GRAPE DEVELOPMENT AND IMPROVEMENT

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THE present commercial grape industry in the United States has developed along two main lines. On the Pacific coast the industry has depended upon the importation and improvement of varieties of the grape of the Old World, *Vitis vinifera* L., while in the remainder of the country the industry has been based upon the development of the American species indigenous to the region, hybrids of these species, and finally hybrids of native species with *V. vinifera*. On the other hand, the industry in the Old World originated actively from the single species *V. vinifera*. This species has also played a vital part in the improvement of our native grapes. It was known in prehistoric times. Sacred writings and ancient myths and fables extol the value of this grape. Seeds of the grape have been found in the remains of lake dwellings of the Bronze Age in Switzerland and Italy and in the tombs of ancient Egypt. Remains of grape leaves have also been found in calcareous rocks in France, where they were apparently deposited in prehistoric times. It is the belief of botanists that the ancient home of this species was the Caspian Sea region.

DISTRIBUTION AND EARLY HISTORY

FROM its original habitat the grape was carried westward into favorable locations in Africa and Europe and eastward in Asia. The distribution of the species by birds, wind, and water undoubtedly began very early, even before cultivation, and possibly before the existence of man in Asia or Europe. Grape growing was practiced very early in Palestine, and cultural material was transported by the early Phoenician navigators to the countries bordering on the Mediterranean Sea. According to Alphonse de Candolle, records of the cultivation of the grapevine and the making of wine in Egypt go back 5,000 to 6,000 years. Viticulture in Greece was flourishing during the time of Homer and must

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have been known before his time. The Romans doubtless gained their knowledge of grape growing and the art of wine making from the Greeks. For a time the Romans seemed to prefer the Grecian product, and not until about the first century of the Christian Era did Italian wines begin to have a favorable reputation in their own region.

In the meantime French viticulture was originating in the vicinity of what is now Marseilles and spreading up the valley of the Rhone. In the second century A. D. it had spread along the banks of the Rhine. From a centralized beginning the growing of *Vitis vinifera* has gradually spread until at the present time it is grown commercially in parts of Europe, Asia, Africa, Australia, North America, and South America. Grape growing is practiced in the Northern Hemisphere mainly between 20° and 51° N. latitude, and varieties of *Vitis vinifera* are found in many of the countries bounded by these parallels. The most northern range of the varieties of *Vitis vinifera* is in the grape area of northern Germany, while the southern range extends into India. In the Southern Hemisphere, including Australia, South Africa, and South America, grape growing is carried on mainly between 20° and 40° S. latitude.

Introduction of Old World Grapes Into the United States

American colonists at a very early period understood the culture of the vine. The abundance of native grapevines along the Atlantic coast attracted their attention, but the first attempts, made early

THE *major portion of the grape-breeding work conducted by public institutions has been to improve quality, which is an elusive factor. The quality of our native varieties has been improved by crossing them with the best varieties of the European grape. Improvements in type of cluster and type of berry have been made by combining different native species. Rootstocks have been developed through hybridization which have suitable resistance to phylloxera, the deadly insect enemy of the grape, and are adapted to various soil types. Thus real progress has been made. But continued improvement is possible, and the results so far indicate that it can be obtained through hybridization. Grape breeding is relatively new, and there is need for more information on the inheritance of such characteristics as size, quality, seedlessness, cold hardiness, disease and insect resistance, and adaptability to environment. Rich collections of species and varieties are available as breeding material to bring about the further improvements that will result in increased consumption of grapes.*

in the seventeenth century, were with the vinifera or European grape. In 1619–21 the London Co., actively urging the culture of the vinifera grape as a source of revenue, brought French vine workers and collections of the best vinifera grape varieties of France to the settlements in Virginia. The Colonial Assembly was also active at the same time in encouraging and even ordering the care and cultivation of the vine. Similar attempts were made in the various colonies from New England to Georgia from 1619 to the beginning of the Revolutionary War.

Much has been written concerning these early attempts at growing vinifera grapes in eastern United States. The reports can be briefly summarized. The first year or two the vines gave considerable promise, then disease and insects appeared, resulting in dead vines and finally an abandoned vineyard. From present experience it would appear that lack of resistance to cold, insects, and disease in the northern regions, and susceptibility to disease and insect injury in the southern regions, were the factors responsible for the general failure of vinifera grape culture in eastern United States.

While failures were being recorded with vinifera grapes along the Atlantic coast, a start in their culture was being made on the Pacific slope in California. The Mission Fathers, going northward from Mexico, established the San Diego Mission in 1769. They brought grape material with them to plant at the various missions established from San Diego to Sonoma. The first plantings made were of a variety that became known as the Mission and represents earliest successful culture of vinifera grapes in the United States. Very little further development took place in California until after 1850. An essay by Col. Agostin Haraszthy on grape growing and wine making, published in 1858 and given wide circulation by the California State Agricultural Society, so stimulated viticulture in the State that 20,000,000 vines had been planted by 1862. Cuttings and rooted vines, including many of the better known varieties then grown in Europe, were introduced into California and distributed to growers. During the following years commercial grape growing, based entirely on vinifera grapes, developed rapidly. Production increased from 11,000 tons in 1869 to 360,000 in 1899, 1,827,000 in 1929, and 2,065,000 tons in 1935. Vinifera grape culture has also spread to other Western and Southwestern States. In favorable locations in Idaho, Washington, Oregon, Nevada, Arizona, Utah, New Mexico, and Texas, vinifera grapes prove profitable for local sale and, in special southern locations, for early commercial shipments.

Development and Early Improvement of American Native Grapes

After many failures with varieties of *Vitis vinifera* in the East, the native species were finally considered to be the best basis for an eastern grape industry.

Out of a planting of vinifera grapes made by the Kentucky Vineyard Society shortly after 1802, near the present site of Vevay, Ind., several varieties resisted unfavorable conditions better than others. One of these was called the Cape grape by John James Dufour II. This grape was later supposed to be identical with Alexander, a native

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American vine, which had been planted in some way among the vinifera varieties. Later, from 1806 on, this native grape became generally distributed and was grown with apparent success. Grape authorities later considered the Alexander an offshoot of *Vitis labrusca* L., with a possibility of some vinifera species in its parentage. It probably originated along the banks of the Schuylkill in Pennsylvania, and its history antedates the Revolutionary War.

The next incentive to native grape growing came with the introduction of the Catawba variety. Its origin is uncertain. There is evidence that it originated in North Carolina. In 1819 John Adlum (1759–1836) obtained cuttings of the Catawba from a cultivated vine in Maryland for extensive nursery propagation in the District of Columbia. The cuttings of the variety were widely distributed by Adlum and some were sent to Nicholas Longworth (1783–1863) in Ohio, who became greatly impressed with it. During the period from 1825 to 1850 this variety, as well as Isabella and others less well-known, was planted in widely separated parts of the Eastern States. These two varieties were predominant until the introduction of the Concord, which originated from a chance seedling grown by Ephraim Wales Bull (1805–95), of Concord, Mass. The seed was planted in 1843 and produced fruit in 1849. The grape was named Concord and introduced in the spring of 1854. The Concord grew rapidly in popularity and its culture had spread to Missouri by 1855, 1 year after its introduction.

The improved varieties of native grapes introduced between 1800 and 1850 were principally chance seedlings or selections from wild native species. Since 1850 many men have been interested in grape breeding for the improvement of our native species.

Native species of *Vitis* are found in all parts of the United States. The fruit of many of them is of little direct value, but even the species producing poor fruit may have characters of value for hybridization and plant breeding. Some have been the source of our cultural varieties, while others are very valuable as stocks resistant to phylloxera and the root knot nematode. Table 1 indicates the main grape species that have been used in breeding work.

TABLE 1.—*Grape species possessing special breeding qualities*

Species, common name, and natural range	Character of vine	Resistance to—					Qualities for breeding
		Phylloxera [1]	Cold [2]	Heat [2]	Wet [2]	Dry [2]	
Vitis aestivalis Michx.; summer grape. New England to Georgia and westward to the Mississippi River.	Vigorous, climbing; leaves large, 20 cm, 3- to 5-lobed.	14	VG	G	F	G	Resistance to fungus diseases; high sugar percentage; suitable wine properties; possible table use if crossed with large-berried varieties.
V. aestivalis var. *bourquiniana* Bailey (*V. bourquiniana* Muns.); Bourquin grape. Origin doubtful; adapted to Southeastern States.	Vigorous, climbing; leaves large, 3- to 5-lobed.	----	F	G	F	G	Vigor; disease resistance; productiveness; colored juice.

TABLE 1.—*Grape species possessing special breeding qualities*—Continued

Species, common name, and natural range	Character of vine	Resistance to—					Qualities for breeding
		Phylloxera [1]	Cold [2]	Heat [2]	Wet [2]	Dry [2]	
V. berlandieri Planch.; Spanish grape, winter grape. Texas and northern Mexico.	Medium vigor, slender; leaves medium, 10 cm, 3-to 5-lobed.	19	F	G	F	G	Rootstock resistance to phylloxera; ability to grow on strong, limy soils.
V. candicans Engelm.; mustang grape. Mainly Texas, parts of Arkansas, Oklahoma, Louisiana, and Mexico.	Very vigorous, high climbing; leaves medium, nonlobed to 3-lobed.	15	F	G	F	G	Vigor for rootstock; easily hybridized; adapted to black limestone lands; large-berried fruit for wild vine.
V. champini Planch.; Champin grape. Mainly Texas.	Very vigorous, climbing; leaves medium, 10-12 cm, nonlobed to 3-lobed.	15	F	G	G	G	Vigor for rootstock; healthy foliage; wide adaptability; large-berried fruit.
V. cordifolia Lam.; frost grape. Wide range, from Great Lakes to Florida.	Vigorous, climbing; leaves medium, 10 cm.	18	G	G	G	G	Vigor; phylloxera resistance; wide natural range.
V. labrusca L.; fox grape. New England to northern Georgia, westward to Indiana, and bordering the Ohio River.	Medium vigor, climbing; leaves large, nonlobed to slightly lobed.	5	VG	F	F	F	Cold resistance; large-berried fruit; strong distinctive flavor.
V. linsecomii Buckl.; pinewoods grape, post-oak grape. Texas, parts of Louisiana, Oklahoma, Arkansas, and Missouri.	Vigorous, bushy to climbing; leaves very large, 3- to 5-lobed.	14	F	G	G	VG	Vigor; disease resistance; large clusters and berries; strong flavor.
V. longii Prince; Longs grape, bush grape. Parts of Arkansas, Oklahoma, Texas, New Mexico, and southeastern Colorado.	Very vigorous, bushy to climbing; leaves large, 3- to slightly 5-lobed.	14	G	G	VG	G	Vigor; phylloxera resistance; easy rooting of cuttings; vinous flavor.
V. monticola Buckl.; sweet mountain grape. Texas.	Medium vigor, slender, climbing; leaves small, nonlobed to slightly 3-lobed.	18	G	F	F	G	Phylloxera resistance; health of foliage; fruit medium to small.
V. rotundifolia Michx.; muscadine grape. Potomac River to Florida and west to eastern Texas.	Vigorous, slender, climbing; leaves small, not lobed.	20	F	G	F	G	Disease-resistant vine and fruit; special fruit flavor.
V. rupestris Scheele; sand grape. Southern Missouri and Illinois, Kentucky, Tennessee, Oklahoma, and eastern and central Texas to the Rio Grande.	Very vigorous, bushy, rarely climbing; leaves small, mostly nonlobed.	19	F	G	G	G	Phylloxera resistance; easy propagation; vigorous.
V. vulpina L.; riverbank grape. Canada to Texas and west to Great Salt Lake; wide range.	Vigorous, slender, moderately climbing; leaves large, mostly nonlobed, to slightly 3-lobed.	19	VG	F	G	F	Phylloxera resistance; cold resistance; easy propagation.
V. vinifera L.; European grape, wine grape. Introduced species.	Medium to strong vigor, bushy to climbing; leaves mostly 3- to 5-lobed, occasionally 7-lobed.	1	F	VG	F	G	Productiveness; high quality; easy propagation; some seedlessness.

[1] Ratings under phylloxera resistance are from 1 indicating greatest susceptibility to 20 indicating almost complete resistance.

[2] Symbols for resistance to cold, heat, wet soil, and drought are: VG=very good. G=good. F=fair.

One of the native species used extensively for breeding is *Vitis labrusca*, the fox grape. From chance seedlings of this species came Catawba and Concord, though they may also possibly have some

V. vinifera in their parentage. Through early hybridization work a number of popular varieties were obtained from *V. labrusca* crossed with *V. vinifera*. One of the earliest grape breeders in this country to utilize this cross was Edward Staniford Rogers (1826–99), of Massachusetts (fig. 1). Although engaged primarily in the shipping business with his father, he became interested in horticulture and conducted his experiments in grape hybridization in a garden on a city lot back of his home. In originating the group known as Rogers hybrids he used a large-fruited red labrusca known as Carter and fertilized the blossoms with pollen of two vinifera varieties, Black Hamburg and White Chasselas. From these crosses, made in 1851, he obtained about 150 seeds, which eventually produced 45 fruiting vines of high quality. These came into bearing between 1856 and 1858 and were numbered from 1 to 45 by Rogers. They were widely distributed, and some were finally named. Rogers continued his work and recrossed varieties already produced, but none of the later seedlings was promising enough to be introduced. This early work of Rogers indicated the value of *V. vinifera* in hybridizing to improve the quality of the native fruit. The Agawam variety is one of his main contributions that is still grown.

Figure 1.—Edward Staniford Rogers, of Massachusetts, a pioneer in grape hybridization.

Contemporary with Rogers were many other men who introduced hybrid varieties of their own breeding. Only a few of these can be mentioned here.

Andrew Jackson Caywood (1819–89), a nurseryman and fruit grower, became interested in grape breeding in New York. Little record of his methods remains. He differed from other grape breeders of his time, however, in concentrating on second-generation hybrids. The Dutchess represents one of his most important named varieties.

