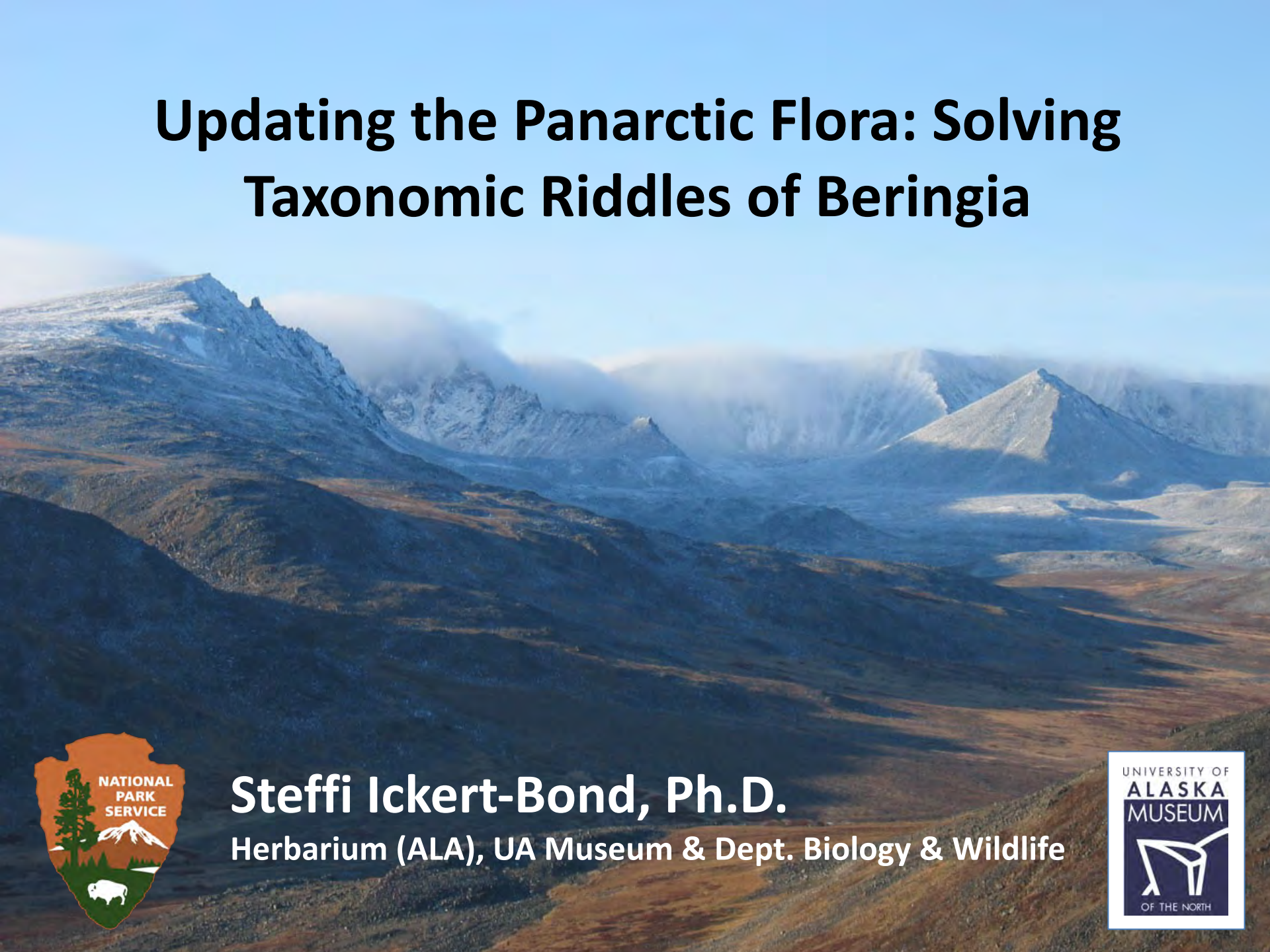
Updating the Panarctic Flora: Solving Taxonomic Riddles of Beringia



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Herbarium (ALA), UA Museum & Dept. Biology & Wildlife

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Naoki Takebayashi, Campbell Webb, Roger Topp (UAF)
Bob Gabbitas, Jordan Metzgar (UAF)
Alaska Center for Conservation Science (UAA)

