

## Plant Exploration for Fruit Genetic Resources in Sakhalin Territory

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### Abstract

The Far East Experimental Station (FEES) of the N.I. Vavilov All-Russian Institute of Plant Industry (VIR) is close to N.I. Vavilov's East Asian center of origin for cultivated plants. Many diverse fruit plants and their wild relatives are native in this region. Between 2003 and 2005, plant exploration trips were jointly sponsored by VIR in collaboration with the United States Department of Agriculture (USDA). During these trips, island samples of many forms of berry species were collected from many populations and localities. Unusual polyploid *Fragaria* were found on the islands. Five species of *Ribes* were collected. Samples of an orange- (*Rubus chamaemorus*) and dark purple-fruited cloud berry (*R. pseudo-chamaemorus*), were obtained. Diverse *Actinidia kolomikta* Maxim. and *Scizandra chinense* (Turcz.) Baill. were obtained from southern Sakhalin. In total, more than 160 accessions were collected. These expeditions were conducted under the guidelines of the International Treaty on Plant Genetic Resources for Food and Agriculture through a bilateral agreement between the Russian Federation and the United States. Plant materials and seeds are now preserved in genebanks in both systems. Requests for research of this plant material can be made to the Curator of the USDA Agricultural Research Service, National Clonal Germplasm Repository (NCGR) in Corvallis, Oregon.

### INTRODUCTION

Sakhalin is a long, narrow island about 1,000 x 200 km, with a north-south orientation. This island is about 6 km east of the Asian Continent at its closest point. Recently, Sakhalin is being rigorously developed by companies prospecting and drilling for oil. Much of the natural habitat of wild species is being lost due to the expanding oil operations. Prior to this, the major industries of Sakhalin were lumber and fishing. The climate is not so harsh in winter, as in continental Russia with winter minimum temperatures of -8°C on Iturup, and -12 to -31°C on Sakhalin. High snow protects the plants from winter damage. This territory is home to many native berry crop species. *Vaccinium* species grow particularly well on this island and some species are only found there. Native *Vaccinium* and other berries are gathered by inhabitants to supplement their food and income.

Iturup Island (also known as Etorofu in Japan) is the second biggest island to the northeast of Hokkaido and is the largest island of the Greater Kurile Archipelago. It is about 100 km x 25 km, with a northeast-southwest alignment. These islands are highly volcanic in origin (Kimura and Tamaki, 1985). The flora of this region is pre-boreal, and indigenous island genera have related species in Western Europe and North America (Kryvolutskaya, 1973; Charkevich, 1996). The human population of Iturup is mainly comprised of military personnel and fishermen. The island is difficult to access by boat or plane, due to weather conditions and political constraints, and only a few plant collecting expeditions have visited the island during the past decade.

Our expeditions to Sakhalin and Iturup Islands, Sakhalin Territory, Russian Federation, occurred in 2003 to 2005 (Hummer et al., 2003, 2005, 2006). Wild plants and open pollinated seed lots were collected and brought to the Far East Experiment Station ex situ genebank. Plant material was also shared with the NCGR at Corvallis, Oregon.

The range of some of the collected species is only on the islands. Others also have a distribution in continental Russia. Plants from the islands break bud and bloom later than do continental ones so the time of the collecting trips had to be adjusted accordingly.

#### **PLANT MATERIALS COLLECTED**

Russian floras have described the richness of berry crops in the Sakhalin Territory (Barkarlov, 2006; Kojevnikov and Probatova, 2006). During these expeditions more than 160 accessions of small fruits were collected, including 8 genera and 22 species (Table 1). Discussion of the species for each genus follows.

##### ***Actinidia***

Only one species of hardy kiwifruit, *Actinidia kolomikta*, was observed in fruit on Sakhalin and Iturup Islands during these expeditions. The plants for this species were commonly present in the mountain forests. They vined upon *Betula platyphylla* and other common forest trees. This species was found in the Southern region of Sakhalin and Iturup Islands. Fruit were oblong-ovate with a 1.5 to 4 g/berry. The largest fruit was collected from the Nevelski Region near the Obutonay River. Fruit ripened at the end of September.

