

(1) Capability of thriving under great and sudden changes of temperature, and of humidity and aridity of atmosphere and soil.

(2) (a) Some varieties to very limy soils; (b) others to very sandy soils. Few are found equally adapted to both.

(3) There is room for much work in improving varieties especially adapted to this region in every class of fruits, as the work of originating varieties especially adapted to it is in its infancy.

MENDELIAN INHERITANCE IN PRUNUS HYBRIDS

S. A. BEACH AND T. J. MANEY

Ames, Iowa

The following data are offered as a contribution to our knowledge of Mendelian inheritance in *Prunus* hybrids. Brief notes on the correlation of certain characters are also given. Although these data do not supply a sufficient basis for the demonstration of conclusive results, they do in some instances give striking indications of the operation of Mendelian factors.

Material under investigation.—The material under observation consists of two general classes of F_2 *Prunus* hybrids produced by unguarded F_1 parents. One class is composed of sandcherry-cherry hybrids, the other of sandcherry-plum hybrids.

The sandcherry-cherry hybrids, *Prunus besseyi* \times *Prunus cerasus*, consist of F_2 plants from seed of the Montbesseyi, which is a named horticultural variety produced by Theo. Williams, Benson, Nebr., by cross-pollinating the western sandcherry, *Prunus besseyi* Bailey, with pollen of the Montmorency, a horticultural variety of the common garden cherry, *Prunus cerasus* Linn. The forms of leaf of Montbesseyi and its parents are shown in figure 1.

The sandcherry-plum hybrids, *Prunus besseyi* \times *Prunus americana*, consist of F_2 plants from seed of F_1 hybrids known as Wagner Nos. 2, 4, and 6. These were originated by J. F. Wagner, Bennett, Iowa, by pollinating the Dwarf Rocky Mountain cherry of Pennock, a horticultural variety of *P. besseyi*, with pollen of the Wyant plum, a cultivated variety of the native *P. americana*. The forms of leaf of these Wagner Nos. 2, 4, and 6 and their parents are shown in figure 2.

As has been remarked, the F_2 plants above mentioned all came from F_1 unguarded parents, which fact introduces an element of uncertainty into the interpretation of the results. But the populations under

observation are so large that it is probable that the general averages do not differ greatly from those which would have been found with corresponding populations from guarded seed. The general character of the different sets of plants mentioned is such as to support this opinion. The results are all of interest from the Mendelian point of view. Those on immunity from aphid are especially significant to practical plant breeders as bearing upon the question of breeding varieties of plants possessing immunity from certain insect pests.

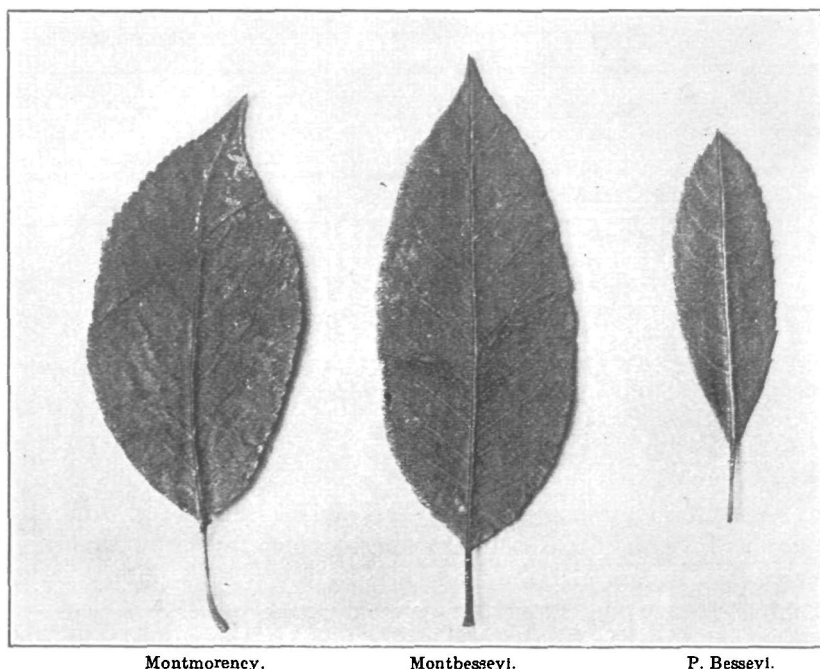


FIG. 1. LEAF FORMS OF MONTBESSEYI AND ITS PARENTS.

