

NOTES ON *SUAEDA* (AMARANTHACEAE) IN BOREO-ARCTIC NORTH AMERICA

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ABSTRACT

A population of an anomalous *Suaeda* in arctic Canada is found to be conspecific with the arctic Russian species *S. arctica*, which has not previously been identified in North America. The Canadian population studied includes large, fully mature plants, which were hitherto unknown in *S. arctica*. A fuller characterization of the species was thus made possible. Additional Canadian populations of *S. arctica* have previously documented but misidentified as *S. calceoliformis*, which appears to be entirely absent from arctic environments, though it is present in boreal regions. Notes are also provided on the identities of *S. americana*, *S. richii*, and *S. fernaldii*. *Suaeda nigra* (at least in a broad sense) is reported as a new find for boreo-arctic latitudes, in northern Alberta. A key is provided to boreo-arctic North American species of *Suaeda*.

An anomalous population of *Suaeda* (Figs. 1-2) was found on the shore of Bathurst Inlet, Nunavut, mainland arctic Canada in 2012. Numerous consistent phenotypic distinctions can be identified between this population and other previously known northern North American members of the genus. Several additional specimens and photographic records were found to have these same distinctive characteristics, all of them from the shores of the Arctic Ocean and Hudson Bay in arctic Canada, plus one non-marine specimen from Great Bear Lake, northern mainland Northwest Territories. Almost all specimens of these arctic plants include only small or immature individuals, which has made correct identification difficult. The discovery of a population in mature condition helps to further characterize this arctic entity.

Description of the arctic Canadian plants. **Plants** annual, glabrous. **Stems** prostrate, weakly ridged, red or purple-red, seldom yellow, to 30 cm, secondary branches absent. **Nodes** mostly alternate, all fertile, even those immediately above the cotyledons. **Internodes** (between nodes with flowers in anthesis or fruiting) 3–28 mm. **Cotyledons** succulent, oblong (fresh) or linear (dry), red or seldom yellow, persistent. **Leaves** (fresh) ascending or a few spreading, succulent, purplish to strongly purple-red, seldom grey-green, oblong-ovate, ovate, or lance-ovate, (2.5–)4.5–6.5 × 1.7–3 mm (measured dry), adaxially flat or shallowly concave, abaxially bluntly ridged, margins crenulate-denticulate, base rounded to truncate, apex obtuse, lacking any mucro; dried leaves lanceolate. **Glomes** free. **Perianths** 2.2–2.9 mm (long axis), 1–4 per node, nearly sessile, segments about 1/3 fused, bluntly cone shaped, not strongly angular, subequal to moderately unequal in size, not transversely winged. **Fruit wall** fragile. **Seeds** ca. 1.4 mm wide, horizontal, minutely pitted, of two types: 1) glossy, medium brown, easily freed from the fruit wall, and 2) matte, blackish brown, not easily freed from the fruit wall and margins forming an obscure thickened ring. Description based on Björk 26854 (UBC), which corresponds to the population represented in Figures 1-2.

Similar arctic Canadian populations have usually been named as *Suaeda calceoliformis* (Hook.) Moq. (Ferren & Schenk 2003; Gillespie et al 2015). The arctic plants differ from *S. calceoliformis* most strikingly in their consistently prostrate, radiating branches, their lack of secondary branches, their numerous opposite nodes, their lack of sterile nodes, their smaller and more or less ovate leaves lacking



Figures 1 and 2. *Suaeda arctica*. Bathurst Inlet, Nunavut. 1 (top). Mature, fruiting plants. 2 (bottom). Young plants. Photographs by the author.

any mucro, and their smaller perianths, the segments of which are less angular and which lack any trace of transverse wings. The type of *S. calceoliformis* (**Saskatchewan**. Carlton House, *Drummond s.n.* (isotype: NY324401 - scan!) shows characteristics like those of the live plants shown in Figs. 3-4. The leaves are linear with a mucronate apex, the stem is secondarily branched and appears to have been erect, and the perianth segments are larger and more sharply angular than those of the arctic plants. I was unable to find any arctic specimens having the characteristics of *S. calceoliformis*. Accordingly, that species should be removed from checklists of the region.

I was prepared to propose a new name for the arctic plants as described above. However, the identity of these plants became clear upon examination of the type sheets of the Russian species *Suaeda arctica* Jurtzev & V.V. Petrovsky (Bot. Zhurn. 63: 371. 1978. **TYPE: Russia, Chukotka**. Chaumskaya Bay, 4 Aug 1968, *Korobkov s.n.* (holotype: LE 1019672 - scan!; isotype: LE 1019673 - scan!). Just as with most Canadian specimens, plants of the *S. arctica* type are small and/or immature. Presumably due to the small/young plants of the type, *S. arctica* has been differentiated from related species simply by its small size and small number of nodes and leaves (Lomonosova et al. 2008). However, distinctive commonalities among the Canadian plants (whether small and young or large and mature) and the plants of the *S. arctica* holotype and isotype can now be identified: all nodes are fertile, the leaves are small, ovate, and appressed, and the perianth segments are only weakly horn-shaped and they lack any transverse wing. Though the live plants I observed on the shore of Bathurst Inlet are strongly pigmented, the color faded upon drying, so the green color of plants of the *S. arctica* type is not a distinction from the Canadian populations.