##### ***Fragaria***

The only known Asian octoploid strawberry, *F. iturupensis* Staudt ( $2x = 2n = 56$ ), was collected from Atsonupuri Volcano, Iturup. The berry is very aromatic. This species has many attributes that resemble *Fragaria virginiana* subsp. *glauca* (Staut, 1963, 1989) which is native east of the Rocky Mountains in the United States. This species was first collected by a Japanese explorer in 1929, but the herbarium sample was found to be octoploid and was named as a species by Staudt (1963). Since this expedition, strawberry geneticists throughout the world have received seeds or seedlings of this singular Asian octoploid and many have incorporated it into their breeding programs (C. Finn, per. comm.)

*Fragaria nipponica* (synonym = *F. yezoensis*), a diploid strawberry ( $2x = 2n = 14$ ) was also collected on Sakhalin Island. This dioecious species has red conical fruit, about 1 cm long, and has pubescent leaves and petioles (Charkevicz, 1996).

Besides these two species, several localities on Sakhalin and Iturup Islands had large fruited strawberries, sometimes with poor fruit set. These strawberries were of high ploidy (octoploids) and seemed to be escaped from cultivated locations near villages.

##### ***Lonicera***

*Lonicera caerulea*, the edible fruited honeysuckle, was collected from Iturup and Sakhalin Islands. The shrubs from the foot of volcano Baranovskiy were prostrate. This was noted as the earliest berry to ripen in the Sakhalin Territory. The fruit form was similar to the torpedo shaped fruits of Hokkaido rather than the cylindrical Russian continental type. These fruits are eaten directly, processed into jams, or sold fresh by the regional inhabitants. No large natural stands of this species were observed on Sakhalin, unlike on continental Far Eastern Russia. Seeds of this species were collected from two populations on Iturup and one on Sakhalin.

##### ***Prunus***

Bird cherry, *Padus ssiarii* [(Fr. Schmidt) C. K. Schneid.] (syn. = *Prunus ssiiori*) was observed on Iturup and in the southern region of Sakhalin Island. The plants had 15 to 25 cm long inflorescences with 53 to 63 pinkish flowers and large (1.0-1.3 cm in diameter) fruit. On Iturup this species was in bloom in July. The flowers were spectacular

with long inflorescences. The berries ripen at the end of September. This species has been collected from Russian locations over the past 20 years and is being used in breeding programs in Siberia.

### **Ribes**

Five species of currants were observed or collected from different regions on Sakhalin Island. These species were: *R. horridum* Rupr., *Ribes latifolium* Jancz, *R. procumbens* Pall., *R. sachalinense* Nakai, *R. triste* Pall.

*R. horridum* Rupr. was a sticky currant with small black glandular fruit. The plants grew on the slopes of Yalu River. They had erect habits, but no fruit.

*R. latifolium* Jancz. was a red currant with late ripening (September) berries. The bush was erect, 1.5 to 2 m tall. The inflorescence length ranged from 2 to 12.5 cm with 6 to 23 purple flowers per strig. Berries were 0.6 to 1.3 cm in diameter, and were sour to taste. The plants from Gastelovka and Arkansas Rivers had the highest yield and the largest fruits.

*R. procumbense* Pall. was distributed in continental Asia and the north of Sakhalin Island. This species has a prostrate habit. This species grows on the banks of creeks among sphagnum moss. The fruits are 0.7 to 1.5 cm in diameter, ovoid to tear-shaped with reddish-brown or green skin color. The berries tasted pleasantly sweet with a tender aroma. Home gardeners on Sakhalin Island cultivate this currant. *R. procumbens* was used fresh and for jam. The island forms of *R. procumbense* had larger fruit and were adapted to more diverse environments than were plants from the continent. We observed white pine bluster rust, caused by *Cronartium ribicola* Fischer, on the plants from Kandyna River.

