than we might have expected, although the mean of the index correlations for mushroom gills and ivy leaves, *i.e.*, $\frac{1}{2}$ (·5490 + ·2726) = ·4108, is almost identical with the value ·4 given for brothers by the law of ancestral heredity. The low value of the correlation gives of course a high value to the percentage variation, the variation of the individual plant being within 4 per cent. of the racial variation. The variability of the ivy leaf, as judged by this character, has not the intensity which is popularly associated with it; it is sensibly less than that of the mushroom gill, and about equal to that of the tunics of the onion.

I now pass to the absolute measurements of the leaf.

Dr. WARREN being much pressed with other work, kindly placed all his measurements at my disposal, and I proceeded to draw up the same four tables as in the case of the mushroom gills. The work here was, however, much more laborious as I had to deal with 25 leaves instead of 10 gills, and this involved 300 pairs for each plant, instead of only 45! In the course of a fortnight's work I had completed the length-breadth organic correlation, the length-length homotypic correlation, and about a third of the length-breadth homotypic correlation. At this point Dr. LEE took the work off my hands and finished the last table and the breadth-breadth homotypic correlation. So that the results are again the product of co-operation.* I give below the data arranged as in the case of the mushroom gills. The dimensions are given in eighths of inches.

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* We have now systematised the working of these long tables, involving 10,000 to 60,000 entries providing appropriate checks for accuracy up to each stage of construction. It seems unnecessary to describe these here, but we shall be glad to put our experience at the service of any one working at similar problems. At the same time the collection, measurement and formation of a table for the cross homotypic correlation of two characters in 25 undifferentiated like organs of 100 individuals will cost a *single* worker at least three weeks to a month's fairly continuous labour.

Absolute Dimensions of Wild Ivy Leaves.

Character.	Mean.	S. D.	Coefficient of variation.	S. D. of array.	Percentage variation.	Correlation.
Length. .	10·9504 ± ·0457	3·3885 ± ·0612	30·9442	2·8033	82·73	·5618 [± ·0092]
Breadth .	13·2148 ± ·0323	4·5384 ± ·0433	34·3430	3·8376	84·56	·5332 [± ·0096]

Cross-Correlations.

Length and breadth, organic . .	·8718 ± ·0032
Length and breadth, homotypic .	·5157 [± ·0099]

These results differ very considerably from those for the mushroom gills. The coefficients of variation are even higher than those for the gills, and I think this is a result of a certain amount of heterogeneity, as well as of the leaves on individual runners not being all quite at the same stage of development. In the case of the deciduous trees the leaves were gathered in the fall of the year, and no further development of veins was possible; but in the ivy leaves, taken indeed at the same time, the equal development of all the leaves taken from the runner could hardly have been reached when they were gathered. On the other hand the correlations are much lower than in the case of the gills,—much more within the range of the results obtained for other characters. I am inclined to think, therefore, that there has been some balancing of opposing factors here, heterogeneity due to locus of collection and to stages of growth being to some extent counteracted by a differentiation due to position of the leaf on the runner.* I have not included these results for lengths and breadths of ivy leaves in my homotypic series because the values, although well within the range of the other determinations, appear to me to be somewhat fictitiously so. The disturbing factors referred to above seem to me to have also given the cross homotypic correlation a higher value than it ought to have. It will be seen that the correlation of length and breadth of pairs of leaves from the same runner is almost as high as that of the breadths of pairs of leaves from the same runner. I should expect a considerably greater inequality. I regret that the great labour of these cross-correlation investigations has hindered their being carried further than these two cases in the vegetable kingdom, but in the zoological data, which we have at present in hand, I hope to get material less open to criticism than in the cases of mushroom gills and ivy leaves. These two series were originally undertaken with the view of ascertaining how far the use of indices would cancel the influence of the factor of growth. As we have

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* The reader must of course bear in mind that the leaves were taken from runners which had not reached the tops of their walls or trees, *i.e.*, they were not from reproductive shoots.

TABLE XXVIII.—Wild Ivy. Homotypic Correlation of Lengths of Leaves.

Length of First Leaf.

Length of Second Leaf.

Eighths of inches.	2·95–3·95.	3·95–4·95.	4·95–5·95.	5·95–6·95.	6·95–7·95.	7·95–8·95.	8·95–9·95.	9·95–10·95.	10·95–11·95.	11·95–12·95.	12·95–13·95.	13·95–14·95.	14·95–15·95.	15·95–16·95.	16·95–17·95.	17·95–18·95.	18·95–19·95.	19·95–20·95.	20·95–21·95.	21·95–22·95.	22·95–23·95.	23·95–24·95.	24·95–25·95.	Totals.
2·95– 3·95	2	13	23	18	8	9	6	11	1	3	0	0	2	—	—	—	—	—	—	—	—	—	—	96
3·95– 4·95	13	112	218	198	112	97	52	26	5	7	0	0	0	—	—	—	—	—	—	—	—	—	—	840
4·95– 5·95	23	218	504	520	330	322	188	100	39	42	10	4	4	—	—	—	—	—	—	—	—	—	—	2304
5·95– 6·95	18	198	520	760	627	510	429	306	152	103	53	33	29	4	1	1	—	—	—	—	—	—	—	3744
6·95– 7·95	8	112	330	627	736	655	689	466	259	273	136	72	42	17	12	1	3	0	1	0	1	—	—	4440
7·95– 8·95	9	97	322	510	655	866	1034	803	558	464	255	184	55	56	21	10	5	0	0	0	0	—	—	5904
8·95– 9·95	6	52	188	429	689	1034	1254	1108	847	722	432	278	110	98	59	33	18	5	3	0	3	—	—	7368
9·95–10·95	11	26	100	306	466	803	1108	1200	1067	934	576	440	200	170	94	40	32	15	7	3	7	3	—	7608
10·95–11·95	1	5	39	152	259	558	847	1067	1040	989	653	514	239	222	105	80	66	13	9	11	14	5	—	6888
11·95–12·95	3	7	42	103	273	464	722	934	989	958	674	546	268	200	138	57	43	12	13	13	13	8	—	6480
12·95–13·95	0	0	10	53	136	255	432	576	653	674	516	436	228	187	136	69	29	21	15	14	11	12	1	4464
13·95–14·95	0	0	4	33	72	184	278	440	514	546	436	336	202	143	104	52	41	28	29	11	12	14	1	3480
14·95–15·95	2	0	4	29	42	55	110	200	239	268	228	202	100	104	75	55	43	16	16	12	9	11	4	1824
15·95–16·95	—	—	—	4	17	56	98	170	222	200	187	143	104	100	55	70	67	10	22	13	11	5	6	1560
16·95–17·95	—	—	—	1	12	21	59	94	105	138	136	104	75	55	38	36	30	22	20	14	10	13	1	984
17·95–18·95	—	—	—	1	1	10	33	40	80	57	69	52	55	70	36	40	41	17	17	13	3	8	5	648
18·95–19·95	—	—	—	—	3	5	18	32	66	43	29	41	43	67	30	41	44	17	21	8	8	8	4	528
19·95–20·95	—	—	—	—	0	0	5	15	13	12	21	28	16	10	22	17	17	12	14	4	1	9	0	216
20·95–21·95	—	—	—	—	1	0	3	7	9	13	15	29	16	22	20	17	21	14	8	7	5	8	1	216
21·95–22·95	—	—	—	—	0	0	0	3	11	13	14	11	12	13	14	13	8	4	7	6	6	8	1	144
22·95–23·95	—	—	—	—	1	0	3	7	14	13	11	12	9	11	10	3	8	1	5	6	2	4	—	120
23·95–24·95	—	—	—	—	—	—	—	3	5	8	12	14	11	5	13	8	8	9	8	8	4	4	—	120
24·95–25·95	—	—	—	—	—	—	—	—	—	—	1	1	4	6	1	5	4	0	1	1	—	—	—	24
Totals . .	96	840	2304	3744	4440	5904	7368	7608	6888	6480	4464	3480	1824	1560	984	648	528	216	216	144	120	120	24	60,000

TABLE XXIX.—Wild Ivy. Homotypic Correlation of Breadths of Leaves.

Breadth of First Leaf.

Breadth of Second Leaf.

Eighths of inches.	2·95–3·95.	3·95–4·95.	4·95–5·95.	5·95–6·95.	6·95–7·95.	7·95–8·95.	8·95–9·95.	9·95–10·95.	10·95–11·95.	11·95–12·95.	12·95–13·95.	13·95–14·95.	14·95–15·95.	15·95–16·95.	16·95–17·95.	17·95–18·95.	18·95–19·95.	19·95–20·95.	20·95–21·95.	21·95–22·95.	22·95–23·95.	23·95–24·95.	24·95–25·95.	25·95–26·95.	26·95–27·95.	27·95–28·95.	28·95–29·95.	29·95–30·95.	30·95–31·95.	31·95–32·95.	32·95–33·95.	33·95–34·95.	34·95–35·95.	35·95–36·95.	Totals.
2·95– 3·95	0	3	8	10	7	7	4	7	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	48
3·95– 4·95	3	42	132	60	71	54	27	17	4	10	5	3	1	0	1	0	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	432
4·95– 5·95	8	132	308	214	252	198	123	89	42	43	23	17	6	1	5	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1464
5·95– 6·95	10	60	214	358	346	269	188	215	94	70	41	23	15	10	14	2	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1944
6·95– 7·95	7	71	252	346	380	379	354	331	203	148	97	66	68	47	17	16	20	4	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2808
7·95– 8·95	7	54	198	269	379	328	439	428	289	214	173	129	106	73	50	33	19	15	7	4	2	—	—	—	—	—	—	—	—	—	—	—	—	—	3216
8·95– 9·95	4	27	123	188	354	439	572	634	527	389	372	209	241	160	88	73	53	17	12	5	0	0	1	—	—	—	—	—	—	—	—	—	—	—	4488
9·95–10·95	7	17	89	215	331	428	634	766	634	509	501	367	287	218	145	132	79	36	35	15	7	5	7	4	0	2	1	0	1	—	—	—	—	—	5472
10·95–11·95	2	4	42	94	203	289	527	634	680	574	602	436	412	227	182	156	106	55	46	18	12	1	14	5	2	1	3	0	1	—	—	—	—	—	5328
11·95–12·95	—	10	43	70	148	214	389	509	574	616	658	473	403	306	215	198	134	65	60	39	21	14	19	8	9	3	5	0	5	—	—	—	—	—	5208
12·95–13·95	—	5	23	41	97	173	372	501	602	658	748	625	537	393	285	239	179	92	83	50	28	5	34	12	6	7	5	3	2	0	1	1	0	1	5808
13·95–14·95	—	3	17	23	66	129	209	367	436	473	625	574	473	386	323	271	222	134	87	60	34	14	59	27	16	14	8	5	6	0	1	1	0	1	5064
14·95–15·95	—	1	6	15	68	106	241	287	412	403	537	473	396	377	255	222	165	87	77	54	31	13	42	19	19	14	12	5	4	0	1	1	0	1	4344
15·95–16·95	—	0	1	10	47	73	160	218	227	306	393	386	377	272	237	208	155	72	64	63	36	18	39	18	18	14	11	3	6	0	0	0	0	0	3432
16·95–17·95	—	1	5	14	17	50	88	145	182	215	285	323	255	237	194	211	133	71	61	39	33	13	45	23	11	12	7	4	8	0	2	2	0	2	2688
17·95–18·95	—	0	1	2	16	33	73	132	156	198	239	271	222	208	211	174	135	69	78	50	23	12	45	23	6	13	11	5	9	0	3	3	0	3	2424
18·95–19·95	—	2	2	15	20	19	53	79	106	134	179	222	165	155	133	135	100	56	38	39	21	10	27	22	3	15	10	4	6	0	2	2	0	2	1776
19·95–20·95	—	—	—	—	4	15	17	36	55	65	92	134	87	72	71	69	56	20	32	16	13	5	18	13	4	6	5	1	3	0	1	1	0	1	812
20·95–21·95	—	—	—	—	1	7	12	35	46	60	83	87	77	64	61	78	38	32	22	22	14	12	16	10	5	10	7	3	5	0	3	3	0	3	816
21·95–22·95	—	—	—	—	1	4	5	15	18	39	50	60	54	63	39	50	39	16	22	14	8	7	15	7	5	5	8	1	4	0	1	1	0	1	552
22·95–23·95	—	—	—	—	—	2	0	7	12	21	28	34	31	36	33	23	21	13	14	8	8	8	10	10	3	9	4	1	0	0	0	0	0	0	336
23·95–24·95	—	—	—	—	—	—	0	5	1	14	5	14	13	18	13	12	10	5	12	7	8	2	5	5	4	6	4	1	1	0	1	1	0	1	168
24·95–25·95	—	—	—	—	—	—	1	7	14	19	34	59	42	39	45	45	27	18	16	15	10	5	18	8	1	4	2	1	2	0	0	0	0	0	432
25·95–26·95	—	—	—	—	—	—	—	4	5	8	12	27	19	18	23	23	22	13	10	7	10	5	8	4	0	10	5	2	2	0	1	1	0	1	240
26·95–27·95	—	—	—	—	—	—	—	0	2	9	6	16	19	18	11	6	3	4	5	5	3	4	1	0	6	0	2	0	0	0	0	0	0	0	120
27·95–28·95	—	—	—	—	—	—	—	2	1	3	7	14	14	14	12	13	15	6	10	5	9	6	4	10	0	6	5	4	2	0	2	2	0	2	168
28·95–29·95	—	—	—	—	—	—	—	1	3	5	5	8	12	11	7	11	10	5	7	8	4	4	2	5	2	5	0	1	1	0	1	1	0	1	120
29·95–30·95	—	—	—	—	—	—	—	0	0	0	3	5	5	3	4	5	4	1	3	1	1	1	1	2	0	4	1	0	1	0	1	1	0	1	48
30·95–31·95	—	—	—	—	—	—	—	1	1	5	2	6	4	6	8	9	6	3	5	4	0	1	2	2	0	2	1	1	0	0	1	1	0	1	72
31·95–32·95	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32·95–33·95	—	—	—	—	—	—	—	—	—	—	1	1	1	0	2	3	2	1	3	1	0	1	0	1	0	2	1	1	1	0	0	1	0	1	24
33·95–34·95	—	—	—	—	—	—	—	—	—	—	1	1	1	0	2	3	2	1	3	1	0	1	0	1	0	2	1	1	1	0	1	0	0	1	24
34·95–35·95	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	0
35·95–36·95	—	—	—	—	—	—	—	—	—	—	1	1	1	0	2	3	2	1	3	1	0	1	0	1	0	2	1	1	1	0	1	1	—	—	24
Totals . .	48	432	1464	1944	2808	3216	4488	5472	5328	5208	5808	5064	4344	3432	2688	2424	1776	912	816	552	336	168	432	240	120	168	120	48	72	0	24	24	0	24	60,000

TABLE XXX.—Wild Ivy. Organic Correlation of Length and Breadth of Leaves.