Charles Arnold (1818–83), of Canada, produced many seedlings. Since he lived near the northern limits of grape culture, he was interested mainly in producing cold hardiness in seedlings of high quality. His crosses were mainly a combination of *Vitis labrusca*, *V. vulpina* (the riverbank grape), and *V. vinifera*. His productions proved hardy under severe climatic conditions but were more or less susceptible to disease. Canada and Othello are two of his named varieties.

George W. Campbell (1817–98) conducted his grape-breeding work in Ohio and raised many seedlings. He used varieties mainly of *Vitis labrusca* and *V. vinifera* and to some extent *V. aestivalis* var. *bourquiniana* (Munson) Bailey. Campbell Early represents his main contribution to present-day viticulture.

Louis Suelter, of Carver, Minn., carried on most of his hybridizing work between 1870 and 1884. Previous to this time he had grown many seedlings of the wild grape, *Vitis vulpina*. One of these seedlings appeared to blossom earlier and develop fruit color earlier than others. By crossing this with Concord as the pollen parent, four seedlings were produced and named Beta, Dakota, Monitor, and Suelter. These are reported to be hardy for the more northern and northwestern parts of the country, and they illustrate the use of *V. vulpina* in obtaining cold-resistant varieties.

James H. Ricketts (1818–1915), who conducted a bookbinding business in Newburgh, N. Y., became interested in grape improvement, and one of his first productions was Raritan. In order to utilize vinifera varieties to cross with native grapes he constructed a glasshouse for their culture. While his seedlings were not very vigorous, because of their large proportion of vinifera parentage, they were characterized by high quality and large cluster and berry. His crosses were mostly *Vitis labrusca* and *V. vinifera*. Some however, were complex hybrids, containing in addition either *V. aestivalis* (the summer grape) × *V. aestivalis* var. *bourquiniana* or *V. vulpina* parentage. Some of his named varieties include Downing, Empire State, and Jefferson.

Figure 2.—Thomas Volney Munson, of Texas, who did notable work in the botanical study and hybridizing of grapes. He originated and introduced many superior hybrid varieties, including varieties of the bunch type especially suitable for southern conditions.

Thomas Volney Munson (1843–1915, fig. 2) conducted most of his breeding work with grapes at Denison, Texas. The region in which he lived is rich in native species. Munson gave much of his time to the botanical study of grape species as well as to breeding and cultivating new varieties. In 1909 he published a summary of his extensive work with grape species, breeding, and the testing of grape varieties (*6*).[2] His work was largely instrumental in producing grape varieties of the bunch type suitable for southern conditions, where most of our varieties of northern parentage fail. Of particular interest and special value was his use of the native species *Vitis linsecomii*, the pinewoods grape, in the origination of hybrid varieties. By combining and selecting the vigorous, healthy native species Munson was able to originate fruiting varieties that are productive, vigorous, and better in

[2] Italic numbers in parentheses refer to Selected References on Grape Breeding, p. 655.

fruiting qualities than the parental types. More hybrid grape varieties have been originated and introduced through his efforts than by any other agency in the United States.

Other grape breeders who have contributed some of our better known varieties include Joseph Backman, Hermann Jaeger, Jacob Moore, and Jacob Rommel.

Table 2 gives the parentage and origin, so far as they are known, of a number of the more important native American grape varieties. Some of the varieties that originated as chance seedlings, including Catawba, Concord, and Delaware, are among the most important commercial varieties at the present time. However, when varieties were needed for a specific purpose, such as hardiness, insect resistance, or improved quality, controlled crossing became necessary. The better known varieties are marked with an asterisk, and these can usually be obtained from some of the many commercial nurseries. Others are included as a partial list of varieties available for breeding purposes in State or Federal experimental plantings.

TABLE 2.—*Parentage and origin of American native grape varieties*

[An asterisk (*) denotes the better known varieties.]

Variety	Color	Stamens	Species parentage [1]	Originated or introduced by—	Date	State or country of origin
Agawam*	Red	Upright	Lab., Vin	E. S. Rogers	1855	Massachusetts.
Arkansas	do	do	Lab	Joseph Hart	1893	Arkansas.
Bacchus	Black	do	Vulp., Lab	J. H. Ricketts	1879	New York.
Banner	Red		Lab., Vin., Bourq.	Joseph Backman	1898	Arkansas.
Barry	Black	Reflex	Lab., Vin	E. S. Rogers	1855	Massachusetts.
Beacon*	do	Upright	Linc., Lab	T. V. Munson	1886	Texas.
Berckmans	Red	do	Vulp., Lab., Bourq.	A. F. Wylie	1871	South Carolina.
Beta*	Black	do	Vulp., Lab	Louis Suelter	1881	Minnesota.
Brighton*	Red	Reflex	Lab., Vin	Jacob Moore	1872	New York.
Brilliant*	do	Upright	Lab., Vin., Bourq.	T. V. Munson	1883	Texas.
Caco*	do	do	Lab., Vin	J. T. Lovett	1901	New Jersey.
Campbell Early*	Black	do	do	G. W. Campbell	1892	Ohio.
Canada	do	do	Vulp., Lab., Vin	Charles Arnold	1860	Canada.
Carman*	do	do	Linc., Lab., Vin., Bourq.	T. V. Munson	1892	Texas.
Catawba*	Red	do	Lab., Vin	John Adlum	1823	District of Columbia.
Champanel	Black	do	Champ., Lab	T. V. Munson	1893	Texas.
Champion*	do	do	Lab	Uncertain	1870	New York.
Charles A. Green	White	do	do	F. W. Loudon		Wisconsin.
Clinton*	Black	do	Vulp., Lab	L. B. Langwell	1835	New York.
Colerain	White	Reflex	Lab	David Bundy	1880	Ohio.
Columbian Imperial.	Black	Upright	Lab., Vulp	J. S. McKinley	1885	Do.
Concord*	do	do	Lab	Ephraim W. Bull	1849	Massachusetts.
Creveling	do	Reflex	Lab., Vin	F. F. Marceron	1857	Pennsylvania.
Croton	White	Upright	Lab., Vin., Bourq.	S. W. Underhill	1865	New York.
Cynthiana*	Black	do	Aest., Lab	W. M. Prince	1850	Arkansas.
Dakota	do	do	Vulp., Lab	Louis Suelter	1881	Minnesota.
Delaware*	Red	do	Lab., Vin., Bourq.	A. Thompson	1881	Ohio.
Diamond*	White	do	Lab., Vin	Jacob Moore	1870	New York.
Diana	Red	do	do	Diana Crehore	1884	Massachusetts.
Downing	Black	do	do	J. H. Ricketts	1865	New York.
Dracut Amber	Red	do	Lab	A. Clement	1855	Massachusetts.
Dutchess*	White	do	Lab., Vin., Bourq., Aest.	A. J. Caywood	1868	New York.
Eaton	Black	do	Lab	M. C. Eaton	1879	New Hampshire.
Ellen Scott*	Red	do	Linc., Lab., Vin	T. V. Munson	1902	Texas.
Elvira*	White	do	Vulp., Lab., Vin	Jacob Rommel	1853	Missouri.
Empire State	do	do	Lab., Vulp., Vin	J. H. Ricketts	1874	New York.
Eumelan	Black	Reflex	Lab., Vin., Aest	— Thorne	1847	Do.
Fredonia*	do	Upright	Lab	N. Y. Agr. Expt. Sta.	1915	Do.

[1] Abbreviations are used for species as follows: Aest. for *Vitis aestivalis;* Bourq. for *V. aestivalis* var. *bourquiniana;* Champ. for *V. champini;* Cin. for *V. cinerea;* Lab. for *V. labrusca;* Linc. for *V. linsecomii;* Rup. for *V. rupestris;* Vin. for *V. vinifera;* Vulp. for *V. vulpina.*

TABLE 2.—*Parentage and origin of American native grape varieties*—Continued

Variety	Color	Stamens	Species parentage	Originated or introduced by—	Date	State or country of origin
Goethe	Red	Reflex	Lab., Vin	E. S. Rogers	1855	Massachusetts.
Golden Muscat	White	Upright	Vin., Lab	N. Y. Agr. Expt. Sta.	1916	New York.
Governor Ross	do	do	Lab., Vin	T. V. Munson	1894	Texas.
Green Early	do	do	Lab	O. J. Green	1887	New York.
Grein Golden	do	Reflex	Vulp., Lab	Nicholas Grein	1881	Missouri.
Hartford	Black	Upright	Lab., Vin	P. W. Steel	1849	Connecticut.
Herbemont*	Red	do	Bourq	Indefinite		South Carolina.
Herbert	Black	Reflex	Lab., Vin	E. S. Rogers	1855	Massachusetts.
Iona*	Red	Upright	do	C. W. Grant	1855	New York.
Isabella*	Black	do	do	— French	1816	Do.
Ives*	do	do	Lab., Aest	H. Ives	1840	Ohio.
Jefferson	Red	do	Lab., Vin	J. H. Ricketts	1888	New York.
Lady Washington.	White	do	do	do	1878	Do.
Lenoir*	Black	do	Bourq	Indefinite		
Lindley	Red	Reflex	Lab., Vin	E. S. Rogers	1855	Massachusetts.
Louisiana	do	Upright	Bourq	M. Theard	1850	Louisiana.
Lucile*	do	do	Lab	J. A. Putman	1890	New York.
Lutie	do	do	do	L. C. Chisholm	1865	Tennessee.
Manito	Black	do	Linc., Rup., Lab., Vin., Bourq.	T. V. Munson	1899	Texas.
Martha	White	do	Lab., Vin. (?)	S. Miller	1864	Missouri.
Mills	Black	do	Vin., Lab	W. H. Mills	1870	Canada.
Moore Early*	do	do	Lab	J. B. Moore	1871	Massachusetts.
Muench*	do	do	Linc., Bourq	T. V. Munson	1886	Texas.
Niagara*	White	do	Lab., Vin	Hoag and Clark	1872	New York.
Nitodel	Black	do	Cin., Lab., Vin., Bourq.	T. V. Munson	1902	Texas.
Noah	White	do	Vulp., Lab	Otto Wessenzicher	1873	Illinois.
Ontario *	do	do	Lab., Vin., Aest	N. Y. Agr. Expt. Sta	1908	New York.
Oriental	Red	do	Lab., Vin	M. B. White	1883	Massachusetts.
Perkins	do	do	do	J. Perkins	1830	Do.
Pierce*	Black	do	do	I. B. Pierce	1903	California.
Pocklington	White	do	Lab	John Pocklington	1870	New York.
Portland*	do	do	do	N. Y. Agr. Expt. Sta.		Do.
Poughkeepsie	Red	do	Lab., Vin., Bourq.	A. J. Caywood	1880	Do.
Rebecca	White	do	Lab., Vin	E. M. Peak	1856	Do.
Ripley	do	do	Lab., Vin., Aest	N. Y. Agr. Expt. Sta.	1912	Do.
Rommel	do	do	Vulp., Lab., Vin	T. V. Munson	1885	Texas.
Salem	Red	Reflex	Lab., Vin	E. S. Rogers	1855	Massachusetts.
Secretary	Black	Upright	Vulp., Lab., Vin	J. H. Ricketts	1867	New York.
Sheridan	do	do	Lab., Vin	N. Y. Agr. Expt. Sta.	1921	Do.
Suelter	do	do	Vulp., Lab	Louis Suelter	1883	Minnesota.
Sunrise	Red	do	Lab., Vin., Bourq.	J. Backman	1897	Arkansas.
Vergennes*	do	do	Lab	W. C. Green	1874	Vermont.
Westfield	Black	do	Lab., Vin	N. Y. Agr. Expt. Sta.	1922	New York.
Winchell*	White	do	Lab., Vin., Aest	J. A. Clough (?)		Vermont.
Wine King	Black	do	Aest., Linc., Rup.	T. V. Munson	1898	Texas.
Worden*	do	do	Lab	Schuyler Worden	1863	New York.
Wyoming	Red	Reflex	do	S. J. Parker	1870	Do.

TECHNIQUE OF BREEDING

STRUCTURE OF GRAPE BLOSSOMS

TO UNDERSTAND the technique of breeding new grape varieties, some knowledge of the floral parts (fig. 3) is necessary. The blossoms of *Vitis* are arranged in a pyramidal, loosely branched cluster known as a panicle. In the wild state some vines may bear only male or staminate flowers, while others bear perfect or hermaphrodite flowers that have both stamens and pistils. American native species bear male flowers and hermaphrodite flowers on separate vines, while most European vines of *Vitis vinifera* bear only hermaphrodite flowers. The male flowers (fig. 3, *A*) differ from the hermaphrodite flowers in bearing well-developed stamens and only an incompletely developed pistil, which has no style or stigma and only a very small ovary, the ovules of which cannot be fertilized. The pollen grains of the male

flowers will germinate and can fertilize flowers that have a normally developed pistil.

The hermaphrodite blossoms range from flowers having reflexed, very poorly developed stamens (fig. 3, *B*) to perfect flowers with upright stamens (fig. 3, *C*). Varieties with reflex stamens usually do not set fruit, or set only very loose clusters, unless they are cross-pollinated, either naturally or artificially. Each individual perfect flower normally bears five stamens although the number may vary on the same flower cluster from four to eight. The stamen consists of the filament tipped by the anther containing a pair of pollen sacs. The stamens surround the fruit-producing part of the flower known as the pistil, which is made up of the stigma, a slender-necked style, and an enlarged ovary. The ovary contains the ovules which develop into seeds after fertilization has taken place.

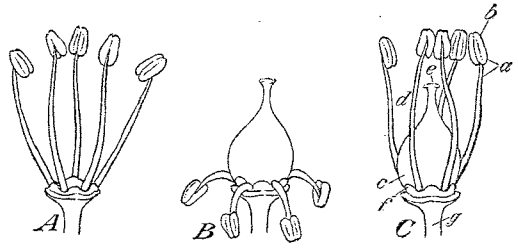

Figure 3.—Grape flower parts. *A*, Male flower. *B*, Flower with reflex stamens. *C*, Flower with upright stamens: *a*, Filament; *b*, anther; *c*, ovary; *d*, style; *e*, stigma; *f*, nectar gland; *g*, pedicel.

