BEN

BOTANICAL ELECTRONIC NEWS

ISSN 1188-603X

No. 227 July 5, 1999

aceska@victoria.tc.ca

Victoria, B.C.

Dr. A. Ceska, P.O.Box 8546, Victoria, B.C. Canada V8W 3S2

BEN # 226 and BEN # 277 are dedicated to

DR. THOMAS CHRISTOPHER (CHRIS) BRAYSHAW,

Curator Emeritus of the Royal British Columbia Museum,
Victoria, British Columbia, Canada,
on the occasion of his 80th birthday, July 2, 1999.

CLASSIFICATION OF *SALIX* IN THE NEW WORLD

George W. Argus, 1999

The genus *Salix* is a large, taxonomically complex, genus of about 450 species worldwide; estimates range from 330-350 to 500. *Salix* occurs mainly in the Northern Hemisphere. Its center of abundance is in China, where there are about 270 species, and in the former Soviet Union, where there are about 120 species. There are 103 species in North America and 65 species in Europe. The genus also occurs in Japan, Africa, the Middle East, India, and Central and South America. In Australasia and Oceania it occurs only as introductions, some of which are regarded to be weedy.

In a revised classification of New World species of *Salix* (Argus, G.W., 1997, Systematic Botany Monographs No. 52), based on a numerical taxonomic study, ninety morphological characters were recorded for each of 103 species. A phenetic distance matrix was generated using the Gower metric. The data were analyzed using several clustering methods; the most consistent results were achieved using ISS FLEX. The New World species were grouped into four subgenera. *Salix* subg. *Salix* is represented by four sections, *S.* subg. *Longifoliae* by one section, *S.* subg. *Chamaetia* by eight sections, and *S.* subg. *Vetrix* by 15 sections. The species composition of each of the sections was compared with previous taxonomic treatments and problematic taxa were discussed.

The major problem in the classification of *Salix* into a linear arrangement of subgenera and sections is the presence of polyploidy as well as hybridization and introgression. Many *Salix* are polyploid, with ploidal levels of 4*x*-12*x*. The hypothesis was presented (Argus 1997) that intersectional and intersubgeneric polyploidy is responsible for difficulties in placing some species into sections and sections into subgenera. An indirect method used to identify the possible ancestry of some allopolyploids was to compare species with their nearest neighbors, based on their Gower dissimilarity value. If the nearest neighbors belonged to a different section it was hypothesized that the alloploid may be of intersectional hybrid origin. For example, *Salix maccalliana* (dodecaploid) has as its nearest neighbors members of *S.* sect. *Salicaster* (subg. *Salix*) and *S.* sect. *Hastatae* (subg. *Vetrix*) and *Salix glauca* (tetraploid to hexaploid) has nearest neighbors in *S.* sect. *Glaucae*, *S.* sect. *Myrtilloides*, and *S.* sect. *Hastatae* (the first two are in subg. *Salix*, the third in subg. *Vetrix*). In the cluster analysis, using different sets of taxa and characters, these species, and other high polyploids, often moved between subgenera. Because the evolutionary pattern of many *Salix* is reticulate the placement of intersectional allopolyploids in one section or another is arbitrary.

The following classification of New World *Salix* arranges species into subgenera and sections. Some of the nomenclature in sections *Subalbae*, *Albae*, *Glaucae*, *Cordatae Phylicifoliae* and *Geyerianae* has been modified

from Argus (1997). The names and citation of introduced and naturalized taxa are marked with asterisk (*) and appear in colored Arial font.

Salix subg. *Salix*

Salix sect. *Floridanae* Dorn

Salix floridana Chapman, Fl. South. U.S. 430. 1860.

Salix sect. *Humboldtianae* Andersson

Salix amygdaloides Andersson, Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 15: 114. 1858; *Salix bonplandiana* Kunth in H.B.K., Nov. Gen. Sp. 2: 24. 1817; *Salix caroliniana* Michx., Fl. bor.-amer. 2: 226. 1803; *Salix gooddingii* C. R. Ball, Bot. Gaz. 11: 376. 1905; *Salix humboldtiana* Willd., Sp. Pl. 4: 657. 1805; *Salix laevigata* Bebb, Amer. Natu. 8: 202. 1874; *Salix nigra* Marshall, Arbust. amer. 139. 1785.

Salix sect. **Subalbae* Koidz.

**Salix babylonica* L., Sp. Pl. 2: 1017. 1753; **Salix ´pendulina* Wenderoth, Schrift. Nat. Ges. Marb. 2: 235. 1831 (*S. babylonica ´ S. fragilis*).

