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Integrating Taxonomic Resources for Alaskan Plants

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Version 1.0

Behind a checklist or flora

- ...is a comprehensive **integration of existing data**:
  1. Names: accepted names and synonyms according to various prior opinions;
  2. Distribution: occurrence data from specimens and observations;

  (3. Descriptions: character data)

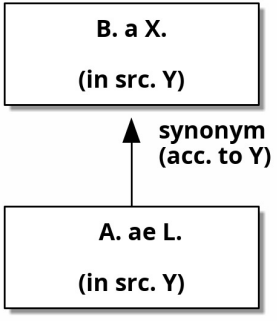
  Creating what we might call the *unchecked-list*.
- Followed by **new taxonomic opinions**

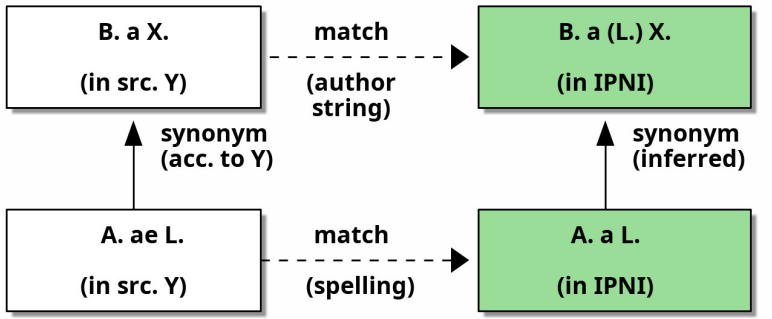
Integration via names

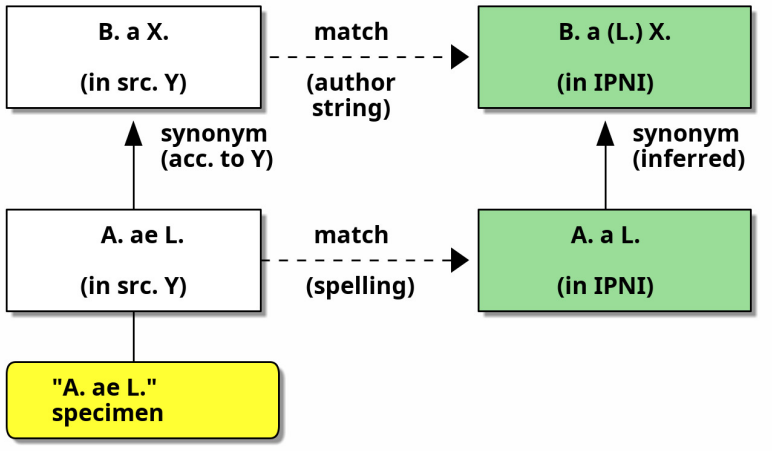
- Patterson et al. (2010): "Names are key to the big new biology" ($\rightarrow$ Global Names Architecture)
- But... **variation in the name string** is common:

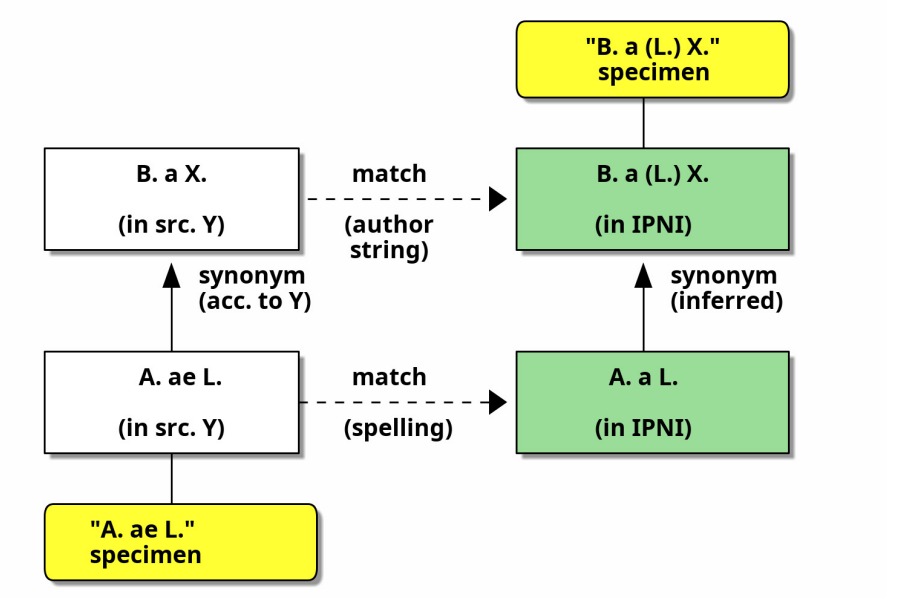
  Ciminalis prostrata (Haenke) Á. Löve & D. Löve
  Ciminalis prostrata (Haenke) A.Love & D.Love
  Ciminalis prostrata Love & Love
  Ciminalis prostratus (Haenke) Á. Löve & D. Löve

- So, **matching** names is also key...