Previous to opening, these flower parts are enclosed in a cap-shaped united corolla (fig. 4, *A*). At the time of blossoming, the corolla is shed by becoming loosened at the base and coming off like a cap (fig. 4, *B*). When the flowers are in full bloom, each pollen sac of the anthers splits and sheds the pollen, which is in the form of small, ellipsoid, yellow grains. When moistened the grains take on a globular form. If examined microscopically, it can be noted that the pollen grain is enclosed in a cell wall with three thin-walled bands extending around the grain from pole to pole. In the middle of each of these bands is located a germinal pore through which the pollen tube will subsequently develop.

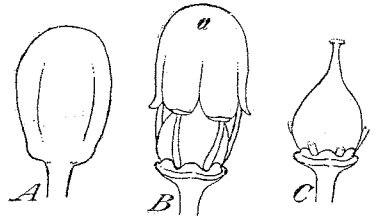

Figure 4.—*A*, Grape flower bud. *B*, Flower bud partly opened; *a*, corolla or cap. *C*, Emasculated flower.

The pollen grains are deposited on the stigma through natural or artificial means. If the stigma is receptive and the pollen grain viable, the pollen germinates and the pollen tube grows through the style, reaches the ovary, and enters an ovule through a small passage between its outer and inner coverings known as the micropyle. Fertilization then takes place by fusion of a sperm nucleus from the pollen tube with the egg nucleus in the ovule. The fertilized ovules become the grape seeds, and the ovary develops into the fruit or grape berry.

Method of Hybridizing

The steps used in the actual hybridizing of grapes by various workers are more or less similar. After selection of the parent varieties, the flower clusters of the male or pollen parent are enclosed on the vine in sacks of paper, cellophane, or other material before any of the individual flowers have opened. This prevents contamination of the desired pollen by the pollen of other nearby varieties. As the blossoms open, the pollen remains within the sack and can be carried directly to the variety to be pollinated or gathered into a suitable container for future use.

The anthers are removed from flowers of the female parent before any pollen has been shed, and the emasculated cluster is enclosed in a bag to prevent the entrance of foreign pollen. At the time of pollination, the pollen from the selected male parent is brushed over the stigmas of the emasculated seed parent. When the fruit is ripe, the seeds are collected, washed, cleaned, and stored for future planting.

Time can be saved by germinating the seeds in a greenhouse. The young seedlings are usually transplanted to pots, cans, or a coldframe for growing one season before they are planted in the field for fruiting tests. The seedlings need some protection the first summer, varying with the climatic conditions under which they are grown. For field trial they are usually planted closer than in commercial vineyards, mainly to conserve space. From reports received, the distances vary from 6 inches to 4 feet in the row, with rows 5 to 12 feet apart. Fruiting may take from 2½ to 4½ years after the seedlings were set in vineyard form, or from 3½ to 5½ years from the time the seed was planted.

Recently a procedure that hastens the fruiting of grape seedlings has been followed at the United States Experiment Vineyard, Fresno, Calif. Grape seeds from controlled crosses in breeding work are planted in flats and started under greenhouse conditions about February 1. The seedlings are transplanted to 1-gallon cans after three or four true leaves are formed. During May and early June of the same season these seedlings attain a growth of from 12 to 16 inches. At this time three or four buds from the basal part of the seedling shoot can be obtained which are suitable for T budding. These seedling buds are T-budded into vigorous shoots of rootstocks or of bearing vines that are growing in vineyard form. With special care and training the seedling buds can be forced into growth. By the end of the first growing season, shoots from 6 to 12 feet long can be developed. At pruning time a cane 3 to 4 feet long can be left for next season's fruiting wood. At the Fresno station ripe fruit has been picked in August, 18 months from the time the seeds were planted in flats. This method saves at least 2 or 3 years compared with the usual method of fruiting grape seedlings. While it may not serve as a test of the commercial merits of a seedling, it does serve to determine many qualities such as color, shape, size, and flavor of the fruit. As with all breeding work, selection of desirable seedlings is necessary. A number of vines of each seedling must be grown and observations made of its commercial possibilities under various soil and climatic conditions before it can be introduced for commercial culture.

PRESENT GRAPE-BREEDING WORK IN THE UNITED STATES

In recent years hybridization of grape varieties and species has been actively carried on at Federal and State experiment stations. Most of the expansion has taken place since 1900, although a few of the State stations were engaged in grape breeding previous to that time. The most active interest has been evidenced since 1920. A recent survey indicates that in addition to the grape-breeding program of the Department the following State stations are conducting grape-breeding work: California, Georgia, Maryland, Minnesota, Missouri, New York, South Dakota, Texas, and Virginia.

The principal objectives have been improvement in fruit quality, productivity, disease resistance, and adaptability to soil and climatic conditions. The work is being carried on with three distinct types that are of commercial importance in the United States—the American native bunch grapes, the muscadine grapes, and the European or Old World grapes.

Native Bunch Grapes

The native bunch grapes have been developed from various native species, in many cases with the infusion of the European grape through natural or controlled hybridization. The species from which the varieties of this group have been derived rank in importance in the following order: *Vitis labrusca, V. vinifera, V. aestivalis, V. linsecomii, V. vulpina, V. aestivalis* var. *bourquiniana, V. champini, V. rupestris, V. cinerea.* This group, represented commercially by such varieties as Beacon, Catawba, Concord, Cynthiana, Delaware, Iona, Lenoir, Niagara (fig. 5), and others of lesser importance, is grown, at least for home consumption, in every State in the Union. Commercial production is principally in the North Atlantic States, the Great Lakes region, the Central States, and to a lesser extent in the South and in the Pacific Northwest. They are used for table, local markets, shipment for some distance, unfermented juice, and wine. The vines of this type are characterized by medium to vigorous growth; the leaves are medium to large, three- to five-lobed or entire; the tendrils are forked; and the fruit clusters are small to above medium in size. The individual berries of different varieties vary in outline from globular to ovoid. The skin separates easily from the pulp, while the seeds are firmly retained in the pulp. The varieties that have *V. labrusca,* or fox grape, parentage are characterized by what is called a foxy flavor, which is very important in the manufacture of unfermented juice.

The trend of grape breeding with the native bunch grapes has been to improve quality by crossing with varieties of *Vitis vinifera.* This has been successfully done by the New York (State) Agricultural Experiment Station, which has introduced 21 named seedlings for commercial trial. The northern species, *V. labrusca* and *V. vulpina,* have been utilized by the Minnesota and South Dakota Stations to develop varieties with cold hardiness for the northern regions. Size of berries has been increased by the use of *V. labrusca.* Cold hardiness and adaptability have been developed by the use of *V. vulpina.* Thirty-two named seedlings have been introduced by the South

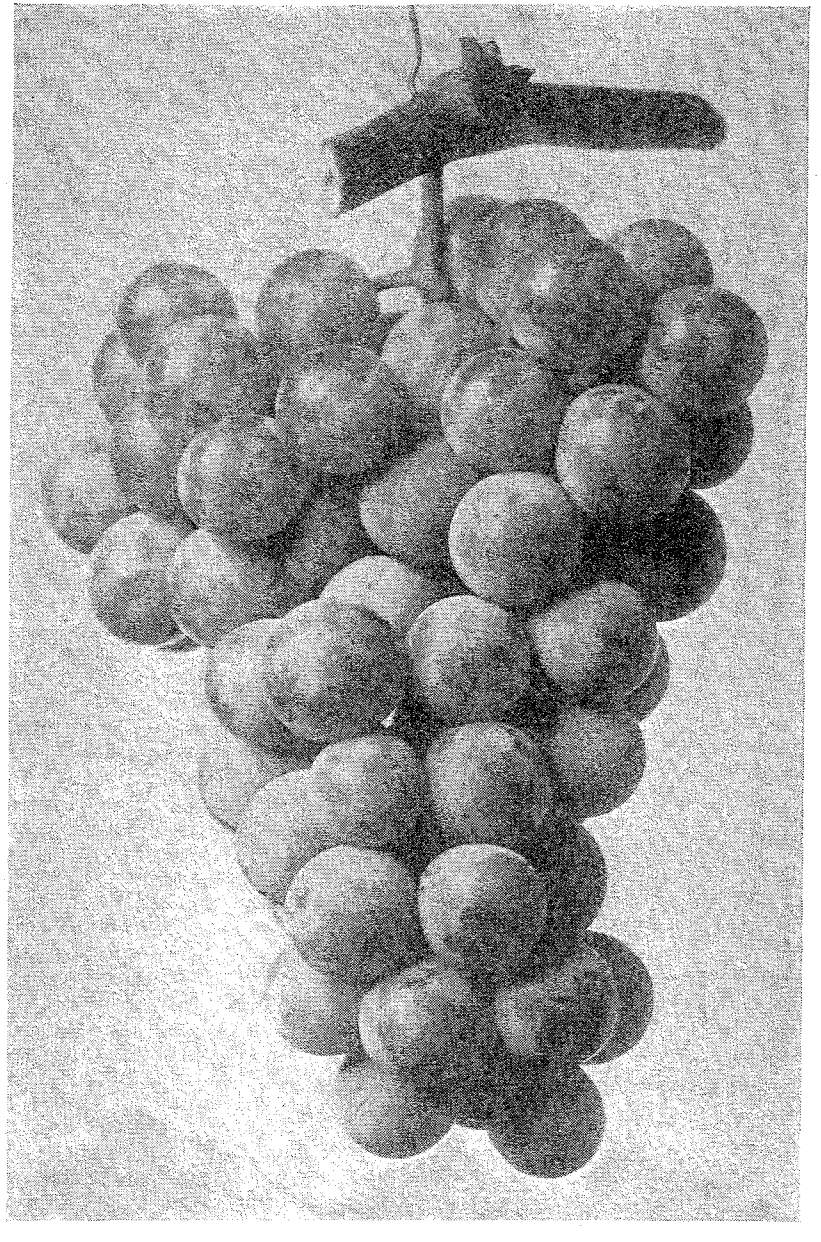

Figure 5.—The Niagara, one of the high-quality grape varieties developed from American species.

Dakota Station. The stations of Maryland, Missouri Texas, and Virginia, and the United States Department of Agriculture at Beltsville, Md., are conducting grape-breeding work to improve the quality and adaptability of the native bunch-grape types by crossing varieties containing labrusca and vinifera parentage with varieties developed from more southern species, such as *V. aestivalis*, *V. aestivalis* var. *bourquiniana*, *V. champini*, *V. linsecomii*, and *V. rupestris*.

Desirable Objectives in Breeding American Bunch Grapes

In the United States the desirable objectives in breeding the American bunch grapes vary with the regions in which they are grown, and regional needs must be studied separately. Three main regions are involved: (1) The North Atlantic States, the grape-growing areas along the Great Lakes, and the North Central States; (2) the Southern States; and (3) the northern Great Plains.

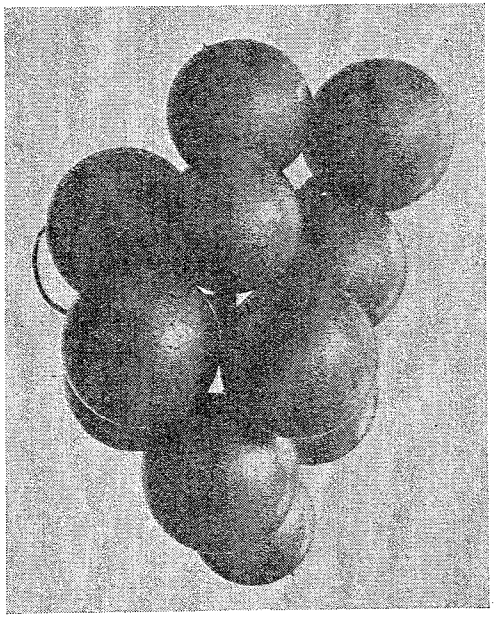

Figure 6.—A typical cluster of muscadine grapes, Scuppernong variety.

In the first region it would seem desirable, in the case of table grapes, to combine increased production with increased size of cluster and berry. In quality, the strong flavor of the labrusca may be ameliorated by the addition of the rich vinous flavor of the vinifera. The skin should be more edible and the flesh more melting than is the case with the Concord type if these qualities can at the same time be combined with improved shipping and handling qualities. The sugar content could be increased and the acidity adjacent to the seeds decreased. The seeds should separate readily from the pulp. It may not be too much to hope that the seeds can at some future time be entirely eliminated. In the case of varieties for unfermented juice, increased productiveness, a more highly colored juice, and a more melting pulp would seem desirable. Desirable improvement in varieties for wine varies with the type of wine. In general, increased sugar content, more juice production, and earlier maturity are desirable objectives. The development of a more vigorous, hardy, disease-resistant, and insect-resistant root system would materially aid the industry as a whole.

In the second region, the Southern States, important consideration should be given to resistance to disease and insect injury, principally downy mildew (*Plasmopara viticola* (Berk. and Curt.) Berl. and DeToni), black rot (*Guignardia bidwellii* (Ell.) Viala and Ravaz), root rot, and phylloxera injury. Improved size of berry and better quality would seem desirable. Varieties adapted to the various soil and climatic conditions would be of great assistance to the industry in this region.

In the third region, the northern Great Plains, cold hardiness must of necessity be of primary importance. It would seem possible to combine the cold hardiness of the more northern species with the

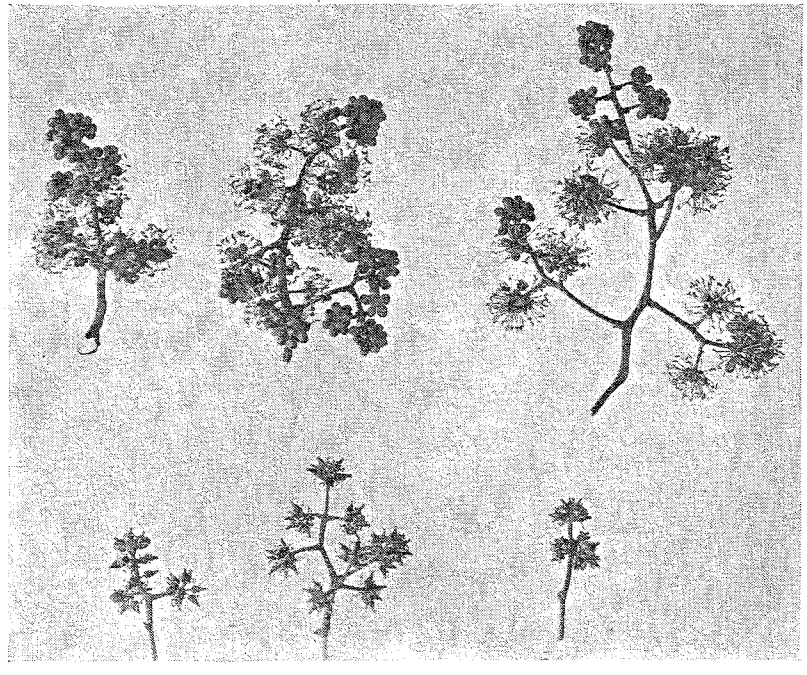

Figure 7.—Flower clusters of muscadine grapes. Upper three clusters, staminate blossoms; lower three clusters, pistillate or fruit-bearing blossoms.

size and quality of some of the improved varieties. Some of the more hardy vinifera varieties that mature in a short growing season may be hybridized with the more hardy native species to promote both early maturity and improved quality.

