BLACKBERRY AND RASPBERRY IMPROVEMENT

GEORGE M. DARROW, Senior Pomologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry [1]

BLACKBERRIES, INCLUDING DEWBERRIES

EXCEPT for the Logan (Loganberry), cultivation of the blackberry is chiefly limited to North America and most varieties of blackberries have originated in this country. Hedrick (*31*) [2] states that the blackberry came into cultivation little by little early in the nineteenth century. It became more common as a cultivated fruit about 1850, when several selections from the wild were introduced into cultivation. Among these was the Lawton, which is still grown. The Snyder variety was introduced about 1860, the Eldorado before 1891, and the Lucretia trailing blackberry or dewberry about 1875. These, as well as almost all others that have been grown commercially, were selections from the wild. Wilson Junior, raised from seed of Wilson Early, and Minnewaski, grown from seed at Marlboro, N. Y., have resulted from efforts to improve this fruit in Eastern States, but neither variety is now grown commercially to any extent.

In the West, efforts to improve the blackberry have met with much greater success. Selections of the wild trailing blackberry were first grown. Among these was the Aughinbaugh. In 1881, J. H. Logan raised the Logan and probably the Mammoth from seed of the Aughinbaugh. A second generation was raised from some of the seedlings, and from these the Black Logan and other promising varieties were selected. The Logan is still important, but the Mammoth is only occasionally grown now. The Black Logan may possibly still be raised, either as Black Logan or under other names. In 1897 Luther Burbank introduced the Phenomenal, very similar to the Logan. This was widely grown for a while, but it has largely disappeared.

About 1926 the Young dewberry (Youngberry) or trailing blackberry was introduced. This is a hybrid between the Phenomenal and the eastern Mayes dewberry (Austin Mayes), made by B. M. Young, of Louisiana. In 1935 the Boysen (Boysenberry), very similar to the Young, was introduced. Its origin is unknown.

In Oregon, Washington, and New Jersey the Evergreen or Black Diamond is cultivated. It is a very old variety from England that has

[1] Many experiment station workers and private breeders have contributed records and information. To these the writer is most grateful. Among those especially generous of their time were George L. Slate and L. M. Cooley (New York), J. H. Clark (New Jersey), A. S. Colby (Illinois), E. Angelo and A. N. Wilcox (Minnesota), C. F. Williams (North Carolina), and George F. Waldo (Oregon). W. J. Strong, M. B. Davis, N. H. Grubb, C. G. Dahl, and P. Stedje contributed information on work at foreign stations. B. M. Young (Louisiana), H. Rockhill (Iowa), W. E. Lammertz (California), and George Pyne, of Topham, Devon, England, have all contributed information.

[2] Italic numbers in parentheses refer to Literature Cited, p. 523.

become widely naturalized west of the Cascade Mountains in Oregon and Washington. In California, and to a slight extent in Oregon and Washington, the Himalaya (*Rubus procerus* P. J. Muell.) is raised. This is considered identical with the Theodor Reimers variety of Germany. It also is widely naturalized west of the Cascade Mountains Besides these two, several other European varieties that have been named in recent years have been tested, but no others have succeeded in the United States. In 1932 the Brainerd, a hybrid between the Himalaya and an eastern variety, was introduced. Thus, except for the Logan, Phenomenal, Young, Brainerd, and possibly the Boysen, the cultivated varieties of blackberries have originated as chance seedlings in the wild.

At present the Eldorado (Stuart) is the leading blackberry of the eastern erect type, Lucretia the leading trailing blackberry or dewberry of the eastern group, Logan and Young the leading trailing varieties of the western type. The Evergreen (Black Diamond) is the leading variety of the European type.

American Wild Blackberries and How Varieties Originated From Them

The wild blackberries of North America fall into five major groups: (1) The erect or nearly erect types, like Early Harvest (fig. 1) and Eldorado, of the eastern United States from Florida to Canada and from the Atlantic coast to the Prairie States; (2) the eastern trailing blackberries, not red-hairy caned, much like the Lucretia, having about the same range as the erect ones; (3) the southeastern trailing blackberries having red hairs on the canes, like the Manatee and Advance, ranging along the Atlantic and Gulf coasts from Delaware to Texas; (4) the trailing blackberries, from which the Logan is derived, of the Pacific coast from Canada to southern California; and (5) the semitrailing Evergreen (Black Diamond) and Himalaya

---

IN SPITE *of the fact that a good deal has already been accomplished, the possibilities of improving the red raspberry by utilizing the available cultivated varieties in further breeding work are still enormous. Some of the qualities, now found separately, that may be combined in raspberries of the future are the very large fruit size of European varieties and newer American productions, immense fruit clusters, great productiveness, firmness, vigor, and resistance to diseases. But there is also a large reservoir of germ plasm, hardly yet touched by raspberry breeders, in the wild species of Asia and elsewhere, some of which resemble the grape, hawthorn, bamboo, maple, and apple in their leaf forms, and vary from low and soft-stemmed plants to plants with stems 3 inches thick and 14 feet high.*

---

of Oregon, Washington, and California, that have been naturalized from Europe and which have become serious weeds of roadsides, pastures, and open forests. There are no native blackberries in the Rocky Mountains of the United States.

Originally, when North America was settled, most of the wild blackberries could be classified into a few relatively distinct species, and though blackberries were gathered from the wild, they were nowhere as abundant as at present. When the forests were cut and the land was cleared for pasture and meadow, the chief cover in many northern sections for several years was the wild blackberry. Birds ate the berries and dropped the seeds in the brush. These clearings of forest and pasture gave the opportunity for seedlings of different wild species to grow side by side, as they had not when dense virgin forest covered the land.

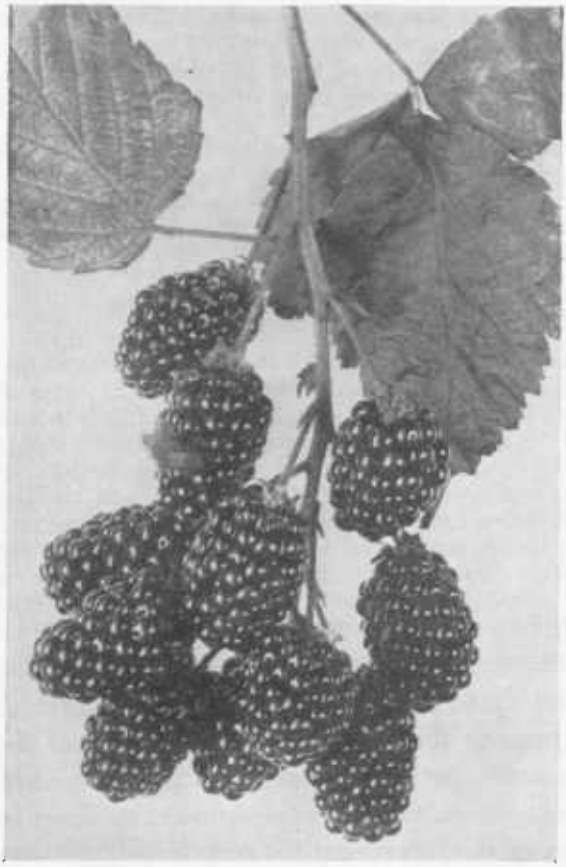

Figure 1.—Early Harvest, derived from the eastern erect blackberry.

Normally, the wild blackberries of the East are entirely or nearly self-sterile, and those of the Pacific coast have male and female organs on separate plants. All need cross-pollination. In the clearings and pastures bees and other insects have crossed the blackberry species for the last 100 to 300 years, and hybrid seedlings have grown up, so that immense numbers of hybrids may now be found. These hybrids vary from sterile to productive plants, and many are extremely vigorous. Backcrosses between a hybrid and one parent and crosses between hybrids are also appearing. Thus man, by clearing the forest, has started an immense breeding project. For the last 75 or 80 years man has been cashing in on this project by selecting the best of these wild hybrids and trying them under cultivation. Always he has overlooked the fact that the wild species were cross-fertilized.

Two or more selections were not planted together, so that many of the selections, when propagated by themselves under cultivation, were not productive. Furthermore, most of the wild blackberries are woodland plants, fruiting best in the leafmold at the edge of the forest and along streams. No wonder many of the selections were unproductive under cultivation. Through scores of years, however, selections of species and of hybrids have been found that have been productive when grown by themselves in open fields. In the South no productive selection that will set fruit by itself has yet been made of the trailing species with red-hairy canes. When the Rogers or Advance is grown, two or more selections are actually interplanted and cross-pollination is thus made possible, but many growers are unaware of this fact.

There is no final agreement as to just how many botanical species should be recognized, because the species have hybridized freely. Brainerd and Peitersen (*6*) list eight erect or semierect and four trailing species for New England. Canes of these species are shown in figure 2. Their survey of the wild forms was extensive and thorough and was supplemented by experiments on the effect of environment on botanical characters and by studies in hybridization. It seems best to follow their classification and viewpoint. The qualities of possible value to breeders are briefly described for several species as follows:

The "high-bush" or "black-long berry", *Rubus allegheniensis* Porter.—Canes strong, erect growing, with stout prickles; leaves mostly very large and strongly heart-shaped; clusters largest of American blackberries, 14- to 18-flowered; fruit large, long, sweet, and one of the best. Common in fields and pastures from New England to Wisconsin, but ranging from Minnesota to Nova Scotia and in the mountains to North Carolina and Tennessee. This is one of the purest and most distinct of northeastern erect blackberries. Snyder, though probably a hybrid, is close to the wild type, while Ancient Briton, Eldorado, Taylor, Agawam, Jumbo, Lawton, Stone, and Wachusett are probably hybrids of this species with others. Albino forms are fairly common in the wild.

The "tall" blackberry, *Rubus argutus* Link.—Canes very erect, deeply furrowed, prickly; clusters 8- to 12-flowered; fruit often with bitter aftertaste. This, or closely related forms, is the most common blackberry of the roadside and fields of the eastern United States. Early Harvest is close to the wild type of this species, while Erie is probably a hybrid.

The "short" or "square-fruited" blackberry, *Rubus pergratus* Blanch.—Canes tall and arching, prickly; leaves large and broad; clusters 8- to 12-flowered; fruit short, cylindric. A hardy blackberry of the higher elevations in New England, New York, and Pennsylvania, with large but short fruit of excellent flavor. It does not seem to be represented in cultivated varieties.

The "leafy-flowered" blackberry, *Rubus frondosus* Bigel.—Canes arched and recurving, prickly; leaves broad; clusters 8- to 12-flowered; fruit not so large as that of the above species. This is the common blackberry of the fields of New England, and next to *R. argutus* the most common of the blackberries of the eastern United States. It seems to thrive better than most species in the open fields. It has probably hybridized most extensively with *R. argutus*. Varieties nearest to the wild types are Joy, La Grange, Ward, and Watt, while most of the varieties listed above as hybrids of *R. allegheniensis* are probably hybrids with this species.

The "thornless mountain" blackberry, *Rubus canadensis* L.—Canes erect to arching, without prickles; leaves without hairs; leaflets long with long stalks, especially the terminal one; clusters loose; fruit long, tart. This thornless or prickleless blackberry is native to the higher mountains from Georgia northward to Newfoundland and Quebec, but is found at the lower elevations from northern Maine west to Wisconsin. It is a forest plant and does not succeed well at the lower elevations in open fields. Its fruit is excellent and the plant is very hardy northward. No variety derived from this is now under cultivation.

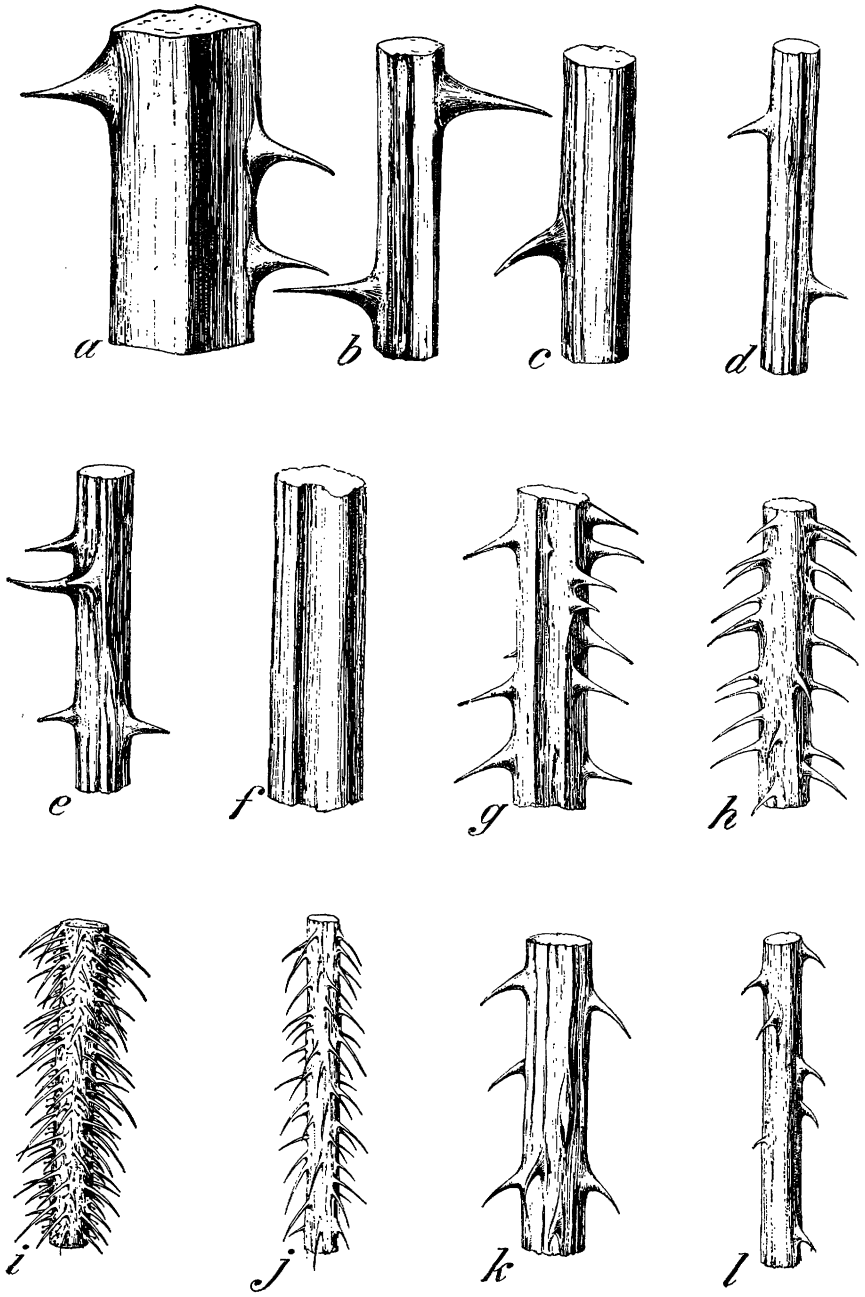

Figure 2.—Canes and prickles of 12 eastern species of the blackberry group (*Eubatus* section of genus *Rubus*): *a*, *Rubus allegheniensis*; *b*, *R. argutus*; *c*, *R. pergratus*; *d*, *R frondosus*; *e*, *R. recurvans*; *f*, *R. canadensis*; *g*, *R. elegantulus*; *h*, *R. vermontanus*; *i*, *R. setosus*; *j*, *R. hispidus*; *k*, *R. procumbens*; *l*, *R. baileyanus*. (After Brainerd.)

