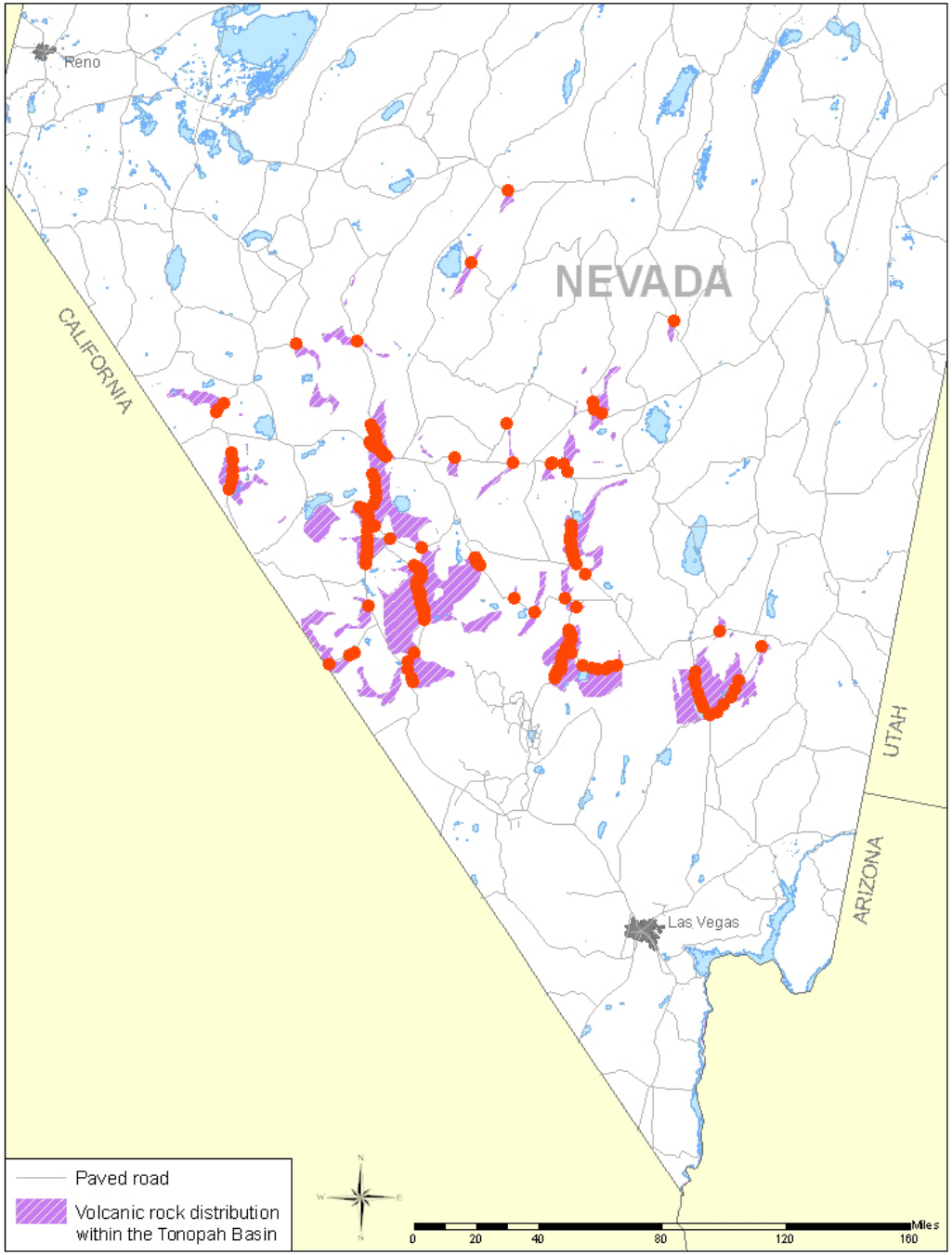
Particulate and Biological Databases from a Geolocation Perspective

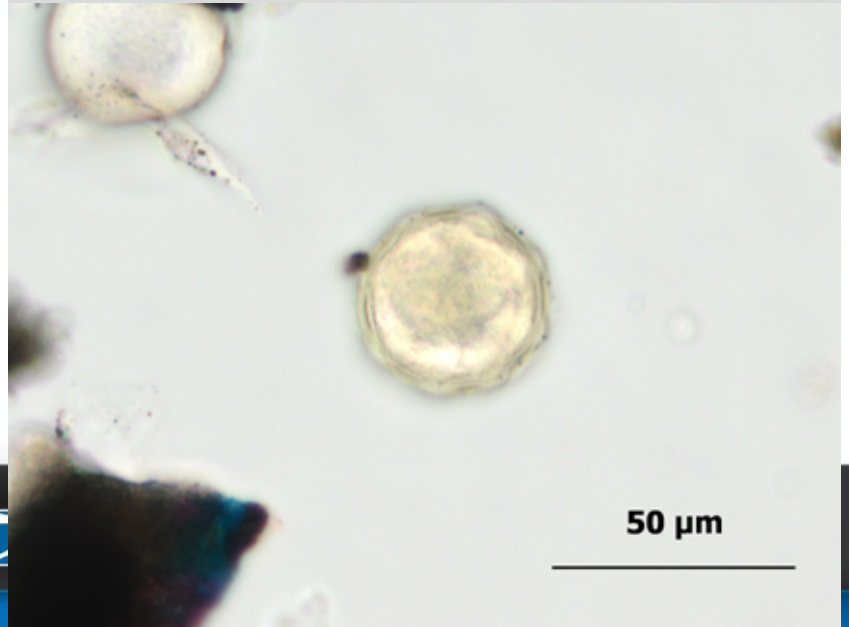
Andrew Bowen

Introduction

- Background – geolocation / geosourcing research
- Broader range of particles than used in traditional trace evidence
- Resources of value for identification
- Resources of value for interpretation
- Application of these resource to traditional trace evidence