Muscadine Grapes

The muscadine grapes are especially adapted to the Southeastern and Gulf States. Selections have been made from chance seedlings and from the native wild vines of *Vitis rotundifolia*, the muscadine grape. This type of grape is represented commercially by the varieties Eden, James, Mish, Thomas, Scuppernong (fig. 6), and

others less prominent. They are used for table, local markets, juice, and wine. The vines of this type are characterized by vigorous growth, small, nonlobed leaves, simple tendrils, and small fruit clusters, sometimes with only a few berries. The adherence of berry to pedicel is generally poor. The individual berries are globular. The skin is mostly tough and leathery and separates readily from the pulp. The seeds are large and firmly embedded in the pulp. The strong musky flavor is very characteristic.

The present commercial varieties of muscadine grapes are not self-fertile (fig. 7). In commercial plantings it is necessary to include male vines to pollinate the fruiting varieties. Through crosses and selections by the Department at Willard, N. C., a number of self-fertile varieties have been produced. The breeding work at this station has concentrated on the production of these self-fertile, perfect-flowered types. Hybrids have also been obtained between the muscadine grapes and the European and the American bunch-type grapes. The Georgia Experiment Station has also been conducting breeding work with muscadine grapes for improvement in vine and fruit qualities. Eleven muscadine varieties having improved characters have been introduced for commercial trial by the Georgia Station.

Desirable Objectives in Breeding Muscadine Grapes

The muscadine grapes normally have a high resistance to disease and insect injury, and these qualities should be retained. It is desirable to combine quality and size of fruit with the perfect- or hermaphrodite-flowered types. The bunch size might be increased and adherence of the berry to the pedicel developed. The skin might be made more tender and the sweetness and flavor ameliorated by crossing with other grape species. The seeds of the muscadine grapes are larger than those of any other native species, and the development of varieties with smaller seeds would be a decided improvement.

European or Vinifera Grapes

The European or Old World grape types have been developed from the one species, *Vitis vinifera*. The vinifera grape industry in the United States, representing approximately 90 percent of the total commercial grape production, is centered in California, with local plantings in other Western States. The vines of this type are stocky and vigorous to very vigorous in growth. The leaves are medium to very large and usually characteristically lobed. The fruit clusters vary widely with the variety, from very small to very large. The individual berries range from small, as in the seedless currant type, to very large in the table varieties. While the more typical shape of the berries of this type is ovoid, there are globular and elongated forms. The skin adheres to the pulp, whereas the seeds separate readily from the pulp. Some varieties, such as the currant and seedless raisin types, develop without seeds. The fruit is characterized by a relatively high sugar content and a rich vinous flavor. There are types suitable for table use, distant shipping, storage, raisins, juice, and wine (fig. 8). Numerous varieties have been imported from foreign sources for trial in the United States, and of course all of our present commercial vinifera varieties are of foreign origin.

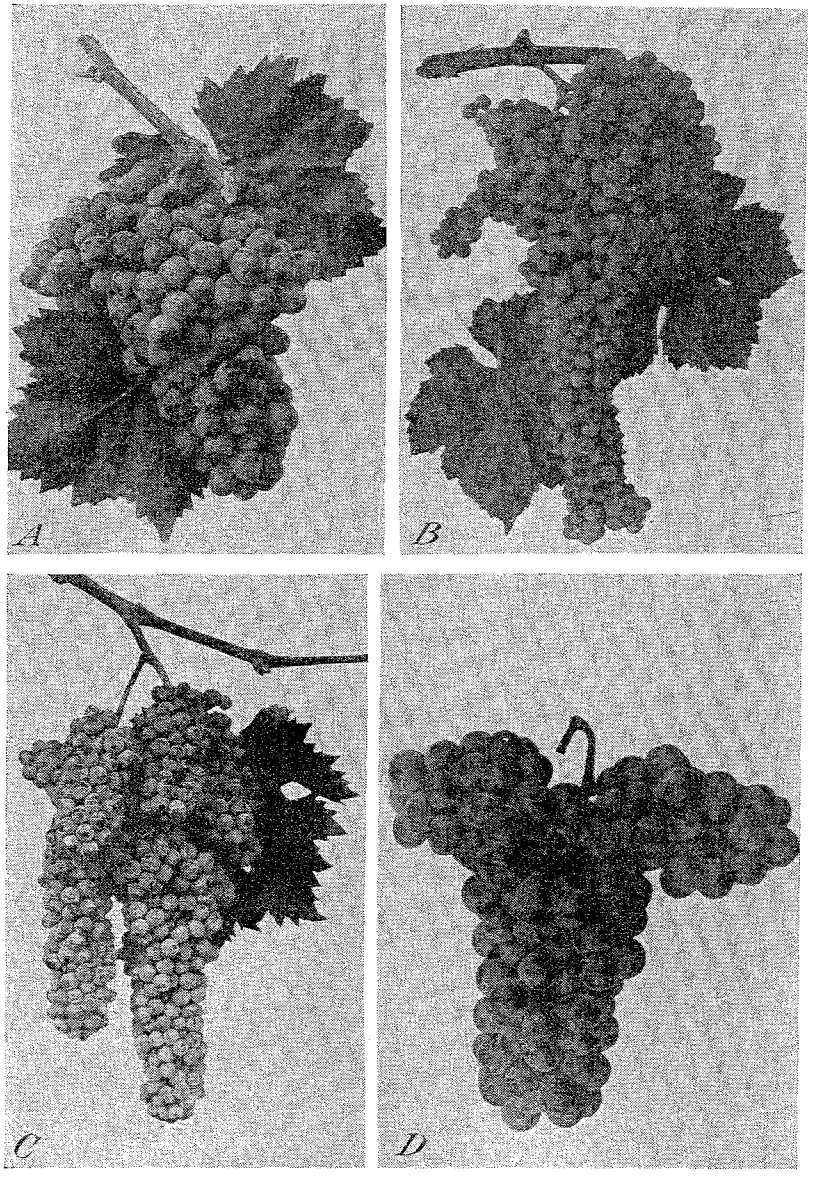

Figure 8.—Typical vinifera grape varieties: *A*, Flame Tokay, table type; *B*, Sultanina (Thompson Seedless), seedless raisin type; *C*, Panariti, currant raisin type; *D*, Petit Syrah, wine type.

The important table varieties are represented by Alexandria (Muscat of Alexandria), Alphonse Lavalle (Ribier), Castiza (Red Malaga), Emperor, Flame Tokay, Malaga, Ohanez, Olivette Blanche, Olivette Noire, and Sultanina (Thompson Seedless). The chief raisin varieties grown are Alexandria, Panariti (Zante currant type), Sultana, and Sultanina. There are many varieties utilized for wine manufacture. The white varieties used for wine include Alexandria, Burger, Chasselas de Fontainebleau, Feher Zagos, Franken Riesling, Gewürz Traminer (pink), Green Hungarian, Muscadelle du Bordelais, Muscat de Frontignan, Palomino, Pedro Ximines, Sauvignon Blanc, Sauvignon Vert, and Semillon. The black varieties include Alicante Bouschet, Aramon, Barbera, Cabernet Sauvignon, Carignane, Cinsaut, Grenache, Mataro, Mission, Mondeuse, Petit Syrah, Refosco, St. Macaire, and Zinfandel.

The trend in vinifera grape breeding in the United States has been to produce more seedless types and improved table, raisin, and wine varieties. Breeding work is being conducted by the Department at Fresno, Calif., and by the California Agricultural Experiment Station at Davis.

At the United States Experiment Vineyard, Fresno, Calif., approximately 500 seedlings have fruited, and seedless-type seedlings have been produced. Earlier maturity has been promoted by crossing early-ripening varieties. Richness of flavor has been transmitted by muscat-flavored varieties. Large-sized berries and a wide range of berry forms have been obtained. Seedlings with red juice adaptable to unfermented juice and to wine manufacture have been produced. Selections have been made of the most promising types for further production tests.

Desirable Objectives in Breeding Vinifera Grapes

In the United States the desirable objectives in breeding vinifera grapes vary with the purpose for which the fruit is intended. The type may be divided into table, raisin, and wine groups, although some varieties may be used interchangeably.

The table group is made up of varieties used locally, shipped to distant markets, and held in cold storage for later use. Since the major portion of the table-grape crop must be shipped from California to the distant eastern markets, firmness of fruit and adherence of berry to pedicel are of primary importance. These qualities are possessed by most of the present shipping varieties. The quality of these table varieties might be improved by the infusion of some of the aroma and flavor of the muscat-flavored grapes. Seedlessness in table grapes has become an important factor. While some seedless varieties are available at present, improvements are possible in size, adherence to stem, quality, color, and extended season of maturity. Improved early- and late-ripening grapes would have a distinct value in prolonging the market season. A storage grape of fine eating quality would be of great value. An assortment of black, red, and white grapes ripening from early to late would supply a demand that is not filled at the present time.

The raisin-grape group at the present time consists of currant-type, seedless-type, and muscat-type varieties. A currant-type variety with the addition of muscat flavor that would be productive without the annual ringing or cutting of the bark, which is now necessary, would be a decided improvement over present varieties. The present seedless-type raisin varieties could well be increased in size and improved in flavor. A large-sized, seedless, muscat-flavored variety would be very valuable to the raisin industry. A seeded muscat type that would set well-filled, uniform clusters would be a valuable improvement.

In the wine group, many varieties are utilized to make the various kinds of wine. To make certain wine types, the juice of several varieties, often three or more, is blended. It would seem to be within the realm of possibility to blend the varieties by breeding to produce a single variety with all the requirements for a particular kind of wine. Varieties with improved flavors and juice of a more intense and lasting color might be developed. At present all vinifera varieties must be grafted on roots resistant to phylloxera. Some day, varieties resistant to phylloxera, with fruit of desirable quality, may be developed so that grafting will not be necessary. The legalized sale of wines has, of course, furnished an incentive to produce a better product, and this will ultimately result in a greater demand for improved varieties for wine purposes.

EARLY IMPROVEMENT OF GRAPES IN EUROPE

As previously stated, the history of *Vitis vinifera*, the European grape, begins in prehistoric times. During this long period, selection was undoubtedly largely responsible for the numerous varieties concerning the origin of which we have no definite information. Early hybridization work with this species was started by Louis and Henry Bouschet in 1828. Their crosses were made with the definite object of combining the intense color of the Tinto with the high yield of varieties in southern France. Their efforts resulted in the production of three varieties, Alicante Bouschet, Petit Bouschet, and Grand Noir de la Calmette, which are still of commercial importance.

In France, hybridization of native American species assumed very great importance after phylloxera had made the grafting of vinifera varieties on resistant roots necessary. Between 1860 and 1870, diseased spots were noted in many French vineyards. The weakening of the vines was found to be caused by an insect (*Phylloxera vitifoliae* Fitch) living on the roots. Winged forms of the insect, which cause the formation of galls on the leaves, were also found. The phylloxera is indigenous to the eastern and central United States and probably was carried to France before 1860 on rooted American vines imported to resist damage then being caused in Europe by powdery mildew (*Uncinula necator* (Schw.) Burr). Phylloxera spread rapidly over France and the adjacent vine-growing countries. In order to save the vinifera vineyard industry from complete destruction, it was found necessary to graft the European varieties on native American rootstocks, which were resistant to the phylloxera insects. The United States thus furnished both the disease and the cure. Since the American grape species varied in their adaptability to the soil and climatic conditions of Europe, hybrids between American species

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and hybrids between European and native American grapes were utilized for phylloxera-resistant rootstocks.

Some breeding work to combine American and European vines had been started previous to 1876 by the School of Agriculture at Montpellier, France. Foëx, Millardet, Viala, Ravaz, de Grasset, Ganzin, Couderc, Castel, and Seibel practiced similar hybridizing work, which resulted in producing many rootstocks resistant to phylloxera and adapted to different soil types. Direct-producing varieties were also sought that would combine the resistance of the American species with the fruit qualities of *Vitis vinifera*. Many direct-producing varieties were originated through breeding. While the efforts were most successful in producing resistant rootstocks that are used today in the vinifera regions of foreign countries as well as the United States, ideal direct-producing fruit types were not obtained. A start was made, however, which may eventually bring results.

Phylloxera infestations occurred early in the commercial vinifera plantings in California. The only present method of control that has general application is the use of resistant rootstocks on which the vinifera grape varieties are grafted. These rootstocks are of American species and hybrids of American species, though the actual development of them occurred in Europe where phylloxera ravaged the vineyards before it became serious in California. Up to this time, the vinifera grape industry in the United States has depended for stocks on these species selections and hybrids made in Europe. The adaptability of the stocks to the various soil and climatic conditions and their suitability for the vinifera varieties in the United States have been tested by Federal and State workers. Breeding work is now under way for the production of improved stocks for the vinifera regions of the United States.

PRESENT GRAPE-BREEDING WORK IN OTHER COUNTRIES

Czechoslovakia

Investigations in grape breeding in Czechoslovakia are under the direction of Albert Stummer in Nikolsburg and Dr. Franz Frimmel in Brünn. This work, located at the extreme northern edge of commercial grape growing in Europe, includes the testing of resistant stocks, hybridization of varieties to secure wine and table grapes well adapted to northern production, and related investigations. Crossing and selfing of many varieties has been done.