Examples of Beringia Flora

Tussock-sedge arctic tundra
- Pekulney Range foothills, **Chukotka, Russia**

Eriophorum scheuchzeri Hoppe

Gravel bars dominated by dwarf fireweed with scattered *Artemisia tillesii*, Chetigun River lowlands, **Chukotka, Russia**

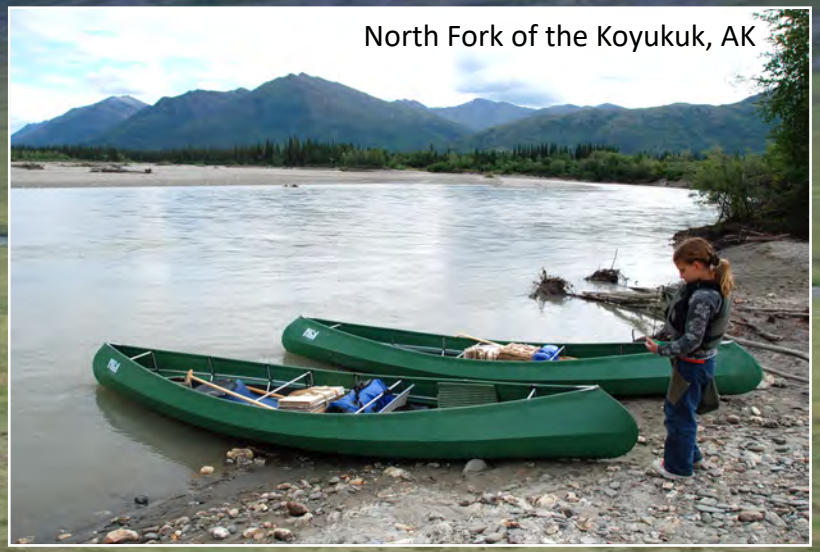
Chamerion latifolium (L.) Holub.

Low shrub birch-willow
Alaska Range, Denali Nat. Park

6190 m

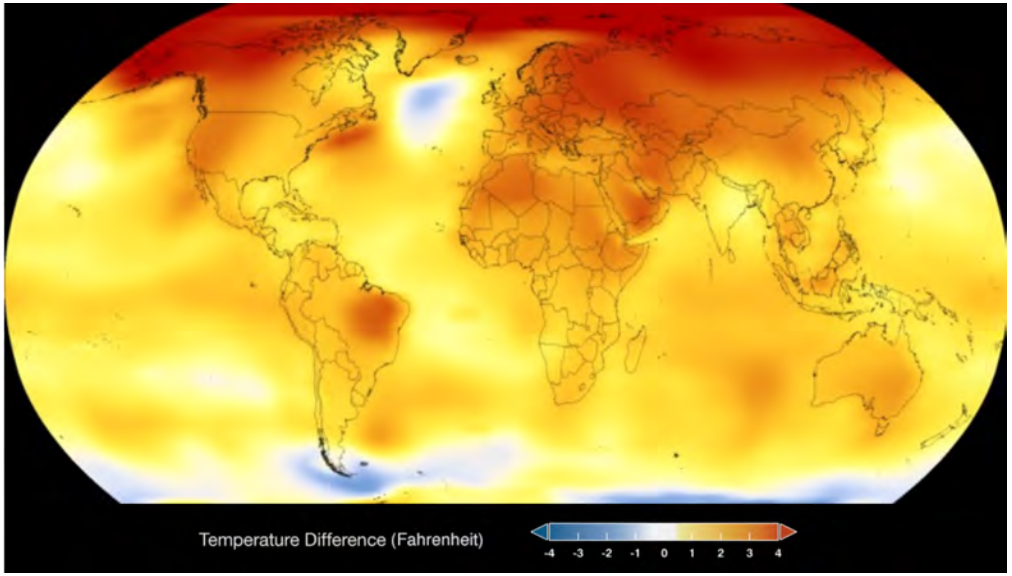
Research challenges - Logistics


Near Chetigun River, Chukotka


North Fork of the Koyukuk, AK


Novoe Chaplino to Lorino

Climate challenges: Consequences of climate change amplified at high latitudes



Meltofte et al. 2013

Taxonomic challenge

Claytonia arctica **species complex**

Taxonomic challenge

Claytonia arctica species complex

Species complex:

A species complex is as an informal assemblage of taxa, whose members are related phylogenetically and share morphological similarities (i.e., they resemble each other), often being virtually indistinguishable on morphological grounds due to reticulations, convergence or recent phylogenetic divergence.