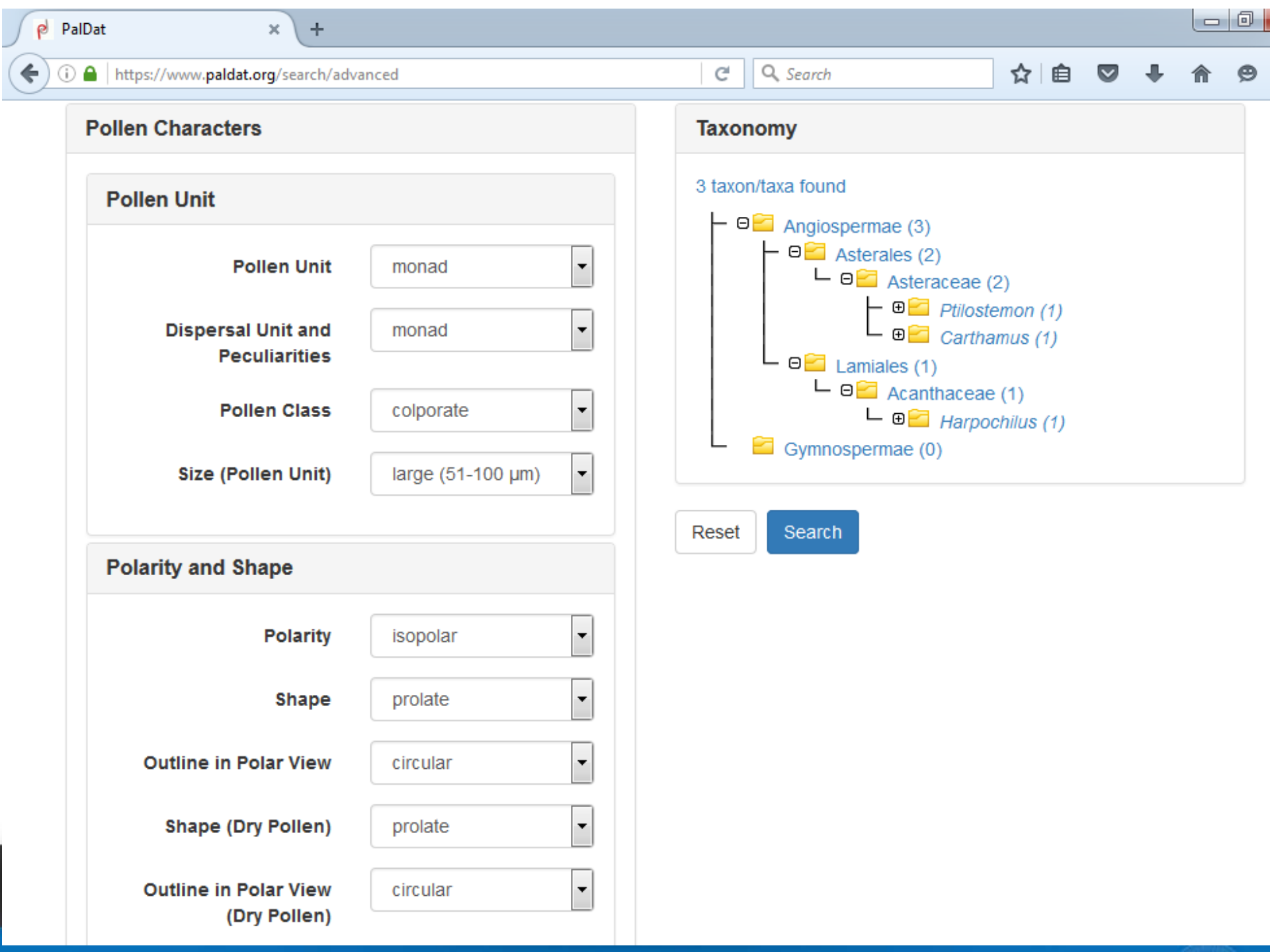

Reno
NEVADA
CALIFORNIA
UTAH
ARIZONA
Las Vegas
Paved road
Volcanic rock distribution within the Tonopah Basin
N
S
W
E
0
20
40
80
120
160
Miles

Pollen



Pollen Identification

- PalDat - Palynological Database
  - www.paldat.org
- PIGLT - Pollen Identification and Geolocation Technology
  - D. Masters et al.
- Textbooks, articles, additional websites, etc.


PalDat
https://www.paldat.org/search/advanced
Search
Pollen Characters
Pollen Unit
Pollen Unit
monad
Dispersal Unit and Peculiarities
monad
Pollen Class
colporate
Size (Pollen Unit)
large (51-100 µm)
Polarity and Shape
Polarity
isopolar
Shape
prolate
Outline in Polar View
circular
Shape (Dry Pollen)
prolate
Outline in Polar View (Dry Pollen)
circular
Taxonomy
3 taxon/taxa found
Angiospermae (3)
Asterales (2)
Asteraceae (2)
Ptilostemon (1)
Carthamus (1)
Lamiales (1)
Acanthaceae (1)
Harpochilus (1)
Gymnospermae (0)
Reset
Search

PalDat

https://www.paldat.org/search/results/pollenUnit:monad~pollenClass:colporate

Search

PalDat - Palynological Database

an online publication on recent pollen

Login

Home | **Search Data** | Submit Data | Terminology | Information | Get Pictures | Register

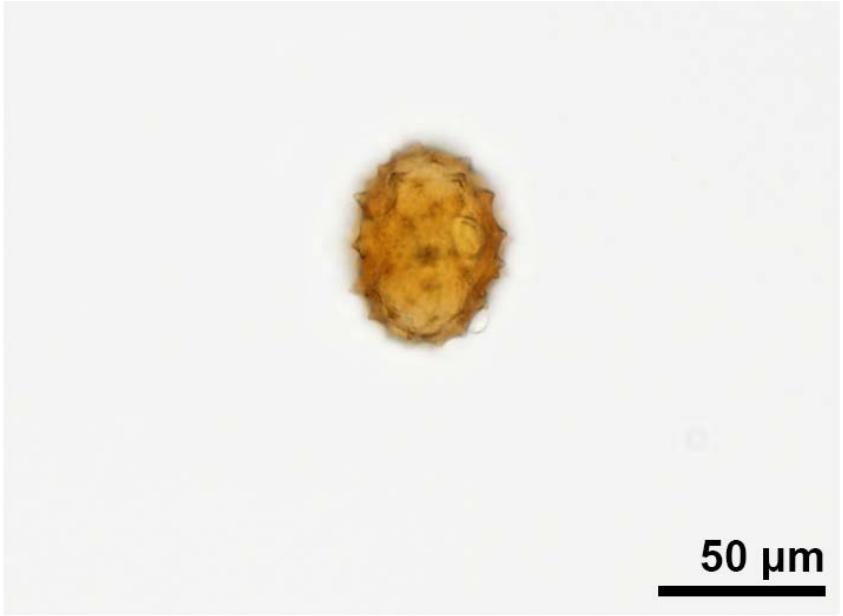
Alphabetical Search | **Combined Search**