France

French investigators, through selecting and breeding rootstocks resistant to phylloxera and congenial to vinifera varieties, saved the industry of Europe after phylloxera was introduced. A number of privately supported experimental vineyards, as well as a few publicly supported research stations, are still working on resistant understocks, also on hybridizing American species with vinifera varieties to secure varieties sufficiently resistant to grow on their own roots and be resistant to downy mildew (*Plasmopara*) and that will produce fruit of value. Work of this type is under way in the Cognac region.

Germany

Grape breeding is conducted at several points in Germany, as follows:

Alzey Grape Experiment Station (Leader, Grape Inspector Scheu).—Crosses are made with the objective of securing early-ripening and vigorous, good-quality wine grapes and also a series of table-grape varieties ripening from early until extremely late that are well adapted to the Rhineland area. From 15,000 cross-bred seedlings, 450 selections are being tested.

Freiburg; Badisches Weinbauinstitute (Director, Dr. Muller).—Breeding investigations are to secure varieties giving very high wine quality. Crosses of Sylvaner × Rülander have given exceptional wine quality and are being tested on various rootstocks. Resistance of varieties to downy mildew and the development of varieties having dark-red juice are other objectives. Twenty-five selections producing dark-red wine have been made.

Geisenheim a. Rh.; Versuchs- und Forschungsanstalt für Wein-, Obst- und Gartenbau (Director, Prof. Dr. Rudloff; in charge of grape investigations, Dr. Birk).—The work includes attempts at improvement of the varieties through clone selection; the breeding and testing of phylloxera-resistant rootstocks having good adaptation and an affinity to the important varieties and that are resistant to diseases; and the breeding of early- and late-ripening, high-quality table grapes.

Müncheberg; Kaiser Wilhelm-Institut für Züchtungsforschung (Director, Prof. Dr. Rudorf; in charge of grape investigations, Dr. Husfeld and Dr. Scherz).—Investigations are primarily to develop disease-resistant and insect-resistant rootstocks, vines, and varieties. Seedlings are grown by the hundreds of thousands and exposed to disease infection. Fifty thousand seedlings resistant to *Plasmopara* have been found. Their stock compatability and value for wine remain to be tested.

Weinsberg; Württembergische Anstalt für Rebenzüchtung und Rebenpfropfung (Leader, Mr. Herold).—The work consists primarily of the testing of understocks against phylloxera and the development by hybridization and testing of red-wine varieties.

Würzburg; Staatliche Hauptstelle für Rebenzüchtung (Leader, Dr. Ziegler).—Breeding investigations include clone selection and hybridization between grape varieties. Some 200 prospective varieties from crosses between varieties are now under test. Breeding of rootstocks resistant to *Plasmopara* and phylloxera, and showing good affinity with varieties, has resulted in about 1,500 selections that appear resistant and are receiving further test. Development of direct producers that combine resistance to phylloxera and diseases with good fruit and wine characteristics is also being attempted.

Italy

Grape-breeding experiments have been actively conducted at various places in Italy. Special attention has been given to the hybridizing of American vines for rootstocks. F. Paulsen, A. Ruggeri, C. Grimaldi, and C. Montoneri, working principally in Sicily, have produced hybrids of American vines for rootstocks. Some of the

more promising productions are Paulsen hybrids (*Vitis berlandieri* × *V. rupestris*) Nos. 771, 775, 779, and 1103; (*V. berlandieri* × (*V. riparia* × *V. rupestris*)) No. 1120; (*V. berlandieri* × (Aramon × Rupestris Ganzin)) No. 1045; (*V. berlandieri* × (Mourvedre × *V. rupestris* 1202)) No. 1323; Ruggeri hybrids (*V. berlandieri* × *V. rupestris* du Lot) No. 140; (*V. berlandieri* × *V. riparia*) Nos. 225, 240, and 325. Other hybrid rootstocks have been originated in Puglia by G. Ceccarelli and V. Prosperi.

Breeding for better table-grape varieties has been conducted by Alberto Pirovano, director of the Institute of Fruit Culture and Electogenetics at Rome. Crosses and backcrosses have been made with a number of vinifera varieties. Among the most interesting and noteworthy seedlings produced are Primus, Termidoro, Delizia di Vaprio, Italia, Aurora, Galvani, Perlona, Angelo Pirovano, Teresa Pirovano, and Principessa di Piemonte.

V. Prosperi, director of the Royal Nursery of American Vines at Velletri, has also obtained some interesting table-grape seedlings. Of special note are No. 167 (Moscato de Terracina × Chasselas Vibert) and No. 8 (Panse Precoce × Moscato Fior d'Aranico).

The Royal Experiment Station of Viticulture and Oenology of Conegliano, founded in 1923, began hybridizing work with *Vitis vinifera*. Particular attention has been given to the production of new types of wine and table grapes with regard to their adaptability to the natural conditions of northern Italy. The work of this station was planned by Director G. Dalmasso and L. Manzoni. Italian and French varieties of *V. vinifera* have been used in the grape-breeding work. Better types have been secured so far from crosses of Trebbiano × Traminer, Prosecco × Cabernet Sauvignon, Trebbiano × Verdiso, and Besgano × Moscato de Amburgo. More recently the Conegliano station has started hybridization of *V. vinifera* with American vines, and hybridizing American vines, for the production of new rootstocks more adapted to conditions in the Province of Venezia.

Union of Soviet Socialist Republics

The following outline of the grape investigations in the Union of Soviet Socialist Republics has been taken from Plant Breeding in the Soviet Union, by N. I. Vavilov, published by the Imperial Bureaux of Plant Genetics, Cambridge and Aberystwyth, 1933. Fourteen plant-breeding centers, covering every section of the Soviet Union, constitute regional headquarters for breeding work covering all agricultural crops. These are all under the direction of the Institute of Plant Industry, N. I. Vavilov, director. The grape program includes the following:

(1) Immunity: (*a*) Phylloxera. Breeding resistant varieties by method of cyclic crossing of *Vitis vinifera* with American species and obtaining generations up to F_2 and F_3 (with study of characters of phylloxera). (*b*) Mildew. Breeding resistant varieties by method of cyclic crossing of *V. vinifera* with American species (obtaining generations up to F_2 and F_3, and study of resistance to mildew). (*c*) *Oidium*. Breeding resistant forms by method of cyclic crossing of *V. vinifera* with American species (obtaining generations up to F_2 and F_3, and study of resistance to *Oidium*).

(2) Resistance to frost and cold. Breeding resistant varieties by means of *Vitis vinifera* × *V. amurensis* with study of this character.

(3) Vegetative period. Breeding early and later varieties (in order to extend their cultivation northward) by means of intercrossing of *V. vinifera* and also by crossing with other *Vitis* species.

(4) Chemical characters. Breeding of dessert varieties with transportability, varieties for wine and alcohol-free beverages (sugar and acid content).

(5) Specific characters: (*a*) Preliminary work, on study of characters related to transportability and storing; (*b*) study of seedless varieties in order to obtain productive seedless strains; (*c*) study of character of rooting in *Vitis*.

(6) Problem of sex. Study of heredity of sex in order to obtain self-fertile varieties.

(7) Self-sterility and self-fertility. Study to improve yield.

(8) Permanent modifications. Genetic study (yield of quantitative characters).

(9) The origin of cultivated plants. Comparative genetics of wild *Vitis* species.

(10) Chimeras: (*a*) Study of chimeras in order to find agriculturally valuable characters; (*b*) production of chimeras of practical value; (*c*) qualitative inequality of ontogenetic system of individuals.

Vitis should be included in studies of inbreeding.

Phytopathology and entomology: Methods of inoculation of seedlings with phylloxera, downy mildew, and *Oidium*. Testing of seedlings for resistance to phylloxera under various ecological conditions.

Physiology Stimulation of seedlings and seeds to accelerated growth and fruit bearing.

Australia

The Department of Agriculture, New South Wales, Australia, at its Yanco Experiment Farm, started grape breeding in 1928, under the direction of H. Wenholz, to produce a black table grape of high quality and with the shipping quality of Ohanez. Breeding for disease resistance and for the production of seedless raisin and table varieties has been in progress.

ACHIEVEMENTS AND NEEDS

The major portion of the grape-breeding work has been to improve quality. Quality is an elusive factor. In quality of fruit, native American types are considered inferior to the vinifera types. The quality of fruit has been improved where our native varieties have been crossed with the best-quality varieties of *Vitis vinifera*. Improvements in cluster and berry types have been made by combining different native species. Grape rootstocks have been developed through hybridization which have suitable resistance to phylloxera and are adapted to various soil types.

The results so far obtained indicate that grape improvements can be obtained through hybridization. The field of grape breeding is still relatively new. There is need for more information, especially on the inheritance of desirable characters such as size, quality, seedlessness, cold hardiness, disease and insect resistance, and adaptability to environment. Collections of species, native American varieties, and European varieties are available as breeding material. Progress has been made, but continued improvement is possible. Better quality, more attractive appearance, and a prolonged season will result in increased demand and consumption, to the ultimate profit of the grape industry.

INHERITANCE IN GRAPES[3]

Early grape breeding was carried on mainly to obtain desirable varieties or stocks, and little attention was given to the study of inherita-

[3] The following pages are written primarily for students and others professionally interested in breeding or genetics.

ble qualities. As intensive breeding work has been in progress a relatively short time, and the time necessary from seed to fruit in one generation of grapes occupies ordinarily from 3½ to 5½ years, only limited data are available on the transmission of inheritable qualities. Genetic and cytological research projects at State and Federal institutions are listed in the appendix material.

The somatic chromosome number of most vinifera grapes and most American bunch-grape species is 38. Gigas forms of American and vinifera varieties are tetraploids with 76 chromosomes in the somatic tissues. Most American bunch-grape species will cross readily with one another and with vinifera varieties, forming fully fertile hybrids. The two muscadine species cross freely with each other, with fertile hybrids resulting. The muscadines and vinifera varieties or American bunch-grape types are crossed with some difficulty, and the F_1 hybrids of these crosses generally set but few if any fruits.

One important commercial consideration concerns the character of grape flowers—whether the stamens are upright or reflex. At the New York (State) Agricultural Experiment Station, crossing two varieties with reflex stamens gave in the F_1 a ratio of 1 reflex to 1 upright in the resultant progeny. Crossing upright stamens with reflex stamens gave the same ratio, while crossing two varieties with upright stamens gave 4.3 upright to 1 reflex in the F_1 progeny. From crosses of vinifera varieties with upright stamens at the United States Experiment Vineyard, Fresno, Calif., the ratio of upright to reflex stamens in the F_1 seedlings was 5.4 to 1.

In color of fruit, white is a recessive character, and only white-fruited progeny results when two white-fruited varieties are crossed. Both red and black are dominant over white, and most of the red and black varieties studied appear to be heterozygous for color.

The investigations of Hedrick and Anthony (*5*) at Geneva, N. Y., reported in 1915, relative to color, indicated that crosses of black-fruited and white-fruited varieties gave in the F_1 approximately 3 black-fruited seedlings to 1 white-fruited. Black-fruited and red-fruited varieties segregated into these colors only when selfed or crossed. At the United States Experiment Vineyard at Fresno, Calif., the segregation obtained in the first and later generations of crosses among varieties with colored fruit has varied with the different parent varieties used. It would appear that the majority of colored grapes on which data are available are heterozygous for both red and black color.

During recent years attention has been given to the origination of more seedless varieties of grapes through breeding. A. B. Stout, of the New York Botanical Garden, in cooperation with the New York (State) Agricultural Experiment Station, has produced seedless or near-seedless types by using the pollen from the present seedless vinifera varieties to pollinate American-type varieties. At the United States Experiment Vineyard, Fresno, Calif., crosses have been made between the seedless vinifera varieties and many of the seed-bearing vinifera varieties. Of the seedlings that have fruited to date, 12.4 percent have produced seedless-type fruit in the F_1 generation. The production of seedlessness in the F_1 generation has proved the value of seedless varieties as male parents to produce new seedless types.

While the inheritable factor for seedlessness has not been determined, progress has been made in developing more seedless varieties for breeding work, some of which may also be of commercial value.

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APPENDIX

Location of Present Grape Breeding in the United States and Investigators Conducting the Work

United States Department of Agriculture, Bureau of Plant Industry, Division of Fruit and Vegetable Crops and Diseases:
- Beltsville, Md.: C. A. Magoon, I. W. Dix, J. R. Magness.
- Fresno, Calif.: Elmer Snyder, F. N. Harmon.
- Meridian, Miss.: N. A. Loomis.
- Willard, N. C.: C. T. Dearing.

State agricultural experiment stations:
- California, Davis: H. P. Olmo.
- Georgia, Experiment: H. P. Stuckey.
- Maryland, College Park: A. L. Schrader, S. W. Wentworth.
- Minnesota, University Farm, St. Paul: A. N. Wilcox.
- Missouri, Mountain Grove: Paul H. Shepard.
- New York:
  - Geneva: Richard Wellington and coworkers.
  - Fredonia: F. E. Gladwin.
  - New York Botanical Garden, Fordham Station, New York: A. B. Stout.
- South Dakota, Brookings: N. E. Hansen.
- Texas, College Station: S. H. Yarnell.
- Virginia, Blacksburg: F. W. HofMann.

Summary of Present Grape Breeding in the United States

California

Main grape breeding work started in 1931 to produce new seedless varieties, improve the quality of table varieties, and to study genetic factors. Crosses and selfed varieties have yielded approximately 3,000 seedlings. The chromosome number for Sultanina was found to be 38 and of the Gigas types to be 76. Breeding material includes a large number of vinifera varieties and a collection of native American species. Selfed seedlings are being grown of the following varieties: Alexandria (Muscat of Alexandria), Alphonse Lavallee (Ribier [4]), Angulato, Black Corinth, Chaouch, Chasselas Cioutat, Diamond Jubilee, Emperor, Flame Tokay, Gros Colman, Hunisa × Muscat, Malaga, Malvasia Bianca, Molinera, Muscatello Fino, and Ohanez.