Length of Leaf.

Breadth of Leaf.

Eighths of inches.	2·95–3·95.	3·95–4·95.	4·95–5·95.	5·95–6·95.	6·95–7·95.	7·95–8·95.	8·95–9·95.	9·95–10·95.	10·95–11·95.	11·95–12·95.	12·95–13·95.	13·95–14·95.	14·95–15·95.	15·95–16·95.	16·95–17·95.	17·95–18·95.	18·95–19·95.	19·95–20·95.	20·95–21·95.	21·95–22·95.	22·95–23·95.	23·95–24·95.	24·95–25·95.	Totals.
2·95– 3·95	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
3·95– 4·95	1	5	8	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
4·95– 5·95	1	16	23	17	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	61
5·95– 6·95	0	9	22	35	9	5	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	81
6·95– 7·95	0	2	21	36	33	10	8	5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	117
7·95– 8·95	1	0	10	34	28	35	19	5	0	2	—	—	—	—	—	—	—	—	—	—	—	—	—	134
8·95– 9·95	0	2	5	19	46	51	34	21	4	3	2	—	—	—	—	—	—	—	—	—	—	—	—	187
9·95–10·95	1	0	3	6	33	60	73	24	20	4	2	0	2	—	—	—	—	—	—	—	—	—	—	228
10·95–11·95	—	—	2	2	17	45	55	61	24	10	6	0	0	—	—	—	—	—	—	—	—	—	—	222
11·95–12·95	—	—	1	2	5	21	51	60	40	24	8	2	1	1	0	0	1	—	—	—	—	—	—	217
12·95–13·95	—	—	—	1	6	14	40	49	60	42	22	6	2	0	0	0	0	—	—	—	—	—	—	242
13·95–14·95	—	—	—	—	3	3	13	35	63	51	21	17	3	2	0	0	0	—	—	—	—	—	—	211
14·95–15·95	—	—	—	—	0	0	7	36	32	45	37	12	7	2	2	0	1	—	—	—	—	—	—	181
15·95–16·95	—	—	—	—	0	0	2	10	23	36	25	30	8	5	3	1	0	—	—	—	—	—	—	143
16·95–17·95	—	—	—	—	1	1	1	8	9	24	21	20	10	9	4	3	1	—	—	—	—	—	—	112
17·95–18·95	—	—	—	—	1	0	0	2	5	12	21	27	12	18	1	1	1	—	—	—	—	—	—	101
18·95–19·95	—	—	—	—	—	—	2	1	3	11	13	11	14	10	5	1	0	3	—	—	—	—	—	74
19·95–20·95	—	—	—	—	—	—	1	0	0	3	7	12	5	2	4	1	1	1	1	—	—	—	—	38
20·95–21·95	—	—	—	—	—	—	—	—	0	2	1	7	6	3	7	5	1	0	1	0	0	1	—	34
21·95–22·95	—	—	—	—	—	—	—	—	2	0	0	1	6	6	2	3	2	1	0	0	0	0	—	23
22·95–23·95	—	—	—	—	—	—	—	—	—	1	0	0	0	2	1	4	3	1	1	0	0	0	1	14
23·95–24·95	—	—	—	—	—	—	—	—	—	—	—	—	—	1	4	0	2	0	0	0	0	0	—	7
24·95–25·95	—	—	—	—	—	—	—	—	—	—	—	—	—	4	5	2	2	0	2	2	1	0	—	18
25·95–26·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	4	1	1	0	0	0	—	10
26·95–27·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	1	0	1	2	0	1	0	—	5
27·95–28·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	0	1	1	1	1	0	—	7
28·95–29·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	0	0	0	1	2	—	5
29·95–30·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	0	1	0	0	—	2
30·95–31·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	0	2	0	0	—	3
31·95–32·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	—	0
32·95–33·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	—	1
33·95–34·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
34·95–35·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	—	0
35·95–36·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
Totals . .	4	35	96	156	185	246	307	317	287	270	186	145	76	65	41	27	22	9	9	6	5	5	1	2500

TABLE XXXI.—Wild Ivy. Homotypic Cross Correlation of Length and Breadth of Leaves.

Length of First Leaf.

Breadth of Second Leaf.

Eighths of inches.	2·95–3·95.	3·95–4·95.	4·95–5·95.	5·95–6·95.	6·95–7·95.	7·95–8·95.	8·95–9·95.	9·95–10·95.	10·95–11·95.	11·95–12·95.	12·95–13·95.	13·95–14·95.	14·95–15·95.	15·95–16·95.	16·95–17·95.	17·95–18·95.	18·95–19·95.	19·95–20·95.	20·95–21·95.	21·95–22·95.	22·95–23·95.	23·95–24·95.	24·95–25·95.	Totals.
2·95– 3·95	—	9	13	9	7	6	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	48
3·95– 4·95	6	44	144	97	49	48	26	9	1	6	0	0	2	—	—	—	—	—	—	—	—	—	—	432
4·95– 5·95	18	126	398	313	188	190	123	54	14	29	5	4	2	—	—	—	—	—	—	—	—	—	—	1464
5·95– 6·95	16	160	314	489	300	263	176	95	45	33	19	16	16	2	—	—	—	—	—	—	—	—	—	1944
6·95– 7·95	12	164	385	486	424	420	358	208	137	94	60	37	14	8	0	1	—	—	—	—	—	—	—	2808
7·95– 8·95	4	114	328	469	505	466	454	290	217	156	100	67	20	15	6	4	0	1	—	—	—	—	—	3216
8·95– 9·95	8	77	211	420	609	655	761	557	411	332	192	136	55	30	22	9	0	3	—	—	—	—	—	4488
9·95–10·95	3	72	200	434	521	776	919	722	544	499	301	230	93	66	49	20	9	6	4	1	1	2	—	5472
10·95–11·95	1	22	78	290	460	657	900	802	668	551	355	231	109	89	54	36	12	9	1	1	2	0	—	5328
11·95–12·95	9	25	84	214	348	541	764	869	669	597	402	274	118	127	67	40	26	13	10	3	4	3	1	5208
12·95–13·95	5	9	41	146	251	520	781	948	813	818	523	409	185	151	99	48	27	13	8	3	7	3	0	5808
13·95–14·95	3	10	33	102	201	384	556	723	758	741	476	402	201	177	106	65	61	16	21	8	13	5	2	5064
14·95–15·95	2	2	25	99	206	313	489	637	630	615	428	347	188	137	96	36	44	14	23	5	10	7	1	4344
15·95–16·95	3	3	18	53	128	242	307	476	467	505	374	313	176	117	94	40	46	26	21	5	6	11	1	3432
16·95–17·95	2	1	12	57	88	125	240	341	359	367	311	241	134	147	84	57	45	16	13	15	11	8	4	2688
17·95–18·95	1	1	11	19	55	109	180	295	375	358	272	219	145	125	72	74	42	12	17	18	10	10	4	2424
18·95–19·95	3	1	7	33	59	86	116	186	247	278	206	171	98	88	51	45	40	13	14	13	9	10	2	1776
19·95–20·95	—	—	2	8	22	41	71	125	145	132	95	74	45	47	25	25	23	7	7	7	6	4	1	912
20·95–21·95	—	—	—	4	7	28	56	98	103	108	93	71	49	52	31	34	24	10	13	16	7	9	3	816
21·95–22·95	—	—	—	1	6	14	24	54	73	75	67	58	44	38	19	25	23	5	7	7	4	6	2	552
22·95–23·95	—	—	—	1	0	4	12	22	36	37	41	35	20	26	22	20	22	14	12	4	2	6	0	336
23·95–24·95	—	—	—	—	0	3	8	11	8	9	15	19	14	12	9	12	11	10	10	6	3	7	1	168
24·95–25·95	—	—	—	—	5	10	29	40	64	39	43	37	38	35	19	23	27	6	7	2	3	3	2	432
25·95–26·95	—	—	—	—	1	0	5	15	34	32	20	22	14	25	13	10	17	7	8	6	5	6	—	240
26·95–27·95	—	—	—	—	—	1	3	13	8	11	17	24	10	10	7	2	4	3	4	0	2	1	—	120
27·95–28·95	—	—	—	—	—	0	2	3	23	20	12	15	9	14	13	8	16	7	7	7	4	8	—	168
28·95–29·95	—	—	—	—	—	1	3	7	12	12	13	12	11	10	7	6	8	5	4	4	2	3	—	120
29·95–30·95	—	—	—	—	—	0	1	0	9	8	5	4	3	4	4	2	1	0	1	2	2	2	—	48
30·95–31·95	—	—	—	—	—	1	1	7	12	9	10	6	5	5	6	3	0	0	1	2	2	2	—	72
31·95–32·95	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0
32·95–33·95	—	—	—	—	—	—	—	—	2	3	3	2	2	1	3	1	0	0	1	3	1	2	—	24
33·95–34·95	—	—	—	—	—	—	—	—	2	3	3	2	2	1	3	1	0	0	1	3	2	1	—	24
34·95–35·95	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	0
35·95–36·95	—	—	—	—	—	—	—	—	2	3	3	2	2	1	3	1	0	0	1	3	2	1	—	24
Totals . .	96	840	2304	3744	4440	5904	7368	7608	6888	6480	4464	3480	1824	1560	984	648	528	216	216	144	120	120	24	60,000

seen the mean of the index-correlations for mushroom gills and ivy leaves = ·4108, a result by no means bad, or widely divergent from the mean result of all our data.

If we test the hypothesis as to the value of the cross-correlation we have the following results arranged as in the case of the mushrooms :

Product of direct homotypic length correlation with organic length-breadth correlation = ·4897

Product of direct homotypic breadth correlation and organic length-breadth correlation = ·4648

Product of mean of direct homotypic length and breadth correlations with the organic length-breadth correlations = ·4773

These numbers have to be compared with the cross length-breadth correlation, *i.e.*, with ·5157.

We see that, as in the case of the mushroom, they are somewhat too small, 48 say as compared with 52. But the difference is considerably less here, and allowing for the action of disturbing factors, I think we may say that the two quantities under investigation are at least of the same order of magnitude. There I think we must leave the hypothesis until my zoological measurements are reduced.

I give the four tables of classified data for the absolute lengths and breadths of the ivy leaves. In the first or organic correlation table the reader will be able, in the distribution at least of breadths, to find something of the irregularity to which I have already referred.

VI. Summary of Results.

(23.) In summing up my results and comparing them with those obtained for fraternal correlation by my co-workers and myself, I felt some difficulty. If I made a selection of what I considered the best homotypic correlation series, and the best fraternal correlation, I might well lay myself open to the charge of selecting statistics with a view to the demonstration of a theoretical law laid down beforehand. Accordingly, I determined to include all my homotypic results, except those for the absolute dimensions of mushroom gills and ivy leaves, where it was pretty evident that we had to a greater or less degree an influence exerted by the growth factor. I thus drew up Table XXXII., containing a summary of all my results. I am quite sure that heterogeneity due to one or another cause, exerts an influence of one kind at the top, and differentiation an influence of another kind at the bottom of this table. The amount of these influences and of other disturbing causes, one cannot measure and allow for. I can only hope that having taken a fairly wide range of races and characters, the influences tending to obscure the homotypic correlation, on the one hand by raising it, and on the other by reducing it, will about balance, and the average of the whole series be a fairly close approximation to the true mean value of homotypic correlation. The result is ·4570. Turning now to our results for fraternal correlation, I put into a second table every single result that we have worked out up to the date of writing this memoir. I felt this was the only safe method, although I might be justified in cutting out several values from the top and from the bottom of this table. I am sure the value for Daphnia is much too high,

TABLE XXXII.—General Results for Homotypic Correlation.

Race.	Character.	Percentage variation.	Correlation.	Remarks.
Mushroom, Hampden . . .	Lengths of gills .	50·92	·8607	All these results introduce a correlation due to stages of growth and accordingly are not included in the determination of means.
„ „ . . .	Breadths of gills .	67·67	·7363	
„ „ . . .	Lengths and breadths of gills	—	·6275	
Wild Ivy, mixed localities .	Lengths of leaves .	82·73	·5618	
„ „	Breadths of leaves	84·56	·5332	
„ „	Lengths and breadths of leaves	—	·5157	
(i.) Ceterach, Somersetshire	Lobes on fronds .	77·57	·6311	Said to be largely affected by growth and environment.
(ii.) Hartstongue, Somersetshire	Sori on fronds .	77·64	·6303	
(iii.) Shirley Poppy, Chelsea .	Stigmatic bands .	78·86	·6149	Much selected in transit.
(iv.) English Onion, Hampden	Veins in tunics .	79·18	·6108	Possibly slightly heterogeneous.
(v.) Holly, Dorsetshire . .	Prickles on leaves	80·11	·5985	
(vi.) Spanish Chestnut, mixed	Veins in leaves .	80·65	·5913	Heterogeneous.
(vii.) Beech, Buckinghamshire	Veins in leaves . .	82·17	·5699	
(viii.) *Papaver Rhœas*, Hampden	Stigmatic bands .	82·71	·5620	
(ix.) Mushroom, Hampden .	Gill indices . . .	83·58	·5490	Possibly influenced by individual growth.
(x.) *Papaver Rhœas*, Quantocks	Stigmatic bands .	84·59	·5333	
(xi.) Shirley Poppy, Hampden	Stigmatic bands .	85·18	·5238	
(xii.) Spanish Chestnut, Buckinghamshire	Veins in leaves . .	88·51	·4655	
(xiii.) Broom, Yorkshire . .	Seeds in pods . .	90·96	·4155	
(xiv.) Ash, Monmouthshire .	Leaflets on leaves .	91·44	·4047	
(xv.) *Papaver Rhœas*, Lower Chilterns	Stigmatic bands .	91·66	·3997	All from one field.
(xvi.) Ash, Dorsetshire . . .	Leaflets on leaves .	91·81	·3964	
(xvii.) Ash, Buckinghamshire .	Leaflets on leaves .	92·73	·3743	
(xviii.) Holly, Somersetshire .	Prickles on leaves	93·12	·3548	
(xix.) Wild Ivy, mixed localities	Leaf indices . . .	96·21	·2726	From two localities and possibly slightly influenced by differentiation.
(xx.) *Nigella Hispanica*, Slough	Segments of seed-capsules	98·18	·1899	Differentiation of organs due to position on stem.
(xxi.) *Malva Rotundifolia*, Hampden	Segments of seed-vessels	98·32	·1827	Principally spread from one clump by stolons.
(xxii.) Woodruff, Buckinghamshire	Members of whorls	98·49	·1733	Members really different in morphological origin.
Mean of 22 cases . .	—	87·44	·4570	—

