I. QUANTITATIVE INHERITANCE IN TOMATO FRUITS

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II. A PRELIMINARY RECORD OF THE LICHENS OF MANITOBA

BY

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QUANTITATIVE INHERITANCE IN TOMATO FRUITS

I. Introduction

Not a great deal of work has been done on the inheritance of size in tomatoes. The following brief reviews summarize what are, as far as can be ascertained, the most important papers on the subject.

The earliest paper considered is that of Price and Drinkard (12) which deals with inheritance of shape and color of fruit, and foliage characters. A relation of 75 dominant to 25 recessive was found in crosses between varieties with pear-shaped fruit and varieties with round-shaped fruit, the first generation bearing fruits all round or oval. The F2 generation plants were distributed as follows: 84 % roundish fruit (without neck) and 16 % pear-shaped. A normal ratio of 75 % to 25 % was found also for red and yellow fruits respectively in the color crosses, and the same in crosses between bright red fruits and pink fruits.

Frimmel (2) published in 1922 the results of an investigation on the inheritance of fruit-size and shape in the tomato. He found size-characters rather difficult to work with from the genetic standpoint. He used various classes for crossing purposes, based on weight of fruits, e.g. weight 0 - 5 grams, 5 - 15, 15 - 25 and so forth, up

to 195 - 205 grams. Burbank's Preserving, a small-fruited variety of size 0 - 5 grams, was crossed with 30 other varieties. He found intermediacy in the F1 with respect to the two-loculed condition. He found also that small-fruited tomatoes crossed with large-fruited types gave only small-fruited tomatoes in the F1 generation, although the size of the fruit was somewhat greater than that of the small-fruited parent.

Wellington (16) deals with a comparison between dwarf and standard sorts, productivity, earliness and other economic characters being taken into consideration. The only conclusion of interest to the present investigation is that the F1 crosses produce smaller fruits on the average than the larger parent, and also than the mean of the two parents.

Groth (3) in Table 30, page 50, gives the diameters in millimeters of the F2 populations of a number of size-crosses, of which one is a cross between Plum and Ponderosa. The size-distribution of 158 individuals fruits is tabulated. Three modes appear, one at 32 - 33 mm. diameter (14 variates), one at 38 - 39 and one at 42 - 43 (13 each). It is presumed that a larger number of measurements would have simplified the modal value. Comparison will be found elsewhere between this distribution and the distribution in the present investigation. In a size-cross between Currant and Peach Groth does not find the parental

sizes reappearing in the F2 in ratios that can be interpreted as being due to a single pair of factors. Without going into details, it will suffice to say that Groth does not find the multiple factor hypothesis satisfactory in the Plum - Ponderosa crosses. He finds the number of locules per ovary to be correlated with the diameter, and the shape of the fruit likewise to be correlated with the locule number.

Perry (11) made size-crosses between Yellow Pear and Red Currant and between Livingston's Beauty and Yellow Pear, and carried his results to the F3 generation. The average weight of the first ten fruits was compared with the average weight of ten fruits taken in the latter part of the fruit-bearing period. It was found that the fruits ripening first were not larger than those ripening later. The average weight of the Yellow Pear parent used in the crosses varied from 12.7 to 19.2 grams, in 4 different plants, and the Red Currant in 2 different plants from .62 to .66 grams. The F1 of this cross was found to be intermediate in size, the average being 2.76 grams. Perry found a marked agreement between the average weight of the F1 and the geometrical mean between the two parents. He quotes Groth as finding that the size of F1 fruits in respect to diameters represents the geometric mean between the two parents. He also quotes Bruce as having obtained like results with tomatoes. Perry finds that in general it is indicated that when two variates are

crossed, differing greatly in fruit-size, that of one parent being two, three or more times that of the other, the resulting F1 fruit-size will be nearer the geometrical than the arithmetical mean, but that when 2 parents similar in fruit-size are crossed, the size of fruit in the F1 will approach more nearly the arithmetical than the geometrical mean. He found in his F2 generation of 44 plants the segregation of size-characters to be so incomplete as to warrant the assumption of at least 4 size-factors. The small size-factors of the Red Currant seem to be incompletely dominant over the large size-factors of the Yellow Pear. Finally he finds the average fruit-size of the F2 not to exceed, and to be even slightly less than the average fruit-size of the F1 generation.

Warren (14) deals with the heredity of fruit-shape in the tomato. It need be mentioned here only that the depth of fruits is considered to be due to complementary factors called A and B.

II. Material and Methods.

The problem involves a study of the inheritance of the quantitative characters expressed by fruit-size in terms of weight and diameter, and by the number of locules per ovary.

The crosses were made in the summer of 1925 in the experimental garden of the University. In all, seven crosses were made, of which results were obtained through the F1 and F2 generations. The crosses in question were as follows:

Hybrid No.	I.	Golden Ponderosa	X	Red Ponderosa
" "	II.	Red Ponderosa	X	Golden Ponderosa
" "	III.	Golden Ponderosa	X	Yellow Plum
" "	IV.	Yellow Plum	X	Golden Ponderosa
" "	VI.	Red Cherry	X	Yellow Plum
" "	VII.	Golden Ponderosa	X	Red Cherry
" "	VIII.	Red Ponderosa	X	Yellow Plum

The hybrid fruits produced in the fall of 1925 were harvested in September. The seeds were extracted by being scraped out with the juice and spread upon blotting paper, to which they firmly adhered when dry. On October 1st, seeds, selected at random from each particular hybrid, were planted in duplicate pots, about 6 in a pot. These were kept in the greenhouse, and as the seedlings appeared and required it, they were transplanted to larger pots.

Owing to limited greenhouse space, the F1 plants grown to maturity were of necessity limited, the number being confined to 6 for each of the 7 hybrids.

By December 9th the flower buds had appeared on many of the plants, and by December 11th there were twelve blossoms. From this time on, as each blossom appeared it was carefully self-pollinated, using sterile forceps, and each was wrapped and tagged immediately.

By January 15th there were young fruits developing on almost all the plants; on February 17th the first ripe fruit was picked, many others being almost ripe. As each fruit ripened it was gathered, its weight and volume carefully taken, its horizontal diameter measured in cm., the number of locules counted, and the number of seeds determined. The juice containing the seeds was crushed out on to blotters and dried, the blotters being carefully labelled with the plant and fruit number and filed away for future use. Careful notes were made as to the type of fruits produced by each plant, with respect to size, shape and color.

In November, 1925, duplicate pots as before were planted with the seeds of the respective parents, and the seedlings later transplanted, as in the case of the hybrids. Of these, only the small-fruited parents survived; the large-fruited types, which were later in maturing, were destroyed through an accident in the greenhouse.

Toward the end of March, 1926, seeds of the F1 fruits were planted in pots in the greenhouse, each pot being carefully labelled. About 30 seedlings of each hybrid were ready for transplanting to the field near the end of May. These were planted in the garden of the Agricultural College, in long rows 4 feet apart, the plants themselves being 2 feet apart. Our thanks should be expressed here to Professor F. W. Brodrick of the Department of Horticulture for the courtesy of the loan of the experimental ground.

The blossoms as they appeared were bagged and tagged with the hybrid and plant number. The ripe fruits were picked toward the first of September, from twenty to thirty representative fruits being taken from each plant and placed in a large paper bag. The number of plants used for measurements for each hybrid varied between 10 and 31, with an average of about 15. Fruits to the number of about 10, of average size and shape, were selected from each plant, and the weight in grams, volume in cubic centimeters, diameter in centimeters and the number of locules were all carefully determined. The seeds were counted of all the fruits of one plant of each type within each hybrid group.

After accumulation of the data referred to above, and preliminary work upon determining the Mendelian ratios in the F2 generation, it was found necessary, on account of the relatively small number of plants involved in each cross, to assemble together the hybrids in which the crosses were of the same size-types, thus bringing together in a single series for purposes of calculation Hybrids III, IV, and VIII. Hybrids VI and VII are dealt with separately.

Summaries from the original data for both the F1 and the F2 generations, from which the tables for all the hybrids were compiled, are to be found in Tables 5 to 12.

Hybrids III, IV and VIII are all crosses involving the Ponderosa type of parent and the Yellow Plum type. Two hybrids, III and IV, involve Golden Ponderosa, and VIII Red Ponderosa. However, the differences between the Red and Golden Ponderosa are merely differences in color, and not of size or form of the fruits. They can therefore be combined in the same series for the purpose in hand.

Further, since the number of plants in the F2 generation of the crosses was found to be too small to admit of calculating a Mendelian segregation, it was decided to assemble them in a single biometric series; to plot a frequency curve for the total F2 generation, on the basis of the weights of fruits, and to plot the graphs for the number of locules per ovary and the diameter of the

~~of the~~ fruits across this frequency curve.

It may be stated here that the data for volume so closely duplicated the data for weight that it was unnecessary to take volume into consideration in calculating the results. This is no doubt due to the fact that the high content of water in the tomato fruit composition renders the volume in centimeters about equivalent to the weight in grams.

After determining the mean of weights, assuming the weight factor to represent one or more major factors for size, it was decided to regard, for experimental purposes, the frequency graph as representing an F2 segregation toward the 2 parental types (maximum and minimum regions of the graph) presumeably $\frac{1}{4}$ each, with the central $\frac{1}{2}$ area of the graph representing the 50 % Dr individuals of the F2, on the hypothesis of a possible single factor for size. The $\frac{1}{4}$ maximum area of the graph then represents hypothetically a recessive group, rr, constituting about 25 % of the whole; the minimum $\frac{1}{4}$ area a possible DD class of about 25 %, on the basis of a single factor for size.

The means for number of locules per ovary and diameters were also determined, and a similar division of these graphs showed their mid-distribution (mid $\frac{1}{2}$ area) to approximate closely to the mid $\frac{1}{2}$ area for weights, thus demonstrating the correctness of the method adopted of selecting weight as a major or determining size-factor,

which is further justified by the fact that it is easily and more accurately determined than almost any other size-factor possible to be considered.

It may therefore be taken as stated that the attempt herein constitutes an effort to investigate a possible Mendelian segregation in the F2 by biometric methods, where the number of individual plants is too small to allow normal segregation, but where the data involved are sufficient to admit of biometric handling. The frequency graph for weights (Graph I) is a normal frequency curve, and therefore, so far as biometric methods can be legitimately employed in the interpretation of a possible Mendelian segregation, the present data are available in this manner.

The further details with regard to the interpretation of the data involved in the graphs, and their application, are dealt with in the following section.

III. Discussion of the Experimental Data.

(1). Hybrids Nos. III, IV and VIII.

The data will now be discussed for the following crosses: Golden Ponderosa X Yellow Plum (No. III), Yellow Plum X Golden Ponderosa (No. IV), and Red Ponderosa X Yellow Plum (No. VIII).

In these crosses the total number of plants involved in the F1 generations is 17, the number of fruits measured being 84. In the F2 generation the number of plants involved is 64 and the number of fruits measured 625.

The graph based on the weights of fruits (Graph 1) of the above hybrids is a normal frequency curve of quite the usual biological type, having the mode at the 30 - 39 g. class amd the mean at 41.8. Now by dividing the graph into four equal parts on either side of the mean, we have an area represented on the abscissa line from 32.8 g. to 50.8 g. as the mid-region, in which 31 individual plants are located. The area from 32.8 minus is the region of lowest values, in which 19 individual plants are located, and from 50.8 plus is the region of highest values, in which 14 plants are located. We have thus two quarters or one-half of the total area grouped about the mean, and one-quarter each of the area of the graph representing the

highest and lowest values respectively, expressed as the weight of fruits in grams. Manifestly, in a Mendelian segregation in the F2, if it were to be plotted biometrically, the one-quarter number of large-fruited individuals approximating to the large-fruited parental type would be found in the upper one-quarter area of the frequency curve, while the approximate twenty-five per cent of individuals segregating toward the small-fruited parental type would be found in the lower one-quarter area of the graph, while the central region, comprising the individuals grouped about the mean value would be most apt to include the majority of the individuals in the Mendelian segregation (approximately one-half), if the segregation of the latter was related to a single size-factor, and if the hybrid was intermediate, instead of representing parental dominance. (See Table 1.)

It is possible to compare the F1 generation in the case of these hybrids with the Yellow Plum parent, but not with the Ponderosa parent directly, since the plants of the latter which were depended upon to furnish the data for the fruits were destroyed through an accident in the greenhouse. However, in view of the fact that a color cross was made between Red Ponderosa and Yellow Ponderosa and reciprocally, in which the weight relations of the

two parents are the same, the only difference being the color factor, it was decided to use the F1 data from this cross as representing the data for weight, diameter, etc., of the Ponderosa parent. These data appear as follows:

	Yellow Plum parent	Ponderosa parent	F1
Weight (g.)	9.2	165.7	21.3
Diameter (cm.)	2.4	7.3	3.4
No. locules	2.0	9.6	3.1

The percentage difference between the F1 and the respective parents is then:

Weight	- 131.1	+ 677
Diameter	- 41.7	+ 114
No. locules	- 55	+ 209

It thus appears, so far as can be calculated from the available data, that there is no intermediacy in the F1 as to the three characters of weight, diameter and number of locules per ovary.

From the segregation series in the F2 of these hybrids, Nos. III, IV and VIII, the maximum values for weight, diameter and number of locules are as follows:

	III	IV	VIII	Group Av.
Highest wt.	110.6	83.4	57.6	83.8
" Dia.	7.6	6.6	5.3	6.5
" no. loc.	7.8	6.8	5.3	6.6

It is manifest that in no case will the maximum values for the fruits in the F2 be likely to exceed the maximum values for the fruits in the large or Ponderosa parent.