The "Vermont" blackberry, *Rubus vermontanus* Blanch.—A rather rare blackberry with recurving canes that has small but very numerous fruits. It is found at the higher elevations from New York to Nova Scotia and is quite hardy.

The "sand" blackberry, *Rubus cuneifolius* Pursh, is native along the coast from Connecticut to Texas and is not fully hardy in the North. It has very erect and quite thorny canes, and the fruit ripens much later than that of other American blackberries. In fact this species, with its often pink flowers, grayish foliage, and late fruit, is the closest of any to the European group of blackberries. Eureka belongs to this species, and Nanticoke is close to it.

The dewberry or trailing blackberry, *Rubus baileyanus* Britt.—Canes trailing, prickly; clusters one- to three-flowered; seeds large. This is one of the probable parents of the cultivated dewberries Mayes and Lucretia, which are probably hybrids of *R. baileyanus* with *R. argutus*. It is one of about three widely distributed trailing species in the eastern United States.

The "southern red-caned" dewberry, *Rubus trivialis* Michx.—Canes trailing, prickly, usually with dense red bristles, often evergreen; flowers large, usually solitary; fruit large, long, very early. This species, like the sand blackberry, is native along the coast from Maryland to Texas, but extends up the Mississippi Valley to Arkansas and southern Missouri. It has large, long fruit that ripens earliest of all. The Advance, Rogers, and Manatee all belong to this species. The Advance and Rogers have extremely firm fruit in several-fruited clusters and are apparently immune to double-blossom or rosette disease.[3] The limitations of the species are usually 1-flowered clusters, entire self-sterility (*24*), lack of hardiness except in the South, and prevalence of the double-blossom or rosette disease in the South.

The trailing blackberries or dewberries of the Pacific coast, *Rubus ursinus* Cham. and Schlecht., *R. macropetalus* Dougl., and *R. loganobaccus* Bailey.—Canes trailing, prickly, nearly evergreen; clusters usually 5- to 10-flowered, with sexes on separate plants; fruit to 1½ inches in length, deep wine colored to black. All three species are very subject to leaf spot and anthracnose, which limit their culture in the Eastern States. *R. macropetalus* occurs mostly in Oregon, Washington, and British Columbia, and *R. ursinus* and *R. loganobaccus* in California. All have highly flavored tart berries, the Logan being derived from *R. loganobaccus*, which occurs from about Watsonville north to the California-Oregon State line. The Young, Boysen, and Cameron derive their fine flavor from this latter species. Cazadero and other varieties have been derived from *R. macropetalus*.

The probable derivations of cultivated varieties are:

Rubus allegheniensis × *argutus:* Ancient Briton, Eldorado, Taylor.
R. allegheniensis × *frondosus:* Agawam, Erskine Park, Jumbo, Lawton, Snyder, Stone, Wachusett.
R. argutus × *frondosus:* Blowers, Erie, Merscreau.
R. baileyanus × *enslenii* Tratt.: Premo.
R. baileyanus × *argutus:* Mayes, Lucretia.
R. argutus: Early Harvest.
R. frondosus, or (*R. frondosus* × *argutus*) × *R. frondosus:* Joy, La Grange, Ward, Watt.
R. cuneifolius: Eureka, Nanticoke (possibly *R. cuneifolius* × *argutus*).
R. trivialis: Manatee, Rogers, Advance.
R. loganobaccus: Logan.
R. loganobaccus × (*R. baileyanus* × *argutus*)*:* Young, Boysen.

Great Names in Blackberry History

The important names in blackberry history include W. O. Focke, H. Sudre, E. Brainerd and A. K. Peitersen, L. H. Bailey, B. Lidforss, J. H. Logan, and B. M. Young.

Focke was a German botanist with a broad viewpoint who made the study of the systematic botany of the blackberry-raspberry group a large part of his life work. He (*25*) divided the genus into subgenera and species in an understandable way. He described 132 species of

[3] Double-blossom or rosette disease is caused by a species of *Cercosporella* fungus which infects the buds causing a rosette or witches'-broom type of growth. The infected blossoms become distorted and are sterile.

blackberries. He gave a discussion of the origin of European blackberries to which reference is made in the appendix.

Sudre (*54*), a French botanist, confined himself to the European blackberries. He tried to determine the original species of Europe by a study of their distribution and relationships and of the percentage of good pollen in their flowers. He described 110 species for all Europe.

Brainerd and Peitersen (*6, 44*) worked chiefly in Vermont and elsewhere in New England. In their two bulletins on the blackberries of New England they give an understandable grouping of the wild blackberries of the eastern United States. The two men made extensive field surveys, grew the wild forms side by side under cultivation, and made many crosses and many experiments on the effect of climatic conditions on the different forms. They describe 12 species for New England and refer many of the cultivated varieties to the species or their hybrids. Experiments in shading parts of plants showed that leaves of plants in heavy shade had less than one-seventieth the number of hairs and far fewer prickles than leaves in the sun. Canes in the shade were trailing, but those in the open were erect. The work showed (1) that the species of eastern North America and most hybrids were self-sterile or nearly self-sterile; (2) that hybrids had a large percentage of aborted pollen; and (3) that the hybrids showed segregation.

Figure 3.—B. M. Young, of Morgan City, La., at about the time he originated the Young dewberry (Youngberry) over 30 years ago. Mr. Young is still breeding raspberries and blackberries.

Bailey (*3, 4, 5*) has compiled much information regarding the history of both the cultivated and the wild blackberries and has made extensive field collections of both. He has issued a series of monographs on his interpretation of the wild species and has described many new forms.

Lidforss's studies (*34*) on inheritance in European blackberries, which were published in 1914 after his death, furnish an account of the development of the wild European blackberries. He obtained true and false hybrids in crosses and in selfing. The true hybrids always split in the second generation, while the false hybrids reproduce the mother exactly. In the false hybrids (1) no seed development occurs without pollination; but (2) when the flowers are pollinated false seed develops; (3) this false seed apparently does not develop from the ovule but from a cell in the wall of the ovary; and (4) the plants grown from such false seed are just as like the mother plant as if

propagated from a rooted tip or a root cutting. Gustafsson (*28*) also studied the development of false hybrids. Some European forms produce these false seedlings only; others may produce some true and some false, while others produce all true seedlings. Thus in Oregon and Washington the Evergreen and Himalaya blackberries usually reproduce each other exactly from these false seeds, and hundreds of thousands of wild plants occur that are just as alike as if they had been propagated by root cuttings or by tip plants (*20*). Only rarely are true seedlings of these two varieties found.

B. M. Young, of Morgan City, La. (fig. 3), produced a hybrid between the Phenomenal (very similar to Logan) and the Mayes

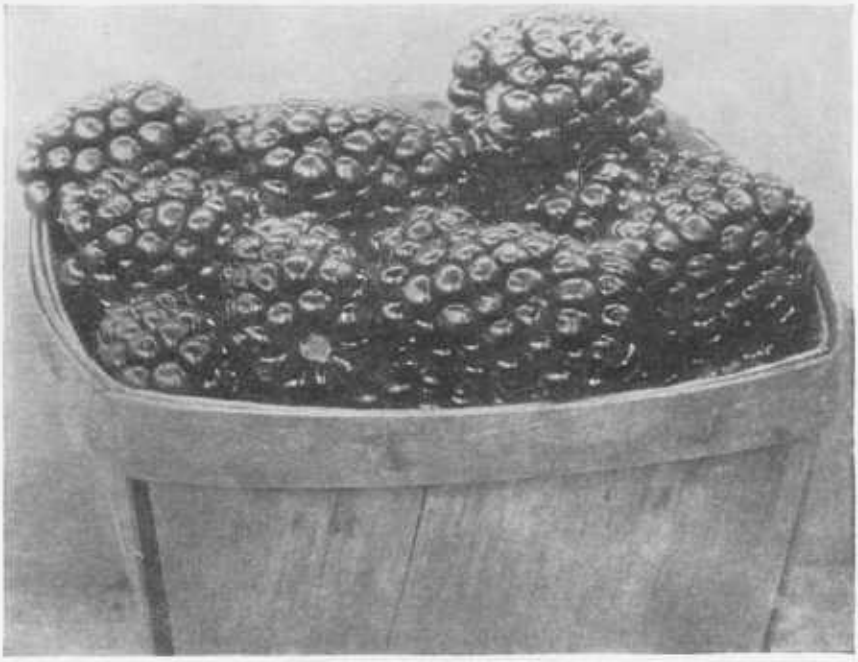

Figure 4.—The Young dewberry or trailing blackberry (Youngberry), one of the finest-flavored, largest, and most productive varieties; a cross of Phenomenal × Mayes.

dewberry or trailing blackberry about 1905. It was not introduced until about 1926, but it has quickly become an important sort (Young dewberry, or Youngberry, fig. 4), replacing the Logan to a large extent in California and to some extent in Oregon and Washington. In regions to which it is adapted it is the finest in flavor of all the blackberry group. Though Young has done extensive berry work since then, he has introduced no other variety.

The Logan and Its Relatives

The origin of the Logan is not yet fully explained. As stated above, in 1881 Judge Logan, at Santa Cruz, Calif., grew seedlings of a very rank-growing trailing blackberry, the Aughinbaugh. It was

pistillate-flowered, so that the flowers must have been pollinated either by wild male blackberries nearby, by an eastern erect blackberry in his garden, or by a red raspberry. Among about 100 seedlings there was the one later named Logan (fig. 5) with large, deep-red fruits. Judge Logan assumed that it was a cross of the black-fruited Aughinbaugh with the red raspberry. In recent years several facts have thrown doubt on this: (1) Blackberry-raspberry hybrids are mostly sterile, and if they do fruit they neither pick off like the blackberry nor pull off like the raspberry, but mash in the hand, while the Logan picks off like a blackberry. (2) Seedlings of the Logan

Figure 5.—The Logan blackberry (Loganberry), derived from the western trailing blackberry.

are all red-fruited and pick off like a blackberry. They vary in size, sweetness, season of ripening, vigor, etc., but show no distinct raspberrylike characters. (3) Cytologically the Logan seems like a pure species (*22*). Chromosome pairing is regular and reduction division is quite normal as for a pure species, not abnormal as in hybrids. It has 42 chromosomes, while the raspberry has 14. Plants of the species nearest like the Logan have 42 as the most common number. (4) Many hybrids of the Logan with selections of the wild blackberry are fertile, while most crosses of the Logan with the raspberry are not.

On the other hand, blackberry-raspberry hybrids resemble the Logan in habit of growth and to some extent in type of fruit. The red-fruited wild blackberries of the Pacific coast so far observed are much lighter red than the Logan. Perfect-flowered self-fertile selections of the wild observed so far differ considerably from the Logan.

Further study of the wild blackberries of the West, as grown under cultivation, and hybrids with the red raspberry and blackberry should do much to unravel the origin of the Logan. The evidence at hand indicates that the Logan is most probably a red-fruited sport of the wild blackberry.

Evolution of the Blackberries of Europe

There are two great centers of wild blackberries, eastern North America and Europe. According to Focke (*25*), the European and American species were separated in comparatively recent time, geologically speaking, probably by the southern movement of glaciers in the ice age. He holds that there are some 15 general types with a few more species to which all European blackberries can be referred. Sudre (*54*) came to a similar conclusion. Gustafsson (*28*, *29*), of Sweden, concluded that when the ice age brought two widely different species groups together so that they hybridized, many of the pseudogamic blackberries of Europe that come true to seed originated. Because they came exactly true to seed they could reproduce themselves down through hundreds and thousands of years and eventually became widely distributed. At the present time in Europe there are thousands of forms of blackberries. Some few are good species; more are ancient hybrids that are more or less widely distributed; and many others are pseudogamic forms resulting from hybridizing, of which Oregon Evergreen and Himalaya are representative in this country. The Brainerd (*23*), which originated as a cross of Himalaya and an American variety, reproduces to some extent by pseudogamy, though no purely American variety is known to reproduce in this way.