*R. sachalinense* was widely distributed. It grew well in moist soil, rotten stumps, on the slope of shaded hills, under the upper story forest cover. The branches were mostly creeping to slightly upright. The plants and fruits have a specific odor. The berries were 0.6 to 1.4 cm in diameter, had glandular hairs and were sweet to taste. Leaves of plants near Ujno-Sakhalinsk City were infected with white pine blister rust.

*R. triste* Pall. fruit was similar to that of the cultivated red currants of commerce. It had red, early ripening berries (July). The plants had erect to prostrate habits. Berries were 0.7 to 1.1 cm in diameter, had transparent skin, and were sour tasting.

### **Rubus**

Four species of *Rubus* were obtained. The berries were tasty and highly valued by the inhabitants in Sakhalin for eating fresh and processing into jams (Table 3).

*R. arcticus*, the delicate, fragrant, red fruited raspberry, was collected from Sakhalin. This species is dioecious. Not many female plants were fruiting during the collecting trips. Berries from the southern Sakhalin weighed 1 to 2 g.

*R. chamaemorus* L. had solitary orange fruit. Fruit of it and its dark fruited cousin, *R. pseudochamaemorus*, were obtained. The yellow fruits of *R. chamaemorus* ranged from 1.0 to 2.4 g/berry. The darker *R. pseudochamaemorus* fruits were larger, 1.8 to 4.0 g/berry but were more sour to taste. *R. pseudochamaemorus* was distributed south of Poronaisk City, and *R. chamaemorus* was north from this point. The morphological appearance of the plant seemed to indicate that it was a cross between *R. arcticus* and *R. chamaemorus*.

Plants of *R. sachalinensis* Level., the red raspberry species native to Sakhalin, grew mostly in the open forest edge along roads, and on river banks. Fruits were small, 0.6 to 1.2 g/berry, and tasted sweet. The plants near Ujno-Sakhalinsk City and at the basin Pelenga River were very high yielding.

### **Vaccinium**

*Vaccinium* berries were a popular food for the inhabitants of this region. These berries also play an important part in the local economy.

*Vaccinium ovalifolium* (syn.= *Vaccinium axillare*) was distributed on Sakhalin,

Kurile, and Japanese Islands. In continental Russia, the distribution was restricted to the coast opposite Sakhalin. This species grew on duff and humus in moist coniferous forests at high elevation on the north-east and coastal slopes. Plants grew to 0.5 to 2 m high, and were branchy, with reddish stems. The branches were ribbed, green or light green, and leaves were oblong-ovate. Leaf margins were entire or undulate, serrate. Fruit were singly borne, had dark blue skin color and a waxy bloom. The fruit shape was roundish-flat, pear-shaped or ovate, with a diameter of 0.5 to 1.7 cm. The skin was firm and the flesh had varying intensity of anthocyanin color. The taste was sweet and little tart. People used these berries for jam, dried fruits, and prepared filling for pies and pastries. The plants from southern Sakhalin and Iturup Island did not yield well. Large fruit (2.4 g/berry) and high productive plants were found near Vzmor'e Village and in Northern Sakhalin, Shmid Peninsula.

*Vaccinium smallii* was distributed only in the southern and middle Sakhalin Island. This species tended to have red oblong leaves in the middle of summer. The plants had very ornamental foliage in August and the fall. This species preferred drier places than did other *Vaccinium*. It grew in sandy soils at the open south slopes of hills. Plants usually grew 50 to 120 cm high, and were semi-spreading. Branches were not ribbed. Leaves were oblong oval, or lanceolate with small crenate serration and acute top. Fruit occurred in clusters of 4 to 7. The fruit was globe- or pear-shaped, was mostly black color, with a waxy skin. The fruit diameter was 0.5 to 1.4 cm. The fruit matured from 20 August to end of September. Skin was durable and the flesh was dark. The largest fruited and most productive plants were near Vzmor'e, Gastelovka and Ul'a Villages.