Calculating the percentage differences between the average values for the fruits of the F1 generation and the maximum values for the extractives of the F2, these appear as in the following table:

	F1 Av.	Highest F2 extractives	Excess %
Weight	21.3	83.8	293.4%
Diameter	3.4	6.5	91.2%
No. locules	3.1	6.6	112.9%

Now, examining the frequency graph for the F2 we find that the total number of plants in the approximate 25 per cent maximum range of the graph comprising those from the 50 - 59 class up, is 14, or 21.9 % of the total number of 64 plants. Assuming the values for this group rather than the maximum individual measurements, as representative of the values of the fruits for the F2 segregation toward the large parent, we have the following as the averages for the weight, diameter and number of locules per ovary for the members of this group (for actual data see Table 2):

	F2 Av. of max. ¼ class	Excess over F1
Weight	70.4	230 %
Diameter	4.5	32 %
No. locules	5.9	90 %

On comparing the percentage excess of the maximum individuals in the F2 over the F1, on the one hand, with the percentage excess of the average of the maximum ¼ class of the F2 on the other, assuming the latter to represent

more nearly the large parental values, we have the following table:

	Percentage excess of F2 over F1	
	Max. ind. values	Max. ¼ class value
Weight	293.4	230
Diameter	91.2	32
No. locules	112.9	90

We may next consider the differences found between the Yellow Plum (small) parental values and the F1, on the one hand, and the values of the maximum ¼ class of the F2 together with that of the Ponderosa parent (calculated) in comparison with the F1, on the other.

	F1	Yell. Plum	% - F1	Pond	% + F1	Max. ¼ F2	% + F1
Wt.	21.3	9.1	131.1	165.7	677	70.4	230
Dia.	3.4	2.4	41.7	7.3	114	4.5	32
No. loc.	3.1	2.0	55.0	9.6	209	5.9	90

It is thus clear that even if we take the mean of the percentage number of individuals (21.9 %) which occupy the upper or maximum ¼ class of the F2 as representing the approximate mean values for the Ponderosa parent, assuming a single factor for size, it appears that with respect to weight and number of locules the percentage excess of this class over the F1 is much greater than the minus difference of the Yellow Plum parent below the F1. If we take the mean F1 value of the Ponderosa X Ponderosa crosses, as representing the Ponderosa parental values, the difference is very much greater. This indicates that the swing of the F2 generation never approximates in any large segregate to the size of the large parent.

The fact is now fairly evident that instead of a single factor for small size dominance in the F1, there is a possible complex of factors with perhaps also an inhibiting factor from the Ponderosa parent, operating to limit the potential of the small size factor or factors in the Yellow Plum parent. The fact that we do not get either small size dominance or intermediacy in the F1, but a stage between these, indicates a more complex situation than the operation of a single factor for size could bring about. The absence of size-classes in the F2 to represent size segregation according to a theory of multiple factors may be due on the one hand to insufficient numbers, or on the other, it may indicate the possibility of the operation of complementary factors, e.g., a factor for small size inheritance from the Yellow Plum parent and an inhibiting factor from the Ponderosa parent limiting its operation.

We may now take the individuals of the lower or minimum F2 class (32.8 g. and less) numbering 19, or 29.6 % of the total, and compare them with the F1. Considering the comparatively small number of plants involved (64), this will fairly well represent a possible minimum segregation of 25 % (Table 2). If we assume again a single factor for size to be concerned, we have the following data for the values of the individuals in

this group:

Av. Wt. 24.7
Av. Dia. 3.4
Av. no. loc. 3.1

Comparing these values with the values of the F1, as in the maximum class, we have as follows:

	F1	Min. ¼ F2	Excess of Min. ¼ over F1
Weight	21.3	24.7	15 %
Diameter	3.4	3.4	0
No. locules	3.1	3.1	0

From this table it is evident that even a presumed minimum segregation of F2 individuals falls as a matter of fact above the F1, rather than below it. The explanation of this is not exactly clear, and may be due to the small number of plants involved.

Considering next the mid-class, comprising 31 plants with weights of fruits between 32.8 g. and 50.8 g. grouped equally about the mean of 41.8 g., we have the following data in comparison with the two parents and the F1 generation, assuming temporarily that this mid-class may represent a Dr condition for size (weight) of fruits where a single size factor is concerned (Table 2)

	Yell. Plum parent	Pond. parent	Hypothetical F1	Actual F1	F2 Mid-class
Wt.	9.2	165.7	82.9	21.3	34.3
Dia.	2.4	7.3	4.8	3.4	3.5
No. loc.	2.0	9.6	5.3	3.1	3.4

Mean of the F1 values of the two parents.

	Difference of Mid-class (50%) from Hypothetical F1	Actual F1
Weight	- 50.6 g. or - 58.6 %	+13.0 g. or + 61 %
Diameter	- 1.3 g. or - 18.6 %	+ .1 g. or + 2.9 %
No. locules	- 1.9 g. or - 35.8 %	+ .3 g. or + 9.7 %

It is thus clear that the mid-class of the F2 does not represent a Dr condition, since it is in excess of the actual F1 in all three factors considered, and extremely so in respect to weight. It is also clear that the mid-class does not represent a hypothetical F1 condition which would be intermediate between the two parents, since it is markedly below this. It is therefore impossible to consider from the data of the F2 that we are dealing with a single size-factor if the method of estimation may be admitted as correct for working purposes.

It thus appears from consideration of all three classes assumed in the F2 that there are no reasonable grounds for considering a single factor for size as operative. Had such been the case it is probable that the actual segregation in the F2 would have given a grouping of individuals which would at least have demonstrated a probable Dr condition for the mid-group.

Graph 2 comprises a graphing of the data for the quantitative relation between the F1 generation and the Yellow Plum and Ponderosa parents, with respect to weight, and of the F2 generation with respect to the same factor, for the three principal areas of the frequency polygon, the mid 50%, the lower 25% and the upper 25%. The graph shows distinctly that while the mean of the F1 generation (21.3 g.) is in excess of the small parent with respect to weight, it is very far from inter-

mediacy (the arithmetical mean of the two parents, 82.5 g.), but approaches, although not closely, the geometric mean, 39.5 g. This agrees with the results found by Groth (3) and Perry (11).

It is interesting further to note from the graph that the division of the F2 into minimum, mid and maximum classes, when graphed according to the means of the same, shows in all three classes an excess over the F1 and over the small-sized parent, and not merely with respect to the maximum size-class alone.

Whether the frequency curve represents a legitimate expression of Mendelian segregation in the F2, or not, it certainly adequately displays the fact that the totality of the F2 generation regarded from any standpoint, is in excess of the F1 with respect to weight, and that in no case does it show segregation to the size of the large fruited parent.

TABLE NO. 1

Distribution of plants of the F_2 generation into size-classes with respect to weight of fruits in grams, as related to the number of locules per ovary and the diameter of fruits in centimetres.

Wt. in G.	No. of Plants.	Av. No. Loc.	Av. Dia. Cm.
Hybrid No. III.			
20 - 29	4	3.0	3.2
30 - 39	10	3.4	3.6
40 - 49	7	4.0	4.4
50 - 59	4	4.7	4.9
60 - 69	2	6.0	7.1
70 - 79	1	6.1	5.5
80 - 89	2	6.4	6.1
90 - 99	0		
100 -109	0		
110 -119	1	8	6.6
Hybrid No. IV.			
20 - 29	3	2.9	3.3
30 - 39	10	3.5	3.8
40 - 49	9	4.1	4.2
50 - 59	2	4.9	4.9
60 - 69	1	6.8	5.4
70 - 79	1	7.0	5.9
80 - 89	1	7.2	6.6
Hybrid No. VIII.			
10 - 19	4	5.5	3.2
20 - 29	0		
30 - 39	1	5.0	4.3
40 - 49	0		
50 - 59	1	6.4	5.3

TABLE NO. 2.

Data for weight, diameter and number of locules grouped according to areas on the frequency graph (Graph 1) representing (1) a minimum class, 32.8 g. and less; (2) a mid-class, 32.8 g. to 50.8 g.; (3) a maximum class, 50.8 g. and above.

Plant No.	No. Fruits.	Wt.	Dia.	Loc.
(1) Minimum Class - (32.8 g. and less).				
Hybrid No. III.				
6	12	378	46.8	43
12	19	494	61.5	56
13	10	321	40.4	43
14	7	206	25.8	27
26	7	206	24.4	17
28	10	239	31.8	27
30	10	324	34.8	30
Hybrid No. IV.				
6	14	389	51.5	39
11	9	280	35.9	30
14	7	209	25.4	20
15	4	118	13.6	9
16	10	317	36.7	28
18	8	173	26.0	25
25	14	336	46.0	40
Hybrid No. VIII.				
1	9	274	36.3	45
3	10	158	31.9	39
4	9	104	40.1	19
5	19	252	48.0	50
6	10	125	26.9	40
Total: 19	198	24.7 (Average)	3.4 (Average)	3.1 (Average)

TABLE NO. 2, continued.

Plant No.	No. Fruits.	Wt.	Dia.	Loc.
(2) Mid-Class - (32.8 g. to 50.8 g.)				
Hybrid No. III.				
3	10	372	36.4	36.0
7	12	439	37.3	43.0
8	12	429	46.7	54.0
9	12	533	53.6	51.0
11	5	253	25.0	29
15	19	898	85.8	83
18	10	335	38.1	31
21	5	201	20.2	14
22	10	455	44.5	45
24	9	410	40.9	38
27	6	276	28.1	25
31	10	419	44.3	43
2	13	428	45.5	33
17	7	230	27.3	21
23	11	361	43.2	35
Hybrid No. IV.				
5	9	336	37.7	33
7	7	254	27.3	23
8	8	322	35.8	35
9	9	413	44.1	49
10	12	556	53.9	42
12	10	398	44.3	44
17	8	323	35.1	35
19	7	291	32.2	35
21	10	373	39.2	43
22	13	514	55.1	47
23	10	417	43.7	40
27	10	377	42.4	43
1	9	453	41.8	45
2	7	313	30.4	32
4	6	279	24.9	20
26	9	306	36.3	34
Hybrid No. VIII.				
0	0	0	0	0
Total: 31	295	34.3 (Average)	3.5 (Average)	3.4 (Average)

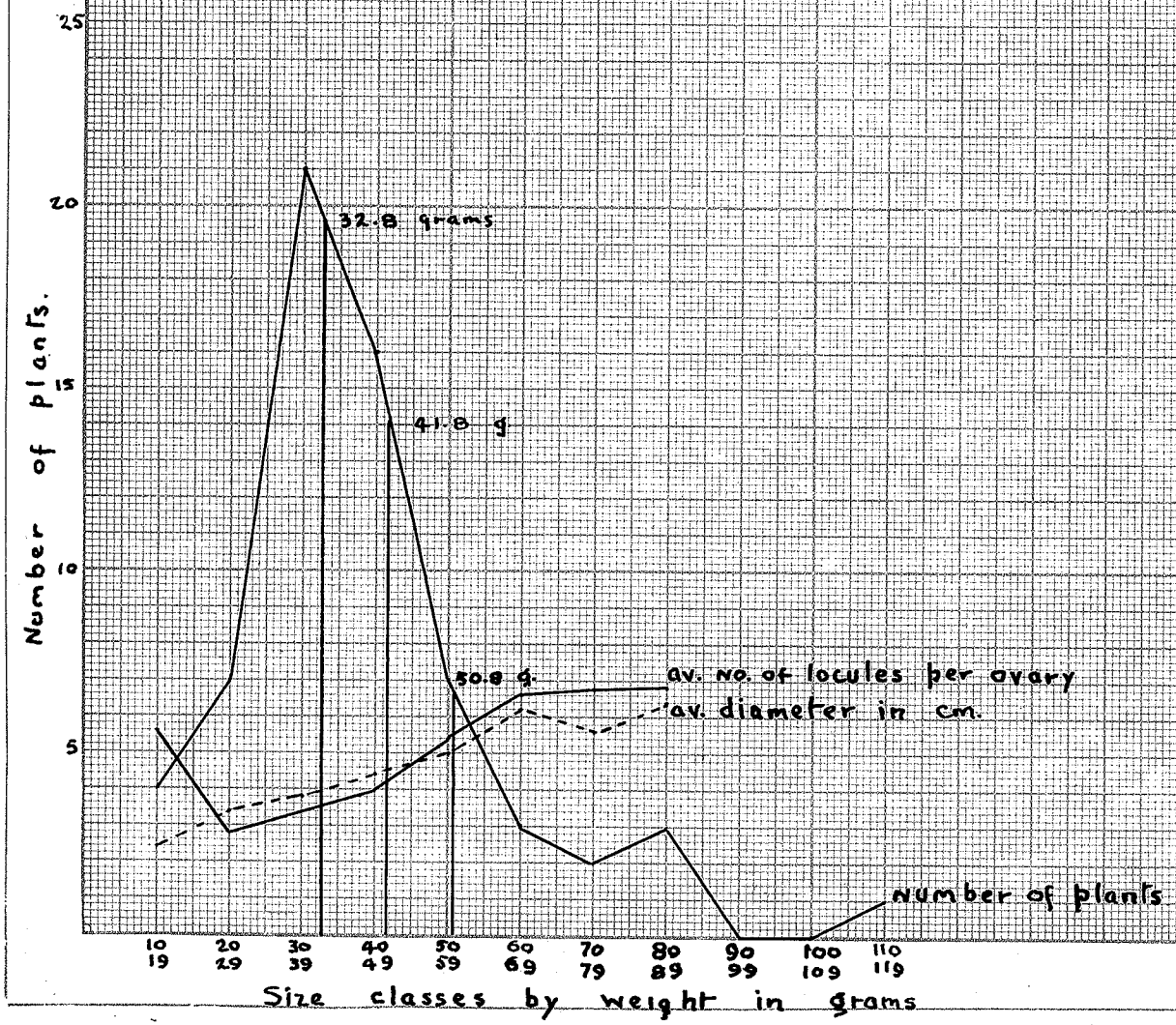
TABLE NO. 2, continued.