Salix sect. **Salix*

**Salix alba* L., Sp. Pl. 2: 1021. 1753; **Salix alba* var. *vitellina* (L.) Stokes, Bot. Mat. Med. 4: 506. 1812 (Basionym: *Salix vitellina* L., Sp. Pl. 1016. 1753); **Salix alba* var. *caerulea* (Sm.) Sm. Engl. Fl. 4: 231.1828 (Basionym: *Salix caerulea* Sm. Engl. Bot. 34: t 2431. 1812); **Salix fragilis* L., Sp. pl. 2: 1017. 1753 (Probably equals *S. ´rubens* Schrank, Reidar Elven, pers. com. June 1999); **Salix ´sepulcralis* Simonk. Oest. Bot. Zeitschr. 40: 424. 1890 (*Salix alba* L. ´ *S. babylonica* L.); **Salix ´sepulcralis* Simonk. nothovar. *chrysocoma* (Dode) Meikle, Watsonia 15: 274. 1985 (Basionym: *S. chrysocoma* Dode, Bull. Soc. Bot. Fr. 55: 655. 1909; **Salix alba* var. *vitellina ´ S. babylonica*).

Salix sect. *Salicaster* Dumort.

Salix lucida Muhl., Ges. Naturf. Freunde Berlin II. 4: 239. 1803; *Salix lucida* subsp. *caudata* (Nutt.) E. Murray, Kalmia 15: 11. 1984 "1985" (Basionym: *Salix pentandra* L. [var.] *caudata* Nutt., North Am. Sylva 1: 61. 1842); *Salix lucida* subsp. *lasiandra* (Benth.) E. Murray, Kalmia 15: 11. 1984 "1985" (Basionym: *Salix lasiandra* Benth. Pl. Hartweg. 335. 1857); *Salix lucida* subsp. *lucida*; **Salix pentandra* L., Sp. pl. 2: 1016. 1753; *Salix serissima* (L. H. Bailey) Fernald, Rhodora 6: 6. 1904 (Basionym: *Salix lucida* Muhl. var. *serissima* L. H. Bailey, Geol. & Nat. Hist. Surv. Minn. Bull. 3: 19. 1887).

Salix sect. *Maccallianae* Argus

Salix maccalliana Rowlee, Bull. Torr. Bot. Club 34: 158. 1907.

Salix subg. *Longifoliae* (Andersson) Argus

Salix sect. *Longifoliae* (Andersson) Andersson

Salix exigua Nutt. N. Amer. Sylv. 1: 75. 1842; *Salix interior* Rowlee, Bull. Torrey Bot. Club 27: 253. 1900; *Salix fluviatilis* Nutt. N. Amer. Sylva 1: 89. 1842; *Salix melanopsis* Nutt. N. Amer. Sylva 1: 78. 1842; *Salix microphylla* Schldl. & Cham. Linnaea 6: 354. 1831; *Salix sessilifolia* Nutt. N. Amer. Sylva 1: 68. 1842; *Salix taxifolia* Kunth in H.B.K. Nov. gen. sp. 2: 18. 1817. The nomenclature proposed for this section by Dorn (Brittonia 50: 193-210. 1998) has not yet been evaluated.

Salix subg. *Chamaetia* (Dumort.) Nasarov

***Salix* sect. *Chamaetia* Dumort.**

Salix nivalis Hook. Fl. bor-amer. 2: 152. 1838; *Salix reticulata* L., Sp. pl. 2: 1018. 1753; *Salix reticulata* subsp. *glabellicarpa* Argus, Canad. J. Bot. 43: 1021. 1965; *Salix reticulata* subsp. *reticulata*; *Salix vestita* Pursh, Fl. Amer. Sept. 2: 610. 1814.

***Salix* sect. *Setchellianae* Argus**

Salix setchelliana C. R. Ball, Univ. Calif. Publ. Bot. 17: 410. 1934.

***Salix* sect. *Herbella* Ser. (*S.* sect. *Retusae*)**

Salix herbacea L., Sp. pl. 2: 1018. 1753; *Salix nummularia* Andersson in DC. Prodr. 16(2): 298. 1868.