*V. praestans* Lamb. was found at the three villages mentioned above. These plants grew as a ground cover, with light green leaves and red fruits. Fruit of this plant was a delicacy for the Sakhalin inhabitants, who called it "redberry" or "bugberry" because of the aroma of the fruit. Fruit was collected on rocky outcrops by the sea, slopes of hills and mountains, and in marshy places. Plants grew 5 to 10 cm tall, frequently spreading on or on top of sphagnum. Each plant produced 4 to 12 berries. The berries were globose, with slightly polygonal cross-sections, were 0.6 to 1.5 cm in diameter. They tasted sour and had a unique aroma. The inhabitants of the region processed this fruit into jam, syrup and juice.

*Vaccinium vitis-idaea* L. was distributed in many part of Russian Far East. Lingonberry grew on rocky barrens slopes, at dry sandy soil, on rotting trees and stumps and fallen logs. Plants were 10 to 20 cm high. Leaves were thick and leathery, green or dark green. The fruit was bright red, ovate shape, 0.4 to 1.2 cm in diameter, with a blue-grey thin waxy bloom on the skin. We observed the greatest productivity in plants on the coastal slopes of Sakhalin Island in the Makarovskiy Region. The fruit matured at the end of August to September.

*V. oxycoccus* L., cranberry, was latest ripen berry plant. Cranberries grew in the low swampy places in river basins of Sakhalin. Two forms of cranberry were collected, the small-leaf, *V. oxycoccus* f. *microphylla*, [*Vaccinium microcarpon* (Turcz.) Hook], and the large-leaf form, *V. oxycoccus* subsp. *palustris*. The berries of the large-leafed form were close in size to native North American cranberries. Plants in bogs from marshland basin of the Kadylania River in the Okhinskogo Region had the largest fruits (1.4 x 1.2 cm).

*V. uliginosum* L., the Russian blueberry, was commonly distributed throughout the Sakhalin Territory. It grew on moist organic acid marshland in sphagnum bogs. The plants occurred on wet or moist, organic or inorganic acid soil and grow on bogs, humid heaths and moors. This species was one of the highest yielding and the plants grew 1.1 to 1.5 m tall. Infrequently, dwarf plants of 15 to 30 cm were found. The fruit was found in clusters of 2 to 4. The fruit varied in shape from globose to elongate and were 6 to 15 mm in diameter. The skin color ranged from dark blue to white glaucous. The fruit skin was soft, not firm, and did not last long as fresh product. The fruit taste was sour so berries were mixed with sugar to produce jams, juices and wine. This species ripened from the end July to end August.

## CONCLUSION

In summary, more than 150 accessions of berry crops were obtained from the native localities of Sakhalin and Iturup Islands on these expeditions. These plants and seeds have impacted international berry breeding programs. Significant species, such as the Iturup strawberry, and the dark fruited cloudberry, were obtained and are now available to researchers. The collection of the Iturup strawberry, *F. iturupensis*, was also significant because it had not been previously recognized in Russian flora.

The Sakhalin native environment is in danger of loss due to human encroachment and development of the land for oil. This native habitat contains invaluable genetic resources that have potential for domestication of specialty crops for human consumption. Native plant stands not only provide people with required nutritional needs of vitamins, but also improve the economy of the region. Ex situ conservation is critical for the availability of collections of these species but is insufficient to match the diversity found in the natural habitat. The value of these pristine forests must be recognized for the needs of future generations.

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## **Tables**

Table 1. Accessions collected from Sakhalin and Iturup Island between 2003 and 2005.