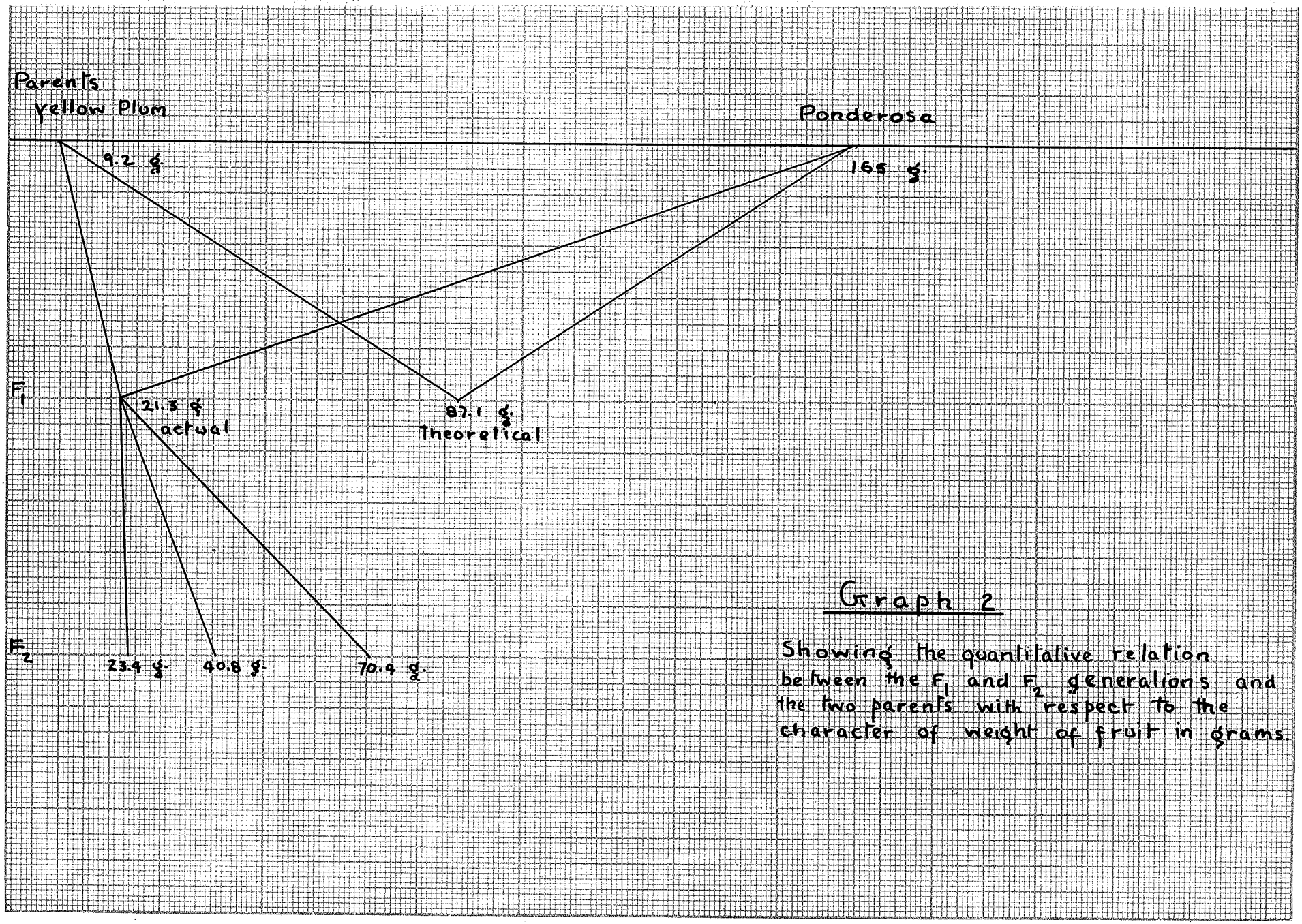
Plant No.	No. Fruits.	Wt.	Dia.	Loc.
(3) Maximum Class - (50.8 g. and above).				
Hybrid No. III.				
19	8	476	40.5	38
20	9	473	40.9	37
1	13	1167	-	66
4	9	598	-	56
5	8	885	53.2	64
10	12	788	68.1	70
16	7	572	42.9	55
25	7	546	39.1	43
29	10	508	47.3	46
Hybrid No. IV.				
3	10	572	52.3	48
13	11	918	66.7	80
20	5	315	27.0	34
24	8	618	47.6	56
Hybrid No. VIII.				
2	15	864	79.8	97
Total: 14	132	70.4 (Average)	4.5 (Average)	5.9 (Average)

Graph I

Hybrids Nos. 3, 4, 8

The abscissae represent the weights of fruits in grams according to classes, the no. of locules per ovary and the diameters of fruits in cm. being plotted across the graph for weights to the same scale.





Graph 2

Showing the quantitative relation between the F_1 and F_2 generations and the two parents with respect to the character of weight of fruit in grams.

(2). Hybrid No. 6

The following are the data for a cross between Red Cherry and Yellow Plum. In this case the number of plants involved in the F1 generation is 5, the number of fruits measured being 28. In the F2 generation the number of plants involved is 20, the number of fruits measured 164.

It is found that the plants fall into the following classes with respect to the weights of fruits, number of locules per ovary, and diameter of fruits (Graph 3).

Size-class	No. plants	Av. No. loc.	Av. Dia.
0 - 9 g.	3	2	2.2 cm.
10 - 19	11	3.1	2.9
20 - 29	6	4.4	3.8

The mean fruit values are as follows: Weight, 17 grams; No. locules, 3.2; Diameter, 2.9.

Now taking as before the group of plants occupying the mid ½ area of the graph and distributed equally on either side of the mean, we have as averages: weight 16.6 g.; no. locules 3.1; diameter 3.0 cm. There were 11 variates which fell within this mid group, - a little over half the total distribution - and these were found in a range of weights from 12 to 22 grams.

Taking the 3 variates in the minimum class,

0 - 12 grams, we have averages as follows: weight 8.4 g.; no. locules 2; diameter 2.3 cm. In the maximum class, from 22 grams plus, the averages are : weight 26.9 g.; no. locules 4.7; diameter 3.9 cm.

In the F1 the averages for these characters are as follows (measurements of 28 fruits from 5 plants); Weight 9.8 grams; no. locules 2.5; diameter 2.4 cm.

Summarizing the data for the two parental types (Table 5), the F1 and the F2, the latter distributed in the three artificial groups as stated from the frequency distribution as to weight of fruits, we have a table as follows:

	Wt.	No. loc.	Dia.
Red Cherry	5.3	2	1.5
Yellow Plum	9.2	2	2.2
F1	9.8	2.5	2.2
F2 lower 25 %	8.4	2	2.3
F2 mid 50 %	16.6	3.1	3.0
F2 upper 25 %	26.9	4.7	3.9

It thus appears that the size factor or factors for the larger (Yellow Plum) parent dominate in the F1, the average being somewhat in excess of the larger sized parent.

The F2 generation shows an astonishing behaviour in respect to all three of the factors determined. Only the lower 25 per cent of the frequency distribution for weights approximated to the F1 and to the larger fruited parent, the mid 50 percent being approximately 50 per cent in excess as to weight, number of locules and diameter of

fruits, and the upper 25 per cent attaining a weight nearly three times that of the F1 and the Yellow Plum parent, and nearly two-thirds in excess of the F1 as to number of loc-ules and diameter of fruits.

It is impossible to explain this behaviour of the F2 on the basis of the material at hand. The only analogy in other investigations accessible is in the statement of Groth (3) pg. 60, "In this cross we have 96 F2 individuals and we should thus expect about 15 plants with Currant size fruits, but we found none even approaching it in smallness of size, the smallest averaging 15 cm. instead of 11. It may be noted that 15 cm. is beyond the range of fluct-uation of the Currant size even in individual fruits."" The above is from the cross Currant by Peach.

The only conclusion possible to draw is a hy-pothesis that there may be multiple complementary factors for size, the recombination of which in the F2 may give an excess in weight, number of locules, and diameter of fruits over the F1 and the larger sized parent. There is evidently no question of heterosis, but recombination of factors which must be multiple in character and possibly complementary in order to produce such an extraordinary result in the F2.

This behaviour, however, is substantially the same as the behaviour of hybrids Nos. III, IV and VIII, crosses involving Yellow Plum as the small sized parent

and Ponderosa as the large sized parent.

It will be interesting to reproduce here the figures for Hybrids III, IV and VIII in the same manner as for the Red Cherry - Yellow Plum cross above, for purposes of comparison.

	Weight	No. locules	Diameter
Yellow Plum	9.2	2	2.4
Ponderosa	165.7	9.6	7.3
F1	21.3	3.1	3.4
F2 lower 25 %	23.4	3.2	3.4
F2 mid 25 %	40.8	4.0	4.1
F2 upper 25 %	70.4	5.9	5.5

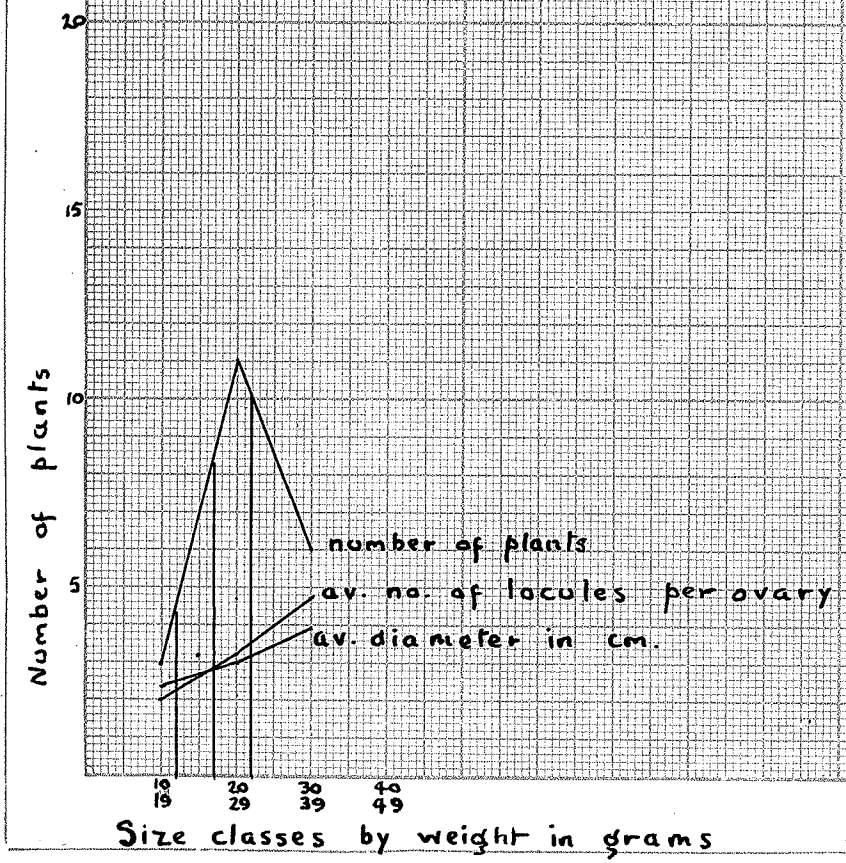
It is thus apparent that the small size-factor or factors functioning in the case of the Yellow Plum parent and the Red Cherry parent are somewhat similar in their mode of operation to that in the Plum - Ponderosa crosses.

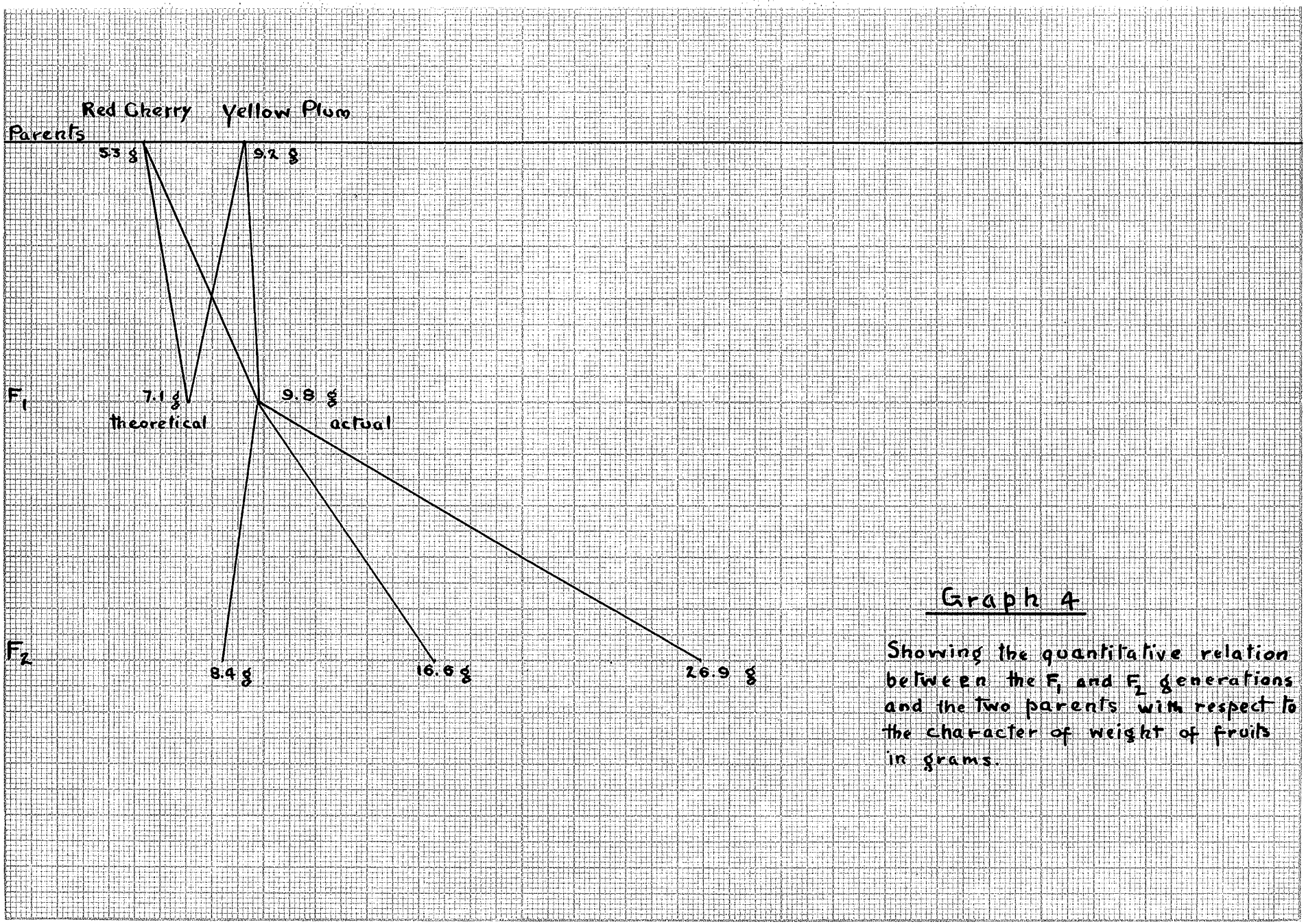
Graph 4 expresses the data for the relation between the F1 generation and the Red Cherry and Yellow Plum parents with respect to weight, and of the F2 generation with respect to weight for the minimum, mid and maximum classes of the frequency curve. It shows the mean of the F1 generation to be in excess of the mean of both parents, which result is quite dissimilar from that shown in Graph 2. The F2 generation, however, similarly to Graph 2, is in excess of the F1. with the exception of the minimum group, which is below the mean of the Yellow Plum (larger-fruited parent) but considerably above the mean of the Red Cherry (the smaller-fruited parent).

