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The Limits in Hybridization of Vitis Rotundifolia With Related Species and Genera

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Division of Horticulture

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
CONDUCTED JOINTLY BY THE
STATE DEPARTMENT OF AGRICULTURE
AND THE
NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING
RALEIGH AND WEST RALEIGH

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THE LIMITS IN HYBRIDIZATION OF VITIS ROTUNDIFOLIA WITH RELATED SPECIES AND GENERA

FIRST REPORT*

L. R. DETJEN, Assistant Horticulturist

INTRODUCTION

The investigational work with Muscadine grapes at the North Carolina Agricultural Experiment Station has proceeded to a point where it has become both desirable and necessary to determine at least the approximate limits within which hybridization of individuals of this species with other species, and even genera, can be effected. Such a determination being made, there is no doubt that conclusions concerning the most profitable course to pursue in the work of hybridization can be drawn, thus gaining valuable information and time in the work of improving this most important Southern grape.

Some work along this line has already been done, but because of the meagre amount of literature on the subject and its evident lack of support in the form of results of systematic investigation, as well as for the sake of collecting and preserving the facts concerning what has been accomplished, a brief review of the work of earlier grape breeders with special regard to the limits within which Vitis rotundifolia can be hybridized will first be made.

A REVIEW OF THE WORK ON HYBRIDIZATION OF VITIS ROTUNDIFOLIA

1. WORK OF VAN BUREN, CLARKSVILLE, GA., PRIOR TO 1868.

From all that we can learn of Van Buren's work in hybridizing Vitis rotundifolia, we find that he never was successful in producing a hybrid of this with any other species.

2. WORK OF DR. PETER WYLIE, CHESTER, S. C., PRIOR TO 1877.

From the meagre evidence that is available of Dr. Peter Wylie's work on the hybridization of the Rotundifolia grapes, we learn that he was without doubt the first to produce hybrids with Vitis rotundifolia. These hybrids were the progeny of Vitis vinifera crossed with pollen from Vitis rotundifolia.

Because of the brevity of the article in which Dr. Wylie sets forth his conclusions drawn from work that he did with Vitis rotundifolia, the last two paragraphs from his report on progress of his experiments in

* Original manuscript submitted for publication January, 1919.

hybridizing this species of grape found on page 116 of the Am. Pom. Soc. Report for 1871 are herewith reproduced.

My experience will go far to establish the following facts, viz.: that we cannot fertilize the Scuppernong with the pollen from any other species, or their hybrid varieties, or with male (staminate) hybrid Scuppernongs. Second, that we can impregnate the Foreign, (*vitis vinifera,*) with pollen from the Scuppernong, producing thereby only male (staminate) plants, and imperfect hermaphrodite or pistillate plants, which bear no fruit. Third, that we cannot impregnate Labrusca, Æstivalis, Cordifolia, or their hybrids with Foreign (*vitis vinifera,*) with pollen from Scuppernong. Fourth, that we can fertilize both native and foreign and their hybrids, with male (staminate) hybrid Scuppernong pollen, producing thereby prolific hybrid Scuppernong vines. Fifth, that we can fertilize those prolific hybrid Scuppernong plants, with pollen from the hybrid male (staminate) Scuppernong vines, thereby giving more of the Scuppernong constitution to the progeny. I find that the seed of the prolific hybrid Scuppernongs grow, and that you can impregnate other varieties with pollen from prolific hybrid Scuppernongs.

Owing to various circumstances, which I will not attempt to detail, I have not pushed the production of prolific hybrid Scuppernongs, as rapidly as I expected and desired. There is one difficulty in using the hybrid Scuppernong pollen, where we have no hot-house; it blooms, like the Scuppernong, after nearly every other grape has done blooming; but, besides this difficulty, I have lost many plants and seed already hybridized, from other sources.

Without a doubt but rather unfortunately, Dr. Wylie uses the term Scuppernong as a specific (quite customary in his day and not even now completely eradicated from the vocabulary of the layman) instead of a varietal name as we find it in our present-day nomenclature. By keeping this terminology clearly in mind, the five conclusions reached by Dr. Wylie seem not as hazy and contradictory as might appear at first glance. By substituting the words Vitis rotundifolia in place of his term Scuppernong, these conclusions will read as follows: "First, that we cannot fertilize Vitis rotundifolia with the pollen from any other species, or their hybrid varieties, or with male (staminate) hybrid Rotundifolia vines. Second, that we can impregnate the foreign, (*vitis vinifera,*) with pollen from Vitis rotundifolia, producing thereby only male (staminate) plants, and imperfect hermaphrodite or pistillate plants, which bear no fruit. Third, that we cannot impregnate Labrusca, Æstivalis, Cordifolia, or their hybrids with Foreign (*vitis vinifera,*) with pollen from Vitis rotundifolia. Fourth, that we can fertilize both native and foreign and their hybrids, with male (staminate) hybrid Rotundifolia pollen, producing thereby prolific hybrid Rotundifolia vines. Fifth, that we can fertilize those prolific hybrid Rotundifolia plants, with pollen from the hybrid male (staminate) Rotundifolia vines, thereby giving more of the Rotundifolia constitution to the progeny. I find that the seed of the prolific hybrid Rotundifolia vines grow, and that you can impregnate other varieties with pollen from prolific hybrid Rotundifolia vines."

In the second conclusion, we see where Dr. Wylie successfully hybridized Vitis vinifera with pollen from Vitis rotundifolia. From the hybrid seeds he grew progeny which consisted of two types, namely: male (staminate) plants and imperfect hermaphrodite plants which bore no fruit.

Although these hybrid vines are nowhere described, any doubt as to the authenticity of their hybrid nature is soon dispelled when we read that the imperfect hermaphroditic plants bear no fruit. This means that they were practically sterile. From our work with hybrids of this nature to be published in another bulletin, we have observed that this sterility is very pronounced and typical in the F_1 hybrids and such sterility should not occur if his seedlings were not true hybrids. Furthermore, in his last paragraph, Dr. Wylie clearly states that the blooming period of these hybrid vines is like that of the "Scuppernong" (meaning V. rotundifolia) which is later than that of nearly every other species. With us V. rotundifolia begins to bloom fully two weeks later than V. vinifera, and some of the hybrids also bloom at a similarly late date. Unfortunately these Rotundifolia hybrid vines of Dr. Wylie were lost to horticulture during a period of misfortune that befell that great Grape Breeder.