The central Asian species *Suaeda tschujensis* Lomon. & Freitag (**TYPE: Russia, Altai Republic**. Kosh-Agach District, 32 Aug 2002, *Lomonosova 254*, isotype K-899733 - scan!) may appear similar to mature plants of *S. arctica* (cf. figure in Pyak et al. 2008), but has ascending inflorescences, narrower proximal leaves, ovate-elliptic inflorescence leaves, and shorter internodes. *Suaeda tschujensis* is differentiated from *S. prostrata* Pall. in its more or less cone-shaped segments (Pyak et al. 2008) and from *S. corniculata* (C.A. Meyer) Bunge in its small size and longer internodes (Lomonosova et al. 2008). The ITS-derived phylogeny in Brandt et al. (2015) suggests a close relationship of *S. arctica* and *S. tschujensis*.

Suaeda arctica was not previously reported from North America. Populations of this species identified as *S. calceoliformis* were the basis for reporting the latter as a new find for the Canadian Arctic Archipelago in Gillespie et al. (2015). Figure 11 of that publication shows young and small plants, apparently recently germinated, just as those of the type of *S. arctica*. Young plants of *S. calceoliformis* (Fig. 3) are dissimilar — they are erect, with linear leaves, sterile nodes, and frequent secondary branching. Thus, even immature plants of *S. arctica* can be differentiated from those of *S. calceoliformis*.

Suaeda arctica in North America is represented by specimens from the Northwest Territories and Nunavut, but it likely also occurs in the Yukon and along the northern coastline of Alaska. Also, an image of *S. arctica* from Ontario, near the southernmost point of Hudson Bay, appears in an iNaturalist observation (iNaturalist 2021) currently identified as *S. calceoliformis*. This confirms the presence of *S. arctica* in Hudson Bay and suggests the species may also occur in Quebec.

North American specimens of *S. arctica* studied. **Canada, Northwest Territories.** Great Bear Lake, N shore of McTavish Arm, vicinity of cold mineral spring, 66° 20'N 119° 30'W, *Porsild 5193* (CAN 50603 - scan!); Anderson R. Delta 69° 42'N 129°W, 26 Aug. 1959, *Barry 63* (CAN 450470 - scan!); Illisarvik, 60 km W of Tuktoyaktuk, 69° 29'N 134° 35'W, 10 Aug 1985, *Ovendon 2241A* (CAN 527829 - scan!); Victoria Island, Minto Inlet, 71° 31'6.5"N 115° 6'30"W, 25 Jul 2010, *Gillespie 10243* (CAN 598331 - scan!); Victoria Island, Boot Inlet, 71° 28'14.5"N 117° 21'36.7"W, 10 July 2010, *Gillespie 9662* (CAN 598332 - scan!). **Nunavut.** Rae River, mouth, 2 Aug 1955, *Miller 312* (CAN

244966 - scan!); Victoria Island, vicinity of Nakoyoktok River, 68° 38'37"N 110° 42'22"W, 19 Jul 2008, *Gillespie* 8068, (CAN 593265 - scan!); Kitikmeot Region, Richardson Bay, Coronation Gulf, 67° 54'11.2"N 115° 32'27.4"W, 8 Jul 2014, *Saarela* 3668 (CAN 608134 - scan!); Bathurst Inlet, estuary of S-flowing creek at base of S-pointing peninsula on the W shore of the inlet near its S end, 66.636 - 107.723, 25 Jul 2012, *Björk* 26854 (UBC).

Other boreo-arctic North American annual *Suaeda*

Suaeda calceoliformis has also been applied to other plants in eastern North America that may at times be confused with *S. arctica* or the Old World species *S. maritima* (L.) Dumort. *Suaeda americana* (Pers.) Fernald (syn. *Salsola salsa* var. *americana* Pers., Synops. Pl. 1: 296. 1805) was listed in synonymy under *S. calceoliformis* in Ferren & Schenk (2003). **TYPE: CANADA.** Mouth of the St. Lawrence River, *Michaux s.n.* (holotype: P 662820 - scan!) does not express the key characteristics of *P. calceoliformis*. Its lower nodes are fertile, the perianths are smaller, and the perianth segments are rounded over the surfaces rather than angular. Plants having characteristics like those of the *S. americana* type occur in the arctic on the shore of Hudson Bay (i.e., 7 Sep 1953, *Lepage* 32825 (CAN 228972 - scan!) and 3 Sep 1954, *Dutilly* 32981 (CAN 234525 - scan!)).