Graph 3

Hybrid No. 6

The abscissae represent the weights of fruits in grams according to classes, the number of locules per ovary and the diameters of fruits in cm. being plotted across the graph for weights and to the same scale.





Graph 4

Showing the quantitative relation between the F_1 and F_2 generations and the two parents with respect to the character of weight of fruits in grams.

(3). Hybrid No. VIII.

In this cross, Golden Ponderosa X Red Cherry, the number of plants involved in the F1 generation is 6, the number of fruits measured being 59. In the F2 generation the number of plants involved is 16 and the number of fruits measured 166.

Within the classes 14.9 g. to 24.5 g. of the F2 generation, comprising that portion (½) of the total area of the graph (Graph 5) lying equally on either side of the mean, there are 12 plants, somewhat over one-half the total number (16). In the minimum 25 % of the graph lying from 0 to 22 (weight of fruits in grams) there was 1 plant (with 9 fruits) and in the maximum class from 32 to 49 grams there were 3 plants (25 fruits). It is thus apparent that in the one-half area of the graph lying to either side of the mean there are not greatly exceeding one-half the total number of plants in the distribution series. In the maximum class, the total number 3 is exceedingly close to 25 % (4) of the total number of plants in the series. Allowing throughout for the small number of variates involved, it is sufficiently clear that the distribution is normal enough with respect to the mean to be available for estimation so far as the same can be based upon a biometric treatment of the material.

In the mid-group of variates grouped around the mean of 22.3 grams (weight of fruits) there are 12

individuals having averages as follows: number of locules 3.3; diameter 3.2 cm.; the total mean value for number of locules anddiameter of fruits in the entire F2 segregation is 3.7 and 3.5 respectively. These mean valyes differ from the mean values for the 50 % mid-class by 12 % and 9 % respectively. Allowing 10 % for experimental error in the case of small numbers, it appears, roughly speaking, that it is possible to accept a grouping around the mean of weight (22 g.) as a basid for examining the distribution of the 50 % mid-class with respect to the frequency distribution of weight of fruits, as in the previous case, instead of using the 50% group surrounding the true means of 3.7 and 3.5 for number of locules and diameter of fruits, respectively.

The purpose of this alignment is to make as close a comparison as possible, as in the previous case of the distribution, and hence the possible segregation of the individuals in a frequency graph of weights,using this as a base, with respect to whatever segregation may be indicated of a Mendelian character, with regard to the number of locules and diameter of fruits.

Examining in like manner the individuals in a frequency graph for weights lying from 1 to 12 grams (the presumed lower 25 % of a Mendelian segregation) and the individuals from 32 grams on, we have the following results, which are now tabulated together with the mid-group.

Variates in the minimum (approximately) 25 %, the mid-50 % and the maximum 25 % of the total frequency distribution as to weight of fruits in grams.

		Weight g.	No. loc.	Dia. cm.
0 - 12	lower	9.4	2.3	2.9
12 - 32	mid	20.2	3.3	3.2
32 - 45	maximum	41.5	5.6	5.1

It is now necessary to compare the above presumed distribution in the F2 as respects locules per ovary and diameter of fruits, with the parental averages and the F1 for these factors. For the parents, only the Red Cherry data are available directly. These are as follows: No fruits, 10; Weight 5.3 g.; No. loc. 2; Dia. 1.5 cm. The values for the Ponderosa parent, while not obtainable directly, can be taken as previously stated, from the F1 generation of Hybrids Nos. I and II, being crosses between Golden Ponderosa and Red Ponderosa and the reciprocal. It is obvious that in this cross no values are introduced but those appertaining to the size-type of Ponderosa, since the differences are only color differences. From an average of the F1 data for Hybrids I and II then, we have the following values: Weight 155.7 g.; no. locules 9.6; diameter 7.3. The data for the F1 generation, obtained from 59 fruits from 6 plants, are as follows: Weight 12.6; no. locules 2.5; diameter 2.8.

Calculating a presumed F1 generation from the Golden Ponderosa X Red Cherry cross, taken as intermediate between the two parent types, and comparing these values with the actual values as found, we have as follows:

	Weight	No. locules	Diameter
Ponderosa	165	9.5	7.4
Red Cherry	5.3	2.0	1.5
F1 as found	12.6	2.5	2.8
F1 intermediate	85.2	5.8	4.5

It is thus seen from the above table, that the F1 generation is not at all intermediate either with respect to weight, number of locules or diameter of the fruits, between the Ponderosa parent and the Red Cherry parent, but inclines decidedly toward the dominance of the Red Cherry type.

Assuming dominance of the Red Cherry type as to number of locules per ovary and diameter, 75 % of the F2 should approximate toward the Red Cherry type in respec to these characters, if a single size-factor were operative. Taking thelower 25 % as representing the dominance of the Red Cherry fruit size, and the mid 50 % of the F2 as representing a possible Mendelian distribution for dominance (DD - Dr), we find that the averages for these two classes with respect to number of locules per ovary and diameter of fruits are 2.8 and 3.0 respectively. The differences between these averages and the actual values of the F1 for the same two characters amount to .3 and .2, or a difference of plus 10 % and plus ~~xox%~~ 7 % in the two cases, which is within the limits of ~~in~~ allowable experimental error. However, the upper 25 % of the class distribution should represent approximately the type of the Ponderosa parent, and in no case does it do so. The highest weight in the

F2 generation is 44.4 grams, the highest number of locules per ovary 6.2 and the greatest diameter 5.5 cm., the averages being 40.6 grams for weight, 5.6 locules per ovary and 5.1 cm. diameter. It must be assumed that the reason for the irregularity in this distribution with respect to the higher values may well be due to the limited number of plants, and therefore necessarily of fruits available in the F2, the number of plants being only 16, sith an average of 10 fruits per plant. It is manifest that a very much larger number of plants and fruits would have rendered it more likely that a satisfactory distribution series would have been found. At all events the data at hand indicate marked dominance of the Red Cherry type as to weight and partial dominance as to number of locules per ovary and the diameter of fruits.

Graph 6 represents a graphing of the data similarly to Graph 4 for the quantitative relation between the F1 generation and the Red Cherry and Ponderosa parents with respect to weight, and of the F2 generation with respect to mean weight of the minimum, mid and maximum classes of the frequency curve. It shows the mean of the F1 generation as in the case of Hybrid No. VI to be somewhat in excess of the mean, of the smaller parent, but does not show in the least an intermediate condition. The F2 generation, similarly to Graphs 2 and 4 shows as excess over the F1, with the exception of the minimum group.

TABLE NO. 4.

Data for weight, diameter and number of locules grouped according to areas on the frequency graph (Graph 3) representing (1) a minimum class, 0 - 12 g.; (2) a mid-class, 12-32 g.; (3) a maximum class, 32 g. and above.

Plant No.	No. Fruits.	Wt.	Dia.	No. Loc.
Hybrid No. VII.				
(1) Minimum Class, 0 - 12 g.				
5	9	9.4	2.9	2.3
(2) Mid-Class, 12-32 g.				
1	10	193	33.7	32
2	10	180	31	32
4	6	145	20.9	25
6	17	480	65.2	67
7	7	117	20.5	27
8	17	268	48.6	51
10	14	258	43.3	40
11	7	208	27.3	30
12	11	232	37.4	35
13	15	282	49	39
14	10	138	27.8	29
16	8	162	25.7	25
(3) Maximum Class, 32 g. and above.				
3	10	444	50.5	56
9	9	390	48	56
15	6	204	26.5	30

F2 generation is 44.4 grams, the highest number of locules per ovary 6.2 and the greatest diameter 5.5 cm., the averages being 40.6 grams for weight, 5.6 locules per ovary and 5.1 cm. diameter. It must be assumed that the reason for the irregularity in this distribution with respect to the higher values may well be due to the limited number of plants, and therefore necessarily of fruits available in the F2, the number of plants being only 16, sith an average of 10 fruits per plant.
It is manifest that a very much larger number of plants and fruits would have rendered it more likely that a satisfactory distribution series would have been found. At all events the data at hand indicate marked dominance of the Red Cherry type as to weight and partial dominance as to number of locules per ovary and the diameter of fruits.

Graph 6 represents a graphing of the data similarly to Graph 4 for the quantitative relation between the F1 generation and the Red Cherry and Ponderosa parents with respect to weight, and of the F2 generation with respect to mean weight of the minimum, mid and maximum classes of the frequency curve. It shows the mean of the F1 generation as in the case of Hybrid No. VI to be somewhat in excess of the mean, of the smaller parent, but does not show in the least an intermediate condition. The F2 generation, similarly to Graphs 2 and 4 shows as excess over the F1, with the exception of the minimum group.

TABLE NO. 3.

Distribution of plants of the F_2 generation into size-classes with respect to the weight of fruits in grams as related to the number of locules per ovary and the diameter of the fruits in centimetres.

Wt. In G.	No. of Plants.	Av. No. Loc.	Av. Dia. Cm.
Hybrid No. VII.			
0 - 9	1	2.3	2.9
10 - 19	7	2.4	2.3
20 - 29	5	3.7	3.4
30 - 39	1	5.0	4.4
40 - 49	2	5.9	5.4

TABLE NO. 4.

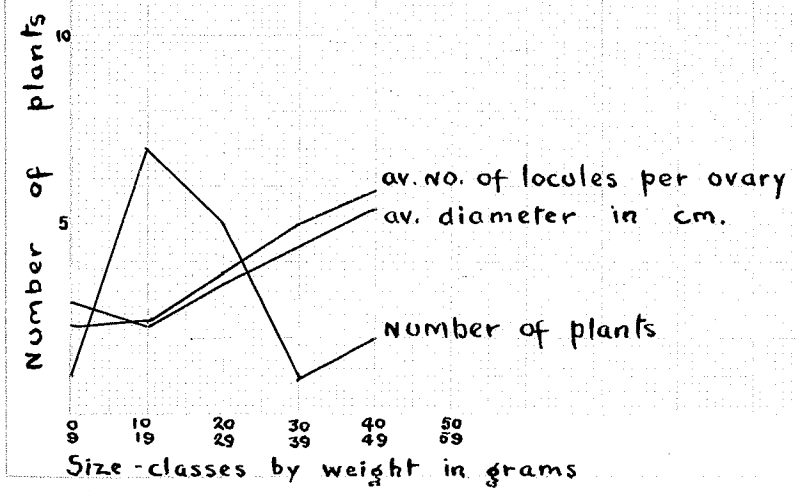
Data for weight, diameter and number of locules grouped according to areas on the frequency graph (Graph 3) representing (1) a minimum class, 0 - 12 g.; (2) a mid-class, 12-32 g.; (3) a maximum class, 32 g. and above.