In view of all these considerations and of the fact that the production of new sets of plants from guarded seeds and the development of them to the age of those used by the writers would require six years or more, it has seemed best to present a preliminary report at this time. This is done with the hope that it may help to interest others in the matter of Mendelian characters in *Prunus* hybrids.

Characters observed.—Observations were made on the inheritance of the characters of color of foliage, form of leaf, persistence of stipules, habit of tree growth, and immunity from plant lice. The correlation of certain characters was also noted.

In studying the different characters the population was generally classified into these four groups:

- (1) Individuals most closely approximating the type of the mother P_1 .
 - (1a) Intermediates which most favor the mother type P_1 .
 - (2a) Intermediates favoring the male parent P_1 .
- (2) Individuals most closely approximating the type of the male parent P_1 .

Color of foliage.—The sandcherry is characterized by foliage having a rather pale green, glabrous, shiny upper surface, with the under surface of a lighter and softer greenish gray. The Montmorency cherry has a leaf which is comparatively dark green, as also has the Wyant plum. Classified according to leaf color, the F_2 plants gave the following records:

Group.	Sandcherry \times Montmorency, F_2 .		Sandcherry \times Wyant, F_2 .	
	Number.	Per cent.	Number.	Per cent.
1	44	34.2	31	24.8
1a	50	38.7	..	....
2a	..	....	50	40.0
2	35	27.1	44	35.2
Total population.	129	....	125	....

It is remarkably interesting that among the sandcherry-Montmorency hybrids there are no intermediates which favor the Montmorency, class 2a, but with the sandcherry-Wyant hybrids, on the other hand, there are no intermediates which favor the sandcherry, class 1a. Thus it appears that in one case the sandcherry color is either dominant or imperfectly dominant and the cherry color is distinctly recessive, while in the other case the plum color is either dominant or imperfectly dominant and the sandcherry color is distinctly recessive. In both hybrid groups there was a clear demarcation between the recessives and the dominants or imperfect dominants.

Form of leaf.—Inheritance of form in the leaf was studied by comparing the F_2 Prunus hybrids with their F_1 parents and more especially with their grandparents, the sandcherry and the cherry or the sandcherry and the plum as the case might be. This showed at once that in these plants the form of the leaf is determined neither by a single factor nor by any set of factors combined together so as to act as a unit. It was found, for example, that an F_2 hybrid might have the

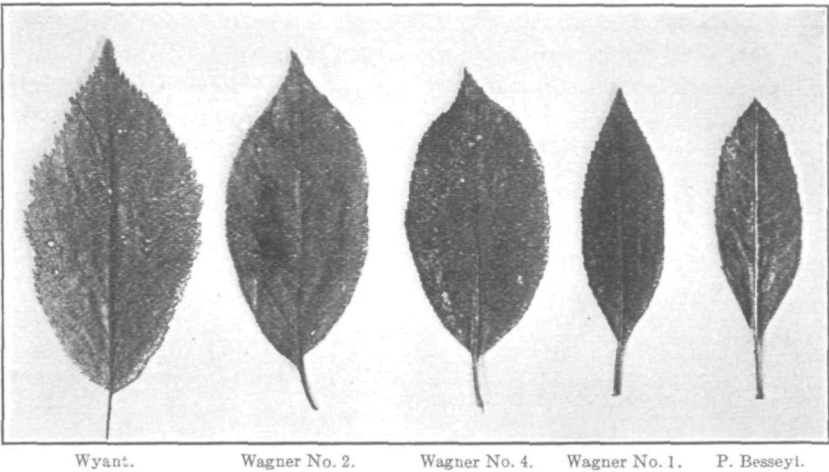


FIG. 2. LEAF FORMS OF WAGNER HYBRIDS AND THEIR PARENTS.