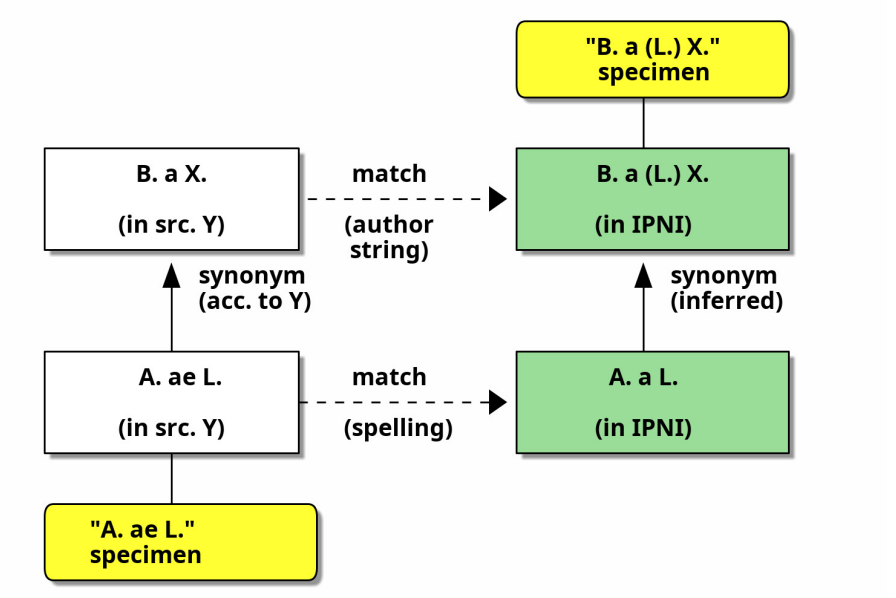

B. a X.
(in src. Y)
synonym
(acc. to Y)
A. ae L.
(in src. Y)


B. a X.
(in src. Y)
match
(author string)
B. a (L.) X.
(in IPNI)
synonym
(acc. to Y)
synonym
(inferred)
A. ae L.
(in src. Y)
match
(spelling)
A. a L.
(in IPNI)


B. a X.
(in src. Y)
match
(author string)
B. a (L.) X.
(in IPNI)
synonym
(acc. to Y)
synonym
(inferred)
A. ae L.
(in src. Y)
match
(spelling)
A. a L.
(in IPNI)
"A. ae L."
specimen


"B. a (L.) X."
specimen
B. a X.
(in src. Y)
match
(author
string)
B. a (L.) X.
(in IPNI)
synonym
(acc. to Y)
synonym
(inferred)
A. ae L.
(in src. Y)
match
(spelling)
A. a L.
(in IPNI)
"A. ae L."
specimen

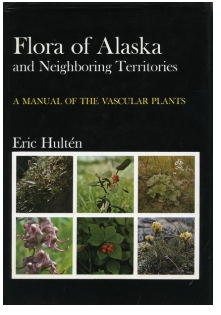
A names *graph*

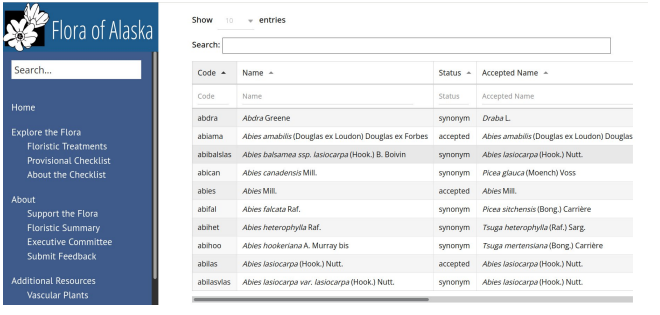


Example graph query: “find all specimens of “B. a (L.) X.”

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 checklist almost finished





For our informatics component, thanks to...