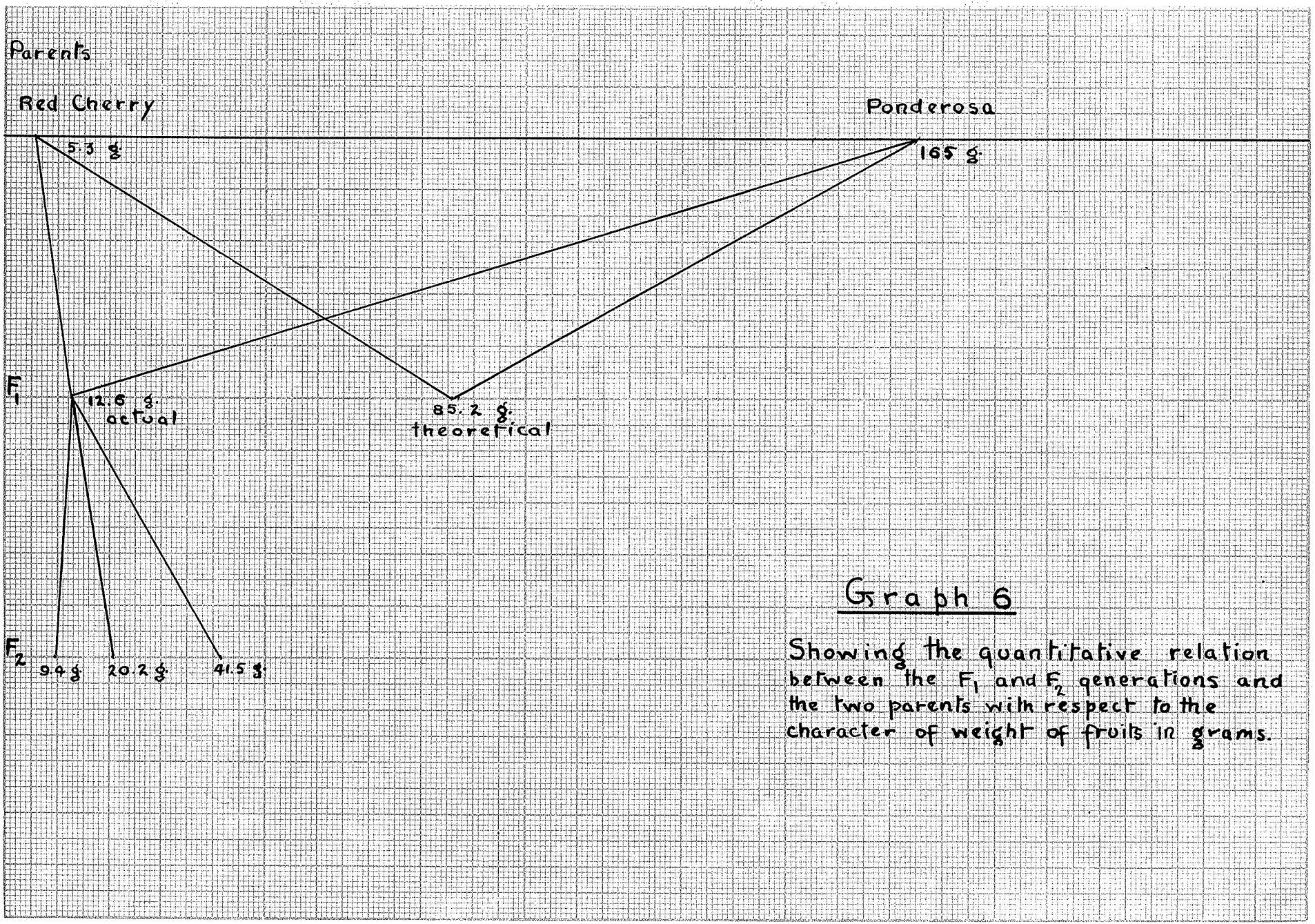
Plant No.	No. Fruits.	Wt.	Dia.	No. Loc.
Hybrid No. VII.				
(1) Minimum Class, 0 - 12 g.				
5	9	9.4	2.9	2.3
(2) Mid-Class, 12-32 g.				
1	10	193	33.7	32
2	10	180	31	32
4	6	145	20.9	25
6	17	480	65.2	67
7	7	117	20.5	27
8	17	268	48.6	51
10	14	258	43.3	40
11	7	208	27.3	30
12	11	232	37.4	35
13	15	282	49	39
14	10	138	27.8	29
16	8	162	25.7	25
(3) Maximum Class, 32 g. and above.				
3	10	444	50.5	56
9	9	390	48	56
15	6	204	26.5	30

Graph 5

Hybrid No. 7

The abscissae represent the weights of fruits in grams according to classes, the no. of locules per ovary and the diameters of fruits in cm. being plotted across the graph for weights to the same scale.





Graph 6

Showing the quantitative relation between the F_1 and F_2 generations and the two parents with respect to the character of weight of fruits in grams.

In addition to the data already presented, an extensive attempt was made to determine whether any relation might exist between the number of seeds produced by the fruits of the F1 generation and by those of the parents. It soon became evident that the range of variation of the number of seeds from the different fruits of the same plant was so great as to render the seed number quite unsuitable for out purpose. Indeed it is possible for one of the small tomatoes, e.g. Cherry, to possess as many seeds as quite a large example of the large Ponderosa type.

In the F1 the seeds were counted of 189 fruits from 36 plants of 7 crosses. In the F2 273 fruits from 29 plants were employed. On comparing the results of the F1 from crosses between parents having large and small-sized fruits, no general conclusion could be drawn.

IV. Summary

1. The paper deals with an investigation of size inheritance in seven tomato crosses involving large and small fruited parents, the data for size being interpreted in terms of weight of fruits in grams.

2. In all the crosses involving a large size (Ponderosa) and a small size (Yellow Plum or Red Cherry) the mean of the F1 shows an excess over the mean of the small-sized parent, but in no case approaches the arithmetical mean between the two parents. In a cross between parents of less dissimilar size (Red Cherry X Yellow Plum) the mean of the F1 is very slightly in excess of the mean of the larger parent.

3. The number of plants of the F2 generation was too small to allow adequately for the calculation of the segregation of Mendelian characters. It was decided, therefore, to express the results in frequency graphs, so as to demonstrate biometrically whatever segregation might be operative. These graphs show, when the large (Ponderosa) and small (Cherry or Plum) types are involved, that the mid and maximum size-classes exceed the mean of the F1, and moreover, in one case the minimum size-class does so. In no instance was any segregation to the small-sized parent evident. When parents of not such great size difference

(Cherry and Plum) are involved, the mid and maximum size classes also exceed the mean of the F1 and the minimum size-class falls only slightly below it, in this respect resembling one of the Cherry X Ponderosa crosses, Graph 6.

4. No definite conclusion as to the number of size factors operating in the various crosses can be drawn from this investigation. It is evident, however, that the factors of the small parental type are noticeably dominant over those of the large parental type. Nowhere is there dominance of the large parental type in the F1, and no indication of intermediacy. In all crosses the small-sized parent approaches domplete dominance, but falls short of it sufficiently to demonstrate that we are not concerned with a single dominant size-factor.

5. The data from this investigation agree to a certain extent with the findings of Groth and Perry, that the mean of the F1 in tomato crosses involving maximum size differences more nearly approaches the geometrical than the arithmetical mean of the two parents.

6. Extensive counting showed the variation in seed numbers of the fruits from one plant to be so great that it is impossible to obtain any general conclusion from such data. This phase of the problem obviously requires special investigation.

TABLE NO. 5.

Parental Data.

Plant No.	No. Fruits.	Wt.	Vol.	Cells.	Dia.	Seeds.
Yellow Plum.						
1	6	10.2	10.6	2	2.4	73
2	3	6.3	6.3	2	2	64
3	9	11.3	13.5	2	2.4	79.4
Red Cherry.						
1	10	52.5	55	2	1.5	86
Ponderosa.						

Derived from the data for the F_1 generation of Hybrids I and II (Crosses of Golden Ponderosa by Red Ponderosa and the reciprocal).

TABLE NO. 6.

Hybrid No. I. Golden Ponderosa x Red Ponderosa.

Plant No.	No. Fruits.	Av. Wt.	Av. Vol.	Av.No.Loc.	Av. Dia.	Av.No.Seeds.
F_1						
1	4	137.5	141	10.2	6.8	107
2	4	158	166.6	9.5	6.6	105
3	1	127	149	11	7	106
4	1	140	140	11	7.2	45
5	8	131.2	135	8.2	7.3	67
F_2						
1	4	97	100	7.5		66
2	7	146	146	8	7.7	135
3	3	77	77	8	5.9	
4	5	54	55	7.8	5.5	
5	7	154	154	11.2	7.9	185
6	5	154	154	8.2	7.2	
7	8	169	169	9.7	7.8	
8	14	106.7	107	7	6.5	155
9	4	136.5	143.5	7	6.7	

TABLE NO. 7.

Hybrid No. II. Red Ponderosa x Golden Ponderosa.

Plant No.	No. Fruits.	Av. Wt.	Av. Vol.	Av. No. Loc.	Av. Dia.	Av. No. Seeds
F_1						
1	3	131	132.6	7.6	5.1	94
2	4	181.2	182.5	8.7	8.7	154
3	1	210	210	7	9.5	218
4	3	130	125.3	8.6	6.8	41
5	2	305	305	14	9.5	283
F_2						
1	2	126.5	137.5	6.5	7.4	
2	12	86	85.8	6.5	6.1	
3	9	144.7	146.4	7.1	7.5	
4	6	156.8	161.3	10.6	7.6	
5	5	186.2	189	9.2	8.2	150
6	8	166.3	167	7.5	8.2	
7	5	119	121.2	6.4	6.5	
8	8	95.3	97.1	7.9	6.4	
9	5	112.6	130.6	7	7.3	
10	14	95	95.3	7.2	6.4	
11	8	163.2	183.4	7.9	8.2	117.9

TABLE NO. 8.

Hybrid No. III. Golden Ponderosa x Yellow Plum.

Plant No.	No. Fruits.	Av. Wt.	Av. Vol.	Av. No. Loc.	Av. Dia.	Av. No. Seeds.
F_1						
1	2	21.5	25.5	3.5	3.7	101
2	2	12.5	13.2	3.5	3.2	93
3	7	24.7	26.1	3.7	1.8	104
4	1	14	15	4	3	131
5	2	22.7	28.5	3	4.5	56
F_2						
1	13	89.7	82.6	5		
2	13	32.9	35.1	2.5	3.1	111
3	10	37.2	40.2	3.6	3.3	
4	9	65.3	71.3	6.2	7.6	
5	8	110.6	111.6	8	6.6	168
6	12	31.5	30.9	3.6	3.9	
7	12	36.5	36.7	3.5	3.9	
8	12	35.7	35.3	4.5	3.9	
9	12	44.4	43.4	4.4	4.4	
10	12	65.6	65	5.8	6.6	
11	5	50.6	52.8	5.8	5	
12	19	26	26.8	2.9	3.2	91
13	10	32.1	33.4	4.3	4.4	
14	7	29.2	29.8	3.9	3.6	
15	19	47.2	47.2	4.3	4.5	191
16	7	81.2	82.8	7.8	6.1	
17	7	32.8	33.7	3	3.9	
18	10	33.5	33.9	3.1	3.8	172.7
19	8	59.5	60.6	4.2	5.6	
20	9	52.5	52.6	4.1	4.5	
21	5	40.2	40	2.8	4.4	
22	10	45.5	45.1	4.5	4.4	
23	11	32.8	33	3.1	3.9	
24	9	45.5	45.3	4.2	4.5	
25	7	78	78	6.1	5.5	225
26	7	29.4	30	2.4	3	
27	6	49	48.8	4.1	4.3	
28	10	23.9	25	2.7	3.1	
29	10	50.8	49.9	4.6	4.4	
30	10	32.4	34.5	3	3.1	120
31	10	41.9	40.9	4.3	4.4	

TABLE NO. 9.

rbrid No. IV. Yellow Plum x Golden Ponderosa.

ant No.	No. Fruits.	Av. Wt.	Av. Vol.	Av. No. Loc.	Av. Dia.	Av. No. Seeds.
F_1						
1	6	28.3	28.7	2.6	3.6	105
2	5	27.7	27.4	3	3.9	80
3	1	37.5	54	4	4.5	141
4	12	23.7	25.5	2.9	3.4	76
5	3	27.3	27.3	3.3	4	82
6	5	30.6	34.2	3.2	3.2	96
F_2						
1	9	50.3	46.5	5	4.6	
2	7	44.7	45.7	4.5	4.3	
3	10	57.2	57.4	4.8	5.2	
4	6	46.5	44.3	3.3	3.1	
5	9	34	34.2	3.3	4.1	
6	14	27.7	28	2.7	3.6	
7	7	36.2	37.5	3.2	2.9	
8	8	40.2	40.3	4.3	4.4	
9	9	45.8	46.2	5.4	4.9	
10	12	46.3	46.7	3.5	4.3	150.7
11	9	31.1	32.2	3.3	3.9	
12	10	39.8	40.1	4.4	4.4	
13	11	83.4	84	7.2	6.6	232
14	7	29.8	31.5	2.9	3.6	78
15	4	29.5	30.2	2.2	3.4	
16	10	31.7	31.9	2.8	3.6	
17	8	40.3	40.3	4.3	4.3	
18	8	21.6	22.3	3.1	3.2	
19	7	38.7	39.1	5	4.6	
20	5	63	61.4	6.8	5.4	
21	10	37.3	36.4	4.3	3.9	115
22	13	39.5	39.8	3.6	4.2	
23	10	41.7	42.1	4	4.3	
24	8	77.2	77.6	7	5.9	
25	14	24	24.7	2.9	3.2	
26	9	34	34	3.7	4	
27	10	37.7	37.7	4.3	4.2	

TABLE NO. 10.

Hybrid No. VI. Red Cherry x Yellow Plum.

Plant No.	No. Fruits.	Av. Wt.	Av. Vol.	Av. No. Loc.	Av. Dia.	Av. No. Seeds.
F_1						
1	6	7.3	3.9	2	2.5	56
2	9	11.9	11.6	3.1	2.8	67
3	2	15.5	14.5	2.5	2.7	62
4	9	4	3.5	2	1.5	47
5	2	10.5	11.5	3.2	2.7	55
F_2						
1	12	25.8	27.1	4.3	3.7	
2	10	16	17.4	3.6	2.9	
3	7	12.8	13.7	3.4	2.8	
4	9	14.2	14.4	3.2	2.8	
5	8	26.5	28.9	7.6	4.3	152
6	5	10.4	12.2	2.6	2.6	
7	10	19.6	20.6	3.2	3.3	
8	7	13.4	12.5	2.7	2.7	
9	10	18	18	3.6	3.1	143
10	5	23.8	24.2	3.4	3.6	
11	6	29.1	29.1	4.1	3.9	
12	8	12.7	12.6	2.2	2.8	
13	8	18.3	18.6	3	3.2	
14	6	19.5	19.6	3.3	3.3	
15	10	9.3	9.2	2	2.4	
16	10	20.7	21.1	2.9	2.2	83
17	9	6.7	6.7	2	2.1	68
18	10	17.4	18.1	3.2	3.1	
19	7	29.2	29.5	4.2	4	
20	7	9.1	9.1	2	2.3	

TABLE NO. 11.