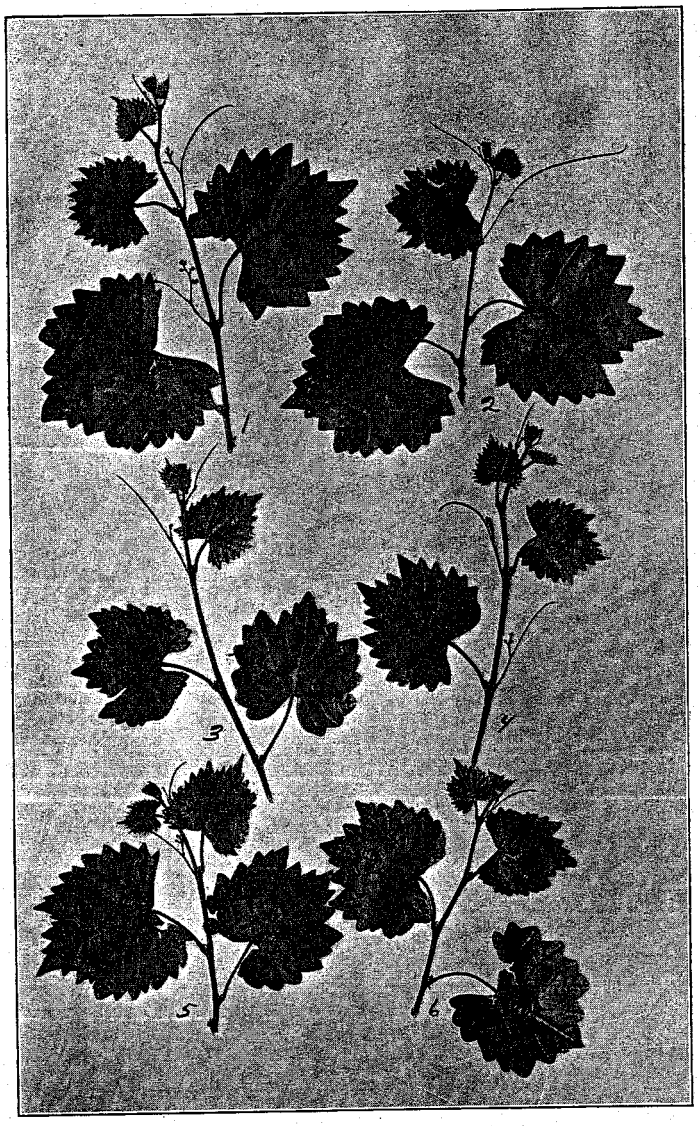
From this data, meagre as it is, the evidence is quite clear that Dr. Wylie must be recognized as having been the first to successfully hybridize Vitis vinifera with Vitis rotundifolia pollen.

Dr. Wylie failed completely to hybridize Vitis rotundifolia with pollen from any species of Euvitis, their hybrids, and even from his own male (staminate) hybrid Rotundifolia vines. He also failed completely to hybridize V. labrusca, V. æstivalis, V. cordifilia or any other native species of Vitis or their hybrids with V. vinifera, with pollen from V. rotundifolia. It seems his conclusions were based on insufficient experimental evidence because many such hybrids have since been produced.

From the very nature of the sterility of the F_1 hybrids with species of Euvitis, and also from the fact that hermaphroditic varieties are frequently subject to self-fertilization in the bud, Beach* (1), M. J. Dorsey (2), Hedrick and Anthony (3), it seems rather doubtful whether Dr. Wylie actually produced the attenuated (prolific) hybrids as he states in his fourth and fifth conclusions.

This resumé practically covers the most important part of Dr. Wylie's work in the hybridization of Vitis rotundifolia with related species and genera. He performed much work and attempted to establish and formulate limits beyond which hybridization cannot be effected, but fell far short of attaining that end. His conclusions are, therefore, subject to revision.

* References to cited literature will be made by number.



Six fruiting branches of as many vines which Dr. Munson placed on the market as being hybrids between V. rotundifolia and species of Euvitis. The six varieties are known as follows: (1) Sanalba, (2) Labama, (3) La Salle, (4) San Jacinto, (5) San Melaska, (6) Sanmonta. Reduced.

3. WORK OF PROFESSOR A. MILLARDET, FRANCE, SUBSEQUENT TO 1877.

All we can learn of the work of Prof. A. Millardet on the hybridization of the Rotundifolia grape is that he never was successful in its hybridization. He produced a lot of seedling vines which he fully believed were true hybrids but which we shall later learn were apparently only direct descendants of Vitis rotundifolia.

4. WORK OF DR. T. V. MUNSON, DENISON, TEXAS, 1890-1900.

In 1891 Dr. T. V. Munson saved seed from fruits of a Scuppernong vine which he presumed to have been pollinated and fertilized with pollen from some near-by Post-Oak x Herbemont hybrid vines. From the resulting seedlings of this lot he saved some 50 vines which he considered as hybrids, for a trial in his nursery. From these 50 seedlings he finally selected two which he named La Salle and San Jacinto and these he propagated and disseminated as his first hybrid varieties.

In 1898 Dr. Munson covered some flower clusters on the San Jacinto vine with tissue paper bags and pollinated these with pollen from Brilliant, which is a Labrusca-Vinifera-Bourquiniana hybrid. From the seeds produced by these clusters he grew some 200 plants from which he selected 85 for trial in his nursery. From these he finally selected four vines for propagation and dissemination and named them Sanalba, Sanmelaska, Sanamonta and Sanrubra.

Dr. Munson also made a number of hybrids between Vitis rotundifolia and Vitis munsoniana, chief among which is the DeSoto.

With the exception of the last one, one vine of each of the above named varieties was secured by the North Carolina Experiment Station in January, 1909, and these plants have since that time been constantly under observation. After a time, the observations made gave rise to some doubt as to their real hybrid origin, and more recently to a very careful comparison of these vines with known hybrid material produced in the breeding plots at this Station. These comparisons together with conclusions drawn from them will appear in a separate bulletin which will follow immediately.