Taxonomic challenge

Claytonia arctica species complex

Species complex:
A species complex is as an informal assemblage of taxa, whose members are related phylogenetically and share morphological similarities (i.e., they resemble each other), often being virtually indistinguishable on morphological grounds due to reticulations, convergence or recent phylogenetic divergence.

> *"There are strong indications of such reticulations in many large arctic genera…"*
>
> (Reidar Elven, David Murray, Boris Yurtsev 1998)

Taxonomic challenge: history of annotations

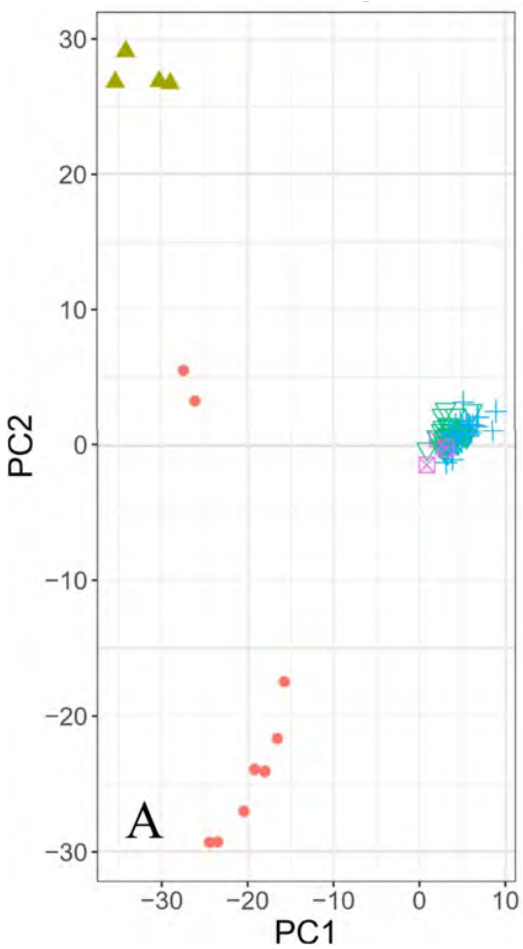
Claytonia arctica species complex

Original ID: *Claytonia sarmentosa* C.A. Mey. by Dave Murray in **1971**

Annotated as: *Claytonia scammaniana* Hultén by John M. Miller **1991**

Annotated as: *Claytonia arctica* sensu Porsild by Dave Murray in **1979**

Genetic structure within *Claytonia* (2023)



▲ *C. sarmentosa*

▽ *C. scammaniana (1)* – 'porsildii morphotype'

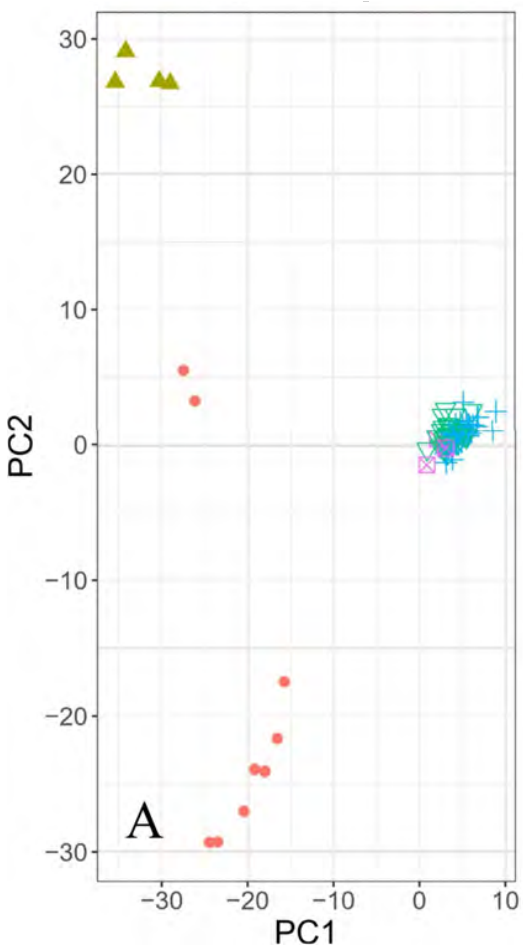
\+ *C. scammaniana (2)* – 'type morphotype'

⊞ *C. scammaniana (3)* – 'noatakensis morphotype'

Gabbitas et al. in prep.