Hybrid No. VII. Golden Ponderosa x Red Cherry.

Plant No.	No. Fruits.	Av. Wt.	Av. Vol.	Av. No. Loc.	Av. Dia.	Av. No. Seeds
F_1						
1	8	13.7	15.6	2.5	3	71
2	6	10.5	12.2	2.6	2.6	71
3	7	13.5	14	2.4	3.3	74
4	9	10.7	10.8	2.4	2.7	67
5	15	14.1	16.2	2.6	2.9	79
6	14	13.6	13.7	2.8	2.8	67
F_2						
1	10	19.3	19.7	3.2	3.3	98
2	10	18	18.3	3.2	3.1	78
3	10	44.4	45.6	5.6	5.5	
4	6	24.1	24.1	4.1	3.4	
5	9	9.4	10	2.3	2.9	
6	17	28.2	28.5	3.9	3.2	
7	7	16.7	17.4	3.9	3.9	
8	17	15.7	16	3	2.8	
9	9	43.3	44.4	6.2	5.3	
10	14	18.4	19	2.8	3	
11	7	29.7	29.2	4.2	3.9	69
12	11	21	21	3.1	3.4	129
13	15	18.9	19.3	2.6	3.2	73
14	10	13.8	13.6	2.9	2.7	
15	6	34	34.6	5.	4.4	51
16	8	20.2	20.7	3.1	3.2	
			Av.	3.7	3.5	

TABLE NO. 12.

ybrid No. VIII. Red Ponderosa x Yellow Plum.

Plant No.	No. Fruits.	Av. Wt.	Av. Vol.	Av. No. Loc.	Av. Dia.	Av. No. Seeds.
F_1						
1	2	5.5	9	2	2	75
2	13	12.3	13	3	3.1	52.5
3	8	14.6	16.8	2.8	3	88.5
4	4	24.7	25.3	3.2	3.5	93
F_2						
1	9	30.4	30.6	5	4.3	
2	15	57.6	60.6	6.4	5.3	105
3	10	15.8	16.6	3.9	3.1	
4	9	11.5	11.3	2.1	4.4	93
5	19	13.2	13	11.8	2.5	
6	10	12.5	12.5	4	2.6	

V. Bibliography

1. Crane, M.B. Heredity of Types of Inflorescence and Fruits in Tomato. Journ. Genetics, Vol. 5, No. 1, July, 1915.

2. Frimmel F. Uber die Vererbung der Fruchgrosse der Tomaten. Zeit. f. Pflanzenzuchtung. 8 : 457 - 462. 1922.

3. Groth, B.H.A. Some results in size inheritance. New Jersey Agr. Exp. Sta. Bull. 278. April 1915.

4. ---------- The Fl Heredity of Size Shape and Number of Tomato Fruits. N. J. Agr. Exp. Sta. Bull. 242. 1912.

5. Halsted, B.D. Experiments with tomatoes. New Jersey Agr. Exp. Sta. Report. 1906.

6. Hedrick U.P. and Booth, N.O. Mendelian Characters in Tomatoes. Proc. of Soc. for Hort. Sc. 1907.

7. Lesley, J.W. and Rosa, J.T. The Improvement of Tomatoes by selection. Hilgardia, Vol. 2, No. 2. Aug. 1926.

8. Lindstrom E.W. A Genetic Linkage between Size and Color Factors in the Tomato. Science 60: 182-183. 1924.

9. ---------- Hereditary Correlation of Size and Color Characters in Tomatoes. Iowa State Coll. of Agric. Res. Bull. 93. June, 1926.

10. ---------- Linked Inheritance in Tomatoes. Iowa State Coll. Journ. of Sc. Vol. 1, No. 1. Oct.1926.

11. Perry, F.E. The Inheritance of Size in Tomatoes. The Ohio Naturalist. Vol. XV. No. 6. April 1915.

12. Price, H.L. and Drinkard, A.W. Cross-breeding of Tomatoes. Vir. Agr. Exp. Sta. Bull. 177. July 1908.

13. Reeves, F.S. An Investigation in Tomato Breeding. Proc. of Soc. for Hort. Sc. 1914.

14. Warren, P.A. The Heredity of Fruit Shape in the Garden Tomato. Papers of the Mich. Acad of Sc., Arts and Letters, Vol. IV, 1924.

15. Wellington, R. Influence of Crossing in Increasing the Yield of the Tomato. N.Y. Agr. Exp. Sta. Bull. 346. 1912.

16. ---------- Comparison of First Generation Tomato Crosses and their Parents. Univ. of Minn. Agr. Exp. Sta. Bull. 6. July 1922.

A PRELIMINARY RECORD OF THE LICHENS OF MANITOBA

The following list comprises over seventy lichens which have been collected in different parts of Manitoba. There has been up to the present no published information concerning the lichens which are to be found in the province, and it was thought advisable to make this preliminary record even though it must represent only a small percentage of the large number that most probably occur. The collection has been made by the writer during the last three years and permanent specimens of each are now in the herbarium of the University.

The various localities are fairly representative of the different parts of the province and include: Indian Bay, which is in southeastern Manitoba, Victoria Beach, Carberry, Treesbank, Norway House, and all the districts in the vicinity of Winnipeg. Specimens found at Kenora are also included, because its flora is almost identical with that of Indian Bay, and some specimens found there have not yet been obtained actually on this side of the boundary line.
The genera are listed in alphabetical order, not according to the families to which they belong. This seemed the wiser plan in view of the incompleteness of the list. A short description of the macroscopic characters of each lichen is given, together with a short ecological note.

Much help in the identification of the specimens has been given me by Dr. Fink of Miami University, and his book, "The Lichens of Minnesota" has been of great value. It is hoped that shortly a more complete record will be ready for publication.

A PRELIMINARY LIST OF THE LICHENS OF MANITOBA

Arthonia lecideela Nyl.

Thallus pale to sea green, thin, continuous, in uneven patches 5 to 25 mm. in diameter, looking something like a green mould. Apothecia dark brown or black, numerous, plane or somewhat convex, very small, immersed or adnate.

Occurs on trees, especially hawthorne and plum, and on old wood. Found at Charleswood, Bird's Hill, M.A.C., Indian Bay, Kenora.

Buellia parasema Ach.

Thallus thin, smooth and fairly continuous, becoming rough or granulate, sea green or ashy white. Apothecia very tiny to medium size, sessile or adnate, the disk flat and surrounded by a thin black exciple.

Occurs on trees and dead wood. Found at Kenora, on trunk of Balsam fir.

Calicium polyporaeum Nyl.

Parasitic and no thallus distinguishable, stipes dark brown to black in color, 0.7 to 1 mm. in length. Apothecia small or minute, .1 to .3 mm. across, disk flat.

Occurs on fungi: Daedalea unicolor and Polyporus pargamenus. Found at M. A. C. and City Park.

Catillaria globulosa (Floerke) T. Fries

Thallus appears in slight grayish mouldy looking patches. apothecia numerous, minuteaand black in color.

Occurs on bark of trees. Found on balsam fir, Victoria Beach.

Catillaria micrococca (Koerb.) Fink.

Crusted olive green warty looking thallus, dotted with minute brown apothecia.

On bark of Tamarack or Jack Pine. Found at M. A. C.

Cetraria aurescens Tuck.

Thallus foliose, middle-sized to small, 15 to 60 mm. in diameter. Surface quite smooth, sinuously lobed, the lobes much cleft, with crisped ascendant margins; straw colored to sea green or yellow above, pale yellow below, with fibrils. Apothecia 1 to 7 mm. in diameter, sub-pedicellate on margins of lobes, disk brown, concave, with thalloid margin crenulate.

Occurs on conifers, cedars, birch, etc. Found at Indian Bay on old birch log.

Cetraria ciliaris (Ach.) Tuck.

Thallus foliose, 25 to 50 mm. in diameter, much lobed, narrow, margins crenate and bearing scattered cilia or fibrils. Olive green to dark brownish above, lighter brown below. Apothecia 1.5 to 2 mm. in diameter, sessile

on the margins of the lobes, usually somewhat concave, disk light or olive brown, margin crenulate.

Occurs on trees and old wood. Found in tamarack swamp at Bird's Hill, and on tamarack at Simpson's, Indian Bay.

Cetraria islandica (L.) Ach.

Thallus tufted, fruticose and subfoliose, rigid, laciniate, lobes often grooved or canaliculate, margins bearing cilia or spinules. Whitish soredia occur along the grooves; the thallus is dark olive brown in color, becoming lighter at the base, 3 to 8 cm. in length. (Specimens from Iceland are much larger.) Apothecia from 1 to 8 mm., sessile at tips of lobes, with thalloid margin entire or crenulate. Disk brown or chestnut, irregular in shape.

Occurs usually in cold regions, on humus over rocks, or on dry ground. Found at Treesbank , on dry prairie ground.

Cetraria juniperina (Scop.) Ach.

Thallus foliose, small to middle-sized, 15 to 50 mm. in diameter, with crowded crisped ascendant lobes, greenish to straw colored above and pale yellow below, often bright yellow toward the margins of the lobes, these covered with bright yellow soredia. Apothecia 2 to 6 mm. in diameter, rare, disk chestnut brown.

Common on trees and old wood, especially in swamps, found at Indian Bay, Birds' Hill, Kenora.

Cladonia alpestris (L) Rabenh.

Primary thallus rarely present, crustose, thin irregular and clumped or scattered verrucae, straw colored. Podetia arise from these, or from old podetia, 5 to 20 cm. long, .5 to 2 mm. in diameter, sub-cylindrical, dilated in axils, cupless, sometimes sub-dichotomously, commonly radiately or fasciculately branched, one usually taller than the others. Occurs in dense clusters, whitish or straw-colored, apices subulate or radiately spinose or straight. Apothecia tiny, .3 to .5 mm. in diameter, found in dense corymbs at apices of branches, solitary or clustered, light to darkish brown.

Occurs on earth over rocks, among moss, in rock crevices, or on sandy soil under pine and spruce trees. Almost always associated with C. rangiferina, often with Stereocaulon paschale. Found at Indian Bay, Point du Bois, Kenora.

Cladonia coccifera (L.) Willd.

Primary thallus usually persistent as irregular crenate flat squamules, light to sea green above, whitish below. Podetia arise from surface of primary thallus, 4 to 50 mm. long, cup-bearing, cylindrical or turbinate, erect corticate, ashy to sea green; cups gradually or abruptly

dilated, may be oblique, sub-entire, dentate, or proliferate with 1 to 4 proliferations rising from margin of cup. Apothecia vary in size, may be clustered or solitary on apices of proliferations, or sessile on margin of cup, scarlet.

Occurs on earth, humus or sandy soil, under pine or spruce trees or in bogs on old and rotten wood. Found at Indian Bay, Kenora.

Cladonia cristatella Tuck.

Primary thallus usually persistent, incised crenate small squamules, flat, scattered or clustered. Sea green to pale yellow above, whitish below. Podetia arise solitary or clustered, from surface of squamules, 4 to 25 mm. long, enlarged toward apex, without cups, branches short and apices terminated by apothecia, the latter clustered or solitary, medium sized or small, convex, immarginate, scarlet.

Occurs on old wood and earth, especially recently burned areas. Much commoner than C. coccifera, but often associated with it. Found at Indian Bay, Kenora, Point du Bois, Carberry, Charleswood, Bird's Hill.

Cladonia deformis (L.) Hoffm.

Primary thallus usually dies away, when present is composed of incised crenate or lobed medium sized squamules, 2 to 7 mm. long and wide, ascending or depressed,

scattered or clustered, sea green above, sometimes light red at base, paler below. Podetia arise from surface of squamules, 20 to 80 cm. in length, subcylindrical or elongate turbinate, scyphiform, or rarely cupless, erect and partly and uniformly sorediate, lower part squamulose, straw colored to sea green, upper part more yellowish; cups are gradually or abruptly dilate, imperforate, medium sized, 3 to 10 mm. in diameter, margin subentire, or irregularly proliferate, the proliferations solitary or numerous in 1 to 3 ranks, the lower rank long, the upper ranks and proliferations short, the cavity of the cups usually somewhat farinose. Apothecia medium sized, .5 to 5 mm in diameter, scattered on margins of cups, or clustered at dilated apices of proliferations, convex or depressed, scarlet. Most often sterile.

On earth and old wood, most commonly single ranked. Found at Indian Bay.

Cladonia degenerans (Floerke.) Spreng.

Primary thallus more or less evanescent, composed of medium sized flat squamules, 2 to 12 mm. long, a little less wide, ascending, scattered or clustered. Olive to sea green above, whitish below. Podetia arise from surface of squamules, 10 to 55 mm. long, .5 to 3.5 mm in diameter, irregularly cylindrical or turbinate, erect and ascending with scattered squamules, olive green to sea green; occur in large or small clusters, commonly scyphiform, proliferate,

proliferations arising from margin or from centre of cup, and solitarily or radiately arranged, ranks 1 to 5 in number, the sterile apices scyphiform, cornute, or rarely subulate. Apothecia small to medium sized, .5 to 2.5 in diameter, solitary or clustered at apices of proliferations, convex to flat, immarginate, pale to darker or reddish brown. Most commonly sterile.

Occurs on earth over rocks, or on sandy soil. Found at Indian Bay.

Cladonia fimbriata apolepta (Ach.) Wainio.