TABLE XXXIII.—General Results for Fraternal Correlation.*

Race.	Sex.	Character.	Source of material.	No. of cases.	Reduced by	Corre-lation.	Remarks.
(i.) Daphnia	♀ & ♀	Length of spine	ERNEST WARREN . . .	330	K. PEARSON	·6934	Probably much too high, owing to heterogeneity introduced by the selection of a few mothers only.
(ii.) Horse .	♀ & ♀	Coat-colour. .	WEATHERBY'S Studbooks .	1000	K. PEARSON, L. BRAMLEY-MOORE, and A. LEE	·6928	Probably much too high, owing to heterogeneity introduced by the use of comparatively few sires.
(iii.) ,,	♂ & ♂	,,	,, ,,	1000		·6232	
(iv.) ,,	♂ & ♀	,,	,, ,,	1000		·5827	
(v.) Man . .	♀ & ♀	Forearm. . .	PEARSON, family data . .	441	A. LEE	·5424	One pair only from each family.
(vi.) Hound (Basset)	mixed	Coat-colour. .	GALTON, from studbook .	—	K. PEARSON and A. LEE	·5257	All members of litter without regard to sex.
(vii.) Man .	♂ & ♂	Eye-colour . .	GALTON, family data . .	1500	K. PEARSON	·5169	All possibly pairs in family taken.
(viii.) ,,	♀ & ♀	Cephalic index	FRANZ BOAS, N. A. Indians	—	C. FAWCETT	·4890	Paternity doubtful.
(ix.) ,,	♂ & ♀	Eye-colour . .	GALTON, family data . .	1500	K. PEARSON	·4615	See remark to (vii.).
(x.) ,,	♀ & ♀	,,	,, ,,	1500	,,	·4463	,, ,,
(xi.) ,,	♀ & ♀	Stature . . .	,, ,,	595	,,	·4436	,, ,,
(xii.) ,,	♂ & ♂	,,	,, ,,	605	,,	·3913	,, ,,
(xiii.) ,,	♂ & ♂	Cephalic index	FRANZ BOAS, N. A. Indians	—	C. FAWCETT	·3790	See remark to (viii.).
(xiv.) ,,	♂ & ♀	Stature . . .	GALTON, family data . .	1181	K. PEARSON	·3754	See remark to (vii.).
(xv.) ,,	♂ & ♀	Cephalic index	FRANZ BOAS, N. A. Indians	—	C. FAWCETT	·3400	See remark to (viii.).
(xvi.) ,,	♀ & ♀	Longevity . .	Quaker records	1050	M. BEETON	·3323	Reduced below true value by non-selective deaths.
(xvii.) ,,	mixed	Temper . . .	GALTON, family data . .	1294	K. PEARSON	·3167	Character very indefinite, and difficult to estimate.
(xviii.) ,,	♂ & ♂	Longevity . .	Peerage records	1000	M. BEETON	·2602	See remark to (xvi.).
(xix.) ,,	♂ & ♀	,,	Quaker records	1947	,,	·1973	,, ,,
—	—	—	—	—	Mean of 19 series . .	·4479	—

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* [Since the above memoir was written I have deduced another exceedingly interesting value for fraternal correlation from the measurements of Prof. C. B. DAVENPORT on the statoblasts of the Bryozoa (*Pectinella Magnifica*, LEIDY). See 'The American Naturalist,' vol. 34, p. 964, 1900. DAVENPORT gives for the standard-deviation of the number of hooks in all statoblasts the value 1·326, and for the average standard deviation of colonies of statoblasts 1·197. If we represent the former by σ, the latter will be $\sigma\sqrt{1-r^2}$, whence I find for the "fraternal correlation" $r = ·4302$, a result in excellent agreement with the mean values we have just found.—July, 1901.]

and the value for longevity in man much below the true fraternal correlation. In the former case, the mothers were few in number, in the latter the non-selective death-rate reduces very considerably the intensity of collateral inheritance. Both longevity and temper are included in this table for the same reason as *Nigella Hispanica* and woodruff in the first table. I would not run the risk of any apparent selection to reduce either homotypic or fraternal correlation to a closer range of values. The mean of this second table gives the value ·4479 for fraternal correlation. Now I do not propose to lay great stress on what at first sight might look like a most conclusive equality between the mean values of homotypic and fraternal correlations,—within the limits of the probable errors ·4479 and ·4570 are indeed equal. I am quite aware that a few further series added to either the homotypic or fraternal results might modify to some extent this equality. But what I would ask the reader to do is to examine the two tables side by side, to note how the first and last several results of both may fairly be held to be subject to quite definite modifying factors, and then to consider whether there is not very substantial evidence gathered from a fairly wide range of characters in nearly as wide a range of species to show that both homotypic and fraternal correlation fluctuate about a mean value between ·4 and ·5.

I will not venture to assert that either are absolutely constant, but I do realise that it is extremely difficult with the complex system of factors influencing living forms to reduce our conditions to that theoretically perfect state in which we shall measure solely the factor we are investigating. If the intensity of homotyposis were exactly ·45, I should be inclined to distrust any long series of results, one and all of which gave the answer ·45 exactly. There are so many other disturbing factors which only those who have endeavoured to collect series of this kind will fully appreciate. In the first place, the theoretical conception of undifferentiated like organs is very hard to realise practically ; position of the organ on the branch or of the branch on a plant, however careful be the collector, may really have introduced differentiation, and so weakened the apparent homotyposis. Secondly, the environmental factor comes into play. It is difficult to obtain a hundred individuals with like environment ; soil, position with regard to other growths, sunlight, insect life, &c., may differ in a manner that the collector cannot appreciate. Unlike environment may produce a fictitious likeness in the organs of the same individual when we pass from one individual to a second. The fact that half our series grew in one field, the other half in another, that part came from one side of a road, part from another, may introduce an unperceived heterogeneity which increases the apparent homotyposis. Thirdly, the difficulty of ensuring that all individuals are of the same age or in the same stage of development, is very great. The leaves of an old tree may have a fictitious likeness when compared with those of a young tree ; we may gather organs from one individual when it is in a stage of development, which would only be reached in another individual some days or weeks later. These and other factors may perhaps be to some extent eliminated—far better of course by the trained botanist than by the mere mathematician—but I very much doubt the possibility of their complete elimination. If homotyposis had a practically constant value throughout nature, I should only expect this value to be ascertained as a result of the average of many series in which the opposing factors of differentiation, environment, age, stage of growth, &c., may more or less counteract each other. In this manner we may approach to a fair appreciation of the bathmic influence of individuality in the production of undifferentiated like organs. What I should accordingly deduce as legitimate from the above general results would be this, the intensity of pure homotyposis throughout the vegetable kingdom probably lies between ·4 and ·5; this is also the mean value found up to the present for fraternal correlation. We may accordingly conclude that heredity is really only a phase of the wider factor of homotyposis. At bottom it is only part of the principle that when an individual puts forth undifferentiated like organs these are not exactly the same, but with a definite intensity of variation have a definite degree of likeness. When we associate heredity with sexual reproduction, we are only considering the result of homotyposis (variation and likeness) between individual spermatozoa and between individual ova. Such homotyposis leads to a likeness of the individuals resulting from the zygotes, which has probably the same mean value as homotypic correlation itself. Thus if the continuity of the germ cells between parent and offspring be realised, we face no longer the problem of heredity, but that of homotyposis, and this again might possibly be reduced to the simplest problem of budding or cell multiplication. Why does the fundamental life-unit on self-multiplication produce homotypes with a definite degree of likeness and a definite degree of variation? I shall hope for further light on this problem when my data for homotyposis in the animal kingdom, already being collected, are somewhat more complete; but only the biologist, not the mathematician, can solve it.

(24.) Now let us turn to another point: homotyposis involves, as we have seen, not only a certain degree of likeness in the group of homotypes but a certain degree of variation. Our series does not include any groups of more than twenty-six homotypes, except in the case of the Hampden Shirley poppies. Hence it is not really possible to calculate directly the variability of the individual. But from theoretical considerations, as well as from the support of individual instances, we have seen that the standard deviation of the array is a reasonable measure of the variability of the individual.* Of course more elaborate direct investigations on this point would be of great interest. But I consider that the present series indicate that on an average the variation in the individual is some 87 to 88 per cent. of that of the race. If the reader will examine the column headed *Percentage Variation* in Table XXXII., he will notice that excluding the lengths and breadths of mushroom gills—cases in which the stage of growth is all important—no percentage variation falls below 77. Now

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* It is quite easy to find isolated individuals with a greater degree of variability than this, and even a greater variability than that of the race, it is the *average* individual variability which is represented by the S. D. of the array.

this seems to me very instructive when we consider the statements made by some writers who theorise about variation rather than actually measure it: *The undifferentiated like organs put forth by the individual have in round numbers* 80 *to* 90 *per cent. of the variation of such organs in the race.* Does not this completely refute the views frequently expressed that variation is the result of sexual reproduction, and that it is quite insignificant in the case of budding? Sexual reproduction may produce a type which is not that of either parent, but this does not *à fortiori* alter the variability of the race with regard to any organ. With continuous variation such type would have previously existed as far as any special organ or character is concerned, and its repetition contributes nothing to the racial variability. We have to meet the fact that the individual produces undifferentiated like organs with a remarkable degree of variety, and if the investigations of the present memoir be valid the practical result of the homotyposis factor having a value of ·4 to ·5 would denote that the individual variability is 91·65 to 86·60 per cent. of the racial.

(25.) Lastly, we may consider a third point of very great interest, which is involved in Table XXXIV. Here we have the coefficients of variation given for some twenty-two series. Now this coefficient seems to me the only satisfactory comparative measure we can find at present of variability. A variation of two in the petals of a buttercup is far more significant than one of two in the florets of an ox-eyed daisy; the measures of the *absolute* variations as given by the standard deviations seem to me of no use when we are comparing different characters in different species. In default of the suggestion of any better standard, all we can do is to get rid of absolute size or number by using the percentage variation of the character as indicated in the coefficients of variation. Now our table gives a fairly continuous series from 7·80 up to 41·96.* The mean value of 19 is in very good accord with the results I have obtained for variation in a much wider series for the vegetable kingdom. Now I think it will be admitted:

(*a*.) that this variation is based on results for a wide number of species;
(*b*.) that this variation covers a considerable variety of characters;
(*c*.) that it is roughly continuous in value between 8 and 40.

But if we examine the fourth column in this table, which gives the place of the corresponding homotypic correlation, we find absolutely no relationship between the intensity of the homotyposis and of the variability. The homotypic order will not compare in any way with the variation order. The mean variability of the first eleven series is 22·95, and of the last eleven series 14·28, very sensible deviations from the mean 18·62 of the whole twenty-two series. But the mean homotypic correlation of the first eleven series is ·4559, and of the last eleven series ·4581, neither of which

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* If we excluded the hartstongue as largely influenced by environment, we should find broom heading the list, one of my most satisfactory series, both as to similarity of individual environment and as to smoothness of frequency. We should still conclude that variation might reach to nearly 40.

exhibits any sensible difference from ·4570 the mean of all twenty-two series. We are compelled therefore to conclude that there is no relationship between the variability of a species with regard to any organ, and the homotypic correlation of such organs. It would be quite impossible to assert that as the variability of a species decreased, its homotyposis increased. But according to the results reached in this paper heredity is a result of homotyposis. Hence there seems, so far as our researches go, no ground for asserting that increased intensity of heredity means decreased intensity of variation and *vice versâ*. The general impression formed upon my mind by our measurements is the approximate constancy of the *pure* homotypic factor, or at any rate its variation within a fairly small range, and consequently the approximate constancy within a like small range of the hereditary factor for all species and all characters.

TABLE XXXIV.—General Results for Variability.

Race.	Character.	Coefficient of variation.	Position in correlation table.
Hartstongue, Somersetshire	Sori on fronds	41·96	(ii.)
Broom, Yorkshire	Seeds in pods	36·78	(xiii.)
Holly, Dorsetshire	Prickles on leaves	26·29	(v.)
Nigella Hispanica, Slough	Segments in capsules	19·39	(xx.)
Holly, Somersetshire	Prickles on leaves	18·74	(xviii.)
Ash, Dorsetshire	Leaflets on leaf	18·65	(xvi.)
Ash, Monmouthshire	,, ,,	18·57	(xiv.)
Mushroom, Buckinghamshire	Gill-indices	18·28	(ix.)
Ceterach, Somersetshire	Lobes on fronds	18·25	(i.)
Papaver Rhœas, top of Chilterns	Stigmatic bands	17·81	(viii.)
Wild Ivy, mixed	Leaf-indices	17·77	(xix.)
Papaver Rhœas, Quantocks	Stigmatic bands	17·66	(x.)
English Onion, Hampden	Veins in tunics	17·43	(iv.)
Spanish Chestnut, mixed	Veins in leaves	15·72	(vi.)
Ash, Buckinghamshire	,, ,,	15·46	(xvii.)
Papaver Rhœas, Lower Chilterns	Stigmatic bands	15·27	(xv.)
Shirley Poppy, Hampden	,, ,,	15·17	(xi.)
Spanish Chestnut, Buckinghamshire	Veins in leaves	14·31	(xii.)
Shirley Poppy, Chelsea	Stigmatic bands	13·99	(iii.)
Woodruff, Buckinghamshire	Members in whorls	13·46	(xxii.)
Beech, Buckinghamshire	Veins in leaves	10·77	(vii.)
Malva Rotundifolia, Hampden	Segments in seed-vessels	7·80	(xxi.)
Mushroom, Buckinghamshire	Lengths of gills	21·00	—
,, ,,	Breadth of gills	23·42	—
Wild Ivy, mixed	Lengths of leaves	30·94	—
,, ,,	Breadths of leaves	34·34	—
Mean of first 22 cases	—	18·62	—
Mean of all 26 cases	—	19·97	—

On the other hand, great diversity in the variability of different species. I do not wish to be dogmatic on this point, however, but I would definitely assert that so far no relationship between variability and homotyposis is discoverable. Further, it does not seem to me that looking down the order of variability we can assert that our table in any way corresponds to the order of evolutionary descent. It does not seem to me that the species towards the top of it are the more primitive and those towards the bottom the more complex. Indeed two series of the same species may stand at very different points in the table. I am accordingly forced to the conclusion that my table gives no support whatever to the view that variability in the vegetable kingdom is greatest for the more primitive and simpler organisms. Nor, again examining Table XXXII., can we conclude that homotyposis is least intense for such organisms, for the second half of our table cannot be said to contain more of such organisms than the first. Shortly, I see no relation between the position of an organism in the evolutionary descent and the intensity of either its variability or its homotyposis. Hence it follows that, if homotyposis be the source of heredity, the intensity of the latter cannot be related to either variability or position in evolutionary descent.