Crane refers to *Rubus thyrsiger* Banning and Focke, *R. nitidioides* Watson, *R. borreri* Bell Salt., *R. laciniatus* Willd. (Evergreen), *R. rusticanus* E. Merc. and its variety *inermis* Willd., *R. schlechtendahlii* Wiehe, *R. calvatus* Blox. (Edward Langley), and *R. procerus* (Himalaya) as being European blackberries of possible value for breeding, *R. thyrsiger* and *R. nitidioides* have very large clusters of good-sized fruit of excellent flavor. *R. borreri* is early for a European blackberry. *R. rusticanus* is late and small-fruited, but hybrids are cultivated varieties. *R. inermis* is a thornless form of *R. rusticanus*.

Thornless Sports of Blackberries

Productive thornless sports of the Evergreen, Logan, Mammoth, and Young have been found, propagated, and introduced. Bud sports in general are considered to be due to the appearance of recessive characters, and this is probably the case with these blackberries. However, these productive thornless sports are all chimeras, having a thin layer of thornless tissue overlying thorny. Whenever they are propagated by root cuttings, or when the canes freeze back so that shoots come up from below the crown, they are always thorny. Seedlings of the thornless Evergreen raised by the writer, and seedlings of other thornless sports raised by H. M. Butterfield, of the University of California, have all been thorny.

Most thornless sports have been unproductive, and thornlessness may be linked with sterility (*19*). For a thornless sport to be productive the thornless tissue around the outside of the cane apparently

138904°—37——33 ++

should be thick enough to prevent the production of thorns, but not thick enough to form the tissue that produces flowers and berries. If the thornless layer is relatively thick so that flowers are produced from it, then the flowers seem to be entirely or nearly sterile.

Breeding Work at Experiment Stations

Compared with other berries, little systematic breeding work has been done with the blackberries. The aims of experiments now under way probably represent some of the most worth-while objectives.

At the Rhode Island Agricultural Experiment Station the origination of hardy thornless forms is being studied. The first crosses were made in 1929. Thornless sorts such as *Rubus canadensis*, Austin Thornless, Cory, and Thornless Young have been crossed with Snyder, Eldorado, Alfred, Lucretia, and Gardena.

At the New York (State) station the first crosses were made in 1912, and some have been made from time to time ever since, notably a considerable number in 1927. Eldorado has been crossed with Agawam, Rathbun, Joy, Best of All, Brewer, Buckeye, and Erskine Park; Erskine Park with Rathbun and Buckeye; Rathbun with Agawam and Snyder. Agawam has been selfed and crossed with Snyder; Buckeye with Joy; Mersereau with Snyder. Strawberry Flavored has been selfed. The Eldorado × Brewer cross is considered a good one.

At the North Carolina station dewberry breeding began in 1926. Young and Lucretia were crossed, and the first-generation selections have been backcrossed in an attempt to obtain productive, disease-resistant, high-flavored, thornless sorts. The Cameron variety has been selected, propagated, and named for its vigor, high flavor, firmness, thornlessness, and resistance to anthracnose, to septoria leaf spot, and to nematodes, and D–3 and D–4 for the size of their cluster. In a cross of Young × Austin Thornless there were 334 thornless and 411 thorny in the first-generation progeny.

At the Texas station breeding work began in 1909. Ness (*41*) crossed a selection of the southern dewberry, *Rubus trivialis*, with the Brilliant red raspberry in 1912. The first and second generations were quite sterile except for five of the second-generation (open-pollinated) plants. These gave rise to a third generation, from which selections were made that were introduced as Nessberry in 1921. The Nessberry was then backcrossed with the dewberry, two raspberries, and a blackberry. The resulting progenies have been selfed for two to four generations.[4] The Nessberry is drought-resistant and has high flavor, but the fruit does not separate from the stem like either a blackberry or a raspberry. The obtaining of fertile seedlings in the third and fourth generations indicates that it may be possible through backcrossing to obtain seedlings the fruit of which will separate either like a raspberry or like a blackberry. Other breeding begun by Yarnell in 1934 (*57*) involves crosses and selfing of Young, Early Harvest, Hall Lawton, Crandall Early, Early Wonder, Lucretia, Dallas, Haupt, and Mayes.

[4] S. H. Yarnell (*57*), who has carried on the work in recent years, found that the Nessberry ($n=14$) has twice the chromosome number of its parents ($n=7$), and he concluded that its fertility was due to chromosome doubling. Plants of the F_3 of Nessberry ($n=14$) × Hailsham red raspberry ($n=7$), and plants of the F_4 of Nessberry × Early Harvest blackberry all had the 14 ($2n=28$) chromosome number and were fertile.

Breeding Work of the United States Department of Agriculture

The first crosses in the blackberry-breeding work of the United States Department of Agriculture were made in gardens in Atlanta, Ga., in 1919, and the seedlings were raised at Glenn Dale, Md. Only two seedlings grew to maturity, one of which was named the Brainerd (fig. 6) (*23*). It is a cross of Himalaya with an erect garden variety, probably the Georgia Mammoth. The Brainerd is grown commer-

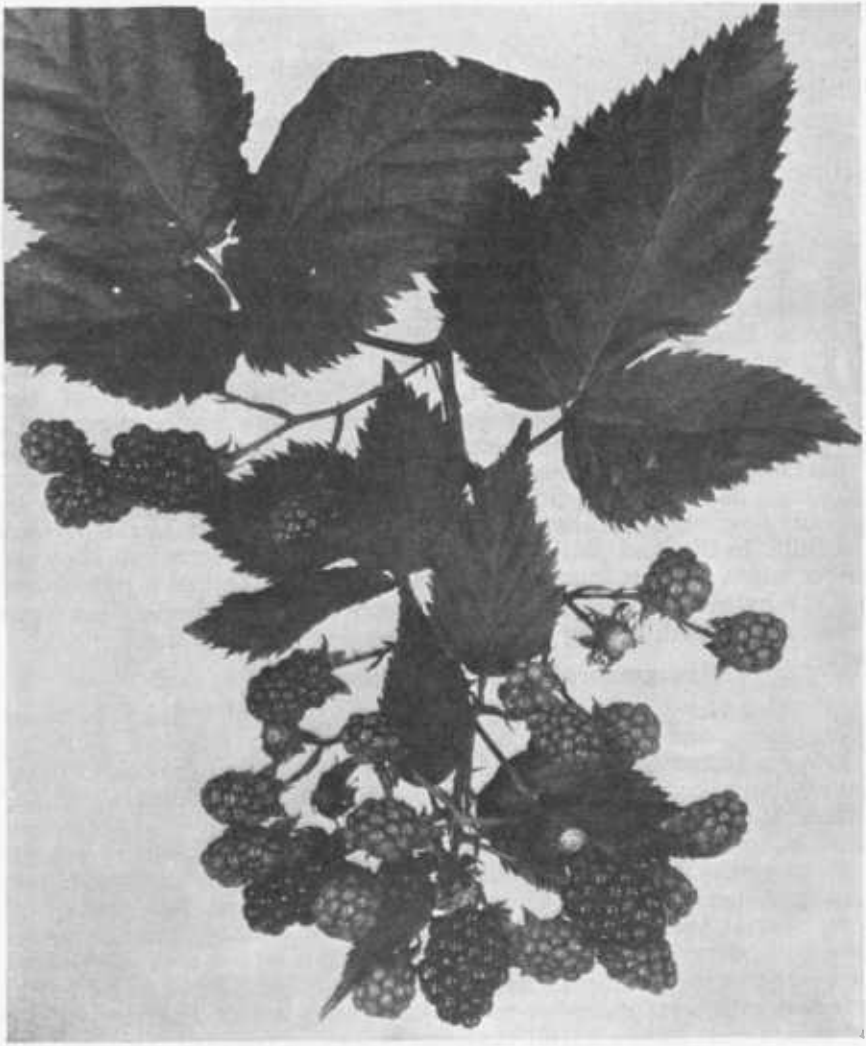

Figure 6.—The Brainerd blackberry, a cross of Himalaya on an erect-growing eastern variety. Note the large clusters of this variety. It is being grown in western Oregon for shipping and canning.

cially at Gresham, Oreg., for canning and shipping, replacing Himalaya for that purpose. It was hardy in Maryland until the winters of 1934–35 and 1935–36, when it was injured by temperatures of −17° and −23° F. Later crosses made at Beltsville, Md., and Willard, N. C., were between cultivated varieties such as Joy, Eldorado, Jumbo, Mersereau, and Blowers, while Eldorado and Joy were selfed. Recent crosses have been between Himalaya and Evergreen, Joy, Snyder, Early Wonder, Austin Thornless, Taylor, Lawton, and Eureka. The objective is to combine the size of fruit and hardiness of eastern varieties with the productiveness and vigor of the Himalaya. In these crosses a large proportion of the first-generation hybrid plants are true Himalaya, due to the development of "false" seedlings in this variety of the European type. In the crosses of Himalaya with American varieties 64 percent were maternal, that is, just like Himalaya, and 36 percent were true hybrids. In the cross Himalaya × Thornless Austin, about half of the true seedlings are thornless.

The breeding work at Corvallis, Oreg., is chiefly directed toward combining the high flavor of the native trailing blackberry with the size, firmness, productiveness, and hardiness of commercial varieties. Selections of different types of the wild blackberry, as well as the Logan, Young, Ideal Wild, and Zelinski, have been used in crossing with one another and with Lucretia, Austin Thornless, Eldorado, Oregon, Evergreen, Himalaya, and Mammoth. Crosses of the Logan with Mammoth, Lucretia, and Young were mostly sterile (*22*), even though they have the same chromosome number. Many selections have been made from the wild and Logan crosses, some having the high flavor of the wild, which is considered the highest quality in all the dewberry-blackberry group. One Himalaya × Logan hybrid is fully fertile and fairly vigorous, the second generation showing segregation into an immense number of forms. Out of a population of 817 hybrids of Logan × Young, 2 very firm-fruited selections have been made, both having the deep wine-colored fruit of the Young.

Blackberry-Raspberry Hybrids in England

Besides the Nessberry discussed above, several hybrids between blackberry and raspberry have been raised in England. Among these are Laxtonberry (Logan × Superlative), Mahdi (Belle de Fontenay × common English blackberry), Veitchberry (November Abundance × common English blackberry), and Kings Acre. The Mahdi and Kings Acre have 21, Veitchberry has 28, and Laxtonberry 49 chromosomes in vegetative cells. The Veitchberry is the most fertile and productive. None of these hybrids, however, has proved of commercial value, though they are of good quality. Just as with the Nessberry, they do not separate readily from the stem like either a raspberry or a blackberry. Possibly they will need to be backcrossed with a raspberry or with a blackberry before seedlings can be obtained that produce fruit that can be picked readily. Gruber (*27*) in Germany is doing some work in crossing blackberries and raspberries to transfer the disease resistance of the blackberry to a raspberry.

Some Problems and Objectives of Blackberry Breeders

Among the most important objectives for breeders are hardier northern varieties, thornlessness, small seed, high flavor, firmness, and resistance to double blossom and orange rust. Sources of each of these desirable characters are known and are listed in the appendix. Thus, both *Rubus canadensis*, the thornless blackberry, and *R. pergratus* are native in northern regions where most cultivated varieties are not hardy. Austin Thornless, Burbank Thornless, Cameron, and *R. canadensis* are available for breeding thornless varieties. With their superior flavor, *R. pergratus* and *R. allegheniensis* for eastern and *R. macropetalus*, *R. ursinus*, Logan, Young, and Boysen for western blackberries furnish material for great improvement in dessert quality. Excepting *R. cuneifolia*, the most erect blackberries have the smallest seeds, though a large-fruited and large- but few-seeded trailing variety like the Young may not be objectionably seedy.

It may be possible to utilize some of the immense-fruited blackberries of northern South America in breeding (*45*). They belong to a very different group from North American blackberries; but it is possible that hybrids with this group might be large-fruited seedlings that would reproduce exactly from seed, as do certain European varieties resulting from wide crosses.

RASPBERRIES

History of the Raspberry

According to Hedrick (*31*), the first red raspberries were introduced into cultivation in Europe about 400 years ago. Three hundred years ago there were at least two varieties cultivated in England, but variety names were not applied until after 1800. The European varieties were introduced into the United States even before 1800 and at first were raised even more extensively than were selections of native American raspberry. Probably one or more selections of the American red raspberry were in cultivation by 1800. The first named black raspberries were probably the Doolittle, introduced by H. H. Doolittle, Oaks Corners, N. Y., about 1850, and the Ohio Everbearing, found by Nicholas Longworth, Cincinnati, Ohio, in 1852.

A Dr. Brinkle, of Philadelphia, Pa., was the first successful raspberry breeder of this country. He originated many varieties of raspberries, among which was the high-flavored Orange (Brinkles Orange). This he raised from seed in 1845. Although there was a considerable acreage of raspberries around some of the larger cities, it was nearly 1870 before the raspberry became a crop of any great importance. The Cuthbert variety was found as a chance seedling in 1865 in what is now a part of New York City; it was probably a cross of Hudson River Antwerp, a European variety, with a wild native red. Ever since the introduction of the Cuthbert, which is still the chief variety of the Northwest, the raspberry has been an important small fruit. Cuthbert and Ranere (St. Regis) are the only important varieties of red raspberry now grown that originated as chance seedlings.

Other leading red raspberries are Latham, Chief, Ohta, Marlboro, and King, all of which resulted from definite attempts to improve the

raspberry. The Marlboro was originated by A. J. Caywood, Marlboro, N. Y., before 1880, and at one time was the leading variety. The Latham originated at the Minnesota Fruit Breeding Farm as a cross between King and Loudon, and was introduced in 1912. Since then it has become the leading variety east of the Rocky Mountains. The Ohta, Chief, June, and Newburgh are other varieties from experiment stations that have succeeded.