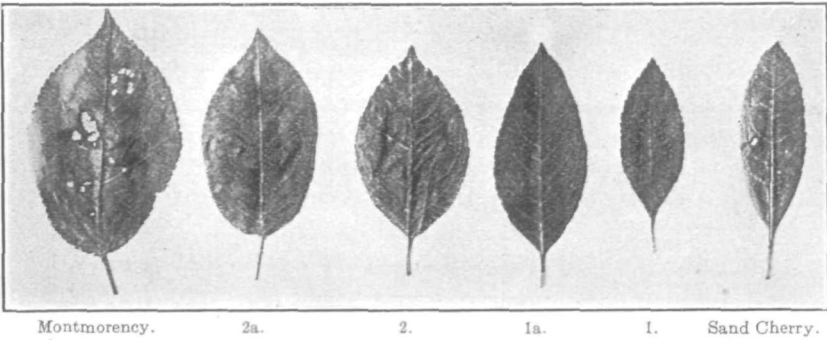


FIG. 3. PRUNUS BESSEYI \times MONTMORENCY.

Base forms of leaves of Montmorency and Sandcherry, and their Hybrids.

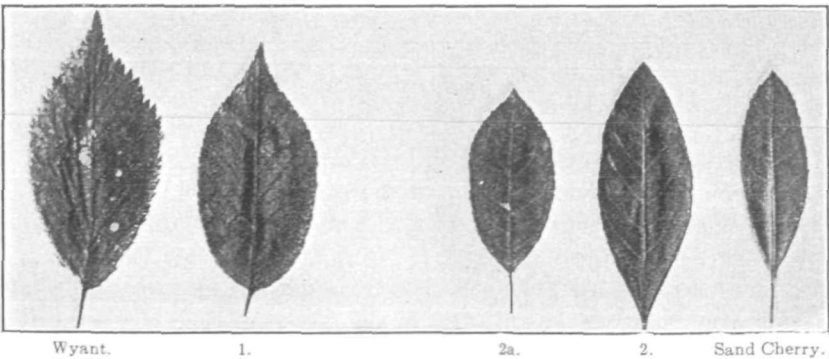


FIG. 4. PRUNUS BESSEYI \times WYANT F_1 .

Base forms of Wyant, and Sandcherry and their F_1 Hybrids.

characteristic tip of the Wyant leaf combined with a base similar to that of the sandcherry, or vice versa it might resemble Wyant in base and the sandcherry in tip, or again it might show intermediate forms in either base or tip. In like manner other parts of the leaf might resemble the plum in one particular and the sandcherry in another. Similar recombinations were found in the sandcherry-cherry hybrids. All this is evidence that the ultimate form of the leaf is the resultant

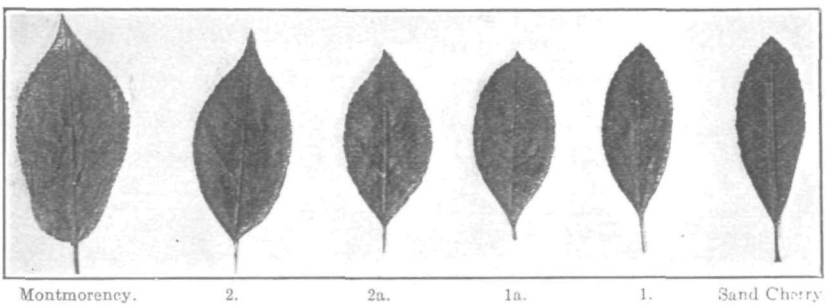


FIG. 5. PRUNUS BESSYI X MONTMORENCY F₂.
Tip forms of Montmorency and Sandcherry and their F₂ Hybrids.

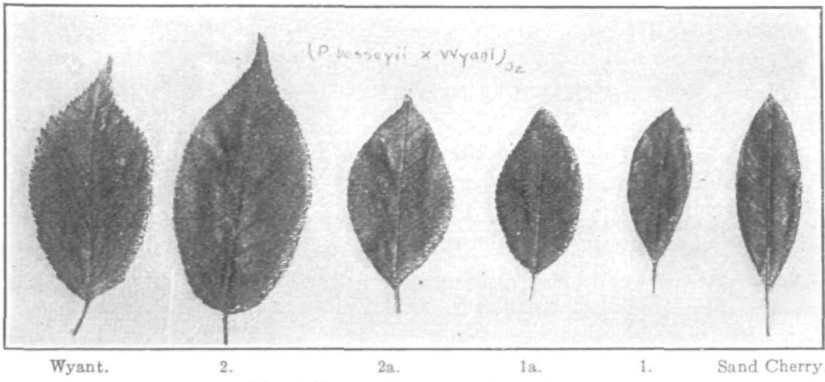


FIG. 6. PRUNUS BESSEYI X WYANT F₂.
Tip forms of Wyant and Sandcherry and their F₂ hybrids.