***Salix* sect. *Myrtosalix* A. Kerner**

Salix arctophila Cockerell ex A. Heller, Cat. N. Amer. Pl., ed. 3, 89. 1910; *Salix chamissonis* Andersson in DC. Prodr. 16(2): 290. 1868; *Salix fuscescens* Andersson, Monogr. Salicum 97. 1867; *Salix phlebophylla* Andersson in DC., Prodr. 16(2): 290.1868; *Salix polaris* Wahlenb. Fl. Lap. 261. 1812; *Salix rotundifolia* Trautv. Nouv. Mem. Soc. Nat. Mosc. 2: 304. 1832; *Salix rotundifolia* subsp. *dodgeana* (Rydb.) Argus, Canad. J. Bot. 47: 795. 1969 (Basionym: *Salix dodgeana* Rydb. Bull. N. Y. Bot. Gard. 1: 277. 1899); *Salix rotundifolia* subsp. *rotundifolia*; *Salix uva-ursi* Pursh, Fl. Amer. Sept. 2: 610. 1814 .

***Salix* sect. *Ovalifoliae* (Rydb.) C. K. Schneider**

Salix jejuna Fernald Rhodora 28: 177. 1926; *Salix ovalifolia* Trautv. Nouv. Mem. Soc. Mosc. 2: 306. 1832; *Salix ovalifolia* var. *arctolitoralis* (Hultén) Argus, Canad. J. Bot. 47: 795. 1969 (Basionym: *Salix arctolitoralis* Hultén, Sv. Bot. Tidskr. 34: 373. 1940); *Salix ovalifolia* var. *cyclophylla* (Rydb.) C. R. Ball, Proc. Nat. Acad. Sci. 21: 184. 1935 (Basionym: *Salix cyclophylla* Rydb. Bull. N. Y. Bot. Gard. 1: 274. 1899); *Salix ovalifolia* var. *glacialis* (Andersson) Argus, Canad. J. Bot. 47: 798. 1969 (Basionym: *Salix glacialis* Andersson, Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 15: 131. 1858); *Salix ovalifolia* var. *ovalifolia*; *Salix stolonifera* Coville, Proc. Wash. Acad. Sci. 3: 333. 1901.

***Salix* sect. *Diplodictyae* C. K. Schneider**

Salix arctica Pall., Fl. Ross. 1: 86. 1788; *Salix cascadensis* Cockerell, Muhlenbergia 3: 9. 1907; *Salix petrophila* Rydb. Bull. N. Y. Bot. Gard. 1: 268. 1899; *Salix sphenophylla* A. K. Skvortsov in Tomatchev, Fl. Arct. URSS 5: 62. 1966.

***Salix* sect. *Myrtilloides* (Borrer) Andersson**

Salix athabascensis Raup, Rhodora 32: 111. 1930; *Salix chlorolepis* Fernald Rhodora 7: 186. 1905; *Salix pedicellaris* Pursh, Fl. Am. Sept. 2: 611. 1814; *Salix raupii* Argus, Canad. J. Bot. 52: 1303. 1974.

***Salix* sect. *Glaucae* (Fries) Andersson**

Salix brachycarpa Nutt. N. Am. Sylva 1: 69. 1842; *Salix brachycarpa* var. *brachycarpa*; *Salix brachycarpa* var. *psammophila* Raup, J. Arnold Arb.17: 230. 1936; *Salix glauca* L., Sp. Pl. 2: 1019. 1753; *Salix glauca* subsp. *acutifolia* (Hook.) Hultén, Ark. f. Bot. 7: 40. 1967 (Basionym: *Salix villosa* Andersson b [var.] *acutifolia* Hook. Fl. bor.-am. 2: 145. 1839); Salix *glauca* subsp. *callicarpaea* (Trautv.) Böcher, Meddel. Groenl. 147: 19. 1952 (Basionym: *Salix callicarpaea*

Trautv. Nouv. Mém. Soc. Nat. Mosc. 2: 295. 1832); *Salix glauca* subsp. *stipularis* (Flod. ex Häyrén) Hiitonen, Suomen kasvio, 272. 1933 (Basionym: *Salix glauca* var. *glauca* auct.; *Salix stipulifera* Flod. ex Häyrén, Mem. Soc. Faun. Fl. Fenn. 5: 133. 1929); *Salix glauca* var. *villosa* Andersson, Proc. Amer. Acad. Arts Sci. 4: 68. 1858; *Salix niphoclada* Rydb. Bull. N. Y. Bot. Gard. 1: 272. 1899.

Salix subg. *Vetrix* (Dumort.) Dumort.