Mr. ADAM SEDGWICK may be right in his view* that in the early stages of evolution variability is large and inheritance small, and that with development this relation is changed, variability decreasing with an increasing intensity of heredity. My statistics only cover a small portion of one kingdom. But so far as I am aware they represent the only material so far published on which a definite judgment can be founded—where by definite judgment, I mean one based on quantitative facts, and not drawn from a general estimate of nature which makes no statement whatever of the intensity of either variability or heredity for any single character in any one species of living things.

The data I have given seem entirely opposed to Mr. SEDGWICK'S view, but I very fully realise that they are far from exhaustive. They indicate, however, what I hold to be the only valid method of approaching any problem in variation or heredity, *i.e.*, laborious statistical collection of actual facts. My statistics may be insufficient, I would heartily welcome additions to them; or they may be dealt with fallaciously. Here is the material; let others add to and, if need be, modify the conclusions. Only let us follow the method so clearly indicated by DARWIN himself in his 'Cross and Self-fertilisation of Plants;' let us cease to propound hypotheses illustrating them by isolated facts or vague generalities; there are innumerable species at hand in Nature ready for us to measure and count. *Sine numero nihil demonstrandum est,* should now-a-days be the motto of every naturalist who desires to propound novel hypotheses with regard to variation or heredity. It is equally valid for those who merely seek either to establish more firmly or to modify the old.

(26.) I would sum up the results of this memoir in the following conclusions:

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* Presidential Address to Section D of the British Association, 1899.

(i.) When an individual of any species produces a number of undifferentiated like organs (homotypes) these are not exactly alike when measured with regard to any character. They exhibit a certain degree of variation combined with a certain degree of likeness (homotypic correlation).

(ii.) The homotypic correlation as tested for twenty-two series of homotypes in a variety of species in the vegetable kingdom, has a mean value between ·4 and ·5. Its exact determination is rendered difficult by a number of conflicting factors; but it seems very possible that the actual value of pure homotypic correlation, *i.e.*, the correlation due to the individuality of the plant as apart from the influence of environment, &c., differs but little from the mean value stated above.

(iii.) If a character occurs in a series of homotypes, it will be found to have in the individual a variability 80 to 90 per cent. of the variability of this character in the species at large. It is thus seen that variability is a primary factor of living forms, and is not in any way dependent on sexual reproduction.

(iv.) With a certain hypothesis as to cross homotypic correlation, *i.e.*, the correlation of two different characters in homotypes, namely, that it is the product of the direct homotypic and of the organic correlations, it would follow that the mean fraternal correlation would equal the mean homotypic correlation. The mean of twenty-two homotypic series is found to be sensibly identical with the mean of nineteen fraternal series. A direct investigation of the value of the cross homotypic correlation is only made for two cases, that of the mushroom gill and that of the ivy leaf. The cross homotypic correlation is not found to differ very widely from the product of the direct homotypic and the organic correlations in these cases, but the results are not close enough to be conclusive.

(v.) It would seem, if (iv.) be true, that heredity is only a phase of the principle of homotyposis (ii.), and that the numerical value of its constants may be found from that principle.

(vi.) No relation whatever could be found between the intensity of variability and that of homotyposis in the twenty-two series dealt with. Nor was any relation to be observed between the relative simplicity of the organism and the intensity either of its variability or its homotypic correlation. Regarding heredity as a case of homotyposis, there seems no reason to suppose, as it has been suggested, that variability has decreased and heredity increased in the course of evolution. On the contrary there seems some ground for supposing that homotyposis (and therefore heredity) is a primary factor of living forms, a condition for the evolution of life by natural selection, and not a product of such selection. If the mushroom, the poppy, and the beech show approximately equal homotyposis, it seems well nigh impossible to consider it as a factor of life, increasing with advancing evolution.

APPENDIX.

On the Homotyposis of the Pods of Leguminous Plants.

I have already indicated that I had initially grave doubts as to whether a true measurement of homotyposis could be obtained by counting the ripe seeds in the pods of leguminous plants; but that a passage in a work of DARWIN'S led me to modify my opinion, and when finishing my memoir, I found time to incorporate in it the broom series from Danby Dale which seemed to confirm DARWIN'S views. Broom is cross-fertilised and much visited by insects, and accordingly the statement made on p. 334 of this memoir appears to have full validity. As the matter seemed of some interest, I suggested to Miss C. D. FAWCETT a fuller study of leguminous plants from this standpoint. Her results have reached me in time to be reduced by Dr. LEE and to be incorporated in this Appendix. I have myself worked series for the common bean and the tare vetch, so that if these be included we have now a fairly extensive range of material from which to draw conclusions.

I will first give the data and state the manner in which it has been reduced, and then consider the results which flow from its consideration. The following is a list of the species dealt with; I have remarked on some of the difficulties arising in the course of our work.

(i.) *Cytisus Scoparius.* Broom from Danby Dale (see p. 334).—It was found difficult to count the total number of ovules, and only the ripened seeds were dealt with. The plant is cross-fertilised. The pods were fairly free from insects.

(ii.) *Lotus Corniculatus.* Bird's-foot trefoil from the neighbourhood of Lyme Regis, Dorsetshire.—The aborted seeds could not be counted, and the pods were largely frequented by grubs, so that it was occasionally doubtful how far ripe seeds had been destroyed. The number of pods on each plant in this first series were too few too allow those with grubs in them to be neglected.*

(iii.) *Lotus Corniculatus.*—A second series from the neighbourhood of Lyme Regis. This series consisted of more vigorous plants from a slightly different environment, so that fourteen to twenty pods could be gathered from each, and thus difficulties as to the possible destruction of ripe seeds by grubs avoided. It would appear that the effect of rejecting such pods has raised the mean number of seeds, but at the same time artificially reduced the homotyposis. The plant is cross-fertilised. (DARWIN: 'Cross and Self-Fertilisation of Plants,' p. 361.)

(iv.) *Lathyrus Odoratus.* Sweet Pea.—This was obtained from a row in a nursery garden at Lyme Regis. Both the fertilised and aborted seeds were counted, so that the total number of ovules could be found. The plant is said to be cross-fertilised in

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* As an illustration of this sort of difficulty I may note that I found something like 90 per cent. of the pods of gorse in the Danby district so full of insect life that nothing could be done in regard to counting their seeds.

countries where it is indigenous, but DARWIN ('Cross and Self-Fertilisation of Plants,' 3rd edition, p. 155, *et seq.*) strongly believes it to be wholly self-fertilised in England.

(v.) *Lathyrus Odoratus.*—A shorter series obtained from a second nursery garden at Lyme Regis.

(vi.) *Lathyrus Sylvestris.* Everlasting pea from the sea coast not very far from Lyme Regis.—Both the ripe and the aborted seeds were counted. The plant appears to be cross-fertilised. Professor F. O. OLIVER tells me that he has watched bees effectively visiting the cultivated everlasting pea.

(vii.) *Vicia Faba.* Common Bean.—I took 100 plants, each having at least ten pods, from a field in Danby Dale, in which a mixture of oats, the common pea, the common bean, and three or four vetches* (described by the owner as tares), was growing as food for cattle. The perfect beans only were counted, but the plants were a poor crop, many pods being stunted in their growth, and it was not always easy to determine whether the seeds had not been fertilised or there had been failure owing to want of nutrition. The common bean is both cross and self-fertilised. I have to thank Miss J. SHARPE and Miss E. CYRIAX for aid in the work on these beans.

(viii.) *Vicia Hirsuta.*—I found twenty-eight plants of the tare vetch growing on a strip of uncut grass along a cut cornfield at Botton, Danby Dale. I could find no more plants in the neighbourhood. There was plenty of the common vetch (*Vicia Sativa*) on the same strip, but the plants had rarely more than two to three pods on them. I was not able to get ten pods from each tare vetch, thirteen plants had fewer, and seven plants more. The series being short, the probable errors are high, but it seemed worth while to include the data. I endeavoured to count both ripe and aborted seeds, but here, as in one or two of the previous cases, I much doubt whether we have succeeded in counting all the ovules. In some of the green pods the number of ovules seemed to be considerably larger than in the fully ripe pods, and I think it possible that the non-fertilised seeds shrink till they are quite unnoticeable even by a cautious observer. Again, it is by no means certain here, as in other cases, that all the seeds reckoned as aborted are really non-fertilised. It is quite possible that in some cases fertilised seeds have dwindled for want of nutriment till they appear aborted.

Vicia Hirsuta is either cross or self-fertilised (DARWIN: 'Cross and Self-Fertilisation of Plants,' p. 367). Whether this vetch, or indeed the common bean, were in our case wholly cross-fertilised or in part self-fertilised, I do not see that we have any means of settling.

Table L. gives the frequency distributions of the various series. Now in these series we must bear in mind that we are only definitely certain of one thing, the number

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* Neither the pea nor the vetches offered enough pods per plant for an investigation of their homotyposis to be of value.

TABLE L.—Variation of the Seeds in the Pods of Leguminous Plants per mille.

Number of Seeds in Pod.

Species.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	Totals.
Cytisus Scoparius (ripe) .	—	7	12	24	39	45	64	82	105	113	112	86	83	82	56	40	28	14	4	3	1	—	—	—	—	—	—	—	1000*
Lotus Corniculatus (i.) (ripe)	9	6	42	50	73	85	108	101	88	72	80	56	63	39	23	25	25	15	8	10	5	8	4	4	0	1	—	—	1000
Ditto (ii.) (ripe) . . .	3	0	11	29	37	77	82	96	110	79	76	78	67	43	57	33	25	23	21	10	13	9	5	8	1	4	1	2	1000
Lathyrus Odoratus (i.) (ovules)	—	—	—	—	—	2	14	95	303	325	209	47	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000
Ditto (ripe)	1	6	11	31	103	208	239	190	134	53	20	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000
Ditto (aborted)	74	167	253	220	178	67	31	8	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000
Lathyrus Odoratus (ii.) (ovules)	—	—	—	—	—	9	36	119	345	294	177	19	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000*
Ditto (ripe)	8	16	45	74	113	194	186	184	120	45	13	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000*
Ditto (aborted)	92	168	225	195	150	74	52	23	15	5	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000*
Lathyrus Sylvestris (ovules)	—	—	—	—	—	—	—	—	1	0	2	6	37	204	476	230	39	5	—	—	—	—	—	—	—	—	—	—	1000
Ditto (ripe)	1	7	20	74	183	227	206	132	79	43	17	9	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000
Ditto (aborted)	—	—	3	10	18	42	84	156	187	203	155	95	33	12	0	1	1	—	—	—	—	—	—	—	—	—	—	—	1000
Vicia Faba (ripe) . . .	35	43	153	408	352	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000
Vicia Hirsuta (ovules) .	—	37	169	408	282	91	13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000*
Ditto (ripe)	2	191	438	308	52	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000*
Ditto (aborted)	226	554	167	38	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000*

* These series were reduced to per milles.

TABLE LI.—The following table sums up our results.

Species.	Fertilisation.	Number of			Nature of seeds.	Mean No. of seeds.	S. D. of seeds.	Coefficient of variation.	S. D. of array.	Percentage variation.	Homotypic correlation.
		Plants.	Pods.	Pairs.							
Cytisus Scoparius . .	C.	120	1200	10,800	Ripe	9·6425	3·54655	36·78	3·22595	90·96	·4155 [± ·0161]
Lotus Corniculatus (i.) .	C.	100	1000	9000	Ripe	8·5020	4·4326	52·14	4·3080	97·19	·2354 [± ·0201]
Ditto (ii.)	C.	100	1000	9000	Ripe	9·9783	4·6276	46·38	4·5447	98·21	·1884 [± ·0206]
Lathyrus Odoratus (i.) .	S.	100	1000	9000	Ovules	8·7750	1·1101	12·65	1·0834	97·59	·2182 [± ·0203]
Ditto (i.)	S.	100	1000	9000	Ripe	6·1310	1·6964	27·67	1·6906	99·66	·0830 [± ·0212]
Ditto (i.)	S.	100	1000	9000	Aborted	2·6400	1·5442	58·49	1·4878	96·34	·2679 [± ·0198]
Lathyrus Odoratus (ii.)	S.	80	800	7200	Ovules	8·4925	1·1369	13·39	1·0581	93·07	·3658 [± ·0207]
Ditto (ii.)	S.	80	800	7200	Ripe	5·6725	1·9831	34·96	1·9393	97·79	·2091 [± ·0228]
Ditto (ii.)	S.	80	800	7200	Aborted	2·8212	1·8945	67·15	1·8650	98·44	·1759 [± ·0231]
Lathyrus Sylvestris . .	C.	100	1000	9000	Ovules	14·0130	·9512	6·79	·9374	98·55	·1695 [± ·0207]
Ditto	C.	100	1000	9000	Ripe	5·6080	1·8456	32·91	1·8015	97·59	·2184 [± ·0203]
Ditto	C.	100	1000	9000	Aborted	8·4150	1·9906	23·66	1·9717	99·05	·1376 [± ·0209]
Vicia Faba	C. or S.	100	1000	9000	Ripe	3·0260	1·0136	33·50	·9956	98·22	·1877 [± ·0206]
Vicia Hirsuta . . .	C. or S.	28	255	2328	Ovules	3·2612	1·0071	30·88	·9920	98·50	·1724 [± ·0410]
Ditto	C. or S.	28	255	2328	Ripe	2·2436	·8598	38·32	·8531	99·22	·1243 [± ·0416]
Ditto	C. or S.	28	255	2328	Aborted	1·0636	·8250	77·57	·8157	98·88	·1493 [± ·0413]
Mean	Four series				Ovules	—	—	13·43	—	96·93	·2315
Mean	Eight series				Ripe	—	—	37·83	—	97·355	·2077
Mean	Four series				Aborted	—	—	56·72	—	98·18	·1827
Mean	Sixteen series				All series	—	—	37·08	—	97·45	·2073

of fully ripened seeds—and this only when the pods were not infested with grubs. We did the best we could to count the aborted seeds, but we cannot be certain that all those counted as aborted were non-fertilised, or that we succeeded in counting all those which had shrunk to microscopic proportions. The number of ovules is simply the sum of the ripe and the aborted seeds counted in each pod, and this again must be somewhat doubtful. The reader will bear in mind that we proceeded with care, but that we think it right, if anything, to rather over- than under-emphasise possible sources of error. Yet allowing for such sources of error we cannot, on examining the results given in Table LI., allow that Broom is in the least representative of the degree of homotyposis to be found in the pods of leguminous plants. Whether we consider the ovules, the ripe, or the aborted seeds, our results are sensibly below that for broom, and the mean of the whole sixteen series gives us a value about *one-half* that of the homotypic correlation based upon characters not depending on fertilisation. If we deal with averages, it would certainly seem that in the results flowing from fertilisation, we have reduced the intensity of the individuality to about half its previous value.