Although we regret it very much, suffice it to say here that while Dr. Munson firmly believed he had produced hybrids between V. rotundifolia and species of Euvitis and disseminated his choicest selected vines as such, these vines are not true hybrids but only seedling vines directly descended from the Muscadinia group.

5. WORK OF THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION 1911 AND 1912.

The North Carolina Agricultural Experiment Station began (4) its work in the hybridization of Vitis rotundifolia with related species in the spring of 1911. During this season, all of the work was confined to

an effort to hybridize the variety Scuppernong with pollen from Vitis æstivalis, Vitis cinera, Vitis bourquiniana variety Herbemont and from the Labrusca-Vinifera hybrid variety Niagara. No hybrid fruits were secured from these crosses. The one seedling vine that was reported as having been secured from the Scuppernong-Herbemont cross proved itself in later years to be only a straight seedling of Vitis rotundifolia.

In 1912 the effort to hybridize the variety Scuppernong was repeated. Scuppernong flowers were again dusted with pollen from Vitis æstivalis, Vitis bourquiniana variety Herbemont and from the Vinifera-Labrusca-Æstivalis hybrid variety Winchell. No hybrid fruits were secured from this work.

Two other crosses, Herbemont and Winchell varieties crossed with pollen from a light-colored staminate vine of Vitis rotundifolia, were made during this season but were not reported because no definite conclusions had been reached in regard to their character up to the time of publishing the last report.

The conclusions drawn in 1914 were to the effect that the variety Scuppernong would not readily hybridize with pollen from V. æstivalis, V. cinerea, V. bourquiniana var. Herbemont and the hybrid varieties Niagara and Winchell. These conclusions have been substantiated by the more extensive work of subsequent years.

6. WORK OF THE VITICULTURAL DIVISION OF THE U. S. DEPARTMENT OF AGRICULTURE, 1911-1917.

The Viticultural Division of the U. S. Department of Agriculture began its work on the hybridization of Vitis rotundifolia with species of Euvitis in 1911. A brief discussion of this work follows.

In 1911 the efforts of hybridizing V. rotundifolia were reported as having resulted in a complete failure.

In 1912 one supposed hybrid was secured, a cross between the Rotundifolia Munsoniana hybrid variety Eden as the female parent and V. vinfera variety Flame Tokay as the pollen parent. This supposed hybrid is described thus, "While it is distinct from other Muscadine seedlings of Eden parentage, it is predominantly Muscadine in character and shows no resemblance to Flame Tokay except in leaves." From the description of this vine and with a fairly good knowledge of the character of these hybrids in general, we should assume it to be probable that this supposed hybrid is similar to those produced by Professor A. Millardet of France and those produced later by Dr. T. V. Munson of Denison, Texas, which will be found discussed under the caption "False Hybrids" in the succeeding bulletin on "Some F_1 Hybrids between Vitis Rotundifolia and Related Species."

The Department reports that in 1913 twenty-two hybrids were produced, of which only eight survived the vicissitudes of the seed bed.

Seven of these surviving vines are said to be of Olivette de Vendemain parentage; no mention is made of the other parent vine. The offspring of this Olivette de Vendemain are described as "Variable in vigor and character, some being vigorous and others weak; some are more Vinifera in type and others more Muscadine." The eighth seedling was the result of crossing the variety Scuppernong with pollen from the variety Winchell. This seedling is reported as being the only hybrid that has been secured by the Department from Scuppernong parentage. It is described thus: "It resembles Winchell more than Scuppernong, though from a Scuppernong seed." The description of this vine, meagre as it is, when compared with the description of a similar but reverse cross, Winchell x Rotundifolia produced by the North Carolina Agricultural Experiment Station in 1912 and which will be found described in the succeeding bulletin, seems sufficient to warrant calling this seedling a true hybrid.

The Department reports that in 1914 the following hybrids were produced and now are growing at Willard, N. C.:

2 seedlings of Eden × Maravilla de Malaga.
1 seedling of Thomas × Rodites.
3 seedlings of Thomas × Carignane.
1 seedling of Thomas × Noah.
1 seedling of V16 R6 B2 × Carignane.
3 seedlings of V17 R6 B2 × Terret Monstre.

In 1915 seventy hybrid seedlings were produced which are represented by the following Euvitis varieties:

Muscat of Alexander	(V. vinifera)
Calabrian	(V. vinifera)
Ferrara	(V. vinifera)
Rodites	(V. vinifera)
Semillon	(V. vinifera)
White Hanepoot	(V. vinifera)
Prune de Cazouls	(V. vinifera)
Huasco	(V. vinifera)
Winchell	(Labrusca-Vinifera-Æstivalis)
Goethe	(Vinifera-Labrusca)
Brilliant	(Labrusca-Vinifera-Bourquiniana)
Catawba	(Labrusca-Vinifera)
Iona	(Labrusca-Vinifera)
Ives	(Labrusca-Æstivalis)

In 1916 a larger crop of hybrid seeds were secured and many seedlings are reported to be growing.

In all of the hybridization work, only imperfect hermaphroditic Muscadine vines were used as the female parents because of their dicœciousness, and reciprocal crosses apparently were not attempted.

The Department reports that of the commercial varieties, Thomas seems the most congenial to the pollen of Euvitis varieties, although some Muscadine seedlings seem even more promising for work in hybridization.

It will be noticed from the foregoing that the given varieties of Euvitis will easily fall into two categories; namely, those of the pure species of Vitis vinifera, and those that are of hybrid origin. Thus only one pure species, Vitis vinifera, is represented in all of this work and all of the other Euvitis varieties, with only one exception (Ives), also contain some blood of the Vitis vinifera species.

While these results represent a large amount of work and are of much practical importance and value, yet that broader field which pertains to different species and genera and reciprocal crosses seems to have been entirely neglected. Results secured from hybrid varieties always will represent what can be done with that or a similar variety and no more, except where bridging becomes a necessity.

This concludes the review of the work on the hybridization of Vitis rotundifolia with related species as has been reported from time to time in Horticultural literature.