Salix sect. *Hastatae* (Fries) A. Kerner

Salix arizonica Dorn, Canad. J. Bot. 53: 1499. 1975; *Salix ballii* Dorn, Can J. Bot. 53: 1501. 1975; *Salix barclayi* Andersson, Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 15: 125. 1858; *Salix boothii* Dorn, Canad. J. Bot. 53: 1505. 1975; *Salix commutata* Bebb, Bot. Gaz. 13: 110. 1888; *Salix cordata* Michx. Fl. bor.-amer. 2: 225. 1803; *Salix eastwoodiae* Cockerell ex A. Heller, Cat. N. Am. Pl. ed. 3 89. 1910; *Salix farriae* C. R. Ball in Standley, Contr. U. S. Natl. Herb. 22: 321. 1921; *Salix hastata* L., Sp. pl. 2: 1017. 1753; *Salix monticola* Bebb in Coulter, Man. Bot. Rocky Mt. Reg. 336. 1885; *Salix myricoides* Muhl. Ges. Naturf. Fr. Neue Schr. 4: 235. 1803; *Salix myricoides* var. *albovestita* (C. R. Ball) Dorn, Canad. J. Bot. 54: 2782. 1976 (Basionym: *Salix glaucophylla* Bebb var. *albovestita* C. R. Ball, Jour. Wash. Acad. Sci. 29: 429. 1939); . *Salix myricoides* var. *myricoides*; *Salix myrtillifolia* Andersson, Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 15: 132. 1858; *Salix orestera* C. K. Schneider, J. Arnold. Arb. 1: 164. 1920; *Salix pseudomonticola* C. R. Ball in Standley, Contr. U. S. Natl. Herb. 22: 321. 1921; *Salix pseudomyrsinites* Andersson, Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 15: 130. 1858; *Salix pyrifolia* Andersson, Monogr. Salicum 162. 1867; *Salix wolfii* Bebb in Rothr. Rep. Bot. U. S. Geogr. Surv. 6: 214. 1878.

Salix sect. *Cordatae* Barratt ex Hook.

Salix eriocephala Michx. Fl. bor.-amer. 2: 225. 1803; *Salix eriocephala* var. *eriocephala*; *Salix eriocephala* var. *famelica* (C.R. Ball) Dorn, Brittonia 47: 165. 1995 (Basionym: *S. lutea* var. *famelica* C.R. Ball, Bot. Gaz. 71: 426. 1921); *Salix ligulifolia* (C. R. Ball) C. R. Ball in E. D. Smith, Amer. Midl. Nat. 27: 236. 1942 (Basionym: *Salix lutea* Nutt. var. *ligulifolia* C. R. Ball, Bot. Gaz. 71: 428. 1921); *Salix lutea* Nutt. N. Amer. Sylva 1: 63. 1842; *Salix monochroma* C. R. Ball, Bot. Gaz. 71: 431. 1921; *Salix prolixa* Andersson, Monogr. Salicum 94. 1867; *Salix turnorii* Raup, J. Arnold Arb. 17: 234. 1936.

Salix sect. *Cinerella* Ser. (*S.* sect. *Vetrix*)

Salix atrocinerea Brotero, Fl. Lusit. 1: 31. 1804; *Salix aurita* L., Sp. pl. 2: 1019. 1753; *Salix caprea* L., Sp. pl. 2: 1020. 1753; *Salix cinerea* L., Sp. pl. 2: 1021. 1753; *Salix discolor* Muhl. Ges. Naturf. Freunde Berlin II. 4: 234. 1803; *Salix hookeriana* Barratt ex Hook. Fl. bor.-amer. 2: 145. 1838; *Salix humilis* Marshall, Arbust. amer. 140. 1785; *Salix humilis* var. *humilis*; *Salix humilis* var. *tristis* (Aiton) Griggs, Proc. Ohio Acad. Sci. 4: 301. 1905; *Salix paradoxa* Kunth in Humboldt and Bonpland, Nov. Gen. Pl. 2: 20. 1817; *Salix scouleriana* Barratt ex Hook. Fl. Bor.-amer. 2: 145. 1838.

Salix sect. *Fulvae* Barratt

Salix bebbiana Sarg., Gard. & For. 8: 463.1895.

Salix sect. *Phylicifoliae* (Fries) Andersson

Salix drummondiana Barratt ex Hook. Fl. bor.-am. 2: 144. 1838; *Salix pedunculata* Fernald, Rhodora 28: 188. 1926; *Salix pellita* Andersson, Monogr. Salicum 139. 1867; *Salix planifolia* Pursh, Fl. Am. Sept. 2: 611. 1814; *Salix pulchra* Cham. Linnaea 6: 543. 1831; *Salix tyrrellii* Raup, J. Arnold Arb. 17: 231. 1936

***Salix* sect. *Arbuscella* Ser.**

Salix arbusculoides Andersson, Monogr. Salicum 147. 1867.

***Salix* sect. *Candidae* C. K. Schneider**

Salix candida Flüggé ex Willd. Sp. Pl. 4: 708. 1806; *Salix wiegandii* Fernald, Rhodora 35: 243. 1933 (Treated here as a species of hybrid origin, *S. calcicola ´ S. candida*.).