To this extent only does the individual constitution appear influential in the number of seeds in the pod, the remainder of the homotypic intensity seems to have disappeared under random influences having nothing to do with the individuality of the plant. This is perhaps what we might expect in the case of *ripe* seeds in cross-fertilised plants, where the fertilisation may depend on the chance or not of insect visitation and the effectiveness or not of the pollen brought on such occasions. We should have to assert that the bird's-foot trefoil and the everlasting pea, whose average for homotypic correlation in the case of ripe seeds is about ·21 to ·22, lose half the intensity of their individuality through the random nature of the chances of the cross-fertilisation. But although this might be fairly satisfactory for these cases, what are we to say for the species which are self-fertilised absolutely or self-fertilised in default of cross-fertilisation? We might have expected a high degree of homotyposis in the field bean or the tare vetch, where failing cross-fertilisation we are told there will be self-fertilisation. We find on the contrary, however, in these results some of the lowest homotypic correlations of the whole series. The sweet pea also in its two series presents some very remarkable results. If the sweet pea be entirely self-fertilised then we should expect the homotyposis of both ovules and ripe seeds to be fully up to the average. In neither case is such a result reached, although in one series we have a value for the ovules higher than that obtained for anything except the broom. The noteworthy fact, however, is that the results for the two series of sweet peas differ so widely in character! In the first series it is the abortion which is most individual in character; in the second series it is the ovules. In the first series the ripe seeds have far less individuality than the aborted seeds, in fact, the smallest homotyposis I have yet observed; in the second series the ripe seeds have a value rising to ·2, which is higher than that of the aborted seeds. Ash trees from Monmouthshire, Buckinghamshire, and Dorsetshire, gave results in good agreement; but sweet peas from two different nursery gardens in the same district give strikingly divergent homotypic correlations!

According to DARWIN ('The Effects of Cross and Self-Fertilisation,' 3rd edition, p. 153) the sweet pea "in this country seems invariably to fertilise itself." He bases this statement on (*a*) the difficulty of access to bees and other insects, (*b*) the fact that the varieties are habitually grown by seed growers close together, and yet the colours do not blend, (*c*) the experience that when the varieties are artificially crossed the colours do change. Professor DELPHINO, of Florence, in a letter to DARWIN, writes that it is the fixed opinion of the Italian gardeners that the varieties do cross; but in Italy other insects may of course be available. Now it is most remarkable that in Series I., whether the sweet pea be crossed or self-fertilised, the number of ripe seeds should be hardly individual at all. It would indicate that, with the particular environment of this series, the chance even ot self-fertilisation depends upon extraneous causes. The comparatively high individuality in the tendency to abort may mark some peculiarity of this variety; there may be a distinct inheritance of sterile tendencies to be kept separate from an inheritance of fertility. But it is probably idle to guess at explanations of such discrepancies. I have gone carefully into the differences of environment in the two series which are interesting, although they do not obviously provide any key to the mystery. The first series were thickly planted in a long row, and the seed pods were gathered unripe. It was more difficult to separate each plant and to be quite certain that some of the seeds would not have had to be reckoned as aborted in the fully ripened pods. The second series consisted of withered plants, the pods being almost all completely ripe; the peas were planted in separate groups a few feet apart. There was no difficulty in ascertaining the individuality of the plant nor as to the number of ripe or aborted seeds. About forty hives of bees were kept in the immediate neighbourhood of this second series;* the first series were at the other end of Lyme Regis, and removed from hives. Both series had had their flowers freely cut. I might have been prepared to attribute the low value of the homotyposis in the sweet pea to this latter cause, but then the common bean and the tare vetch had not been subjected to any similar process, and they give on the whole much lower values. The ovules in either self-fertilised or cross-fertilised plants ought indeed to give a fair measure of homotyposis, but, for reasons already stated, it is not certain that our procedure in counting the perfect and the aborted seeds in the ripened pods has led to a just estimate of them. I am inclined on the whole to attempt no explanations for the anomalies observed in these seed investigations. The influences of self- and cross-

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* I mention this, as I noticed in Yorkshire fairly frequent but apparently ineffectual visits of the hive bees to sweet peas. It is possible that their attempts may assist the self-fertilisation, just as shaking or wind has been observed to do in other species.

fertilisation on homotyposis deserve still fuller and more direct investigation.* I feel we know little as to the influence of external causes even on the completeness or incompleteness of self-fertilisation. So far as homotyposis in the pods of leguminous plants is concerned, I would draw conclusions based solely on averages, and state that :—

(i.) The homotyposis in the case of either ripe or aborted seeds in the pods of plants seems weakened to one-half the average value it has in the case of characters not depending on fertilisation. Thus DARWIN's view, that differences in the number of ripe seeds depend upon the constitution of the plants, seems to be only partially true. Extraneous causes about which we are not very clear appear to be generally influential.

(ii.) The extraneous causes which act in a random manner on the homotypic correlation seem to affect both self-fertilised and cross-fertilised plants, and this both with regard to ripe and to aborted seeds.

(iii.) The order of intensity of homotypic correlation is ovules, ripened seeds, and aborted seeds.

The reduction of homotypic correlation in the case of the fertility of pods may be profitably compared with the like reduction which we find in the case of the coefficients of inheritance of fertility and fecundity in man and the horse.†

Other points worth noting, I think, in our results are those of Table LII., which gives the correlation between ovules and ripe and aborted seeds. As we might anticipate, the more ripe the fewer aborted seeds, and *vice versâ*. The correlation is negative, high for the everlasting pea, remarkably low for the tare vetch. It is interesting to see that the correlation between the ovules and either ripe or aborted seeds is not very high. A large number of ovules not necessarily connoting either a very large number of ripe or of aborted seeds. In fact, in the case of the everlasting pea, the number of ovules has very small influence indeed on the number of seeds which ripen. In the tare vetch only is the relationship more marked. Professor F. O. OLIVER tells me that in certain cases evolution appears to be tending in the direction of the pod containing one ripe seed only. It seems, therefore, that such relations as are indicated in Table LII. (and others of a like kind, for further observations ought certainly to be made) may be useful in indicating the degree of fixity between the number of ovules and the number of ripe or aborted seed which are ultimately to be found in the seed vessel.

While the ovules have the least and the aborted seeds the greatest variability, as measured by the coefficient of variation, the ovules have the most and the aborted seeds the least homotypic correlation. This might at first sight appear to be opposed to the view expressed on p. 363, that there is no relationship between the intensities

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* It seems to me that investigations of this kind ought to be carried out by those who have, what I unfortunately have not, the needful land for experimental investigations.

† 'Phil. Trans.,' A, vol. 192, p. 277 *et seq.*

of variation and of homotyposis. But it is really not so, for if we proceed as on that page to divide up our series into two groups in order of their variability, we find that the first eight give an average coefficient of variation of 22·68, and have an average homotypic correlation of ·1941; the last eight have an average coefficient of variation of 51·47—double and more that of the first eight—while their homotypic correlation is ·2207. Thus, so far from the homotyposis being reduced by greater variability, it actually appears to be slightly increased.

TABLE LII.—Relationship between the Number of Ovules and those of Ripe and of Aborted Seeds.

Species.	Correlation.		
	Ripe and aborted.	Ripe and ovules.	Aborted and ovules.
Lathyrus Odoratus (i.) . . .	− ·7692	·4581	·2155
" " (ii.) . .	− ·8290	·3628	·2203
Lathyrus Sylvestris	− ·8797	·0992	·3660
Vicia Hirsuta	− ·2859	·6195	·5751
Means . . .	− ·69095	·3849	·3442

Lastly, we may notice (Table LI.) that the variation in the individual amounts to upwards of 97 per cent. of that in the race, or we have another strong fact to aid in demolishing the theory that variability is a result of sexual reproduction. Note in particular the 97 per cent. in the case of the ovules whose number is determined before fertilisation!

Tables XXXV.–XLIX. give the data from which the constants of Tables L.–LII. have been calculated.

TABLE XXXV.—*Lotus Corniculatus.* Dorsetshire. First Series.

Number of Perfect Seeds in First Pod.

Number of Perfect Seeds in Second Pod.

	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	Totals.
0	8	1	8	6	13	9	9	3	2	8	1	2	5	2	2	0	0	2	—	—	—	—	—	—	—	—	81
1	1	0	5	1	4	5	9	5	5	2	6	3	2	2	1	1	1	1	—	—	—	—	—	—	—	—	54
2	8	5	24	25	48	42	60	39	37	21	18	10	16	8	4	4	4	3	1	1	—	—	—	—	—	—	378
3	6	1	25	36	45	53	53	59	33	22	37	24	11	12	5	6	7	4	3	2	1	4	1	—	—	—	450
4	13	4	48	45	58	73	95	58	65	28	42	28	34	18	14	5	7	7	3	3	2	4	2	1	—	—	657
5	9	5	42	53	73	88	87	67	61	53	60	45	24	30	10	14	14	7	6	4	3	8	1	1	—	—	765
6	9	9	60	53	95	87	140	57	109	56	90	43	52	31	23	17	17	7	5	8	2	1	1	0	—	—	972
7	3	5	39	59	58	67	57	136	82	75	63	54	62	39	14	26	24	14	5	3	7	9	1	5	0	2	909
8	2	5	37	33	65	61	109	82	54	57	77	48	54	23	14	15	16	9	3	10	4	5	6	3	0	0	792
9	8	2	21	22	28	53	56	75	57	76	38	43	43	28	16	22	16	13	8	7	5	4	3	4	0	0	648
10	1	6	18	37	42	60	90	63	77	38	96	31	47	25	10	18	23	14	5	8	2	4	5	0	0	0	720
11	2	3	10	24	28	45	43	54	48	43	31	38	38	24	13	12	13	6	5	7	4	4	4	4	0	1	504
12	5	2	16	11	34	24	52	62	54	43	47	38	38	36	23	17	21	10	6	8	3	8	5	3	0	1	567
13	2	2	8	12	18	30	31	39	23	28	25	24	36	20	13	12	8	5	2	5	1	3	1	2	0	1	351
14	2	1	4	5	14	10	23	14	14	16	10	13	23	13	2	14	9	3	3	6	1	4	0	2	0	1	207
15	0	1	4	6	5	14	17	26	15	22	18	12	17	12	14	12	10	5	5	1	1	4	0	1	0	3	225
16	0	1	4	7	7	14	17	24	16	16	23	13	21	8	9	10	10	11	2	2	1	2	3	4	—	—	225
17	2	1	3	4	7	7	7	14	9	13	14	6	10	5	3	5	11	0	4	4	3	1	0	2	—	—	135
18	—	—	1	3	3	6	5	5	3	8	5	5	6	2	3	5	2	4	2	1	1	2	0	0	—	—	72
19	—	—	1	2	3	4	8	3	10	7	8	7	8	5	6	1	2	4	1	6	0	0	0	4	—	—	90
20	—	—	—	1	2	3	2	7	4	5	2	4	3	1	1	1	1	3	1	0	0	3	1	—	—	—	45
21	—	—	—	4	4	8	1	9	5	4	4	4	8	3	4	4	2	1	2	0	3	0	2	—	—	—	72
22	—	—	—	1	2	1	1	1	6	3	5	4	5	1	0	0	3	0	0	0	1	2	—	—	—	—	36
23	—	—	—	—	1	1	0	5	3	4	0	4	3	2	2	1	4	2	0	4	—	—	—	—	—	—	36
24	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	—	—	—	—	—	—	—	—	—	—	0
25	—	—	—	—	—	—	—	2	0	0	0	1	1	1	1	3	—	—	—	—	—	—	—	—	—	—	9
Totals	81	54	378	450	657	765	972	909	792	648	720	504	567	351	207	225	225	135	72	90	45	72	36	36	0	9	9000

TABLE XXXVI.—*Lotus Corniculatus.* Dorsetshire. Second Series.

Number of Perfect Seeds in First Pod.