● *C. arctica*

Genetic structure within *Claytonia* (2023)



C. sarmentosa

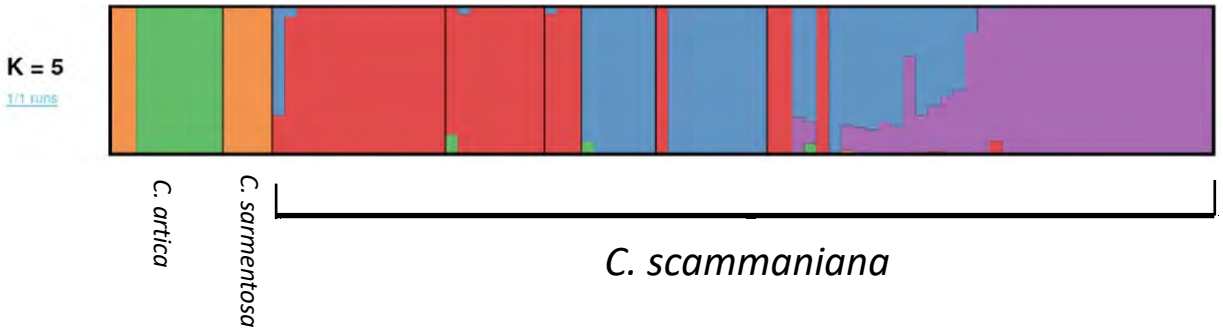
C. scammaniana (1) – 'porsildii morphotype'

C. scammaniana (2) – 'type morphotype'

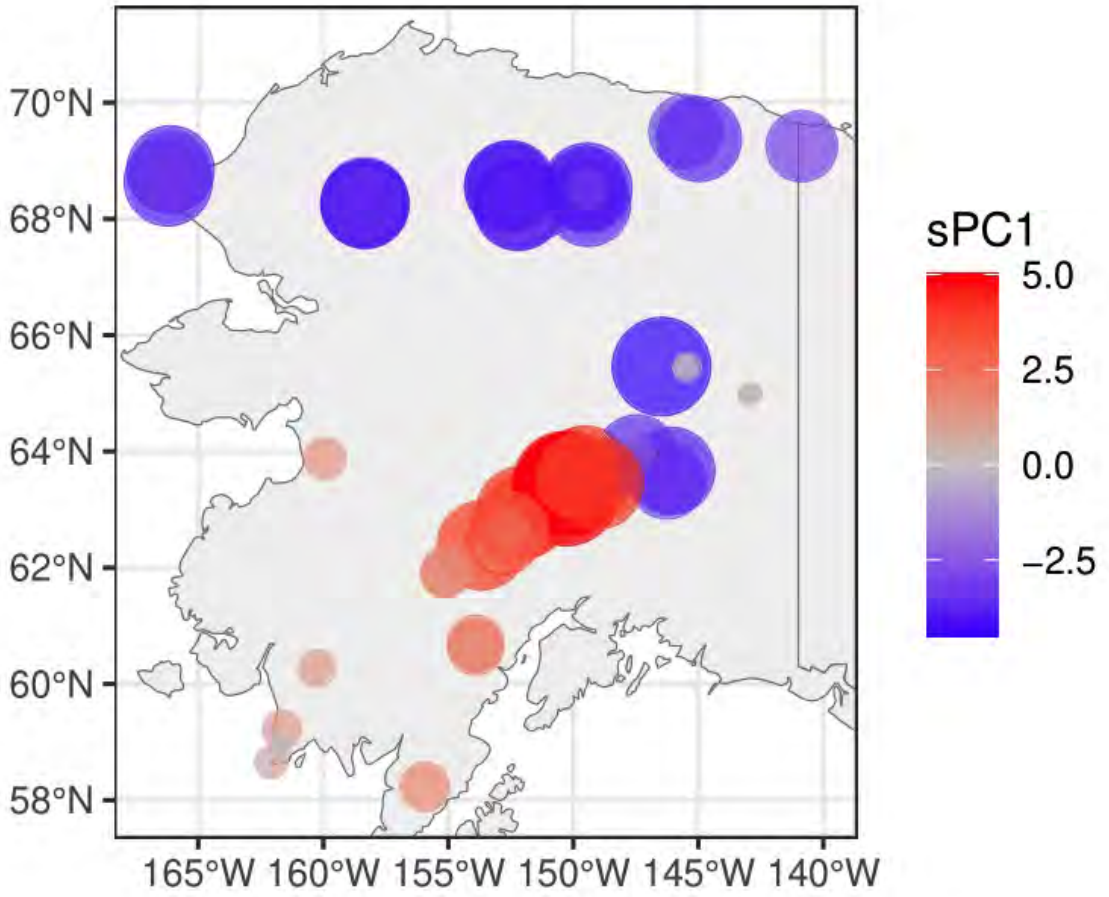
C. scammaniana (3) – 'noatakensis morphotype'