Seedlings have been obtained from the following crosses: Alexandria × Black Corinth, Alexandria × Sultana, Alexandria × Sultanina, Alexandria × Sultanina Gigas, Alexandria × Sultanina Rosea, Alexandria × White Corinth, Alphonse Lavallee × Monukka, Alphonse Lavallee × Sultana, Alphonse Lavallee × Sultanina, Alphonse Lavallee × Sultanina Gigas, Augibi × Sultanina, Black Morocco × Golden Muscat, Burgrave × Monukka, Burgrave × Sultanina, Chaouch × Alexandria, Chaouch × Black Corinth, Chaouch × Monukka, Chaouch × Sultana, Chaouch × Sultanina, Damas Rose × Monukka, Damas Rose × Sultanina, Damas Rose × Sultanina Gigas, Dattier de Beyrouth × Monukka, Dattier de Beyrouth × Sultanina, Diamond Jubilee × Monukka, Diamond Jubilee × Sultanina, Emperor × Monukka, Emperor × Sultanina, Flame Tokay × Black Corinth, Flame Tokay × Monukka, Flame Tokay × Sultana, Flame Tokay × Sultanina, Flame Tokay × Sultanina Rosea, Flame Tokay × White Corinth, Golden Muscat × (Hunisa × Muscat), Golden Muscat × Sultanina, Gros Colman × Monukka, Gros Colman × Sultanina, Gros Colman × Sultanina Gigas, Gros Colman × Sultanina Rosea, Henab × Monukka, Hunisa × Black Corinth, Hunisa × Golden Muscat, Hunisa × Monukka, Hunisa × Sultanina, Hunisa × Sultanina Gigas, (Hunisa × Muscat) × Golden Muscat, (Hunisa × Muscat) × Malvasia Bianca, (Hunisa × Muscat) × Alexandria, Madeleine Angevine × Luglienga, Madresfield Court × Monukka, Madresfield Court × Sultanina, Malvasia Bianca × Sultanina, Marvel de Vaucluse × Malvasia Bianca, Molinera × Monukka, Molinera × Sultanina, Muscat Blowers × Monukka, Muscat Blowers × Sultanina, Muscat Bowood × Black Corinth, Muscatello Fino × Sultanina, Muscat Gigas × Alexandria, Muscat Hamburg × Sultanina, Olivette Blanche × Monukka, Olivette Blanche × Sultanina, Rambela × Monukka, Rambela × Sultanina, Trivoti × Monukka, Trivoti × Sultanina, Zabalkanski × Monukka.

Georgia

Grape-breeding work is entirely with *Vitis rotundifolia* to improve vine and fruit qualities of the muscadine grapes. Eleven varieties have been introduced from 1919 to 1934. Breeding material includes a number of muscadine varieties and station seedlings. Table 3 gives the varieties introduced.

Table 3.—*Grape varieties introduced by the Georgia Experiment Station*

Variety	Year introduced	Parentage	Qualities
Brownie	1933	San Monta × white male	Productive; high sugar content.
Dulcet	1934	Hunt × white male	
Howard	1921	Scuppernong × black male	High sugar content.
Hunt	1919	Flowers × white male	Productive; adherence; thin skin.
Irene	1919	Thomas × black male	Vigorous; adherence; large.
Lucida	1933	Irene × unknown male	Large; attractive appearance.
November	1919	Scuppernong × black male	Productive; good clusters; late.
Qualitas	1919	Thomas × black male	Good quality; sweet.
Spalding	1919	Flowers × white male	Good clusters; long season.
Stuckey	1919	Scuppernong × black male	Large; white; sweet.
Yuga	1934	San Monta × unknown male	Attractive; compact; thin skin.

[4] Alphonse Lavallee is grown commercially in California under the name Ribier.

Maryland

Grape-breeding work was started in 1912. The main attempts were to develop an early black grape of high quality. A study was made of the inheritance of fruit color. While an early black grape of quality for Maryland conditions was not obtained, a few seedlings were propagated in 1929 for further test, some of which show promise as desirable varieties.

Seedlings were grown of the following open-pollinated varieties: Bailey, Brilliant, Creveling, Goethe, Lindley, Lucile, Mericadel, Red Giant, Salem, Wilder, Woodruff, Worden, Wyoming. Seedlings were also obtained from the following crosses: Agawam × Clinton, Brighton × Winchell, Campbell × Winchell, Clinton × Black Hamburg, Delicious × Winchell, Diana × Clinton, Diamond × Clinton, Eclipse × Brilliant, Lindley × Clinton, Lindley × Campbell Early, Lindley × Winchell, Moore Early × Winchell, Salem × Clinton, Winchell × Brilliant, Winchell × Clinton, Winchell × Worden, Worden × Winchell, Worden × Clinton.

Minnesota

Grape breeding has been in progress since 1908. The early work stressed the use of Beta as a hardy parent in combination with the higher quality varieties, Agawam, Campbell, Concord, Delaware, Janesville, Jessica, Lutie, Salem, and Witt. In later work since 1923, selected seedlings from these crosses have been used in further breeding work by intercrossing, crossing with various dessert varieties, and inbreeding. Breeding studies have been conducted, principally with respect to winter hardiness. Selections have been made to develop homozygous material for genetic studies and for superior value in breeding work. Cytological studies have been made on pollen development with special reference to sterility. A chromosome number of 38 was determined in the Beta grape, using root-tip material in making the count determinations.

Missouri

Grape breeding has been in progress since 1933. Earlier crosses were made with the objective of better quality, improved vigor, and more resistance to disease. Seedlings have been obtained from the following grape crosses: Campbell Early × Eaton, Columbia × 42–18, Concord × Caco, Concord × Eaton, Concord × 42–18, Concord × Triumph, 42–2 × 42–8, 44–5 × Caco, 44–5 × Concord, Goethe × Concord, Goethe × 42–8, Herbert × Agawam, Herbert × Concord, Herbert × 42–8, Hubbard × Beta, Eclipse × Eaton, Eclipse × 42–8, Eclipse × Triumph, Lindley × Caco, Lindley × Concord, Lindley × 42–8, Lindley × 42–17, Lindley × Triumph, Moore Early × Caco, Moore Early × Concord, Muench × Beta, Muench × 42–17, Muench × Triumph, Triumph × Concord, Triumph × Eaton, Triumph × 42–17, Triumph × Portland.

In 1935 Concord and Moore Early were crossed with Lindley, Herbert, and Barry (Rogers hybrids) to develop self-fertile varieties with some of the desirable qualities of the Rogers hybrids.

New York

Grape-breeding work at Geneva was started in 1888. More than 30,000 grape seedlings have been grown at this station. Selfing and crossing have been used extensively. Of 282 selfed varieties and selfed seedlings, no seedling appeared worthy of commercial trial. Three hundred and twenty-five varieties and seedlings have been used in the breeding work. Particular attention has been given to vigor, hardiness, productiveness, disease resistance, and quality of fruit. In connection with the breeding work, a study has been made of the transmission of different characters. Reports have been made on the inheritance of stamen characters, color of fruit, and transmission of other vine and fruit qualities. Chromosome counts give a diploid number of 38 in the grape varieties and species studied, excepting several Gigas strains, which give a count of 76. Some seedlings with the triploid chromosome number have recently been produced.

In cooperation with the New York Botanical Garden, extensive breeding work has been carried on mainly for the production of seedless varieties suitable to eastern conditions. Reports have been issued covering this phase of the work. From 1907 to 1937, 21 varieties have been introduced as the result of breeding work conducted at Geneva and Fredonia, N. Y., and in cooperation with the New York Botanical Garden (table 4).

TABLE 4.—*Grape varieties introduced by the New York State Agricultural Experiment Station (Geneva and Fredonia)*

Variety	Year introduced	Parentage	Superior characters
Brocton	1919	Brighton × (Winchell × Diamond)	Productive: white; oval.
Bronx Seedless	1936	(Goff × Dina) × Sultanina	Productive; red.
Dunkirk	1920	Brighton × Jefferson	Medium productive; red.
Fredonia	1915	Champion × Lucile	Large cluster and berry.
Goff	1907	Goff seedling no. 19	Productive; reddish black.
Golden Muscat	1927	Muscat Hamburg × Diamond	Very productive; large cluster; white.
Hanover	1928	Brighton × Niagara	Productive: red.
Keuka	1923	Chasselas Rose × Mills	Productive; red; late.
Melton	1923	Triumph × ((Winchell × Diamond) × Jefferson).	Productive; white.
Ontario	1908	Winchell × Diamond	Productive; white; early.
Pontiac	1922	Herbert × Worden	Medium productive; black.
Portland	1912	Champion × Lutie	Productive; early; white.
Ripley	1912	Winchell × Diamond	Productive; white.
Seneca	1930	Lignan Blanc × Ontario	Medium productive; early; white.
Sheridan	1921	Herbert × Worden	Productive; black.
Stout Seedless	1930	(Triumph × Dutchess) × Sultanina Rosea.	Medium productive; white.
Urbana	1912	Ross × Mills	Medium productive; red; late.
Van Buren	1924	Fredonia × Worden	Earliness.
Watkins	1930	Mills × Ontario	Medium productive; nearly black.
Wayne	1927	Mills × Ontario	Productive; black.
Westfield	1922	Herbert × Concord Seedless	High sugar; high color.

From the following crosses at the New York (Geneva) station, 6 seedlings have been propagated for naming, 35 for extensive trial, and 69 for a small trial: Ontario × Sheridan, Sheridan × Ontario, Ontario × Gros Guillaume, Ontario × Black Corinth, Ontario × Hubbard, Ontario × Moore Early, Ontario × Muscat Hamburg, Eclipse × Portland , Iona × Ontario, Herbert × Watkins, Concord × Sta.[5] 10085 (Triumph × Mills), Sta. 10115 (Triumph × Mills) × Concord, Portland × Moore Early, Wayne × Iona, Hubbard × Gros Guillaume, Hubbard × Golden Muscat, Zinfandel × Ontario, Mead No. 9 × Noir Hatif de Marseille, Golden Muscat × Wayne, Golden Muscat × Sultanina, Sta. 10842 ((Herbert × Triumph) × (116 × Jefferson)) × Sultana, Sta. 7408 (Ross × Mills) × Moore Early, Sta. 8691 ((Iona × Vergennes) × Jefferson) × Khalili, Sta. 8691 (Iona × Vergennes) × Muscat Hamburg, Sta. 8717 (Kensington × Triumph) × Watkins, Sta. 9104 (Triumph × Iona) × Seneca, Sta. 9104 (Triumph × Iona) × Seneca, Sta. 10420 (Muscat Hamburg × Ripley) × Khalili, Sta. 10439 (Bakator × Diamond) × Seneca, Sta. 10526 (Muscat Hamburg × Ripley) × Melton, Sta. 10774 (Chasselas Besson × Diana) × ((Triumph × Sta. 116) × Jefferson) × Muscat Hamburg, Sta. 10605 (Frankenthal Precoce × Diamond) × Ontario, Sta. 10108 (Triumph × Mills) × Ontario, Sta. 10144 (Mills × Triumph) × Dunkirk, Sta. 8536 (Goff × Iona) × Ontario, Sta. 7408 (Ross × Mills) × Ontario, Sta. 10526 (Muscat Hamburg × Ripley) × Khalili. Principal grape varieties used in breeding work by the New York (State) Station:[6] Agawam, Barry, Berckmans, Brighton, Butler, Campbell, Catawba, Champion, *Chasselas Golden, Chasselas Rose, Clinton, Colerain, Collier, Concord, Concord Seedless, Cottage, Croton, Daisy, Delaware, Diamond, Diana, Dutchess, Eclipse, Franken Riesling, Fredonia, Goethe, Golden Muscat, *Herbert, Hubbard, Hubbard Seedless, *Iona, Jessica, Keuka, Lindley, Lucile, Manito, Massasoit, Melton, *Mills, Moore Early, *Muscat Hamburg, Noah, *Ontario, Panariti, Pekin, Petit Syrah, Portland, Regal, Ripley, Rosaki, Salem, Secretary, Seneca, Sheridan, Stout Seedless, Triumph, Urbana, Vergennes, Wayne, Winchell, Worden, and also station seedlings nos. 7408, 8536, 9130, and 10919.

Grape material available for breeding in addition to American Euvitis varieties includes early-maturing vinifera varieties and the following list of unusual varieties:

From Africa: Primativo, Roussanne.

French hybrids: Caperan, Commandant, Bertile, Seyve 2667, Cartier 1, Malegue 2049–3, Peage 5–10, Seibel 2, 14, 1000, 4629, 4643, 5136, 5296, 5437, 5455, 5760, 5898, 6339, 6905, Villard 2–108.

[5] "Sta." denotes station seedling.

[6] An asterisk (*) denotes varieties that have made good parents; others may appear later.

From Hungary: Königin Elizabeth, Königin der Weingarten, Malaga Bleu, Millenium Straube, Szauter Musk.

From Union of Soviet Socialist Republics: Albourla, Aneb-el-Cadi, Apapnish White, Buaki, Charas, Hisakasy, Maska, Muscat de Crime, Rish Baba, Rosy Taifi, Sabsa, Said Galumi, Shuvargani, Tabyrn, Ter-Gulmer, White Chilaki.

South Dakota

Many seedlings of the wild grape of the Dakotas were grown, but little variation and no apparent improvement over the wild type was noticed. This led to the crossing of the wild grape of the Dakotas with choice American-type grapes. The hardiness of the wild type, *Vitis vulpina*, appeared to be strongly dominant, and 32 varieties that appeared hardy and that have superior fruit qualities for the more northern regions were introduced in 1925.

Table 5 indicates the parentage and some of the superior qualities of grape varieties introduced by the South Dakota Station.