WORK DONE AT THE NORTH CAROLINA EXPERIMENT STATION 1912-1918 INCLUSIVE

1. SCOPE OF THE WORK IN HYBRIDIZATION.

From a commercial point of view, the Rotundifolia grapes have proven their worthiness of a place in our permanent national horticulture. The layman has begun to appreciate the real economic value of the vine and his demands for the products of this grape are large and ever on the increase. As never before people all over the world are looking upon Vitis rotundifolia as a new, distinct and valuable asset to our viticulture.

Although Vitis rotundifolia is so valuable and so full of greater promise, it is defective notably in the unimproved state of the vine and natural undesirable characters of the fruit. The former is easily overcome, but the latter is difficult to eradicate. Improvement has become the pass-word among viticulturists. There are, however, many ways of improving a plant. Hybridization is one of these and a fruitful source of variation. The scope and object of this article will be an attempt to discuss, in part, the limits of hybridization of Vitis rotundifolia with related species and genera. By knowing the limits in hybridization and the comparative ease or difficulty with which hybrids of known parentage can be secured, much unnecessary work and vexation may be spared the practical grape breeder.

2. MATERIALS AND METHODS USED.

In order to study the limits in hybridization of a particular species of plant, it becomes imperative to collect for study and use as many of its allied species, genera and hybrids as is practicable. Consequently, we have made a collection of as many of the varieties and species of Vitis and hybrids with Vitis rotundifolia and some species of Parthenocissus and Ampelopsis as were possible to obtain and grow under our local conditions. Many of the species come from distant States, but most of these so far studied and to be reported on in this bulletin with the exception of Vitis vinifera and named varieties of other species are native vines of local habitat. The behavior of other species in hybridization toward Vitis rotundifolia will be reported on in future publications.

The varieties, species and genera reported on in this bulletin are as follows:

(a) Vitis rotundifolia.
(b) Rotundifolia-Munsoniana hybrids.
(c) Vinifera-Labrusca-Æstivalis hybrid, variety Winchell.
(d) Vitis bourquiniana, variety Herbemont.
(e) Vitis vinifera, variety Malaga and two of its seedlings.
(f) Vitis labrusca, native species and the two varieties, Concord and Lutie.
(g) Vitis cordifolia, native species.
(h) Vitis cinerea, native species.
(i) Vitis æstivalis, native species.
(j) Parthenocissus quinquefolia (Planch.), native species (Virginia Creeper).
(k) Parthenocissus tricuspidata (Planch.) (Boston Ivy).
(l) Ampelopsis heterophylla (Sieb. & Zucc.), variety Elegans (Koch) (Variegated Ivy).

The methods used in all of the hybridization work are those that are commonly in vogue (See also Breeding Southern Grapes, Journal of Heredity, Vol. VIII, No. 6). The bags employed for this work were made of what is commercially known as Pacific Lawn.

3. RESULTS SECURED FROM 1912 TO 1918, INCLUSIVE.

Vinifera-Labrusca-Æstivalis Hybrid Var. Winchell × Vitis Rotundifolia

In 1912 Winchell (Vinifera-Labrusca-Æstivalis) vines were used as the female parent and a light-colored male vine (Rotundifolia) was used as the pollen parent. Out of 99 seeds, 34 plants were secured, but as the female parent vines were of a hermaphroditic and self-fertile variety, the number of hybrid vines in this lot was subject to some doubt. Because of the poor conditions existing in the seed-bed, most of the seedlings of this cross perished. Eleven vines were finally transplanted to the nursery for study. Later on it developed that ten of these eleven seedling vines were direct selfed descendants of Winchell, but one

of the eleven was a true hybrid. This hybrid plant is living and healthy at this date. This is the first true Rotundifolia hybrid with the native Euvitis grape (although of hybrid origin) that is recorded. It will be found fully described in our succeeding bulletin entitled, "Some F_1 Hybrids Between Vitis Rotundifolia and Related Species." In the spring of 1916 the variety Winchell was again used as the female parent plant and two self-fertile seedlings (Rotundifolia) were used as the male parent.

The first cross, Winchell x I-1 (light colored seedling of Scuppernong x Hope), resulted in 378 seeds. Of these, 79 hybrid seedlings that were strong enough to set in the nursery were obtained.

The second cross, Winchell x G-52 (dark colored seedling of Thomas x Hope), resulted in 34 seeds. Among the resultant seedlings from this lot, only one strong hybrid was obtained and transplanted to the nursery.

Vitis Rotundifolia × *(Vinifera-Labrusca-Æstivalis Hybrid) Var. Winchell*

In order to test the possibility of a reciprocal cross (V. rotundifolia x Winchell), two Rotundifolia seedlings X-32, a seedling of Scuppernong crossed with Light Male No. 2, and a dark selfed seedling of Hope were used in 1916. The first, an imperfect hermaphroditic vine (X-32), had ten bags covering twenty flower clusters. The flowers on these clusters were hand pollinated every morning with fresh Winchell pollen. None of the flowers developed fruit.

The dark seedling of Hope, a perfect flowering vine, had only one flower cluster prepared and it was crossed with Winchell pollen. No fruit set on this cluster.

Thus far our effort to hybridize Vitis rotundifolia with Winchell pollen has met with only negative results. Dearing (5) reports the production of some hybrid vines from Vitis rotundifolia crossed with Winchell as the male parent. It is quite apparent that hybrids of this reciprocal cross are rather difficult to obtain.

Vitis Bourquiniana Var. Herbemont × *Vitis Rotundifolia*

In 1912 Vitis bourquiniana var. Herbemont was used as the female parent and crossed with V. rotundifolia, Light Male vine No. 2. In the fall of the year 28 seeds were harvested. Of these 28 seeds only two germinated and these died soon afterward.

In 1913 Herbemont was crossed with V. rotundifolia, Light Male vine No. 1, as the pollen parent. Four clusters of the Herbemont vine were emasculated and later crossed with pollen from the male vine. In the fall 19 seeds were gathered from this cross and out of this lot of seeds in 1914 one true hybrid vine, strong enough to withstand the vicissitudes

of the seedbed, was secured. This hybrid vine is living today and will be fully discussed in our succeeding bulletin. This is the first Herbemont-Rotundifolia hybrid that was ever produced and recorded.

