

Guide to *Salix* (Willow)
in the Canadian Maritime Provinces
(New Brunswick, Nova Scotia, and Prince Edward
Island)

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**Guide to the Identification of the Genus *Salix* (Willow) in the
Canadian Maritime Provinces
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SALICACEAE Mirbel - Willow Family

The Salicaceae is described here in the traditional or strict sense. Recent molecular studies indicate that some genera, formerly included in the Flacourtiaceae, should be included in the Salicaceae s.l. There is strong evidence from many sources, morphological, anatomical, biochemical, as well as molecular, indicating of a close relationship between the Salicaceae s.s. and some members of the Flacourtiaceae, but that circumscription is not followed here. For an overview of the new classification see papers by Chase, et al. (2002), the Angiosperm Phylogeny Group II (2003), and Judd (1997).

Trees and shrubs, sometimes forming colonies by root shoots (sobiliferous), deciduous; branching monopodial or sympodial. **Winter buds** with 3--10 imbricate scales or a single scale, the lowermost (or only) scale of lateral buds opposite the twig. **Leaves** alternate, rarely opposite or subopposite, spirally arranged, simple; stipules absent, rudimentary, or foliaceous, persistent or caduceous; leaf blades glandular-toothed or entire, petiolate. **Inflorescences**: unisexual catkins, pendulous or erect, racemose or spicate, sessile or terminating a leafy branchlet; **floral bracts**: subtend each flower, displaced onto pedicels or distinct, scale-like, entire, toothed, or lacinate, the pistillate deciduous or persistent. **Flowers** unisexual, the staminate and pistillate on separate plants; pedicellate or sessile, without a normal perianth, this replaced by a cup-shaped non-nectiferous disc or by 1 or 2 nectaries; **staminate** with 1--60(--70) distinct or basally connate stamens; anthers versatile on slender filaments or basifixed, dehiscent by longitudinal slits; **pistillate** with a single, superior, unilocular ovary of 2--4 carpels, style 1 per carpel, generally connate, sometimes nearly obsolete, stigmas 2--4, simple, bilobed, or trilobed; ovules 1--25 per carpel, placentation parietal. **Fruits** thin-walled capsules, dehiscent by 2--4 valves. **Seeds** small, mostly unitegmic, surrounded by an arillate coma of long, silky hairs; endosperm scant or absent; embryo small, straight, with 2 semicircular or elliptic to oblong cotyledons.

Genera 2, species ca. 450, ca. 110 species in the New World: worldwide except Malaysia, Australasia, and Oceania, chiefly arctic, boreal, and temperate.

1. Buds with 3--10 overlapping scales, often resinous; leaf blades usually less than twice as long as wide, with a strong pair of basal secondary veins (except in *P. angustifolia*); stipules generally caducous; catkins pendulous, sessile; floral bracts lacinate, the pistillate deciduous after flowering; flowers with a non-glandular, cup- or saucer-like disc; stamens 6--70; stigmas 2--4, flattened or cylindrical, 2 mm or more long; capsules 2--4-valved, narrowly ovoid to spherical. **Populus**
1. Buds with a single scale, not resinous (oily in *S. barrattiana*); leaf blades often more than twice as long as wide, but highly variable, generally with pinnate venation; stipules foliaceous, rudimentary, or absent; catkins erect or spreading, rarely pendulous, sessile or on a leafy branchlet; floral bracts usually entire, sometimes slightly erose, or irregularly toothed, persistent or pistillate bracts deciduous after flowering; flowers with a single adaxial nectary or both abaxial and adaxial nectaries which may be distinct or connate and cup-shaped; stamens 1--7; stigmas 2, cylindrical or flattened, 1.5 mm or less long; capsules 2-valved, obclavate to ovoid. **Salix**

1. *Populus* L. Sp. Pl. 2: 1034. 1753 • Poplar

Trees not colonial or clonal by root shoots or branch fragmentation, anemophilous. **Stems**, branching sympodial or monopodial. **Buds** with 3--10 scales, imbricate, more or less resinous. **Leaves**, stipules caducous, foliaceous; petioles not-glandular at distal ends; blades generally heterophyllous, early (preformed) leaves often differing in shape and tothing from late (neoformed) leaves, subcircular to ovate, sometimes with basilaminar glands; margins subtire to finely or coarsely toothed. **Catkins** pendulous, sessile, leafless, flowering before leaves appear; floral bracts deciduous, one subtending each flower; apices deeply divided (lacinate), glabrous or ciliate. **Flowers** pedicellate; discs cup- or saucer-shaped, entire, not nectariferous; staminate flowers; stamens 5-30, filaments distinct; pistillate flowers ovaries 2-[4] carpellate; styles 2; stigmas 2, plate-like, often rolled or convoluted, bilobed; ovules 4-22 per ovary. **Capsules** narrowly ovoid to spherical.

Species ca. 30, 2 in the flora, widespread in North America, Europe, Asia, North Africa, rare in tropical regions.

Eckenwalder (1996) has written an excellent review of the classification and evolution of *Populus*.

Salix L. Sp. Pl. 2: 1015. 1753 • Willow [Latin *salix*, willow]

Trees or **shrubs**, generally not colonial or colonial by rhizomes, layering, or branch fragmentation, entomophilous or anemophilous. **Stems** branching sympodially; **branches** generally flexible at bases; **buds** with a single scale, margins generally fused into a calyptera, not resinous. **Leaves** indistinctly heterophyllous, early and late often differing in stipule presence, size and position of stomata; stipules absent, rudimentary, or foliaceous, generally deciduous in autumn and not persistent for more than one year; **petioles** generally convex to flat or shallowly grooved on adaxial surfaces, generally lacking glandular-dots or lobes at distal ends; **juvenile blades** glabrous or hairy; **proximal blades** generally entire; **largest medial blades** linear to circular, secondary veins generally pinnate, angle of proximal 25% of blade generally < 90°; margins glandular-toothed to entire, glands generally marginal or submarginal, angle of distal 25% of blade generally < 90°, hairs generally white. **Catkins** erect or spreading, sessile or on leafy branchlets, loosely to very densely flowered, flowering as or before leaves emerge, or throughout the year, generally arising from lateral buds, generally unbranched; **floral bracts** one subtending each flower; apices entire, erose or irregularly toothed, generally glabrous or sparsely hairy; pistillate bracts generally persistent in fruit. **Flowers**, **staminate** with an adaxial nectary, rarely also with one abaxially, if both then nectaries distinct or connate into a cup; stamens generally 2, rarely 1 or 3-9; anthers generally purple becoming yellow, long-cylindrical to subglobose, filaments distinct or variously connate; **pistillate** with an adaxial nectary, rarely also with one abaxially; ovaries 2-carpellate, stipitate or sessile, generally with white hairs; styles 2, generally connate or slightly distinct at distal ends, beaks generally gradually tapering or slightly bulged at style; stigmas 2, entire or bifid; ovules [2] 4-24 [44] per ovary. **Capsules** obclavate to ovoid, or ellipsoidal.

Species ca. 450, ca. 104 native species in the New World (22 native species and 10 naturalized introductions in the flora); arctic, boreal, and temperate regions worldwide; absent or uncommon in tropical regions; absent in Malaysia, Australasia, and Oceania, except as introductions.

Taxonomic treatments of many of the *Salix* in the Maritime Provinces can be found in the following papers:

Northeastern United States and adjacent Canada (Fernald 1950, Gleason 1952, Gleason and Cronquist 1991), Maine (Campbell and Hyland 1978, Haines and Vining 1998), New Brunswick (Hinds 2000), Nova Scotia (Zinck 1998), see Fernald and associates for papers on Newfoundland, Quebec, and New England *Salix*.

GENERAL COMMENTS

Willows have been studied from many perspectives, by taxonomists, morphologists, anatomists, geneticists, cytologists, chemists, ecologists, arborists, entomologists, and others, all contributing to our understanding of the genus. Nevertheless their classification and identification remains difficult. In 1878, M. S. Bebb was thanked for writing an, "... account of the Willows [of western United States], which are confessedly among the most difficult of all American genera." And C. K. Schneider (1919b) wrote, "In determining willows one is only too often entirely misled at first, and even by a slow and careful examination it is not always possible to determine the proper identity of the plant."

The genus *Salix* is distributed widely throughout the world, except for Oceania; but there introduced willows are rapidly becoming invasive. Willows occur naturally in disturbed habitats from the shores of tropical rivers to high arctic tundra. In stature, they range from trees 30 m tall to dwarf arctic alpine species less than 2 cm tall. They can be pollinated by wind and insects and their light seeds, which can be wind- or water-borne, can germinate almost immediately upon reaching suitable habitat.

Willows can spread vegetatively by root shoots, or by stem fragmentation, and they are important stabilizers of riparian shores and bars, sand dunes, glacial outwash, and anthropogenic disturbed areas. They provide food and habitat for a variety of mammals and birds, insects, and fungi. Humans have used them for medicines, fuel, shelter, and emergency food, as well for ornamental purposes and environmental amelioration. Although they evidently originated in tropical regions, they proliferated most in the northern hemisphere, this probably in response to major disturbances resulting from repeated glaciation.

Evolution in *Salix* is closely linked to hybridization, introgression, and polyploidy. In tropical regions diploids predominate but in northern regions polyploids are the rule. *Salix* species are highly variable and often only subtly distinct. Hybrids typically share characters of the parental species. Even when polyploidy permits them to behave as independent species, they are often difficult to separate from the ancestral species or backcrosses with them. Their ecological importance is great, but they can certainly be a source of taxonomic perplexity to field biologists and others who must convey information in terms of taxonomic entities.

Biology. *Salix* are pioneer species that are well adapted to disturbance. Each year every pistillate plant can produce thousands of seeds. At maturity, each seed is lifted into the air surrounded by a parachute of fine hairs that can carry them tens to hundreds of meters from the parent plant. Seeds that land on water can float for several days because of the flotation capability of the hairy hilar aril surrounding each seed (E. M. A. Steyn, et al 2004). Willow seeds have no food reserves so that most will perish within days unless they land in a suitable habitat. Only some arctic and subarctic species, are adapted to

survive through the winter and germinate in the spring (R. A. Densmore and J. C. Zasada 1983).

Seedling success depends mainly on abiotic factors, and most importantly, an adequate supply of moisture and the absence of shading (C. F. Sacchi and P. W. Price 1992). When such habitat is available seeds can germinate almost immediately upon arrival. Such conditions were present on a large scale during the Pleistocene when repeated glacial and interglacial periods provided suitable environments for many northern *Salix* to acquire their present circumpolar or transcontinental distributions. Today, willow seedlings are most commonly seen on riparian sand and gravel bars, old burns, landslides, drained lakes and wetlands and in open, unstable arctic and alpine habitats. They also spread along the vast network of roads that crisscross even some of the most remote wilderness areas. Here margins of roads, roadside ditches, and gravel pits provide favored habitats. But even minor disturbances such as upturned tree roots, ungulate tracks in wet meadows and mires, cryogenic frost boils and cracks in tundra, and animal diggings may provide suitable habitat. Because of this need for disturbance for reproduction by seed, large stands of mature willows growing in stable habitats such as marshes, fens, and bogs, treed river banks and even active sand dunes, have become established following disturbance during which exposed open, wet, mineral soil. Individual plants could invade these habitats by seeding into minor disturbances but large stands of willows would require large disturbances, even given their ability to reproduce vegetatively.

Many willows are adapted for vegetative reproduction by root shoots, layering, or stem fragmentation, and all willows can collar sprouts at or below ground level (P. Del Tredici, 2001). Vegetative reproduction by stem fragmentation is characteristic of riparian species, many of which have brittle branches. Their stems can be broken by wind or water and be carried downstream where they may become lodged and root. Beavers commonly feed on willows; at the end of winter uneaten branches in their feeding beds can sprout and become established on the margins of beaver ponds (T. R. Cottrell 1995). Species that spread by root shoots or by layering are more limited in their dispersal potential but often form distinctive clones.

Willows are considered to be shade intolerant, and they decline as habitats become stabilized and invaded by taller vegetation. They can survive for many years without seedling recruitment and during that time produce propagules that may colonize newly disturbed areas elsewhere. It is important to recognize that willows growing in a habitat with a closed ground cover, such as a fen or bog, cannot easily reproduce by seed in the same place. Sometimes small disturbances such as animal trails in which mineral soil is exposed can provide a seed bed, but inasmuch as they are growing on an animal trail, the chances of being trampled or eaten are great. Seedling survival is highly dependent on chance.

As willows are pioneer species they present problems for the conservation of endangered *Salix*. Attempts to protect them by preventing habitat disturbance may be counterproductive. They cannot spread without disturbance but once established they may require protection against biotic factors such as browsing so that they can continue to produce and disperse propagules to nearby disturbances (see *S. arizonica*). Given the opportunity, non-native willows can be very aggressive. In Australia and New Zealand, where *Salix* is not native, introductions from Europe have been so successful that they are

regarded as invasive weeds (C. J. West 1994), and control measures are being implemented.

Variability. Underlying most taxonomic problems is the morphological variability of *Salix* species. Plants are basically dioecious so that a single individual cannot provide the full range of reproductive and vegetative structures needed for identification. Many species flower well before the leaves emerge, and thus, both reproductive structures and foliage are usually not available simultaneously. Phenotypic plasticity among species is the result of habitat modification. Hybridization, introgression, and polyploidy have led to complex variability and the ‘blurring’ of species boundaries.

Hybridization. Approximately 120 different *Salix* hybrids have been recognized in the North American flora, and about half of these are relatively common. Others are either putative hybrids in which one parent may be uncertain, unconfirmed, and/or doubtful hybrids. North American botanists, in general, have been conservative in their recognition of hybrids, probably in reaction to botanists who readily recognized not just simple hybrids but multiple species hybrids. In Greenland, B. Floderus (1923) recognized five pure *Salix* species and seven interspecific hybrids; some of the hybrids were three species hybrids. Working in a similar flora, H. M. Raup (1943, 1959) argued against an uncritical recognition of hybrids and suggested that intermediate specimens should be given the name of the species they resemble most. These views were echoed by A. K. Skvortsov (1999) who agreed that willows are inherently variable and that a better understanding of species variability would reduce the number of presumed hybrids.

There are a number of barriers to hybridization including differences in flowering time (A. Mosseler and C. C. Papadopol 1989), pollen-stigma incompatibility (A. Mosseler 1989), and F_1 hybrid inviability. Nevertheless hybridization among *Salix* species is an important source of variability. Hybridization, combined with clonal reproduction, can result in an effective evolutionary strategy (J. Salick and E. Pfeiffer 1999). Hybrids can sometimes be recognized by discordant character variation such as the occurrence of partially hairy ovaries in a species characterized by glabrous ovaries, or by having leaves glaucous abaxially in a species that lacks leaf glaucescence. Occasionally, such variation may occur along with teratological flowers or other evidence of infertility and reproductive imbalance that is often associated with hybridization. Hybrids that may be difficult to recognize in the herbarium often are recognizable in the field as different from other individuals in the population. M. L. Fernald and his colleagues, while botanizing in Quebec and Newfoundland, were keenly aware of unusual *Salix* many of which proved to be hybrids.

A morphological and molecular study of hybridization and introgression between *Salix eriocephala* and *S. sericea* (T. M. Hardig, et al. 2000) found that about one third of plants identified as *S. eriocephala* were possible introgressants. Other plants showed unequivocal evidence of backcrossing with *S. sericea*; inter- and intraspecific chloroplast diversity found within a hybrid zone suggested both historic introgression, perhaps in a glacial refugium, and contemporary hybridization. They found that hybrids might not be readily observed either in the field or in the herbarium and noted that, “If major distinguishing characters are under the control of one or two dominant genes, hybridization may go unrecognized. Important taxonomic characters that are quantitative might result in recognizably intermediate hybrids but ... hybrids may be imperfectly intermediate or highly variable, resulting in an interpretation that unrecognized hybrids

are merely part of the morphological variation in one of the species.” Furthermore, the practical taxonomic importance of this is that, while it may be unwise to confuse hybridization for species variability, it is equally unwise to confuse species variability for hybridization.

Ploidy. The widespread occurrence of polyploidy in *Salix* is an important indication of the evolutionary importance of hybridization. Chromosome numbers are known for about half of our taxa; of these, 40% are polyploid. It can then be extrapolated that about 40-50 *Salix* species in our flora are polyploid. Furthermore, it is probable that the polyploids are allopolyploids inasmuch as there is little evidence of autopolyploidy in *Salix* (W. Buechler, pers. comm.). Many of the most complex *Salix* species seem to have evolved through hybridization and polyploidy. For example, *Salix glauca* and *S. arctica* each display several ploidy levels, as well as many morphological hybrids; both probably evolved through repeated hybridization and backcrossing with each other and other species. The possibility that recurrent polyploidy has contributed to variability in these and other polyploid species need to be studied.

Classification. Traditionally, the subgeneric classification of *Salix* was based on morphological characteristics, but recent molecular studies have begun to provide useful insights. The first classification of New World *Salix* (C. S. Schneider 1921) recognized 23 sections and arranged them in a linear order corresponding to generally recognized subgenera. The first classification to use subgenera recognized only two: (1) subg. *Salix*, including tree willows and sect. *Longifoliae*, and (2) subg. *Vetrix*, including the shrubby and the dwarf arctic-alpine willows (R. D. Dorn 1976). Later four subgenera were recognized, *Salix*, *Longifoliae*, *Chamaetia*, and *Vetrix* (G. W. Argus 1997). In the present classification, five subgenera are recognized. *Salix* subg. *Salix* is subdivided into subg. *Protitea*, has bud scales with distinct, overlapping margins and flowers with multiple stamens, and subg. *Salix*, with calypterate bud scales and flowers usually with two stamens (see discussion under subg. *Protitea*).

There are two published studies of *Salix* classification based on molecular data. The number of included species, however, is few. A study based on rDNA sequences (E. Leskinen & C. Alstrom-Rappaport 1999) was designed to study the phylogeny of Salicaceae and Flacourtiaceae and to determine the relationship of *Chosenia* to *Salix*; a cladogram, using bootstrap analysis, gave them the best resolution within *Salix*, but the bootstrap support was not strong. All *Salix* and *Chosenia* were placed in a single clade with two major branches. The first branch included *Salix exigua* (subg. *Longifoliae*), and the second branch included two subgroups. One subgroup contained *S. amygdaloides* (subg. *Protitea*) and *S. alba*, *S. fragilis*, and *S. pentandra* (subg. *Salix*), while the second subgroup included all the other species (subg. *Chamaetia* and *Vetrix*). The second subgroup was unresolved except for members of section *Viminella* (*S. viminalis* and *S. schwerinii*).

A study by A. Azuma *et al.* (2000), based on nucleotide sequences of the chloroplast-encoded *rbcL* gene, also was designed to determine the taxonomic position of *Chosenia* and *Toisusu*, as well as the classification of *Salix*. Within *Salix* two major clades were recognized. Clade 1 consisted of three major branches. The first included *S. interior* (subg. *Longifoliae*) along with *S. amygdaloides* and *S. nigra* (subg. *Protitea*), the second branch included the Asian *S. chaenomelioides* (subg. *Pleuradinea*) and, the third, the African and Asian *S. safsaf* and *S. tetrasperma* (subg. *Protitea*). Clade 2 also had three

major branches, the first included *S. triandra* (as *S. subfragilis*), the second grouped unresolved members of subgenera *Chamaetia* and *Vetrix*, and the third the genera *Toisusu* and *Chosenia* (now placed in subg. *Pleuradinea*). The molecular data, although not conclusive, are not in serious conflict with the subgeneric classification used here, but further studies are needed to refine our understanding of the subgeneric classification.

Morphology. *Salix* are woody plants varying from *trees*, up to 30 m tall, to *dwarf arctic-alpine shrubs*, less than 2 cm tall. They often form *colonies* by root shoots, layering, rhizomes, or stem fragmentation. The stems of some species are very brittle at the base, an apparent adaptation to dispersal by stem fragmentation, and most stems will root if in contact with moist soil. *Branchlets* are the stems of the year and *branches* are stems more than one year old. *Buds* have a single bud scale. The margins of the bud scale are connate or free and overlapping (subgenus *Protitea*). *Vegetative* and *reproductive buds* vary in size, shape, and position. Four general types of bud size and shape gradation are recognized, namely, *alba*-type, *arctica*-type, *caprea*-type, and indeterminate (A. K. Skvortsov 1999). Plants with *alba*-type bud gradation have buds that are very similar in size and shape along the length of the branchlet, but floral and vegetative buds cannot be distinguished from one another. Plants with *arctica*-type bud gradation usually have few buds. The two or three (sometimes up to five) distal buds are the largest diminishing in size proximally. Usually only the larger buds toward the distal end open and these buds may be either floral or vegetative. Plants with *caprea*-type bud gradation have floral buds that are strikingly different in size and shape from vegetative buds. Usually the distal two or three buds are vegetative, the next three to six (or more) buds are large floral buds, below them buds diminish in size. *Stipules* borne on either side of the petiole, may be foliaceous, minute, brownish rudiments, or absent. Those on the first (preformed) leaves often are lacking or rudimentary while those on later (neoformed) leaves often are foliaceous. Although it is evident that not all leaves are differentiated in the winter buds (E. Moore 1909) it is difficult to determine exactly the point when neoformed leaves appear. It is probable that there are morphological differences among leaves on an individual plant, as in some *Populus* species (W. Critchfield 1960), but in *Salix*, only stipule differences have been observed. Further study is needed. *Petioles* sometimes have glandular dots or lobes at the distal end just below the blade. Three types of leaves are recognized in *Salix*. *Proximal leaves* are the first two to four reduced true-leaves at the base of branchlets or on catkin-bearing shoots, and they differ from the later leaves in shape, indumentum, dentition, and the prominence of stipules. *Juvenile leaves* are the young unfolding leaves at the branchlet apex. The *largest medial leaves* are the “normal” leaves. These leaves vary in shape from linear to subcircular, bases are cuneate to cordate, margins entire to spinulose-serrulate, leaf teeth in Salicaceae are gland tipped. The glands on teeth, or on entire margins, may be marginal, submarginal, or borne on the adaxial blade surface (epilaminal). The abaxial blade surface, and less commonly the adaxial surface, often are glaucous with a dull, waxy coating, blade surfaces may be glabrous to densely hairy, leaf hairs (trichomes) usually are white but sometimes are ferruginous (rust-colored). Syllepsis, the opening of buds without a rest period, is common in *S.* subg. *Longifoliae*, as well as in some *Populus*. The morphology of sylleptic leaves differs from proleptic leaves (see subg. *Longifoliae*). The inflorescence is a *catkin* (ament), which consists of a flower-bearing rachis (essentially a spike of unisexual, apetalous, sessile flowers each subtended by a floral bract) and its peduncle. The catkin

may be sessile on the branch or borne on, a short, vegetative flowering branchlet (a shoot bearing three or more green leaves). Catkins arise from lateral or subterminal buds. They flower *before the leaves emerge* (precocious), *as the leaves emerge* (coetaneous), or *throughout the season*. For the use of the term serotinous see *Salix serissima*. The flowering rachis is usually unbranched but in subg. *Longifoliae*, secondary or tertiary branching occurs. After anthesis, the rachis of pistillate catkins continues to elongate but staminate catkins do not. A *floral bract* (scale) subtends each flower. Pistillate floral bracts are usually persistent in fruit, but in some subgenera they are deciduous. Each *flower* consists of an *adaxial nectary* (a reduced perianth, according to M. J. Fisher 1928) located between the stamens or pistil and the rachis axis, in some taxa there also is an *abaxial nectary* located between the floral bract and the fertile structures; the two nectaries may be distinct or connate into a cup-like structure. *Staminate flowers* generally have two *stamens*, but the number can be 1 or 3-10. *Pistillate flowers* have a single pistil, sessile or borne on a stalk or *stipe* (M. J. Fisher 1928, S. Sugaya 1960). There are two, usually connate, *styles* each terminated by a two-branched stigma, the lobes are (1) flat abaxially, papillate adaxially and with a rounded or pointed tip, (2) slender-cylindrical (length greater than 4× width) or broad-cylindrical, (length less than 4× width), and (3) subspherical (plump).