Search Results

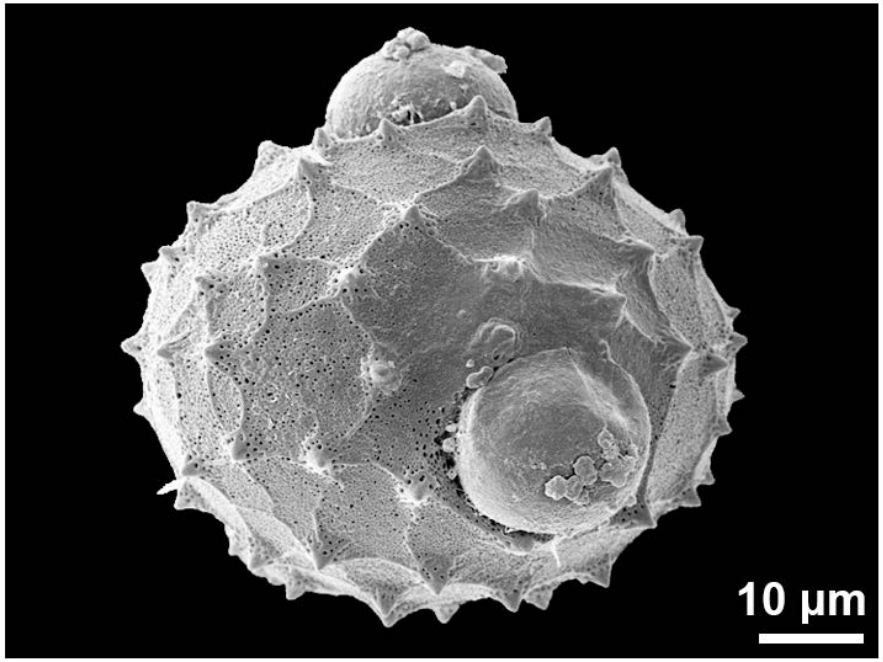
1 taxa found

Family	Species	Plant	LM	SEM	TEM	Compare
Asteraceae	*Carthamus lanatus*					

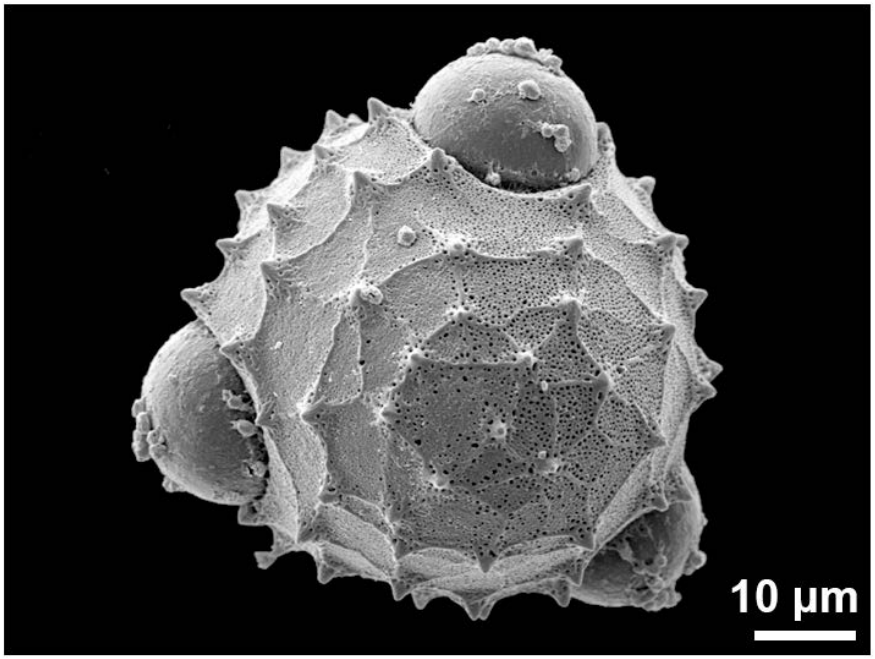
flower(s) / Photographer: Magauer, Marianne