In 1916 and 1917 Herbemont was again crossed with V. rotundifolia, G-52 being the male parent. Five flower clusters on the Herbemont vine were prepared in 1916 and later cross-pollinated with pollen from G-52. A total of 35 seeds was harvested and from this lot of seed 7 fairly strong hybrid vines were secured. Seven flower clusters on the Herbemont vine were prepared in 1917 and again cross-pollinated with pollen from G-52. A total of 86 seeds was harvested from this cross but only 5 fairly strong hybrid vines were secured. Of these two lots of hybrid vines only seven vines are at present (1919) alive. Most of the hybrids of Herbemont with V. rotundifolia are constitutionally weak and only a comparatively few seem able to survive.

Vitis Rotundifolia × *Vitis Bourquianiana*

The results of the reciprocal cross V. rotundifolia x V. bourquiniana var. Herbemont have been altogether negative thus far. In 1916 two Rotundifolia seedlings, X-32 and a perfect flowered selfed seedling of Hope, were used. Ten bags covering 20 flower clusters were applied to the vine X-32 and four bags covering as many flower clusters were applied to the perfect flowered seedling of Hope. The expanding flowers were in due season dusted with fresh pollen from the variety Herbemont. No fruits were secured from either of these pollinations.

In 1917 three flower clusters on a Scuppernong vine* which had been forced in the greenhouse were bagged and cross-pollinated with Herbemont pollen. During the same season seven flower clusters on a Scuppernong vine in the vineyard were bagged and cross-pollinated with Herbemont pollen. N-28 and O-23, two seedlings of Scuppernong x Dark Male vine No. 1 had one flower cluster each bagged and crossed with Herbemont pollen. E-19, a seedling of Thomas x Light Male vine No. 2 also had two flower clusters treated in the same manner. Not one berry was produced in all of these crosses.

Rotundifolia-Munsoniana Hybrid × *Vitis Bourquiniana*

In 1917 three flower clusters of the variety Eden, a Rotundifolia-Munsoniana hybrid, were bagged and cross-pollinated with Herbemont pollen. No fruit was secured from this cross.

* This Scuppernong vine was grown in a box and some time during the month of February was placed in the greenhouse for forcing. In order to ascertain whether this forcing might exert any evil influences in regard to the production of fruit, one flower cluster was cross-pollinated with normal Rotundifolia pollen and typical fruit was obtained. The vine, therefore, was in proper condition to enter into the experimental work.

To obtain this reciprocal cross is apparently a much greater task than to obtain the original cross where Herbemont is used as the female parent.

Vitis Vinifera × *Vitis Rotundifolia*

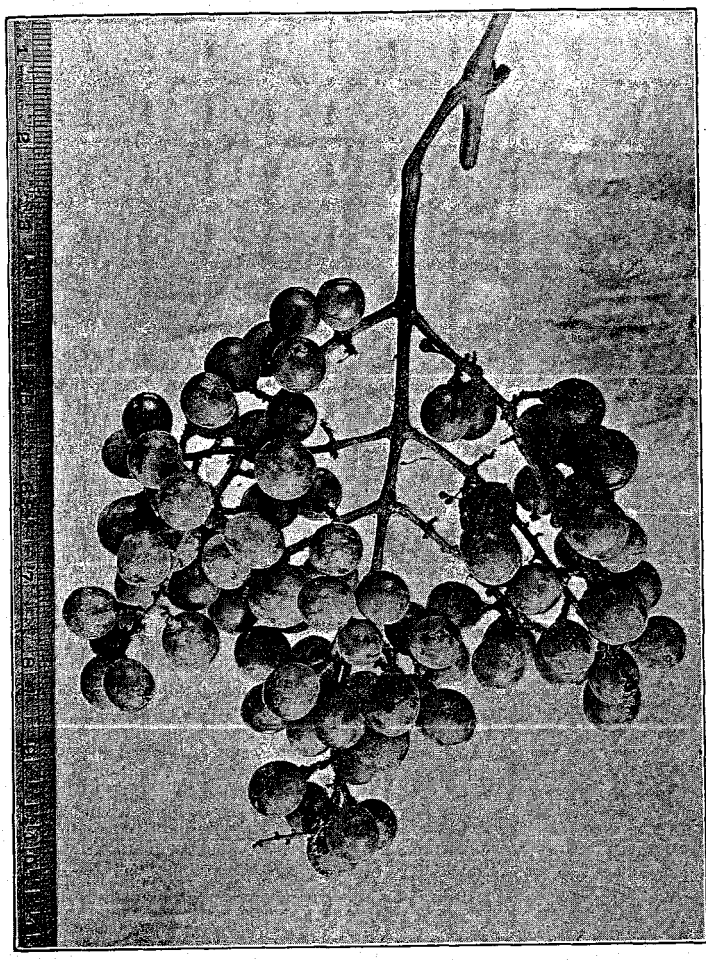
In 1916 three flower clusters on an imperfect hermaphroditic Vinifera vine, Malaga Seedling No. 1, were prepared, covered and later cross-pollinated with pollen from the Rotundifolia vine I-1. Four similar flower clusters were cross-pollinated with pollen from G-52. In the fall 16 seeds were obtained from the cross with I-1 and 15 seeds from the cross with G-52. All the seeds grew in 1917 and 26 were set in the nursery for study.

During this same season (1916) Malaga Seedling No. 1, as well as Malaga Seedling No. 3 which will be found mentioned later, have been thoroughly tested for any signs of self-fertility, and both vines have proven to be practically incapable of producing seed by themselves. Knowledge of this sort is of tremendous importance for the breeder because much labor, time and material can be saved by circumventing the process of emasculating the flowers. The results obtained with Malaga Seedling No. 3 in 1917 amply justify this contention.