Collection and identification. Ideal specimens for identification include flowering, fruiting, vegetative, and winter twigs and often a peeled section of wood from a 3-5 year old branch. By tagging plants and making successive collections throughout the year it is possible to gain an in-depth understanding of the morphological variability. To understand population variability, successive collections can be supplemented by randomly collected population samples. To occasionally attempt to identify every plant in a stand, as suggested by A. K. Skvortsov (1999), can contribute to an understanding of population variability, hybridization and introgression. At a minimum, however, well collected and pressed specimens are essential. All plant parts available at the time, leaves (including juvenile leaves), catkins, and twigs, should be included. Sprout, or compensatory, shoots are rarely included in keys or descriptions and usually cannot be identified using keys; if collected, they should be incidental to normal shoots and labelled as such. To avoid loss of leaf glaucescence (wax on stems or leaves) plants should dried as rapidly as possible but not by using excessive heat. Plant habit and evidence of vegetative reproduction should be noted. Most plant descriptions and keys are based on dried, pressed plant specimens so be aware that there will be color and other differences when identifying live specimens.

Because *Salix* species are variable and often subtly distinct, most traditional dichotomous keys account for a portion of the variability. Keys that include a large number of species are difficult to write and cumbersome to use. The preparation of separate keys to staminate, pistillate, and vegetative specimens can be useful but are rarely provided. A solution to the practical problem of identification is to use computerized interactive keys (M. J. Dallwitz, *et al.* 2000 onwards; R. J. Pankhurst 1991). An interactive key to New World *Salix* (G. W. Argus 2002 onwards) is available on the internet. It can be used not only to identifying specimens but to describe or compare species, or to list *Salix* by state, province, or taxonomic group

Uses. Willows play major roles in ecosystems by rehabilitating disturbed sites through stabilization to prevent erosion, soil improvement, removal of pollutants and

heavy metals, and as wildlife food and habitat. They are used widely used for environmental amelioration. Most introduced species are cultivars developed for this purpose. In many parts of the world they are used in basketry, source of tannins, and in apiaries food for brood rearing and honey. Traditionally, they were used as medicines; salicin (a component of aspirin) was first derived from *Salix*. Their use as a source of energy biomass is being investigated world-wide. Native North Americans have used willows for fuel, construction, basketry, medicines, tools and weapons, and ceremonially.

CLASSIFICATION OF SALIX IN THE MARITIME PROVINCES
(Based on Argus 1997, introduced taxa in regular boldface.)

- I. *Salix* subg. *Protitea* Kimura**
1. *Salix* sect. ***Humboldtianae*** Andersson
Salix nigra Marshall
- II. *Salix* subg. *Salix***
2. *Salix* sect. *Salicaster* Dumort.
Salix* ×*jesupii Fernald
Salix lucida Muhl.
Salix pentandra L.
Salix serissima (L. H. Bailey) Fern.
3. *Salix* sect. *Salix*
Salix alba L.
Salix fragilis L.
Salix* ×*rubens Schrank
Salix* ×*sepulcralis Simonk
Salix* ×*pendulina Wenderoth
- III. *Salix* subg. *Longifoliae* (Andersson)**
Argus
4. *Salix* sect. ***Longifoliae*** (Andersson)
Andersson
Salix interior Rowlee
- IV. *Salix* subg. *Chamaetia* (Dumort.)**
Nasarov
5. *Salix* sect. ***Myrtosalix*** A. Kerner
Salix uva-ursi Pursh
6. *Salix* sect. ***myrtilloides*** (Borrer)
Andersson
Salix pedicellaris Pursh
7. *Salix* sect. ***Glaucæ*** (Fries) Andersson
Salix glauca L. subsp. ***callicarpaea***
(Trautv.) Böcher
- V. *Salix* subg. *Vetrix***
8. *Salix* sect. ***Hastatae*** (Fries) A. Kerner
Salix myricoides Muhlenberg
Salix pyrifolia Andersson
9. *Salix* sect. ***Cordatae*** J. Barratt ex Hook.
Salix eriocephala Michx.
10. *Salix* sect. ***Fulvae*** J. Barratt
Salix bebbiana Sarg.
- K. *Salix* sect. *Cinerella* Ser.**
Salix atrocinerea Brotero
Salix aurita L.
Salix caprea L.
Salix cinerea L.
Salix discolor Muhl.
Salix humilis Marshall var. ***humilis***
Salix pellita (Andersson) C. K. Schneider
Salix* ×*smithiana Willd.
11. *Salix* sect. ***Phylicifoliae*** (Fries)
Andersson
12. *Salix* sect. ***Candidae*** C. K. Schneider
Salix candida Flügge ex Willd.
13. *Salix* sect. ***Viminella*** Ser.
Salix viminalis L.
14. *Salix* sect. ***Canæ*** A. Kerner
Salix elaeagnos Scop.
15. *Salix* sect. ***Geyerianae*** Argus
Salix petiolaris Sm..
16. *Salix* sect. ***Griseae*** (Borrer) J. Barratt ex Hook.
Salix sericea Marshall
17. *Salix* sect. ***Helix*** Dumortier
Salix purpurea L.

KEY TO *SALIX* IN THE MARITIME PROVINCES

1. Ovaries hairy. 2
 1' Ovaries glabrous. 14
- 2.(1) Catkins flowering before leaves emerge. 3
 2' Catkins flowering just before or as leaves emerge. 6
- 3.(2) Leaves and buds opposite or subopposite; stipules on later leaves and vigorous shoots absent; ovaries obturbinate; filaments connate more than half. **Salix purpurea**
 3' Leaves and buds alternate; stipules on later leaves and vigorous shoots minute rudiments or foliaceous; ovaries obclavate, pyriform, ovoid, or obnapiform; filaments distinct. 4
- 4.(3') Petioles glabrous or pubescent on adaxial surface; ovaries very densely hairy. **Salix pellita**
 4' Petioles pilose, tomentose, or velvety on adaxial surface; sparsely to moderately densely hairy. 5
- 5.(4') Largest medial leaf blades moderately- to very densely tomentose or woolly on abaxial surface; mid shrubs, generally of sandy upland; petioles pilose or velvety on adaxial surface; adaxial nectaries square. **Salix humilis var. humilis**
 5' Largest medial leaf blades glabrous, or glabrescent, or sparsely pubescent, pilose, or long-silky on abaxial surface; tall shrubs, usually of wetlands; petioles tomentose on adaxial surface; adaxial nectaries oblong or ovate. **Salix discolor**
- 6.(2') Largest medial leaf blade margins remotely spinulose-serrulate, blades amphistomatous; pistillate bracts deciduous in fruit; plants forming colonies by root shoots. **Salix interior**
 6' Largest medial leaf blade margins not remotely spinulose-serrulate, blades hypostomatous or hemiamphistomatous; pistillate floral bracts persistent in fruit; plants not colonial by root shoots, sometimes forming colonies by layering, or stem fragmentation. 7
- 7.(6') Largest medial leaf blades greater than 4x as long as wide. 8
 7' Largest medial leaf blades 4x or less as long as wide. 11
- 8.(7) Juvenile leaves moderately densely long-silky; largest medial leaf blades glabrescent or long-silky on abaxial surface; ovaries sparsely hairy. **Salix petiolaris**
 8' Juvenile leaves very densely tomentose or short-silky; largest medial leaf blades tomentose, woolly, or short-silky on abaxial surface; ovaries moderately to very densely hairy. 9
- 9.(8') Largest medial leaf blade margins serrulate or crenulate, flat; branchlet hairs straight; ovaries ovoid, beak abruptly tapering to style, short-silky; stigma lobes 0.12-0.2 mm; ovules per ovary 6. **Salix sericea**
 9' Largest medial leaf blade margins entire or undulate, strongly or slightly revolute; branchlet hairs crinkled or geniculate; ovaries pyriform, beak gradually tapering to style, or slightly bulged below style, tomentose, woolly, or long-silky; stigma lobes 0.4-1.8 mm; ovules per ovary 12-19. 10
- 10.(9') Low to mid shrubs; branchlets densely white woolly, hairs crinkled; stipules apex acute; petioles tomentose, or woolly on adaxial surface; largest medial leaf blade glands marginal or submarginal, abaxial surface hairs crinkled, largest medial leaf blades adaxial surface tomentose, often floccose; ovaries tomentose or woolly. **Salix candida**
 10' Tall shrubs; branchlets glabrous, glabrescent, puberulent, villous, or velvety; stipules apex acuminate; petioles puberulent, villous, or velvety on adaxial surface; largest medial leaf blade glands epilaminal, abaxial surface hairs straight or wavy, adaxial surface pubescent, ovaries long-silky. **Salix viminalis**

11.(7') Petioles flat to convex adaxially, staminate catkins moderately densely flowered, pistillate catkins loosely flowered; ovaries obclavate, sparsely hairy. **Salix bebbiana**
 11' Petioles shallowly to deeply grooved adaxially; staminate catkins very densely flowered, pistillate catkins moderately to very densely flowered; ovaries pyriform or obnapiform, moderately to very densely hairy. 12

12.(11') Branchlets densely white woolly; branches gray-brown; petioles tomentose or woolly on adaxial surface; largest medial leaf blades tomentose or woolly on abaxial surface, hairs crinkled, adaxial surface tomentose; staminate abaxial nectaries absent. **Salix candida**
 12' Branchlets glabrescent, or variously hairy not woolly; branches yellow- or red-brown; petioles glabrous, glabrescent, pubescent, or pilose on adaxial surface, largest medial leaf blades glabrescent, pilose, villous, or long-silky on abaxial surface, hairs straight or wavy, adaxial surface glabrous, glabrescent, pilose, villous, or long-silky; staminate abaxial nectaries present. 13

13.(12') Branches dull; branchlets yellow- or gray-brown; petioles glabrous, glabrescent, or pubescent on adaxial surface; juvenile leaves long-silky; largest medial leaf blades glabrous or long-silky on adaxial surface, margins strongly revolute; catkins arising from a subterminal bud; ovaries short-silky, beaks abruptly tapering to style. **Salix vestita**
 13' Branches shiny or highly glossy; branchlets red-brown; petioles pilose on adaxial surface; juvenile leaves villous or tomentose, largest medial leaf blades glabrescent, pilose, or villous. margins slightly revolute or flat; catkins arising from lateral buds; ovaries villous, or tomentose, beaks gradually tapering to style. **Salix glauca subsp. callicarpaea**

14.(1') Petioles without glands at distal end. 15
 14' Petioles with glandular dots or lobes at distal end. 22

15.(14) Stipules on later leaves and vigorous shoots minute rudiments. 16
 15' Stipules on later leaves and vigorous shoots foliaceous. 17

16.(15) Branches gray-brown; branchlets glabrous, glabrescent, or puberulent; petioles glabrous or puberulent on adaxial surface; juvenile leaves glabrous, puberulent, or pubescent; largest medial leaf blades 1.8-4.9 times as long as side, base convex or rounded, abaxial surface glabrous, adaxial surface glaucous; stipes 2.1-3.2 mm; styles 0.1-0.24 mm; native. **Salix pedicellaris**
 16' Branches yellow-brown or red-brown; branchlets pubescent or tomentose; petioles tomentose or velvety on adaxial surface, juvenile leaves tomentose; largest medial leaf blades 6.6-29 times as long as wide, base cuneate, abaxial surface hairy, adaxial surface not glaucous; stipes length 0.3-0.5 mm; styles 0.7-0.9 mm; introduced and naturalized. **Salix elaeagnos**

17.(15') Dwarf trailing shrubs; leaves persistent more than one year; ovules per ovary 4-9.
 **Salix uva-ursi**
 17' Low to tall erect or decumbent shrubs, leaves deciduous in autumn; ovules per ovary 10-19. 18.

18.(17') Floral bracts tawny; stipules early deciduous; petioles glabrous or velvety on adaxial surface.
 **Salix pyrifolia**
 18' Floral bracts brown or bicolor; stipules deciduous in autumn; petioles pubescent, pilose, villous, or tomentose on adaxial surface. 19

19. Stipules on first leaves foliaceous. 20
 19' Stipules on first leaves absent or minute rudiments. 21

- 20.(19) Largest medial leaf blades only with white hairs, margins toothed; anthers 0.4-0.64 mm; styles generally shorter, 0.3-0.6 mm. stigmas two plump lobes, 0.16-0.28 mm; pistillate catkins very to moderately densely flowered. **Salix eriocephala**
 20' Largest medial leaf blade often with ferruginous hairs, margins entire or toothed; anthers 0.6-0.8 mm; styles generally longer, 0.3-1.2 mm; stigmas flat or slender-cylindrical lobes, 0.24-0.56 mm; pistillate catkins loosely flowered. **Salix myricoides**
- 21.(19') Largest medial leaf blades narrower, 2-8 times as long as wide, generally narrowly oblong, very narrowly elliptic or oblanceolate (sometimes elliptic or obovate), apex acuminate or acute; proximal leaves entire or serrulate. **Salix myricoides**
 21' Largest medial leaf blades broader, 1.4-2.8 times as long as wide, elliptic to obovate, apex generally obtuse or rounded, sometimes acute; proximal leaves serrulate or crenulate. **Salix ballii**
- 22.(14') Largest medial leaf blades not glaucous on abaxial surface. 23
 22' Largest medial leaf blades glaucous abaxial surface. 26
- 23.(22) Bud scale margins distinct and imbricate; anther rachis strongly recurved when open. **Salix nigra**
 23' Bud scale margins connate; anther rachis straight when open. 24
- 24.(23') Stipules on first leaves foliaceous. **Salix lucida**
 24' Stipules on first leaves absent or minute rudiments. 25
- 25.(24') Branches yellow-brown, or gray-brown, or red-brown, dull or shiny; pistillate catkins 1-2.3 times as long as wide; ovary beak slightly bulged below style or abruptly tapering to style; native. **Salix serissima**
 25' Branches yellow-green, or brownish, highly glossy; pistillate catkins 3.4-5.3 times as long as wide; ovary beak gradually tapering to style; introduced and naturalized. **Salix pentandra**
- 26.(22') Shrubs; branchlets glabrous; capsules 7-12 mm; native. 27
 26' Trees; branchlets variously hairy sometimes becoming glabrescent; capsules 3.5-6.0 mm, introduced and naturalized 28
- 27.(26) Branches dull, or shiny; stipules on later leaves and vigorous shoots minute rudiments; floral bracts apex toothed, pistillate bracts deciduous in fruit; staminate abaxial nectaries present; pistillate adaxial nectaries oblong or ovate. **Salix serissima**
 27' Branches highly glossy; stipules on later leaves and vigorous shoots foliaceous; floral bracts apex entire, pistillate bracts persistent in fruit; staminate abaxial nectaries absent; pistillate adaxial nectaries square or narrowly ovate. **Salix pyrifolia**
- 28.(26') Largest medial leaf blades persistently silky on both surfaces, adaxial surface dull, petioles long-silky; styles 0.16-0.44 mm; branches flexible to somewhat brittle at proximal end; branchlets straight at proximal end. **Salix alba**
 28' Largest medial leaf blades glabrescent to glabrous on both surfaces, adaxial surface shiny to highly glossy, petioles glabrous or puberulent; styles 0.4-1 mm; branches highly brittle at proximal end; branchlets curved at proximal end. 29
- 29.(28') Largest medial leaf blades glabrous from the start or almost so, margins generally irregularly serrate, blades shiny to glossy and glabrous adaxially, amphistomatous or hypostomatous, buds glabrous; petioles glabrous or puberulent; stipe 0.5-1.5 mm; ovaries obclavate. **Salix fragilis**

29' Largest medial leaf blades at first long-silky but soon glabrous, margins uniformly serrulate or serrate, blades dull to shiny and glabrous to long-silky adaxially, amphistomatous, buds hairy; petioles pilose or villous; stipe 0.3-0.5 mm; ovaries pyriform. **Salix ×rubens**

TAXONOMIC TREATMENT

Salix alba Linnaeus, Sp. pl. 2 : 1021, 1753 • White willow

Trees 10-25 m. **Stems, branches** flexible or somewhat brittle at base, yellow, gray- or red-brown, glabrous or hairy; **branchlets** yellowish or gray to red-brown, pilose or densely villous or long-silky; **buds** hairy. **Leaves, stipules** on first leaves minute rudiments or absent, on later leaves minute rudiments or foliaceous, apex acute; **petioles** shallowly grooved adaxially, 3-13 mm, with pairs or clusters of spherical glands at distal end, abaxial surface long-silky; **juvenile leaves** yellowish green or reddish, abaxial surface very densely long-silky; **proximal leaves** entire; **largest medial blades** amphistomatous; narrowly oblong, very narrowly elliptic, narrowly elliptic, or lanceolate, 63-115 × 10-20 mm, 4.2-7.3 times as long as wide; base cuneate, slightly decurrent, or convex; margins flat, serrate or serrulate; apex acuminate, caudate, or acute; abaxial surface glaucous, very densely long-silky or glabrescent, hair straight; adaxial surface dull, sparsely long-silky. **Catkins** flowering as leaves emerge; **staminate** slender or stout, 27-60 × 6-10 mm, flowering branchlet 2-8 mm; **pistillate** catkins loosely flowered, slender, 31-51 × 4-8 mm, flowering branchlet 3-14 mm; **floral bracts** 1.6-2.8 mm, abaxial surface sparsely hairy all over, hair straight, bracts apex rounded, entire; pistillate bracts deciduous after flowering. **Flowers, staminate** adaxial nectary oblong to square, 0.3-0.7 mm, abaxial and adaxial nectaries distinct or rarely connate; stamens 2; anthers purple becoming yellow, short cylindrical to globose, 0.5-0.7 mm; filaments distinct, hairy on lower half or at base; **pistillate** adaxial nectary square, 0.3-0.65 mm, equal to or shorter than stipe; stipe 0.2-0.8 mm; ovary obclavate to pyriform, beak slightly bulged below styles, glabrous; styles 0.16-0.44 mm; stigmas flat, non-papillate abaxial surface and pointed tip, or broad-cylindrical, 0.32-0.56 mm; 8-9 ovules per ovary. **Capsules** 3.5-5 mm. $2n = 76$.

Flowering early May to late June. Introduced and sometimes naturalized; N.B., Ont., Que., Sask.; Ariz., Ark., Colo., Conn., Del., D.C., Ga., Idaho, Ill., Ind., Ky., Maine, Md., Mass., Mich., Minn., Mo., Mont., Nebr., Nev., N.H., N.C., N.Y., Ohio, Pa., R.I., Tenn., Vt., Va., W.Va., Wis. Eurasia.

Reports that *Salix alba* is naturalized in Alberta, British Columbia, Washington, and California are undocumented.

The several variants of *Salix alba*, commonly cultivated in the flora area, are variously treated as subspecies (Rechinger 1993) or varieties (Meikle 1984) but they are all cultivars. The most common ones are: *S. alba* cv Sericea (*S. alba* var. *sericea* Gaudin) with densely and persistently long-silky leaves and branchlets; *S. alba* cv Vitellina (*S. alba* var. *vitellina* (Linnaeus) Stokes) with yellow to yellow-brown branchlets and branches; *S. alba* cv Caerulea (*S. alba* var. *caerulea* (Smith) Smith) with dark brown branchlets and leaves coarsely toothed and sparsely silky abaxially; and *S. alba* cv Chermesina (*S. alba* var. *chermesina* Hartig) with reddish twigs. Plants referred to in the literature as *S. alba* var. *vitellina* cv Pendula are treated here as *S. ×sepulcralis*.

Hybrids

Salix alba × *S. fragilis*. See *S. ×rubens*.

Salix alba × *S. lucida*. See *S. ×jesupii*.

Salix alba × *S. nigra* (possibly *S. ×hankensonii* Dode) is an infrequent hybrid that has the catkins of *S. alba* and the foliage of *S. nigra* (Bebb 1895).

Salix ballii Dorn, Canad. J. Bot. 53: 1501. 1975 • Ball's willow
Salix myrtillofolia Andersson var. *brachypoda* Fernald

Low to mid shrubs 0.2-1.2 m. **Stems, Branches** red- or yellow-brown, not glaucous or weakly so, dull or shiny, pubescent. **Branchlets** red- or yellow-brown, not or weakly glaucous, pubescent, villous, or short-silky. **Leaves, stipules** on first leaves absent or minute rudiments, on later leaves foliaceous, apex acute or obtuse; **petioles** shallowly to deeply grooved adaxially, 2.5-7.5 mm, adaxial surface pubescent; **juvenile blades** yellowish green or reddish, abaxial surface glabrous or sparsely pubescent on midrib, hair white or white and ferruginous; **proximal leaves** serrulate or crenulate; **largest medial blades** elliptic to obovate, 23-63 × 10-35 mm, 1.4-2.8 times as long as wide; base convex or rounded, sometimes cordate or subcordate, angles less than 90°; margins flat, serrulate or undulate; apex convex, rounded, acute, or acuminate; abaxial surface glaucous, glabrous; adaxial surface shiny, glabrous or sparsely pubescent on midrib, hair white or white and ferruginous. **Catkins** flowering as leaves emerge; **staminate** 17-29.5 × 8-11 mm, flowering branchlets 3.5-12 mm; **pistillate** moderately densely flowered, slender, stout, or subglobose, 10-37.5 (to 45 mm in fruit) × 5-12 mm, flowering branchlets 2.5-16 mm; **floral bracts** brown or bicolor, 0.8-1.6 mm, abaxial surface hairy all over or at proximal end, hair straight, curly, or wavy; apex rounded, obtuse or retuse, entire. **Flowers, staminate** adaxial nectary oblong, square, or ovate, 0.3-0.95 mm; anthers yellow, 0.4-0.8 mm; filaments distinct, glabrous; **pistillate** adaxial nectary square or oblong, 0.2-0.63 mm, shorter than stipe; stipe 0.8-2 mm; ovary pyriform, beak gradually tapering to or slightly bulged below styles, glabrous; styles 0.4-1 mm; stigmas flat, non-papillate abaxial surface and pointed tip, or broad-cylindrical, 0.2-0.3-0.36 mm; 12-18 ovules per ovary. **Capsules** 3-6 mm.