acetolyzed pollen, equatorial view / Photographer: Weber, Martina



equatorial view / Photographer: Halbritter, Heidemarie

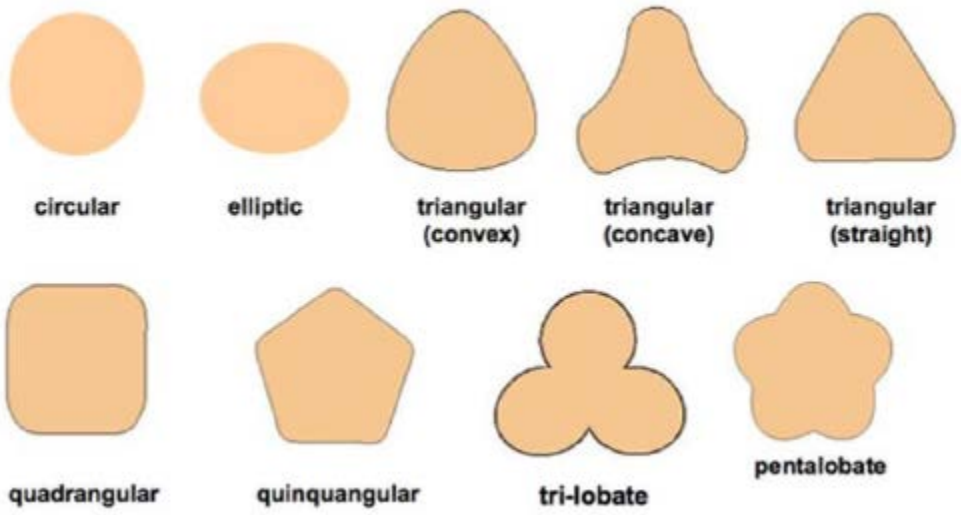


polar view / Photographer: Halbritter, Heidemarie

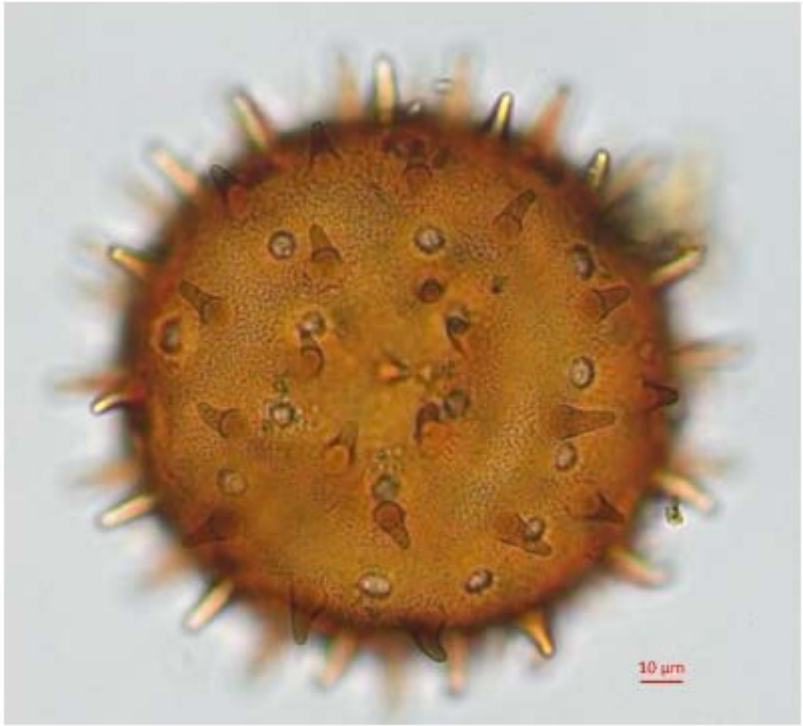
Pollen Identification and Geolocation Technology – PIGLT (1)

- Application similar to PalDat
- Search based on morphological attributes
- Contains photomicrographs of pollen taxa
- Provides geographic distribution data for taxa
  - Taken from Global Biodiversity Information Facility

PIGLT (1)



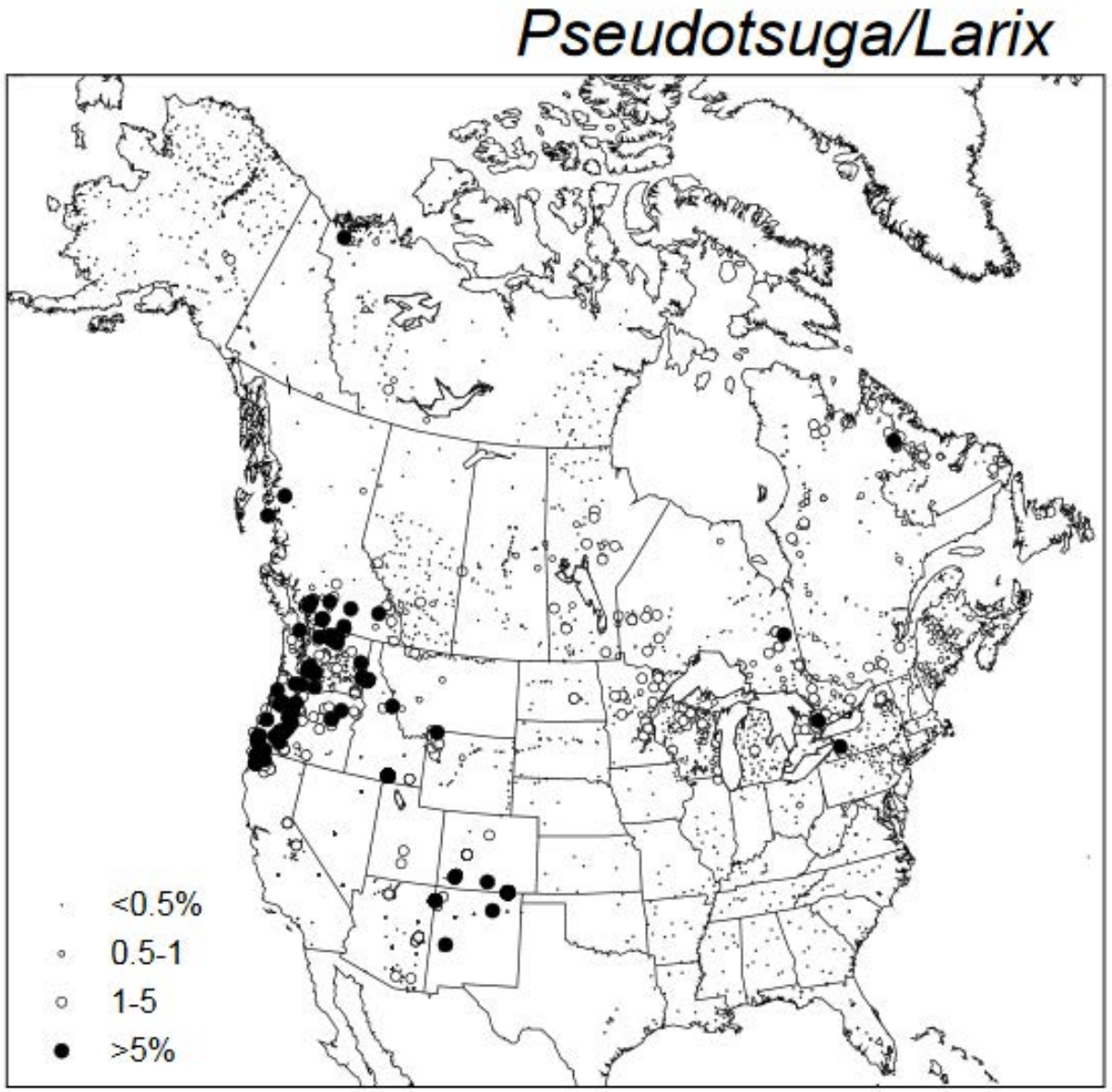
Morphology Attribute	Sample Values
Grain Arrangement	Monad, Dyad
Aperture Count	Numerical (0-6)
Equatorial Shape	Oblate, Prolate
Exine Type	Tectate, Semitectate
Wall Evenness	Even, Thicker on Pole
Columella	Visible, Invisible
Polar Size	Numerical (um)