In 1917 this seedling was cross-pollinated with pollen

A Vinifera-Rotundifolia seedling vine two years of age with eight of its flower clusters bagged for a test in self-fertility. Reduced.

from I-1. Six bags were used and as many clusters treated. These flowers were not emasculated as were the preceding ones, but had the foreign pollen administered to them as soon as they had opened. From



A fruit cluster from Malaga Seedling No. 3, whose self-sterile flowers had been bagged and treated to pollen from a Rotundifolia vine, showing how readily some Vinifera varieties will produce fruit with pollen from V. rotundifolia. Reduced.

this cross 218 seeds were obtained and of the resulting hybrid seedlings 52 were set in the nursery. Four of these died from drought during the summer of 1918.

In 1917 Malaga also was used as a female parent. Four flower clus-

ters were cross-pollinated with I-1 and eight similar clusters were cross-pollinated with G-52. From these covered and cross-pollinated clusters 93 and 143 seeds respectively were obtained.

Because of limited available space in the nursery in 1918, only 14 true hybrids of the Malaga x G-52 cross were retained and none of the seedlings of the Malaga x I-1 cross were planted.

Vitis Rotundifolia × *Vitis Vinifera*

In 1917 one flower cluster on the forced Scuppernong vine in the greenhouse was bagged and cross-pollinated with pollen from Malaga. No fruit developed.

The same year W-38, a seedling of Scuppernong x Dark Male No. 1, was used as the female parent and Malaga was used as the male parent. Seven flower clusters on W-38 were bagged and pollinated with fresh pollen from the Malaga vine. One fruit developed from this work, but not as the result of hybridization.

Five flower clusters on G-12, an imperfect hermaphroditic seedling of Thomas x Hope, were bagged and pollinated with Malaga pollen. No fruit resulted.

Five flower clusters on the Flowers vine were bagged and pollinated with Malaga pollen. No fruit developed from this work.

Ten flower clusters on the Oberlin vine, a Rotundifolia variety originally found growing wild in Oberlin and only about one mile from the college campus, were bagged and pollinated with Malaga pollen. From this work three berries developed and ripened, from which five seeds were secured. These seeds were planted and in 1918 two true hybrid vines were obtained. These two vines are still growing and will be more fully discussed in our succeeding bulletin.

In 1918 ten flower clusters on the Oberlin vine were again bagged and pollinated with Malaga pollen, but no fruit developed from this work.

From the results of the preceding efforts we find that the reciprocal cross, Vitis rotundifolia x Vitis vinifera, although difficult to obtain can be effected. Dearing (5) finds certain varieties of both species more congenial to hybridization than others.

Vitis Labrusca × *Vitis Rotundifolia*

In 1917 ten flower clusters on a Concord vine (V. labrusca) were prepared, bagged and pollinated with pollen from G-52. In the fall of the year 130 seeds were obtained and planted. From this lot of seeds 12 true hybrid seedlings were observed to grow; others may have germinated but were not recognized as such before their death. Only five of the hybrids were strong enough to be transferred to the nursery.

Ten flower clusters on a native imperfect hermaphroditic vine (V.

labrusca) were bagged in 1917 and dusted with pollen from G-52. From this work no fruit was obtained.

In 1918 twenty-two flower clusters on the same native Labrusca vine were bagged and the flowers were dusted with pollen from I-1. In the fall of the year fruit was taken from seven of the bags and a total of 83 seeds was obtained. All of these seeds are the result of a cross because the mother vine which bears reflexed stamens has proven itself to be absolutely self-sterile.*

In 1918 eleven flower clusters on the variety Lutie (V. labrusca) were prepared, bagged and dusted with pollen from I-1. From this work 283 seeds have been obtained. These seeds will be planted in 1919 and the hybrid character of the seedlings noted.

Vitis Rotundifolia × *Vitis Labrusca*

In 1917 four flower clusters on I-1 were prepared, bagged and pollinated with Concord pollen. No fruits developed from this work.

In 1918 six flower clusters on a forced Scuppernong vine were bagged and pollinated with Lutie pollen. Again no fruits developed.

From the results of this work we again see a difficulty in securing the reciprocal cross, V. rotundifolia x V. labrusca.

Vitis Æstivalis × *Vitis Rotundifolia*

In 1918 nine flower clusters on a native imperfect hermaphroditic Æstivalis vine were bagged and cross-pollinated with pollen from I-1. In eight of these bags no fruit developed and in the ninth bag a small cluster of apparently normal fruit developed. This cluster yielded 20 seeds which will be planted, and the resulting seedlings will be keenly watched and examined for hybrid characters.†

Vitis Rotundifolia × *Vitis Æstivalis*

In 1917 one flower cluster on a seedling Rotundifolia vine, N-28, one on another seedling, K-19, and seven on Scuppernong were bagged and dusted with fresh pollen from a staminate Æstivalis vine. No fruits developed in any of these bags.

In 1918 eight flower clusters on Scuppernong and ten on the variety James were bagged and treated as before. The bags on the Scuppernong vine yielded no fruit while only one bag on the James vine yielded but two berries. It is to be regretted that this bag, together with its contents, disappeared just when the fruit was ripening on the vine.

* Since the manuscript for this bulletin was prepared these seeds have germinated and after a careful examination of them all possible doubt as to their hybrid nature has been dispelled.

† Since the manuscript for this bulletin was written these seeds were planted and nineteen of them germinated. Most of these seedlings are constitutionally weak and thus far only nine have survived, but all of them have proved to be true hybrids with Vitis rotundifolia.

Rotundifolia-Munsoniana Hybrid × *Vitis Æstivalis*

In 1917 two flower clusters on the variety Eden were bagged and dusted with fresh Æstivalis pollen. No fruit developed in these bags.

In 1918 ten more flower clusters on the same Eden vine were bagged and treated as before. One fruit developed, from which one seed was obtained. This seed will be planted and the resulting seedling, if it survives, will be studied and duly examined for hybrid characters.

Vitis Cordifolia × *Vitis Rotundifolia*

In 1917 ten flower clusters on a native imperfect hermaphroditic Cordifolia vine were bagged and dusted with pollen from G-52. In the fall some fruit was harvested and a total of 12 seeds was obtained. These seeds were planted and five seedling vines resulted. Of these only two survived the seedbed and were set in the nursery. They will be described more fully in our succeeding bulletin.