Flowering late June to early July. Coastal barrens, terraces, ravines, talus slopes, coastal dunes, river floodplains, *Carex* meadows, scrubby *Picea mariana* woods, dwarfed *Abies balsamea* thickets, and *Picea mariana* – lichen – feathermoss woods. Limestone and calcareous substrates. 1-377 m; Lab., Nfld., Nunavut, Ont., Que.

Salix ballii differs from *Salix myrtillofolia* in having leaves that are distinctly glaucous abaxially. It was described as *S. myrtillofolia* var. *brachypoda* by Fernald who noted that among the characters that distinguish it from *S. myrtillofolia* only the presence of leaf glaucescence does not occur elsewhere in *S. myrtillofolia*. This character is subject to being lost in drying if the plants are dried over excessive heat. For example, the only specimen supporting the occurrence of *S. myrtillofolia* on the Gaspé Peninsula, Quebec is a badly damaged, poorly dried collection that may have lost its glaucescence in drying. A single character difference such as this generally would not recommend a taxon for species rank but in this case it may be justified inasmuch as the ranges of *S. ballii* and *S. myrtillofolia* are allopatric. A specimen from Ile Couture, Lac Mistassini Region, Quebec, may be an exception but confirmatory collections are needed.

Hybrids

Salix ballii × *Salix glauca* subsp. *callicarpaea* (*Salix xungavensis* Lepage). See *S. glauca* subsp. *callicarpaea*

Salix bebbiana Sargent, Gard. & For. 8: 463. 1895 • Gray willow, Bebb's willow, long-beaked willow

Salix bebbiana Sargent var. *capreifolia* (Fernald) Fernald; *Salix bebbiana* Sargent var. *depilis* Raup; *Salix bebbiana* Sargent var. *luxurians* (Fernald) Fernald; *Salix bebbiana* Sargent var. *perrostrata* (Rydberg) C. K. Schneider; *Salix bebbiana* Sargent var. *projecta* (Fernald) C. K. Schneider; *Salix depressa* Linnaeus subsp. *rostrata* (Richardson) Hiitonen

Mid shrubs to trees 0.5-10 m; not colonial. **Stems, branches** flexible or somewhat brittle at base, yellow-brown to dark red-brown, not glaucous or weakly so, glabrous or pilose, peeled wood sometimes smooth, often with very dense striae; up to 25 mm; **branchlets** yellow-green or red-brown, not glaucous or weakly so, villous. **Leaves, stipules** on first leaves minute rudiments or absent, on later leaves foliaceous or minute rudiments, apex acute or obtuse; **petioles** convex to flat adaxially, 2-5.5-13 mm, adaxial surface pubescent; **juvenile blades** yellowish green or reddish, abaxial surface pilose or sparsely to moderately densely tomentose or long-silky; **proximal leaves** entire, gland-dotted; **largest medial blades** narrowly oblong, narrowly elliptic, elliptic, oblanceolate, or obovate, 20-44-87 × 10-16-45 mm, 1.7-2.8-3.9 times as long as wide; base cuneate, convex, rounded, or slightly decurrent; margins flat, entire, crenate, or irregularly serrate, glands submarginal; apex acute, acuminate, or convex, angles less than 90°; abaxial surface glaucous, moderately densely pubescent-long-silky to glabrescent, hair wavy; adaxial surface dull or shiny, finely impressed-reticulate, moderately densely pubescent-short-silky to glabrescent. **Catkins**, pistillate flowering as leaves emerge, staminate flowering just before leaves emerge; **staminate** stout, subglobose, or globose, 10-42 × 7-16 mm, flowering branchlet 0.5-11 mm; **pistillate** loosely flowered, stout, slender, or subglobose, 16.5-85 × 9-32 mm, flowering branchlet 1-26 mm; **floral bracts** tawny, 1.2-3.2 mm, abaxial surface hairy all over or glabrescent, hair straight or wavy; apex rounded, entire. **Flowers, staminate** adaxial nectary oblong or ovate, 0.3-0.8 mm; anthers yellow or purple becoming yellow, ellipsoid or short-cylindrical, 0.5-0.8 mm; filaments distinct or connate less than, glabrous or hairy on lower half; **pistillate** adaxial nectary oblong or square, 0.3-0.75 mm, much shorter than stipe; stipe 2-6 mm; ovary obclavate, long-beaked, beak slightly bulged below styles, short-silky; styles 0.1-0.4 mm; stigmas slender- to broad-cylindrical, 0.32-0.44-0.64 mm, 6-16 ovules per ovary. **Capsules** 5-9 mm. $2n = 38$.

Flowering early April to late June. Riparian and upland conifer forests, wet lowland thickets, *Picea mariana* treed bogs, stream margins, lake shores, prairie margins, dry south-facing slopes, cienegas, seeps, and disturbed areas; 2-3300 m.; Alta., B.C., Lab., Man., N.B., Nfld., N.W.T., N.S., Nunavut; Ont., P.E.I., Que., Sask., Yukon; Alaska, Ariz., Calif., Colo., Conn., Idaho, Ill., Ind., Iowa, Maine, Md., Mass., Mich., Minn., Mont., Nebr., Nev., N.H., N.J., N.Mex., N.Dak., N.Y., Ohio, Oreg., Pa., R.I., S.Dak., Utah, Vt., Wash., Wis., Wyo. Asia.

Hybrids

Salix bebbiana × *S. candida* (*S. ×cryptodonta* Fernald) is intermediate between the parental species. They resemble *S. candida* in juvenile leaves densely woolly, mature leaves sparsely to moderately woolly abaxially, margins strongly revolute to crenulate, and woolly ovaries; and *S. bebbiana* in stipes 2.8-3 mm long, and capsules long beaked, 8-9 mm long. The hybrid seems to be common in Newfoundland.

Salix bebbiana × *S. discolor*. Reported by Schneider (1921b) and Fernald (1950) but was not able to be synthesized by (1974).

Salix bebbiana × *S. eriocephala*. Controlled pollinations had low seed viability (A. Mosseler 1990). Reported for the Northeast (Fernald 1950) but unconfirmed.

Salix bebbiana × *S. humilis*. Reported by Schneider (1921b) and Fernald (1950) and successfully synthesized by Argus (1974, 1986a).

Salix bebbiana × *S. interior* (as *S. exigua*). Controlled pollinations had low seed viability (Mosseler 1990).

Salix bebbiana × *S. myricoides* reported by Fernald (1950) but unconfirmed.

Salix bebbiana × *S. petiolaris* was successfully synthesized by (1974 1986a) and controlled pollinations by Mosseler (1990) had high seed viability; but it seems to be relatively uncommon. It is known only from Ontario, based on an infertile pistillate specimen, and from Alberta.

Salix candida Flügge ex Willdenow, Sp. pl. 4: 708. 1806 • Sage willow, sage-leaf willow
Salix candida Flügge ex Willdenow β *denudata* Andersson

Low to mid shrubs 0.3-2.5 m; often forming colonies by layering. **Stems, branches** dark gray-brown, woolly in patches, floccose or glabrescent; **branchlets** yellow- to gray-brown, densely woolly or tomentose, sometimes floccose; **bud** size gradation of *alba*-type. **Leaves, stipules** on first leaves minute rudiments or foliaceous, on later leaves foliaceous, apex acute; **petioles** shallowly to deeply grooved adaxially, obscured by hair, 3-10 mm, adaxial surface tomentose or densely woolly; **juvenile blades** yellowish green, abaxial surface very densely tomentose; **proximal leaves** entire; **largest medial blades** lorate, very narrowly elliptic, narrowly elliptic, or oblanceolate, 47-103 \times 5-20 mm, 3.3-7.8 (-12) times as long as wide; base convex or cuneate, angles less than 90°; margins strongly to slightly revolute, entire or undulate, apex acute or convex, angles less than 90°; abaxial surface obscured by hair or glaucous, very densely to sparsely tomentose-woolly, cobwebby in age, hair dull white, crinkled; adaxial surface dull or shiny, moderately densely to sparsely tomentose, floccose, hair dull white. **Catkins** flowering as leaves emerge; **staminate** stout or subglobose, 17-39 \times 8-16 mm, flowering branchlet 0.5-7 mm; **pistillate** densely to moderately densely flowered, stout or slender, 20-66 \times 9-18 mm, flowering branchlet 1-24 mm; **floral bracts** tawny or brown, 1.2-1.8 mm, abaxial surface hairy all over, hair straight; apex rounded or acute, entire. **Flowers, staminate** adaxial nectary narrowly oblong to oblong, 0.58-1 mm, anthers purple becoming yellow, ellipsoid, long-cylindrical, or globose, 0.5-0.6 mm; filaments distinct or connate less than half, glabrous; **pistillate** adaxial nectary oblong, 0.4-1 mm, shorter to longer than stipe; stipe 0.1-1.2 mm; ovary pyriform, beak gradually tapering to or slightly bulged styles, tomentose or woolly; styles 0.3-1.9 mm; stigmas flat, non-papillate abaxial surface and rounded tip, or slender-cylindrical, 0.4-0.45-0.52 mm, 12-18 ovules per ovary. **Capsules** 4-6 mm. $2n = 38$.

Flowering mid-April to early July. River floodplains, marl bogs, fens, and meadows; calcareous substrate. 15-2805 m.; St. Pierre and Miquelon; Alta., B.C., Lab., Man., N.B., Nfld., N.W.T., N.S., Ont., P.E.I., Que., Sask., Yukon; Alaska, Colo., Conn., Idaho, Ill., Ind., Iowa, Maine, Mass., Mich., Minn., Mont., N.H., N.J., N.Dak., N.Y., Ohio, Pa., S.Dak., Vt., Wash., Wis., Wyo.

Salix candida is geographically wide ranging but limited to calcareous habitats and for that reason it is quite local or even rare in many parts of its range. It hybridizes with many species.

Hybrids

Salix candida hybrids are easily recognized and often collected. This is due largely to the conspicuous woolly indumentum that often appears discordantly on leaves, stems, and catkins. Intermediates often have ovaries that are woolly in patches, usually only on the beaks. The second parent is often difficult to determine.

Salix bebbiana \times *S. candida* (*S. \times cryptodonta* Fernald). See *S. bebbiana*.

Salix candida \times *S. discolor* reported by Fernald (1950), but unconfirmed.

Salix candida \times *S. eriocephala* (*S. \times rubella* Bebb ex C. K. Schneider) is discussed (as *S. candida* \times *S. cordata* Muhl.) by Rowlee and Wiegand (1896). The hybrids combine the characters of the parents in a variety of ways. Even when a specimen may resemble one parent more than the other usually there are discordant characters that indicate hybridity. They note that the buds of the hybrids generally are shorter, more divergent and more blunt than in *S. eriocephala* and vary from glabrous to hairy. This hybrid is known from New York and Newfoundland; it should be expected throughout the sympatric range of the parental species.

Salix candida \times *S. petiolaris*. Intermediates between these species are known from Michigan and New York (Rowlee and Wiegand 1896) as well as Ontario and Saskatchewan but it can be expected

wherever the two grow in close proximity. The unpublished name *S. ×clarkei* Bebb (Sargent 1878) is sometimes used for this hybrid.

The glabrescent form of *Salix candida*, f. *denudata* (Andersson) Rouleau, may be of hybrid origin.

Salix discolor Muhlenberg, Ges. Naturf. Freunde Berlin II. 4: 234. 1803 • Pussy willow, large pussy willow

Salix ancorifera Fernald; *Salix discolor* Muhlenberg var. *overi* C. R. Ball; *Salix discolor* γ *prinoides* (Pursh) Andersson; *Salix discolor* var. *rigidior* (Andersson) C. K. Schneider

Tall shrubs 2-4 (-8) m; sometimes forming colonies by stem fragmentation. **Stems, branches** dark red-brown or yellow-brown, not glaucous to strongly so, villous or glabrescent, peeled wood smooth or striae sometimes very dense, up to 10 mm; **branchlets** yellowish, red-, or yellow-brown, or dark brown, moderately densely velvety, velutinous, or tomentose to glabrescent; **bud** size gradation *caprea*-type. **Leaves, stipules** on first leaves minute rudiments, on later leaves foliaceous, apex acute to acuminate; **petioles** convex to flat adaxially, 6-17 mm, adaxial surface tomentose; **juvenile blades** reddish or yellowish green, abaxial surface pilose, tomentose or moderately densely short-silky, hair white and ferruginous; **proximal leaves** entire or serrulate; **largest medial blades** narrowly elliptic, elliptic, oblanceolate, or obovate, 30-80 (-135) × 12-33 mm, (2.3-) 3-3.5 (-4.5) times as long as wide; base convex, cuneate, or slightly decurrent; margins flat or slightly revolute, crenate, irregularly toothed, undulate, or entire; apex acute, convex, or acuminate; abaxial surface glaucous, glabrous, pilose, sparsely pubescent or long-silky, midrib glabrous or densely pubescent, hair white and ferruginous or white, wavy; adaxial surface dull or shiny, glabrous or pilose, hair white, or rarely ferruginous. **Catkins** flowering before leaves emerge; **staminate** stout or subglobose, 23-52 × 12-22 mm, flowering branchlet 0-3 mm; **pistillate** densely flowered (loose in fruit), slender or stout, 25-108 (to 115 mm in fruit) × 12-33 mm, flowering branchlet 0-10 mm; **floral bracts** brown, black, or bicolor, 1.4-2.5 mm, abaxial surface hairy all over, hair straight, apex acute or obtuse, entire. **Flowers, staminate** adaxial nectary oblong, 0.6-1.1 mm; anthers yellow or purple becoming yellow, ellipsoid, short-, or long-cylindrical, 0.5-1 mm; filaments distinct, glabrous, hairy at base; **pistillate** adaxial nectary oblong or ovate, 0.7-1.3 mm, shorter than stipe; stipe 2-2.7 mm; ovary obclavate or pyriform, beak gradually tapering to or slightly bulged below styles, short-silky, styles 0.3-1 mm; stigmas slender- or broad-cylindrical, 0.48-0.64-0.72 mm, 6-16 ovules per ovary. **Capsules** 6-11 mm. $2n = 76, 95, 114$.

Flowering early-April to late-May. Marshy margins ponds, creeks, and open alluvial woods, fens, seepage areas; peaty substrate; 5-2440 m; Alta., B.C., Lab., Man., N.B., Nfld., N.W.T., N.S., Ont., P.E.I., Que., Sask.; Conn., Del., Ill., Ind., Iowa, Ky., Maine, Md., Mass., Mich., Minn., Mo., Mont., N.H., N.J., N.C., N.Dak., N.Y., Ohio, Pa., R.I., S.Dak., Vt., Va., W.Va., Wis., Wyo.

Vegetative specimens of *Salix discolor* are difficult to distinguish from *S. planifolia*. There are two, somewhat variable characters that can be used. *Salix discolor* usually has leaves dull adaxially and arcuate secondary veins widely and irregularly spaced; *S. planifolia* has leaves shiny or glossy adaxially and straight secondary veins closely and regularly spaced.

In Northeastern United States *Salix discolor* can be difficult to distinguish from the widely naturalized *S. cinerea* and *S. atrocineae*. Useful diagnostic characters are the tertiary leaf veins which are irregular in *S. discolor* and close and parallel in the introduced species, and the raised striae on the peeled 3-5-year old branches which are absent to indistinct and short in *S. discolor* but long and very prominent in the introductions.

Hybrids

Salix bebbiana × *S. discolor*. See *S. bebbiana*.

Salix candida × *S. discolor*. See *S. candida*.

Salix discolor × *S. eriocephala*. See *S. eriocephala*.

Salix discolor × *S. interior*. See *S. interior*.

Salix discolor × *S. humilis* (*Salix* × *conifera* Wangenheim) has the tomentose leaves of *S. humilis* and the longer catkins and styles of *S. discolor* (Argus 1986a). These species readily hybridized and produce abundant seed (Argus 1974). The hybrids are fertile and backcross. Specimens of *S. discolor* with densely villous branchlets may be hybrids or introgressants with *S. humilis*. The two species generally are ecologically isolated; *S. discolor* occurs in wetland thickets and *S. humilis* in dry, sandy upland forests. Where the two habitats come into close proximity hybrids occur but large swarms have not been observed.

Salix discolor × *S. myricoides* (*S. xlaurentiana*). See *S. myricoides*.

Salix discolor × *S. pellita* (*Salix xpedunculata* Fernald, pro sp.) is characterized by juvenile leaves with infolded or sometimes revolute margins, ovary with patches of hairs composed of short, flattened, crinkled, refractive hairs, and catkins borne on distinct flowering branchlets 2-10 mm long. This sporadic hybrid does not seem to be fertile. It occurs in Newfoundland, Quebec, and Saskatchewan. Although it has been collected at few localities it probably is more common and it should be expected wherever the two species grow together. The type and other collections compare very well with synthetic hybrids (Mosseler 1990), which were reported to show a high hybridization success rate, high F1 pollen viability, and high seedling viability. It was suggested that the variability within these species may be due to interspecific gene flow. In the interpretation of the parentage of wild hybrids it is not possible to rule out hybridization of *S. planifolia* or *S. myricoides* with *S. pellita* or that these hybrids may be *S. myricoides* × *S. planifolia* as suggested by Floderus (1939). *Salix xpellicolor* Lepage is a synonym.

Salix discolor × *S. petiolaris*. Controlled pollinations produced no seed (Mosseler 1990).

Salix elaeagnos Scop., Fl. Carn. 2 ed. 2: 257. 1772 • Hoary willow

Tall shrubs to sometimes multistemmed trees 1-6 (-15) m. **Stems, branches** yellow- or red-brown, glabrous; **branchlets** yellow- or red-brown, densely pubescent or tomentose. **Leaves, stipules** on first leaves absent or minute rudiments, on later leaves minute rudiments; **petioles** shallowly grooved adaxially, 2-5 mm, adaxial surface tomentose or velvety; **juvenile blades** yellowish green, abaxial surface densely tomentose, hair white or gray; **proximal leaves** entire; **largest medial blades** linear, narrowly oblong, narrowly oblanceolate, or very narrowly elliptic, 5-160 × 3-10 (-20) mm, 6.6-16.7-29 times as long as wide; base cuneate, angles less than 90°; margins strongly or slightly revolute, entire or serrulate, glands submarginal or epilaminal; apex acuminate or acute, angles less than 90°; abaxial surface glaucous, densely tomentose or woolly, midrib raised, yellowish, hair appressed, white, curved; adaxial surface dull or shiny, sparsely pubescent to glabrescent, hair white. **Catkins** flowering just before or as leaves emerge; **staminate** stout or slender, 26-34 × 6-10 mm, flowering branchlet 1-1.5 mm; **pistillate** moderately to very densely flowered, slender or stout, 19-40 × 3-10 mm, flowering branchlet 0.25-3.5 mm; **floral bracts** light brown or tawny, 1.5-4 mm, abaxial surface hairy all over, hair straight; apex rounded, truncate, or acute, toothed or entire. **Flowers, staminate** adaxial nectary oblong or square, 0.3-0.88 mm; anthers yellow, 0.5-0.7 mm; filaments connate less or more than half, glabrous, hairy toward base; **pistillate** adaxial nectary oblong or square, 0.3-0.65 mm, shorter or longer than stipe; stipe 0.3-0.5 mm; ovary obclavate, glabrous; styles 0.7-0.9 mm; stigmas slender-cylindrical, 0.22-0.5 mm; 2 ovules per ovary. **Capsules** 3-5 mm. $2n = 38$.

Flowering April to mid-May. Introduced and possibly naturalized; N.S., Ont., Que. (cult.); Conn. (cult.), Maine, Mass. (cult.), S.C. (cult.), Wis. (cult.). Europe.

The occurrence of naturalized *Salix elaeagnos* in the flora area is based on late 19th and early 20th century collections. There is no evidence that it is now either cultivated or naturalized.

Salix eriocephala Michaux, Fl. bor.-amer. 2: 225. 1803 • Missouri willow, diamond willow, heartleaf willow

Salix angustata Pursh; *Salix cordata* Muhlenberg non Michaux; *Salix cordata* Muhlenberg var. *abrassa* Fernald; *Salix missouriensis* Bebb; *Salix rigida* Muhlenberg; *Salix rigida* Muhlenberg var. *angustata*; *Salix rigida* Muhlenberg var. *vestita* (Andersson) C. R. Ball

Tall or mid shrubs 0.2-6 m; sometimes forming colonies by stem fragmentation. **Stems, branches** flexible or highly brittle at base, red-brown, glabrous or glabrescent; **branchlets** yellow- to red-brown, pilose, moderately to very densely velvety, pubescent, or villous. **Leaves, stipules** foliaceous, apex rounded or acute; **petioles** shallowly grooved adaxially, 3-18 mm, leaf blades 4.9-12.3-23.3 times as long as petioles, adaxial surface tomentose; **juvenile blades** reddish or yellowish green, abaxial surface glabrous, pilose, or villous; **proximal blades** entire or shallowly serrulate; **largest medial blades** narrowly oblong, very narrowly elliptic, narrowly elliptic, or obovate, 58-135 × 9-36 mm, 2.3-8 times as long as wide; base cordate, convex, rounded, or subcordate, sometimes cuneate, angles less than 90°; margins flat, serrate or serrulate; apex acute to acuminate, angles less than 90°; abaxial surface glaucous, glabrous, puberulent, sparsely pubescent or short-silky; adaxial surface glabrous or sparsely villous, hair white or white and ferruginous. **Catkins**, staminate flowering just before leaves emerge, pistillate flowering as leaves emerge, **staminate** slender or stout, 19-44 × 7-14 mm, s 0.5-5 mm; **pistillate** densely or moderately densely flowered, slender or stout, 22-65 × 7-14 mm, flowering branchlet 2-10 mm; **floral bracts** dark brown or bicolor, 0.8-1.6 mm, abaxial surface hairy all over, hair wavy; apex rounded, entire. **Flowers, staminate** adaxial nectary narrowly oblong, oblong, or ovate, 0.2-1 mm, anthers yellow or purple becoming yellow, ellipsoid or short-cylindrical, 0.4-0.64 mm, filaments distinct or connate less than half, glabrous; **pistillate** adaxial nectary oblong or flask-shaped, 0.3-0.8 mm, shorter than stipe; stipe 1.2-2.8 mm; ovary pyriform, beak slightly bulged below styles, glabrous, styles 0.3-0.6 mm; stigmas flat, non-papillate abaxial surface and rounded tip, broad-cylindrical, or two plump lobes, 0.16-0.2-0.28 mm, 12-16 ovules per ovary. **Capsules** 3.5-7 mm. $2n=38$.