of various separable growth factors. In order to get data as to what characters entering into the form of the leaf are transmitted in these Prunus hybrids as unit characters, a comparison of the F₂ plants with their F₁ ancestors was made. Normally developed leaves from median nodes were used in all these comparisons.

Following is an account of some of the results of such comparison:
Base of leaf.—The base of the sandcherry leaf is characteristically different from that of either the Montmorency cherry or the Wyant

plum, as is shown in figure 3 and figure 4. It is narrow and makes an acute angle with the petiole, while that of the Montmorency is rounded and blunt and that of the Wyant varies from roundish to a nearly 60° angle.

The following table shows the classification with respect to the form of the base of the leaf:

Group.	Sandcherry × Montmorency, F ₂		Sandcherry × Wyant, F ₂	
	Number.	Per cent.	Number.	Per cent.
1	39	30.2+	25	20.0
1a	30	23.2+	18	14.4
2a	28	21.7+	..	....
2	32	24.8+	82	65.6
Total population..	129	....	125	....

Where Montmorency was used as a male parent the sandcherry hybrids appear fairly evenly distributed among the different classes, there being not far from one-fourth of the population in each class.

Where Wyant was the male parent the Mendelian proportions were not so evident. The Wyant character dominated in a majority of cases. Only about 15 per cent of the plants were intermediates, and these favored the sandcherry in the form of the base of the leaf.

Tip of leaf.—The leaf of Montmorency is characterized by a broad limb with taper-pointed tip, as also is that of Wyant, but the sandcherry leaf is narrow with a rather obtuse tip. See figure 5 and figure 6. Following is the classification of the F₂ plants with respect to the leaf tip:

Group.	Sandcherry × Montmorency, F ₂		Sandcherry × Wyant, F ₂	
	Number.	Per cent.	Number.	Per cent.
1	29	22.40	19	15.2
1a	22	17.05	19	15.2
2a	45	34.80	43	34.4
2	33	25.57	44	35.2
Total population..	129	.....	125	....

The sandcherry-Montmorency hybrids approximate the 25 per cent expected according to the monohybrid formula in the groups 1 and 2. The distribution in the intermediate groups 1a and 2a indicates the

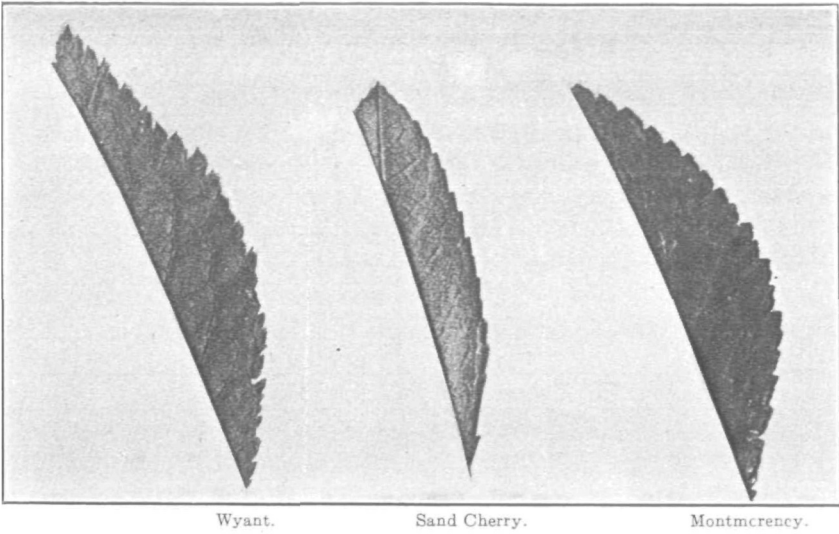


FIG. 7. TYPES OF SERRATIONS.
The simple obtuse serration of the sandcherry as compared with the rather acute serrations of the Montmorency and Wyant.