***Salix* sect. *Lanatae* (Andersson) Koehne**

Salix calcicola Fernald & Wiegand, Rhodora 13: 251. 1911; *Salix richardsonii* Hook. Fl. bor.-amer. 2: 147; *Salix tweedyi* (Bebb ex Rose) C. R. Ball in J. M. Coulter, Bot. Gaz. 40: 377. 1905 (Basionym: *Salix barrattiana* Hook. var. *tweedyi* Bebb ex Rose, Contr. U. S. Natl. Herb. 3: 572. 1902).

***Salix* sect. *Villosae* (Andersson) Rouy**

Salix alaxensis (Andersson) Coville, Proc. Wash. Acad. Sci. 2: 280. 1900 (Basionym: *Salix speciosa* Hook. & Arn. b [var.] *alaxensis* Andersson in DC. Prodr. 16(2): 275. 1868); *Salix alaxensis* var. *alaxensis*; *Salix alaxensis* var. *longistylis* (Rydb.) C. K. Schneider, J. Arnold Arb. 1: 225. 1919 (Basionym: *Salix longistylis* Rydb. Bull. N. Y. Bot. Gard. 2: 163. 1901); *Salix barrattiana* Hook. Fl. bor.-amer. 2: 146. 1838; *Salix silicicola* Raup, J. Arnold. Arb. 17: 236. 1936.

***Salix* sect. **Viminella* Ser.**

**Salix viminalis* L. Sp. Pl. 1021. 1753.

***Salix* sect. **Canae* A. Kerner**

**Salix elaeagnos* Scop. Fl. Carn. 2 ed. 2: 257. 1772.

***Salix* sect. *Argyrocarpae* Fernald**

Salix argyrocarpa Andersson, Monogr. Salicum 107. 1867.

***Salix* sect. *Geyerianae* Argus**

Salix cana Mart. & Gal. Bull. Acad. Roy. Sci. Bruxelles 10: 344. 1843 (This seems to be the proper section for this taxon according to usage, but the type specimen has not yet been studied.); *Salix geyeriana* Andersson, Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 15: 122. 1858; *Salix lemmonii* Bebb in S. Watson, Bot. California 2: 88. 1879; *Salix petiolaris* Sm. Trans. Linn. Soc. 6: 122. 1802.

***Salix* sect. *Mexicanae* C. K. Schneider**

Salix irrorata Andersson, Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 15: 117. 1858; *Salix lasiolepis* Benth. Pl. Hartw. 335. 1857; *Salix lasiolepis* var. *lasiolepis*; *Salix lasiolepis* var. *bigelovii* (Torr.) Bebb in S. Watson, Bot. Calif. 2: 86. 1879 (Basionym: *Salix bigelovii* Torr. Pacific Railway Reports 7: 139. 1857); *Salix mexicana* Seemen, Bot. Jahrb. 21 (52): 9. 1896; *Salix riskindii* M. C. Johnston, Madroño 28: 150. 1981.

***Salix* sect. *Brewerianae* C. K. Schneider**

Salix breweri Bebb in S. Watson, Bot. Calif. 2: 88. 1879

***Salix* sect. *Griseae* (Borrer) Barratt ex Hook.**

Salix sericea Marshall, Arbust amer. 140. 1785

Salix sect. *Sitchenses* (Bebb) C. K. Schneider

Salix delnortensis C. K. Schneider, J. Arnold. Arb. 1: 96. 1919; *Salix jepsonii* C. K. Schneider, J. Arnold Arb. 1: 89. 1919; *Salix sitchensis* Sanson ex Bong. Mem. Acad. St. Petersb. 6. 2: 162. 1833.

Salix sect. **Helix* Dumort.

**Salix purpurea* L., Sp. pl. 2: 1017. 1753.

George W. Argus
R.R.3-310 Haskins Rd.
Merrickville, Ontario
Canada K0G 1N0
argus@sympatico.ca

Note: I apologize to Dr. Argus and to all of you who receive BEN via e-mail for the loss of formatting and special characters in this article. - Adolf Ceska

For the definitive version of this contribution, please consult BEN archives at http://www.ou.edu/cas/botany-micro/ben/ben227.html

---

Subscriptions:
Send "subscribe BEN-L" or "unsubscribe BEN-L" (no apostrophes) to majordomo@victoria.tc.ca.
Send submissions to BEN-L@victoria.tc.ca
BEN is archived at: http://www.ou.edu/cas/botany-micro/ben/

---

http://www.ou.edu/cas/botany-micro/ben/ben227.html