Flowering early April to mid-June. Gravelly or rocky river and stream banks, in marshy fields, and in mixed mesophytic woods on alluvium; 0-1220 m; Man., N.B., Nfld., N.S., Ont., P.E.I., Que., Sask.; Ala., Ark., Conn., Del., D.C., Fla., Ga., Ill., Ind., Iowa, Kans., Ky., Maine, Md., Mass., Mich., Minn., Mo., Nebr., N.H., N.J., N.Dak., N.Y., Ohio, Pa., R.I., S.Dak., Tenn., Vt., Va., W.Va., Wis.

Hybrids

In controlled pollination using *S. eriocephala* as the maternal parent seeds were rarely produced because of pollen-stigma incompatibility (Mosseler 1989).

Salix bebbiana × *S. eriocephala*. See *S. bebbiana*.

Salix candida × *S. eriocephala* (*S. × rubella* Bebb ex C. K. Schneider). See *S. candida*.

Salix discolor × *S. eriocephala*. Controlled pollinations had low success and many seedlings were abnormal (Mosseler 1990). Report by Fernald (1950) is unconfirmed.

Salix eriocephala × *S. interior*. See *S. interior*.

Salix eriocephala × *S. petiolaris*. Controlled pollinations (Mosseler 1990) had low seed set but high percent seed germination and seedling survival. Because reproductive barriers between these species is weak, it was suggested that their morphological variability may be due to interspecific gene flow (Mosseler 1990). Natural hybrids are known from Ont., Que., Mass., Mich., Ill., N.Y., Maine, Mo., and WVa.

Salix eriocephala × *S. sericea*. This hybrids is relatively common wherever the ranges of the two taxa overlap. It has been studied in the southeastern United States (Argus 1986a) and in eastern Canada. In general, the putative hybrids often resemble *S. eriocephala* but have leaves that are sparsely to moderately densely short-silky on the abaxial surface and ovaries hairy but with glabrous patches toward the base or on the beaks. The stipules may be foliaceous on the first leaves, as in *S. eriocephala*, but they are not as long. *Salix sericea* generally lacks stipules, or they may be minute rudiments and then only on the later leaves. The petioles and branchlets of putative hybrids are finely velvety as in *S. sericea*. This hybrid was first described from Maine (Knight 1907) where it was noted that the catkins were generally abortive but occasionally produced one or two fertile seeds.

A study of hybridization and introgression between *S. eriocephala* and *S. sericea* based on morphological and molecular data (Hardig et al. 2000) revealed complex variation. The morphological data they employed included stipule characters and the density of leaf hairiness on the abaxial surface. Their conclusion that, "... hybrids may be imperfectly intermediate or highly variable, resulting in an interpretation that unrecognized hybrid plants are merely part of the morphological variation in one of the species" may be correct; but additional morphological evidence of hybridization, such as ovary hairiness patterns, could have been used to minimize misidentifications. Morphological characters that can be used to distinguish between these species are given in Table 1.

Table 1. Comparison of *Salix eriocephala* and *S. sericea*

	<i>Salix eriocephala</i>	<i>Salix sericea</i>
Stipules	all foliaceous	with first leaves absent or minute rudiments later leaves minute rudiments to foliaceous
length mm	4-6.2-8.3	1.1-1.6-2.1
width mm	2.5-3.6-4.6	0.4-0.6-0.8
l/w ratio	1.5-1.8-2	2.3-2.8-3
Juv. lvs.	glabrous or sparsely hairy	very densely short-silky
hair color	white	white or white and ferruginous
Leaves		
abaxial surface	glabrous to sparsely villous	densely short-silky
base	convex to cordate	convex to cuneate
Pist. fl. brlts.	2-10 mm	1-3 mm
Ovary	glabrous	densely short-silky
Stipe	1.2-2.8 mm	0.6-1.5 mm
Styles	0.3-0.6 mm	0.2-0.4 mm
Capsules	3.5-7 mm	2.5-4 mm
Ovule #/ovary	12-16 6

Salix fragilis Linnaeus, Sp. pl. 2: 1017. 1753 • Crack willow, brittle willow

Trees 3-15 (-20) m. **Stems, branches** highly brittle at base, yellow-, gray-, or red-brown, glabrous; **branchlets** olive-brown, yellow-green, or red-brown, sparsely pubescent, pilose, or very densely long-silky or velvety; **buds** glabrous. **Leaves, stipules** on first leaves minute rudiments, on later leaves foliaceous, early deciduous, apex acuminate; **petioles** shallowly to deeply grooved adaxially, 4.4-20 mm, with pairs or clusters of stalked spherical or foliaceous glands at distal end, adaxial surface glabrous or puberulent; **juvenile leaves** yellowish green or reddish, abaxial surface glabrous, pubescent, or moderately densely silky; **proximal leaves** entire; **largest medial leaf blades** amphistomatous or hypostomatous, lanceolate, narrowly oblong, or very narrowly elliptic, 70-150 (-180) × 13-30 mm, 3.5-7.5 times as long as wide, base convex to slightly decurrent; margins flat,

irregularly or uniformly serrate, apex acuminate to caudate, abaxial surface glaucous, generally glabrous but sometimes very sparsely silk, hair straight or wavy; adaxial surface shiny or highly glossy, glabrous. **Catkins, staminate** slender or stout, 29-63 × 8-11 mm, flowering branchlet 3-12 mm; **pistillate** catkins loosely flowered, slender; 37-80 × 4-10 mm, flowering branchlet 8-20 mm; **floral bracts** tawny or greenish, 1-3 mm, abaxial surface hairy all over, hair straight, apex acute or rounded, entire or erose; pistillate bracts deciduous after flowering. **Flowers, staminate** abaxial nectary (0.25-) 0.5-0.88 mm, adaxial nectary oblong, 0.3-0.63 mm, abaxial and adaxial nectaries distinct; stamens 2; anthers ellipsoid or short-cylindrical, 0.4-0.7 (-0.80) mm; filaments distinct or connate less than half, hairy on lower half; **pistillate** adaxial nectary oblong or square, 0.3-0.63 mm, shorter than stipe; stipe 0.5-1.5 mm; ovary obclavate, beak gradually tapering to or slightly bulged below styles, glabrous; styles 0.5-0.8 mm; stigmas flat, non-papillate abaxial surface and rounded tip, or two plump lobes, 0.2-0.4 mm; 8-10 ovules per ovary. **Capsules** 4-5 mm. $2n = 76, 114$.

Flowering May and June. Rarely introduced or naturalized; Alta., N.B., Nfld., Ont., Que.; Conn., D.C., Ill., Iowa, Kans., Ky., Maine, Md., Mass., Mich., Minn., Nebr., N.H., N.Y., Pa., R.I., Utah, Vt., Va., Wash., W.Va., Wis. Europe.

The distribution of *Salix fragilis* in the flora area is poorly understood. It is apparently uncommonly cultivated but there are many literature references, most of which apply to the commonly cultivated and widely naturalized *S. ×rubens* (*S. alba* × *S. fragilis*). See the hybrid.

Reports of $2n = 38$ are incorrect (Walter Buechler, pers. comm.)

Salix glauca Linnaeus subsp. **callicarpaea** (Trautvetter) Böcher, Medd. Groenl. 147: 19. 1952

• Gray willow

Salix callicarpaea Trautvetter Nouv. Mém. Soc. Nat. Mosc. 2: 295. 1832; *S. cordifolia* Pursh; *S. cordifolia* var. *eucycla* Fernald; *S. cordifolia* var. *intonsa* Fernald; *S. cordifolia* var. *macounii* (Rydberg) C. K. Schneider; *S. cordifolia* var. *tonsa* Fernald; *S. labradorica* Rydberg

Shrubs 0.2-2.5 m. **Branches** yellow- or red-brown, villous to glabrescent; **branchlets** densely villous to glabrescent. **Leaves, stipules** minute rudiments or foliaceous, 1-4.6 (-6.4) mm, oblong to elliptic or ovate, apex acute to caudate; **petioles** deeply grooved adaxially, 2-9 mm, adaxial surface pilose; **juvenile leaves** sparsely to densely villous or tomentose; **proximal leaves** entire or serrulate; **largest medial blades** sometimes hemiamphistomatous, sometimes broadly obovate, 17-63 × 6-28 mm, 1.4-3.5 times as long as wide; base sometimes rounded or rarely subcordate, apex sometimes rounded, abaxial surface pilose, moderately densely villous or long-silky to glabrescent, hair straight or wavy, adaxial surface sometimes dull, pilose or villous to glabrescent. **Catkins, staminate** 10-48 × 5-14, flowering branchlet 2-25 mm; **pistillate** sometimes subglobose or globose, 18-56 (to 60 mm in fruit) × 7-21 mm, flowering branchlet 2-26 mm; **floral bracts** tawny, brown, or bicolor, hair wavy or straight. **Flowers, staminate** abaxial nectary 0.3-1 mm, adaxial nectary narrowly oblong, oblong, ovate, or flask-shaped, 0.5-1.3 mm, abaxial and adaxial nectaries sometimes connate and cup-shaped, filaments distinct or slightly connate, glabrous or hairy on lower half; **pistillate** adaxial nectary 0.4-1.4 mm; ovary densely villous or tomentose; stipe 0.3-1.3 mm; styles connate to distinct about half their lengths or more, 0.7-1.6; stigmas slender-cylindrical, 0.36-0.48-0.72 mm; 10-18 ovules per ovary. **Capsules** 6-7.5 mm.

Flowering late May-late July. Sand and cobbles among granitic boulders, on sandy alluvium, or on exposed eskers, scree slopes, *Sphagnum* bogs, *Empetrum* heath, and snow beds; 4-3220 m; Greenland; St. Pierre and Miquelon; Lab., Man., Nfld., N.W.T., Nunavut, N.S., Ont., Que.

Salix humilis Marshall, Arbust. amer. 140. 1785 var. **humilis** • Prairie willow, gray willow, small pussy willow, upland willow

Salix humilis Marshall var. *hyporhysa* Fernald; *S. humilis* Marshall var. *keweenawensis* Farwell; *S. humilis* Marshall var. *rigidiuscula* (Andersson) Robinson & Fernald

Mid shrubs 0.3-3 m forming colonies by layering. **Stems** erect (sometimes decumbent), **branches** dark red-brown, not glaucous or weakly so, tomentose to glabrescent, peeled wood smooth or striae sometimes very dense, up to 19 mm; **branchlets** red-brown or greenish brown **bud** size gradation transitional type. **Leaves, stipules** on first leaves absent or minute rudiments, on later leaves foliaceous or rarely minute rudiments, apex acute; **petioles** convex to flat or shallowly grooved adaxially, (1.5-) 3-7 (-12) mm, adaxial surface velvety or pilose, **proximal blades** entire or serrulate; **juvenile blades** yellowish green, abaxial surface densely tomentose or glabrescent, hair white or white and ferruginous; **largest medial blades** narrowly oblong, narrowly elliptic, elliptic, oblanceolate, obovate, or broadly obovate, (20-) 50-90 (-135) × (7-) 13-23 (-35) mm, 2.3-4-7.5 times as long as wide; base cuneate, convex, or slightly decurrent; margins strongly revolute to flat margins entire, crenate, or undulate, glands submarginal; apex acuminate or convex; abaxial surface glaucous, sparsely to densely tomentose or woolly, hairs erect or spreading, white, rarely white and ferruginous, wavy; adaxial surface shiny or highly glossy, glabrous, pubescent, or pilose, hair white or white and ferruginous. **Catkins** flowering before leaves emerge, moderately to very densely flowered, stout, subglobose, or globose; **staminate** 14.5-34 × 7-19 mm, flowering branchlet 0 mm; **pistillate** 9-47 (to 55 mm in fruit) × 5.5-19 mm, flowering branchlet 0-4 mm; **floral bracts** brown, black, or bicolor, 1.2-2 mm, abaxial surface moderately densely hairy all over, hair white, straight or wavy, apex rounded or acute, entire. **Flowers, staminate** adaxial nectary oblong or square, 0.2-0.7 mm; anthers purple becoming yellow, ellipsoid or cylindrical, 0.4-0.6 mm; filaments distinct, glabrous; **pistillate** adaxial nectary square, 0.4-0.75 mm, shorter than stipe, stipe 1-2.5 mm, ovary obclavate, beak slightly bulged below styles, valves recurving in fruit, moderately densely to sparsely, short-silky-villous, hair refractive; styles connate or slightly distinct at distal ends, 0.2-0.44 mm; stigmas slender-to broad-cylindrical, stigmas 0.24-0.33-0.56 mm, 6-12 ovules per ovary. **Capsules** 7-12 mm. 2n = 38 or 76.

Flowering early March to early June in north, late January to late April in south. Dry mixed woods and forests, *Picea mariana* - lichen woods, *Picea glauca* – *Abies balsamea* forests, wet to dry prairies, grassy balds, loess bluffs, sandy river terraces, coastal barrens, *Carex* – *Typha* meadows; fine sand to rocky granitic, gneissic, limestone, and serpentine substrates; 20-1640 m; Lab., Man., N.B., Nfld., N.S., Ont., P.E.I., Que.; Ala., Ark., Conn., Del., D.C., Fla., Ga., Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Mass., Mich., Minn., Miss., Mo., Nebr., N.H., N.J., N.C., N.Dak., N.Y., Ohio, Okla., Pa., R.I., S.C., Tenn., Tex., Va., W.Va., Wis.

There are two varieties of *Salix humilis*, var. *humilis* and var. *tristis*. Their ranges are almost sympatric. In Maine they occur in the same populations without evident intermediate forms while in other places, e.g. Florida, Georgia, and Nebraska, they apparently intergrade. Generally, however, they are distinct in habit, size of leaves and catkins and, most conspicuously, the presence of foliaceous stipules in var. *humilis* and their absence in var. *tristis*.

Hybrids

Salix bebbiana × *S. humilis*. See *S. bebbiana*.

Salix discolor × *S. humilis* (*Salix* × *conifera* Wangenheim). See *S. discolor*.

Salix eriocephala × *S. humilis*. See *S. eriocephala*.

Salix humilis with glabrous or glabrate leaves may be hybrids with *S. discolor* or *S. planifolia*.

Salix interior Rowlee, Bull. Torrey Bot. Club 27: 253. 1900 • Sandbar willow

Salix exigua Nuttall var. *exterior* (Fernald) C. F. Reed; *S. exigua* subsp. *interior* (Rowlee) Cronquist; *S. exigua* var. *pedicellata* (Andersson) Cronquist; *S. exigua* var. *sericans* (Nees) Nesom; *S. fluviatilis* var. *sericans* (Nees) Boivin; *S. interior* var. *exterior* Fernald; *S. interior* var. *pedicellata* (Andersson) C. R. Ball; *S. interior* var. *wheeleri* Rowlee; *S. linearifolia* Rydberg; *S. longifolia* Muhlenberg non Lambert; *S. longifolia* var. *interior* (Rowlee) M. E. Jones; *S. longifolia* (var.) *pedicellata* Andersson; *S. longifolia* var. *sericans* Nees; *S. longifolia* var. *wheeleri* (Rowlee) C. K. Schneider; *S. wheeleri* (Rowlee) Rydberg

Shrubs or trees to 4-9 m. **Stems, branches** densely tomentose or villous to glabrescent. **Leaves, stipules** on first normal leaves absent or minute rudiments, on later leaves minute rudiments or foliaceous; **petioles** 1-5 (-9) mm, adaxial surface glabrous or sparsely villous; **juvenile leaves** reddish or yellowish green, abaxial surface moderately densely to sparsely long-silky; **largest medial leaf blades** 60-160 × 4-11 mm, (6.5-) 11-19 (-31) times as long as wide; base, cuneate to slightly decurrent; margins flat, remotely spinulose-serrulate; apex acute or subacuminate; abaxial surface thinly glaucous, densely villous or long-silky to glabrescent; adaxial surface shiny, pilose or densely villous to glabrescent. **Catkins, staminate** 20-61 × 4-10 mm; flowering branchlet 3-20 mm; **pistillate** loosely flowered, slender or stout, 20-67 × 5-9 mm; flowering branchlet 3-19 mm; **floral bracts** tawny or greenish 1.5-3.5 mm, abaxial surface hairy mainly at proximal or at distal end, hair wavy; apex acute, acuminate, or rounded, entire, erose, or toothed. **Flowers, staminate** abaxial nectary 0.5-1.1 mm, adaxial nectary ovate, narrowly oblong, or flask-shaped, 0.6-1.4 mm; anthers 0.4-0.9 mm; **pistillate** adaxial nectary narrowly oblong, 0.4-1.1 mm, shorter to longer than stipe; stipe 0.4-0.8 mm; ovary beak abruptly tapering to style, long-silky or glabrescent; styles 0-0.2 mm; stigmas with flat, not papillate abaxial surface and pointed tip, or broad-cylindrical, 0.32-0.72 mm. **Capsules** (4-) 5-8 (-10) mm. $2n = 38$.

Flowering early April to early July. Sandy to silty floodplains of rivers and creeks, margins of lake, ponds and prairie sloughs, dry prairie sand hills and marshes, disturbed areas, forming large clones; 15-1770 m; Alta., B.C., Man., N.B., N.W.T., Ont., Que., Sask., Yukon; Alaska, Ark., Colo., Conn., Del., D.C., Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Mich., Minn., Miss., Mo., Mont., Nebr., N.J., N.Dak., N.Y., Ohio, Okla., Pa., S.Dak., Tenn., Tex., Va., W.Va., Wis., Wyo. Mexico (Tamaulipas, Veracruz) (Little 1976).

Sometimes this species is treated as *S. exigua* Nuttall subsp. *interior* (Rowlee) Cronquist (Dorn 1998b). *Salix exigua* and *S. interior* hybridize and apparently intergrade in the western Great Plains; but, because the area of overlap is relatively small and the distinctiveness of the two species is not compromised by the hybridization and introgression that may take place, it is best to treat them as species.

This species sometimes has shoots that arise from buds adjacent to the central axillary buds. They seem not to be related to the stipules because they are enclosed by the petiole. This not known to occur elsewhere in the genus and deserves further study.

Hybrids

Controlled pollinations using *Salix interior* (as *S. exigua*) from southern Ontario (Mosseler 1990) successfully produced F₁ hybrids with *Salix bebbiana*, *S. discolor*, *S. eriocephala* and *S. petiolaris*. Seed production was generally low, except in crosses with *S. discolor*. In general F₁ viability was low in crosses with these members of subg. *Vetrix*. No seeds were produced in crosses with members of the subgenera *Protitea* or *Salix*. The morphology of the hybrids generally was intermediate between the two parents, but when *S. petiolaris* was used as the maternal parent the F₁s more closely resembled that species. Salick and Peffer (1999) extended these finding to show that although crosses between *S. interior* (as *S. exigua*) and *S. eriocephala* are partially sterile their clonal growth

parameters (sprouting, shoot length, and biomass production) are strong and thus permit these partially sterile hybrids to exist as successful individuals and perhaps to "... make a contribution to interspecific gene flow over time." Of particular taxonomic interest is that in this cross the male parent has a significant influence on leaf shape whereas in the cross *S. eriocephala* × *S. petiolaris* it is the female parent that is significant to leaf shape. Hybrids resembling those produced by A. Mosseler have not been recognized in nature; but it is possible that the unusually broad-leaved plants named *Salix interior* var. *exterior* and var. *wheeleri*, from Nebraska, New York, West Virginia, and northern Maine and probably elsewhere, may be hybrids. Phenological isolation may be strong enough to prevent mating in nature (Mosseler and Papadopolus 1998), but it is probably easily overridden by *S. exigua*, which produces sylleptic catkins throughout the year.

Salix eriocephala × *S. interior* reported by Fernald (1950) but unconfirmed.

Salix lucida Muhlenberg, Ges. Naturf. Freunde Berlin II. 4: 239. 1803 • Shining willow.

Pleiarina lucida (Muhlenberg) N. Chao & G. T. Gong; *S. lucida* var. *angustifolia* (Andersson) Andersson; *S. lucida* var. *intonsa* Fernald

Tall shrubs or trees 4-6 m. **Stems, branches** yellow-, or gray- or red-brown, shiny to highly glossy, glabrous or villous to glabrescent; **branchlets** yellow-, gray- or red-brown, glabrous, pilose or very densely villous or velvety, hair spreading, straight, wavy or crinkled. **Leaves, stipules** foliaceous, apex convex to rounded; **petioles** shallowly to deeply grooved adaxially, 5-13 mm, with clusters of spherical or foliaceous glands at distal end, adaxial surface glabrous, pilose, or densely villous; **juvenile leaves** reddish or yellowish green, abaxial surface glabrous or densely villous or long-silky, hair white and ferruginous; **proximal leaves** entire and glandular dotted, serrulate or crenulate; **largest medial blades** hypostomatous, hemiamphistomatous, or sometimes amphistomatous, lorate, very narrowly elliptic, narrowly elliptic, or lanceolate, (24-) 55-133 × 11-43 mm, 2.5-6.2 times as long as wide, base convex, cuneate, or slightly decurrent; margins flat, serrulate, apex acuminate to caudate, abaxial surface not glaucous (rarely so), glabrous, pilose, or moderately densely villous or long-silky, hair appressed or spreading, white and/or ferruginous, straight or wavy, coarse, and caducous, adaxial surface shiny or highly glossy, glabrous, pilose, or long-silky, hair white and/or ferruginous. **Catkins, staminate** stout or slender, 19-69 × 4-14 mm, flowering branchlet 5-23 mm; **pistillate** moderately densely to loosely flowered, slender to stout, 23-56 (to 70 mm in fruit) × 8-12 mm, flowering branchlet 8-25 mm; **floral bracts** 1.5-3 mm abaxial surface sparsely hairy all over or mainly at proximal end, hair wavy, apex convex or rounded, entire or toothed; pistillate bracts deciduous after flowering. **Flowers, staminate** abaxial nectary 0.45-1.1 mm, adaxial nectary square or ovate, 0.3-0.85 mm, abaxial and adaxial nectaries connate and cup-shaped; stamens 3-6; anthers ellipsoid, short-cylindrical, obovoid, or globose, 0.6-0.8 mm; filaments distinct, hairy on lower half or at base; **pistillate** abaxial nectary absent; adaxial nectary square or ovate, 0.2-0.45 mm, shorter than stipe; stipe 0.5-2 mm; ovary pyriform, beak slightly bulged below or gradually tapering to styles, styles connate or distinct about half, 0.5-0.8 mm; stigmas flat, non-papillate abaxial surface and rounded tip, broad-cylindrical, or two plump lobes, 0.24-0.31-0.42 mm; 18-24 ovules per ovary. **Capsules** 5-7 mm. 2n = 76.