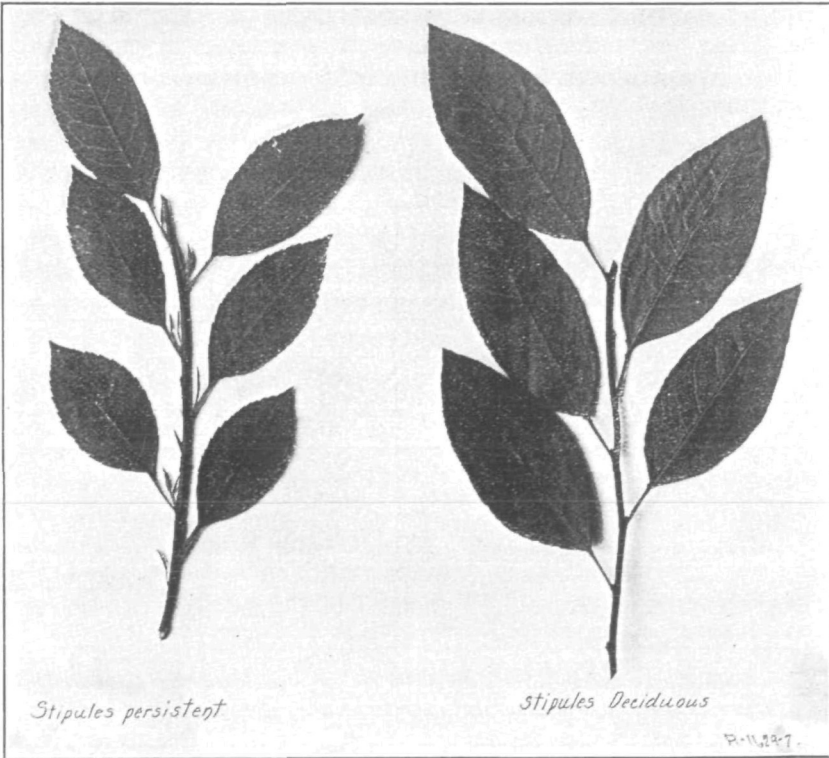


FIG. 8. PERSISTENCY AND DECIDUOUSNESS OF STIPULES OF F₂ HYBRIDS OF SANDCHERRY X MONTMORENCY.

imperfect dominance of the Montmorency tip. The Wyant tip likewise appears imperfectly dominant, but the groups 1 and 2 do not in this case approximate the expected 25 per cent.

Serration.—The serration of the sandcherry is simple and obtuse, while that of Wyant is sharply acute and often double. See figure 7.

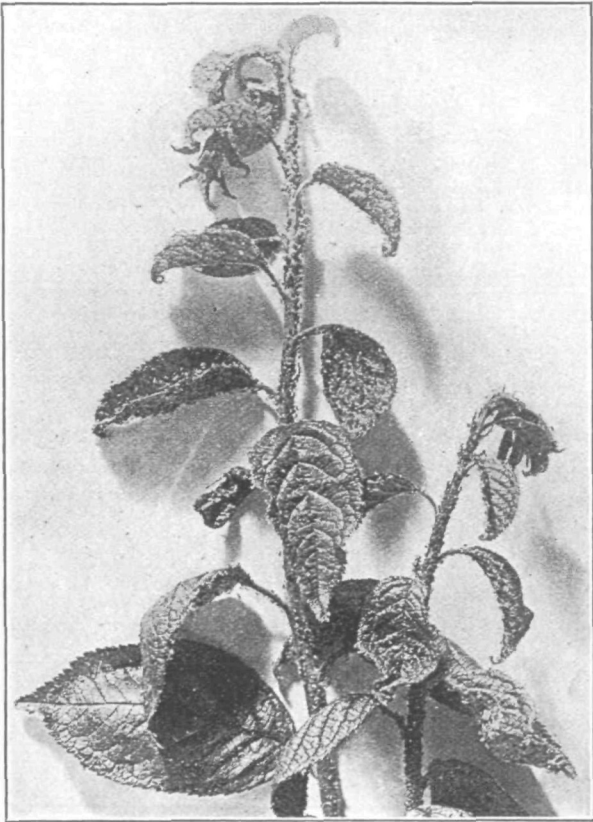


FIG. 9. WYANT BRANCH SHOWING SEVERE INFECTION WITH APHIS.