Primary thallus persistent, irregular lobate flat or concave or ascending scattered or clustered squamules, 2 to 9 mm. long and wide, olive green above, whitish below. Podetia arise from surface of squamules, quite short, 10 to 20 mm. long, cupless or narrowly scyphiform, simple or rarely branched, the sterile apices subulate, commonly straight and erect, but sometimes flexuous. Apothecia rare, borne at apices of podetia.

Occurs on earth, sandy soil and old wood. Found at Indian Bay, Man.

Cladonia fimbriata simplex (Weiss) Wainio.

Primary thallus persistent, irregular lobate and flat or involute, scattered or clustered squamules, sea green to olive green, whitish below. Podetia 3 to 30 mm. in length, scyphiform, cups well developed, 2 to 7 mm. in

diameter, regular with quite entire margins, podetia erect and straight. Apothecia sessile or pedicellate on margins of cups, rare.

Occurs on old stumps and fallen logs in bogs, and on sandy soil. Found at Indian Bay.

Cladonia furcata paradoxa (Wainio) Fink

Primary thallus often present, sometimes disappearing composed of medium sized squamules, crenately or irregularly lobed, 2 to 5 mm. long and wide, ascending, scattered or clustered, brownish to sea green above, white below. Podetia arise from surface of squamules, lower part dying away, 15 to 85 mm. long, cylindrical, dichotomously and more frequently radiately branched, erect, smooth or squamulose, sea green to brownish, branches divaricate or recurved, axils dilated and frequently perforate, apices sub erect and recurved, slender. Apothecia small, .5 to 1.5 mm in diameter, irregularly ar apices of branches, sometimes lobate or reniform, dark brown varying toward brick color.

Occurs on earth, sandy soil, rocks or old wood. Found at Indian Bay.

Cladonia furcata racemosa (Hoffm.) Floerke

Primary thallus disappearing, small and irregularly scattered squamules when present. Podetia arise from surface of squamules, lower part dying away, 50 to 90 mm. long, cylindrical, much branched, erect, smooth,

sea green to ashy color, spices dilated, slender and recurved. Apothecia tiny, at ends of branches, dark brown.

Occurs on humus over rocks. Found at Indian Bay.

Cladonia gracilis (L.) Willd.

Primary thallus usually persistent, composed of irregular ascending clustered or scattered squamules, middle sized, 2 to 5 mm. long, sea green to olive green above, white below. Podetia arise from surface of these, 10 to 75 mm. long, cylindrical and trumpet shaped or scyphiform, in large or small clusters, erect, squamulose toward the base, sea green to ashy color, simple or branched cups 1 to 6 mm. in diameter, abruptly of gradually dilated, regular or sub regular, shallow or deep, margin dentate or proliferate, rarely proliferate from centre, the ranks from 1 to 5. Apothecia middle sized, 1 to 5 mm,, borne on short pedicels arising singly or in clusters from margins of cups, pale or dark chocolate brown.

On earth, sandy soil or old wood. Found at Indian Bay.

Cladonia gracilis hybrida Tuck.

Primary thallus may be persistent, of small irregular squamules, sea green to olive green. Podetia 10 to 75 mm. long, slender and simple, unbranched. Apothecia rare. On earth and old wood. Found at Indian Bay.

Cladonia pyxidata (L.) Hoffm.

Primary thallus persistent, irregular incised ascending and clustered squamules, 2 to 8 mm. long, 1.5 to 6mm. wide, sea green to olive green above, white below. Podetia arise from surface of squamules, 3.5 to 30 mm. long, 3 to 4.5 mm. in diameter, turbinate or tubaeform, erect, cortex verrucose or subcontinuous toward the base, usually squamulose, sea green in color, closely clustered, scyphiform; the cups 1 to 7 in diameter, usually ifregular, on well developed podetia, or the dilation beginning just above the primary thallus; the cavity non-perforate, entire or proliferate from the margin, proliferations 1 or more, ranks 1 to 3. Apothecia rare, medium sized, 1 to 4 mm. in diameter, solitary or clustered on margins of cups, sessile or on pedicel, brown.

On earth and old wood. Found at Indian Bay, Charleswood, Bird's Hill.

Cladonia rangiferina (L.) Web.

Primary thallus rarely present, somposed of crustose irregular and scattered verrucae, ashy white to straw color. Podetia arise from surface of verrucae or from old podetia, dying at the base, 3 to 20 cm. long and 0.7 to 3 mm. in diameter. Subcylindrical and cupless, subdichotomously or subradiately branched, the short branches usually unilaterally deflexed, axils dilated and often perforate, apices subulate. Occurs clustered or sub solitary among other lichens, erect or rarely ascendant or even decumbent,

the sterile apices brownish, the remainder of the podetium ashy green to gray or grayish brown. Apothecia small, .5 to 2 mm. in diameter, solitary or clustered at the spices of the branches, convex, brown.

Occurs on earth over rocks, among moss, in rock crevices, or on sandy soil. Commonly associated with C. alpestris. Found at Indian Bay, Kenora, Point du Bois.

Cladonia turgida Hoffm.

Primary thallus persistent, large foliose laciniate or irregularly or sub dichotomously lobed squamules, 5 to 25 mm. long, 2 to 8 mm. wide, ascending, nearly erect, may be concave, ashy to seagreen above, white beneath. Podetia arise from surface of primary thallus, base sometimes dying away, turbinate or subcylindrical, frequently turgescent, scattered or clustered, erect or ascending, may be clothed with usually large squamules. Apices cupless, obtuse, olive brown. Cups dilate, shallow, perforate, radiately proliferate from the margin. Apothecia small or medium sized, borne at apices of branches or proliferations, brown, often perforate. On earth, especially over rocks, in cold parts.

Found at Indian Bay.

Cladonia uncialis (L.) Hoffm.

Primary thallus rarely present, composed of small irregular ascending squamules, sea green above, white below. Podetia formed from branches or fragments of old podetia,

dying at base, 20 to 75 mm. long, 1 to 3 mm in diameter, subcylindrical, usually cupless, but apices frequently dilated and somewhat scyphiform, dichotomously or radiately branched, axils perforate, cortex subcontinuous, smooth, straw colored to sea green or whitish, apices straight, subulate or radiately spinose, rarely brown. Apothecia small, at apices of branches, brick color to brown.

Occurs on ~~xxxkxx~~ bark of trees. Found at Indian Bay and at Bird's Hill.

Cladonia verticillata Hoffm. Deutsch.

Primary thallus usually persistent, irregular lobed flat or ascending clustered or scattered squamules, sea green to ashy above, white below. Podetia arise from squamules, 3 to 55 mm. long, .5 to 3.5 mm. diameter, tubaeform to turbinate, solitary or clustered, erect, with few squamules; cups are medium sized to large, 2.5 to 9 mm in diameter, usually abruptly dilated, shallow, margin subentire or dentate, commonly proliferate from the closed cavity of the cup, i.e. the top of the disk, proliferations 1 to several, ranks 2 to 5. Apothecia small to medium sized, rounded or irregular, sessile on the margins of the cups or on short pedicels, pale to dark brown.

On earth or on humus over rocks, or on sandy soil. Found at Indian Bay, Carberry.

Dermatocarpon miniatum (L.) Fr.

Thallus loosely or strongly attached by an umbilicus, somewhat orbicular in outline, the margin entire or lobed, 5 to 50 mm. in diameter, ashy to grayish brown above, smooth, below darker to black. Apothecia indicated by the pores or ostioles appearing as tiny black dots on the thallus.

Occurs on rocks, especially calcareous. Foumd near Simpon's, Indian Bay.

Evernia thamnodes (Flot.) Nyl.

Thallus fruticose, strap-shaped, ascending or pendulous, much branched, usually dichotomously, roughish above, with canals or channels below. Apothecia terminal or subterminal, but rare.

Occurs in tufts on trees, especially conifers, often associated with Usneas and Ramalinas. Found at Indian Bay, Bird's Hill, Kenora.

Graphis scripta (L.) Ach.

Thallus appears as a smooth thin ashy looking to white crust in patches over substratum. Apothecia as little streaks or lines, elongated and variously curved or brandhed very narrow and from 1 to 5 mm. in length.

Occurs on bark of trees and dead wood. Found on old fallen poplar at Kenora.

Gyrophora muhlenbergia Ach.

Thallus usually more or less irregular, or lobed, with ragged margin, middle sized or large, 5 to 17 mm. in diameter, sometimes perforate, the smooth upper surface more or less reticulately pitted. Brown to olive brown to black in color, beneath usually darker, papillose and reticulated with plates of supporting tissue. Apothecia usually in groups, raised, black and rounded or irregular in outline. Thallus attached to rocks by an umbilicus, a stem of cortical tissue.

Occurs on rocks. Found at Indian Bay and Kenora.

Lecanora hageni Ach.

Thallus crustose, small in quantity, often verrucose, sometimes scattered or disappearing, ashy green to black, closely adhering to substratum. Apothecia minute, .4 to 1 mm. in diameter, flat, adnate, disk dark brown to black, with heavy white thalloid exciple, the latter crenate or regular.

Occurs commonly on rocks, sometimes on wood, usually in association with Physcia stellaris, Lecanora muralis, etc. From Treesbank, Man.

Lecanora muralis (Schreb.) Tuck.

Thallus closely adnate, subfoliose. Lobes narrow and much divided, very thin. Sea green to ashy. Apothecia very small, .5 to 1 mm. in diameter, adnate, pale chestnut brown, with thalloid exciple entire or crenate depending on size.

Occurs very closely attached to rocks, mostly igneous. Found at Treesbank, Kenora and Indian Bay.

Lecanora rubina (Lam. & DC.) Ach.

Thallus commonly closely acnate and subfoliose, rarely foliose, attached by an umbilicus. Irregularly lobed, frequently imbricated and closely aggregated into crust. Straw green color above, black below. Apothecia scattered or clustered, small to middle sized, 1.5 to 5 mm. in diameter, sessile or adnate, palish brown to chestnut, the disk flat or irregular.

Occurs on rocks. Found at Indian Bay, Kenora and reported from Swift Current.

Lecanora subfusca (L.) Ach.

Thallus crostose, ashy or whitish, sometimes sea green appearing as thin mould -like layer in irregular patches 2 to 5 cm. in diameter over substratum. Apothecia tiny, almost sessile, .5 to 2 mm. in diameter, disk flat or some what convex, brown to black in color, with very evident exciple, entire to crenate.

Occurs on old wood and trunks of trees, rarely on rock. Found on trunks of old poplar and oak at Kenora and Indian Bay.

Lecidea anthracophila NYL.

Thallus crustose, appearing as tiny scattered granules on surface of wood. Pale green to whitish color. Apothecia middle sized, chestnut brown, rounded, sessile, with entire margins.

Occurs on old burnt wood. From Norway House.

Lecidea granulosa Hoffm. Ach.

Thallus composed of tiny irregular granules, ashy gray to green, .1 to .5 mm. in diameter, with numerous heaps of greenish or whitish soredia, widely spread over substratum, with clusters of apothecia here and there. Apothecia .3 to 1.5 mm. in diameter, adnate, black, with lighter margin, disk convex.

Occurs on bits of Jack pine wood and cedar. From Victoria Beach.

Lecidea parasema Ach.

Thallus crustaceous, sppearing as tiny granules, scattered or in patches, ashy gray to green, appearing as irregular mouldy looking spots on wood. Apothecia dark brown to black, small to middle-sized, about 1 mm. in diameter disk plane to convex or globular.

Occurs on bark of trees or dry old wood, also on rock. Found on bark of old oak and poplar at Victoria Beach.

Lecidea vernalis (L.) Ach.

Thallus composed of very minute irregular granules,

scattered or contiguous, ashy to green in color. Appears as sort of a chinky crust. Apothecia small, adnate, .1 to 5 mm. in diameter, rounded or very convex, the disk pale yellow to reddish brown.

Occurs most commonly over mosses ~~xkm~~ at the bases of trees. Found at Kenora.

Parmelia borreri Turn.

Thallus rather closely adnate, with raised margin, lobes rather large, 6 to 14 cm. diameter, sea green to pearl gray on upper surface, lower surface pale brown. Apothecia middle sized to large, 3 to 10 mm. in diameter, loosely sessile, disk chestnut, with margin entire, crenulate or irregular, usually deeply concave.

Occurs on trees and among moss on rocks. Found at Indian Bay.

Parmelia caperata L. Ach.

Thallus medium sized to large, 5 to 20 cm. in diameter, prostrate with ascendant margins, central part often entire and margins only slightly lobed; upper surface undulate, rugose, usually sorediate, the margins of the lobes incised crenate or almost entire. Straw colored to deep green, beneath black to dark brown, lighter toward margins of lobes, with scattered rhizoids. Apothecia rare, sessile, 3 to 12 mm. in diameter, disk chestnut, concave, margin crenulate or subentire. Occurs on trees, old wood and rock. Found at Indian Bay, Charleswood, Kenora.

Parmelia conspersa Ehrb. Ach.

Thallus prostrate, medium sized, 5 to 15 cm. in diameter, upper surface smooth or subrugose, lobes long and rather narrow, often sorediate toward centre, varying toward green or yellow. Lobes closely imbricated toward centre, forming continuous crust, beneath varying from brown to black. Rhizoids usually present, of same color. Apothecia common, varying in size, subsessile, 3 to 11 mm. in diameter, disk chestnut brown, concave, with crenulate or subentire or rounded margin.

Occurs on rocks and rarely on wood. Found at Indian Bay and Kenora.

Parmelia cetrata Ach.

Thallus large, 8 to 16 cm. in diameter, prostrate, with lobes crowded and ascendant, margins of lobes densely sorediate, upper surface light green, lower surface black but brown toward margins. Sterile.

On trees and old wood. Found at Indian Bay.

Parmelia encausta (Sm.) Nyl.