The leading black raspberries, Cumberland in the East and Munger in the Northwest, both resulted from growing seedlings, the Munger coming from seed of the Shaffer Purple. Quillen, an anthracnose-resistant variety grown in the Midwest, resulted from a cross between Cumberland and Hopkins. The other black raspberries grown to any extent commercially originated as chance seedlings. Recently, however, the New York (State) Agricultural Experiment Station, at Geneva, has introduced four black raspberries that seem to be succeeding.

The most important of the purple varieties, Columbian, was grown from seed of Cuthbert. Recently the Potomac and Sodus purple varieties have been introduced. Both are succeeding and are adapted to a wider range of conditions than Columbian. The Potomac is one of the hardiest of all raspberries.

American and European Raspberries

The commercial cultivated raspberries of the world have come from the wild red raspberry of Europe (*Rubus idaeus* L.) and the red (*R. strigosus* Michx.) and black (*R. occidentalis* L.) wild raspberries of North America (*16*).

Rubus idaeus is native in much of Europe, but closely allied forms occur across northern Asia to Japan. It is much like the North American red raspberry, but in general is not so hardy and usually has stout purple prickles, larger leaves, and duller and more conical berries. The largest size in cultivated berries has come from the Lloyd George and Pynes Royal varieties, which are derived from this species.

The American red raspberry, *Rubus strigosus*, is native in the mountains from Georgia to Pennsylvania and in both lowlands and mountains from Maine to the Dakotas, far north in Canada, and west to British Columbia. Allied forms occur in the Rocky Mountains. It has much greater hardiness than the European species, the canes are more slender and often more erect, the prickles are not so stout and sometimes are absent. The berries are seldom thimble-shaped and are usually bright red. The species is extremely variable in the wild.

The American black raspberry, *Rubus occidentalis*, has much the same range in the United States as *R. strigosus*, but ranges as far south as Oklahoma, Atlanta, Ga., and the lowlands of Virginia. It is not so hardy as the wild red raspberry, and although found from North Dakota and Quebec to Maine and New Brunswick, is far less common than the red raspberry toward its northern limit. A closely allied species, *R. leucodermis* Dougl., occurs from British Columbia to California.

The black raspberry has a sweeter but a more seedy fruit than the red. Curiously, though, yellow- or amber-fruited black raspberries

are common, and yellow and amber colors are common in the red raspberries of Europe, these colors are rarely found in American wild red raspberries. Natural hybrids between the black and the red, called purple raspberries, occur quite commonly in some sections. The purple raspberries are more vigorous and if fertile are more productive than either the red or black. The fruit is often larger and usually has more pulp or flesh in proportion to the seed.

Related berries that are often called raspberries are the two flowering raspberries of the woods, *Rubus odoratus* L. and *R. parviflorus* Nutt., with large, showy, purplish-red and white flowers and soft, thin-fleshed berries; the salmonberry, *R. spectabilis* Pursh, a perennial-caned tender species of the Pacific coast with large berries not in clusters; and the baked-apple berry, *R. chaemaemorus* L., of the bogs of northern Canada, Alaska, northern Europe, and Asia.

Future Raspberries

Three other raspberries are grown slightly in some parts of the world —the Andes black raspberry (*Rubus glaucus* Benth.) in northern South America; *R. niveus* Thunb. (*R. lasiocarpus* Sm.) in northern India and Burma; and the wineberry (*R. phoenicolasius* Maxim.), introduced from Japan, in the northeastern United States. Besides these 6 kinds, the Van Fleet, grown to some extent in the Southern States, is a cross of Cuthbert and *R. kuntzeanus* Hemsl., a Chinese raspberry (*17*).

The possibilities of improving the raspberry by utilizing just these seven species are enormous. The very large size of the varieties now in cultivation in Europe, such as Lloyd George, Pynes Royal, and the new Imperial, as well as of Marcy and many recent selections at the Geneva, Corvallis, and Puyallup stations, would hardly have been thought possible 10 years ago. Some of the qualities to be combined in raspberries of the future are the firmness of the Newburgh, U. S. D. A. No. 9 (Latham × Ranere), and Potomac; the vigor of Van Fleet; the productiveness of plants of Dixie and Van Fleet; the immense fruit clusters of *Rubus kuntzeanus* (fig. 7); the resistance to cold of Ohta, Sunbeam, Latham, Chief, Potomac, and Sarah and some other Canadian varieties; the resistance of Van Fleet and Quillen seedlings to anthracnose; of Lloyd George and Newburgh to mosaic-carrying aphis, and of Cuthbert to verticillium wilt.

The cultivated raspberries, however, are but a small part of the raspberries of the world. Focke (*25*), in his latest book on the subject of raspberries, published some 20 years ago, described 195 wild kinds of eastern and southern Asia alone. These range from whole groups with vines and leaves much like those of the grape to others with leaves like the hawthorn, bamboo, viburnum, maple, and apple. Some have soft, others woody stems. Some are low plants, while *Rubus ellipticus* Sm., the Golden Evergreen raspberry, may have canes 3 inches in diameter and grow 14 feet high (fig. 8). Eastern Asia is the center of the wild raspberries of the world.

Some of the species of Asia and elsewhere are already being crossed. The Hawaiian station and the Armstrong nurseries are working with several forms of the Akala raspberry of Hawaii. Crosses have been made between both *Rubus biflorus* Buch., a Chinese species, and the

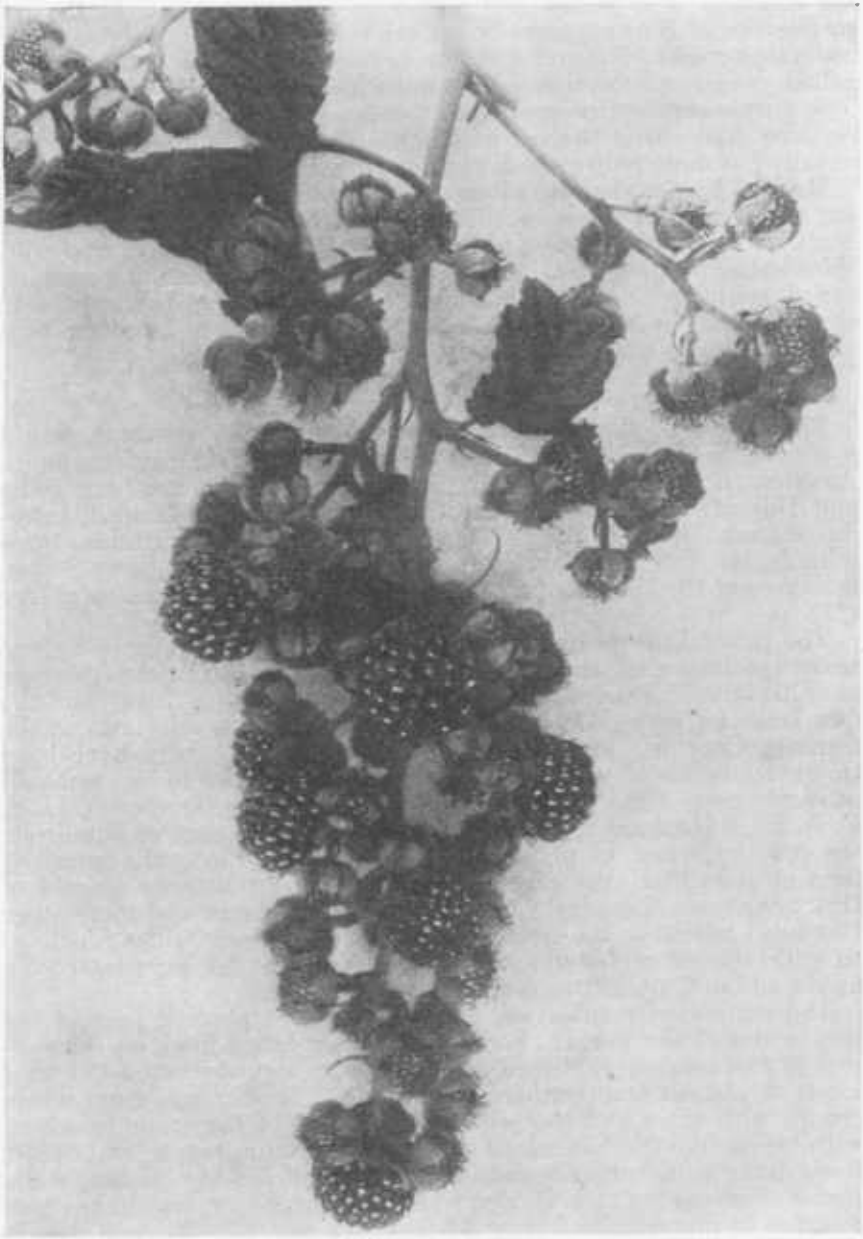

Figure 7.—Rubus kuntzeanus, a very large-clustered, vigorous species of raspberry from Asia, with red, wine, and black fruit. The Van Fleet resulted from a cross between this species and Cuthbert.

salmonberry, *R. spectabilis*, and red-raspberry varieties at the Corvallis station. At the Willard and Beltsville stations and at the Tennessee station *R. kuntzeanus* of Asia and the Van Fleet are being used. At the United States Horticultural Field Station, Cheyenne, Wyo., *R. deliciosus* Torr. of the Rocky Mountains is being crossed with red raspberries. At the Beltsville and Willard stations there are about 2,000 crosses of *R. parvifolius* L. (fig. 9), an Asiatic trailing raspberry, with red, black, and purple varieties. *R. niveus* has been used by B. M. Young, of Morgan City, La., and at the Beltsville

Figure 8.—A single plant of the Golden Evergreen raspberry, *Rubus ellipticus*, 14 feet high and 26 feet across. Some of the canes were 3 inches in diameter. (Watsonville, Calif.)

station. William E. Whitehouse, of the Department, has succeeded recently in introducing several other species, and they are now available to breeders. The woolly raspberry, *R. lasiostylus* Focke (fig. 10), is a very large-fruited species from Asia. All the raspberry species so far studied have seven chromosomes in the reproductive cells, as have most cultivated varieties. Raspberry species so far tried in breeding have crossed readily, though many of the seedlings have not been fertile. Some of these species that have superior germ plasm of value are: For size of fruit, Akala and *R. biflorus*; for vigor of plant, Golden Evergreen (*R. ellipticus*) and *R. biflorus*; for resistance to disease, *R. biflorus*, *R. ellipticus*, *R. coreanus* Miq. (fig. 11), the Andes berry (*R. glaucus*), *R. kuntzeanus*, *R. innominatus* Moore. Most of the breeding work with raspberries lies ahead.

Raspberries and Blackberries of Unusual Colors

In the raspberry there are yellow- or golden- and apricot- or amber-colored berries as well as black, red, purple, and various shades of color from red to purple and purple to black. The yellow and apricot

colors are found in seedlings of the European red and in varieties derived in part from the European, such as Cuthbert and Herbert, but never, so far as known, from the American red. In black raspberries, the yellow form is common in the wild, especially in Maryland.

Figure 9.—Rubus parvifolius, the trailing raspberry of Japan and eastern China, which is very disease-resistant in the United States. Selections of this species are promising in southern States, and hybrids with red, black, and purple varieties are being fruited.

The introduced species of raspberries from Asia have a great variety of colors, ranging through red, orange, yellow, lavender, purple, and wine color to black.

In the blackberry, the white or pale yellow is rather commonly found in the wild in many and possibly all species in North America as well as in many species in Europe. Pink selections have been seen in Alabama and in Oregon, while lavender-colored ones have been reported in North Carolina. In the West the wild blackberry often is not quite black but a very deep wine color.

Raspberry Breeding at State Stations

At the New York (State) Agricultural Experiment Station (*50*, *51*, *56*) at Geneva, the first crosses were made in 1892, and the work has been continued to the present. Over 250 different crosses have been made and over 15,000 seedlings raised. Of these crosses 130 were of

red raspberries, 27 were of black raspberries, and 93 were with or for purple raspberries. For the breeding work the station maintains a collection of some 38 species of raspberries and blackberries, 33 varieties of red raspberries, 18 of black raspberries, and 7 purple varieties.

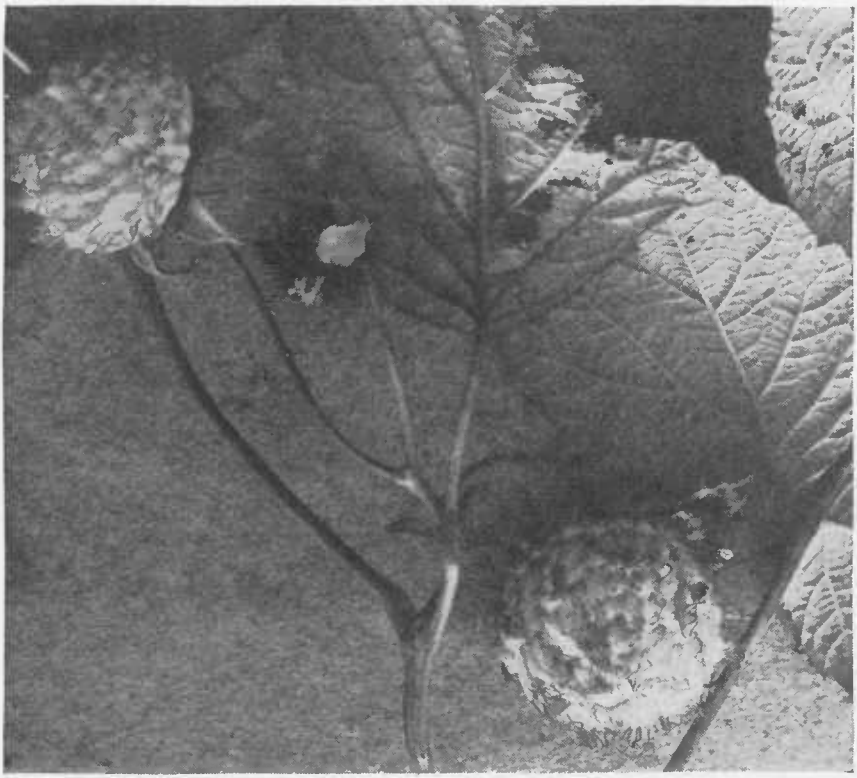

Figure 10.—Rubus lasiostylus, a very large-fruited species from Asia, the fruit of which is covered with a thick mat of hair. The upper fruit is ripe. (Natural size.)