Gabbitas et al. in prep.

C. arctica



Spatial population structure within *C. scammaniana* (2023)



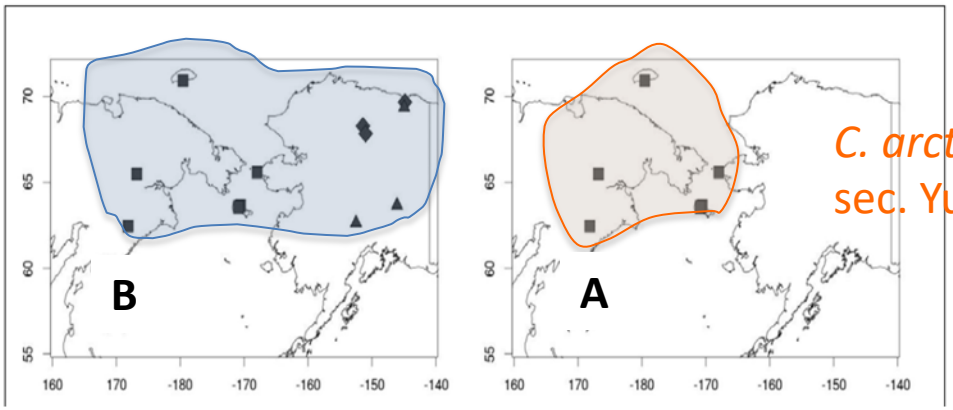
Gabbitas et al. in prep.

Taxon Concept Mapping

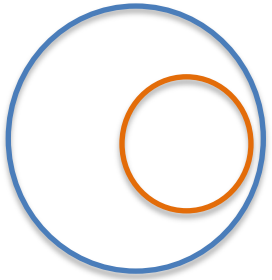
Taxon concepts describe the nature of agreement between different authors over time, by using *sensu* or *sec*.

Example:
***Claytonia arctica* Adams *sensu* Porsild (1974)**

Taxon Concept Mapping

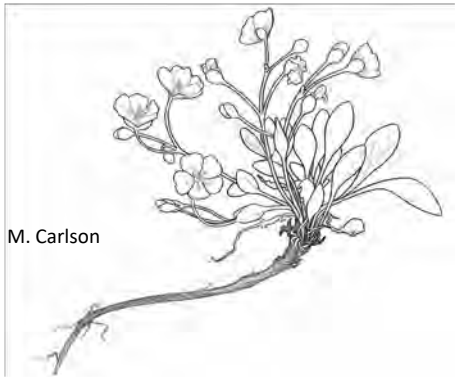


C. arctica Adams
sec. Yurtsev (1981)



A<B

C. arctica Adams
sec. Porsild (1974)



Ickert-Bond et al.
2019

Phylogenomics of willows (*Salix* L.) in Alaska

Campbell O. Webb [1,*]
J. Gordon Burleigh [2]
Stefanie M. Ickert-Bond [1]

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2: Univ. of Florida Dept. of Biology, Gainesville, FL
*<cowebb@alaska.edu>

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Figure 1 – A selection of Alaska willow species: (a) *S. pulchra* ♂, (b) *S. pseudomyrsinites* ♀, (c) *S. alaxensis* ♀, (d) *S. lasiandra* ♀, (e) *S. glauca* ♀, (f) *S. myrtillifolia* ♂, (g) *S. pseudomonticola* ♀, (h) *S. bebbiana* ♀, (i) *S. niphoclada* ♀. Photographed near North Pole, AK, by Webb.