Number of Perfect Seeds in Second Pods.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	Totals.
0	6	0	3	0	3	0	0	6	0	3	0	0	3	0	0	0	0	3	—	—	—	—	—	—	—	—	—	—	27
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	—	—	—	—	—	—	0
2	3	0	0	0	6	19	6	14	12	5	7	6	6	4	3	3	2	1	1	1	—	—	—	—	—	—	—	—	99
3	0	0	0	24	28	37	35	16	20	22	16	12	7	9	8	3	2	5	6	2	1	2	0	0	0	6	—	—	261
4	3	0	6	28	24	49	36	36	32	20	20	10	12	10	9	10	7	1	4	1	5	2	0	1	1	6	—	—	333
5	0	0	19	37	49	86	69	97	66	40	52	28	38	21	28	21	9	2	13	4	7	1	1	2	1	1	0	1	693
6	0	0	6	35	36	69	80	72	75	69	64	49	41	28	28	25	19	6	13	3	5	6		4	0	1	0	2	738
7	6	0	14	16	36	97	72	84	87	79	69	55	49	34	43	31	20	13	16	9	9	6	1	9	1	5	0	3	864
8	0	0	12	20	32	66	75	87	124	86	64	86	92	48	60	33	26	21	16	8	11	5	5	7	0	3	3	0	990
9	3	0	5	22	20	40	69	79	86	68	53	68	47	26	32	18	13	21	10	11	5	6	0	1	0	5	0	3	711
10	0	0	7	16	20	52	64	69	64	53	46	65	48	32	43	22	21	15	12	8	12	5	2	5	1	1	0	1	684
11	0	0	6	12	10	28	49	55	86	68	65	74	46	36	59	17	15	20	14	6	8	9	5	10	1	0	0	3	702
12	3	0	6	7	12	38	41	49	92	47	48	46	46	33	35	23	16	12	14	5	11	8	5	2	0	3	1	0	603
13	0	0	4	9	10	21	28	34	48	26	32	36	33	18	29	12	13	7	9	4	3	3	4	3	0	1	0	0	387
14	0	0	3	8	9	28	28	43	60	32	43	59	35	29	34	20	7	27	10	5	9	5	3	11	1	0	1	3	513
15	0	0	3	3	10	21	25	31	33	18	22	17	23	12	20	14	6	11	10	3	4	3	2	5	1	0	0	0	297
16	0	0	2	2	7	9	19	20	26	13	21	15	16	13	7	6	4	7	8	7	8	5	5	3	0	0	1	1	225
17	3	0	1	5	1	2	6	13	21	21	15	20	12	7	27	11	7	12	6	4	2	2		2	0	1	2	1	207
18	—	—	1	6	4	13	13	16	16	10	12	14	14	9	10	10	8	6	10	3	3	-	3	4	1	1	0	—	189
19	—	—	1	2	1	4	3	9	8	11	8	6	5	4	5	3	7	4	3	0	3	2	1	0	0	0	0	—	90
20	—	—	—	1	5	7	5	9	11	5	12	8	11	3	9	4	8	2	3	3	4	5	0	0	1	0	1	—	117
21	—	—	—	2	2	1	6	6	5	6	5	9	8	3	5	3	5	2	2	2	5	2	1	1	0	0	—	—	81
22	—	—	—	0	0	1	2	1	5	0	2	5	5	4	3	2	5	3	3	1	0	1	0	2	0	0	—	—	45
23	—	—	—	0	1	2	4	9	7	1	5	10	2	3	11	5	3	2	4	0	0	1	2	0	0	0	—	—	72
24	—	—	—	0	1	1	0	1	0	0	1	1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	—	—	9
25	—	—	—	6	6	1	1	5	3	5	1	0	3	1	0	0	0	1	1	0	0	0	0	0	0	2	—	—	36
26	—	—	—	—	—	0	0	0	3	0	0	0	1	0	1	0	1	2	0	0	1	—	—	—	—	—	—	—	9
27	—	—	—	—	—	1	2	3	0	3	1	3	0	0	3	0	1	1	—	—	—	—	—	—	—	—	—	—	18
Totals	27	0	99	261	333	693	738	864	990	711	684	702	603	387	513	297	225	207	189	90	117	81	45	72	9	36	9	18	9000

TABLE XXXVII.—*Lathyrus Odoratus.* First Series.

Number of Ovules in First Pod.

Number of Ovules in Second Pod.

	5.	6.	7.	8.	9.	10.	11.	12.	Totals.
5	—	—	—	7	7	3	1	—	18
6	—	22	24	23	35	20	2	—	126
7	—	24	172	282	205	134	36	2	855
8	7	23	282	1168	786	371	81	9	2727
9	7	35	205	786	1114	625	132	21	2925
10	3	20	134	371	625	592	127	9	1881
11	1	2	36	81	132	127	42	2	423
12	—	—	2	9	21	9	2	2	45
Totals	18	126	855	2727	2925	1881	423	45	9000

TABLE XXXVIII.—*Lathyrus Odoratus.* First Series.

Number of Ripe Seeds in First Pod.

Number of Ripe Seeds in Second Pod.

	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	Totals.
0	—	—	—	—	—	2	1	3	2	1	—	—	—	9
1	—	—	1	2	14	13	8	10	2	3	1	—	—	54
2	—	1	2	1	9	34	23	20	6	3	0	—	—	99
3	—	2	1	6	45	61	59	41	33	22	8	1	—	279
4	—	14	9	45	120	193	201	164	124	41	14	2	—	927
5	2	13	34	61	193	426	461	351	208	86	29	6	2	1872
6	1	8	23	59	201	461	564	418	251	111	48	3	3	2151
7	3	10	20	41	164	351	418	338	238	87	29	7	4	1710
8	2	2	6	33	124	208	251	238	234	76	29	3	—	1206
9	1	3	3	22	41	86	111	87	76	30	15	2	—	477
10	—	1	0	8	14	29	48	29	29	15	4	3	—	180
11	—	—	—	1	2	6	3	7	3	2	3	—	—	27
12	—	—	—	—	—	2	3	4	—	—	—	—	—	9
Totals	9	54	99	279	927	1872	2151	1710	1206	477	180	27	9	9000

TABLE XXXIX.—*Lathyrus Odoratus.* First Series.

Number of Aborted Seeds in First Pod.

Number of Aborted Seeds in Second Pod.

	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Totals.
0	78	151	167	129	92	35	12	2	—	—	—	666
1	151	286	388	296	225	104	37	14	1	0	1	1503
2	167	388	636	468	375	161	61	17	1	0	3	2277
3	129	296	468	510	355	127	72	18	2	0	3	1980
4	92	225	375	355	362	117	61	10	3	0	2	1602
5	35	104	161	127	117	32	16	10	1	—	—	603
6	12	37	61	72	61	16	18	1	1	—	—	279
7	2	14	17	18	10	10	1	—	—	—	—	72
8	—	1	1	2	3	1	1	—	—	—	—	9
9	—	0	0	0	0	—	—	—	—	—	—	0
10	—	1	3	3	2	—	—	—	—	—	—	9
Totals	666	1503	2277	1980	1602	603	279	72	9	0	9	9000

TABLE XL.—*Lathyrus Odoratus.* Second Series.

Number of Ovules in First Pod.

Number of Ovules in Second Pod.

	5.	6.	7.	8.	9.	10.	11.	12.	Totals.
5	2	17	24	14	6	—	—	—	63
6	17	62	95	59	26	2	—	—	261
7	24	95	196	300	150	82	8	—	855
8	14	59	300	1066	689	321	34	1	2484
9	6	26	150	689	754	439	48	3	2115
10	—	2	82	321	439	394	37	3	1278
11	—	—	8	34	48	37	6	2	135
12	—	—	—	1	3	3	2	—	9
Totals	63	261	855	2484	2115	1278	135	9	7200

TABLE XLI.—*Lathyrus Odoratus.* Second Series.

Number of Ripe Seeds in First Pod.

Number of Ripe Seeds in Second Pod.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Totals.
0	2	3	2	10	13	11	3	6	3	1	—	—	54
1	3	2	8	13	19	31	11	12	15	1	1	1	117
2	2	8	22	50	44	68	45	38	29	16	2	0	324
3	10	13	50	62	85	105	67	70	46	17	4	2	531
4	13	19	44	85	108	178	149	129	65	20	5	4	819
5	11	31	68	105	178	300	257	251	146	42	6	0	1395
6	3	11	45	67	149	257	278	284	174	50	20	3	1341
7	6	12	38	70	129	251	284	258	183	71	18	3	1323
8	3	15	29	46	65	146	174	183	118	59	23	3	864
9	1	1	16	17	20	42	50	71	59	36	10	1	324
10	—	1	2	4	5	6	20	18	23	10	0	1	90
11	—	1	0	2	4	0	3	3	3	1	1	—	18
Totals	54	117	324	531	819	1395	1341	1323	864	324	90	18	7200

TABLE XLII.—*Lathyrus Odoratus.* Second Series.

Number of Aborted Seeds in First Pod.

Number of Aborted Seeds in Second Pod.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Totals.
0	112	166	138	116	57	27	25	15	6	3	1	666
1	166	266	280	230	131	51	39	26	13	4	0	1206
2	138	280	396	312	249	115	71	29	18	10	2	1620
3	116	230	312	278	237	106	75	18	23	6	3	1404
4	57	131	249	237	156	113	82	30	19	5	1	1080
5	27	51	115	106	113	48	36	18	12	4	1	531
6	25	39	71	75	82	36	30	12	4	4	0	378
7	15	26	29	18	30	18	12	8	6	0	0	162
8	6	13	18	23	19	12	4	6	6	0	1	108
9	3	4	10	6	5	4	4	0	0	—	—	36
10	1	0	2	3	1	1	0	0	1	—	—	9
Totals	666	1206	1620	1404	1080	531	378	162	108	36	9	7200

TABLE XLIII.—*Lathyrus Sylvestris.* Sea Coast, Dorsetshire.

Number of Ovules in First Pod.

Number of Ovules in Second Pod.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	Totals.
8	—	—	—	—	—	2	3	3	0	1	9
9	—	—	—	—	—	0	0	0	0	0	0
10	—	—	—	—	2	9	7	0	0	0	18
11	—	—	—	—	5	10	28	10	1	0	54
12	—	—	2	5	28	90	167	38	2	1	333
13	2	0	9	10	90	486	837	348	51	3	1836
14	3	0	7	28	167	837	2162	920	143	17	4284
15	3	0	0	10	38	348	920	610	121	20	2070
16	0	0	0	1	2	51	143	121	30	3	351
17	1	0	0	0	1	3	17	20	3	0	45
Totals	9	0	18	54	333	1836	4284	2070	351	45	9000

TABLE XLIV.—*Lathyrus Sylvestris.* Sea Coast, Dorsetshire.

Number of Ripe Seeds in First Pod.

Number of Ripe Seeds in Second Pod.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	Totals.
0	—	—	—	1	1	1	0	1	1	4	—	—	—	9
1	—	—	4	4	16	12	11	7	7	1	1	—	—	63
2	—	4	16	10	40	33	37	29	5	6	0	—	—	180
3	1	4	10	42	146	170	135	65	53	20	12	6	2	666
4	1	16	40	146	412	378	299	197	86	42	16	13	1	1647
5	1	12	33	170	378	476	426	267	145	77	33	16	9	2043
6	0	11	37	135	299	426	402	251	163	84	31	13	2	1854
7	1	7	29	65	197	267	251	168	107	59	19	15	3	1188
8	1	7	5	53	86	145	163	107	70	39	24	10	1	711
9	4	1	6	20	42	77	84	59	39	38	12	5	—	387
10	—	1	0	12	16	33	31	19	24	12	2	3	—	153
11	—	—	—	6	13	16	13	15	10	5	3	—	—	81
12	—	—	—	2	1	9	2	3	1	—	—	—	—	18
Totals	9	63	180	666	1647	2043	1854	1188	711	387	153	81	18	9000

TABLE XLV.—*Lathyrus Sylvestris.* Sea Coast, Dorsetshire.

Number of Aborted Seeds in First Pod.

Number of Aborted Seeds in Second Pod.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Totals.
2	—	—	1	6	4	2	1	7	5	1	—	—	—	—	—	27
3	—	—	3	4	11	21	18	13	10	8	2	—	—	—	—	90
4	1	3	2	12	18	23	24	27	29	14	5	3	0	0	1	162
5	6	4	12	28	46	61	73	66	45	25	7	5	0	0	0	378
6	4	11	18	46	84	155	141	123	107	42	15	6	0	4	0	756
7	2	21	23	61	155	250	286	262	164	123	41	14	0	2	0	1404
8	1	18	24	73	141	286	344	354	241	143	41	16	0	0	1	1683
9	7	13	27	66	123	262	354	396	305	195	55	22	0	0	2	1827
10	5	10	29	45	107	164	241	305	254	148	65	19	0	1	2	1395
11	1	8	14	25	42	123	143	195	148	100	39	15	0	1	1	855
12	—	2	5	7	15	41	41	55	65	39	18	7	0	1	1	297
13	—	—	3	5	6	14	16	22	19	15	7	0	0	0	1	108
14	—	—	0	0	0	0	0	0	0	0	0	0	—	—	—	0
15	—	—	0	0	4	2	0	0	1	1	1	0	—	—	—	9
16	—	—	1	0	0	0	1	2	2	1	1	1	—	—	—	9
Totals	27	90	162	378	756	1404	1683	1827	1395	855	297	108	0	9	9	9000

TABLE XLVI.—*Vicia Faba.* Danby Dale, Yorkshire.

Number of Ripe Seeds in First Pod.

Number of Ripe Seeds in Second Pod.	0.	1.	2.	3.	4.	5.	Totals.
0	46	38	35	120	76	—	315
1	38	46	70	142	89	2	387
2	35	70	274	608	386	4	1377
3	120	142	608	1542	1237	23	3672
4	76	89	386	1237	1332	48	3168
5	—	2	4	23	48	4	81
Totals	315	387	1377	3672	3168	81	9000

TABLE XLVII.—*Vicia Hirsuta.* Danby Dale, Yorkshire.

Number of Ovules in First Pod.

Number of Ovules in Second Pod.	1.	2.	3.	4.	5.	6.	Totals.
1	6	22	33	21	4	—	86
2	22	98	169	81	21	2	393
3	33	169	360	292	86	10	950
4	21	81	292	194	57	11	656
5	4	21	86	57	38	6	212
6	—	2	10	11	6	2	31
Totals	86	393	950	656	212	31	2328

TABLE XLVIII.—*Vicia Hirsuta.* Danby Dale, Yorkshire.

Number of Ripe Seeds in First Pod.

Number of Ripe Seeds in Second Pod.	0.	1.	2.	3.	4.	5.	Totals.
0	—	—	3	1	1	—	5
1	—	160	165	89	31	—	445
2	3	165	492	304	45	11	1020
3	1	89	304	278	38	6	716
4	1	31	45	38	10	—	120
5	—	—	11	6	—	—	22
Totals	5	445	1020	716	120	22	2328

TABLE XLIX.—*Vicia Hirsuta.* Danby Dale, Yorkshire.

Number of Aborted Seeds in First Pod.

Number of Aborted Seeds in Second Pod.	0.	1.	2.	3.	4.	Totals.
0	160	263	88	9	6	526
1	263	788	176	52	10	1289
2	88	176	92	16	16	388
3	9	52	16	10	2	89
4	6	10	16	2	2	36
Totals	526	1289	388	89	36	2328

TABLE IV. European Chestnut Trees.