Flowering from early May to mid-July. Sandy or gravelly floodplains of rivers and streams and lake margins, sedge meadows, vernal pools, alvars, open fens, marl bogs, treed bogs; 3-600 m; St. Pierre and Miquelon. Lab., Man., N.B., Nfld., N.S., Ont., P.E.I., Que., Sask.; Conn., Del., Ill., Ind., Iowa, Maine, Md., Mass., Mich., Minn., N.H., N.J., N.Dak., N.Y., Ohio, Pa., R.I., S.Dak., Vt., Va. (naturalized), W.Va., Wis. Endemic

The *Salix lucida* complex is a group of three weakly delimited taxa, *S. lucida*, *S. lasiandra* var. *lasiandra*, and *S. caudata* var. *caudata*. The morphological characters used to separate them, namely,

leaves amphistomatous or hypostomatous and leaf blades glaucous abaxially or not are generally geographically correlated, but there are exceptions. It was proposed (Argus 1986b), based on principal components analysis of morphological data, to treat them as a single species consisting of three subspecies. The area of overlap between the northeastern *S. lucida* and the western *S. lasiandra*, however, is a very small area in central Saskatchewan. Evidence of intergradation was based on the cultivation of a plant which in the wild had leaves that were not glaucous abaxially but were glaucous in cultivation. It seems best to treat them as two species, *S. lucida* and *S. lasiandra* the latter with two varieties, var. *lasiandra* and var. *caudata*.

Hybrids

Salix alba × *S. lucida* (*Salix* × *jesupi* Fernald, Rhodora 48: 38. 1946) is characterized by leaves glaucous abaxially but with juvenile and mature leaves with white and ferruginous hair. In North America it was mistaken for the European *Salix* × *ehrhartiana* G. Meyer (*S. alba* Linnaeus × *S. pentandra* Linnaeus) (Argus 1986a). Study of nectary morphology confirmed that the North American plants were not the same as the European hybrid. In herbaria, *S. ×jesupii* often is misidentified as *S. alba*, *S. fragilis*, *S. ×rubens*, or *S. lucida*. The two putative parents generally occur in the same area as the hybrids but plants from Kentucky, Virginia, West Virginia, and Ohio (Braun 1961) are from just outside the range of *S. lucida*; they may be cultivated introductions.

Salix lucida × *S. nigra* (*Salix* × *schneiderii* B. Boivin), however, seems to be a rare intersubgeneric hybrid between the tetraploid *S. lucida* and the diploid *S. nigra*. It is known only from the type specimen, an infertile plant, growing with both parents. It resembles *S. lucida* in bud scale margins connate, petiolar glands stalked or foliaceous, and in leaf shape and *S. nigra* in stipules rudimentary on proximal leaves and sometimes even on the first leaves, stipule apex acute, pistillate catkins long and slender, and short styles.

Salix myricoides Muhlenberg, Ges. Naturf. Fr. Neue Schr. 4: 235. 1803 • Blue-leaf willow

Salix glaucophylla Bebb var. *albovestita* C. R. Ball; *Salix glaucophylloides* Fernald; *Salix glaucophylloides* Fernald var. *albovestita* (C. R. Ball) Fernald; *Salix glaucophylloides* var. *glaucophylla* (Bebb) C. K. Schneider; *Salix myricoides* Muhlenberg var. *albovestita* (C. R. Ball) Dorn

Low to tall shrubs 0.25-5 m; sometimes forming colonies by stem fragmentation, or layering. **Stems, branches** flexible or highly brittle at base, red- or yellow-brown, shiny or highly glossy, not glaucous or weakly so, glabrous or villous; **Branchlets** red- or yellow-brown, glabrous or sparsely to very densely villous; **bud** size gradation *caprea*-type. **Leaves, stipules** on first leaves minute rudiments or foliaceous, on later leaves foliaceous, apex acute or acuminate; **petioles** shallowly grooved or convex to flat adaxially, 3.5-7.3-13 mm, not glandular or occasionally with paired spherical glands at distal end, adaxial surface villous, tomentose, pilose, or pubescent; **juvenile blades** reddish or yellowish green, translucent, abaxial surface glabrous or sparsely pubescent, midrib often very densely hairy, hair white or white and ferruginous; **proximal leaves** entire or serrulate; **largest medial blades** narrowly oblong, narrowly elliptic, elliptic, or oblanceolate, 35-61.3-110 × 11-16-46 mm, 2-2.7-5.2 times as long as wide; base convex, rounded, subcordate, or cuneate, angles less than 90°; margins flat or slightly revolute (thickened and raised), crenulate or serrulate; apex acuminate, acute, or convex, angles less than 90°; abaxial surface glaucous, glabrous or pilose, midrib pubescent to tomentose, hair white or white and ferruginous, curved, wavy, or straight; adaxial surface shiny, glabrous or pilose, midrib sparsely pubescent, hair white or white and ferruginous. **Catkins**, pistillate flowering as leaves emerge, staminate flowering before leaves emerge; **staminate** stout or slender, 23.5-35.6-51 × 9-12.7-22 mm, flowering branchlet 1-3.9-10 mm; **pistillate** loosely flowered, stout or slender, 19-42-62 (to 85 in fruit) × 8-13-18 mm, flowering branchlet 1.5-5.9-13 mm; **floral bracts** brown or bicolor, 1.2-1.8-3 mm, abaxial surface hairy all over, hair straight or wavy; apex rounded or acute, entire or toothed. **Flowers, staminate** adaxial nectary narrowly oblong, oblong, square, or

ovate, 0.44-0.48-1.4 mm; anthers yellow, ellipsoid or globose, 0.52-0.69-0.76 mm; filaments distinct), glabrous; **pistillate** adaxial nectary oblong, narrowly oblong, square, or flask-shaped, 0.56-0.8-1.4 mm, shorter than stipe. stipe 0.96-1.7-3.4 mm; ovary pyriform, beak slightly bulged below styles, styles connate or distinct about half, 0.3-0.8-1.3 mm; stigmas flat, non-papillate abaxial surface and rounded or pointed tip, or slender-cylindrical, 0.24-0.43-0.56 mm, 12-14 ovules per capsule. **Capsules** 5-7-11 mm.

Flowering early April to early July. Stream and lake shores, gravel river bars, subalpine conifer forests, alkaline fens, sea cliffs, dry limestone talus, swamps, tidal meadows, and sand dunes; 0-1070 m; N.B., Nfld., Ont., Que.; Ill., Ind., Maine, Mich., Ohio, Pa., Wis.

Plants with densely villous branchlets and branches have been named *S. myricoides* var. *albovestita* (C. R. Ball) Dorn. Branchlet indumentum, however, varies widely in the species and seems to be continuous, with both villous and glabrous variants sometimes occurring in the same area. This character is more common in populations on the shores of the Great Lakes and on the western coast of James Bay but even these populations are variable.

Hybrids

Salix bebbiana × *S. myricoides*. See *S. bebbiana*.

Salix discolor × *S. myricoides* (*Salix* × *laurentiana* Fernald, pro sp. 1907, syn. *S. paraleuca* Fernald (1914) generally resembles *Salix myricoides* but has hairy ovaries (Dorn 1975, 1976). The binomial name, which is applied to this hybrid, was described as a species from the lower St. Lawrence River, Quebec. Its most unique feature is that the hair appears on the ovary in patches, at its base or, sometimes, only on the stipe. A similar ovary indumentum pattern appears in other putative hybrids or species of hybrid origin, e.g. *S. hookeriana*. Characters of *S. discolor* found in *S. ×laurentiana* include epidermis with gray-margined splits, leaf margins entire or undulate, leaves with 2-4 teeth per cm., anthers yellow or purple, filaments hairy on lower half or at base, ovaries greenish brown or green with red sutures, as well as hairy, adaxial pistillate nectaries ovate. Characters of *S. myricoides* include inner bud scales separating from the other, more prominent stipules, catkins on distinct flowering branchlets, and longer styles sometimes distinct about half. This hybrid occurs throughout the area of overlap between the putative parents. All three taxa often are intermixed but few hybrids seem to produce well-developed seed.

Salix eriocephala × *S. myricoides*. See *S. eriocephala*

Salix glauca subsp. *callicarpaea* × *S. myricoides* (*S. ×amoena* Fern.). See *S. glauca* subsp. *callicarpaea*.

Salix nigra Marshall, Arbust. amer. 139. 1785 • Black willow

Salix nigra var. *falcata* (Pursh) Torr.; *S. nigra* var. *lindheimeri* C. K. Schneider

Trees 5-20+ m. **Stems, branches** highly brittle at base, red- to yellow-brown, glabrous; **branchlets** gray- to red-brown, glabrous or pilose. **Leaves, stipules** on first leaves minute rudiments or foliaceous, on later leaves generally foliaceous, (few glands, if any, on adaxial surface), apex acuminate, acute, or rounded; **petioles** (2-) 3-10 (-15) mm, with spherical glands at distal end, adaxial surface glabrous or pilose; **juvenile leaves** abaxial surface glabrous or pilose, hair white and/or ferruginous; **proximal leaves** serrulate; **largest medial blades** hypostomatous or amphistomatous, very narrowly elliptic, lanceolate to narrowly so, or linear to lorate, (50-) 70-103 (-190) × (6-) 7.5-17 (-23) mm, 6-13 times as long as wide; base cuneate to convex, margins flat, serrulate; apex acuminate, acute, or caudate, abaxial surface not glaucous, glabrous or pilose, hair white or ferruginous, wavy, adaxial surface shiny, glabrous or pilose, especially on midribs. **Catkins; staminate** 35-83 × 7-13 mm; flowering branchlet 5-35 mm; **pistillate** 23-74 (to 80 mm in fruit) × 5-

10 mm; flowering branchlet 6-35 mm; **floral bracts** 1-3 mm, abaxial surface sparsely hairy all over, hair wavy, apex acute or rounded, entire. **Flowers, staminate** abaxial nectary 0.3-1 mm, adaxial nectary oblong to ovate, 0.2-0.63 mm, abaxial and adaxial nectaries distinct or connate and shallowly cup-shaped; stamens 4-6; anthers 0.4-0.6 mm, (axes strongly recurved); filaments generally distinct, hairy on lower half or at base; **pistillate** adaxial nectary oblong, (swollen), 0.2-0.53 mm, shorter than stipe; stipe 0.5-1.5 mm; ovary pyriform to obclavate, beak slightly bulged below styles, glabrous (very rarely pilose); styles 0.1-0.25 mm; with flat, non-papillate abaxial surface and rounded tip, or two plump lobes, 0.2-0.28-0.36 mm; 12-16 ovules per ovary. **Capsules** 3-5 mm. $2n = 38$.

Flowering in the south from early February to early May, and in the north from late March to early July. River margins and floodplains, edges of ponds and lakes, swamps, marshes, white cedar bogs, wet meadows, open fields, and roadside ditches, as well as in mixed upland deciduous woods along rivers; 11-1375 m; N.B., Ont., Que.; Ala., Ark., Conn., Del., D.C., Fla., Ga., Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Mass., Mich., Minn., Miss., Mo., Nebr., N.H., N.J., N.C., N.Y., Ohio, Okla., Pa., R.I., S.C., Tenn., Tex., Vt., Va., W.Va., Wis.; Mexico (Chihuahua).

Hybrids

Salix alba × *S. nigra*. See *S. alba*.

Salix lucida × *S. nigra* (*S. ×schneiderii* B. Boivin). See *S. lucida*.

Salix pedicellaris Pursh, Fl. Am. Sept. 2: 611. 1814 • Bog willow.

S. myrtilloides var. *hypoglauca* (Fernald) C. R. Ball; *S. pedicellaris* var. *hypoglauca* Fernald; *S. pedicellaris* var. *tenuescens* Fernald

Low to mid shrubs 0.2-1.5 m, forming colonies by layering. **Stems** erect, decumbent or trailing; **branches** gray-brown, shiny or highly glossy, glabrous; **branchlets** yellow-brown or red-yellow, glabrous or puberulent, hair straight, minute. **Leaves, stipules** absent or minute rudiments; **petioles** deeply to shallowly grooved adaxially, 3-8 mm, adaxial surface glabrous or puberulent; **juvenile leaves** reddish or yellowish green, abaxial surface, glabrous, puberulent, or sparsely pubescent, hair white or white and ferruginous; **proximal leaves** entire; **largest medial blades** hypostomatous, narrowly oblong, oblong, or narrowly elliptic, elliptic, broadly elliptic, narrowly oblanceolate or oblanceolate, 19-53 (-69) × 5-20 mm, 1.8-4.9 times as long as wide, base convex or rounded, angles less than 90°; margins flat or slightly revolute, entire, apex acute, convex, or rounded, abaxial surface glabrous, adaxial surface dull, glaucous, glabrous (rarely very sparsely short-silky, hair white or white and ferruginous). **Catkins, staminate** 11-21 × 4-8 mm, flowering branchlet 3-12 mm; **pistillate** loosely flowered, stout or subglobose, 14-37 × 5-14 mm, flowering branchlet 7-25 mm; **floral bracts** tawny or light rose, 0.8-1.6 mm, abaxial surface very sparsely hairy at distal end, hair straight or wavy, apex rounded, entire. **Flowers, staminate** adaxial nectary oblong or narrowly oblong, 0.5-1.1 mm; anthers yellow, ellipsoid, 0.4-0.6 mm; filaments distinct or connate less than half, glabrous or hairy on lower half or at base; **pistillate** adaxial nectary oblong, 0.2-1.4 mm, shorter or longer than stipe; stipe 2.1-3.2 mm; ovary obclavate, often glaucous, glabrous; styles connate or distinct about half their lengths, 0.1-0.24 mm; stigmas flat, non-papillate abaxial surface and rounded tip, or two plump lobes, 0.2-0.25-0.36 mm; 4-6 ovules per ovary. **Capsules** 4-8 mm. $2n = 38, 57, 76$.

Flowering mid-April to mid-July. *Sphagnum* bogs, fens, and black spruce treed bogs; 5-1440 m; St. Pierre and Miquelon; Alta., B.C., Lab., Man., N.B., Nfld., N.W.T., N.S., Ont., Que., Sask., Yukon; Conn., Idaho, Ill., Ind., Iowa, Maine, Mass., Mich., Minn., N.H., N.J., N.Dak., N.Y., Ohio, Oreg., Pa., R.I., Vt., Wash., Wis.

Salix pedicellaris is a very distinct species with a decumbent habit, leathery, glabrous leaves which are glaucous on both surfaces; loosely flowered catkins; ovaries reddish, glabrous and often glaucous, and long stipes (2.1-3.2 mm). In our flora it hybridizes with six other species, see below. This compares with the closely related European *S. myrtilloides* Linnaeus, which is reported in Flora Nordica (Jonsell 2000) to hybridize with seven species. Its distinctive appearance may make hybrids easily recognizable but it is complex cytologically. Chromosome numbers of $2n = 38$ (A. Löve 1954), $2n = 76$ (Löve & Ritchie 1966) and $2n = 57$ (Suda & Argus 1969) have been reported. Although there are no voucher specimens for the Löve counts the triploid count, based on typical *S. pedicellaris*, suggests that their specimens were correctly identified. It is possible that large *S. pedicellaris* populations consist of diploids, autotetraploids and their triploid “hybrids.”

Hybrids

Salix candida × *S. pedicellaris*. See *S. candida*.

Salix eriocephala × *S. pedicellaris*. See *S. eriocephala*.

Salix glauca subsp. *callicarpaea* × *S. pedicellaris*. See *S. glauca* subsp. *callicarpaea*.

Salix pedicellaris × *S. pellita* (*S. ×jamesensis* Lepage). See *S. pellita*.

Salix pellita (Andersson) Bebb, Bot. Gaz. 16: 106. 1891 • Satiny willow

Salix chlorophylla Andersson **Salix pellita* Andersson, Kongl. Svenska Vetensk. Akad. Handl. II, 6(1): 139. 1867.

Mid to tall shrubs 0.5-6 m; sometimes forming colonies by stem fragmentation. **Stems, branches** highly to somewhat brittle at base, red-brown, violet or yellow-brown, generally strongly glaucous, glabrescent; **branchlets** yellow- or red-brown, generally strongly glaucous, glabrous or densely to sparsely pubescent or tomentose; **bud** size gradation *caprea*-type. **Leaves, stipules** on first leaves absent or minute rudiments, on later leaves foliaceous, minute rudiments, or absent; **petioles** convex to flat or shallowly grooved adaxially, 3-6.3-14 mm, sometimes with dark spherical glands at distal end, adaxial surface glabrous or pubescent; **juvenile blades** reddish or yellowish green, abaxial surface densely tomentose, short-silky, pubescent or glabrous, hair white or white and ferruginous; **proximal leaves** entire; **largest medial blades** linear, lorate, or narrowly elliptic 40-79-123 × 6-12-20 mm, (2.3-) 4.2-7.2-1.3 times as long as wide; base convex, cuneate, or slightly decurrent, angles less than 90°; margins strongly or slightly revolute, glands submarginal or epilaminal, entire, undulate or sometimes crenulate; apex acuminate to acute, angles less than 90°; abaxial surface glaucous or obscured by hair, densely villous, short-silky, woolly, or tomentose to glabrescent, hair white or white and ferruginous, straight or wavy; adaxial surface shiny to highly glossy, glabrous, sparsely villous or pubescent, hair white or white and ferruginous. **Catkins** flowering before leaves emerge; **staminate** 20-39 × 7-20 mm, flowering branchlet 0-2 mm; **pistillate** densely flowered, slender, stout, or subglobose, 19-65 (to 90 mm in fruit) × 7-17 mm, flowering branchlet 0-7 mm; **floral bracts** tawny, brown, or black, 1-2.6 mm, abaxial surface hairy all over, hair straight; apex acute, convex, or rounded, entire. **Flowers, staminate** adaxial nectary oblong or narrowly oblong, 0.6-1 mm; anthers purple becoming yellow, ellipsoid, 0.4-0.6 mm; filaments distinct, glabrous or hairy at base; **pistillate** adaxial nectary oblong to depressed-ovate, 0.25-1 mm, shorter than or equal to stipe; stipe 0.5-1.1 mm; ovary pyriform, beak gradually tapering to or slightly bulged below styles, short-silky, styles 0.6-1.5 mm; stigmas slender-cylindrical, 0.4-0.55-0.76 mm, 10-18 ovules per ovary. **Capsules** 3.5-6.5 mm. $2n = 38, 76$.

Flowering late April to late June. Sandy or gravelly river floodplains, stream and lake margins, marshes, fens, and coastal dunes; substrate often metamorphic or calcareous; 5-762 m. St. Pierre and Miquelon; Lab., Man., N.B., Nfld., N.S., Ont., Que., Sask.; Maine, Mich., Minn., N.H., Vt., Wis.

Salix pellita occasionally has foliaceous stipules on the later leaves. When present they are correlated with hairy rather than glabrous branchlets. There is no clear evidence of hybridity in such specimens but further study is indicated.

Hybrids

Salix discolor × *S. pellita* (*Salix* × *pedunculata* Fernald). See *S. discolor*.

Salix pedicellaris × *S. pellita* (*Salix* × *jamesensis* Lepage) was described from the west coast of James Bay, Ontario. It is to be expected throughout northern Ontario and Quebec. According to Lepage (1964) its yellowish midveins and the hairiness of the floral bracts superficially resembles *Salix pellita* f. *psila* C. K. Schneider (syn. *S. pellita* f. *denudata*), but its reticulate leaf venation resembles *Salix pedicellaris*.

Salix pellita × *S. petiolaris*. The leaves of this putative hybrid are distinctly serrate and flat, as in *S. petiolaris*, but the branchlets are glaucous and the buds gradation is of the *caprea*-type as in *S. pellita*. It is uncommon in eastern Saskatchewan.

Salix pellita × *S. planifolia* is suspected to occur in Newfoundland, Labrador and Ontario. Both are tetraploids and flower at the same time. *Salix pellita* f. *psila* may be this hybrid.

Salix pentandra Linnaeus, Sp. pl. 2: 1016. 1753 • Bay-leaf willow, laurel willow.

Tall shrubs or trees 5-15 m. **Stems, branches** flexible at base, brownish or yellow-green, highly glossy, glabrous; **branchlets** yellow-green or red-brown or brownish, glossy, glabrous; **stipules** on first leaves absent or minute rudiments, on later leaves minute rudiments or foliaceous, apex rounded. **Leaves, petioles** deeply to shallowly grooved adaxially, 5-15 mm, with pairs or clusters of spherical glands at distal end or scattered along petioles, adaxial surface glabrous; **juvenile leaves** reddish, glabrous; **proximal leaves** entire or serrulate; **largest medial blades** hypostomatous; narrowly elliptic, elliptic, or lanceolate, 50-135 × 20-50 mm, 2-4 times as long as wide; base convex or slightly decurrent; margins slightly revolute or flat, serrulate; apex acuminate; abaxial surface not glaucous (but pale), glabrous; adaxial surface highly glossy, glabrous. **Catkins, staminate** slender or stout, 27-81 × 9-13 mm, flowering branchlet 9-21 mm; **pistillate** moderately to very densely flowered, slender or stout, 29-68 × 7-15 mm, flowering branchlet 9-42 mm; **floral bracts** 2-4 mm, abaxial surface sparsely hairy mainly at proximal end, hair wavy or straight, apex acute or rounded to truncate, entire or toothed. **Flowers, staminate** abaxial nectary 0.58-1.68 mm, adaxial nectary square, ovate, or oblong, 0.5-1.5 mm, abaxial and adaxial nectaries distinct or ±connate and cup-shaped; stamens 4-10; anthers ellipsoid or globose, 0.5-0.6 mm; filaments distinct, hairy on lower half; **pistillate** adaxial nectary oblong, square, or ovate, 0.4-0.8 mm, shorter than or equal to stipe, abaxial and adaxial nectaries distinct or connate and shallowly cup-shaped; stipe 0.5-1.6 mm; ovary pyriform, glabrous; styles connate to distinct, 0.4-0.6 mm; stigmas flat, non-papillate abaxial surface and rounded tip, or slender-cylindrical, 0.36-0.6 mm; 18-22 ovules per ovary. **Capsules** 6-9 mm. 2n = 76.

Flowering late May to mid-June. Introduced and occasionally naturalized; to 2040 m; Alta., B.C., Man., N.B., Nfld., N.S., Ont., Que., Sask.; Alaska, Colo., Conn., D.C., Ill., Iowa, Ky., Maine, Md., Mass., Minn., Mont., Nebr., N.H., N.J., N.C., N.Y., Pa., R.I., S.Dak., Vt., Va., Wis., Wyo. Eurasia.