Findings

- The phylogeny was largely robust to choices about data (only-exon vs. exon-plus-flanking) and method (IQTree2 ML on concatenated matrix vs. Astral species tree).
- Our results support the patterns found previously [5, 9] of i) a clade of species ("Clade II") from mixed sections in subgenera *Vetrix* and *Chamaetia* (the former generally being shrub willows and the latter dwarf willows), with ii) *S. reticulata* and *S. interior/exigua* being the outer groups within this clade.
- 22 out of the 32 species with more than one sample are monophyletic in the tree. Overall, more species in section *Vetrix* were monophyletic than in section *Chamaetia*.
- The lack of species monophyly in the clade containing *S. glauca* may reflect the evolutionary porosity of that species. Argus [1] describes it thus: "a high polyploid consisting of tetraploids, hexaploids, and octoploids. The morphological links between *S. glauca* and [other sections] suggest that this species may [...] have evolved through complex hybridization and allopolyploidy with members of those groups [...]. The placement of sect. *Glaucae* in subg. *Chamaetia* is arbitrary. It could equally well have been placed in subg. *Vetrix*."
- More sampling is needed to draw conclusions about the monophyly of most sections, but section *Hastatae* may form a natural group.
- The sister relationship of *S. setchelliana* and *S. interior* has not been reported before, but is consistent with field characteristics.

1. Argus (1997) doi:10.2307/2509658
2. Argus (2010) Flora of North America https://floranorthamerica.org/Salix
3. Breinholt et al. (2021) doi:10.1002/ajb3.11406
4. Chang et al. (2015) doi:10.1186/s13059-015-0596-2
5. Lauron-Moreau et al. (2015) doi:10.1371/journal.pone.0121965
6. Mirarab et al. (2015) doi:10.1093/bioinformatics/btv234
7. Nguyen et al. (2015) doi:10.1093/molbev/msu300
8. Rambaut et al. (v.1.4.4 = 2018) https://github.com/rambaut/figtree
9. Wagner et al. (2020) doi:10.3389/fpls.2020.01077

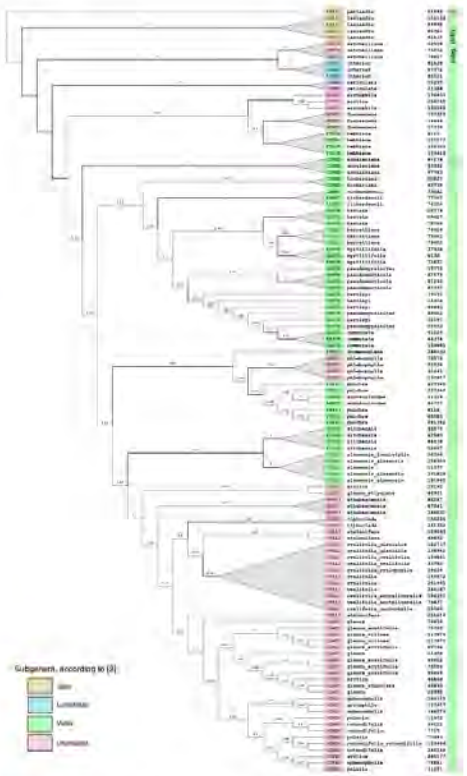

Figure 2 – Cladogram of 119 Alaskan *Salix* samples from 43 taxa. Branch annotation is Astral support value; branches with support ≥ 0.9 have wider lines. Monophyletic species are drawn with a triangular clade. Sections and subgenera according to [2] are indicated respectively by the five letter codes preceding species names and the colored boxes around them. Section codes: ARBUS = *Arbuscella*, CHAMA = *Chamaetia*, CINER = *Cinerella*, DIPLO = *Diplodictyae*, FULVA = *Fulvae*, GLAUC = *Glaucae*, HASTA = *Hastatae*, HERBE = *Herbella*, LANAT = *Lanatae*, LONGI = *Longifoliae*, MYRTI = *Myrtilloides*, MYRTO = *Myrtosalix*, OVALI = *Ovalifoliae*, PHYLI = *Phylicifoliae*, SALIC = *Salicaster*, SETCH = *Setchellianae*, SITCH = *Sitchenses*, VILLO = *Villosae*. The colored bar at the right indicates the likely new subgenus for each species according to [5]. The numbers after species names are the catalog numbers in the Arctos database (prefix with https://arctos.database.museum/guid/UAM:Herb: to view online).