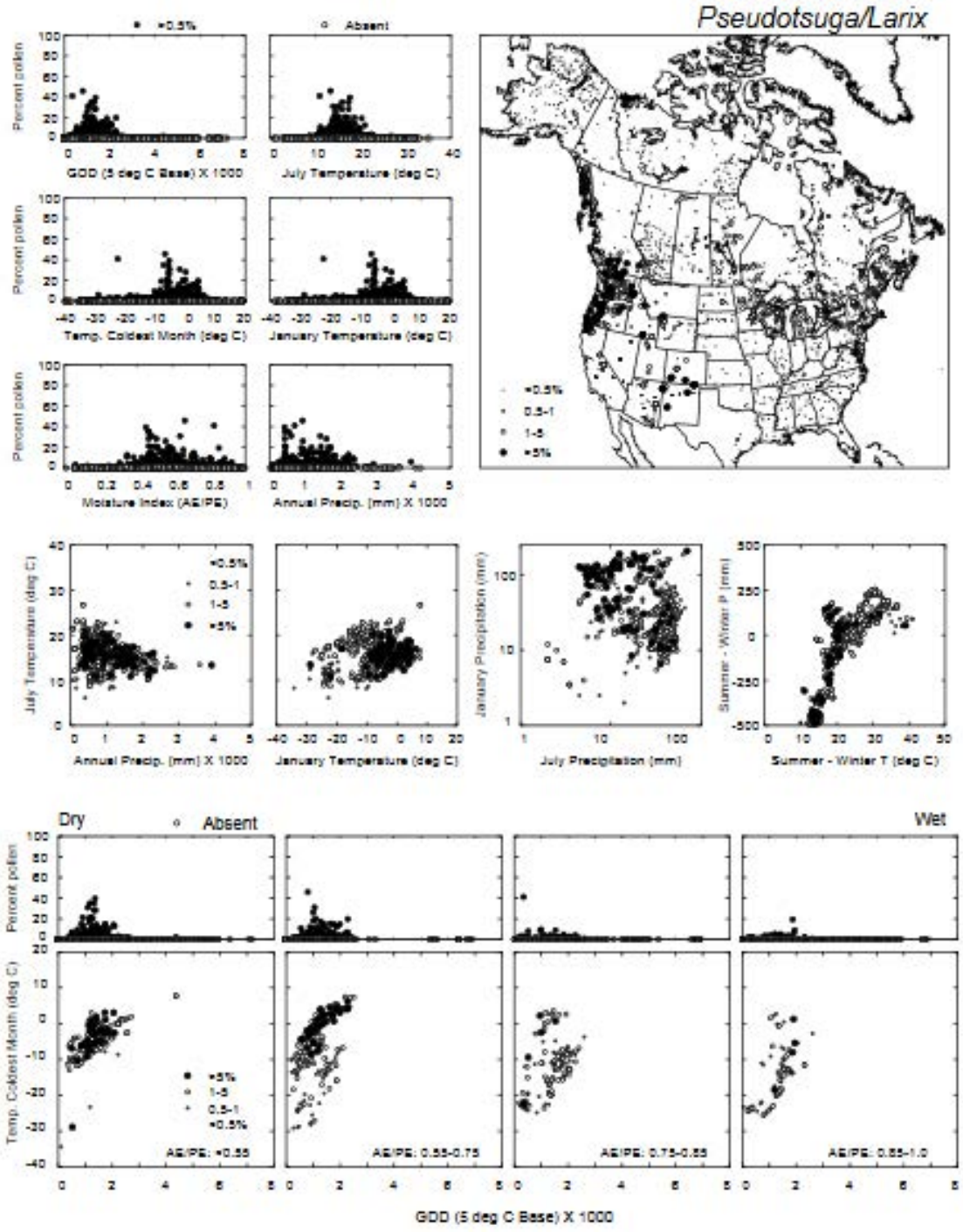


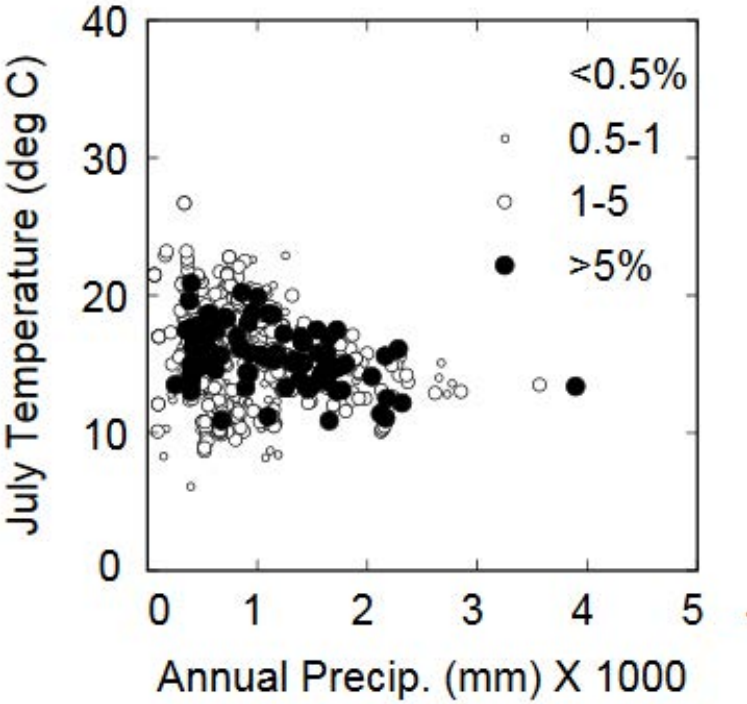
Pollen Interpretation

- North American Pollen Atlas
  - http://www.ncdc.noaa.gov/paleo/pollen/atlas/atlas.html
- Pollen Viewer
  - http://www.geography.wisc.edu
- Flora Publications
- Ecoregions, climate data, topographic maps