- **Funding**: US National Science Foundation, Advances in Biological Informatics Innovation Grant 1759964
- **People**: Flora of Alaska Executive Committee, Nico Franz, Alan Weakley, James Macklin, **Kimberly Cook**
- **Data**: Collectors, flora & monograph authors, iNat observers, data curators, database admins, Ottawa FNA team, Dusty McDonald
- **FOSS**: Linux, Apache, MySQL/MariaDB, Jena, Gawk, ImageMagick, Graphviz, GIMP, ditaa, LaTeX

Data sources

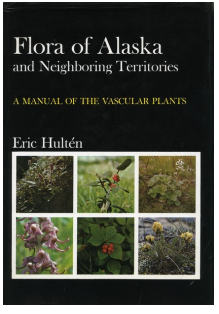
1. External, **"canonical" names**, with GUIDs:
   - Create raw list of all possible names
   - Used Global Names Resolver
   - IPNI > Tropicos > Kew's World Checklist of Selected Plant Families

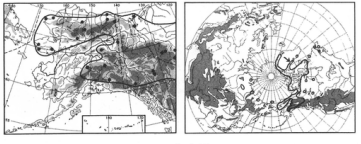
Data sources

1. External, “canonical” names
2. Names in **floras & checklists**
   - Flora of North America (*via* Ottawa team)
   - Previous checklists at ALA, ACCS
   - Panarctic Flora (http://panarcticflora.org/)
   - Hultén’s 1968 Flora of Alaska

Digitizing Hultén's Flora

- Slice up scan with `ImageMagick` (& manual)
- OCR using wordlist including all names
- Distribution dots to long/lat with `ImageMagick`
- View at: https://alaskaflora.org/hulten/





Lesquerella S. Wats.

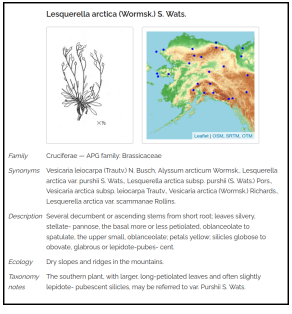
1. Lesquerélla árctica (Wormsk.) S. Wats.

Alyssum arcticum Wormsk.; *Vesicaria arctica* (Wormsk.) Richards.; *V. arctica* subsp. *leiocarpa* Trautv.; *V. leiocarpa* (Trautv.) N. Busch; *Lesquerella arctica* var. *Purshii* S. Wats.; *L. arctica* subsp. *Purshii* (S. Wats.) Pors.; *L. arctica* var. *Scammanae* Rollins.

Several decumbent or ascending stems from short root; leaves silvery, stellate-pannose, the basal more or less petiolated, oblanceolate to spatulate, the upper small, oblanceolate; petals yellow; silicles globose to obovate, glabrous or lepidote-pubescent.

Dry slopes and ridges in the mountains.

The southern plant, with larger, long-petiolated leaves and often slightly lepidote-pubescent silicles, may be referred to var. **Pùrshii** S. Wats.



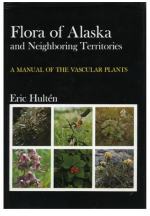
Data sources

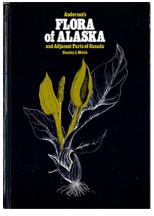
1. External, “canonical” names
2. Names in floras & checklists
3. **Taxonomic concepts**
   - “The problem with names alone”
   - New taxonomic concept mapping work here at the U. Alaska Museum (ALA)

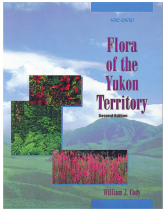
Taxonomic concept mapping

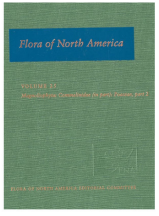
- **Kimberly Cook** aligned concepts in five key Alaskan flora sources: Hultén (1968); Welsh (1974); Cody (2000); FNA Eds. (1993+); Elven et al. (2017)
- TC relationships inferred from taxonomy, morphology, geography (Cook et al., 2021)

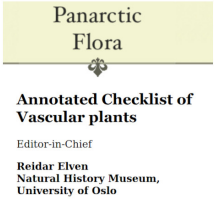
→ 557 taxonomic concepts in 13 genera & 482 taxonomic concept relationships



