Rubus Diversity

The brambles, botanically known as the genus *Rubus*, contain an amazing range of plant forms. Darrow (1937) described wild *Rubus* as "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."

Members of this genus are native to six continents at elevations from sea level to 4500 m. More than 740 species have been described throughout the world (Gu et al., 1990) and variously classified into 12 or 15 subgenera (Jennings, 1988).

Two economically important crops, raspberries (*Rubus idaeus* L.) and blackberries (*R. allegheniensis* Porter, *R. ursinus* Cham. & Schldl.) are included in this genus. World production of raspberries exceeded 286,000 t in 1993 (Food and Agriculture Organization, 1994). Production is highest in Europe and North America, although interest in producing and shipping berries to northern markets is increasing at temperate locations in Chile, Argentina, South Africa, and New Zealand.

Recent breeding objectives have included increasing yields, improving the ease and uniformity of harvest, developing spine-free plants, improving disease and pest resistance, and expanding production into suboptimal environments. Breeders hope to accomplish this list of improvements by incorporating a broader germplasm base rather than emphasizing chemical or cultural means. *Rubus* research programs are active in more than 25 states of the United States and in 26 foreign countries (Smolarz and Zmarlicki, 1993). Breeders have identified more than 70 genes for traits such as resistance to diseases and pests, and fruit, flower, and plant qualities (Jennings, 1988).

Preserving *Rubus* genetic resources is important to many countries of the world. At least 18 have established genebanks to protect and maintain species and clones of this genus (Bettencourt and Konopka, 1989). Genebanks,

such as the U.S. Dept. of Agriculture, Agricultural Research Service, National Clonal Germplasm Repository–Corvallis (USDA–ARS NCGR), are expanding *Rubus* collections through plant exploration and exchange to provide the raw materials for crop development.

Center of origin and distribution

Gu et al. (1993) speculate that the center of origin for *Rubus* is southwestern China, as it is geologically archaic and was not covered by glaciers during the Quaternary. At least 299 botanical taxa are described from China and are distributed in 27 provinces (Gu et al., 1993). Vavilov (1940) considers China to occupy the "first place in all the world" as far as the "composition of wild and cultivated fruit is concerned." Vavilov (1926) does not discuss in detail the center of origin for *Rubus*; however, this genus may overlap his Chinese and Indo-Malayan centers (Vavilov, 1926, 1940). He lists only one *Rubus* species, *R. rosifolius* Smith, subgenus *Ideaobatus*, as originating in the Indo-Malayan center (Vavilov, 1935). This species was introduced into cultivation on Java and was found wild in the Philippines, with its range extending to southern Japan. Vavilov (1926) mentions *Rubus* in a group of fruit and berry genera typical of both the Old and New worlds.

The three subgenera containing the most species are *Ideaobatus*, *Rubus* [formerly *Eubatus* (Focke, 1910, 1911, 1914)], and *Malachobatus*. *Ideaobatus*, the raspberries, contains about 200 species that are native in southern China primarily, but they also occur in North America and East and South Africa. *Rubus*, the blackberries, contains at least a few hundred species that are native to Europe, North and South America. *Malachobatus* contains 114 species and occurs principally in

southeastern Asia, Japan, Malaya, Australia, and Madagascar (Jennings, 1988). Several other Asian subgenera, such as *Dalibardastrum*, *Lampobatus*, and *Chamaebatus*, contain a few additional species. The remainder of the subgenera occur from the arctic (for example, *Cylactis*) to South America (for example, *Orobatus*). *Orobatus* is thought to be derived from the North American subgenera *Rubus* and *Anoplobatus* (Jennings, 1988). The recently described subgenus *Micranthobatus* occurs in Australia and New Zealand (Kalkman, 1987).

Morphological diversity

Most *Rubus* species are perennial shrubs with biennial canes. A few species produce perennial or annual canes. The plant habit varies from erect to trailing. Some plants are climbing, such as the bush lawyers (*R. cissoides* Cunn.) of New Zealand. Others, for example, cloudberry (*R. chamaemorus* L.), are dwarf alpine forms that spread by underground stolons. Most species are deciduous, but some are evergreen. Leaves differ in length from ≤ 1 cm to ≥ 20 cm. Leaves can be entire, lobed, trifoliate, pentifoliate, or pinnately compound. Stem diameter varies from 2 to 7 cm. *Rubus* species can be armed with large, recurved spines up to 1.5 cm long. Some have spines and bristles; others are spineless.

Ripe fruit color includes white, yellow, orange, red, purple, and black. Some fruit have orange drupelets with purple-black at the styler base. Raspberry-type fruit consist of an aggregate of drupelets that pull away from the floral receptacle; blackberry drupelets adhere to the receptacle. In blackberries, the drupelets and receptacle separate from the pedicel upon harvest. Fruit weight in various species ranges from 0.4 (Gu et al., 1993) to 20.5 g (Hall, 1990).

Fig. 1. Frequency distribution by ploidy ($x = 7$) of the *Rubus* accessions preserved at the U.S. Dept. of Agriculture, Agricultural Research Service, National Clonal Germplasm Repository–Corvallis in 1995.

Received for publication 31 July 1995. Accepted for publication 6 Oct. 1995. This research was funded by the U.S. Dept. of Agriculture, Agricultural Research Service CRIS 5358–21000–011–00D. The assistance of Maxine M. Thompson for the compilation of the chromosome frequency data is gratefully appreciated. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

¹Research Leader/Curator.