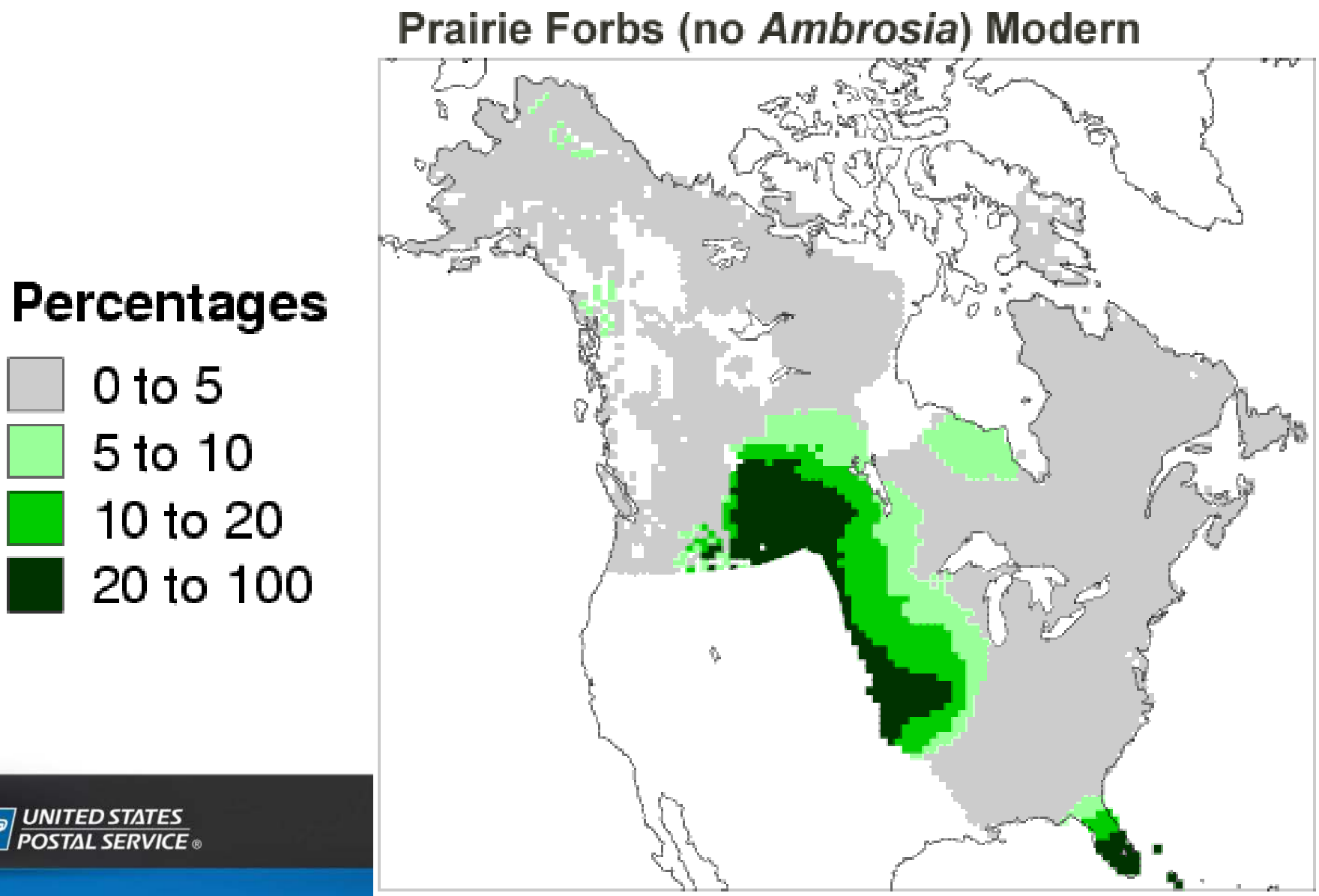
North American Pollen Atlas



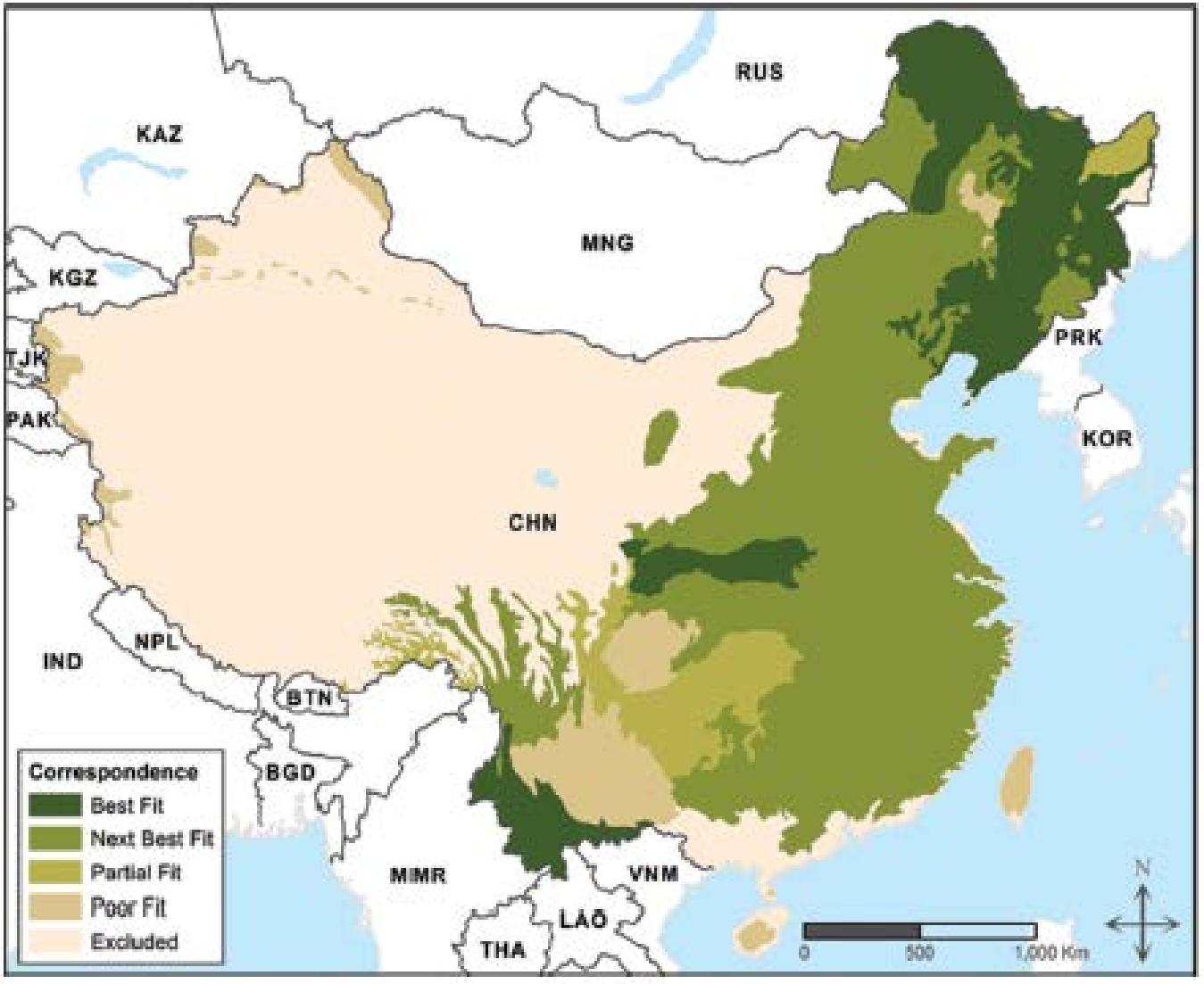




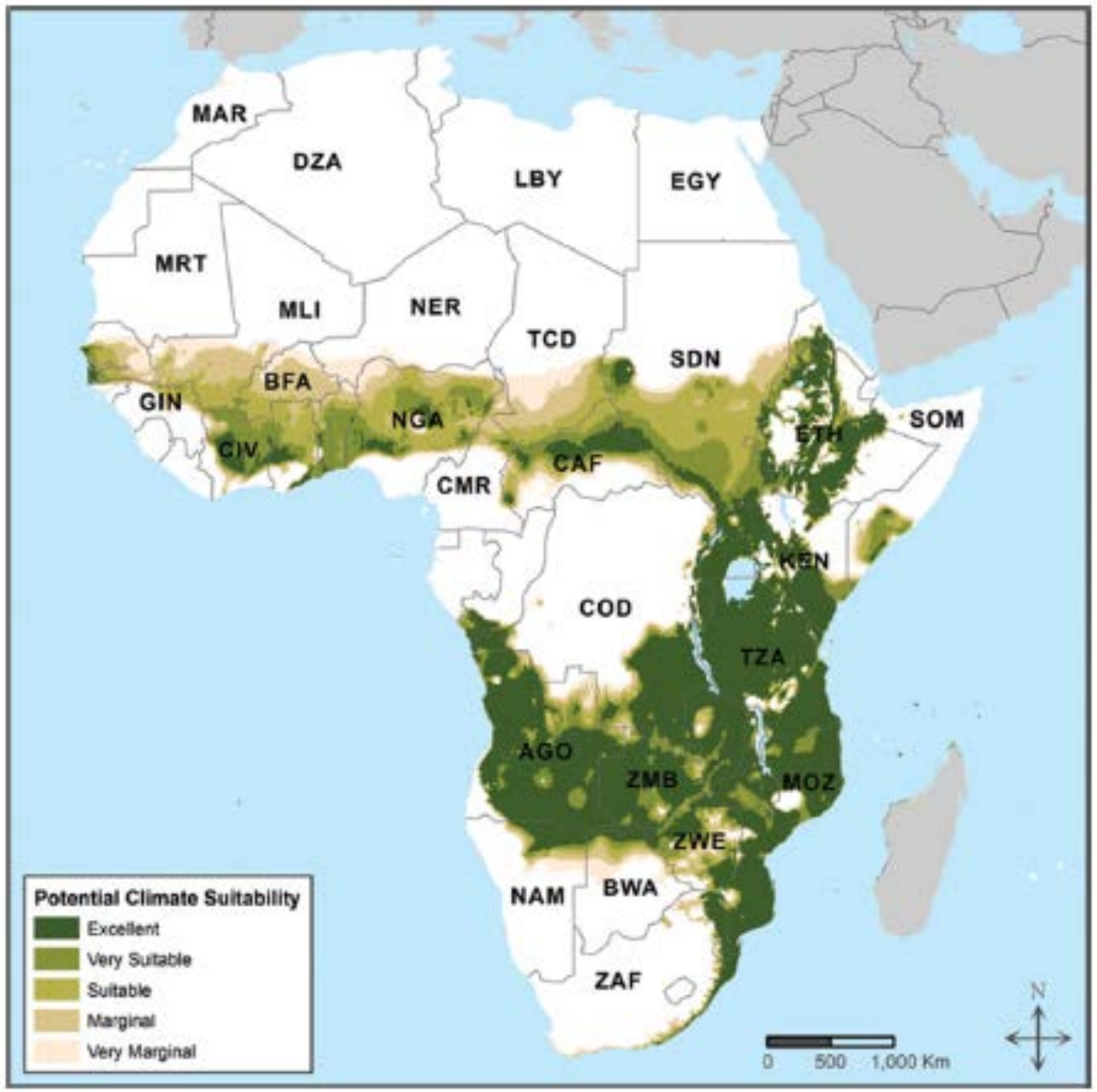
Pollen Viewer



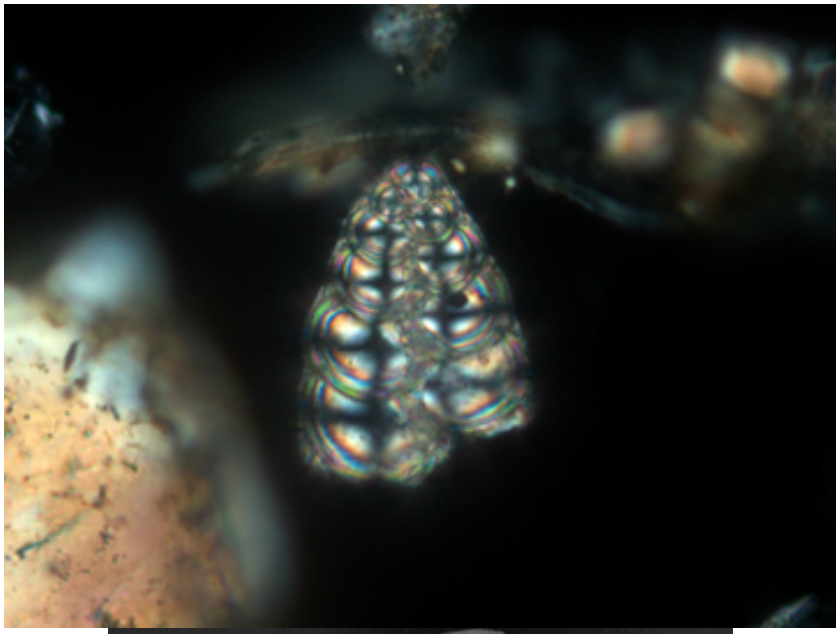
Ecoregion Maps

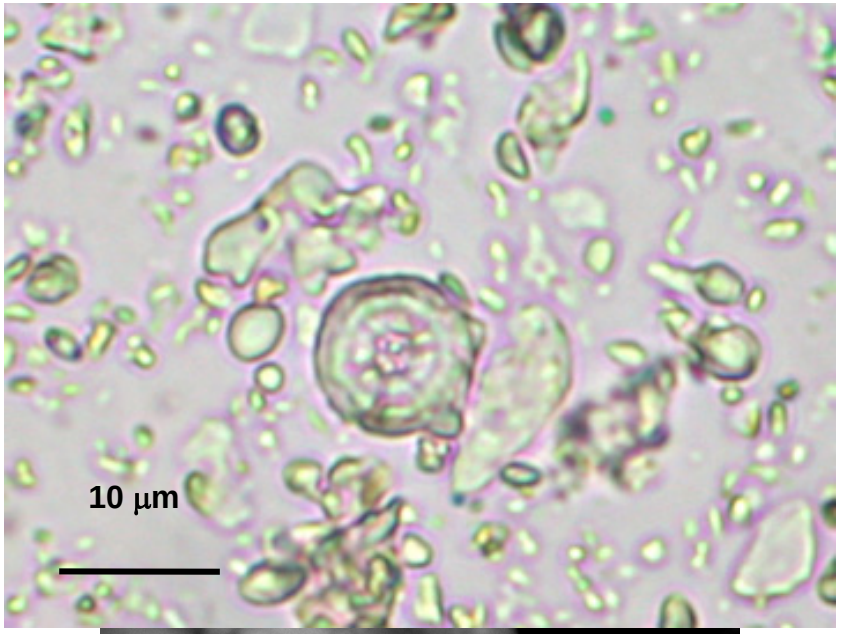


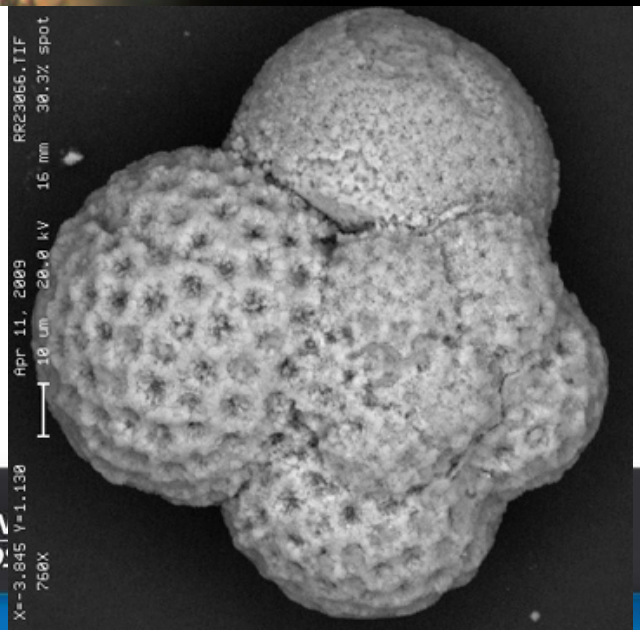