There still are 41 station selections under test for possible introduction. Besides many commercial varieties, 55 of their own selections have been used in the breeding work, as well as the named varieties that have been introduced by the New York station.

Of the red raspberries, George L. Slate, who has had charge of the berry breeding for many years, states that Lloyd George, Newman, Herbert, and Loudon have been exceptional parents. Cuthbert has not been so good a parent, though it has transmitted its high flavor and canning quality in some crosses. Erskine Park, Buckeye, Count, Douboro, Empire, Owasco, Syracuse, Gold Drop, Ohta, Ranere, Superlative, Newman 20, and Marldon have been poor parents in the crosses made. Selfed populations resulted in dwarfs, weaklings, a high proportion of seedlings lacking hardiness, and a considerable amount of partial and complete sterility. Establishment of inbred lines has not been made a part of the breeding program because of (1) the long

time between generations, (2) the high proportion of the weaklings, dwarfs, and otherwise inferior seedlings, and (3) the difficulty of maintaining a number of inbred lines because of virus diseases, winter injury, and lack of vigor. Slate states: "The vast possibilities of improving raspberries by variety crossing make this method the

Figure 11.—Rubus coreanus, an Asiatic black raspberry resistant to leaf and cane diseases that is promising for breeding for southern States.

most promising line of attack in red raspberry improvement at this station."

Many hybrids, backcrosses, and selfed seedlings have been raised involving crosses with blackberries. Among these crosses are:

Mahdi × Herbert
(Mahdi × Herbert) × (Newman × Herbert)
(Mahdi × Herbert) × Herbert
(Mahdi × Herbert) × Lloyd George
Mahdi × Phenomenal
Mahdi × Lucretia
Mahdi × Mersereau
Mahdi × (Mahdi × Lucretia)
Mahdi × *Rubus odoratus*
(Mahdi × Herbert) selfed
(Mahdi × Lucretia) selfed
(Mahdi × Lucretia) × Herbert
(Mahdi × Lucretia) × Snyder
Herbert × Logan
Cuthbert × Logan
Latham × Logan
Donboro × Logan
(Herbert × Logan) selfed
Rubus phoenicolasius × Agawam
R. phoenicolasius × Empire
(*R. phoenicolasius* × Empire) selfed
(*R. phoenicolasius* × Empire) × Empire
Smith No. 1 (black raspberry) × Snyder
Kansas × Agawam
Kansas × Mayes
Mammoth × Agawam
Mammoth × Cuthbert
Mammoth × Herbert
Mammoth × Snyder

Thus, the Mahdi, a raspberry × blackberry cross, has been backcrossed with both the raspberry and the blackberry, and the progeny

Figure 12.—A hybrid seedling with a desirable fruiting habit. Note exposed fruit, which makes picking easy.

backcrossed a second time with each. So far no selections have been introduced.

Thirty-four different crosses between the black and the red raspberries, 19 different selfings, some 21 different backcrosses with red, and 19 second backcrosses with red have been made. Over 4,300 seedlings have been raised (fig. 12), and 3 varieties have been intro-

duced, of which Brant and Sodus are first crosses and Webster is a backcross of a black and a purple. Backcrossing is still considered promising in this group. Typical red and black raspberries have not appeared when the hybrids were selfed or when purples have been crossed with purples. Dundee × Newburgh has been considered one of the most promising crosses. Besides hybrid vigor, drought resistance has been noted in the purple raspberries.

With the black raspberry, emphasis has been placed on size, color, firmness, and quality of berry, and vigor, yield, and hardiness of plant. Cumberland, Dundee, Eureka, Farmer, Grant, Gregg, Hilborn, Honeysweet, Kansas, Lane, Palmer, Rachel, Smith No. 1, and Watson Prolific have been used in crosses.

At the South Dakota station (*30*) many thousands of seedling raspberries have been grown, particularly crosses of cultivated varieties with selections of the wild red raspberry that have proved fully hardy at Brookings, with no winter protection. Sunbeam and Ohta (Flaming Giant) are two of the eight named selections resulting from the crosses that have proved to be adapted to the climatic conditions of eastern South Dakota.

At the Illinois station raspberry breeding (*1, 2, 8, 9, 10*) was begun in 1922 and over 14,000 seedlings are now under test. Some 121 selections have been made for further observations. The Quillen, Farmer, Older, Munger, and Pearl black varieties and Latham, June, Starlight, Newburgh, Ulster, and Taylor red sorts have been used in this work. Among the best crosses for purple varieties are Quillen × June, Quillen × Latham, and Quillen × Newburgh. In a study of the inheritance of anthracnose resistance, 52 percent of the selfed seedlings of Quillen were free from anthracnose, and no selfed seedlings of Cumberland, Pearl, Farmer, Honeysweet, Older, Munger, Royal Purple, Earheart, or Conrath were free. Of 661 Quillen selfed, 622 had reddish-brown canes and 34 yellow canes. Of 105 Pearl selfed, 96 had reddish-brown canes and 9 yellow, close to a 15:1 ratio. When Cumberland was selfed, all 452 seedlings had reddish-brown canes.

At the Washington State station at Puyallup raspberry breeding was first begun in 1909 (*33*). No varieties were introduced from the early work. In 1928 new breeding work was begun to obtain varieties hardier than Cuthbert, which would be satisfactory for canning, freezing, and shipping, and resistant to mosaic. Selections of Cuthbert and Lloyd George parentage are especially promising. Inheritance of fruit characters and of winter hardiness has been made an important part of the study (*48, 49*).

At the Minnesota station the breeding work has been notable for the origination of Latham and Chief red raspberries, the Latham being the leading red variety of the eastern United States. It is estimated that at the present time there are about 25,000 acres of Latham and 3,000 acres of Chief grown. The work is being continued, and many black and red selections are now being tested. Among the principal varieties crossed are Latham, Chief, Herbert, Ranere, King, Lloyd George, Cuthbert, selections of the wild, and the Farmer and Platt black varieties. The Farmer and Platt black and the Chief red varieties have been inbred. E. Angelo, in charge of the work at

present, emphasizes the need for studies on the mode of inheritance of characters, breeding for disease resistance, and improving the flavor of the fruit.

Extensive breeding work began at the Tennessee station in 1931, using the Van Fleet for its disease resistance and vigor in the South, to cross with red varieties. Selections have been made and are being tested.

At the North Carolina station breeding was begun in 1926 to obtain varieties resistant to diseases and adapted to the South, by using Asiatic species, especially *Rubus biflorus*. One variety, Dixie, is being introduced in 1936–37. Although not large-fruited, it is one of the most productive of red raspberries and is desirable for home use. Beginning in 1936, the work was made cooperative with the Department.

Raspberry Breeding at United States Department of Agriculture Stations

The first raspberry breeding of the United States Department of Agriculture was done by W. Van Fleet while he was at the United States Plant Introduction Garden at Chico, Calif., in 1909 (*17*). He crossed *Rubus kuntzeanus*, a species from China, with the Cuthbert, and from the seedlings selected one that was later named the Van Fleet. The writer became associated with Dr. Van Fleet at the Department's station at Glenn Dale, Md., in 1920 and has carried on the breeding work since. The Potomac (purple) is the only variety introduced besides Van Fleet. The work at Beltsville, Md., and Willard, N. C., consists largely of (1) genetic studies, (2) hybridizing foreign species with cultivated varieties, and (3) crossing to obtain resistance to leaf spot, anthracnose, and leaf rust (*18*, *21*). At Willard, in cooperation with the North Carolina Agricultural Experiment Station, varieties adapted to the South are being bred, using foreign species in the crosses.

At Corvallis, Oreg., in cooperation with the Oregon station, a large part of the work is directed toward obtaining large-fruited varieties suitable for canning, freezing, and long-distance shipment. Inheritance of resistance to diseases is being studied in cooperation with the small-fruit pathologists. Red varieties used in crossing include Antwerp, Cayuga, Chief, Cuthbert, Herbert, Latham, Lloyd George, Newburgh, Ranere, and Viking; black varieties, Cumberland, Munger, and Farmer; and the purple variety, Potomac. Species used include *Rubus spectabilis*, the salmonberry, *R. leucodermis*, the western black raspberry, and several Asiatic species. Lloyd George×Newburgh crosses have been particularly promising, selections from these having larger fruit than any yet found.

At Cheyenne, Wyo., crosses are being made with the entirely hardy perennial-caned *Rubus deliciosus* in the attempt to obtain much greater hardiness.

Raspberry Breeding Abroad

Canada

Raspberry breeding was begun in Canada at Ottawa as early as 1873 (*38*), when William Saunders (*47*), later Director of the Experimental Farm at Ottawa, crossed the Doolittle (black) with the Philadelphia (dark red—a probable black × red hybrid) and obtained

24 purple-fruited seedlings. His work was transferred in 1887 to the Dominion station when he entered the Dominion service, and it has been continued since. At least 23 varieties have been introduced, of which 2, Brighton and Count, are still important varieties in Canada.

Raspberry breeding began at Vineland, Ontario, in 1913 (*43*). According to W. J. Strong, in charge of the work at present, some 125 crosses and 167 open and self-pollinations, using 16 varieties, resulted in 21,000 seedlings. About 140 selections were propagated, and one variety, the Viking, was named and introduced. This variety, introduced in 1924, is extensively grown in Ontario and is increasing slowly in importance in other sections in Canada and the northern United States. It is estimated that 1,500 acres of this variety are grown.

England

In England (*52, 53*), extensive work in breeding raspberries by N. H. Grubb (*26*) at East Malling, Kent, has included selfing 19 varieties to study the inheritance of characters. Of 74 selfed seedlings of Pynes Royal, 22 were worthy of propagation, and of 92 selfed Lloyd George, 17 were propagated. Pynes Royal seedlings were much larger, but were mostly dark, hard to pick, and not of high flavor. Lloyd George seedlings produced many canes, but few had large fruit. Red Cross and Preussen, selfed, were very disappointing. Of 4 selections chosen for trial, all were from self-pollinated progenies of Royal × Lloyd George hybrids.

Chief emphasis has been placed by M. B. Crane and W. J. C. Lawrence (*11, 14, 15*), of John Innes Institute, Merton, on inheritance of characters such as sex, color of prickles and fruit, and hairiness. Two pairs of factors were found to determine sex, two color, and one hairiness.

Private Breeders of Raspberries

Several private breeders have valuable varieties to their credit, especially C. P. Newman, of La Salle, Quebec, Canada, and George Pyne, of Topsham, Devon, England. Newman (*42*) originated the Newman from seed of several varieties mixed. This variety is outoutstanding for its firmness of fruit, hardiness of cane, and mosaic resistance. It was introduced in 1919 and is still grown commercially. It is important as one of the parents of the Newburgh, Monroe, Taylor, Marcy, and Potomac raspberries.

Pyne selected Devon and Pynes Royal from self-sown seedlings and Park Lane and Red Cross from self-sown seedlings that he transplanted and tested. Mayfair came from seed of Park Lane, and Imperial from seed of Royal. Better-Late is a seedling of a blackberry-raspberry hybrid. The Red Cross is notable as an early productive sort with a long season, Park Lane and Mayfair for their high flavor, Pynes Royal for its large size, excellent flavor, and firmness, while Imperial is reported to be larger than Pynes Royal, which has been the largest raspberry known.

A third private breeder, George Adams, of Smithville, Ontario, has grown seedlings over a period of some 40 years, starting with purple and black varieties. His Adams 87 and Adams 101 are grown to a considerable extent in western New York. Adams 101 is a red variety rooting at the tips of canes, while Adams 87 is an especially hardy sort.

Generic Crosses

Hybrids between raspberries and blackberries have been discussed above and the reported hybrids with the strawberry are discussed in the article on strawberry breeding in this yearbook. Hybrids of raspberries or blackberries with roses, apples, etc., have been reported, but no authentic cases are known. Van Fleet once stated that he had tried to cross the raspberry and a rugosa rose (*Rosa rugosa* Thunb.). He obtained sterile seedlings, which may possibly have been hybrids.

Everbearing or Fall-Fruiting Raspberries

The so-called everbearing raspberries produce a crop in the early summer at the same time as other varieties and later a second crop on the new canes. The Ranere (St. Regis) is the most common American red variety of this group. Erskine and La France are two others, and the New York (State) station has just introduced another, Indian Summer. These varieties form fruit buds on the most vigorous canes in midsummer, beginning at the tips and flowering and fruiting downward toward the base. Besides these, other varieties like the Lloyd George in Oregon and Washington begin to flower and fruit in September. Even some of the ordinary varieties such as Cuthbert may start flowering in September in some years. In the wild, fall-fruiting raspberries are often found.