Only pistillate plants of *Salix pentandra* are known to occur in the flora area.

Salix petiolaris Smith, Trans. Linn. Soc. 6: 122. 1802 • Meadow willow

Salix gracilis Andersson; *S. gracilis* var. *textoris* Fernald; *S. petiolaris* Smith var. *gracilis* (Andersson) Andersson; *S. ×subsericea* (Andersson) C. K. Schneider

Tall shrubs 1-6 m. **Stems, branches** red-brown or violet, dull or shiny, not glaucous or weakly so, puberulent; **branchlets** yellowish, not glaucous or weakly so, sparsely pubescent or moderately densely velvety; **bud** size gradation transitional type. **Leaves, stipules** minute rudiments or absent; **petioles** shallowly grooved adaxially, 3-11 mm, adaxial surface pubescent or velvety to glabrescent; **juvenile blades** yellowish green, abaxial surface moderately densely long-silky, hair white or white and ferruginous; **proximal leaves** entire or serrulate; **largest medial blades** lorate or very narrowly elliptic, 38-110 × 6-19 mm, 5-9 times as long as wide; base cuneate or convex, angles less than 90°; margins flat to slightly revolute, entire, serrate, serrulate, or spinulose-serrate; apex acute to acuminate, angles less than 90°; abaxial surface glaucous, densely long-silky or glabrescent, hair white or white and ferruginous, straight; adaxial surface dull or shiny, glabrous or sparsely pubescent, hair white or white and ferruginous. **Catkins** flowering as leaves emerge; **staminate** stout, subglobose, or globose, 12-29 × 6-17 mm, flowering branchlet 0.75-3 mm; **pistillate** loosely flowered, stout, subglobose, or globose, 12-39 × 6-18 mm, flowering branchlet 1-11 mm; **floral bracts** brown, tawny, light rose, or bicolor, 1-2 mm, abaxial surface sparsely hairy all over, hair straight; apex rounded, entire. **Flowers, staminate** adaxial nectary square, ovate, or oblong, 0.3-0.7 mm; anthers purple becoming yellow, ellipsoid or globose, 0.4-0.6 mm; filaments distinct, hairy at base; **pistillate** adaxial nectary oblong to ovate, 0.3-0.88 mm, shorter than stipe; stipe 1.5-4 mm; ovary pyriform, beak abruptly tapering to styles, short-silky; styles 0-0.5 mm; stigmas slender- to broad-cylindrical, 0.24-0.43-0.6 mm; 6-12 ovules per ovary. **Capsules** 5-9 mm. $2n = 38$.

Flowering mid-April to mid-June. Sedge meadows, openings in moist, low, rich deciduous woods, sandy or peaty wet prairie, lake shores; 10-2740 m.; Alta., B.C., Man., N.B., N.W.T., Ont., P.E.I., Que., Sask.; Colo., Conn., Ill., Ind., Iowa, Maine, Mass., Mich., Minn., Nebr., N.H., N.J., N.Dak., N.Y., Ohio, Pa., S.Dak., Vt., Wash., Wis.

Because reproductive barriers between *Salix petiolaris* and *S. eriocephala* is weak, Mosseler (1990) suggested that their morphological variability may be due to interspecific gene flow.

Hybrids

Salix bebbiana × *S. petiolaris*. See *S. bebbiana*.

Salix candida × *S. petiolaris*. See *S. candida*.

Salix discolor × *S. petiolaris*. See *S. discolor*.

Salix eriocephala × *S. petiolaris*. See *S. eriocephala*.

Salix pellita × *S. petiolaris*. See *S. pellita*.

Reports of *Salix petiolaris* × *S. sericea* from Pennsylvania and Massachusetts (Schneider 1921b) probably refer to the densely sericeous variant of *S. petiolaris*. It is sometimes named *S. ×subsericea* (Andersson) C. K. Schneider but it does not seem to be a hybrid (Argus 1965, 1986a, Voss 1985.)

Salix purpurea Linnaeus Sp. pl. 2: 1017. 1753 • Purple willow, basket willow, purple osier.

Mid shrubs to trees 1.5-5 m; sometimes forming colonies by stem fragmentation. **Stems, branches** flexible or somewhat brittle at base, yellow- or olive-brown, sometimes weakly glaucous, glabrous; **bud** size gradation *caprea*-type; **branchlets** yellow- or olive-brown, violet tinged, glabrous. **Leaves** opposite or subopposite, **stipules** absent; **petioles** shallowly grooved adaxially, 2-7 mm, adaxial surface glabrous; **juvenile blades** yellowish green or reddish, abaxial surface sparsely, glabrous or pubescent, hair white or white and ferruginous; **proximal leaves** entire; **largest medial blades** amphistomatous; lorate, narrowly oblong, narrowly oblanceolate, oblanceolate, 35-77 × 5-20 mm, 2.8-9.2 times as long as wide; base convex or rounded, angles less than 90°; margins strongly revolute, entire, serrulate; apex acute, acuminate, or convex, angles less than 90°; abaxial surface glaucous, glabrous; adaxial surface dull to sublusterous, glabrous. **Catkins** flowering before leaves

emerge, subopposite, recurved; **staminate** stout or subglobose, 25-33 × 6-10 mm, flowering branchlet 0 mm; **pistillate** densely flowered, slender or stout, 13.5-34.5 (35 mm in fruit) × 3-7 mm, flowering branchlet 0.5-3 mm; **floral bracts** black or bicolor, 0.8-1.6 mm, abaxial surface hairy all over, straight or wavy; apex rounded, entire. **Flowers, staminate** adaxial nectary oblong, square, or ovate, 0.4-0.8 mm; stamens 1 (filaments connate, anthers distinct); anthers purple becoming yellow, ellipsoid or globose, 0.4-0.5 mm; filaments connate, hairy at base; **pistillate** adaxial nectary ovate, 0.3-0.7 mm, longer than stipe; stipe 0-0.1 mm; ovary obturbinate, short-silky; styles 0.15-0.3 mm; stigmas flat, non-papillate abaxial surface and rounded tip, 0.16-0.2-0.24 mm; 6 ovules per ovary. **Capsules** 2.5-5 mm. $2n = 38$.

Flowering mid-March to mid-May. Introduced and naturalized. N.B., Nfld., N.S., Ont., P.E.I., Que.; Calif., Conn., Del., D.C., Ga., Ill., Iowa, Ky., Maine, Md., Mass., Mich., Minn., Mo., N.H., N.C., N.Y., Oreg., Pa., R.I., Vt., Va., W.Va., Wis.; Europe.

Salix pyrifolia Andersson, Kongl. Svenska Vetensk. Akad. Handl. II, 6(1): 162. 1867 • Balsam willow

Salix balsamifera Barratt ex Andersson; *Salix pyrifolia* var. *lanceolata* (Bebb) Fernald

Low to tall shrubs 0.4-4 m. **Stems, branches** red-brown, highly glossy, glabrous; **branchlets** red-, yellow-brown, or yellowish, not glaucous or weakly so, glabrous. **Leaves, stipules** on first leaves foliaceous or minute rudiments, on later leaves foliaceous, apex acute, convex, or rounded; **petioles** convex to flat or shallowly grooved adaxially, 7-20 mm, not glandular or rarely with spherical glands at distal end, adaxial surface glabrous or sparsely velvety; **juvenile blades** translucent yellowish green, abaxial surface glabrous or pilose, hair white; **proximal leaves** serrulate or entire; **largest medial blades** narrowly oblong, oblong, elliptic, or broadly elliptic, 30-103 × 19-40 mm, 1.5-3.4 times as long as wide; base cordate, subcordate, rounded or convex, angles less or greater than 90°; margins flat or slightly revolute, serrulate, or irregularly serrate, crenate, or undulate; apex acute or acuminate, angles less than or greater than 90°; abaxial surface glaucous, glabrous; adaxial surface shiny or highly glossy, glabrous. **Catkins, pistillate** flowering as leaves emerge, staminate flowering just before leaves emerge; **staminate** stout or slender, 18.5-63 × 7-15 mm, flowering branchlet 1-5 mm; **pistillate** loosely flowered, stout or slender, 25-85 × 8-20 mm, flowering branchlet 2-22 mm; **floral bracts** tawny, 1-2.4 mm, abaxial surface sparsely to moderately densely hairy all over, hair straight or wavy; apex acute or convex, entire. **Flowers, staminate** adaxial nectary square or ovate, 0.3-0.45 mm; anthers yellow, ellipsoid or short-cylindrical, 0.5-0.8 mm; filaments distinct, glabrous or sparsely hairy at base; **pistillate** adaxial nectary narrowly ovate or square, 0.3-0.7 mm, shorter than stipe; stipe 1.8-3.5 mm; ovary obclavate, beak slightly bulged below styles, glabrous, styles 0.4-0.5 mm; stigmas flat, non-papillate abaxial surface and rounded tip, or two plump lobes, 0.2-0.23-0.32 mm; 10-19 ovules per ovary. **Capsules** 7-8 mm. $2n = 38$.

Flowering May to mid-June (to mid-July in subalpine). Fens, wet lake and slough margins, and treed bogs; 0-320 m (to 1600 m in subalpine), Alta., B.C., Lab., Man., N.B., Nfld., N.W.T., N.S., Ont., P.E.I., Que., Sask., Yukon; Maine, Mich., Minn., N.H., N.Y., Vt., Wis.

Salix pyrifolia is characterized by juvenile leaves membranaceous and translucent; largest medial leaves subcoriaceous, abaxial surface reticulate, and base often cordate. The buds and foliage are reported to have a balsam-like fragrance.

Hybrids

Salix discolor × *S. pyrifolia*. See *S. discolor*.

Salix ×rubens Schrank. Baier. Fl. 1: 226. 1789 • Hybrid white willow.

Salix alba Linnaeus × *S. fragilis* Linnaeus

Trees 3-20 m. **Stems** erect or drooping; **branches** highly brittle at base, yellow- or gray-brown, pubescent at nodes or glabrous; **branchlets** red-brown or golden-yellow, pubescent, puberulent, pilose, or moderately densely long-silky. **Leaves, stipules** on first leaves minute rudiments, on later leaves minute rudiments or foliaceous, apex acuminate to caudate; **petioles** deeply grooved adaxially, 4-16 mm, with spherical or foliaceous glands at distal end, adaxial surface pilose or villous; **juvenile leaves** yellowish green or reddish, abaxial surface glabrous or densely long-silky; **proximal leaves** entire or serrulate; **largest medial blades** amphistomatous; very narrowly elliptic or narrowly elliptic, 68-157 × 11-30 mm, 3.8-7.3 times as long as wide, base cuneate, slightly decurrent or concave, margins flat, serrate or serrulate; apex acuminate to caudate; abaxial surface glaucous, very sparsely long-silky to glabrescent, hair straight; adaxial surface shiny or dull, glabrous or sparsely long-silky. **Catkins, staminate** slender or stout 34-61 × 5-13 mm, flowering branchlet 3-11 mm; **pistillate** loosely flowered, slender, 33-82 × 4-12 mm, flowering branchlet 5-15 mm; **floral bracts** tawny or greenish, 1-2.8 mm, abaxial surface sparsely hairy all over, hair straight, apex acute or rounded, entire. **Flowers, staminate** abaxial nectary 0.5-0.68 mm, adaxial nectary square, ovate, or oblong, 0.3-0.7 mm, abaxial and adaxial nectaries distinct or connate and shallowly cup-shaped; stamens 2; anthers ellipsoid to globose, 0.5-0.7 mm; filaments distinct, hairy on lower half; **Flowers, pistillate** adaxial nectary square, 0.3-0.7 mm, shorter than or equal to stipe; stipe 0.3-0.5 mm; ovary pyriform; styles 0.4-1 mm; stigmas flat, non-papillate abaxial surface and rounded tip, or two plump lobes, 0.28-0.35-0.5 mm; 6-12 ovules per ovary. **Capsules** 4.5-6 mm. $2n = 57, 76$.

Flowering late May to early June. Introduced and naturalized; Alta., B.C., Man., N.B., Nfld., N.S., Ont., P.E.I., Que., Sask.; Ariz., Ark., Calif., Colo., Conn., Del., D.C., Ga., Idaho, Ill., Ind., Iowa, Ky., Maine, Md., Mass., Mich., Minn., Mo., Mont., Nebr., Nev., N.H., N.J., N.Mex., N.Y., Ohio, Oreg., Pa., R.I., S.Dak., Tenn., Utah, Vt., Va., Wash., W.Va., Wis., Wyo. Europe.

Salix ×rubens is the most commonly cultivated and naturalized tree willow in the flora area. It may persist for many years by trunk suckers and in riparian habitats it commonly spreads by shoot fragmentation. There are at least five clones of *S. ×rubens* in cultivation (Jonsell 2000); the pistillate are sterile but the staminate produce viable pollen. The hybrid is often misidentified as *S. fragilis* or *S. nigra*. The confusion of the hybrids with *S. fragilis* is due in large part to the lack of agreement between continental European and British botanists on the circumscription of *S. fragilis* itself. The former treat many species and varieties included in *S. fragilis* as the hybrid, *S. ×rubens*. As a result, the names on specimens in botanical gardens and in the nursery trade are in confusion. This has carried over into the American literature. I am in agreement with Skvortsov (1999) and Berg (2000) in treating *S. fragilis* in a narrow sense, but problem is not simple because it is very difficult to separate the hybrid from *S. fragilis*.

Based on molecular and genetic studies of the *Salix alba* – *S. fragilis* complex in Belgium, Triest and coworkers (Triest 2001) concluded that in modern open agricultural situations hybridization was of low occurrence and that morphologically intermediate plants were not necessarily genetically intermediate. The reproduction of these species in this area and their hybrid is mainly vegetative. Skvortsov (1999), noted that, within its native range, *S. ×rubens* predominated over *S. fragilis*. Also in North America, *S. fragilis* seems to be much less common than *S. ×rubens*, but the two are difficult to separate.

Salix sericea Marshall, Arbust amer. 140. 1785 • Silky willow
Salix coactilis Fernald

Tall shrubs 0.5-4 m; sometimes forming colonies by stem fragmentation. **Stems, branches** highly brittle at base, gray-brown or violet, tomentose or glabrescent; **bud** size gradation *caprea*-type; **branchlets** red-brown, violet or mottled yellow-brown, sparsely to very densely velvety. **Leaves, stipules** on first leaves absent or minute rudiments, on later leaves minute rudiments or foliaceous (small); **petioles** convex to flat or shallowly grooved adaxially, 3.5-12 (-21) mm, not glandular or with paired spherical glands at distal end, adaxial surface velvety; **juvenile blades** reddish or yellowish green, abaxial surface very densely short-silky, hair white or white and ferruginous; **proximal leaves** entire; **largest medial blades** lorate, narrowly oblong, or narrowly elliptic, (48-) 65-100 (-125) × (7-) 13-25 mm, (3.5-) 4-6 (-11) times as long as wide; base cuneate or convex, angles less than 90°; margins flat, serrulate or crenulate; apex acute, acuminate, or convex, angles less than 90°; abaxial surface glaucous or obscured by hair, densely short-silky, hair straight; adaxial surface dull, sparsely pubescent to glabrescent. **Catkins** flowering as or just before leaves emerge; **staminate** 13.5-40 × 4-9 mm, flowering branchlet 0-2 mm; **pistillate** loosely to moderately densely flowered, slender to stout, 18-43 × 5-12 mm, flowering branchlet 1-3 mm; **floral bracts** dark brown, black, or bicolor, 0.8-1.5 mm, abaxial surface hairy all over, hair straight or wavy; apex rounded, entire. **Flowers, staminate** adaxial nectary ovate to oblong, 0.33-0.8 mm; anthers purple becoming yellow, 0.4-0.6 mm; filaments distinct or connate less than half, glabrous to hairy at base; **pistillate** adaxial nectary oblong, ovate, or flask-shaped, 0.4-0.7 mm, shorter than stipe; stipe 0.6-1.5 mm; ovary ovoid, beak abruptly tapering to styles, short-silky; styles 0.2-0.4 mm; stigmas flat, non-papillate abaxial surface and rounded tip, broad-cylindrical, or two plump lobes, 0.12-0.16-0.2 mm, 6 ovules per ovary. **Capsules** 2.5-4 mm.

Flowering early March to early June. Wet, boggy shores, sandy terraces, and ledges along rivers and streams, low woods, sedge meadows, acid bogs, and open seepages; rocky, silty, sandy, or peaty substrates, possibly also on serpentine; 7-1275 m; N.B., N.S., Que.; Ala., Ark., Conn., Del., D.C., Ga., Ill., Ind., Iowa, Ky., Maine, Md., Mass., Mich., Minn., Mo., N.H., N.J., N.C., N.Y., Ohio, Pa., R.I., S.C., Tenn., Vt., Va., W.Va., Wis.

See *Salix eriocephala*.

Hybrids

Salix candida × *S. sericea*. Michigan

Salix eriocephala × *S. sericea*. See *S. eriocephala*.

Salix petiolaris × *S. sericea*. See *S. petiolaris*.

Salix serissima (L. H. Bailey) Fernald, Rhodora 6: 6. 1903 • Autumn willow.

Salix lucida Muhlenberg var. *serissima* L. H. Bailey, Bull. Geol. Nat. Hist. Surv. Minn. 3: 19. 1887

Mid to tall shrubs 1-5 m. **Stems, branches** generally flexible at base, sometimes brittle, yellow-, red-, or gray-brown, glabrous, shiny or dull; **branchlets** yellow- or red-brown, glabrous, glossy or shiny; **stipules** absent or minute rudiments; **petioles** shallowly to deeply grooved adaxially, 3-13 mm, with pairs of spherical glands at distal end or scattered along petioles, adaxial surface glabrous; **juvenile leaves** reddish or yellowish green, glabrous; **proximal leaves** serrulate or entire; **largest medial blades** hypostomatous or hemiamphistomatous; narrowly oblong, very narrowly elliptic, elliptic, lanceolate, or narrowly ovate, 43-103 × 9-33 mm, 2.4-6 times as long as wide; base convex or

cuneate; margins flat, serrulate; apex acuminate, caudate, or acute; abaxial surface not glaucous (but pale), rarely thinly glaucous, glabrous, shiny; adaxial surface highly glossy, glabrous. **Catkins, staminate** stout, 25-53 × 12-16 mm, flowering branchlet 5-14 mm; **pistillate** moderately densely to loosely flowered, stout to globose, 17-42 (to 65 mm in fruit) × 11-22 mm, flowering branchlet 5-32 mm (to 65 mm in fruit); **floral bracts** sometimes greenish-tawny, 1.2-4 mm, abaxial surface moderately densely hairy all over, hair straight or wavy, apex acute, rounded, or truncate, glandular toothed. **Flowers, staminate** abaxial nectary 0.5-1.1 mm, adaxial nectary oblong or ovate, 0.4-1.1 mm, abaxial and adaxial nectaries distinct or connate and cup-shaped; stamens 3-9; anthers ellipsoid or short-cylindrical, 0.5-0.7 mm; filaments distinct or connate at base, hairy on lower half or at base; **pistillate** adaxial nectary ovate or oblong, 0.3-1.1 mm, shorter than stipe; stipe 1.2-2.4 mm; ovaries pyriform to obclavate, beak slightly bulged below or abruptly tapering to styles; styles 0.3-1 mm; stigmas flat, non-papillate abaxial surface and rounded tip, or slender-cylindrical, 0.4-0.68 mm; 12-16 ovules per ovary. **Capsules** 7-12 mm. $2n = 76$.

Flowering from early June to early July. Wet thickets in fens and brackish marshy strands, marly lake shores, treed bogs, gravelly riverbanks and lake shores; 9-2960 m. Alta., B.C., Lab., Man., N.B., Nfld., N.W.T., P.E.I., Que., Sask., Yukon; Colo., Conn., Ill., Ind., Mass., Mich., Minn., Mont., N.J., N.Dak., N.Y., Ohio, Pa., S.Dak., Vt., Wis., Wyo. Endemic.

The catkins in *Salix serissima* emerge as the leaves are emerging. They are not serotinous (i.e. flowering long after the leaves emerge); but they do flower somewhat later than related species and set fruit in late summer. The fruiting catkins sometimes persist for more than one year.

The North American *Salix serissima* is closely related to the Eurasian *Salix pseudopentandra* (Floderus) Floderus (Skvortsov 1999), which is known in China as *S. pentandra* var. *intermedia* Nakai and possibly also *S. humaensis* Y.L. Chou & R.C. Chou (Fang Zhenfu et al. 1999). The relationship of *S. serissima* and *S. pseudopentandra* is similar to that of *S. arbusculoides* and *S. boganidensis* (Argus 1997). These two species, along with the amphiberian *S. vestita*, are relictual members of former panboreal distributions. A comparative molecular study could provide useful insights into their relationships and age of origin.

79. *Salix* × *smithiana* Willd. Enum. pl. 1008. 1809. [Not included in the key.]

Salix cinerea L. × *S. cinerea* L., *S. ×sericans* Tausch ex A. Kerner (*S. caprea* L. × *S. viminalis* L.)

Mid to tall shrubs or trees 2-10 m, plants sometimes colonial by stem fragmentation. **Stems, branches** yellow-brown, brownish or gray-brown, pubescent to glabrescent, somewhat brittle at base, peeled wood striae sparse and short; **branchlets** yellowish or yellow-brown to brownish, not glaucous, moderately densely pubescent, hairs spreading, straight, wavy or crinkled; **bud** size gradation of *caprea*-type. **Leaves, stipules** on first leaves minute rudiments or absent, later leaves foliaceous, early deciduous or deciduous in autumn, 2-10 mm, apex acuminate (slender); **petioles** convex to flat adaxially, 5-14 mm, not glandular, adaxial surface pubescent; **juvenile leaves** yellowish green or color obscured by hair, abaxial surface very densely tomentose, hairs white; **proximal leaves** stipules absent or minute rudiments, entire or undulate; **largest medial blades** very narrowly elliptic, narrowly elliptic, narrowly oblong, or sometimes oblanceolate, 56-145 × 16-28 mm, 2.8-4.9(-6.4) times as long as wide; base cuneate to convex; base and apex less than 90°; margins slightly revolute or strongly revolute, entire to undulate, glands submarginal or epilaminar; apex acuminate; abaxial surface obscured by hair or glaucous or apparently not, very densely or moderately densely or sparsely, tomentose, pubescent, or short-silky, along midrib, hairs spreading or appressed, white, wavy, straight, or curved, short; adaxial surface shiny, sparsely glabrescent, hair spreading, white. **Catkins** flowering before leaves emerge; **staminate** stout, 20-37 × 13-22 mm, flowering branchlet 0-1 mm; **pistillate** moderately densely flowered, stout, 30-46 × (50 in fruit) 8-13

mm, flowering branchlet 0-6 mm; **floral bracts** brown or bicolor, 1.8-3 mm, abaxial surface hairy all over, hairs white, straight or wavy, bract apex acute to convex, entire. **Flowers, staminate** adaxial nectary narrowly oblong; anthers yellow, ellipsoid to short-cylindrical, 0.6-0.86 mm; filaments distinct, glabrous; **pistillate** adaxial nectary narrowly oblong to oblong, 0.4-1.1 mm, shorter than, equal to, or longer than stipe; stipe 0.9-2 mm; ovary pyriform to obclavate, moderately to very densely short-silky; styles 0.5-1.2 mm; stigmas slender-cylindrical, 0.6-1.2 mm; x-x ovules per capsule. **Capsules** 5-7 mm. $2n = 38$

Flowering March to May. Introduced, cultivated and naturalized; N.B., Nfld., N.S., P.E.I. Europe.