Number of Veins on First Leaf.

Number of Veins on Second Leaf.

	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	59.	Totals.
20	—	—	—	—	1	0	1	0	0	1	2	7	1	1	0	2	0	4	0	2	0	0	1	0	0	2	0	1								—	—	—	—	—	25
21	—	—	—	—	0	1	2	1	2	1	3	2	0	2	4	5	1	3	3	3	7	1	1	2	1	1	3	0	—	—						—	—		—	—	50
22	—	—			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—										—	0
23					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	—	—	—						0
24	1	0	0	0	0	1	2	1	[illegible]	2	3	9	10	5	5	12	7	7	11	9	6	6	5	5	2	7	3	4	1		—	—	—	—	—			—			125
25	0	1	0	0	1	0	2	1	2	1	6	4	4	0	6	10	7	8	8	8	8	6	9	0	4	1	1	0	0	0	0	0	1	—	—		—	—	—		100
26	1	3	0	0	2	2	2	3	4	6	9	9	5	0	9	17	4	10	9	11	13	7	6	3	0	6	1	4	0	0	0	0	0				—	—	—	—	150
27	0	1	0	0	1	1	3	3	1	11	16	15	21	20	37	26	22	20	18	21	31	9	20	11	5	7	2	1		0	0	0	0	0	2	—	—			—	350
28	0	2	0	0	1	2	1	4	1	11	25	12	7	20	25	42	13	27	27	26	31	19	19	6	7	9	6	5		5	0	0	1	0	2	—				—	350
29	1	1	0	0	2	1	6	11	[illegible]	13	36	23	19	22	31	42	28	32	45	32	14	19	23	8	8	7	5	4	0	2	0	0	0	0	0	—					475
30	2	2	0	0	3	6	9	10	35	30	38	53	43	56	88	100	61	73	82	69	86	44	53	27	30	15	11	0	5	4	0	0	3	0	3		—	—	—	—	1050
31	5	2	0	0	9	4	9	17	12	33	53	36	51	56	67	95	63	80	77	79	70	44	46	29	26	27	10	16	9	9	5	2	6	1	2	—	—	—	—	—	1075
32	1	0	0	0	10	4	5	21	7	19	43	51	46	39	76	90	73	74	107	74	92	73	32	36	24	35	33	13	18	9	7	4	2	0	3	—	—			—	1225
33	1	2	0	0	5	6	6	29	26	29	66	56	59	83	95	133	104	101	125	121	124	51	47	42	34	31	38	13	17	5	3	3	2	1	13	—					1500
34	0	6	0	0	5	6	9	37	35	31	68	67	78	95	131	156	358	152	171	155	183	114	131	95	57	67	52	43	48	35	16	6	11	3	5	—					2225
35	2	5	0	0	14	10	17	26	32	42	100	93	99	133	156	174	174	180	221	208	197	137	148	87	74	60	50	35	32	33	7	7	6	3	7		—	—	—		2550
36	0	1	0	0	7	7	4	24	19	23	61	61	73	106	158	174	222	233	252	244	251	189	240	160	160	85	54	58	63	45	25	16	22	3	5		—	—	—	—	3000
37	4	3	0	0	7	8	10	20	25	32	73	59	71	101	158	180	253	242	261	260	256	196	219	158	145	103	71	14	62	28	57	11	10	0	9		—		—	—	3125
38	0	3	0	0	11	8	9	18	27	45	85	77	107	125	171	221	252	267	292	328	307	240	255	181	172	128	106	65	72	37	40	15	20	3	5	—					3725
39	2	3	0	0	8	9	11	21	33	52	59	73	74	111	185	208	214	200	328	346	341	316	343	239	141	149	144	113	117	36	50	50	21	10	11	—	—	—			4125
40	0	7	0	0	8	5	12	31	31	44	89	50	95	124	183	197	251	206	307	344	396	307	393	311	277	280	219	163	163	67	77	40	75	17	26	5	4	4	0	8	4950
41	0	1	0	0	6	6	7	9	13	19	44	[illegible]	75	51	113	137	189	196	240	315	307	312	326	252	244	261	173	173	132	13	46	29	26	8	8	0	0	0	0	0	3875
42	1	1	0	0	5	9	9	20	12	23	53	48	58	57	131	116	240	249	288	313	303	326	378	300	228	256	207	174	145	61	75	35	57	13	16	4	0	4	0	6	4475
43	0	3	0	0	5	0	3	11	3	2	27	29	56	43	95	87	140	136	181	233	331	252	309	278	232	222	235	215	170	103	49	71	72	26	26	14	7	12	0	16	3825
44	0	1	0	0	2	4	0	5	7	8	30	23	31	34	57	74	140	234	174	185	277	346	299	292	226	275	297	283	173	93	101	55	61	23	27	4	1	1	0	6	3550
45	1	1	0	0	7	1	6	7	3	7	15	27	38	31	67	60	85	105	179	190	380	264	256	282	277	284	309	231	200	119	118	56	57	32	35	7	1	7	0	11	3725
46	0	3	0	0	3	1	1	2	6	3	11	18	53	53	52	36	64	54	103	144	210	175	207	255	237	309	342	256	258	155	148	99	120	32	47	10	11	5	0	6	3525
47	1	0	0	0	4	0	4	4	5	4	9	16	13	15	43	35	58	44	65	118	62	176	174	215	234	251	256	224	203	105	96	81	75	32	36	7	8	5	0	3	2775
48	—	—			1	0	0	1	1	0	5	9	13	17	18	32	63	64	72	177	63	132	145	178	172	290	258	293	230	125	131	108	11	25	33	5	9	3	0	1	2675
49			—	—	—	0	0	0	2	2	4	8	9	3	15	13	5	28	34	50	67	43	64	103	94	149	155	104	128	80	86	61	57	25	24	5	6	4	0	0	1475
50	—	—	—	—	—	0	0	0	0	0	0	5	7	3	16	7	35	27	40	50	77	46	71	69	101	116	116	88	151	96	122	47	92	44	39	2	3	2	0	1	1550
51	—	—	—			0	0	0	0	0	0	2	4	2	6	7	10	11	15	30	49	29	34	71	56	56	89	51	106	61	37	42	67	25	20	6	11	3	0	0	975
52	—	—			—	1	0	0	1	0	8	5	2	3	14	6	22	16	20	24	75	96	57	79	64	87	120	73	114	55	92	57	60	21	18	7	11	5	0	5	1300
53			—	—	—	—		0	0	0	0	1	0	1	3	3	3	0	5	10	17	9	19	26	23	32	35	32	25	25	34	24	24	4	11	2	4	1	0	0	375
54	—	—	—	—	—	—		3	2	0	3	3	2	13	5	7	8	9	5	14	26	8	16	26	27	35	47	36	33	23	58	20	15	11	15	7	9	4	0	1	475
55	—	—					—	—	—	—	—	—	—				—				5	0	1	11	1	7	10	7	5	5	3	6	7	2	7	2	6	1	0	3	100
56				—	—	—	—	—				—	—	—	—	—	—	—	—	—	4	0	0	7	1	1	11	5	0	0	3	11	11	[illegible]	9	6	6	3	0	0	100
57			—	—	—	—				—	—				—	—	—	—			4	0	4	12	4	7	7	5	3	4	2	3	5	1	1	4	3	0	0	3	75
58	—	—	—				—	—		—	—	—	—				—				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59		—				—	—	—					—	—							3	0	6	15	6	11	6	3	1	6	4	0	5	0	1	3	0	3	0	2	75
Totals.	25	50	0	0	125	100	150	350	350	475	1050	1075	1225	1500	2225	2550	3000	3125	3725	4125	4950	3875	4475	3825	3550	3725	3525	2775	2675	1475	1550	975	1300	375	175	100	100	75	0	75	65550

[To face p. 300.

Series (ii.). TABLE V.—Mixed Set Spanish Chestnut Leaves.

Number of Veins on First Leaf.

Number of Veins on Second Leaf.

	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	Totals.
19	—	—	—	1	1	5	1	2	4	2	5	3	2	0	0	0	1	0	0	0	1	0	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
20	—	—	—	0	0	0	0	1	0	0	1	1	1	3	1	2	0	1	1	3	1	3	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
21	—	—	—	0	1	0	0	0	1	0	3	0	1	6	2	3	1	2	4	1	0	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
22	1	0	0	0	1	2	2	3	5	3	10	8	4	1	5	1	2	0	0	0	1	0	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
23	2	0	1	1	0	2	2	3	0	3	9	6	6	13	8	6	7	7	6	1	3	3	0	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100
24	3	0	0	3	2	4	4	8	16	14	14	13	9	6	7	10	8	6	2	1	5	0	1	4	2	2	0	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	150
25	1	0	0	2	2	4	4	5	10	11	20	20	21	12	20	10	17	10	6	7	7	0	1	5	11	6	2	2	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	225
26	2	1	0	8	3	8	6	1	30	13	26	16	15	11	17	19	12	10	8	8	12	13	2	4	2	8	2	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	250
27	4	0	1	5	0	20	10	30	36	30	53	47	40	30	11	47	36	53	17	23	23	18	5	11	8	2	0	0	1	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	375
28	2	0	0	3	2	14	11	18	30	22	41	25	36	29	58	30	39	20	16	16	27	29	6	5	8	4	0	1	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	475
29	5	1	3	10	9	11	20	26	33	41	70	65	65	55	75	78	79	31	41	42	44	46	26	27	23	19	0	5	5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1000
30	3	1	0	5	9	13	20	18	47	28	65	54	63	58	73	77	57	69	40	48	66	65	52	38	30	27	14	18	5	8	6	2	0	2	3	1	—	—	—	—	—	—	—	—	1025
31	1	2	1	4	6	9	21	15	40	30	65	68	50	62	28	96	42	73	53	67	70	69	42	39	53	29	14	18	3	9	3	2	1	2	1	1	—	—	—	—	—	—	—	—	1175
32	0	3	5	1	15	5	12	11	50	22	55	56	62	86	103	111	100	92	84	86	72	85	51	47	45	23	11	14	17	10	9	6	0	1	3	2	0	0	0	1	—	—	—	—	1350
33	0	1	2	3	4	1	20	17	41	38	75	76	89	108	94	121	130	110	98	109	113	117	61	56	70	72	24	21	6	19	11	0	1	4	3	6	0	0	0	0	—	—	—	—	1700
34	0	8	3	1	9	10	10	20	47	46	75	77	56	111	123	101	160	161	137	111	132	144	88	77	86	80	27	20	21	15	7	3	1	5	0	6	1	2	4	0	—	—	—	—	2300
35	1	0	1	2	7	8	11	22	36	39	70	57	52	100	119	160	158	17	170	164	178	190	122	104	126	81	42	48	23	20	12	0	5	7	0	3	0	1	0	0	—	—	—	—	2350
36	0	1	2	0	7	5	10	10	33	20	51	84	73	99	113	164	171	200	196	209	220	209	183	164	143	136	80	87	11	11	27	7	8	15	12	6	9	6	5	8	—	—	—	—	2800
37	0	1	4	0	3	2	6	5	17	15	41	40	39	54	65	137	175	166	186	229	213	266	205	240	181	182	96	84	41	41	29	15	6	11	10	8	5	4	5	8	—	—	—	—	2775
38	0	3	1	0	1	1	7	5	26	18	42	45	31	83	102	171	141	250	220	253	268	321	258	260	250	206	154	138	70	87	61	47	17	19	22	12	6	6	2	1	—	—	—	—	3675
39	1	1	0	1	3	8	7	12	26	27	44	53	70	72	118	142	178	220	217	248	266	354	391	287	263	305	153	164	80	81	58	20	13	20	3	2	2	7	1	2	1	—	—	—	3750
40	0	3	0	0	3	6	6	15	15	20	49	55	60	85	117	133	180	252	253	331	361	382	353	294	329	293	202	177	106	88	80	29	19	27	16	8	3	6	0	0	2	—	—	—	4100
41	0	0	0	0	0	1	1	5	5	6	26	22	42	51	61	92	120	183	205	258	264	356	352	310	300	376	211	257	142	107	90	43	34	23	27	21	8	10	10	12	0	—	—	—	4000
42	1	0	0	1	4	1	5	4	11	9	27	33	29	47	55	77	101	164	140	260	261	294	310	304	318	335	271	252	191	140	131	79	37	42	31	21	19	20	21	20	1	0	0	1	4050
43	—	—	—	—	0	5	11	2	9	0	26	30	50	43	50	88	134	236	121	250	281	329	351	328	354	334	260	232	153	143	122	85	56	53	29	32	9	9	5	14	0	0	0	0	4525
44	—	—	—	—	2	8	8	5	2	4	13	27	29	28	52	60	81	136	132	206	255	223	278	375	304	416	311	399	235	216	171	81	54	53	43	49	53	10	1	11	8	0	0	6	4375
45	—	—	—	—	—	0	2	3	0	0	6	21	14	11	24	27	12	80	90	164	158	202	214	271	280	311	275	271	250	219	166	121	72	63	25	26	22	23	14	11	5	0	0	5	3850
46	—	—	—	—	—	0	3	1	0	—	5	18	13	24	21	29	46	87	84	138	155	171	207	255	282	338	271	290	246	210	170	185	70	76	29	43	23	10	5	7	2	0	0	1	3425
47	—	—	—	—	—	1	0	1	1	1	1	6	3	17	6	21	30	14	11	75	68	109	112	131	185	253	220	240	235	191	178	140	79	117	86	43	55	35	20	22	5	0	0	5	2825
48	—	—	—	—	—	—	—	1	0	2	4	6	9	10	19	15	20	11	14	57	81	85	107	146	149	219	218	210	194	184	190	150	58	57	25	37	13	16	6	13	1	0	0	2	2425
49	—	—	—	—	—	—	—	—	—	—	—	0	3	9	11	7	24	27	20	61	68	60	99	104	122	171	166	170	173	190	189	172	85	115	61	57	28	26	17	13	1	0	0	0	2225
50	—	—	—	—	—	—	—	—	—	—	—	2	2	0	9	3	9	7	15	41	20	39	42	73	45	181	121	135	140	160	172	138	75	120	58	45	18	29	8	15	1	0	0	1	700
51	—	—	—	—	—	—	—	—	—	—	—	0	1	0	—	1	5	8	6	17	12	10	41	37	58	64	52	70	79	56	96	79	42	72	40	44	25	19	12	5	0	0	0	0	950
52	—	—	—	—	—	—	—	—	—	—	—	2	2	1	3	5	7	13	14	18	20	21	28	12	33	53	68	70	117	87	113	120	72	92	56	42	20	33	18	13	0	0	0	0	1200
53	—	—	—	—	—	—	—	—	—	—	—	0	1	3	3	5	3	13	10	22	8	18	23	31	23	48	35	50	66	28	61	52	40	56	50	50	35	15	20	13	1	0	0	0	900
54	—	—	—	—	—	—	—	—	—	—	—	1	1	5	6	1	3	6	6	12	2	8	21	21	22	49	34	45	45	37	57	43	32	55	50	24	23	8	12	9	1	0	0	0	625
55	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	1	0	2	3	6	3	3	8	13	0	23	22	33	38	13	16	18	28	20	35	26	10	7	12	6	1	0	0	1	350
56	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	1	4	6	4	6	7	8	10	10	8	13	23	30	35	16	20	23	10	25	15	8	7	4	6	6	0	0	0	1	300
57	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	4	0	5	5	2	1	0	10	11	5	1	14	6	20	6	17	9	19	16	20	12	12	6	14	12	—	—	—	—	225
58	—	—	—	—	—	—	—	—	—	—	—	—	—	2	0	3	0	6	6	1	2	0	12	10	12	11	14	7	22	12	13	15	5	18	16	8	5	6	12	6	—	—	—	—	225
59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	0	1	0	5	2	2	3	1	1	7	0	0	1	1	1	0	—	—	—	—	—	—	35
60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	—	—	0
61	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	—	—	0
62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0	6	5	1	7	3	0	1	0	0	0	0	0	—	—	—	—	—	—	—	25
Totals	25	25	25	50	100	150	225	250	375	475	1000	1025	1175	1350	1700	2300	2350	2800	2775	3675	3750	4100	4000	4050	4525	4375	3850	3425	2825	2425	2225	1700	950	1200	900	625	350	300	225	225	35	0	0	25	67000

TABLE XX.—English Onion. Great Hampden.