Figure 13.—*A*, Red-raspberry buds and flowers. The bud at the lower left is ready to cross, or in warm, dry weather it may be so far advanced that pollen is already shedding. The other flowers are too advanced to use out of doors. *B*, After emasculating with scalpel, forceps, or the thumbnail, pollen is applied directly by twirling the flower so that the pollen is brushed from the anthers to the pistils. *C*, Blackberry flower with pistils in receptive condition and with some of the anthers on the outer stamens already split open and shedding pollen.

138904°—37——34

Summer- and fall-fruiting black raspberries are also rather commonly found in the wild, and several have been introduced. The Ohio Everbearing was one of the first black raspberries ever named and cultivated. However, fall-fruiting black raspberries are not very practicable, for fruiting on the tips of the canes interferes with propagation. So far, only with special care have they succeeded. Purple summer- and fall-fruiting raspberries present the same difficulties as do the blacks.

TECHNIQUE OF BLACKBERRY AND RASPBERRY CROSSING

Most of the breeding work with blackberries and raspberries is done out of doors, though when tender varieties are to be used it may be done with potted or tubbed plants in the greenhouse. Flowers of

Figure 14.—Flower clusters bagged after crossing, to protect from bees.

all except self-sterile kinds should be emasculated at least 1 day before the calyx begins to split, because in some varieties under certain conditions the anthers may open and shed pollen before the buds open (fig. 13). The thumbnail is commonly used to cut away the calyx, corolla, and anthers, and the operation does not seem to injure the setting of the flowers. In the field the flower clusters should be covered with ordinary paper bags to keep insects away (fig. 14). After 1 to several days the pistils are receptive and pollen is applied. Pollen may be gathered in a dish and applied with a small, soft brush, or a flower may be twirled between the fingers so that the pollen is brushed from the stamens onto the pistils of the flowers used as the female parent. The paper bags may be taken off the flower clusters

after the third day, or, in all except the windiest or rainiest weather, they may be left on to protect the clusters until the berries ripen.

The seed of the ripe berries may be cleaned or the berries crushed in dry sand. Though dried seed of some varieties and species may germinate if given suitable conditions, they are likely to require 2 or more years. For this reason, in the work of the Department the fresh seed is planted immediately, and the flats or pots of seed are stored in a cool, moist place and are exposed the following winter to 2 or more months of cold weather just above freezing. The soil in the flats is kept moist from sowing until germination. Good germination has followed this practice. Fresh seed of tropical species generally germinates at once. Occasionally seed of some raspberry varieties has also germinated immediately after planting. Under favorable conditions the seedlings can be set in the field in the spring, and by the following year many kinds may fruit.

LITERATURE CITED

(1) ANTHONY, R. D.
1916. SOME NOTES ON THE BREEDING OF RASPBERRIES. N. Y. Agr. Expt. Sta. Bull. 417: 75–88.

(2) ———
1916. SOME RESULTS IN THE BREEDING OF SMALL FRUITS. Amer. Soc. Hort. Sci. Proc. 12: 121–125.

(3) BAILEY, L. H.
1932. NORTH AMERICAN BLACKBERRIES. Gentes Herbarum 2: 271–423.

(4) ———
1933. BLACKBERRIES OF THE LOWER SOUTH. Gentes Herbarum 3: 119–148.

(5) ———
1934. CERTAIN NORTHERN BLACKBERRIES. Gentes Herbarum 3: 247–271.

(6) BRAINERD, E., and PEITERSEN, A. K.
1920. BLACKBERRIES OF NEW ENGLAND—THEIR CLASSIFICATION. Vt. Agr. Expt. Sta. Bull. 217, 84 pp., illus.

(7) CHOMISURY, N.
1927. BEITRAG ZUR KEIMFAHIGKEIT UND ZYTOLOGIE DES POLLENS EINIGER PRUNUS UND RUBUSSORTEN. Angew. Bot. 9: 626–636.

(8) COLBY, A. S.
1928. THE INHERITANCE OF ANTHRACNOSE RESISTANCE. Jour. Heredity 19: 327–382.

(9) ———
1933. HORTICULTURAL INVESTIGATIONS. Ill. Agr. Expt. Sta. Rept. for 1932–33, pp. 240–241.

(10) ———
1936. THE INHERITANCE OF SUCKERING AND TIP LAYERING IN PURPLE RASPBERRY SEEDLINGS. Amer. Soc. Hort. Sci. Proc. 33 (1935): 427–429.

(11) CRANE, M. B.
1936. BLACKBERRIES, HYBRID BERRIES, AND AUTUMN-FRUITING RASPBERRIES. Roy. Hort. Soc.: 121–128.

(12) ——— and DARLINGTON, C. D.
1927. THE ORIGIN OF NEW FORMS IN RUBUS, I. Genetica 9: 241–278.

(13) ——— and DARLINGTON, C. D.
1932. CHROMATID SEGREGATION IN TETRAPLOID RUBUS. Nature 129: 869.

(14) ——— and LAWRENCE, W. J. C.
1930. STUDIES IN STERILITY. Intern. Hort. Cong. 9: 100–116.

(15) ——— and LAWRENCE, W. J. C.
1931. INHERITANCE OF SEX, COLOUR, AND HAIRINESS IN THE RASPBERRY, RUBUS IDAEUS L. Jour. Genetics 24: 243–255, ap. 1931, no. 2.

(16) DARROW, G. M.
1920. ARE OUR RASPBERRIES DERIVED FROM AMERICAN OR EUROPEAN SPECIES? Jour. Heredity 11: 179–184.

(17) DARROW, G. M.
1924. THE VAN FLEET RASPBERRY, A NEW HYBRID VARIETY. U. S. Dept. Agr. Cir. 320: 1–13.

(18) ———
1926. RASPBERRY BREEDING EXPERIMENTS, HYBRIDS AND BACK CROSSES BETWEEN RED AND BLACK VARIETIES. Jour. Heredity 17: 339–348.

(19) ———
1928. NOTES ON THORNLESS BLACKBERRIES. THEIR CHROMOSOME NUMBER AND THEIR BREEDING. Jour. Heredity 19: 139–142.

(20) ———
1931. EUROPEAN BLACKBERRY SEEDLINGS AND HYBRIDS IN THE PACIFIC NORTHWEST. Jour. Heredity 22 (5): 143–146.

(21) ———.
1935. SUSCEPTIBILITY OF RASPBERRY SPECIES AND VARIETIES TO LEAF SPOT (MYCOSPHAERELLA RUBI) AT BELTSVILLE, MARYLAND. Phytopathology 25: 961–962.

(22) ———.
1933. CYTOLOGY AND BREEDING OF RUBUS MACROPETALUS, THE LOGAN, AND RELATED BLACKBERRIES. Jour. Agr. Research 27: 315–330.

(23) ———.
1932. THE BRAINERD BLACKBERRY. U. S. Dept. Agr. Cir. 220, 4 pp., illus.

(24) DETJEN, L. R.
1916. SELF-STERILITY IN DEWBERRIES AND BLACKBERRIES. N. C. Agr. Expt. Sta. Tech. Bull. 11: 5–37.

(25) FOCKE, W. O.
1910–14. SPECIES RUBORUM. MONOGRAPHIAE GENERIS RUBI PRODROMUS. 3 v., illus. Stuttgart.

(26) GRUBB, N. H.
1935. RASPBERRY BREEDING AT EAST MALLING, 1922–34. Jour. Pomol. and Hort. Sci. 13 (2): 108–134.

(27) GRUBER, F.
1932. BEERENOBSTZUCHTUNG. Zuchter 4: 237–242.

(28) GUSTAFSSON, Å.
1930. KASTRIERUNGEN UND PSEUDOGAMIE BEI RUBUS. Bot. Notiser 6: 477–494.

(29) ———.
1933. CHROMOSOME NUMBERS IN THE GENUS RUBUS. Hereditas 18: 77–80.

(30) HANSEN, N. E., and HARALSON, C.
1907. RASPBERRIES, BLACKBERRIES, AND DEWBERRIES. S. Dak. Agr. Expt. Sta. Bull. 104: 268–297.

(31) HEDRICK, U. P., asst. by HOWE, G. H., TAYLOR, O. M., BERGER, A., SLATE, G. L., and EINSET, O.
1935. THE SMALL FRUITS OF NEW YORK. N. Y. State Dept. Farms and Markets Ann. Rept. 33, pt. 2, 614 pp., illus.

(32) HOAR, C. S.
1916. STERILITY AS A RESULT OF HYBRIDIZATION AND THE CONDITION OF POLLEN IN RUBUS. Bot. Gaz. 62: 370–388.

(33) LAWRENCE, W. H.
1912. PLANT BREEDING. Wash. Agr. Expt. Sta. Bull. 7: 115–118.

(34) LIDFORSS, B.
1914. RÉSUMÉ SEINER ARBEITEN ÜBER RUBUS. Ztschr.-Induktive Abstamm. u. Vererbungslehre 12: 1–13.

(35) LONGLEY, A. E.
1924. CYTOLOGICAL STUDIES IN THE GENUS RUBUS. Amer. Jour. Bot. 11: 249–282.

(36) ———
1927. RELATIONSHIP OF POLYPLOIDY TO POLLEN STERILITY IN THE GENERA RUBUS AND FRAGARIA. Mem. Hort. Soc. N. Y. 3: 15–17.

(37) LONGLEY, A. E. and DARROW, G. M.
1924. CYTOLOGICAL STUDIES OF DIPLOID AND POLYPLOID FORMS IN RASPBERRIES. Jour. Agr. Research 27: 737–748.
(38) MACOUN, W. T.
1923. REPORT OF THE DOMINION HORTICULTURIST. Canada Expt. Farms, Div. Hort., Rept. 1922: 12.
(39) MICHURIN, I. V.
1934. [REVIEW OF 60 YEARS' WORK IN BREEDING NEW VARIETIES OF FRUITS.] 366 [2] pp., illus. Moskva. [In Russian.] 3d ed. [THE RASPBERRY TEKHAS—"TEXAS"], pp. 313–314; [THE "ABUNDANT" BLACKBERRY], pp. 315–316.
(40) MORRIS, H. F.
1933. A STUDY OF BLACKBERRY AND DEWBERRY VARIETIES AS BREEDING MATERIAL. Amer. Soc. Hort. Sci. Proc. 30 (1933): 117–121.
(41) NESS, H.
1925. BREEDING EXPERIMENTS WITH BLACKBERRIES AND RASPBERRIES. Texas Agr. Expt. Sta. Bull. 326: 1–28.
(42) NEWMAN, C. P.
1916, SOME RESULTS IN RAISING NEW RASPBERRIES. Ann. Rept. Pomol. and Fruit Growing Soc., Quebec, pp. 114–121.
(43) PALMER, E. F., and STRONG, W. J.
1927. A NOTE ON RASPBERRY BREEDING. Scientific Agr. 7: 387.
(44) PEITERSEN, A. K.
1921. BLACKBERRIES OF NEW ENGLAND—GENETIC STATUS OF THE PLANTS. Vt. Agr. Expt. Sta. Bull. 218, 34 pp., illus.
(45) POPENOE, W.
1920. THE COLOMBIAN BERRY OR GIANT BLACKBERRY OF COLOMBIA. Jour. Heredity 11: 195–203.
(46) ROZANOVA, M. A.
1934. MODES OF FORM GENESIS IN THE GENUS RUBUS. Bot. Zhurn. USSR 19: 376–384. no. 4.
(47) SAUNDERS, W.
1894. NOTES ON EXPERIMENTS IN CROSS FERTILIZATION. Trans. Roy. Soc. Canada.
(48) SCHWARTZE, C. D.
1933. THE GENETIC CONSTITUTION OF CERTAIN RED RASPBERRY VARIETIES IN RELATION TO THEIR BREEDING BEHAVIOR. Proc. Amer. Soc. Hort. Sci. 30 (1933): 113–116.
(49) ———
1934. FURTHER OBSERVATIONS UPON THE LLOYD GEORGE RED RASPBERRY AS A PARENT IN BREEDING. Proc. Amer. Soc. Hort. Sci. 31: 411–415.
(50) SLATE, G. L.
1933. THE BEST PARENTS IN PURPLE RASPBERRY BREEDING. Proc. Amer. Soc. Hort. Sci. 30: 108–112.
(51) ———
1934. THE BEST PARENTS IN RED RASPBERRY BREEDING. Amer. Soc. Hort. Sci. Proc. 31: 407–410.
(52) SPINKS, G. T.
1925. PROGRESS REPORT ON FRUIT BREEDING. Ann. Rept. Agr. and Hort. Sta. Univ. Bristol, pp. 38–39.
(53) ———
1932. PROGRESS REPORT ON FRUIT BREEDING. Ann. Rept. Agr. and Hort. Res. Sta., Univ. Bristol, pp. 19–23.
(54) SUDRE, H.
1908–13. RUBI EUROPAE VEL MONOGRAPHIA ICONIBUS ILLUSTRATA RUBORUM. fasc. 1–6, illus. Paris.
(55) THAYER, P.
1923. RASPBERRY BREEDING NOTES. Jour. Heredity 14: 12–13.
(56) WELLINGTON, R.
1913. RASPBERRY BREEDING. Amer. Soc. Hort. Sci. Proc. 90: 155–159.
(57) YARNELL, S. H.
1936. CHROMOSOME BEHAVIOR IN BLACKBERRY-RASPBERRY HYBRIDS. Jour. Agr. Research 52: 385–396.