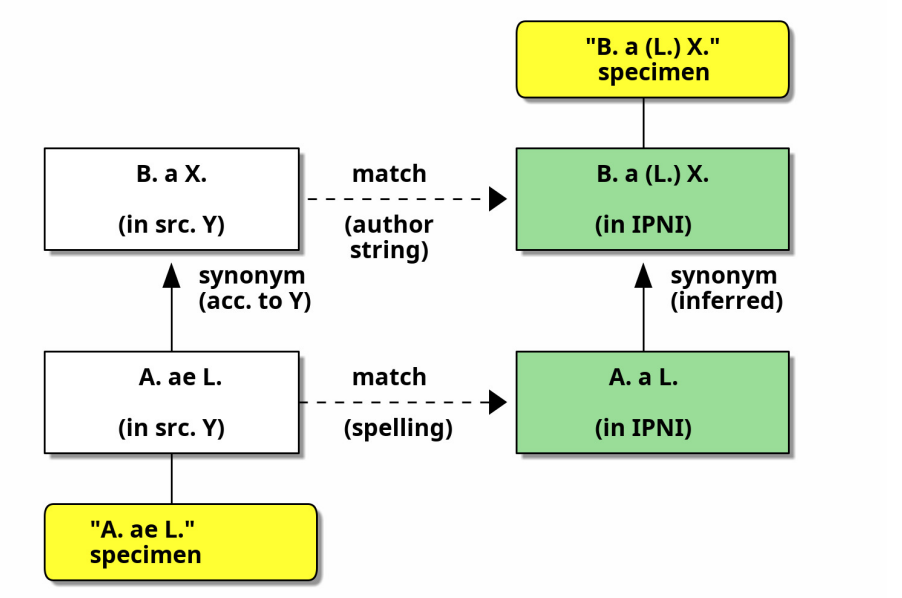




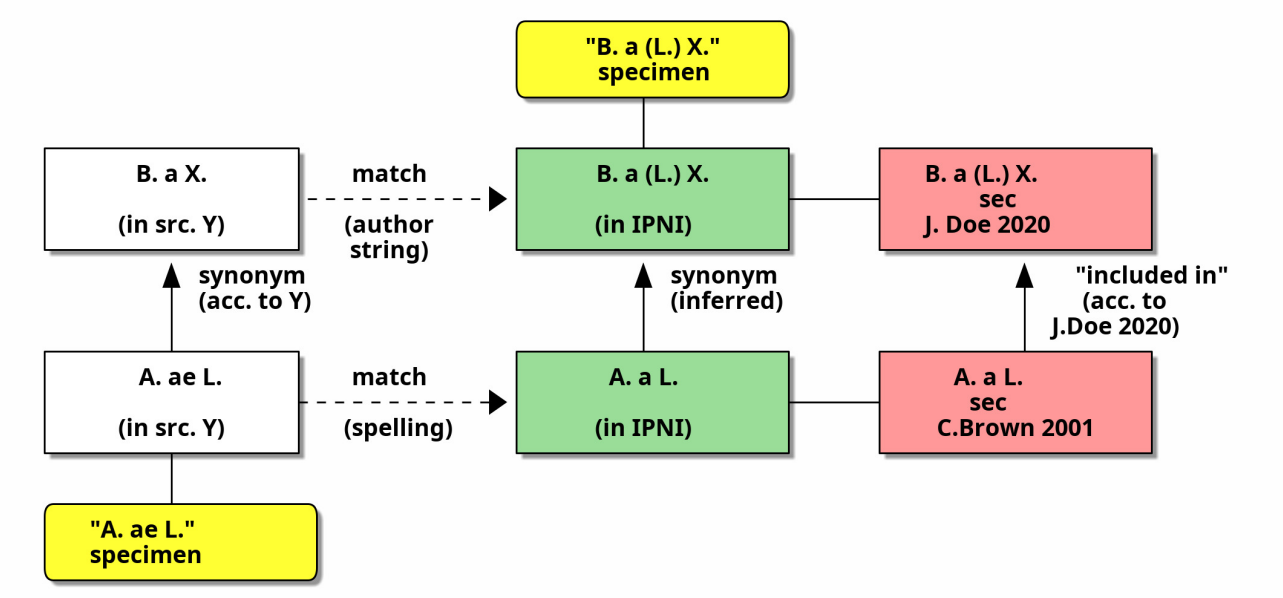




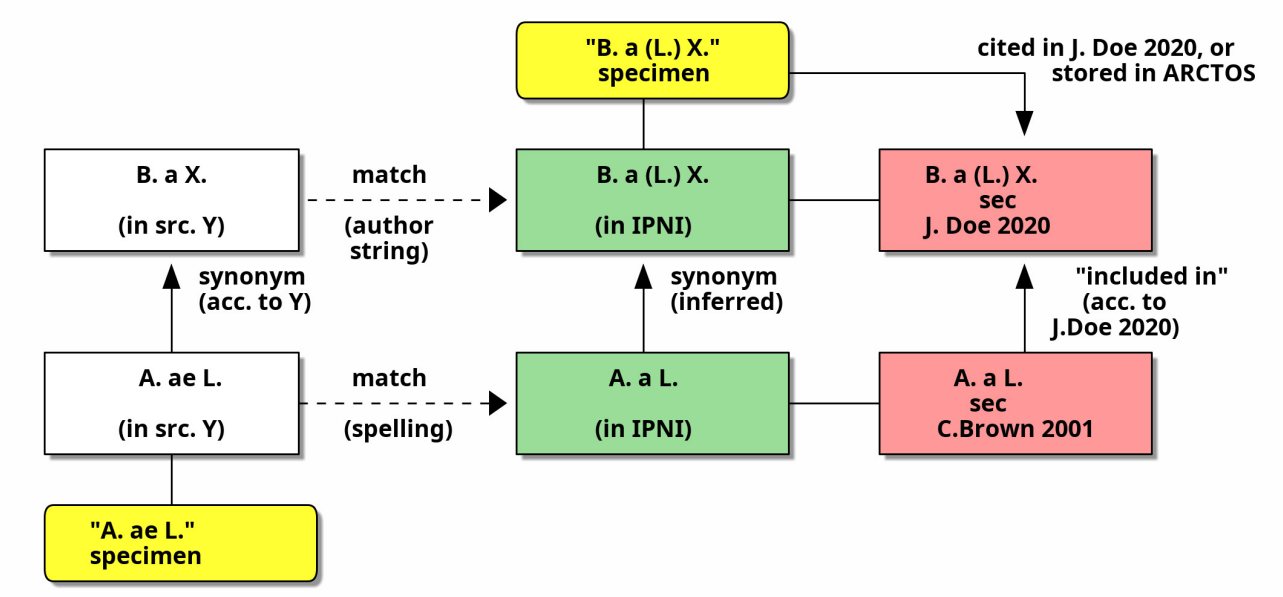
The names graph



The names graph

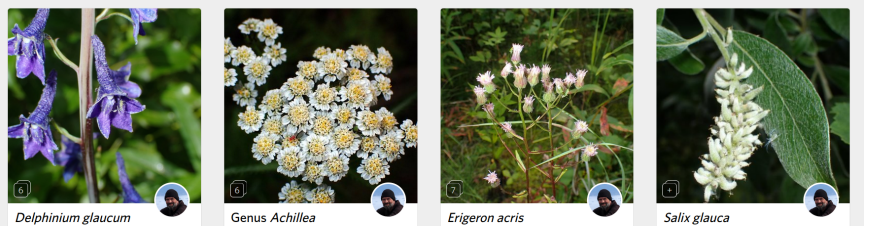


The names graph



Data sources

1. External, “canonical” names
2. Names in floras & checklists
3. Taxonomic concepts
4. **Occurrences**
   - ALA herbarium specimens, GBIF specimens
   - iNaturalist observations



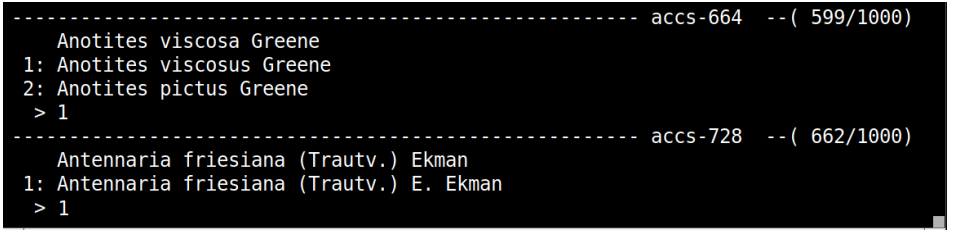
Graph assembly

- Data cleaning, reformatting, filtering scripts
  $\Rightarrow$ Bespoke "data curation"
- All steps recorded in Github and open to review
  https://github.com/camwebb/akflora