Front cover: A composite of leaves from more than 20 *Rubus* species (photo credit: Joseph Postman, U.S. Dept. of Agriculture–Agricultural Research Service).

Seed mass ranges from 0.3 mg for *R. eustaphanos* Focke ex Diels to 24 mg for *R. megalococcus* Focke (Hummer and Peacock, 1994). Pregermination requirements vary from none to scarification and several months of warm and cool prechilling treatment (Peacock and Hummer, 1996).

Chromosomal diversity

Rubus has an exceptional range of ploidy levels ($x = 7$) from diploid, $2n = 14$, to tetradecaploid, $2n = 98$. While most species in the primary and secondary raspberry gene pools are diploid, blackberry ploidy varies from $2n = 14$ to $2n = 84$. Raspberry and blackberry hybridization depends on ploidy, so breeders seek specific levels in wild material.

The Corvallis Repository *Rubus* collection includes more than 175 species encompassing 11 ploidy levels plus aneuploids (Fig. 1). The chromosome numbers of this collection are described by Thompson (1995a, 1995b).

Genetic resource availability

As of July 1995, the USDA-ARS NCGR-Corvallis has more than 1500 *Rubus* accessions preserved as seedlots in a freezer and as plants in greenhouse, screenhouse, laboratory, and field collections. Plant material is available for distribution as seed, plants, cuttings, crown divisions, pollen, or tissue cultures. Pathogen-tested material is available for more than 70% of the cultivars. The Corvallis repository has distributed plant material to 37

countries during the past 5 years and can provide the U.S. Dept. of Agriculture phytosanitary certification when presented with the appropriate import permit from the requesting country.

Literature Cited

- Bettencourt, E.J. and J. Konopka. 1989. Directory of germplasm collections 6.11: Temperate fruits and tree nuts. Intl. Board for Plant Genetic Resources, Rome.
- Darrow, G. 1937. Blackberry and raspberry improvement, p. 496–533. In: Yearbook of agriculture. U.S. Dept. of Agr., Government Printing Office, Washington, D.C.
- Focke, W.O. 1910. Species Ruborum Monographiae generis Rubi Podromus. Biblioth. Bot. 17(72, part 1):1–120.
- Focke, W.O. 1911. Species Ruborum Monographiae generis Rubi Podromus. Biblioth. Bot. 17(72, part 2):121–223.
- Focke, W.O. 1914. Species Ruborum Monographiae generis Rubi Podromus. Biblioth. Bot. 17(83):1–274.
- Food and Agriculture Organization. 1994. FAO yearbook: Production. vol. 47 1993. FAO Statistics Ser. 112. Food & Agriculture Organization of the United Nations, Rome.
- Gu, Y., C.M. Zhao, and W. Jun. 1990. On *Rubus* resources in Hunan and Fujian provinces. XXIII Intl. Hort. Congr. Abstr. 4014.
- Gu, Y., C.M. Zhao, W. Jin, and W.L. Li. 1993. Evaluation of *Rubus* germplasm resources in China. Acta Hort. 352:317–324.
- Hall, H. 1990. Blackberry breeding, p. 249–312. In: J. Janick (ed.). Plant breeding reviews. vol. 8. Timber Press, Portland, Ore.
- Hummer, K. and D. Peacock. 1994. Seed dimension and weight of selected *Rubus* species. HortScience 29:1034–1036.
- Jennings, D.L. 1988. Raspberries and blackberries: Their breeding, diseases and growth. Academic, London.
- Kalkman, C. 1987. The genus *Rubus* (Rosaceae) in Malesia. 3. The subgenus *Micranthobatus*. Blumea 32:323–341.
- Peacock, D.N. and K.E. Hummer. 1996. Pregermination studies with liquid nitrogen and sulfuric acid on several *Rubus* species. HortScience 31:238–239.
- Smolarz, K. and K. Zmarlicki. 1993. Sixth international symposium on *Rubus* & *Ribes*. Acta Hort. 352:1–606. Skierniewice, Poland.
- Thompson, M.M. 1995a. Chromosome numbers of *Rubus* species at the National Clonal Germplasm Repository. HortScience 30:1447–1452.
- Thompson, M.M. 1995b. Chromosome numbers of *Rubus* cultivars at the National Clonal Germplasm Repository. HortScience 30:1453–1456.
- Vavilov, N.I. 1926. Tsentry proiskhozhdeniya kul'turnykh rasteniy [Centers of origin of cultivated plants]. Tr. pl. prikl. botan I selek. [Papers on Applied Botany and Plant Breeding] 16(2):1–124.
- Vavilov, N.I. 1935. Botaniko-geograficheskie osnovy selektsii rasteniy [The phyto-geographical basis for plant breeding]. Teoreticheskie osnovy selektsii [Theoretical bases for plant breeding] All-Union Inst. Plant Industry, Moscow.
- Vavilov, N.I. 1940. Uchenie o proiskhozhdenii kul'turnykh rasteniy posle Darvina. [The theory of the origin of cultivated plants after Darwin]. Sov. Nauka [Soviet Science] 2:55–75.

KIM E. HUMMER
U.S. Dept. of Agriculture
Agricultural Research Service
National Clonal Germplasm Repository
33447 Peoria Road
Corvallis, OR 97333–2521