APPENDIX

TABLE 1.—*Breeding work with blackberries at experiment stations*

Location	Past workers	Present workers	Year begun	Objectives
State stations:				
Georgia, Experiment	J. G. Woodroof	J. E. Bailey, H. L. Cochran, H. P. Stuckey.	1927	High-flavored southern varieties.
New Jersey, New Brunswick.		J. H. Clark	1928	Productive, disease-resistant sorts.
New York, Geneva		George L. Slate, R. Wellington.	1912	Hardy, productive sorts.
North Carolina, Raleigh.		C. F. Williams	1926	Thornless, high-flavored, disease-resistant, hardy sorts.
South Dakota, Brookings.	N. E. Hansen, Charles Haralson.			Hardy varieties.
Rhode Island, Kingston		A. E. Stene, T. E. Odland.	1929	Thornlessness.
Texas, College Station	H. Ness	S. H. Yarnell, H. F. Morris.	1908	Drought-resistant, high-flavored, productive hybrids.
Washington, Puyallup	W. H. Lawrence, J. L. Stahl.		1909	Crosses of Evergreen and American varieties.
Department stations:				
Maryland, Beltsville (formerly at Glenn Dale).	W. Van Fleet, G. F. Waldo.	George M. Darrow	1920	Thornless productive Himalaya hybrids, Logan × eastern blackberry hybrids.
North Carolina, Willard.	G. F. Waldo	George M. Darrow, C. F. Williams.	1929	Do.
Oregon, Corvallis	C. E. Schuster, B. S. Pickett, George M. Darrow.	G. F. Waldo	1928	Thornless, firm, high-flavored hybrids of Logan, Himalaya, Evergreen, Eldorado, and selections of the wild.
Canada:				
Ontario, Lennoxville				
British Columbia, Sidney.				
England:				
Long Ashton, Bristol		J. G. Maynard, G. T. Spinks.		Table and canning varieties.
John Innes Institute, Merton (*12*, *13*).	W. O. Backhouse	M. B. Crane, C. D. Darlington.	1911	Genetics and thornlessness.
Union of Soviet Socialist Republics:				
Michurin Institute (*39*, *46*).	I. V. Michurin	A. Petrov, V. G. Lithovitzer.		Hardiness.

TABLE 2.—*Blackberry varieties originated by public agencies*

Location	Variety	Year introduced	Parentage	Superior qualities
State stations:				
North Carolina, Raleigh.	Cameron	1936–1937	Young × Lucretia	Disease resistant, thornless, high flavor.
South Dakota, Brookings.	Siberian	1930	Seedling of wild from Siberia.	Hardy dewberry.
Texas, College Station.	Nessberry	1921	*Rubus trivialis* × Brilliant raspberry.	High flavor, drought resistance.
Department stations:				
Maryland, Beltsville (formerly at Glenn Dale).	Brainerd	1932	Himalaya × erect eastern variety.	Vigorous, productive.
England:				
John Innes Institute, Merton.	John Innes		*R. rusticanus inermis* × *R. thrysiger*.	Large, late, long seasons.
Long Ashton, Bristol	Ashton Cross	1932	Seedling of wild	Large, bright, productive.
Union of Soviet Socialist Republics:				
Michurin Institute (*39*).	Abundant		Seedling of Lucretia	Hardy.

TABLE 3.—*Blackberry varieties originated by private agencies*

Name and location	Variety	Year introduced	Parentage	Superior qualities
B. M. Young, Morgan City, La.	Young	1926	Phenomenal × Mayes	Disease resistance, excellent flavor, large.
Laxton Bros., Bedford, England.	Bedford Giant	1934	Veitchberry seedling	Early for European type, large.

SOURCE OF SUPERIOR QUALITIES IN BLACKBERRIES

Plant Characters

Hardy against cold. *Rubus pergratus*, *R. canadensis*, *R. alleghenicnsis*, Snyder, Eldorado, Ancient Briton, Agawam.

Resistant to orange rust. Eldorado, Oregon Evergreen (Black Diamond), Russell, Snyder.

Resistant to double blossom. Himalaya, Rogers, Advance (may be same as Rogers).

Resistant to root nematode. Hall Lawton, Young, Crandall.

Resistant to crown gall. Austin Thornless, Advance.

Resistant to leaf spot (septoria). Young, Himalaya, Evergreen, Boysen, Early Harvest.

Resistant to anthracnose. Young, Boysen.

Resistant to verticillium wilt. Himalaya and Evergreen, immune; Logan and Mammoth, resistant.

Thornless (genetically thornless). Austin Thornless, *R. canadensis*, Burbank Thornless, Cameron.

Vigorous. Himalaya, Evergreen, Brainerd, Logan, *R. macropetalus*, *R. ursinus*, Young, Boysen; Haupt in Texas, Eldorado in North.

Resistant to drought. Nessberry.

Large flower clusters. *R. thyrsiger*, *R. nitidioides*, Himalaya, Evergreen.

Fruit Characters

Early ripening. Advance and Rogers (earliest), McDonald, Haupt, Lucretia, Young, Mayes, Early Harvest, Wilson Early; *R. borreri* of Europe.

Late ripening. Burbank Thornless, Himalaya, Evergreen, Brainerd, *R. cuneifolia*, Nanticoke, Eureka; *R. rusticanus* of Europe.

Firm. Oregon (Logan × Young), Advance, Evergreen; Merscreau of eastern blackberries.

Large. Boysen, Young, Mammoth, Logan, Eldorado, and Brewer.

Do not turn red in shipment.—Brainerd.

Canning. Evergreen in Oregon and Washington; Brainerd, Young, Boysen, Logan, Ideal Wild.

Freezing. Young, Boysen, Cameron, Logan.

Excellent flavor. Ideal Wild, Zelinski, Young, Boysen, Logan, *R. macropetalus* of western type; Cameron, Eldorado, Brewer, *R. alleghenicnsis*, *R. pergratus*.

Small seed. Early Harvest.

Lack of seediness. Young, Boysen.

TABLE 4.—*Breeding work with raspberries at experiment stations*

Location	Past workers	Present workers	Year begun	Objectives
State stations:				
Arkansas, Fayetteville.	----------	J. E. Vaile	(1)	
Colorado, Loveland	R. V. Lott	----------	1930	(Work transferred to Cheyenne, Wyo., 1836.)
Connecticut, New Haven.	----------	D. F. Jones, W. R. Singleton.	------	Value of inbreeding.
Georgia, Experiment.	J. G. Woodroof	H. L. Cochran, H. P. Stuckey, J. E. Bailey.	1927	Southern variety of high flavor.

See footnotes at end of table.

TABLE 4.—*Breeding work with raspberries at experiment stations*—Continued

Location	Past workers	Present workers	Year begun	Objectives
State stations—Contd.				
Hawaii, Honolulu	----------	W. T. Pope	1930	Crosses with native raspberries.
Illinois, Urbana	C. J. Alexopoulus	A. S. Colby	1922	Hardiness, disease resistance, high flavor, productiveness.
Iowa, Ames	----------	----------	------	Anthracnose resistance.
Maine, Orono	----------	R. M. Bailey	1932	
Massachusetts, Amherst.	----------	A. P. French	1934	Isolation of pure lines for later work.
Minnesota, Excelsior	Charles Haralson, M. J. Dorsey, J. H. Beaumont, S. B. Green.	W. H. Alderman, E. Angelo, F. E. Haralson.	1891 [2]	Hardiness.
New York, Geneva	S. A. Beach, O. M. Taylor, W. H. Alderman, R. D. Anthony, M. J. Dorsey.	George L. Slate, R. Wellington.	1892	Disease resistance, fall fruiting, size of fruit, quality, productiveness.
North Carolina, Raleigh.	----------	C. F. Williams	1926	Obtaining hybrids with Asiatic species for South.
North Dakota, Fargo	----------	A. F. Yeager, D. H. Scott.	1920	Hardiness.
Ohio, Wooster	P. Thayer (*dd*)	----------	------	Genetics of yellow color.
South Carolina, Clemson College.	W. J. Young	----------	----	
South Dakota, Brookings.	Charles Haralson	N. E. Hansen	1898	Hardiness.
Tennessee, Knoxville.	J. A. McClintock	B. A. Drain	1931	Better varieties through use of Van Fleet and *Rubus kuntzeanus*.
Washington, Puyallup.	M. B. Hardy, J. L. Stahl, W. H. Lawrence.	C. D. Schwartze	1909 [3]	Hardiness, mosaic resistance, adaptation to canning, freezing, and dessert.
Department stations:				
Wyoming, Cheyenne.	----------	LeRoy Powers	1935	Resistance to cold and drought. Crossing *R. deliciosus*.
Maryland, Beltsville	G. F. Waldo	George M. Darrow	1920	Disease resistance, hybrids with species, genetic studies.
North Carolina, Willard.	----do----------	George M. Darrow, C. F. Williams (cooperator of North Carolina station).	1929	Do.
Oregon, Corvallis	C. E. Schuster, B. S. Pickett, G. L. Rygg, G. M. Darrow.	G. F. Waldo	1928	Large-fruited, hardy, canning, and freezing varieties, hybrids with species.
Canada:				
Ottawa	William Saunders, W. T. Macoun, A. J. Logsdail, John Craig.	M. B. Davis, W. Hunter.	1873 [4]	Hardiness.
Agassiz, British Columbia.	----------	----------	------	
Vineland, Ontario	F. S. Reeves	W. J. Strong, E. F. Palmer.	1913	Disease-resistant, canning, large varieties, earliness, hardiness, yield, high flavor.
England:				
LongAshton, Bristol	----------	J. G. Maynard, G. T. Spinks.	------	Table and canning varieties.
East Malling, Kent	----------	N. H. Grubb	------	Disease resistance.
Merton, John Innes Horticultural Institute.	----------	C. D. Darlington, M. B. Crane, W. J. C. Lawrence, Faberge.	1920	Blackberry-raspberry genetics.
Sweden: Alnarp	----------	C. G. Dahl	1930	High flavor with suckers.
Norway: Njos, Hermansverk.	----------	P. Stedje	1930	
Switzerland: Wadenswil Experiment Station.	----------	----------	------	

[1] Recently.
Or earlier.

[3] About.
[4] Official since 1887.

TABLE 5.—*Raspberry varieties originated by public agencies*

Location	Variety	Year introduced	Parentage	Superior qualities
State stations:				
Alaska, Sitka	Bensonberry	1920	Cuthbert × Salmonberry.	Perennial canes, suckers, light-yellow fruit.
Minnesota, St. Paul	Latham	1914	King × Loudon	Hardy, productive, large, attractive, late, firm.
	Chief	1930	Latham Selfed	Cold-resistant, high flavor, early, productive, vigorous, bright red.
North Carolina, Raleigh.	Dixie	1936–37	*Rubus biflorus* × Latham	Productive, disease resistant.
North Dakota, Fargo	P–117	1935	(Latham × Farmer) F_2	Cold-, drought-, and red-spider resistant, purple.
New York, Geneva	Red:			
	Donboro	1908	Loudon × Marlboro	Bright red.
	Louboro	1908	do	
	Marlative	1908	Marlboro × Superlative	Attractive.
	Marldon	1908	Marlboro × Loudon	
	June	1909	Loudon × Marlboro	Bright red, very early, productive.
	Ontario	1918	N. Y. 94 (Superlative × Loudon) selfed.	Very early, bright, productive.
	Cayuga	1922	June × Cuthbert	Earlier, firmer, brighter than Cuthbert.
	Owasco	1922	do	Large, high flavor.
	Seneca	1922	do	Late, high flavor.
	Newburgh	1929	Newman × Herbert	Very large, firm, productive, mosaic-escaping.
	Monroe	1932	Newman × Cuthbert	Midseason, firm, good.
	Ulster	1933	Herbert × June	Early, large, productive.
	Taylor	1935	Newman × Lloyd George	Large, late, firm, bright-red, high flavor.
	Indian Summer	1936	1950 (Empire × Herbert) × Lloyd George.	Fall fruiting, large.
	Marcy	1936	Lloyd George × Newman.	Very large, good flavor, mosaic-escaping.
	Black:			
	Dundee	1927	Smith No. 1 × Palmer	Large, attractive, high flavor.
	Naples	1931	Honeysweet × Rachel	Late, firm.
	Bristol	1934	Watson Prolific × Honeysweet.	Early, firm, high flavor.
	Evans	1935	do	Early, attractive, high flavor.
	Purple:			
	Brant	1926	Smith No. 1 × June	Large, firm, attractive.
	Webster	1926	Smith No. 1 × unknown purple.	Firm, productive.
	Sodus	1935	Dundee × Newburgh	Firm, large, productive, attractive.
South Dakota, Brookings.	Sunbeam	1906	Shaffer × Cavalier wild	Hardy.
	Ohta	1912	Cavalier wild × Minnetonka.	Late, firm.
	Fewthorn	1922	Minnetonka × Black Hills wild.	Few prickles, firm.
	Moonbeam	1922	(Cavalier wild × Black Hills wild) × Shaffer.	Late, firm.
	Smoothcane	1922	Black Hills wild × Minnetonka.	Firm, thornless.
	Spineless	1922	Cavalier wild × Loudon	No prickles.
	Starlight	1922	Cavalier wild × Minnetonka.	right, large.
	Twilight	1922	Seedling of wild or hybrid with cultivated.	Light red.
U. S. D. A. station: Maryland, Glenn Dale.	Van Fleet	1924	*Rubus kuntzeanus* × Cuthbert.	Vigorous, disease-resistant, hardy in South.
	Potomac	1932	Farmer × Newman	Disease-resistant (resistant to streak virus), purple, hardy, jam and canning.
Canada:				
Ottawa	Saunders	1880	Philadelphia × McCormick.	Dark red.
	Sarah	1893	Seedling of Shaffer	Suckers, very late, firm, high flavor.
	Carleton	1894	Seedling of Biggar	Early.
	Citizen	1894	Gregg × Cuthbert	Purple, suckers.
	Count	1894	Seedling of Biggar	Early, vigorous, large, bright-red, firm.