Matching names

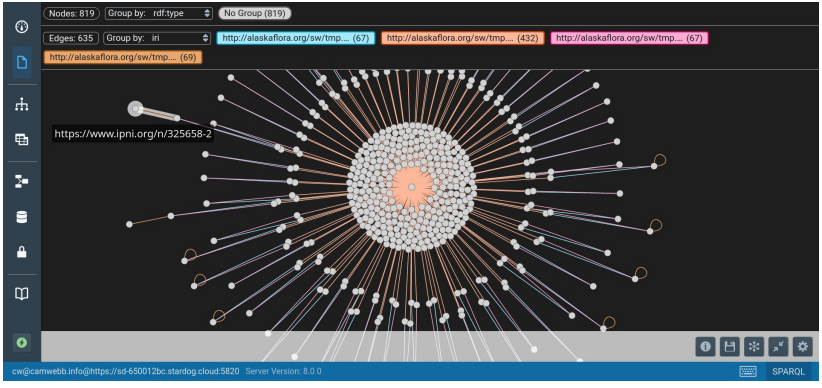
`matchnames` (Webb and Ickert-Bond, 2020)

1. Parse into components
2. Taxonomic logic: missing basionym, *ex*, *in*, etc.
3. De-punctuation matching
4. Fuzzy matching
5. Manual matching:



Graph databasing & query

- Plain text files & Gawk **scripts**
- SQL database (MariaDB) & **SQL**
- Graph databases (Allegrograph, Jena, Stardog) & **SPARQL**



Query via web app

- https://alaskaflora.org/graph/
- Displays name status according to source
- Displays occurrences, both by original name and by synonymized name

Query = *Salix bebbiana*;

Salix bebbiana Sarg. {ipni} ← {accs}, {ala}, {fna}, {gbif}, {hulten}, {paf}
ACCEPTED by ACCS, ALA, FNA, GBIF, PAF
SYNONYM of **Salix depressa subsp. rostrata (Andersson) Hiltonen** {trop} according to HULTEN ← {hulten}

Salix bebbiana var. capreifolia (Fernald) Fernald {trop} ← {accs}, {fna}
SYNONYM of **Salix bebbiana Sarg.** {ipni} according to ACCS ← {accs}, FNA ← {fna}

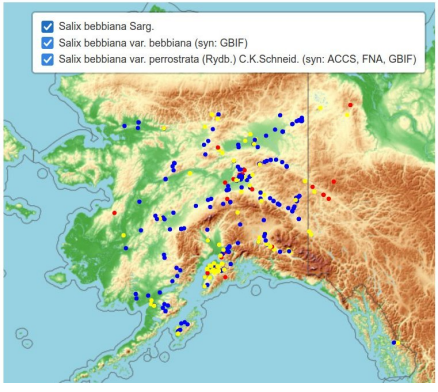
Salix bebbiana var. depilis Raup {ipni} ← {accs}, {fna}
SYNONYM of **Salix bebbiana Sarg.** {ipni} according to ACCS ← {accs}, FNA ← {fna}

Salix bebbiana var. luxurians (Fernald) Fernald {trop} ← {accs}, {fna}
SYNONYM of **Salix bebbiana Sarg.** {ipni} according to ACCS ← {accs}, FNA ← {fna}

Salix bebbiana var. perrostrata (Rydb.) C.K.Schneid. {ipni} ← {accs}, {fna}, {gbif}
SYNONYM of **Salix bebbiana Sarg.** {ipni} according to ACCS ← {accs}, FNA ← {fna}, GBIF ← {gbif}

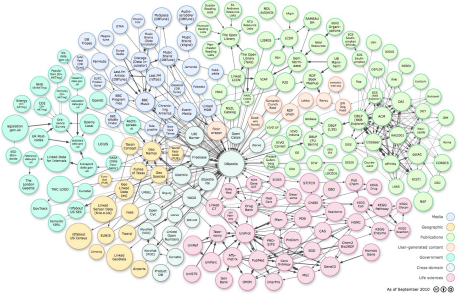
Salix bebbiana var. projecta (Fernald) C.K. Schneid. {trop} ← {accs}, {fna}
SYNONYM of **Salix bebbiana Sarg.** {ipni} according to ACCS ← {accs}, FNA ← {fna}

Salix bebbiana Sarg. {ipni} ← {gbif}



Full graph

- RDF: plain text, XML-based, self-documenting. Directly links into the global Open Data graph.
- 1,243,156 triples: `subject, predicate, object`
- As RDF-XML the file is 78MB (zipped: 5.1 MB)
- Draft version at https://alaskaflora.org, once final also at Zenodo



“Unchecked-lists” are stand-alone resources

- **Integration** of existing taxonomic data (digital and paper) permits complex queries and visualizations
- ... that enable users to see **taxonomic history** and **compare taxonomic opinions**.
- And forms the foundation for new reference checklists and floras.

References

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