Following is the classification of the F_2 sandcherry-Wyant hybrids with respect to this character:

Group.	Number.	Per cent.
1	46	36.8+
1a	34	27.2
2a	12	9.6
2	33	26.0
Total population.....	125	

It appears that the Wyant character is recessive and the sandcherry dominant or imperfectly dominant for the most part.

Number of serrations.—As a result of numerous measurements it was found that the number of serrations to the inch averaged 9.7 on



FIG. 10. SANDCHERRY BRANCH SHOWING TOTAL FREEDOM FROM APHIS ATTACK.

the sandcherry and 12.6 on Wyant. The classification follows. The results are inconclusive.

Group.	Number.	Per cent.
1	14	11.2
1a	29	23.2
2a	37	29.6
2	45	36.0
Total population.....	125	....

Ratio of length to width.—In making this classification ten typical leaves each of sandcherry and plum were measured in inches and the ratio of the length to the width of each was ascertained.

The sandcherry has a long and comparatively narrow leaf. In this case the ratio went as high as 3.12": 1.00"; and as low as 2.65": 1.00".

The Wyant plum has a long leaf, but it is also quite broad. In this case the ratio ran as high as 2.32": 1.00", and as low as 1.95": 1.00".

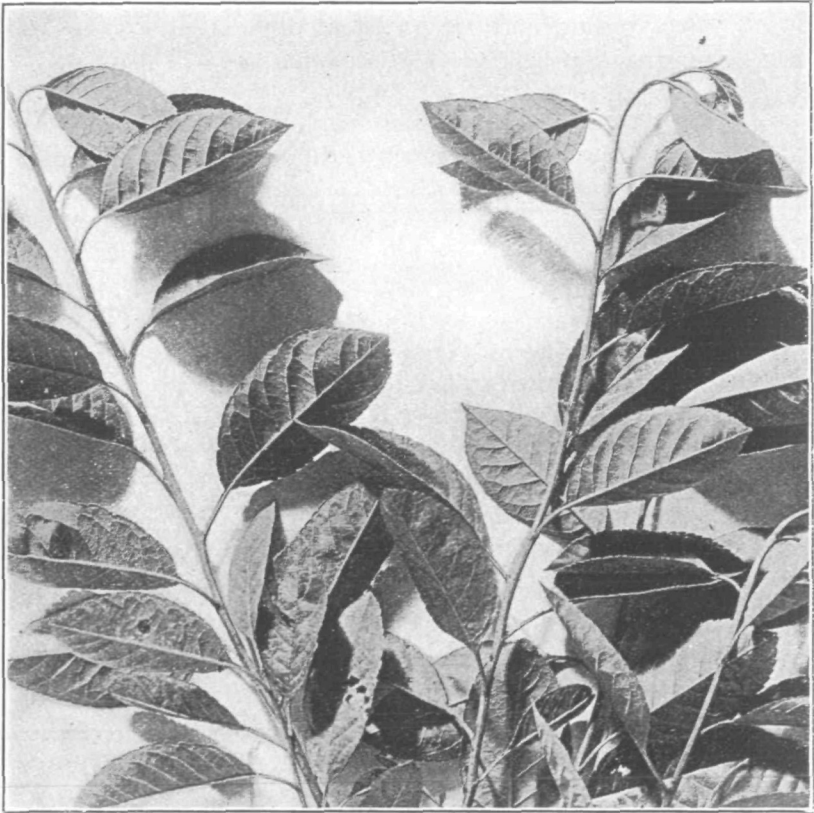


FIG. 11. HYBRIDS OF SANDCHERRY X WYANT SHOWING FREEDOM FROM APHIS ATTACK.

On the basis of these ratios the following grouping was worked out. Typical leaves from 123 of the hybrids were measured and the ratios determined. The result as given in the following table shows that the sandcherry takes the place of a Mendelian recessive in this character.