TABLE 5.—*Raspberry varieties originated by public agencies*—Continued

Location	Variety	Year introduced	Parentage	Superior qualities
Canada—Continued.				
Ottawa	Craig	1894	Unknown	Midseason.
	Duncan	1894	Gregg × Cuthbert	Purple, suckers and tips, late, vigorous, firm.
	Empire	1894	Seedling of Biggar	Early, vigorous, firm.
	Garfield	1894	do	Firm.
	Garnet	1894	Seedling of Philadelphia	Purple, suckers, late, vigorous.
	Lady Ann	1894	Seedling of Biggar	Yellow.
	Mary	1894	Unknown	
	Muriel	1894	Seedling of Biggar	Vigorous, early.
	Sharpe	1894	do	Early, firm, vigorous.
	Sir John	1894	do	Early, bright-red.
	Trusty	1894	Unknown	Late, firm, vigorous.
	Deacon	1900		Deep red.
	Henry	1900		Early, hardy, productive.
	Nelson	1900		Deep red.
	Lorne	1900		Early.
	Shinn	1900		Firm, productive.
	Brighton	1900	Unknown	Hardy, deep red, very early.
	Percy	1900	Gregg × Cuthbert	Purple, firm.
Vineland, Ontario	Viking	1924	Cuthbert × Marlboro	Vigorous, high flavor, productive, firm.
Union of Soviet Socialist Republics:				
Michurin Institute	Tekhas Productivnaia.	1905[1]	Seedling of Logan	Hardy, tip-rooting.

[1] Selected.

TABLE 6.—*Private raspberry breeders*

Name and location	Varieties	Year introduced	Cross	Desirable qualities
United States:				
W. E. Lammertz, Armstrong Nurseries, Ontario, Calif.				
H. Rockhill, Conrad, Iowa.	3 being propagated.		Latham × Older	Purple, hardy, firm.
H. M. Butterfield, Berkeley, Calif.				
A. C. Dike, Bristol, Vt.	Dike	1933	June × Latham	Heavy bearer, resistant to mosaic.
Canada:				
C. P. Newman, Ville La Salle, Quebec.	Newman	1919	From mixed seed of Herbert, King, Loudon, Cuthbert, and Eaton.	Hardy, productive, firm, mosaic-resistant.
	Newman 20	1915	Seedling of Eaton	Large, late, firm.
George Adams, Smithville, Ontario.	Adams 87			Hardy, bright red, does not turn dark.
	Adams 101			Firm, propagates by tip-rooting.
England:				
Laxton Bros., Bedford	Bountiful	1917		Large, sweet.
	Prolific	1922		Productive.
	Renown	1925	Abundance × Superlative.	Bright, red, sweet.
	Yellow Hammer	1925		
	Reward	1935		
George Pyne, Topham, Devon.	Devon	1904	Seedling	Vigorous, large clusters; does not turn dark.
	Pynes Royal	1913	Seedling raised in 1907	Largest English, sweet.
	Red Cross	1917	Seedling	Tart, large, early.
	Park Lane	1922	do	High flavor.
	Mayfair	1929	Seedling of Park Lane	Do.
	Better-Late	1931	Blackberry-raspberry × raspberry.	Jam variety, very late.
	Imperial	1935	Seedling of Royal	Larger than Royal, conical, very vigorous, productive.

Source of Superior Qualities in Raspberries

Plant Characters

Hardy against cold. Ohta, Latham, Chief, Potomac (purple), Sarah, Starlight, Sunbeam, Newman, Adams 87, Newburgh, King, London, N. Y. 3024 (June × Brighton), P 117 (Latham × Farmer F_2 of North Dakota), Heath (black), Tekhas (in Russia).

Resistant to heat. Van Fleet, Dixie, Ranere.

Resistant to drought. Sodus, Latham, Marcy.

Resistant to leaf spot. Van Fleet, Ranere, U. S. D. A. No. 9 (Latham × Ranere), Dixie, Potomac, Evans; Pynes Royal and Baths Perfection (in England); *Rubus biflorus*, *R. innominatus*, *R. inopertus*, *R. kuntzeanus*, *R. parvifolius*, *R. phoenicolasius*.

Resistant to anthracnose. Van Fleet, *Rubus coreanus*, *R. kuntzeanus*, *R. biflorus*, *R. innominatus*, *R. niveus*, North Carolina R–14, Quillen and Naples (black), Potomac (purple), Ranere.

Resistant to yellow rust (*Phragmidium rubi-idaei*). Black raspberries (*Rubus occidentalis* and *R. leucodermis*) immune; highly resistant reds are Lloyd George, Owasco, Seneca, Antwerp, Ranere (not in California), Cayuga, Herbert, Chief.

Resistant to leaf rust (late raspberry rust). Hailsham red; all black raspberries are very resistant.

Resistant to spur blight. Columbian, Newman, and Marcy red show some resistance; probably all black varieties are resistant.

Resistant to streak. Potomac and all red varieties.

Immune to leaf curl. All purples and Farmer and New Logan blacks.

Resistant to green mottled mosaic. Latham, Chief, Ranere.

Escaping green mottled mosaic. Lloyd George, Herbert, Newman, Marcy, Indian Summer, Ranere, Potomac.

Resistant to mosaic in England. MacLaren, Baumforth A, Red Antwerp B.

Resistant to crown gall. Surprise (of California).

Resistant to verticillium wilt. Syracuse, Cuthbert, Ohta, Antwerp, Marlboro, Cayuga, Owasco, Seneca; Superlative and Black Antwerp A (in Europe); *Rubus biflorus*.

Resistant to aphid (*Amphorophora rubi*). Lloyd George, Herbert, Newburgh, Newman.

Everbearing. Ranere, La France, Erskin Park (summer bearing), Lloyd George (fall fruiting in the Northwest), Indian Summer, Hailsham (in England), November Abundance.

Fruit Characters

Early ripening. U. S. D. A. No. 0 (Latham × Ranere), Ranere, June, Chief Ohta, Marlboro, N. Y. 3024, Red Cross (in England); black varieties, Shuttleworth, Kansas, Bristol, Evans.

Late ripening. Van Fleet, Latham, Newman, Taylor, Cuthbert, N. Y. 3041; black variety, Rachel.

Firm. Potomac, Newman, U. S. D. A. No. 9 (Latham × Ranere), Newburgh, Latham, Ranere (in California); Baumforth seedling B, Burnett Holm, Penville Champion, and Pynes Royal (in England).

Large. Imperial, Pynes Royal, Lloyd George, Preussen (in England); Marcy, Newburgh, Taylor, Latham; Sodus (purple); Bristol, Dundee, and Cumberland (black).

Preserving. Cuthbert, Potomac, Columbian, Lloyd George.

Canning. Washington No. 89 (Cuthbert × Lloyd George); Cuthbert, Potomac, Royal, Sodus (purple).

Freezing. Latham, Chief, Viking (in the East); Washington No. 16, Lloyd George, Cuthbert, Viking, and Newburgh (in the West).

Small seed. Van Fleet, Lloyd George.

Bright red. U. S. D. A. No. 9 (Latham × Ranere), Washington No. 76 (Lloyd George × Cuthbert), Ohta, Ranere, Chief, June, Newman, Taylor, Adams 87, and Latham; Newburgh (in Oregon); Preussen (in England).

Do not turn dark. U. S. D. A. No. 9. Newburgh, Taylor, Viking, June, Adams 87; in England, Burnett Holm, Northward, Preussen, Baumforth B, Hornet A.

Excellent flavor. Cuthbert, Viking, Cayuga, Chief, Taylor; black varieties, Bristol, Evans, Honeysweet, Cumberland; in England, Norwich Wonder A, Preussen, Baumforth B, Hornet A, Pynes Royal, Park Lane.

Productiveness. Latham, Viking, Newburgh, June, Taylor, Marcy, and Bristol (reds); Cumberland (black); Potomac and Sodus (purple); in England, Lloyd George and Baumforth A.

Somatic Chromosome Numbers in Rubus

[See literature citations 7, 12, 22, 28, 29, 32, 35, 36, 37. An asterisk (*) after a name indicates an unpublished record of A. E. Longley]

14 somatic chromosomes

Blackberries:
- European:
  - *R. rusticanus* E. Merc.
  - *R. rusticanus inermis* Willd.
  - *R. tomentosus* Borkh.
  - *R. ulmifolius* Schott.
  - Burbank Thornless (*R. inermis* Willd.).
- American:
  - *R. allegheniensis* Porter.*
  - *R. argutus* Link.
  - *R. canadensis* L.
  - *R. setosus* Bigel.
  - Ancient Briton.*
  - Crystal White.*
  - Eureka (*R. cuneifolia* Pursh).*
  - Haupt.*
  - Jordan.*
  - Maxwell.*
  - McDonald.*
  - Pink.*

Raspberries:
- *R. adenophorus* Rolfe.
- *R. coreanus* Miq.
- *R. idaeus* L. (European red).
- *R. illecebrosus* Focke (strawberry-raspberry).
- *R. kuntzeanus* Hemsl.
- *R. lasiostylus* Focke.
- *R. leucodermis* Dougl. (western black-cap).
- *R. mesogaeus* Focke.
- *R. occidentalis* L. (eastern blackcap).
- *R. odoratus* L. (eastern flowering raspberry).
- *R. parviflorus* Nutt. (western flowering raspberry).
- *R. phoenicolasius* Maxim. (wineberry).
- *R. spectabilis* Pursh (salmonberry).
- *R. strigosus* Michx. (American red raspberry).
- *R. triphyllus* Thunb.
- *R. xanthocarpus* Bur. and Franch.
- Cardinal (purple).
- Cumberland (black).
- Cuthbert (red).
- Eaton (red).
- Gregg (black).
- King (red).
- Lloyd George (European red).
- Newman (red).
- Queen Alexandra.

14 somatic chromosomes—Continued

Raspberries—Continued.
- Ranere (red).
- Royal (purple).
- Superlative (European red).

21 somatic chromosomes

Blackberries (American):
- Marvel (Florida Marvel).
- 13 wild forms of New England, probably hybrids.
- 12 wild forms of Maryland and District of Columbia, also probably hybrids.*

Raspberries:
- All Summer.
- Belle de Fontenay.
- Erskine.
- Merveille Rouge.
- November Abundance.
- White Queen.

Blackberry-raspberry hybrids:
- Kings Acre.*
- Mahdi.

28 somatic chromosomes

Blackberries:
- European:
  - *R. acuminatus* Lindeb.
  - *R. affinis* Weihe and Nees.
  - *R. arrhenii* J. Lange.
  - *R. bloxamii* Lees.
  - *R. caesius* L.
  - *R. calvatus* Blox.
  - *R. cletrophilus* P. J. Muell.
  - *R. corylifolius* Sm.*
  - *R. genevieri* P. J. Muell.
  - *R. hirtus* Waldst. and Kit.
  - *R. imbricatus* Hort.
  - *R. incurvatus* Bab.
  - *R. insularis* Aresch.
  - *R. kaltenbachii* Metsch.
  - *R. lindleyanus* Lees.
  - *R. nemorosus* Arrh.
  - *R. nitidioides* Watson.
  - *R. nitidus* subsp. *opacus* Focke.
  - *R. pallidus* Weihe and Nees.
  - *R. plicatus* Weihe and Nees.
  - *R. polyanthemus* Lindeb.
  - *R. radula* Weihe.
  - *R. radula* var. *angustifolia* Lund.
  - *R. schlechtendalii* Weihe.
  - *R. sprengelii* Weihe.

28 somatic chromosomes—Continued

Blackberries—Continued.
European—Continued.
R. strivultus f. Kullensis.
R. suberectus G. Anders.
R. thyrsiger Banning and Focke.
R. villicaulis Koehl.
Edward Langley.
Evergreen or Cut-Leafed.
Himalaya (*R. procerus* P. J. Muell.).
John Innes.
Pollard.*
Sherlock Jr.*
American:
Two wild forms of Maryland, probably hybrids.*
Badger.*
Brainerd.
Early Wonder.*
Eldorado.*
Johnson.*
Joy.*
Jumbo.*
La Grange.*
Lawton.*
Mersereau.*
Miller.*
Nanticoke (*R. cuneifolius* Pursh).*
Queen.*
Snyder.*
Taylor.*
Texas Everbearing.*
Ward.*
Raspberries:
Hailsham.
La France.
Merveille Rouge.
Merveille de Quatre Saisons.
Surpasse Merveille à blanc.
Blackberry-raspberry hybrid:
Veitchberry.

35 somatic chromosomes

Blackberries:
European:
R. bellardi Weihe and Nees.
American:
Two wild forms of Maryland, probably hybrids.*
Two wild forms of New England, probably hybrids.*
Logan seedling.
Logan × Mammoth seedling.

42 somatic chromosomes

Blackberries:
European:
R. borreri Bell Salt.
R. ciliatus Lindeb.
R. divergens Neum.
"*R. insulariformis*"-*R. wahlbergii* Arrh.
R. nitens Lindeb.
R. tiliaceus Liebm.
Bedford Giant.
American:
Five wild forms of New England, probably hybrids.
R. loganobaccus Bailey.
Logan (Loganberry).
Cory.*
Eric.*
Lucretia.
Mammoth.
Phenomenal.
Rathbun.

45 somatic chromosomes

Blackberries (European):
R. eluxatus var. *subnitidus* Lidf.

49 somatic chromosomes

Hybrid blackberries (European):
Laxtonberry.
R. lagerbergii Lindeb. var. *balticus* Aresch.

56 somatic chromosomes

Dewberries (American):
One wild form of Massachusetts.
Austin Thornless.
Ideal Wild.
Premo.*
Windom.*
Form close to *R. loganobaccus* Bailey.

70 somatic chromosomes

Form close to *R. loganobaccus* Bailey.

84 somatic chromosomes

R. macropetalus Dougl., of Oregon and Washington.