TABLE 5.—*Grape varieties introduced by the South Dakota Agricultural Experiment Station*

Variety	Parentage	Qualities
Arikara	Lady × North Dakota wild	White; productive; large.
Atkan	do	White; sweet; long bunch.
Azita	Beta × North Dakota wild	Sweet; vigorous; medium size.
Caddo	Beta × Agawam	Black; sweet; good flavor.
Chonkee	Lady × North Dakota wild	White; productive; vigorous.
Chontay	Massasoit × Beta	Black; vigorous; good flavor.
Edapa	Merrimac × Beta	Black; large; good quality.
Emana	Beta × Agawam	Black; large; good flavor.
Eona	Lady Washington × Beta	White; productive; sweet.
Lachala	Lady × North Dakota wild	White; productive; large.
Luza	Merrimac × Beta	Red; sweet; meaty.
Mandan	Wilder × North Dakota wild	Black; productive; early.
Manota	Merrimac × Beta	Black; large; good quality.
Napka	Salem × Beta	Black; vigorous; good flavor.
Nompah	Lindley × South Dakota wild	Black; large; good flavor.
Oglala	Merrimac × Beta	Black; productive; large.
Onaka	Beta × Salem	White; productive; large.
Osbu	Beta × Agawam	Black; medium size; good flavor.
Pontigo	Lady × North Dakota wild	Light red; very large; sweet.
Ree	do	White; productive; late.
Santee	Merrimac × Beta	Black; productive; large.
Shakoka	Lady × North Dakota wild	Black; vigorous; large.
Siposka	do	Black; large.
Sonona	do	Light red; productive; sweet.
Tahama	do	Black; vigorous; large.
Teopa	Lindley × South Dakota wild	White; sweet.
Toscha	Lady × North Dakota wild	White; sweet; large.
Wachepa	Lady Washington × Beta	Do.
Wakpala	Merrimac × Beta	Black; very large; good flavor.
Wecota	Lady Washington × Beta	White; sweet.
Wetonka	Beta × Salem	Black; productive; vigorous.
Yasota	Merrimac × Beta	Black; large; wild flavor.

Texas

Grape-breeding work started in 1935. Seedlings of selfed and crossed varieties are being obtained in an attempt to improve fruiting varieties relative to vigor, adaptability, disease resistance, and fruit qualities. Breeding material includes vinifera and native varieties and native grape species. Seedlings have been obtained from the following selfed varieties: Allaga, Elvicand, Extra, Lomanto, Marguerite, Mathilda, and R. W. Munson.

Virginia

Grape-breeding work started in 1930 by raising seedlings of open-pollinated standard varieties. Varietal crosses of American native varieties were made in 1935. The main objective is to improve the flesh quality. A study is being made of pollen compatibility, fruit characters, and resistance to disease.

From open-pollinated blossoms seedlings have been grown from the following varieties: Catawba, Concord, Eumelan, Moore Early, Niagara, and Worden.

Seedlings are also being grown from the following controlled crosses: Agawam × Amber Queen, Agawam × Barry, Agawam × V. L. B., Amber Queen × Agawam,

Amber Queen × Catawba, Eumelan × Catawba, Eumelan × Delaware, Eumelan × Wilder, Eumelan × Worden, Eumelan × V. L. B., Niagara × Worden, Wilder × Amber Queen, and selfed seedlings of Agawam, Catawba, Delaware, and Regal.

Two seedlings of earlier crosses were introduced in 1936: V. L. B. (Campbell Early × Herbert) and Agel (Agawam × Regal).

United States Department of Agriculture

Grape-breeding work was started with vinifera varieties at Fresno, Calif., in 1923, to produce seedless varieties suitable for table and raisin use, quality table varieties, and juice varieties Crosses have been made between many vinifera varieties, using the seedless varieties as the male parents. Large-berry varieties have been used to increase size, and highly flavored varieties to improve quality. Seedlings of standard varieties, selfed seedlings, and backcrosses are being grown to study genetic characters and the possibility of obtaining desirable qualities. Some cytological work has been done on pollen development and the development of the ovule. Studies have been made on the inheritance of vine, flower, and fruit characters.

Seedlings are being grown of phylloxera-resistant stock varieties and crosses of stock varieties for further studies on rootstocks resistant to root knot nematode. Varietal improvement through the selection of bud sports is in progress. Publications have been issued on the progress of the breeding work and the production of seedless varieties. Grape-breeding material includes 338 American native varieties, 95 Franco-American direct producers, 136 phylloxera-resistant rootstocks, over 550 varieties of *Vitis vinifera*, and in addition over 200 more recent Plant Introduction numbers from foreign sources.

Seedlings of the following crosses have been obtained: Alexandria × Alicante Bouschet, Alexandria × Monukka, Alexandria × Calmette, Alexandria × Corinthe Blanc, Alexandria × Corinthe Rose, Alexandria × Damas Rose, Alexandria × Hunisa, Alexandria × Malaga, Alexandria × Panariti, Alexandria × Sultanina, Alexandria × Sultanina Gigas, Alexandria × Sultanina Rosea, Emperor × Monukka, Emperor × Maraville de Malaga, Emperor × Sultanina, Flame Tokay × Monukka, Flame Tokay × Maraville de Malaga, Flame Tokay × Sultanina, Gros Guillaume × Monukka, Gros Guillaume × Maskah, Gros Guillaume × Sultanina Gigas, Malaga × Monukka, Malaga × Sultanina, Maraville de Malaga × Monukka, Maraville de Malaga × Sultanina, Maraville de Malaga × Sultanina Gigas, Maraville de Malaga × Tagonti Rouge, Maskah × Gros Guillaume, Muscat Hamburg × Monukka, Muscat Hamburg × Panariti, Ohanez × Monukka, Panariti (sport) × Monukka, Pizzutella × Monukka, Rodites × Monukka, Rodites × Gros Guillaume, Vigne de Zericho × Rodites.

Seedlings have been obtained from crosses of station seedlings and standard varieties as follows: (Alexandria × Monukka) 9642 × Monukka, (Alexandria × Monukka) 96419 × Monukka, (Alexandria × Corinthe Rose) 105616 × Monukka, (Alexandria × Corinthe Rose) 105713 × Monukka, (Alexandria × Sultanina) 96212 × Sultanina, (Damas Rose × Monukka) 8635 × Monukka, (Damas Rose × Monukka) 86310 × Monukka, (Damas Rose × Monukka) 8649 × Sultanina Gigas, (Damas Rose × Monukka) 86311 × Sultanina Gigas, (Muscat Hamburg × Monukka) 106212 × Monukka, (Muscat Hamburg × Monukka) 106312 × Monukka, (Pizzutella × Monukka) 10644 × Monukka, (Pizzutella × Monukka) 10649 × Monukka, and Muscat Hamburg × (Alexandria × Sultanina Rosea) 96212.

Seedlings of the following selfed varieties are being grown: Agadia, Alexandria, Carignane, Chasselas Cioutat, Chasselas Doré, Chasselas Rose de Falloux, Cinsaut, Crabbs Burgundy, Emperor, Flame Tokay, Foster, Gros Guillaume, Lenoir, Malaga, Maraville de Malaga, Maskah, Mission, Muscat Hamburg, Mondeuse, Panariti, Palomino, Petit Syrah, Prune de Cazouls, Sauvignon Vert, Semillon, Sylvaner, Traminer, Zeine, Zinfandel, and seedlings of the following Plant Introduction nos. 105074 to 107086, inclusive, 105922, and 107007.

Seedlings of the following selfed station seedlings are being grown: (Alexandria × Alicante Bouschet) 9582, (Alexandria × Alicante Bouschet) 95915, (Alexandria × Alicante Bouschet) 95919, (Alexandria × Monukka) 9623, (Alexandria × Monukka) 9627, (Alexandria × Monukka) 9628, (Alexandria × Monukka) 96311, (Alexandria × Monukka) 96317, (Alexandria × Monukka) 96319, (Alexandria × Monukka) 9642, (Alexandria × Monukka) 9646, (Alexandria × Monukka) 96419, (Alexandria × Calmette) 96017, (Alexandria × Corinthe Rose) 105616, (Alexandria × Malaga) 9571, (Alexandria × Malaga) 95818, (Alexandria × Malaga) 10587, (Alexandria × Malaga) 105915, (Alexandria × Panariti) 9603, (Alexandria × Panariti) 9118, (Alexandria × Sultanina) 96212, (Alexandria × Sultanina Rosea) 9612, (Alexandria × Sultanina Rosea) 96216, (Muscat Hamburg × Monukka) 106211, (Muscat Hamburg × Monukka) 106212, (Muscat Hamburg × Monukka) 10633, (Muscat Hamburg × Monukka) 10637, (Muscat Hamburg × Monukka) 106312, (Muscat Hamburg × Monukka) 106316, (Muscat Hamburg × Panariti) 8621, (Muscat Hamburg × Panariti) 8623, (Olivette Blanche × Muscat Hamburg) 10616, (Olivette Blanche × Muscat Hamburg) 10626, (Olivette Blanche × Olivette Noire) 9563, (Olivette Blanche × Olivette Noire) 9564, (Olivette Blanche × Olivette Noire) 9566, (Olivette Blanche × Olivette Noire) 9572, (Pizzutella × Monukka) 10649.

Seedlings of Vinifera grape crosses that have fruited at the Fresno station of the United States Department of Agriculture

Parentage	Superior qualities obtained
Alexandria × Alicante Bouschet	Productive; vigorous; red juice; rich flavor.
Alexandria × Monukka	Productive; vigorous; seedless; muscat flavor; adherence.
Alexandria × Calmette	Productive; red juice; rich flavor.
Alexandria × White Corinth	Productive; all white fruit.
Alexandria × Corinthe Rose	Productive; some red fruit; rich flavor.
Alexandria × Damas Rose	Productive; large-size berry.
Alexandria × Hunisa	Vigorous.
Alexandria × Malaga	Productive; large-size cluster and berry; rich flavor.
Alexandria × Panariti	Productive; none seedless.
Alexandria × Sultanina	Productive; vigorous; seedless; no muscat flavor.
Alexandria × Sultanina Rosea	Productive; vigorous.
Damas Rose × Monukka	Productive; vigorous; large size; some seedless.
Gros Guillaume × Monukka	Adherence; large size; seedless.
Muscat Hamburg × Monukka	Productive; muscat flavor; some seedless.
Muscat Hamburg × Panariti	Productive; small size; none seedless.
Ohanez × Monukka	Seedless; late ripening.
Olivette Blanche × Muscat Hamburg.	Elongated types; muscat flavor.
Olivette Blanche × Olivette Noire	Elongated types; white, red, and black colored fruit.
Pizzutella × Monukka	Elongated fruit types; seedless; early ripening.
Rodites × Monukka	Late ripening; seedless.
Rodites × Gros Guillaume	Late ripening; firmness of fruit.

Grape-breeding work with native American grapes and *Vitis vinifera* has been in progress at Arlington, Va., and Beltsville, Md., since 1933, to originate seedless varieties and to improve the quality and adaptability of native American varieties especially for central and southern regions.

Seedlings of the following varieties are under observation at the Beltsville station: August Giant, Bailey, Black Eagle, Caco, Captain, Captivator, Ellen Scott, Eumelan, Golden Muscat, Goff, Manito, Mills, Nitodal, Norwood, Oriental, Rogers nos. 13, 32, 33, Urbana.

Seedlings have been obtained of the following native bunch grape crosses: Bailey × Brilliant Seedling, Captivator × Beacon, Captivator × Columbian Imperial, Captivator × Fredonia, Champanel × Manito, Champanel × Niagara, Columbian Imperial × Empire State, Delaware × Goethe, Empire State × Manito, Goethe × Delaware, Lenoir × Salem, Loretto × Oriental, Manito × Caco, Manito × Empire State, Oriental × Portland, Rogers 13 × Beta.

Seedlings have been obtained of the following native American bunch grapes and vinifera crosses: Atoka × Gros Guillaume, Bailey × Foster, Bailey × Goolabie, Bailey × Gros Guillaume, Blauer Portugieser × Monukka, Campbell Early × Monukka, Campbell Early × Alphonse Lavallee (Ribier [7]), Captain × Goolabie, Captivator × Monukka, Captivator × Alphonse Lavallee, Catawba × Monukka, Catawba × Muscat Hamburg, Catawba × Alphonse Lavallee, Catawba × Sultanina, Cloeta × Goolabie, Cloeta × Muscat Hamburg, Columbian Imperial × Monukka, Columbian Imperial × Goolabie, Concord × Monuk-

[7] See footnote 4, p. 656.

ka, Concord × Sultanina, Ellen Scott × Sultanina, Lucile × Monukka, Manito × Chasselas de Fontainebeau, Manito × Alphonse Lavallee, Niagara × Sultanina, Ontario × Blauer Portugieser, Oriental × Albardiens, Oriental × Monukka, Oriental × Goolabie, Oriental × Muscat Hamburg, Oriental × Panariti Oriental × Sultanina, Portland × Blauer Portugieser, Triumph × Monukka, Vergennes × Monukka, Vergennes × Alphonse Lavallee.

Muscadine grape-breeding work of the Department has been centered at the North Carolina State Department of Agriculture Test Farm, Willard, N. C. This work was started in 1907. From two early crosses, two perfect-flowered hermaphrodite seedlings were obtained. By selfing one of these plants, and also by using the pollen from this type to pollinate standard muscadine varieties, an additional number of perfect-flowered seedlings were obtained. Better berry adherence, increased productivity, and improved fruit quality have been reported. True hybrids were obtained between *Vitis rotundifolia* and *V. vinifera*, and also between *V. rotundifolia* and varieties of American bunch-type grapes.

The following hybrid seedlings of *Vitis rotundifolia* and varieties of American bunch-type grapes obtained at Willard, have been selected for further study: James × Winchell, Labama × Brilliant, muscadine seedling × Campbell Early, muscadine seedling × Catawba, muscadine seedling × Delaware, muscadine seedling × Goethe, muscadine seedling × Winchell, Scuppernong × Louisiana, San Jacinto × Ives, Thomas × Concord, Thomas × Goethe.

The following hybrid seedlings of *Vitis rotundifolia* and *V. vinifera* have been selected for further study: George × Goolabie, muscadine seedling × Black Morocco, muscadine seedling × Semillon, San Alba × Malaga, San Alba × Semillon, San Jacinto × Malaga, Thomas × Black Morocco, Thomas × Maraville de Malaga.