Group.	Number.	Per cent.	Ratio.
1	30	24.3	2.65" and above: 1.00"
1a	21	17.07	2.45" to 2.65": 1.00"
2a	14	11.3	2.32" to 2.45": 1.00"
2	58	47.1	2.32" and less: 1.00"
Total population.....	123	....	....

Stipules.—In the Montmorency cherry the stipules are early deciduous, while in the sandcherry they are persistent. In the F₂ hybrids the stipules on some plants are persistent while on others they are early deciduous. See figure 8. An examination of F₂ plants made late in the season showed the character of persistent stipules to be recessive. Following is the classification as made at that time. Possibly observations continued from spring to fall might discover intermediate forms.

Group.	Sandcherry × Montmorency, F ₂ .	
	Number.	Per cent.
1	96	74.4
1a	..	....
2a	..	....
2	33	25.6
Total population.....	129	....

Habit of tree.—These F₂ hybrid trees are standing about 8 inches apart in nursery rows on fertile black prairie soil. The conditions favor vigorous growth. Marked differences in habit of tree appear among the various individuals. Some are tall and thrifty and are now at least 9 feet high. Others are very dwarf, being not more than from 12 to 15 inches high. Cherry trees of the same nursery age are 6 feet or more in height, while the most vigorous sandcherries have reached a height of 3½ to 4 feet. The following classification of the F₂ plants is based on estimates by the eye, rather than on exact measurements.

Group.	Sandcherry × Montmorency, F ₂ .		Sandcherry × Wyant, F ₂ .	
	Number.	Per cent.	Number.	Per cent.
1	32	25.8+	30	24.0
1a	22	17.7+	15	12.0
2a	60	48.3	62	49.6
2	10	8.06	18	14.4
Total population..	124	....	125	....

In both sets of hybrids the sandcherry habit of growth appears to take the place of a Mendelian recessive, while the cherry and plum respectively show imperfect dominance.

Aphis resistance.—During the summer of 1910 aphis was very abundant on cherry and plum foliage at Ames. Adjacent to the rows of



FIG. 12. F_2 HYBRID OF SANDCHERRY \times WYANT SHOWING APHIS INFESTATION.

F_2 plants of the sandcherry \times Montmorency hybrids and separated from them by a distance of only 4 feet, stood a nursery row of 63 seedlings of the Bixby plum of about the same age as the hybrids. The Bixby seedlings were all badly infested with aphis. Among the adjacent F_2 hybrids mentioned some were attacked by the aphis while others were immune throughout the season. No aphis was found on the sandcherry. See figure 10.

Similar results were found with the hybrids of sandcherry \times Wyant. See figures 10, 11, 12. Whether the immunity in these cases was due to physiological or to structural characters of the leaf has not been determined.

The following statement shows the classification of these hybrids with respect to immunity from aphid.

Group.	Sandcherry \times Montmorency, F ₂ .		Sandcherry \times Wyant, F ₁	
	Number.	Per cent.	Number.	Per cent.
1	96	74.4	92	73.6
1a	..	.....	..	.....
2a	..	.....	..	.....
2	33	25.6	33	26.4
Total population	129	.....	125	.....

From this it appears that in both sets of hybrid plants the character of immunity from aphid is Mendelian. Susceptibility to aphid attacks is transmitted by both the Montmorency cherry and by the Wyant plum as a recessive character, being found in approximately 25 per cent of the F₂ population.

Correlation.—It was observed that in the F₂ hybrids of sandcherry \times Montmorency all plants which were infested with aphid and had leaves with the Montmorency type of base also had the Montmorency type of color of foliage. However, the converse did not hold true.

With a single exception all of the F₂ hybrids of sandcherry \times Wyant which were infested with the aphid and which had foliage with the Wyant type of color also had leaves with the Wyant type of base. The converse did not hold true. The leaf of the exceptional plant referred to had an intermediate form of base favoring the sandcherry.

The hybrid plants which were attacked by the aphid resembled in texture the Montmorency or Wyant respectively, according to their parentage, while those which were immune from the aphid resembled the sandcherry most closely in form, color and texture.