The hybrids *S. caprea* × *S. viminalis* and *S. cinerea* × *S. viminalis* are commonly recognized in North American floras. They are, however, difficult to separate and their hybrid binomial nomenclature very confused. I am following G. Larsson (1995) who has typified *S. ×smithiana* and cites *S. ×sericans* (formerly *S. cinerea* × *S. viminalis*) and *S. caprea* × *S. viminalis* as synonyms. These two *S. viminalis* hybrids are very similar. Inasmuch as *S. cinerea* is tetraploid its hybrid is triploid. It can be recognized by having decorticated wood with long striae, 10 mm or longer, and leaves that are generally broader toward the tip vs. wood with striae 2-6 mm, and leaves generally broadest at the middle (F. Nordica 2000). Authentic specimens of *S. cinerea* × *S. viminalis* have not been seen from the flora area and it is not treated fully here.

It is widely naturalized in the Maritime Provinces, where it seems to spread by stem fragmentation. Only pistillate specimens are known from the flora area, seed set has not been noted.

Salix triandra Linnaeus, Sp. Pl. 1016. 1753. • Almond leaf willow [Not included in the key.]
Salix amygdalina Linnaeus; *S. amygdalina* var. *discolor* Wimm. & Grab.; *S. triandra* subsp. *discolor* (Wimm. & Grab.) Arcang.

Tall shrubs or trees 2-7(-10) m. **Stems, branches** somewhat brittle at base, glabrous glabrescent; **branchlets** yellow- or red-brown or brownish, glabrous or rarely pilose. **Leaves, stipules** on first leaves minute rudiments to foliaceous, on later leaves foliaceous, 4-13 mm, apex acute or acuminate; **petioles** deeply grooved adaxially, margins covering groove, 4-10-26 mm, with pairs or clusters of spherical glands, stalked spherical glands, or foliaceous glands at distal end, adaxial surface pubescent, puberulent, or glabrescent; **juvenile leaves** reddish, abaxial surface sparsely, puberulent or pubescent, hairs white and ferruginous; **proximal leaves** stipules absent or minute rudiments or foliaceous, margins crenate or crenulate; **largest medial leaf blades** hypostomatous, oblong, narrowly oblong, narrowly elliptic, elliptic, or lanceolate to obovate, 53-114 × 14-35, 2.7-6.3 times as long as wide; base convex or cuneate; margins flat or slightly revolute, crenate or serrulate; apex acuminate, acute, or somewhat caudate; abaxial surface not glaucous or glaucous, glabrous or glabrescent; adaxial surface shiny or dull, glabrous or glabrescent. **Catkins, staminate** slender to stout, 20-60 × 5.5-10 mm, flowering branchlet 3-17 mm; **pistillate** catkins moderately to very densely flowered, slender to stout, 20-60 × 5-8 mm, flowering branchlet 5-31; **floral bracts** 1-2.3 mm, abaxial surface hairy mainly at proximal end, hairs wavy, apex rounded, or acute, entire or rarely undulating; pistillate bracts deciduous after fruiting or persistent. **Flowers, staminate** abaxial nectary 0.28-1.1 mm, adaxial nectary oblong, square, or ovate, 0.2-0.66 mm, distinct; stamens 3 (proximal flowers sometimes 2), anthers ellipsoid, 0.32-0.64 mm; filaments distinct, hairy on lower half; **pistillate** adaxial nectary obovate to square, 0.3-0.56 mm, shorter than stipe; stipe 1-2.7 mm; ovaries pyriform, beaks gradually tapering to or slightly bulged below style, glabrous; styles free about half their length, 0.18-0.32 mm; stigmas flat, non-papillate abaxial surface and rounded tip, lobes 0.14-0.24 mm. **Capsules** 3-6 mm. $2n = 38$ (44), 57, or 88.

Flowering late spring. Introduced, cultivated or naturalized; Ont.; Maine, Ohio; Eurasia.

Salix triandra generally has been overlooked in North American floras. At one time it was a very important basket-willow and probably was introduced into North America for that purpose. The leaves of *S. triandra* can be either glaucous or not glaucous abaxially. Some authors treat them as subspecies (F. Martini & P. Paiero 1988, K. H. Rechinger 1993); but A. K. Skvortsov (1998) notes that although the two have somewhat distinct ranges both characters occur through the species and sometimes can be found in the same population. His suggestion that the genetic inheritance of this character should be studied has not been taken up. The species is characterized by bark dark gray, smooth, and flaking in large irregular patches as in *Platanus × acerifolia*. The ovary-style transition is so indistinct that styles are often described as absent; but there are two, short, distinct styles terminating in a short stigma. A color change, later in season, between the styles and the ovary suggests that the tip of the ovary and the two distinct styles are both styler tissue. In general, it appears that the styles are connate proximally and distinct distally. Collections made in 1934-35 by H. Hyland along the Penobscot River, Orono, Maine, were labelled by him as “introduced,” but they could have spread from cultivation or have been naturalized (A. Haines, pers. comm.). A recent naturalized occurrence is known from Toronto, Ontario, and it is reported to occur in Ohio (T. D. Sydnor & W. F. Cowen 2001).

Salix uva-ursi Pursh, Fl. Amer. Sept. 2: 610. 1814 • Bearberry willow.

Salix ivigtutiana Lundström.; *S. myrsinites* Linnaeus var. *parvifolia* Lange

Dwarf shrubs 1-5 cm, forming compact mats by layering. **Stems** prostrate, short-trailing. **Branches** red-, gray-, or yellow-brown, shiny, glabrous; **branchlets** yellow-green or yellow-brown, glabrous or puberulent. **Leaves, stipules** sometimes persisting for 2 or more years, on first leaves absent, minute rudiments, or foliaceous, on later leaves foliaceous, apex acute; **petioles** shallowly to deeply grooved adaxially, 2-6.5 mm; **juvenile leaves** yellowish green, abaxial surface glabrous, pilose, or puberulent; **proximal leaves** entire or serrate; largest medial **blades** amphistomatous to hypostomatous; ovate, broadly obovate, oblanceolate, or elliptic, 4-23 × 3.5-10 mm, 1.7-3.6 times as long as wide; base convex, cuneate, or slightly decurrent; margins flat, serrulate or crenulate; apex convex, acuminate, acute, or retuse; abaxial surface glabrous (rarely with a few hair); adaxial surface shiny or highly glossy, glabrous (rarely with a few hair). **Catkins, staminate** 9-19 × 5-8 mm, flowering branchlet 0.5-9 mm; **pistillate** densely flowered, slender to subglobose, 11-47 (to 55 mm in fruit) × 6-10 mm, flowering branchlet 2-10 mm; **floral bracts** brown, black, tawny, light rose, or bicolor, 1.1-1.8 mm, abaxial surface sparsely hairy, hair straight or wavy, apex rounded or acute, entire. **Flowers, staminate** adaxial nectary narrowly oblong or oblong, 0.4-0.9 mm; stamens 1, rarely 2, anthers ellipsoid or short-cylindrical, 0.4-0.7 mm, filaments glabrous; **pistillate** adaxial nectary narrowly oblong or oblong, 0.5-0.8 mm, shorter to longer than stipe; stipe 0.32-1.6 mm; ovary ovoid or pyriform, beak gradually tapering to styles, glabrous; styles 0.35-1 mm; stigmas flat, non-papillate abaxial surface and rounded tip, or slender-cylindrical, 0.1-0.23-0.4 mm; 4-9 ovules per ovary. **Capsules** 3-5 mm. 2n = 38.

Flowering mid-June to early August. Exposed, often dry or moist, calcareous, serpentine, dioritic, and granitic rocks, boulders, gravel, and sand on beaches, outcrops, and snow beds; 15-1160 m; Greenland, St. Pierre and Miquelon; Lab., Nfld., N.S., Nunavut, Que.; Maine, N.H., N.Y., Vt.

Salix vestita Pursh, Fl. Amer. Sept. 2: 610. 1814 • Rock willow

Salix leiolepis Fernald; *S. vestita* subsp. *leiolepis* (Fernald) Argus; *S. vestita* var. *psilophylla* Fernald & St. John

Low or mid shrubs 0.2-1.5 m, not colonial. **Stems** erect; **branches** brownish or red-brown, dull, glabrous, long-silky, or villous to glabrescent; **branchlets** yellow- or gray-brown, long-silky, pilose, or moderately densely villous. **Leaves, stipules** absent or minute rudiments; **petioles** shallowly to deeply grooved adaxially, 2-8 mm, with glands at distal end or not glandular, adaxial surface sparsely pubescent to glabrous; **juvenile leaves** yellowish green, abaxial surface very densely long-silky, hair white or gray; **proximal leaves** entire or crenate; **largest medial blades** hypostomatous, broadly elliptic, subcircular or obovate, 18-67 × 10-40 mm, 1.1-2.3 times as long as wide; base rounded, convex, or subcordate; margins strongly revolute, crenate or subentire; apex rounded, convex, retuse, or emarginate, abaxial surface sparsely to densely villous or long-silky, veins often with long straight, hair straight; adaxial surface shiny, glabrous or sparsely long-silky. **Catkins, staminate** 13-48 × 4-6.5 (-8) mm, flowering branchlet 3-31 (-50) mm; **pistillate** densely flowered, slender or stout, 18-56 × 4-10 mm, flowering branchlet 3-27 (-40) mm; **floral bracts** tawny, 0.8-1.6 mm, abaxial surface very densely straight-hairy; apex rounded, entire. **Flowers, staminate** abaxial nectary 0.6-0.75 mm, adaxial nectary narrowly oblong, 0.5-1.2 mm, abaxial and adaxial nectaries connate and shallowly cup-shaped or distinct; anthers ellipsoid or globose, 0.3-0.5 mm; filaments distinct, hairy on lower half; **pistillate** abaxial nectary (0-) 0.75-0.9 mm, adaxial nectary oblong, ovate, or narrowly oblong to almost filiform, 0.7-1.4 mm, short to longer than stipe, abaxial and adaxial nectaries distinct or connate and cup-shaped; stipe 0.4-1.2 mm; ovary pyriform or obnapiform, very densely short-silky, hair cylindrical; styles connate about half their lengths to almost distinct, 0.2-0.4 mm; stigmas flat, non-papillate abaxial surface and rounded tip, slender-cylindrical, or two plump lobes, 0.2-0.28-0.36 mm; 13-15 ovules per ovary. **Capsules** 3-5 mm. $2n = 38$.

Flowering mid-June to late July. Moist to dry open forests and rocky stream sides in the upper montane and subalpine zones, rarely in the alpine; 2-2370 m; Alta., B.C., Lab., Man., Nfld., Nunavut, N.S., Ont., Que.; Mont., Oreg., Wash. (extirpated); Russia (disjunct in East Siberia), Mongolia, China (Xinjiang).

Salix vestita is an ancient amphiberian species. Its present distribution consists of a series of isolated, disjunct populations in Central Siberia, the northern Rocky Mountains, the west coast of Hudson Bay, and the northeastern arctic and subarctic.

The flowering and vegetative branchlets sometimes have very short internodes. In subsequent years the branches have the appearance of short shoots similar to those in *Alnus*. Short shoots do not appear on all branches or in all years but when they occur many of the shoots on the plant are of that type. The formation of short shoots may be related to adverse seasonal or local growing conditions.

Salix viminalis Linnaeus, Sp. pl. 1021. 1753 • Osier, basket willow, silky osier

Tall shrubs 3-7 m; not colonial. **Stems, branches** yellow-, gray-brown, or yellowish, glabrous or puberulent; **branchlets** yellow-brown, yellowish or obscured by hair, glabrous, densely to sparsely villous, velvety, or puberulent. **Leaves, stipules** on first leaves minute rudiments or absent, on later leaves foliaceous (sometimes brownish), linear, apex acuminate; **petioles** shallowly grooved adaxially, 4-13 mm, not glandular at distal end, adaxial surface villous, puberulent, or velvety; **juvenile blades** yellowish green, abaxial surface very densely tomentose or short-silky, hair white; **proximal leaves** entire; **largest medial blades** linear, lorate, narrowly oblong, or narrowly elliptic, 53-130 × 5-33 mm, 4.7-13.7 times as long as wide; base slightly decurrent to cuneate, angles less than 90°; margins strongly revolute, undulate or apparently entire, glands epilaminal; apex acuminate, acute, or convex, angles less than 90°; abaxial surface glaucous or obscured by hair, densely short-silky, woolly, or tomentose, midrib raised and pubescent, yellowish, hair appressed, spreading, or erect, white, straight or wavy; adaxial surface dull or shiny, sparsely or moderately densely pubescent, hair gray. **Catkins** flowering just before or as leaves emerge; **staminate** 24-48 mm,

flowering branchlet 0-2 mm; **pistillate** densely flowered, 23-55 mm, flowering branchlet 0-6 mm; **floral bracts** brown or tawny, 1.6-2.2 mm, abaxial surface hairy all over, hair straight; apex obtuse or rounded, entire. **Flowers, staminate** adaxial nectary narrowly oblong or oblong, 0.6-1.5 mm; anthers purple becoming yellow, ellipsoid to short-cylindrical, 0.6-0.8 mm; filaments distinct, glabrous; **pistillate** adaxial nectary narrowly oblong or oblong, 0.9-1.4 mm, longer than stipe; stipe 0.1-0.5 mm; ovary pyriform, densely long-silky; styles 0.6-1.8 mm; stigmas slender-cylindrical, 0.72-1.3-1.8 mm; 18-19 ovules per ovary. **Capsules** 4-6 mm. $2n = 38$.

Flowering April to early May. Introduced and sometimes naturalized; N.B., Nfld., N.S., Ont., P.E.I., Que. U.S.A.: Conn., Ind., Iowa (naturalized), Maine, Mass., N.J., N.Y., Ohio, R.I., Vt. Europe.

The hybrids *Salix cinerea* × *S. viminalis* (*S. ×smithiana* Willd.) and *Salix caprea* × *S. viminalis* (*S. ×sericans* Tausch ex A. Kerner) have been introduced and are sometimes naturalized.

Introduced *Salix* not known from the flora area but often naturalized in North America and to be expected. *Salix atrocinerea* Brotero, *S. cinerea* L., *S. caprea* L., *S. ×pendulina* Wenderoth, and *S. ×sepulcralis* Simonk.

GLOSSARY

References: Flora of Australia 1998; Hickey, 1973, 1979; Jackson 1928; Kiger and Porter 2001; Lawrence 1951; Leaf Architecture Working Group 1999; Skvortsov 1999; Stearn 1966.

Abaxial. The side away from the axis. Dorsal.

Abaxial floral nectaries. Nectaries located between the stamens or ovary and the floral bract.

Acuminate. Margin between apex and 0.75 blade length distinctly concave basally and gradually tapering to tip apically.

Acute. Margin between apex and 0.75 blade length forming an angle less than 90° and essentially straight. Straight.

Adaxial. The side of a structure toward the axis. Ventral.

Adaxial floral nectaries. Nectaries located between the stamens or ovary and the axis.

Adnate. Fusion of dissimilar structures.

Alba-type bud gradation. Buds are similar in size and shape along the entire branchlet length. Floral and vegetative buds cannot be distinguished by size or shape (Skvortsov 1999).

Amphistomatous. Stomata uniformly distributed on both leaf surfaces.

Arctica-type bud gradation. There are usually few buds. The distal two or three are the largest abruptly changing to smaller buds at proximal end. The large distal buds, which open in spring, may be floral or vegetative (Skvortsov 1999).

Branch. A shoot in at least its second year of growth.

Branchlet. The current year's shoot; bearing leaves.

Broadly elliptic. A plane shape, L:W 1.5:1, widest at middle.

Broadly oblong. A plane shape, L:W 1.5:1, widest in the mid-zone.

Broadly obovate. A plane shape, L:W 1.2:1, widest toward apex.

Broadly ovate. A plane shape, L:W 1.2:1, widest toward base.

Caprea-type bud gradation. The floral buds are strikingly different in size and shape from vegetative buds. The large floral buds are sometimes intermixed with smaller vegetative buds (Skvortsov 1999).

Carinal. Applied to stigmas in which the lobes are associated with a single carpel; not jointed across the suture or commissure.

Catkin. Inflorescence a spike of unisexual flowers without conspicuous perianth.

Caudate. Margin between apex and 0.75 blade length distinctly concave basally and gradually tapering to a long tail-like tip apically. Subtype of acuminate.

- Circular.** A plane shape, L:W 1:1, widest at middle.
- Concave.** Margin between base and 0.25 blade length curves toward center of blade.
- Connate.** Fusion of like structures.
- Convex.** Margin between base and 0.25 blade length or apex and 0.75 blade length curves away from center of blade. Obtuse.
- Commissural.** Applied to stigmas when the lobes of one carpel are connate to those of the other carpel. Joined across the suture or commissure.
- Cordate.** Margin between base and 0.25 blade length with rounded projections with the sides toward petioles straight or convex. Subtype of convex.
- Crenate.** Teeth of shallow, rounded notches.
- Cuneate.** Margin between base and 0.25 blade length essentially straight.
- Decurrent.** Margin between base and 0.25 blade length concave basally and straight distally, extending along petiole. Subtype of concave.
- Depressed-ovate.** A plane shape, egg-shaped but broader than long.
- Distal.** Toward the tip of a structure, away from point of attachment.
- Distinct.** Not connate.
- Dwarf shrubs.** Plants 0.1 m or less, e.g. *S. reticulata*.
- Elliptic.** A plane shape, L:W 2:1, widest at middle.
- Emarginate.** Apex deeply notched, 5-25% leaf length.
- Entire.** Margin forming a smooth line, lacking teeth or undulations.
- Ferruginous.** Rust-colored.
- Flask-shaped.** With a more or less abruptly tapering neck.
- Floccose.** Covered with tufts of soft woolly hairs that tend to rub off.
- Flowering branchlet.** A short, vegetative shoot which terminates in a catkin.
- Free.** Not adnate.
- Glabrous.** Without hairs.
- Glabrate.** Becoming glabrous in age.
- Glabrescent.** The process of becoming glabrous in age but a few hairs remaining.
- Glaucous.** With a whitish waxy coating which may be polished by rubbing or scratching.
- Globose.** Solid shape in which length and width are equal; spherical.
- Gourd-shaped.** Lageniform.
- Hairs.** Filamentous epidermal outgrowths. Trichomes.
- Hemiamphistomatous.** Stomata on leaf adaxial surface only at apex and scattered along veins, but uniformly distributed on abaxial surface.
- Hypostomatous.** Stomata uniformly distributed on abaxial leaf surface.
- Indumentum.** General hairiness.
- Juvenile leaves.** Young still unfolding leaves at distal end of branchlets.
- Lanceolate.** A plane shape, L:W 3:1 or more, widest toward proximal end.
- Largest mature leaves.** The normal well developed leaves, usual medial on the branchlet.
- Linear.** A plane shape, L:W 10:1, widest in the mid-zone.
- Lobate.** Margin between base and 0.25 blade length with rounded projections with the sides toward petioles concave. Subtype of concave.
- Long-silky.** Densely covered with fine, long (0.5 mm or more long), straight, appressed, shiny hairs.
- Lorate.** A plane shape, L:W 6:1, widest in the mid-zone. Ligulate.
- Low shrubs.** Plants 0.15-0.5 m, e.g. *S. myrtillifolia*.
- Marcrescent.** Persisting for more than one year in a brown, withered condition.
- Mid shrubs.** Plants 0.6-2.0 m, e.g. *S. humilis*.
- Moderately dense.** Surface 50% visible.
- Narrowly elliptic.** A plane shape, L:W 3:1, widest at middle.
- Narrowly oblanceolate.** A plane shape, L:W 6:1 or more, widest toward apex.
- Narrowly oblong.** A plane shape, L:W 3:1, widest in the mid-zone.

- Narrowly oblong nectary.** A slender-rod, 4 or more times longer than wide.
- Narrowly ovate.** A plane shape, L:W 2:1, widest toward base.
- Non-glaucous.** Lacking a waxy coating.
- Ob lanceolate.** A plane shape, L:W 3:1, widest toward distal end.
- Oblong.** A plane shape, L:W 2:1, widest in the mid-zone.
- Oblong nectary.** A broad-rod, 2-3 times longer than wide.
- Obovate.** A plane shape, L:W 2:1, widest toward distal end. Inverse egg-shaped.
- Obclavate.** Broadest at proximal end. Inverse club-shaped
- Obnapiform.** Broadest at proximal end. Inverse turnip-shaped.
- Obtriangular.** A plane shape. Inverted triangle narrowest at the proximal end.
- Obturbinate.** broadest at proximal end. Inverse top-shaped.
- Obtuse.** Forming an angle of greater than 90°.
- Ovate.** A plane shape, L:W 1.5:1, widest toward proximal end. Egg-shaped.
- Ovoid.** A solid shape widest toward proximal end. Egg-shaped.
- Pear-shaped.** Pyriform.
- Peduncle.** The naked stalk Between the flower-bearing axis and the flowering branchlet or the branch.
- Pilose.** Very sparsely covered with long, soft, wavy or straight, spreading hairs. Shaggy.
- Proximal.** Toward the base of a structure, near point of attachment.
- Proximal leaves.** The first 2-4 leaves at the base (proximal end) of a branchlet or all leaves on a flowering branchlet.
- Puberulent.** Covered with very sparse, minute, soft, straight or wavy, erect or spreading hairs, scarcely visible to the unaided eye.
- Pubescent.** Densely covered with short, soft, spreading hairs. Not used for general hairiness.
- Remotely denticulate.** Widely spaced, small, slender teeth extending more or less at right angle to axis.
- Remotely or irregularly serrate.** Widely separated, uniform teeth with an inclined axis.
- Retuse.** Apex slightly notched, less than 5% leaf length.
- Rounded.** Margin between base and 0.25 blade length or apex and 0.75 blade length forming a smooth arc. Subtype of convex.
- Rudimentary.** Used to describe stipules that appear as minute brownish lobes.
- Serrate.** Uniform large teeth with their axes inclined toward the distal end.
- Serrulate.** Uniform small teeth with their axes inclined toward the distal end.
- Short-silky.** Densely covered with short (less than 0.5 mm), soft, straight, appressed, shiny hairs.
- Silky.** Densely covered with short or long, soft, straight, appressed, shiny hairs.
- Slender.** More than 4× longer than wide.
- Sparse.** Surface little obscured.
- Spindle-shaped.** Ellipsoidal.
- Square.** About as long as wide.
- Squat flask-shaped.** Ampulliform.
- Stipe.** The stalk of an ovary.
- Stout.** Structure less than 4× longer than wide.
- Strongly glaucous.** Conspicuous bluish or whitish waxy coating.
- Subcircular** L:W 1.2:1, widest at middle.
- Subcordate.** Margin between base and 0.25 blade length slightly lobed, grading from convex to rounded apically to concave as it meets petiole. Similar to concavo convex.
- Subglobose.** Slightly longer than wide (1.3-1.1×). Subspherical.
- Tall shrubs.** Plants greater than 2.0 m, e.g. *S. discolor*.
- Tomentose.** Densely covered with short, rather firm, more or less matted or intertwined, hairs erect or spreading.
- Transverse-oblong.** A plane shape, L:W 2:1, widest in the mid-zone but broader than long.

