***Salix arctica* Pallas** arctic willow
SALICACEAE

Synonyms: *Salix anglorum* Cham.
Salix brownie (Anderss.) Bebb
Salix caespitosa Kennedy
Salix pallasii Anderss.
Salix petrophila Rydb.

Illustration source: USDA-FS collection, Hunt Institute

General Description.—*Salix arctica* is commonly known as arctic willow. This deciduous, prostrate, trailing shrub is usually less than 10 cm tall and commonly forms mats. However, its growth habitat is variable, and in the Pacific Northwest it grows up to 50 cm tall (Pojar and MacKinnon 1994). The broadly oval, alternate leaves are 2 to 6 cm long and sparsely hairy when mature. They are a glossy green on the upper side and pale green-grey below (Kershaw and others 1998, Fertig and Markow 2001). Plants are dioecious, possessing male and female flowers on separate, "unisexual" plants. The flowers of both sexes are arranged in dense, erect clusters or catkins. The female catkins are densely hairy, 1 to 8 cm (usually 2 to 4 cm) long and are borne on lateral, sometimes appearing terminal, branchlets (Kershaw and others 1998, Fertig and Markow 2001). The male, staminate, catkins are up to 4 cm long. Flowers appear with the leaves. There are several more synonyms than those listed above and may be referred to in Kartesz (1994), Argus and others (1999), and Dallwitz (1980). Identification may be difficult. Environment can affect the morphology to such an extent it appears a unique species is present (Argus and others 1999). Although many subspecies have been described, they have generally been discarded in favor of the type species. In addition, hybrids are reported, and introgression with other species, such as *S. cascadensis* in Utah and *Salix reticulata* in Russia, is well documented (Hultén 1968, Komarov 1936, Pojar and MacKinnon 1994, Welsh and others 1993).

Range.—Arctic willow is a circumpolar species occurring in North America, Europe, and Asia (Britton 1901, Fertig and Markow 2001, Hultén 1968, Komarov 1936). In North America it grows in the sub-alpine and alpine tundra zones from Quebec to Alaska and south, through the Rocky Mountains, into New Mexico (Kershaw and others 1998). Occurrences are also reported from Utah (Welsh and others 1993) and the Ruby Mountains of Nevada (Charlet 1994). It has disjunct occurrences on the west coast of the U.S.A., occurring in California and in the northern Cascade Mountains in Washington and in the Wallowa Mountains in Oregon (Hitchcock and Cronquist 1973).

Ecology.—Arctic willow grows in dry meadows, rocky tundra, fellfields, and in relatively moist sites in fen lands and at the edge of snowfields. Habitat tends to be related to latitude. In the mountains of New Mexico it is an obligate wetland species, whereas at higher latitudes it grows in both dry and moist habitats (Cooper and others 1997, Dick-Peddie 1993, Fertig and Markow 2001, Hultén 1968). It may be locally dominant in some cushion plant communities and co-occur with other species of dwarf willow such as *Salix reticulata* L. (snow willow). In New Mexico tundra, arctic willow and snow willow are often found associated with lichens and other vascular plants in snowbank and rivulet communities (Dick-Peddie 1993). Similarly in Montana and elsewhere in the Rocky Mountains, a common *S. arctica*/*Polygonum bistortoides* Pursh community was identified in "water-receiving positions" (Cooper and others 1997). However, the latter sites were also reported to have a good probability of experiencing wind scouring, and some

of the associated vegetation suggested the area could be relatively dry (Cooper and others 1997). The elevation at which it occurs is also associated with latitude. Plants are only found above 3,350 m in New Mexico, whereas they occur at sea level and up to 700 m in northern parts of its range, such as Greenland (Carter 1997, Argus and others 1999). It grows in a range of soils, from acidic to calcareous (Argus and others 1999, Cooper and others 1997, Pojar and MacKinnon 1994). A mutualistic association exists between arctic willow and ectomycorrhizal fungi that are primarily agarics, or gilled mushrooms (Cripps and Horak 2002).

Reproduction.—Arctic willow reproduces by seed and also vegetatively by rooting at the nodes of stems (Fertig and Markow 2001). Flowering is from June into August. On calm, sunny days the female catkins can be up to 8.5 ^{o}C warmer and the male catkins up to 7 ^{o}C warmer than the surrounding air temperature (Kershaw and others 1998). The warmer temperatures speed pollen and seed development and also attract insects (Kershaw and others 1998).

Growth and Management.—Seeds have a physiological dormancy and require a 30-day stratification period for germination (Baskin and Baskin 2001). Seeds germinate at 25 ^{o}C although minimum temperatures for germination are not defined (Densmore and Zasada 1983). Thompson (1992) reported that seeds of *Salix* species are "normally absent" from the seed bank in alpine and arctic communities. Individual shrubs live for 60 to 85 years although one specimen was reported to be 180 and another 236 years old (Savile 1979, Raup 1959). Habitat appears to influence the sex that is most abundant. Dawson (1987) reported female plants were significantly more numerous than male plants in mesic-wet, more fertile, low soil-temperature sites, whereas male plants were most prevalent in drier, less fertile sites. In addition, both habitat and sex may influence a plant's response to environmental conditions such as temperature. In a 3-year gas exchange field study, male and female willows from dry and wet habitats were subjected to passively enhanced summer temperature using small open-top chambers (Jones and others 1999). Overall net assimilation was higher in the dry habitat than in the wet habitat, and higher in females than in males, although there appeared to also be some habitat-sex interactions (Jones and others 1999). Elevated temperature enhanced development and growth of both male and female catkins, but the response of the leaves to elevated temperatures was more variable particularly among male individuals (Jones and others 1999). These findings indicate the importance of defining both sex and habitat conditions when making observations on this dioecious species, and they may also have significance in predicting the response of Arctic willow to global climate change.

Benefits.—The majority of *Salix* species provide important browse for wildlife and livestock within their range (Dayton 1931). Arctic willow, particularly the young leaves stems and buds, provide valuable browse for ptarmigan and other arctic animals including muskox and reindeer (Kershaw and others 1998, Komarov 1936, Tolven and others 2001). Arctic willow is tolerant of varied conditions, and cuttings have been rooted and used in restoration projects (Bittman 1997). Willow leaves and bark are commonly used for medicinal purposes and the roots, twigs, and bark are used for a multitude of fiber work, such as basketry and clothing by Native American peoples (Moerman 1998). Arctic willow has been used for similar purposes by peoples native to Asian Arctic regions (Moerman 1998). The Yakuts have used an infusion as a substitute for tea called "chai-talak" (Komarov 1936). It is used as fuel in some regions where it is the only source of wood (Kershaw and others 1998). Arctic willow is cultivated, and it is especially popular for rock gardens (Bailey and others 1976, Pojar and MacKinnon 1994).

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