Thallus foliose, forming radiate patches, freely lobed, margins more or less entire, lobes much imbricated toward centre. Upper surface dark green to gray color, lower surface black to pale brown or white at margins. Mostly sterile.

On spruce and tamarack trees. Found at Indian Bay.

Parmelia Molliuscula Ach.

Thallus foliose, almost fruticose, pale green to straw color and smooth above, black beneath. Lobes very long and narrow, dichotomously branched, recurved. Apothecia not observed. Soredia and rhizoids absent.

Found on rock near Aweme, Man.

Parmelia olivacea (L.) Ach.

Thallus small, 20 to 80 mm. in diameter, closely adnate, upper surface rugose, dark olive green, beneath darker to black with scattered thizoids, lobes somewhat imbricated, with crenate margins. Apothecia small, 2 to 6 mm. in diameter, sessile or subpedicellate, disk chestnut brown margin entire or crenulate, concave or plane.

Occurs on trees and wood, often in tamarack swamps. Found at Indian Bay.

Parmelia perlata L.

Thallus prostrate, with ascendant almost erect margins, orbicular in outline, with large imbricated lobes, with rounded undulate margins, the latter often covered with white soredia, pale green to gray above, below black with lighter margins and a few rhizoids, middle sized to large, 7 to 20 cm. in diameter. Apothecia not seen.

Occurs on old wood and trees. Found at Indian Bay.

Parmelia physodes (L.) Ach.

Thallus of medium size, 5.5 to 10 cm. in diameter,

rather loosely attached to the substratum, usually quite smooth, sea green to whitish, lobes long, narrow and sinuously or dichotmously branched. Margins may be ascendant. Black or brownish black below, without rhizoids. Apothecia rare, middle-sized to large, 3 to 14 mm. in diameter, subpedicellate, disk chestnut or lighter brown, margin entire or irregular, more or less concave.

Occurs commonly on trees, rarely on rocks. Found at Indian Bay, Charleswood, Kenora.

Parmelia saxatilis (L.) Ach.

Thallus almost adnate, smooth or slightly rugose, bearing isidiod granules, ashy gray to green color, lobes long and narrow and subdichotomously branched, somewhat imbricate; beneath black, but lighter toward margins, with black rhizoids. Apothecia rarely present.

Occurs on old wood and trees. Widely distributed, found at Indian Bay, Charleswood, Bird's Hill, Kenora.

Parmelia saxatilis sulcata (Tayl.) Nyl.

Thallus not closely adnate, smooth or slightly rugose, or granular, sea green to ashy color, the lobes usually wider than P. saxatilis, and slightly paler in color. They bear rounded oblong or irregular soredia. Black underneath, or brownish toward the margins, white at edges, with black rhizoids. Apothecia not numerous, small, sessile or almost so, disk chestnut, margin entire, may be irregular, concave.

Occurs on trees and old wood, rarely on rock. Found at Indian Bay.

Parmelia tiliacea (Hoffm.) Ach.

Thallus closely adnate, sub orbicular in outline, 30 to 90 cm. in diameter, ashy gray to green, upper surface rugose, lobes short and rounded, with crenate or irregular margins, beneath black, and densely covered with rhizoids. Apothecia numerous, sessile or subpedicellate, 3 to 12 mm. in diameter, deeply concave to nearly flat, disk chestnut, margin crenulate to entire.

Occurs on trees and old wood and on rocks. Found at Indian Bay, Bird's Hill, Charleswood, Kenora.

Peltigera aphthosa L. Willd.

Thallus more or less closely attached to the substratum with the margins or the entire lobes mostly ascending, middle-sized to large, 6 to 20 cm. in diameter, sprinkled with small irregular cephalodia, smooth above, and devoid of trichomatic hyphae except those below the cephalodia. The lobes are broad and rounded, and somewhat imbricated, the margins subentire, or commonly crisped and irregular. Apple green colored to sea green or brownish, white below, with darker veins, the latter covered with dense coat of delicate rhizoids. Apothecia are on somewhat extended lobules, middle sized or larger, 4 to 8.5 mm. in diameter, ascendant, frequently becoming revolute or convolute, often superficial, the margin entire or crenulate, the disk reddish brown.

Occurs on earth and among moss on humus covered rocks. Found at Indian Bay, Kenora, Bird's Hill, Charleswood, Carberry, Treesbank.

Peltigera canina L. Hoffm.

Thallus closely adnate toward the centre, but ascending toward margins of the lobes, middle-sized to large, 7 to 20 mm. in diameter, lobes rounded or irregular or crenate, sea green to brown, below whitish or brown toward centre, with veins and rhizoids of the same color. Apothecia middle-sized to large, 4 to 8 mm. in diameter, on long and usually erect lobes, rounded or semi-revolute, the disk reddish brown and becoming vertical.

Occurs on earth or among moss over rocks, on sandy soil, or at bases of tree trunks. Found at Indian Bay, Charleswood, Bird's Hill, Kenora.

Peltigera spuria Ach. Leight.

Thallus lobes much smaller and narrower than other Peltigeras. Upper side of thallus sea green to ashy brown, the lower whitish, with few rhizoids. The fertile lobules usually digitately clustered, apothecia reddish brown, disk becoming vertical and semi-revolute.

Occurs on earth, sandy soil, and on moss over rocks. Found in sand pit at Indian Bay.

Physcia caesia (Hoffm.) Nyl.

Thallus light sea green to ashy white, beneath light or dark ,but with tiny dark rhizoids. Crusted on rocks, in patches 10 to 50 mm. in diameter, closely adnate, stellate, upper surface bearing rounded gray soredia, lobes usually quite elongated and branched, ends rounded or crenate, more or less imbricated. Apothecia tiny, sessile, disk flat or concave, dark brown to black. Rare.

Occurs on rocks. Found on rock islands at Indian Bay.

Physcia hispida (Schreb.) Tuck.

Thallus small, 6 to 20 mm. in diameter, commonly fairly ascendant, lobes elongated and narrow, apices rounded, clothed throughout with long darker fibrils, sea green in color Apothecia small, 1 to 2 mm. in diameter, sessile, flat, with entire margin.

Found on balsam bark, Victoria Beach.

Physcia obsessa Mont.

Thallus very small, with narrow lobes, closely attached, almost crusted on rocks. Ashy gray color, almost lacy looking. Apothecia very tiny, rounded and cup-like, black or dark brown colored, not numerous.

Occurs on rocks. Found at Indian Bay.

Physcia pulverulenta (Schreb.) Nyl.

Thallus medium sized, 2 to 6 cm. in diameter, usually closely adnate, but margins sometimes ascendant,

upper surface smooth, ends of lobes smoothly or irregularly rounded. Brownish to pearl gray, beneath darker, but light colored toward margin, with numerous rhizoids. Apothecia 2 to 4 mm. in diameter, sissile, disk flat or somewhat concave, dark brown, margin regular or irregular.

Occurs on trees and old wood, also on rock. Found on bark of old oak trees at Charleswood, Man.

Physcia stellaris (L.)

Thallus medium sized 20 to 85 mm. in diameter. Closely adnate, stellate, the upper surface commonly smooth, lobes may be elongated and branched, ends rounded or crenate, more or less imbricate, frequently crowded into a roughened crust toward the centre, green to whitish or brownish, beneath whitish with rhizoids. Apothecia small, 1.5 to 3.5 mm. in diameter, sessile, disc flat or slightly concave or convex, dark brown to black, margin entire to crenulate.

Occurs on trees and rocks. Very common.

Found on trees all around Winnipeg, at Bird's Hill, Charleswood, Indian Bay, Carberry, Minnedosa, Kenora.

Placodium aurantiacum (Lightf.) Hepp.

Thallus crustose, rugose, lemon colored to gray, warty looking. Apothecia small, .4 to 1 mm. in diameter, sessile, disk flat, orang or orange brown in color, the thalloid margin pale yellow and usually crenulate.

Occurs on trees and old wood. Found at Charleswood, on bark of oak. Usually associated with Physcia stellaris.

Placodium cerinum (Hoffm.) Hepp.

Thallus crustose, thin irregular layer in patches over substratum, sometimes verrucose, ashy white to gray. Apothecia small, .3 to 1.2 mm. in diameter, sessile, disk flat, reddish brown in color, exciple thalloid and entire, sometimes irregular.

Occurs on trees and old wood. Found at Charleswood on poplar bark.

Placodium elegans (Link.) Ach.

Thallus subfoliose, closely adnate or crusted on substratum, lobes long and narrow, often imbricated. Deep orange in color, varying toward paler yellow. Below white or darkening. Apothecia numerous, small to middle sized, .5 to 2 mm. in diameter, sessile, the disk flat or concave, orange colored, exciple entire or crenulate, slightly paler.

Occurs on rocks, found at Indian Bay and Kenora.

Ramalina calicaris (L.) Fr.

Thallus 5 to 30 mm. long, fruticose, and flattened, somewhat rigid, with tufted lobes, numerous and crowded, narrow and irregularly branched, gray to sea green. Apothecia 1 to 5 mm. in diameter, sub pedicellate, lateral or terminal or sub terminal, disk about same color as thallus, the thalloid exciple entire.

Occurs on trees and old wood, rarely on rocks. Found at Indian Bay, Kenora.

Ramalina calicaris farinacea (L.) Nyl.

Thallus lobes narrower and smoother, sometimes become quite long and slender, usually covered with white soredia, paler in color, more straw colored. Apothecia small, lateral or terminal, but rare.

Occurs on rocks, rarely on trees. Found in chinks of rock on islands at Indian Bay. Not common.

Rhizocarpon petraeum Wulf. Koerb.

Thallus very dark brown to black, rough and verrucose areolate, occurring in irregular patches on rocks. Apothecia minute or middle sized, .2 to 1.3 mm. in diameter, immersed or adnate, disk black or blackish brown, flat or convex, exciple present at first, later disappears. Occurs as extensive black patches on rocks, igneous and metamorphic. Found at Indian Bay, Kenora.

Rinodina sophodes confragosa Ach. Tuck.

Thallus whitish or frosted looking, verrucose. Apothecia middle sized, adnate, disk rounded and brown colored. On old wood. From Norway House.

Stereocaulon paschale (L.) Hoff.

Podetia erect, ascending or subdecumbent, 3,5 to 10 cm. long, rather slender, occurring in dense clusters, more or less compressed and somewhat cylindrical. Slightly tomentose or nearly naked, much branched. Ashy to sea green, podetia pass into short squamulose to crenate branchlets.

Apothecia terminal to sub terminal, brown to reddish brown to black, the disk flat and tiny.

Occurs on humus over rocks. Found at Indian Bay, and Kenora, usually associated with Cladonias and Peltigera.

Teloschistes chrysopthalmus (L.) Th.

Thallus tufted, subfruticose, erect, spreading or pendant, rigid, fibrillose, with long lobes often branching dichotomously, fibrils few or more numerous toward apices of lobes, yellow to sea green or orange at top, paler at bottom and on lower side. 4 to 15 mm. long. Apothecia small or medium sized, 1 to 5 mm. in diameter, terminal or sub terminal, with margin more or less ciliate, disk orange, flat or concave. Occurs on trees or old wood. Infrequent. From Kenora.

Teloschistes lychneus (Ach.) Tuck.

Thallus foliose, rather larger than T. polycarpus, 12 to 35 mm. in diameter, ascending or subprostrate, with ascendant margins, compact, lobes more or less imbricate, but not so much divided as T. polycarpus, margins isidiod granulate, lower side with more or less pale yellow fibrils, yellow to deep orange above, paler yellow below. Apothecia quite rare, bright orange to orange red, margin entire or crenulate, commonly sub pedicellate, sometimes fibrillose below. Occurs on trees and rarely on rocks. Found at Indian Bay, Treesbank, Carberry, Charleswood, Bird's Hill.

Teloschistes polycarpus Hoffm. Tuck.

Thallus foliose, 6 to 20 mm. in diameter, prostrate, the margin scarcely raised, circular or irregular, the lobes small, narrow, freely divided or sometimes much reduced, imbricated or scattered, lower side may have pale yellow fibrils on margin, yellow to deep orange above, pale beneath. Apothecia very numerous, orange or a little darker than the thallus, with paler entire or crenulate margin, rather small, concave or flat, usually subpedicellate, may be fibrillose below, 1 to 4 mm. in diameter.

Occurs on trees and old wood, rarely on rocks. Found on bark of oak, poplar, hawthorne, and other trees near Winnipeg, Bird's Hill, Carberry, Indian Bay, Kenora. Very common, usually associated with T. lychneus, and often Phscia stellaris.

Urceolaria scruposa (Schreb.)

Thallus sub orbicular, occurring in irregular patches crusted on rocks, thickened and verrucose, or passing into areolar conditions, the verrucae raised giving thallus a roughened appearance, dark gray to black color, Apothecia usually immersed, minute, .3 to 1 mm. in diameter, the disk urceolate and black, with both a proper and a thalloid exciple.

Occurs crusted on rocks, at Indian Bay, Kenora.

Usnea barbata Fr.

Thallus fruticose, stout, erect or spreading, rather

20 to 60 mm. in length, rigid, divaricately branched, grayish to sea green in color, more or less strigose, fibrillose, the branches and main trunks cylindrical. Apothecia terminal or sub terminal, 3 to 10 mm. in diameter, the disk brown with fibrils on margin. Rare.

Occurs on trees and old wood, especially in swamps. Found at Indian Bay, not fruited.

Usnea plicata (L.) (Usnea barbata plicata L. Fr.)

Thallus pendant and much elongated, slender and lax subdichotomously branched, pale green in color, fibrils absent. Apothecia not seen, rare.

Occurs on trees, particularly in swamps and bogs.

Xylographa parallela (Ach.) E. Fries

Thallus developed within the substratum. Apothecia appear as tiny black dashes in almost parallel rows.
On wood, from Norway House.