In 1918 ten flower clusters were again bagged on the same Cordifolia vine and later dusted with pollen from I-1. In the fall fruit was harvested from each of the bags and a total of 174 seeds was obtained. These seeds will be planted and the resulting seedlings will be duly cared for.

Vitis Rotundifolia × *Vitis Cordifolia*

In 1917 fourteen flower clusters on a Scuppernong vine were bagged and dusted with pollen from a staminate Cordifolia vine. No fruit developed from this work. In 1918 eight flower clusters were again bagged on a Scuppernong vine and dusted with pollen from a staminate Cordifolia vine. Again no fruit developed. Here we once more encounter difficulty in obtaining the reciprocal cross, V. rotundifolia x V. cordifolia.

Vitis Cinerea × *Vitis Rotundifolia*

In 1917 fourteen flower clusters on a native imperfect hermaphroditic Cinerea vine were bagged and later dusted with pollen from perfect flowered Rotundifolia vines. No fruits were produced in any of these bags. In 1918 three flower clusters on another imperfect hermaphroditic Cinerea vine were bagged and later dusted with Rotundifolia pollen. No fruits were produced in these bags.

Vitis Rotundifolia × *Vitis Cinerea*

In 1916 six flower clusters on P-48 were bagged and later dusted with fresh pollen from a staminate Cinerea vine. No fruits developed in any of these bags. In 1917 two flower clusters on N-28, one on E-19, one on James, five on X-32 and seven on Scuppernong vines were bagged and dusted with fresh pollen from a native staminate Cinerea vine. No fruits developed in any of these bags. In 1918 ten flower clusters on the James variety were bagged and later dusted with pollen from a native

staminate Cinerea vine. From these bags one normal berry was taken in the fall. This berry contained three apparently normal seeds. These will be planted and the resultant seedlings will be watched with interest.*

Rotundifolia-Munsoniana Hybrid × *Vitis Cinerea*

In 1917 eight flower clusters on the variety Eden were bagged and later dusted with pollen from a staminate Cinerea vine. No fruit resulted from this work.

Winchell-Rotundifolia Hybrid × *Vitis Rotundifolia*

In 1917 two flower clusters on the Winchell-Rotundifolia hybrid of 1912 were bagged and dusted with Rotundifolia pollen and one berry resulted. From this berry one seed was obtained. This seed was planted and a seedling resulted which will be more fully described in our next bulletin. In 1918 five flower clusters on the same vine were again bagged and dusted with pollen from Rotundifolia vines. Three berries set. Two of these berries were lost through the hands of irresponsible persons. From the third berry one seed was obtained.

Several berries developed on this vine during this season as a result of the activities of natural agents of cross-pollination. Because this vine is completely self-sterile and is entirely surrounded by thousands of Rotundifolia seedlings and will cross with V. rotundifolia, and as the blooming period of this hybrid and that of the Rotundifolia vines practically coincide, we assume that these berries, which developed under no human control, are the natural results of cross-pollination with Vitis rotundifolia. Three fruits of this type have been produced from which three seeds have been obtained.

Vitis Rotundifolia × *Herbemont-Rotundifolia Hybrid*

In 1916 two flower clusters on a seedling vine of Hope parentage were bagged and dusted with pollen from the Herbemont-Rotundifolia hybrid of 1913. No fruit set from this pollination. In 1917 eight flower clusters on Scuppernong vines, one on N-28, one on O-23 and three on Eden were bagged and dusted with pollen from this Herbemont-Rotundifolia vine. One fruit set on the Scuppernong vine, which yielded one seed. No fruits were obtained from any of the other cross-pollinations. Although very little fruit set, we have learned that Vitis rotundifolia will occasionally cross with its F_1 generation with V. bourquiniana.

Vitis Rotundifolia × *Vinifera-Rotundifolia Hybrid*

In 1918 four flower clusters on K-19 were bagged and dusted with pollen from the Vinifera-Rotundifolia hybrids of 1917 origin. Two

* Since the writing of the manuscript for this bulletin one of these three seeds has germinated. This seedling from all appearances is a true Rotundifolia and therefore not of hybrid origin.

berries resulted from this cross, from which two seeds were obtained. Here again we have evidence of Vitis rotundifolia hybridizing with its F_1 generation hybrid vines.

Parthenocissus Quinquefolia (Planch.) × Vitis Rotundifolia

In 1916 eleven flower clusters on a native vine of Parthenocissus quinquefolia (Planch.) were bagged and the flowers, 410 in number, were carefully emasculated and later, when the pistils matured, pollen from some Rotundifolia vine was applied. No fruits developed in any of these bags.

Vitis Rotundifolia × Parthenocissus Quinquefolia (Planch.)

In 1916 nine flower clusters on a Flowers vine were bagged and dusted with fresh pollen from P. quinquefolia. No fruits developed in any of these bags. Four flower clusters were also bagged on Munson's Sanmonta vine which in all probability is a Rotundifolia-Munsoniana hybrid. The flowers were dusted with fresh pollen from P. quinquefolia. No fruits developed in any of these bags. Our efforts so far have been fruitless with both crosses.

Parthenocissus Tricuspidata (Planch.) × Vitis Rotundifolia

In 1916 ten flower clusters (460 flowers) on a local vine of Parthenocissus tricuspidata were carefully emasculated and as the pistils matured they were dusted with pollen from a Rotundifolia vine. None of these flowers produced a berry.

Vitis Rotundifolia × Parthenocissus Tricuspidata (Planch.)

In 1916 six flower clusters on the variety Flowers were bagged and dusted with fresh pollen from P. tricuspidata. No fruits developed in these bags.

Five flower clusters on the variety Sanmonta were bagged and dusted with pollen from P. tricuspidata. No fruits developed from any of these flowers.

Our effort so far to hybridize Parthenocissus tricuspidata with V. rotundifolia and vice versa has proven fruitless.

Ampelopsis Heterophylla (Sieb. and Zucc.) Variety Elegans (Koch) × Vitis Rotundifolia

In 1918 four flower clusters on a vine of Ampelopsis heterophylla (Sieb. and Zucc.) variety Elegans (Koch) were carefully emasculated and dusted with pollen from V. rotundifolia. No fruits developed from any of these flowers.