Two species placed in synonymy under *Suaeda maritima* by Ferren & Schenk (2003) appear to be conspecific with *S. americana*: *Suaeda richii* Fernald, *Rhodora* 9: 146. 1907. **TYPE: USA. Maine.** York Co., Aug 1892, *Perkins s.n.* (isotype: GH 660842 - scan!). *Suaeda fernaldii* (Standley) Standley (syn. *Dondia fernaldii* Standley) N. Amer. Fl. 21: 88. 1916. **TYPE: CANADA. Nova Scotia.** Colchester Co., mouth of the Salmon River, 11 Sep. 1910, *Fernald* 3324 (holotype: GH 37233 - scan!).

Suaeda americana, *S. richii*, and *S. fernaldii* have all been described variably and inaccurately. For example, Fernald (1950) treated *S. americana* as having perianth segments "cucullate-carinate on the back," with 1 or 2 of the segments larger than the others. That would describe the perianths of *S. calceoliformis*, but the type of *S. americana* has perianth segments that are not strongly "cucullate-carinate," and they are roughly equal in size. It may be due to Fernald's exaggeration that *S. americana* has been subsumed by some authors (such as Ferren & Schenk 2003) under *S. calceoliformis*, where it clearly does not belong. Standley (1916) described the perianths of *S. fernaldii* as having transverse wings, but these are only scarcely evident or absent on the type specimen, in contrast to some *Suaeda* species, including *S. calceoliformis*, having perianths that are obviously winged, evident even on dried specimens.

Other commonalities among the types of *Suaeda americana*, *S. richii*, and *S. fernaldii* that stand in contrast to most other North American *Suaeda* species are the erect stems, relatively small distal leaves that are of a broader shape than those of the proximal nodes, and apparently a lack of red or purple pigmentation. These three also differ from the lectotype of *S. maritima* (Anon. LINN 313.21, plant on the left side of the sheet), which has longer internodes, a relatively sinuous stem, longer, more linear leaves even on the distal nodes, and the leaves are more spreading.

Fernald (1950) referred to *Suaeda americana* and *S. richii* as being "the small-seeded *Suaedas*," in contrast to the larger-seeded *S. maritima*. Seeds are not evident on the type specimen. Ball & Akeroyd (1993) in the *Flora Europaea* described the leaves of *S. maritima* as being semi-terete, while at least the distal leaves on the types of *S. americana*, *S. fernaldii*, and *S. richii* are evidently flattened. Accordingly, the Lepage and Dutilly specimens from Hudson Bay referred to above are best identified *Suaeda americana*, inclusive of *S. fernaldii* and *S. richii* as synonyms.



Figure 3. *Suaeda calceoliformis*, young flowering plants, Lake Co., Oregon. Photograph by the author.



Figure 4. Mature flowering and fruiting plants of *Suaeda calceoliformis*, near Kamloops, British Columbia. Photograph by the author.

Suaeda calceoliformis, as correctly applied, is common in temperate to subboreal western North America, becoming rarer with increasing latitude. It ranges north to Alaska and the Yukon, but it appears to be absent from the shores of the Arctic Ocean in Alaska, the Yukon, the Northwest Territories, and Nunavut, and also from Hudson Bay. It occurs primarily in and around saline wetlands in grasslands and shrub steppe. It is less common along marine shores.

Records of *Suaeda calceoliformis* from coastal southern Alaska and northern British Columbia require review. Specimens and images from that region were not available to me. Hultén (1968) attributed *S. depressa* (Pursh) S. Wats. and *S. occidentalis* (S. Wats.) S. Wats. to Alaska, the former from the coast, the latter from the interior and adjacent southwestern Yukon. His illustration of *S. depressa* (a misapplication to *S. calceoliformis*, as explained in Ferren & Schenk 2003) shows an immature plant that does not have the characteristic growth of *S. calceoliformis* but which could illustrate a young plant of *S. americana* or *S. maritima*. His illustration of *S. occidentalis* instead has the appearance of *S. calceoliformis*. *Suaeda occidentalis* occurs in semi-arid and desert climates in the contiguous western USA and is unlikely to occur in coastal Alaska and British Columbia.

Brandt et al. (2015) did not sample from near the type locality (mouth of the St. Lawrence River) of *Suaeda americana*. However, their ITS-derived tree resolved a clade of specimens that had been identified as *S. calceoliformis* (their *S. calceoliformis* clade 1), including three from the Great Lakes region, from which the St. Lawrence River flows. Additional northeastern North American specimens named as *S. calceoliformis* are part of this clade 1, as well as a few from central and western

North America. Figure 1k in Brandt et al. shows a plant from Utah that appears similar to the type of *S. americana*. Their *S. calceoliformis* clade 2 includes two samples from Saskatchewan, south of the type locality of *S. calceoliformis*, though another from that region appears in their clade 1, so it is not clear which clade typical *S. calceoliformis* might be associated with. No samples from northeastern North America, where characteristics of *S. calceoliformis* are not found, appear in their clade 1.