Trees. Plants of "tree" stature, sometimes with several boles.

Triangular. Broadest at proximal end.

Undulate. Wavy, up and down, in and out.

Velvety. Densely covered with short, soft, straight, erect hairs of relatively uniform length.

Very broadly oblong. A plane shape, L:W 1.2:1 or less, widest in the mid-zone.

Very broadly obovate. A plane shape, L:W 1:1 or less, widest toward apex.

Very broadly ovate. A plane shape, L:W 1:1 or less, widest toward base.

Very densely. Surface obscured.

Very narrowly elliptic. A plane shape, L:W 6:1 or more, widest at middle.

Villous. Somewhat densely covered with long, soft, straight or wavy, spreading hairs.

Weakly glaucous. Wax visible only when scratched or as isolated crystals.

Woolly. Very densely covered with long, soft, spreading, wavy, more or less matted or intertwined hairs.

BIBLIOGRAPHY

Angiosperm Phylogeny Group II 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Bot. J. Linn. Soc.* 141: 399-436.

[Salicaceae is expanded to include a large portion of the Flacourtiaceae, including the type genus.]

Argus, G. W. 1964. Preliminary reports on the flora of Wisconsin. No. 51. Salicaceae., The genus *Salix* - willows. *Wis. Acad. Sci. Arts & Letters* 53: 217-272.

Argus, G. W. 1974. An experimental study of hybridization and pollination in *Salix* (willows). *Canad. J. Bot.* 52: 1613-1619.

Argus, G. W. 1980. The typification and identity of *Salix eriocephala* Michx. (Salicaceae). *Brittonia* 32: 170-177.

Argus, G. W. 1986a. The genus *Salix* (Salicaceae) in the Southeastern United States. *Syst. Bot. Monogr.* 9. 170 pp.

Argus, G. W. 1986b. Studies in the *Salix lucida* Muhl. and *S. reticulata* L. complexes in North America. *Canad. J. Bot.* 64: 541-551.

Argus, G. W. 1997. Infrageneric classification of New World *Salix* L. (Salicaceae) *Systematic Botany Monographs* 52.

Argus, G. W. 1999. Classification of *Salix* in the New World. Version: 5 July 1999. *Botanical Electronic News (BEN) # 227*. <http://www.ou.edu/cas/botany-micro/ben227.html>

Argus, G. W. 2007. Salicaceae. In S. Payette, ed. *Flore du Quebec nordique*. [In Press]

Argus, G. W., and M. B. Davis. 1962. Macrofossils from a late-glacial deposit at Cambridge, Massachusetts. *American Midland Naturalist* 67:106-117.

Argus, G. W., C. L. McJannet, and M. J. Dallwitz. 1999. Salicaceae of the Canadian Arctic Archipelago: Descriptions, Illustrations, Identification, and Information Retrieval. Version: 29 March 1999. <http://www.mun.ca/biology/delta/arcticf/sal>

Ball, C. R. 1951. New combinations in *Salix* (sections *Pellitae* and *Phylicifoliae*). *Amer. Midland Natur.* 45: 740-749.

Ball, C. R. 1943b. Illustrating plant organs for taxonomic purposes. *Castanea* 8: 67-71.

Ball, C. R. 1946. More plant study: fewer plant names. *J. Arnold Arb.* 27: 371-385.

Ball, C. R. 1947. Studying willows or making new sections in the genus *Salix*. *Rhodora* 49: 37-49.

Ball, C. R. 1948. *Salix petiolaris* J. E. Smith: American, not British. *Bull. Torrey Bot. Club* 75: 178-187.

Bebb, M. S. 1895. Notes on some arborescent willows of North America -- III. *Gard. & Forest* 8: 423-425.

- Beissmann, J. H. A., H. A. Barker, A. Karp, and T. Speck. 1997. AFLP analysis sheds light on distribution of two *Salix* species and their hybrid along a natural gradient. *Molecular Ecology* 6: 989-993.
- Belland R. J. and S. B. Schofield. 1993. *Salix vestita* Pursh and *Saxifraga oppositifolia* L. arctic-alpine species new to Nova Scotia. *Rhodora* 95: 76-78.
- Berg 2000. *Salix* pp.131-133: In B.Jonsell, *Flora Nordica*. Vol. 1. Stockholm: The Bergius Foundation, The Royal Swedish Academy of Sciences.
- Blanco, P. 1993. *Salix*. In Castroviejo, et al. *Flora Iberica*. Real Jardín Botánico, Madrid.
- Braun, E. L. 1961. The woody plants of Ohio. Ohio University Press, Columbus, Ohio. 362 pp.
- Brunsfeld, S. J., D. E. Soltis, and P. S. Soltis. 1992. Evolutionary patterns and processes in *Salix* sect. *Longifoliae*: evidence from chloroplast DNA. *Syst. Bot.* 17: 239-256.
- Campbell, C. S., and F. Hyland. 1978. Winter keys to woody plants of Maine. Orono: Orono Press, Univ. Maine.
- Chase, M. W., S. Zmarzty, M. D. Lledó, K. J. Wurdack, S. M. Swensen, and M. F. Fay. 2002. When in doubt, put it in Flacourtiaceae: a molecular phylogenetic analysis based on plastid rbcL DNA sequences. *Kew Bulletin* 57: 141-181.
- Cottrell, T. R. 1995. Willow colonization of Rocky Mountain mires. *Can. J. For. Res.* 25: 215-222.
- Del Tredidi, P. 2001. Sprouting in temperate trees: A morphological and ecological review. *Bot. Rev.* 67: 121-140.
- Densmore, R. A., and Zasada, J. C. 1983. Seed dispersal and dormancy patterns in northern willows: ecological and evolutionary significance. *Canada. J. Bot.* 61: 3207-3216.
- Dorn, R. D. 1975a. A systematic study of *Salix* section *Cordatae* in North America. *Canad. J. Bot.* 53: 1491-1522.
- Dorn, R. D. 1976. A synopsis of American *Salix*. *Canad. J. Bot.* 54: 2769-2789.
- Dorn, R. D. 1995. A taxonomic study of *Salix* section *Cordatae* subsection *Luteae*. *Brittonia* 47: 160-174.
- Dorn, R. D. 1998. A taxonomic study of *Salix* section *Longifoliae* (Salicaceae) *Brittonia* 50: 193-210.
- Eckenwalder, J. 1996. Systematics and evolution of *Populus*. Pp. 7-32 in R. Stettler, et al. eds., *Biology of Populus and its implications for management and conservation*. Pt. 1, Chapter 1. Ottawa: NRC Press.
- Fang Zhenfu, Zhao Shidong, and A. K. Skvortsov. 1999. Salicaceae. In, Wu Zheng-yi and P. H. Raven, *Flora of China*. Vol. 4: 139-274.
- Fernald, M. L. 1895. *Salix balsamifera*. *Gard. and For.* 8: 28.
- Fernald, M. L. 1904a. Two northeastern allies of *Salix lucida*. *Rhodora* 6: 1-8.
- Fernald M. L. 1904b. The identity of Andersson's *Salix pellita*. *Rhodora* 6: 191.
- Fernald, M. L. 1905. An anomalous alpine willow. *Rhodora* 7: 185-186.
- Fernald, M. L. 1906. *Salix coactilis*, a handsome willow of the Penobscot Valley. *Rhodora* 8: 21-22.
- Fernald, M. L. 1907a. The soil preferences of certain alpine and subalpine plants. *Rhodora* 9: 145-193.
- Fernald, M. L. 1907b. Some new willows of eastern America. *Rhodora* 9: 221-226. [*Salix laurentiana*, *S. fuscescens* var. *hebecarpa*, *S. obtusata*, *S. syrticola*.]
- Fernald, M. L. 1909. *Salix pedicellaris* and its variations. *Rhodora* 11: 157-162.
- Fernald, M. L. 1912. An early collection of *Salix balsamifera*. *Rhodora* 14: 69-70.
- Fernald, M. L. 1914. Some willows of boreal America. *Rhodora* 16: 169-179. [*Salix myrtillifolia*, et al.]
- Fernald, M. L. 1916. A pubescent form of *Salix uva-ursi*. *Rhodora* 18: 52. [*Salix cordifolia*, *S. uva-ursi*]
- Fernald, M. L. 1917a. A new alpine willow from the White Mountains. *Rhodora* 19: 221-223.

- Fernald, M. L. 1917b. A new alpine willow from the White Mountains. *Rhodora* 19: 221-223. [*Salix peasei*]
- Fernald, M. L. 1924. New or restudied plants of eastern America (*Salix*). *Rhodora* 26: 122-127. [*Salix hebecarpa*]
- Fernald, M. L. 1926a. Two summers of botanizing in Newfoundland. *Salix cordifolia* Pursh. *Rhodora* 28: 181-188.
- Fernald, M. L. 1926b. Two summers of botanizing in Newfoundland, Part III. *Rhodora* 28: 145-178, 181-204, 234-241. [*Salix* pp. 177-178, 181-191.]
- Fernald, M. L. 1930. A new willow from the Côte Nord, Quebec. *Rhodora* 32: 112-113. [*Salix simulans*]
- Fernald, M. L. 1932. Recent discoveries in the Newfoundland flora. *Rhodora* 35: 230-247. [*Salix wiegandii*, *S. ancorifera*, *S. uva-ursi* var. *phyllolepis*.]
- Fernald, M. L. 1935. Critical plants of Upper Great Lakes region of Ontario and Michigan. *Rhodora* 37: 291-222, 238-262, 272-301, 324-341. [*Salix serissima*, *S. humilis*.]
- Fernald, M. L. 1942. Incidents of field-work with J. Franklin Collins. *Rhodora* 44: 98-152. [Contains many references to work on Gaspé Peninsula as well as all new taxa described from there. *Salix* types.]
- Fernald, M. L. 1946a. Difficulties in North American *Salix*. *Rhodora* 48: 13-49.
- Fernald, M. L. 1946b. Technical studies on North American plants, II. Difficulties in North American *Salix*. *Rhodora* 48: 13-16, 27-40, 41-49.
- Fernald, M. L. 1950. Gray's manual of botany, ed. 8. New York: American Book Co.
- Fernald, M. L., and H. St. John. 1922. *Salix vestita* and its varieties, pp. 44-45. In H. St. John, A botanical exploration of the north shore of the Gulf of St. Lawrence including an annotated list of the species of vascular plants. Victoria Memorial Museum Memoir 126. [*S. vestita* var. *psilophylla*]
- Fernald, M. L., and K. M. Wiegand. 1911. *Salix calcicola*, a little known northern willow. *Rhodora* 13: 251-253.
- Fernald, M. L., and C. A. Weatherby. 1931. Some new plants from the Gaspé Peninsula. *Rhodora* 34: 231-240. [*Salix laurentiana*]
- Floderus, B. 1939. Two Linnaean species of *Salix* and their allies. *Kgl. Sv. Vet. Akad. Ark. Bot.* 29A (2): 1-54.
- Gage, E. A., and D. J. Cooper. 2005. Patterns of willow seed dispersal, seed entrapment, and seedling establishment in a heavily browsed montane riparian ecosystem. *Can. J. Bot.* 83: 678-687.
- Gleason, H. A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. Vol. 2. Hafner Press, New York. 655 pp.
- Gleason, H. A. and A. Cronquist. 1991. Manual of vascular plants of Northeastern United States and adjacent Canada. N. Y. Botanical Garden.
- Haines, A. and T. Vining. 1998. Flora of Maine. Bar Harbor, Maine: V. F. Thomas Co. [*Salix* pp. 476-491.]
- Hardig, T. M., Brunsfeld, S. J., Fritz, R. S., Morgan, M., and Orians, C. M. 2000. Morphological and molecular evidence for hybridization and introgression in a willow (*Salix*) hybrid zone. *Molecular Ecology* 9: 9-24.
- Hewson, H.J. 1988. Plant indumentum. A handbook of terminology. Australian Flora and Fauna Series 9. 27 pp.
- Hickey, L. J. 1973. Classification of the architecture of dicotyledonous leaves. *Amer. J. Bot.* 60: 17-33.
- Hickey, L. J. 1979. A revised classification of the architecture of dicotyledonous leaves. Pp. 25-39, in Metcalfe, C. and Chalk, L. *Anatomy of the Dicotyledons*. 2nd ed. Oxford: Clarendon Press.

- Hinds, H. R. 2000. Flora of New Brunswick. 2nd ed. Fredericton, New Brunswick: Department of Biology, University of New Brunswick.
- Holmgren, N. 1998. Illustrated companion to Gleason and Cronquist Manual. New York Botanical Garden. [*Salix* pp. 154-160.]
- Hosner, J. F. 1958. The effects of complete inundation upon seedlings of six bottomland tree species. *Ecology* 39: 371-373.
- Jackson, B. D. 1928. A Glossary of Botanical Terms. London: Gerald Duckworth & Co. Ltd.
- Jenkins, J. and P. Zika. 1995. Contributions to the flora of Vermont. *Rhodora* 97: 291-? [Excludes *S. serissima* and *S. pentandra* from flora.]
- Jonsell, B. 2000. Flora Nordica. Vol. 1. Stockholm: The Bergius Foundation, The Royal Swedish Academy of Sciences.
- Judd, W. S. 1997. The Flacourtiaceae in the Southeastern United States. *Harvard Papers in Botany* 10: 65-79.
- Kartesz, J. T. and C. A. Meacham. 2004. Synthesis of the North American Flora, Version 2. Biota of North America Program and Phylosystems Corporation. Pre-release CD.
- Kiger, R. W. and D. M. Porter. 2001. Categorical glossary for the Flora of North America Project. Pittsburgh: Hunt Institute for Botanical Documentation, Carnegie Mellon University.
- Knight, O. W. 1907. Three plants from Maine. *Rhodora* 9: 202-204.
- Lawrence, G. H. M. 1951. The Taxonomy of Vascular Plants. New York: MacMillan Co.
- Leaf Architecture Working Group. 1999. Manual of leaf architecture – morphological descriptions and categorizations of dicotyledonous and net-veined monocotyledonous angiosperms. Smithsonian Institution, Washington, D. C. .
- Lepage, E. 1964. Hybrides nouveautés dans les genres *Carex* et *Salix*. *Naturaliste Canad.* 99: 165-174.
- Little, E. L., Jr. 1971. *Atlas of United States Trees*. Volume 1. Conifers and important hardwoods. U. S. Dept. Agric. Misc. Publ. 1146.
- Little, E. L., Jr. 1976. *Atlas of United States Trees*. Volume 3. Minor western hardwoods. U. S. Dept. Agric. Misc. Publ. 1314.
- Löve, A. 1954. Cytotaxonomical evaluation of corresponding taxa. *Vegetatio* 5-6: 212-224.
- Löve, A. and J. C. Ritchie. 1966. Chromosome numbers from central northern Canada. *Canad. J. Bot.* 44: 429-439.
- McBride, J. R. and Strahan, J. 1984. Establishment and survival of woody riparian species on gravel bars of an intermittent stream. *Amer. Midl. Nat.* 112: 235-245.
- Meikle, R. D. 1984. *Willows and poplars of Great Britain and Ireland*. Botanical Society of the British Isles, Handbook No. 4. [Available from: BSBI, c/o British Museum (Natural History), Cromwell Rd., London SW7 5BD]
- Mosseler, A. 1990. Hybrid performance and species crossability relationships in willows (*Salix*). *Canad. J. Bot.* 68: 2329-2338.
- Mosseler, A., and C. S. Papadopol. 1998. Seasonal isolation as a reproductive barrier among sympatric *Salix* species. *Can. J. Bot.* 67: 2563-2570.
- Noble, M. G. 1979. The origin of *Populus deltoides* and *Salix interior* zones on point bars along the Minnesota River. *Amer. Midl. Nat.* 102: 59-67
- Raup, H. M. 1959. The willows of boreal western America, *Contr. Gray Herb., Harvard Univ.* 185: 1-95.
- Rechinger, H. K., revised by J. R. Akeroyd. 1993. *Salix* in Tutin, T. G. et. al. *Flora Europaea*, Vol. 1. ed. 2. Salicaceae edited by J. R. Edmonson.
- Rowlee, W. W., and K. M. Wiegand. 1896. *Salix candida* Willd. and its hybrids. *Bull. Torrey Bot. Club* 23: 194-201.

- Sacchi, C. F., and Price, P. W. 1992. The relative roles of abiotic and biotic factors in seedling demography of arroyo willow (*Salix lasiolepis*: Salicaceae). *Amer. J. Bot.* 79: 395-405.
- Sargent, C. S. 1878. North American Willows. *Garden Chronicle* 10: [pages 818-?]
- Schneider, C. K. 1919a. Notes on American willows. III. A conspectus of American species and varieties of sections *Reticulatae*, *Herbaceae*, *Ovalifoliae*, and *Glaucæ*. *Bot. Gaz.* 67: 27-64.
- Schneider, C. K. 1919b. Notes on American willows. IV. Species and varieties of section *Longifoliae*. *Bot. Gaz.* 67: 309-346.
- Schneider, C. K. 1919c. Notes on American willows. V. The species of the *Pleoandrae* group. *J. Arnold Arb.* 1: 1-31.
- Schneider, C. K. 1919d. Notes on American willows. VI. a. The species of the *Phylicifoliae*. b. The species of section *Sitchenses*. c. Section *Breweriana*. *J. Arnold Arb.* 1: 67-97.
- Schneider, C. K. 1920a. Notes on American willows. VII. a. The species of section *Adenophyllae*. b. Sect. *Balsamiferae*. *J. Arnold Arb.* 1: 147-171.
- Schneider, C. K. 1920b. Notes on American willows. VIII. a. The species of the section *Chrysantheae*. b. Sect. *Candidae* Schneider. c. *Salix wolfii* and its systematic position. *J. Arnold Arb.* 1: 211-232.
- Schneider, C. K. 1920c. Notes on American willows. IX. a. The species of section *Discolores*. b. The species of section *Griseae*. *J. Arnold Arb.* 2: 1-25.
- Schneider, C. K. 1920d. Notes on American willows. X. a. The species of section *Fulvae*. b. The species of section *Roseae*. *J. Arnold Arb.* 2: 65-90.
- Schneider, C. K. 1921a. Notes on American willows. XI. a. Some remarks on the species of section *Cordatae*. b. Some remarks on the geographical distribution of American willows. *J. Arnold Arb.* 2: 185-204.
- Schneider, C. K. 1921b. Notes on American willows. XII. a. Systematic enumeration of the sections, species, varieties and forms of American willows. b. Some remarks on the hybrids hitherto observed among American willows. c. Some remarks on the geographical distribution of the American willows. d. Analytical keys to the species of American willows. *J. Arnold Arb.* 3: 61-125.
- Seymour, F.C. 1982. The Flora of New England. 2nd ed., *Phytologia Memoirs* V. [*Salix* 201-214]
- Skvortsov, A. K. 1999. *Willows of Russia and adjacent countries. Taxonomical and geographical review*. Univ. Joensuu Fac. Mathem. and Natru. Sci. Rept. Ser. 39. 307 pp.
- Stearn, W. T. 1966. *Botanical Latin*. London and Edinburgh: Thomas Nelson Ltd.
- Steyn, E. M. A., G. F. Smith, and A. E. Van Wyk. 2004. Functional and taxonomic significance of seed structure in *Salix mucronata* (Salicaceae). *Bothalia* 34: 53-59.
- Suda, Y., and Argus, G.W. 1969. Chromosome numbers of some North American Arctic and Boreal *Salix*. *Canad. J. Bot.* 47: 859-862.
- Triest, L. 2001. Hybridization in staminate and pistillate *Salix alba* and *S. fragilis* (Salicaceae): morphology versus RAPDs. *Pl. Syst. Evol.* 226: 143-154.
- Voss, E. G. 1985. Michigan Flora. Pt. II. Cranbrook Inst. of Sci. Bull. 59 and Univ. of Michigan Herb.
- Warren-Wren, S. C. 1972. *The complete book of willows*. South Brunswick and New York: S. A. Barnes and Co.
- Watling, R. and Raven, J. A. 1992. Willow Symposium. Proceedings of the Royal Society of Edinburgh. Vol. 98.
- West, C. J. ed. 1993. Wild willows of New Zealand. Proc. Willow Control Workshop, Waikato Conservancy, 24-26 Nov 1993, Hamilton, N. Z.
- Zasada, J. C., and Viereck, L. A. 1975. The effects of temperature and stratification on germination in selected members of the Salicaceae in Interior Alaska. *Canad. J. Forest Res.* 5: 333-337.
- Zinck, M. 1998. Roland's Flora of Nova Scotia. Nimbus Publication and Nova Scotia Museum.

[Salicaceae pp. 300-312]

***Salix* Web Sites**

Argus, G. W. 2002 onwards. The interactive identification of native and naturalized New World *Salix* using Intkey (DELTA). <http://aknh.uaa.alaska.edu/willow>. An interactive key to New World *Salix* based on the Argus DELTA database. The files, including Intkey, *Salix* database, and text instruction on its use, must be downloaded to your computer. There are links to other *Salix* books and papers.

Argus, G. W., C. L. McJannet, and M. J. Dallwitz. 1999 onwards. Salicaceae of the Canadian Arctic Archipelago Flora. <http://www.mun.ca/biology/delta/arcticf/sal>. Treatment of *Salix* for the Flora of the Canadian Arctic Archipelago. It includes descriptions, illustrations, maps, and the interactive identification of *Salix*.

An online interactive key to New World *Salix* based on the Argus DELTA *Salix* database. <http://flora.huh.harvard.edu:8080/actkey/actkey.jsp?setId=3001>.