4. OBSERVATIONS AND DISCUSSIONS.

While attempting the work of finding limits in the hybridization of Vitis rotundifolia with related species and genera, the following observations and deductions were made.

a. In order to adhere strictly to the letter and object that is before us, only pure species so far as possible were used. Whenever varieties of Euvitis are mentioned in connection with species, Vinifera excepted because these constitute the species, the evidence thus secured should be looked upon as pertaining to the variety only. Thus the varieties Concord and Lutie have been utilized in hybridization work with V. labrusca. Now it is generally recognized that nobody can say with absolute certainty that these varieties are pure Labrusca and that no Vinifera blood is in any way mixed up with them.

Again, as V. rotundifolia will hybridize more readily with some species than with others, so these varieties, if tainted with blood of another species may be either positively or negatively affected in regard to their hybridizing qualities. For example, V. vinifera vines will readily hybridize when V. rotundifolia pollen is used while V. labrusca vines cannot as readily be hybridized. Now Winchell, a Vinifera-Labrusca-Æstivalis hybrid, is readily hybridized with V. rotundifolia pollen; and is it not possibly because of the presence in the hybrid of Vinifera blood?

b. In hybridizing perfect flowered varieties when the species are divergent in character, it has been found advisable for the sake of economy in time and labor not to lay too much stress on the absolute eradication of pollen from the emasculated flowers at the expense of possibly injuring their delicate pistils. We have discovered and possess evidence which shows that Rotundifolia hybrids are not composed of all dominant characters as has long been supposed, but that they are more of an intermediate type and an experienced eye can readily pick them out from a mixed lot of vines.

c. When hybridizing different species it is advisable to have at hand the freshest pollen obtainable. This may be accomplished in several different ways, chief among which are the following: (1) by forcing late blooming vines in an artificially heated glass house, (2) by retarding the blooming period of early flowering vines, (3) by diligent search for the latest flower clusters on early blooming vines, (4) by forcing, if possible, a second crop of flower clusters on a vine, (5) by collecting and storing the pollen from early blooming vines for later use.

d. Some varieties are frequently found that will not readily yield positive results in hybridization, while others of the same species may be found that will. For example, the variety Scuppernong with us has not yielded to the pollen of V. vinifera while our Oberlin vine has produced three berries. Deering (5) mentions a similar experience.

We (6) have found a vine of our own production which, according to our knowledge has not yet been fertilized with pollen from other vines

of its own species, but it never fails to set fruit with its own pollen. Very often when it seems impossible to secure a hybrid, when all conditions seem to be complied with, the reverse cross might yield abundant results. As an example of this kind we may cite such as V. vinifera, V. bourquiniana, V. labrusca, V. cordifolia and probably others which readily hybridize with V. rotundifolia and V. munsoniana when the latter two species are used as the pollen parents, but will not hybridize as readily when the positions of the parents are reversed.

e. The hybridizer must not be easily discouraged when positive results are not immediately forthcoming. He must try and try again until success follows his efforts. In the case of the Rotundifolia-Vinifera hybrid, when Vinifera was used as the male parent, we worked with 28 flower clusters which comprised no less than 500 individual flowers before a hybrid was secured.

f. When hybrid seeds have finally been secured, great care must be exercised in the handling of the seedbed, otherwise untoward conditions may kill the hybrid vines and nullify all the previous work. The damping-off disease is the archenemy of the seedlings in the seedbed, and to protect the young plants from it requires the greatest of care and vigilance. With the amateur, the word hybrid is very often considered as almost synonymous with great vigor and strength, and the fact that hybrids of wide parentage ofter require the greatest of care and protection is learned only when too late.

g. Occasionally when we sow seeds of supposedly hybrid origin and when the utmost care has been bestowed on the emasculation of hermaphroditic grape flowers, we get a mixed lot of selfed seedlings, together with hybrids, if by chance such were produced. Beach (1) mentions this self-fertilization of the grape flowers in the bud in the case of the variety Mills, Dorsey (2) in the case of the varieties Concord and Hubbard Seedless, Hedrick and Anthony (3) mention other varieties of Euvitis behaving similarly. Our self-fertile varieties and seedlings of V. rotundifolia have proven to be no exception to this fertilization in the bud. Euvitis varieties with us have likewise given similar results. If this phenomenon is not carefully considered, we may be led into erroneous deductions in regard to the transmission of characters from the parental to the F_1 generation vines. When two varieties of the same species are to be hybridized, the selfed seedlings may not be detected and contradictory results may develop; if, however, the parental vines are of widely different types, the two kinds of offspring seedling vines can generally be recognized at once by their general appearance. It is here that several prominent Rotundifolia grape breeders apparently have fallen into erroneous conclusions.*

h. Finally the hybrid nature of a seedling is proof positive that hybridization has been effected between two given individuals.

* See False Hybrids in our next bulletin which will be entitled, "Some F Hybrids between Vitis Rotundifolia and Related Species."

SUMMARY

As a result of our efforts to determine the limits in hybridization of Vitis rotundifolia with related species and genera, we have come to conclusions which may be summarized as follows:

1. Vitis rotundifolia will hybridize with V. munsoniana and some species of Euvitis, namely: V. vinifera, V. bourquiniana, V. labrusca, V. cordifolia, and V. æstivalis, also with the varieties Winchell, Concord, and others. Other species will be reported on later as time and material will permit.

2. It is doubtful if V. rotundifolia will hybridize with all species of Vitis.

3. Our efforts so far indicate that V. rotundifolia will not hybridize either way with Parthenocissus quinquefolia (Planch.), P. tricuspidata (Planch.) or Ampelopsis heterophylla (Sieb. and Zucc.) var. Elegans (Koch).

4. Vitis rotundifolia will hybridize with its own F_1 hybrids with other species of Vitis.

5. Vitis rotundifolia when used as the male parent will hybridize quite readily with some species of Euvitis, but when used as the female parent it will hybridize only rarely. Some combinations seem more congenial for hybridization than do others.

6. The results that are reported in this bulletin do not establish any limit, but will indicate what may be expected in the hybridization of V. rotundifolia with the mentioned related species and genera.

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