Expanding the sampling for ITS plus added markers, and additional molecular methods may help to resolve the identities of Atlantic *Suaeda*. At the present time, however, use of the name *S. calceoliformis* in eastern North America does not seem merited, and *S. americana* should be used in its place in the region. Also, Brandt et al. (2015) did not include any arctic samples in their study, so there is presently no molecular evidence to help resolve whether Ferren & Schenk (2003) were correct to map *S. maritima* from the western shore Hudson Bay, in the vicinity of the origin of specimens that I identify as *S. americana*.

Selected specimens of *Suaeda calceoliformis* studied. Canada. Yukon Territory. Near Klwane Lake, S end, mile 1022, Alaska Highway, 12 Jul 1957 *Schofield* 7784 (UBC 115490 - scan!); Mile 951, Alaska Highway, 3 Jul 1968 *Welsh* 7776 (ALA 40057 - scan!); Alaska Highway km 1500, 60.76516°N 136.2521°W, 1 Aug 2010, *Bennett* 10-709 (WTU 406320 - scan!); ca. 50 km W of Whitehorse, 60° 45'N 135° 15'W, 8 Aug 1977, *Douglas* 10538 (ALA 78659 - scan!). **USA. Alaska.** Swanson Harbor, 40 km SW of Juneau, 58° 18'N 134° 24'W, 27 Jul 1947, *Williams* 47/2 (ALA 23359 - scan!); Pybus Bay, 17 Aug 1958, *Klein s.n.* (ALA 18010 - scan!); Admiralty Island, Wilson Cove, 31 Aug 1993, *Stensvold* 6323 (ALA 120042 - scan!); Yukon Flats, Canvasback Lake area, 66° 24'N 146° 24'W, 28 Jul 1985, *Heglund* 85-488 (ALA 120014 - scan!); Admiralty Island, Gambier Bay, 6 Aug 1980, *Muller* 4027 (ALA 98897 - scan!). **California.** Santa Barbara, abundant in a marsh near the sea. 1879, *Cooper s.n.* (**TYPE** of *Suaeda minutiflora* S. Wats., Proc. Amer. Acad. Arts 18: 194. 1883. **Lectotype, here designated:** GH 214388 - scan!). This specimen has the characteristic erect stems, mucronate linear leaves, and cone shaped perianth segments of *S. calceoliformis* and I tentatively place *S. minutiflora* under synonymy of *S. calceoliformis*.

The *Suaeda nigra* complex

One additional *Suaeda* species occurs in boreo-arctic North America. A population of a perennial species occurs around a salt spring in grassland above the Peace River near Dunvegan, Alberta (*Björk* 18813, UBC, Fig. 5). The stems were not mature at the time of observation, but they are obviously perennial, and remnants of the previous year's perianths confirm the generic identity.

The nearest populations of any perennial or shrubby *Suaeda* are mapped about 800 km distant in far southern Alberta (Packer 1983 — identified as *S. moquinii* (Torr.) Greene; Ferren & Schenk 2003). The *Suaeda nigra* (Raf.) J.F. Macbr. complex is diverse in morphology and in need of further study. Accordingly, the Dunvegan population is only tentatively identified here as *S. nigra*. No perennial or shrubby *Suaeda* has been reported previously from boreo-arctic North America.

Key to North American boreo-arctic *Suaeda*

1. Plants perennial or shrubby; northwestern Alberta ***Suaeda nigra* sensu lato**
1. Plants annual.
2. Lowest nodes sterile; perianth segments angularly cone-shaped ***Suaeda calceoliformis***
2. Lowest nodes fertile; perianth segments bluntly cone-shaped or rounded.
3. Stems erect or ascending, secondarily branched unless dwarfed; proximal leaves linear to oblong ***Suaeda americana***
3. Stems prostrate, secondary branches lacking; leaves all more or less ovate ***Suaeda arctica***



Figure 5. *Suaeda nigra* cfr. on saline clay around a salt spring in grassland, Dunvegan, Alberta.
Photograph by the author.

ACKNOWLEDGEMENTS

I thank Helmut Freitag for his useful comments on the manuscript. Bruce Bennett (BABY), Chris Deduke and Jennifer Doubt (CAN) and Linda Jennings (UBC) provided scans and/or specimens. Lyudmila Krupkina and Marina Legchenko (LE) provided scans of the type specimen of *Suaeda arctica*. Ryan Batten, Natasha Bush, and Daniel McAllister facilitated the Bathurst Inlet field studies.

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