Number of Votes in First Trial.

[To face p. 334.

Number of Votes in Second Trial.

	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	Totals.
18		—	5	1	0	2	2	3	0							—	—	—	—	—	—	—							—	—	—	—	—	—	—	—	—	8
19	—	—	0	0	0	1	1	2	3	1	2						—		—	—						—	—	—	—	—	—	—	—	—	—	—	—	10
20	2	0	1	4	3	3	3	6	5	0	0	1	—	—	—						—		—		—	—	—	—	—	—	—			—			—	31
21	1	0	4	6	2	5	9	11	7	7	0	1	3	0	2	1	0	2	0	0	0	1	0	0	0	1	—	—										65
22	0	0	3	3	2	6	17	16	23	15	15	10	4	4	2	3	0	1		0	0	0	0	0	0	0										—	—	124
23	2	1	5	3	6	8	18	27	27	16	13	11	10	8	5	0	3	3	0	1	1	1	0	0	0	0			—	—	—	—	—	—	—		—	164
24	2	1	8	0	17	18	14	31	28	23	30	10	10	3	5	8	0	2	1	0	0	0	0	0	0	0	—	—	—									208
25	2	2	6	14	16	21	31	32	63	30	33	23	17	12	0	2	0	7	0	1	1	1	0	0	0	1							—			—		323
26	—	3	5	7	23	27	29	42	64	62	12	51	31	21	15	16	2	10	4	3	1	1	0	0	0	0				—	—	—	—	—	—	—	—	481
27		1	0	7	15	16	33	55	62	62	37	45	50	55	8	15	18	16	16	5	2	3	0	0	5	1	—		—	—		—		—	—	—	—	445
28	—	4	0	0	13	13	30	35	18	57	59	40	35	25	27	12	10	10	11	5	6	0		1	0	0	—	—	—						—	—	—	370
29	—	—	1	1	10	14	15	25	51	45	40	58	35	33	15	14	13	9	11	5	3	2	0	5	2	0												421
30				5	8	10	10	15	31	39	38	58	40	23	27	17	20	19	15	13	4	5	1	0	1	0				—	—	—						356
31	—	—	—	5	4	3	6	2	21	33	29	33	35	30	13	16	11	8	12	6	1	3	3	1	0	0	—		—	—	—	—	—	—	—	—	—	275
32	—	—	—	2	2	3	2	9	15	15	17	16	27	13	24	[illegible]	22	23	15	8	7	6	3	1		0		—					—	—	—	—	—	237
33				1	1	0	3	2	16	15	12	13	7	16	1	[illegible]	11	10	17	10	5	0	5	2	3	2												207
34			—	0	0	3	0	6	3	15	10	15	20	1	24	11	20	15	8	12	8	4	8	7	3	1	2	2	0	0	0	0	0	0	0	0	0	207
35		—		3	1	2	2	7	10	16	10	9	20	2	23	10	15	[illegible]	14	12	13	4	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	195
36				5		0	1	0	2	10	11		13	12	15	17	8	14	10	12	5	9	2	8	9	4	1	0	1	0	0	0	1	0	0	0	0	187
37		—	—	0	0	1	0	1	5	8	8	8	15	6	2	10	12	12	19	14	14	4	8	3	8	2	0	0	0	0	0	0	0	0	0	0	0	152
38	—	—		0	0		0	1	1	2	0	2	4	4	7	15	8	13	15	14	14	13	7	0	5	7	3	1	0	0	0	0	0	0	0	0	1	152
39				1	0	1	0	1	1	3	0	2	3	2	3	10	4	4	9	4	13	1	9	2	9	3	1	0	0	0	0	0	0	0	0	0	0	87
40			—	0	0	0	0	0	0	0		0	4	3	5	5	3	2	5	8	7	1	2	2	2	0	1	0	0	0	0	0	0	0	0	0	0	42
41	—	—		0	0	0	0	0	0	0	1	2	0	1	1	3	2	0	8	3	6	2	2	4	2	2	3	0	2	0	0	0	2	0	0	0	0	45
42	—	—		0	0	0	0	0	0	3	0	2	1	0	1	2	3	3	0	8	2	3	3	2	1	1	1	0	0	0	0	0	0	0	0	0	0	60
43				1	0	0	0	1	0		0	0	0	0	0	3	1	2	1	4	7	3	0	2	1	2	1	0	0	0	0	0	0	0	0	0	0	40
44	—		—		—		—				—	—	—			1	2	0		0	2	1	1	3	1	1	0	1	1	0	0	0	1	0	0	0	1	18
45	—	—		—	—			—	—					—	—		2	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	5
46						—	—	—	—	—							0	0	1	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0	0	0	0	5
47			—			—	—				—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	—		—		—									—	—		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	—	—		—	—			—	—	—							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50				—		—		—	—	—	—	—	—			—	0	0	1	0	0	0	0	3	0	0	1	0	1	0	0	0	0	0	0	0	0	5
51			—			—	—				—		—	—	—		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	—	—	—	—	—		—	—	—					—	—		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53		—		—	—			—	—	—		—				—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54					—	—	—		—	—	—	—	—			—	3	0	0	0	1	0	0	0	0	0	1		0	0	0	0	0	0	0	0	0	5
Totals	9	10	31	68	121	164	208	323	481	445	370	421	356	281	237	207	207	195	187	152	152	87	48	45	60	40	18	5	5	0	0	0	5	0	0	0	5	3321

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TABLE XXII. Mushroom Gill-indices.

Index of First Gill.

Index of Second Gill.

	1·5495.	1·6495.	1·7495.	1·8495.	1·9495.	2·0495.	2·1495.	2·2495.	2·3495.	2·4495.	2·5495.	2·6495.	2·7495.	2·8495.	2·9495.	3·0495.	3·1495.	3·2495.	3·3495.	3·4495.	3·5495.	3·6495.	3·7495.	3·8495.	3·9495.	4·0495.	4·1495.	4·2495.	4·3495.	4·4495.	4·5495.	4·6495.	4·7495.	4·8495.	4·9495.	5·0495.	5·1495.	5·2495.	5·3495.	5·4495.	5·5495.	5·6495.	Totals.
1·5495	—	—	—	—	1	1	0	2	1	1	0	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
1·6495	—	—	1	2	1	2	2	1	0	0	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
1·7495	—	4	2	3	7	6	10	5	1	2	0	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36
1·8495	—	2	2	8	5	12	9	6	3	4	5	2	2	0	0	0	0	0	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	63
1·9495	1	3	7	5	14	18	16	11	20	7	5	4	3	0	1	3	0	0	1	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	117
2·0495	1	3	6	12	15	10	26	25	21	8	12	3	0	1	1	2	0	1	0	3	1	0	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	162
2·1495	0	2	10	9	16	20	30	35	35	26	29	8	16	12	7	0	2	3	2	4	2	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	270
2·2495	2	1	5	6	11	25	35	40	42	25	44	28	33	15	8	6	7	6	1	3	3	0	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	351
2·3495	1	0	1	3	20	21	35	42	49	68	72	47	44	29	16	16	6	5	7	4	3	1	2	1	1	0	0	0	1	1	—	—	—	—	—	—	—	—	—	—	—	—	485
2·4495	1	0	2	4	7	9	36	38	68	68	102	75	69	79	38	46	27	13	13	7	13	8	6	0	3	0	3	0	1	0	—	—	—	—	—	—	—	—	—	—	—	—	702
2·5495	0	0	0	0	5	12	29	44	72	102	124	124	104	80	47	50	32	17	15	11	9	5	3	1	4	5	3	0	0	0	0	0	0	0	0	0	0	0	0	1			909
2·6495	2	0	0	3	4	3	8	25	47	76	121	135	105	64	50	12	36	17	10	4	11	2	2	4	7	0	2	0	3	4	0	1	0	0	0	0	0	0	0	2			810
2·7495	1	0	0	2	3	6	16	32	44	62	104	100	112	96	76	54	69	29	23	18	54	3	13	1	8	0	1	0	3	2	0	1	0	1	0	0	0	0	0	1	—	—	900
2·8495	—	—	—	0	0	1	12	16	29	79	90	84	96	98	71	63	60	26	31	16	23	9	9	3	8	0	3	2	5	2	0	0	0	1	0	0	0	0	0	1	—	—	887
2·9495	—	—	—	0	1	1	7	8	15	36	47	50	78	74	58	56	50	27	43	22	17	10	13	5	8	0	2	0	0	1	0	3	0	1	0	0	0	0	0	1	—	—	657
3·0495	—	—	—	0	3	2	5	6	15	46	50	42	54	63	68	44	55	33	25	20	29	16	16	5	7	2	4	0	0	3	0	0	0	0	0	0	0	0	0	0			694
3·1495	—	—	—	0	0	0	2	7	6	27	33	36	69	60	50	55	48	31	40	30	22	12	8	3	7	0	1	0	6	0	0	3	7	1	0	1	0	1	0	1	0	1	558
3·2495	—	—	—	0	0	1	3	6	5	13	17	17	29	26	27	32	31	18	20	23	20	13	21	10	4	1	2	4	2	1	0	3	0	1	0	0	0	0	0	0	0	1	351
3·3495	—	—	—	0	1	0	2	1	7	13	15	10	23	34	43	25	40	20	26	22	42	13	12	9	6	0	4	0	4	2	0	3	1	3	0	1	0	1	0	1	0	1	357
3·4495	—	—	—	1	0	3	4	3	1	7	11	4	16	16	22	20	26	23	22	22	16	7	12	10	5	3	6	3	0	4	0	2	1	2	0	1	0	1	0	1	0	0	270
3·5495	—	—	—	—	—	1	2	3	3	12	9	17	24	20	44	29	22	20	42	16	56	15	24	7	2	3	11	2	0	2	0	3	0	1	0	0	0	0	0	0	0	0	357
3·6495	—	—	—	—	—	0	0	0	1	3	5	1	3	9	10	16	12	18	13	7	15	4	16	4	2	0	1	0	3	2	0	0	0	1	0	0	0	0	0	0	0	0	135
3·7495	—	—	—	—	—	2	1	3	2	6	3	2	15	9	23	10	8	21	12	12	28	10	10	7	1	0	2	6	0	2	0	2	0	1	0	0	0	0	0	0	0	0	150
3·8495	—	—	—	—	—	—	—	—	1	0	1	4	1	3	6	5	5	10	9	10	7	4	7	4	2	0	6	3	0	1	0	1	0	1	0	0	0	0	0	0	0	0	80
3·9495	—	—	—	—	—	—	—	—	1	3	4	7	3	3	3	7	7	4	6	5	2	2	1	3	2	0	5	1	0	3	0	2	2	1	0	2	0	2	0	0	0	2	81
4·0495	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	2	0	1	0	2	2	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	9
4·1495	—	—	—	—	—	—	—	—	0	2	3	3	1	2	2	4	1	2	4	6	11	1	2	6	5	1	12	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	73
4·2495	—	—	—	—	—	—	—	—	0	0	0	0	0	2	0	0	0	4	0	3	2	0	6	3	1	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
4·3495	—	—	—	—	—	—	—	—	1	1	0	2	1	5	0	0	6	2	4	0	0	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	27
4·4495	—	—	—	—	—	—	—	—	1	0	0	4	2	2	1	3	0	1	2	4	2	2	2	1	3	1	1	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	36
4·5495	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4·6495	—	—	—	—	—	—	—	—	—	—	0	1	1	0	3	0	2	3	3	2	3	0	1	1	2	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	1	27
4·7495	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	1	0	1	1	0	0	0	0	2	0	0	0	0	0	0	3	0	0	0	2	0	1	0	0	0	1	9
4·8495	—	—	—	—	—	—	—	—	—	—	0	0	1	1	1	0	1	1	3	2	1	1	1	1	1	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	18
4·9495	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5·0495	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	1	0	1	1	0	0	0	0	5	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	1	9
5·1495	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5·2495	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	1	0	1	1	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	9
5·3495	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	0
5·4495	—	—	—	—	—	—	—	—	—	—	1	2	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	9
5·5495	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	0
5·6495	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	1	0	1	—	—	—	—	9
Totals ...	9	9	36	63	117	162	270	351	490	702	908	810	900	537	657	694	668	361	387	279	357	135	180	90	81	9	72	27	27	36	0	27	9	18	0	0	0	9	0	9	0	3	8690

N.B.—1·5495 denotes the group formed of all indices from 1·4995 to 1·5995, or since the ratio, length/breadth, was formed to three decimal places, all values of the index from 1·500 to 1·599 inclusive.