Muscadine seedlings selected for further trial are the following: 10- Latham × (Eden × (Eden × male Munsoniana)), 14- Latham × (Thomas × (Eden × (Eden × male Munsoniana))), 3- Latham × male (muscadine seedling × (Eden × (Eden × male Munsoniana))), 1- Latham × male (muscadine seedling × (Eden × male Munsoniana)), 8- Luola × (Eden × (Eden × (Eden × male Munsoniana))), 3- Luola × (Thomas × (Eden × (Eden × male Munsoniana))), 5- Luola × (muscadine seedling × (Eden × (Eden × male Munsoniana))), 1- Luola × (muscadine seedling × (Eden × (Eden × male Munsoniana))), 1- San Alba × (Eden × (Eden × male Munsoniana)), 2- San Alba × male (Eden × (Eden × male Munsoniana)), 6- San Alba × (Thomas × (Eden × (Eden × male Munsoniana))), 3- San Alba × (muscadine seedling × (Eden × male Munsoniana)), 5- San Rubra × male (Eden × (Eden × male Munsoniana)), 3- San Rubra × (Eden × (Eden × male Munsoniana), 1- San Rubra × (Thomas × (Eden × (Eden × male Munsoniana))), 1- muscadine seedling × (Eden × (Eden × male Munsoniana)), 1- muscadine seedling × male (Eden × male Munsoniana), 1- muscadine seedling × (muscadine seedling × (Eden × (Eden × male Munsoniana))), 13- muscadine seedling × male (Eden × (Eden × male Munsoniana)), 1- muscadine seedling × (Eden × (Eden × male Munsoniana)), 2- muscadine seedling × (muscadine seedling × (Eden × (Eden × male Munsoniana))), 20- muscadine seedling × (muscadine seedling × (Eden × (Eden × male Munsoniana))), 3- muscadine seedling × (Eden × male Munsoniana), 1- (Eden × (Eden × male Munsoniana)) × male (Eden × (Eden × male Munsoniana)), 3- (James × white male) × (Eden × (Eden × male Munsoniana)), 2- (James × white male) × (muscadine seedling × (Eden × (Eden × male Munsoniana))), 1- James seedling × (muscadine seedling × (Eden × (Eden × male Munsoniana))), 1- muscadine seedling × male (Eden × (Eden × male Munsoniana)), 1- selfed seedling (James × (Eden × (Eden × male Munsoniana))), 3- selfed seedlings (Thomas × (Eden × (Eden × male Munsoniana))), 1- selfed seedling (muscadine seedling × (Eden × (Eden × male Munsoniana))), 2- selfed seedlings (muscadine seedling × (Eden × (Eden × male Munsoniana))). (All pollen parents were hermaphrodite seedlings unless designated as male.)

Vinifera grape varieties available for breeding work in United States Department of Agriculture experiment vineyards [8]

[Alphabetically arranged]

Ach-I-Soum, Affenthaler, Agadia, Agra Ash, Ak Saibe, Aibatly Isium, Ajmi, Ak-usum, Aldara, Aleatico, Alexandria, Alicante, Alicante Bouschet, Alnwick

[8] This list contains many names of Persian or other foreign origin that have no exact English equivalent and also includes some recent introductions that have not yet found a place in American grape literature. Such names are to be regarded as tentative and not necessarily authentic and final.

seedling, Alvarna, Amlachu, Aneb-el-Cadi, Angur Khalili, Angur Noir Grande, Apapnish White, Appley Towers, Aramon, Ascot Citronelle, Askaree, Asmi, Aspiran Noir, Atch Gau, Augulato, Awasarghua.

Baba, Bakator, Barbarossa, Barbera, Barducci, Bastardo, Beclan, Bellino, Bengi, Bermestia Violacea, Bicane, Black Alicante, Black Hamburg, Black Morocco, Black Prince, Black Seedless, Black Shahanee, Black Zante (South Africa currant grape), Blanc d'Ambre, Blaney White, Blauer Portugieser, Boal de Madeira, Bocalilla, Bolgnino, Bonarda, Boudelais, Bowood Muscat, Brustiano, Buaki, Buccleuch, Buckland Sweetwater, Buhirzi, Burger.

Cabernet Sauvignon, Calabrian, Calmette, Cannon Hall Muscat, Carignane, Castiza, Cefid, Ceskarg Charial, Chabach, Chali Sar, Chani Rouge, Chaouch blanc, Chaouch Rose, Charas, Chasselas Ciotat, Chasselas de Fontainebleau, Chasselas Rose de Falloux, Chasselas Rouge, Chasselas St. Bernard, Chaweesh, Child of Hall, Chirazi, Chauch Gris, Chauch Noir, Cinsaut, Cipro Nero, Clairette a Gros Grain, Coarna Neagra, Corazon de Cabrito, Corinthe a Gros Grain, Corinthe Rose, Coristano, Crabbs Burgundy.

Damas Rose, Danugue, Dattier de Beyrouth, Deis-el-A'anze, Diamond Jubilee, Directeur Tisserand, Dizmar, Doctor Hogg, Drnekusa, Dronkane, Duc de Malakoff, Duchess of Buccleuch, Duke of Buccleuch.

Emperor, Esandri, Eskari Riz, Etraire de l'Adhui.

Fajaumi Jaune, Faphly, Feher Szagos, Feher Som, Fintendo, Flame Tokay, Foster, Frankenthal Précoce, Fredericton.

Gamay de Bourgogne, Gamay Teinturier, Gewürz Traminer, Ghiliaki Krasnaya, Ghulabi Black, Ghulabi Red, Ghusaine, Golden Champion, Golden Hamburg, Goolabie, Gradiska, Grove End Sweetwater, Green Hungarian, Grenache, Gros Blanc de Lausanne, Gros Colman, Gros Guillaume, Gros Manzenc, Gros Verdot, Guadalupe.

Hebron, Hunisa, Hycales.

Imperial Blanc, Insolia Bianca, Italia Elqui.

J'bai, Johannisberger, Jubeili.

Kabasma, Kabbajuk, Kadarka, Kahalillee, Kharashani, Kara-Usum, Karoo Belle, Kasufi-Dakar, Kasufi inti, Katta-Kurgan, Kechwechi Bleue, Kechwechi Rouge, Keropodia, Kandihar, Khasseyne, Khudud-ul-Banat, Kishmish daba, Kölner, Koptchak, Koshu, Ksil-isjum, Kurdi, Kurtelaska.

Lady Downe, Lady Hastings, Lady Hutt, Lal Cefid, Lal Guermez, La Mollar, Larien, Leani Zolo, Lignan Blanc, Lore Koche, Luglienga Nera.

Macaboe de Satin, Madeleine Angevine, Madeleine d'Ambre, Madeleine Royale, Madresfield Court, Malaga, Malaga Rose, Malakoff Isjum, Malvasia de Brogliana, Malvasia Rosaria, Malvasia Rovasenda, Mamelon, Mantuo di Pilo, Marmora, Marascina, Marzamina Genuina, Maskah (Nos. 24772, 24774, 24775, 24776, 24781, 24782, 24783, 24784, 24785, 24786, 24787, 24788, 24792, 24793), Mataro, Melhi Khany, Melton Constable, Meslier Hatif, Meunier, Miksasi, Millenium, Mission, Monake, Mon. Deludda, Mondeuse, Monukka, Mourastel, Mourisco Bianca, Mourisco Preto, Mrs. Pince, Mskhali, Mukhkh-ul-Baghl, Muscatel Commune, Muscat Bonod, Muscat Capusines, Muscat de Frontignan, Muscat Gros Noir Hatif, Muscat Hamburg, Muscat Noir d'Hongrie, Muscat Noir Precoce, Muscat Rose, Muscat Talabot.

Nasa Valentiana, Nebbiolo, Nebbiolo Bourgu, Nebbiolo Fino, Negro Amaro, Negrara di Gattinara, Negra Elqui, Negra Nero, Nimrang.

Ohanez, Ojo de Liebre, Olivette Blanche, Olivette de Vendemain, Olivette Noire, Opiman.

Pagadebito, Palarusa, Palomino, Panariti, Parc de Versailles, Pastilla Elqui Paykanee Razuki, Perle de Csaba, Pedro Ximines, Perle Imperial Blanche, Perruno, Persian (no number), Persian (no tag), Persian (nos. 21–26), Petit Syrah, Petit Verdot, Peverella, Piment, Pince Muscat, Pineau de Chardonnay, Pineau Noir Epernay, Pinot St. George, Pirovano, Pizzutella, Plavai, Poulsard, Pomology No. 68091, Prince of Wales, Prune de Cazouls, Purple Damascus.

Quagliano, Quanque.

Red Hanepoot, Refosco, Rka-tzital, Robin Noir, Rodites, Ronde Weisse, Rose d'Italia, Rose of Peru, Rothgipfler, Rousseau, Royal Ascot.

Schach-I-Soum, Sahibi, Sahibi Charial, Saidi, San Giovetto, Satin Blanc, Sauvignon Blanc, Sauvignon Vert, Schiradzouli Blanc, Schiradzouli Violet, Semillon, Serektia, Serine, Servan Blanc, Servan Rose, Schaani, Shahmani, Shakaifi, Shanzi,

Shirshira, Shuvarghani, Sicilien, Slankamenka, Souvenir du Congrès, St. Laurient, St. Macaire, Sufetha, Sultana, Sultanina, Sultanina Rosea, Suri, Sylvaner.

Tadone, Tagonte Rouge, Tanfi Rose, Tannat, Tavris (no. 27963, 30467), Teneron de Cadenet, Tifafihi Ahmer, Tinta Amerella, Tinta Cao, Tinta de Madeire, Trentham Black, Trojka, Trousseau.

Ubeide, Umagum, Uva de Casta.

Valandova, Valdepenas, Veltliner, Verdel, Vermentino, Vigne de Zericho.

Walschriesling, Werme, West Prolific, White Corinth, White Frontignan, White Nice, White Tokay, Wilmot No. 16.

Zabalskanski, Zeine, Zenkoji, Zinfandel, Zinzillosa.

Grape rootstock varieties available for breeding work in United States Department of Agriculture experiment vineyards

[Alphabetically arranged]

Adobe Giant; (*Vitis aestivalis* × *monticola*) × (*V. riparia* × *rupestris*), no. 554–5; (*V. aestivalis* × *rupestris*) × *riparia*, no. 227; Alicante Bouschet × *V. cordifolia*, no. 142–B; Alicante Bouschet × *V. riparia*, no. 141–A; Aramon × *V. riparia*, no. 143–A; Aramon × Rupestris Ganzin (nos. 1, 2, 9); Arizonica Phoenix; Australis.

Barnes; *Vitis berlandieri* (nos. 1, 2); Berlandieri Lafont, no. 9; *V. berlandieri* × *riparia* (nos. 33 E. M., 34 E. M., 157–11, 420–A, 420–B); (Bourrisquou × *V. rupestris*, no. 601) × Calcicola, no. 13205.

Cabernet × *V. berlandieri*, no. 333 E. M.; Cabernet × Rupestris Ganzin, no. 33–A; Chasselas × *V. berlandieri*, no. 41–B; (*V. cinerea* × *rupestris*) × *riparia*, no. 229; Columbaud × *V. riparia*, no. 2502; Constantia; *V. cordifolia* × *riparia*, no. 125–1.

DeGrassett; Dog Ridge.

Hotporup.

Jolly; Judge.

V. monticola × *riparia* (nos. 18804, 18808, 18815); *V. monticola* × *rupestris*; Motley; Mourvedre × *V. rupestris* (nos. 1202, 1203).

Pinot-Bouschet × *V. riparia*, no. 3001; Pinot × *V. rupestris*, no. 1305; Ponroy.

Ramsey; Riparia Gloire; *V. riparia* × *berlandieri*, no. 161–49; *V. riparia* × (*cordifolia* × *rupestris*), no. 106–8; Riparia Grand Glabre × (Aramon × *V. rupestris*), no. 4110; *V. riparia* × *rupestris* (nos. 101, 101–14, 108–103, 3306, 3309); *V. riparia* × *V. rupestris*, Jaeger; *V. riparia* × (*rupestris* × Aramon), Jaeger, no. 201; *V. riparia* × Rupestris Ramond; Rupestris des Causettes; Rupestris des Semis, no. 81–2; Rupestris Ganzin; Rupestris Le Reux; Rupestris Martin; Rupestris Metallica; Rupestris Mission; Rupestris Othello; Rupestris Pillans; Rupestris St. George; *V. rupestris* × *berlandieri* (nos. 219–A, 301–A, 301–B, 301–37–152); *V. rupestris* × Chasselas Rose, no. 4401; *V. rupestris* × *cinerea*; *V. rupestris* × *cordifolia*, no. 107–11; *V. rupestris* × (*cordifolia* × *rupestris*), no. 202–5; *V. rupestris* × Azemar, no. 215; *V. rupestris* × Petit Bouschet, no. 503; *V. rupestris* × Petit Bouschet, no. 504; *V. rupestris* × *riparia*, no. 108–16.

Salt Creek; Solonis Ordinaire; Solonis Robusta; Solonis × (*V. cordifolia* × *rupestris*), no. 202–4; Solonis (*V. longii*) × Othello ((*V. riparia* × *labrusca*) × *vinifera*), no. 1613; Solonis × *V. riparia* (nos. 1615, 1616).

Taylor Narbonne; Tisserand.

Vermorel; Viala; Viala × *V. riparia*; *V. candicans*.

York × Rupestris Ganzin, no. 212.

Direct-producing grape varieties available for breeding work in United States Department of Agriculture experiment vineyards

Bourrisquou × *Vitis rupestris* (nos. 601, 603, 109–4, 3907, 4306, 4308).

Carignane × *V. rupestris* (nos. 404, 501); Castel (nos. 1028, 19002); Clairette Dore Ganzin; Couderc (nos. 101, 201, 503, 704, 3701, 4401, 28 × 112, 71–06, 71–20, 74–17, 82–32, 4 × 61, 85 × 113, 87 × 115, 124 × 30, 132–11, 199–88, 241–55, 267–27, 272–60).

Pardes.

Seibel (nos. 1, 2, 14, 29, 38, 60, 70, 78, 80, 128, 156, 209, 215, 334, 1004, 1070, 1077, 2010, 2029, 2033, 2043, 2044, 2056).