(version: 1.0)

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Revised Panarctic Flora

http://panarcticflora.org/

Panarctic Flora

Home Browse Search Introduction References Contact

Web History and Contacts

Data parsing: Christian Svindseth originally created the PAF database from text documents supplied by the editors.

Website design: Christian Svindseth also developed the web application to serve the PAF data, using `Ruby` and the `sinatra` web server. The site was originally hosted at `http://nhm2.uio.no/paf/`.

Current hosting: Since October 2018, the original website application has been re-hosted at `http://panarcticflora.org`. Please contact Cam Webb for any concerns to do with the website.

Institutional home of PAF: The PAF project is now managed out of the Herbarium of the University of Alaska, Fairbanks (ALA). Please contact Reidar Elven, David Murray, or Steffi Ickert-Bond, the herbarium curator, with questions about ongoing work on the Panarctic Flora.

Search Results

Therorhodion
Therorhodion glandulosum

7402 *Therorhodion* Small

Small, N. Amer. Fl. 29: 45 (1914).

GBIF

Notes: Elven and Murray: Kron and Judd (1990) presented good molecular evidence for accepting *Therorhodion* apart from Rhododendron. This is further strengthened by the analyses of Kron et al. (1999) and Kurashige et al. (2001).

The northern, amphi-Beringian Therorhodion glandulosum and the more southern, amphi-Pacific *T. camtschaticum* (Pall.) Small (*Rhododendron camtschaticum* Pall.) must be closely related but are consistently different in some characters. No intermediates have been seen in the material (ALA) from Alaska where they nearly meet. We therefore accept two species. *Therorhodium camtschaticum* is not yet documented to reach the Arctic even if Hultén (1973) reported it from March Mountain north of Dillingham in southwestern Alaska. The three reports of diploid chromosome numbers (2n = 24, 26) included for the collective species by Löve and Löve (1975a) belong to *T. camtschaticum*.

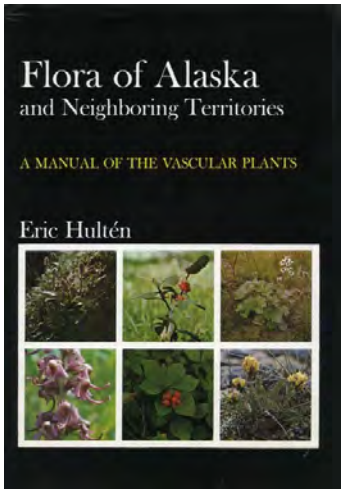
A new Flora of Alaska

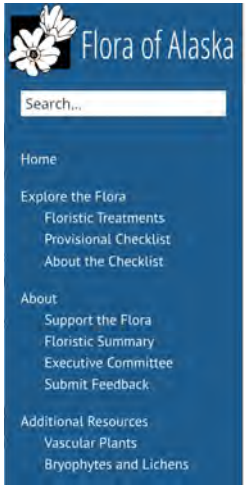
- Time for an update – Hultén's Flora was in 1968

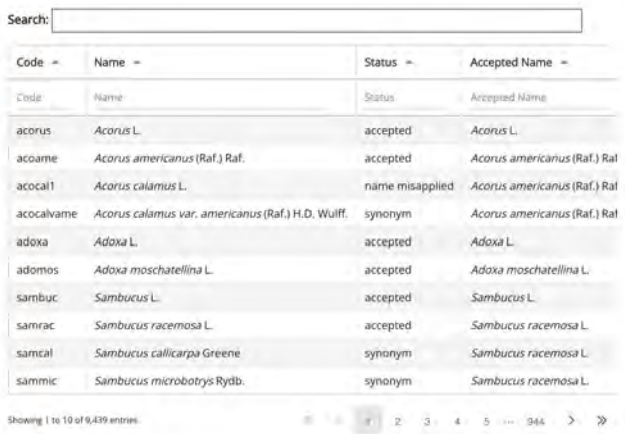
- The (larger) new Flora of Alaska project https://floraofalaska.org/, since 2018

- Taxonomic review of the checklist is almost finished

- Flora links out to TCM data







Crossroads of Beringia Exhibit at UAM

Virtual tour

Bering Food Bridge

Field work knows no borders

Ancient Travelers

UNIVERSITY OF ALASKA MUSEUM OF THE NORTH

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REVIEW

Ancient DNA genomics and the renaissance of herbaria

Hernán A. Burbano[1]*† and Rafal M. Gutaker[2]†