<u>Species</u>	<u>Amount of Accessions</u>
<i>Actinidia kolomikta</i>	11
<i>Fragaria iinumae</i>	1
<i>F. iturupensis</i>	2
<i>F. yezoensis</i> = <i>F. nipponica</i>	2
<i>F. hybrid</i> species	6
<i>Ribes horridum</i>	1
<i>R. sachalinensis</i>	7
<i>R. latifolium</i>	12
<i>R. procumbens</i>	5
<i>Rubus chamaemorus</i>	3
<i>R. pseudochamaemorus</i>	2
<i>R. arcticus</i>	1
<i>R. sachalinensis</i>	9
<i>Lonicera caerulea</i>	3
<i>Padus sisorii</i> = <i>Prunus</i>	1
<i>V. smallii</i>	13
<i>V. ovalifolium</i> = <i>V. axilare</i>	22
<i>V. praestans</i>	15
<i>V. uliginosum</i>	13
<i>V. vitis-idaea</i>	10
<i>V. oxycoccos</i> = <i>O. microcarpus</i>	7
<i>V. oxycoccos</i> = <i>O. quadripetalus</i>	6
<i>V. smallii</i>	13
Total	165

Table 2. Distinguishing features of *Ribes* L. species from Sakhalin Territory.

Species	Habit	Fruit color	Fruit Size (cm)	Fruit Weight (g)	Inflorescence		
					Length (cm)	No. of flowers	
<i>R. horridum</i>	erect, prostrate	black	1.0	1.1	2.0 - 4.5	4 - 12	sweet
<i>R. latifolium</i>	erect	red	1.3 x 1.2	1.3	2.0 - 12.5	6 - 23	sour
<i>R. triste</i>	erect, prostrate	red	1.1	0.8	2.5 - 7.5	6 - 17	sour
<i>R. procumbens</i>	prostrate	green, black, brown	1.5	1.9	1.5 - 7.0	7 - 16	sweet, nice aroma
<i>R. sachalinense</i>	prostrate	red	1.35	1.2	4.5 - 9.5	6-14	sweet, specific aroma

Table 3. Distinguishing features of *Rubus* L. species from Sakhalin territory.

Species	Plant height (cm)	Fruit color	Size (cm)	Weight (g)	Flavor
<i>R. arcticus</i>	10 - 20	yellow-red	1.0	2.0	sweet, sweet-scented
<i>R. chamaemorus</i>	10 - 20	yellow	1.3 x 1.2	2.4	sweet-sour
<i>R. pseudochamaemorus</i>	15 - 30	purple	1.1	4.0	sour
<i>R. sachalinensis</i>	50 - 150	red	1.5	1.4	sweet

Table. 4. Distinguishing features of *Vaccinium* species from Sakhalin territory.

Species	Plant height (cm)	Leaf color	Max size (cm)	Max wt (g)	Fruit Flavor	Skin color	Ripening date	Comments
<i>V. ovalifolium</i>	50-120	green, light green	1.7 x 1.6	2.4	tart, sweet	blue, dark blue	July 10-August	intense pigment concentration, large fruit
<i>V. smallii</i>	20-120	green-red, red	1.6 x 1.5	2.2	sour-sweet	black, red-black	August 20-September	ornamental, not demanding to soil
<i>V. uliginosum</i>	15 - 120	green	1.5 x 1.4	1.7	sour-sweet	blue	August	
<i>V. praestans</i>	5 - 20	bright green, red-green	1.4 x 1.3	1.5	sour, with specific aroma	red	July 15-August	ornamental
<i>V. vitis-idaea</i>	5 - 15	green, dark-green	1.2 x 1.1	0.8		dark red	September-October	productivity
<i>V. oxycoccus</i> f. <i>microphylla</i>	0 - 0.5	green, dark green	1.1 x 0.9	0.6	sour	claret-	October	
<i>V. oxycoccus</i> subsp. <i>palustris</i>	0 - 0.5	green, dark green	1.4 x 1.2	1.3	sour	Claret-	October	