Potential Climate Suitability

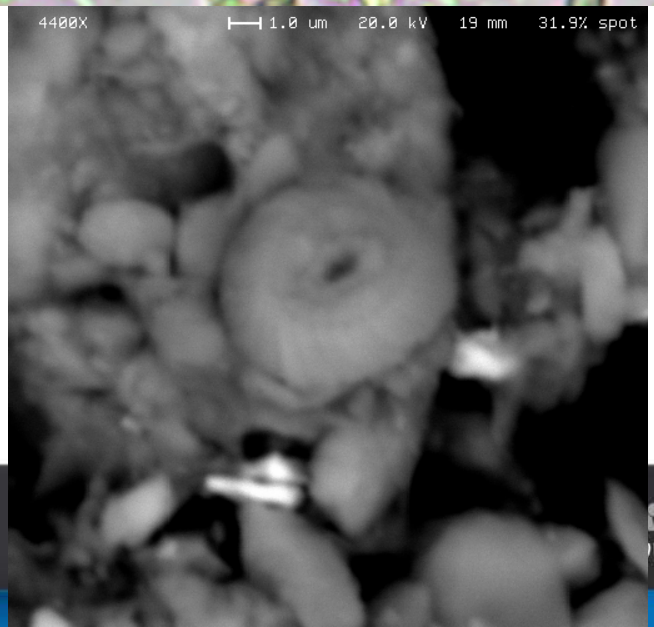


Calcareous Microfossils









Foraminifera Resources

- The Foraminifera.eu-Project
  - http://www.foraminifera.eu/taxo.php
- Marine Species Identification Portal
  - http://species-identification.org/index.php
- Limited geographic regions covered

Foraminifera.eu Key to Benthic Species

How to use **by text** by illustrations Key to Planktonic Species includes so far 632 species

Overall test shape		Coiling	tri-/bi- to uni-/biserial	Wall Material			
Chamber Form	brick	Aperture Position	basal	Aperture Form			
Tooth		Neck		Lip			
Sutures: Depr./Raised		Sutures: Straight/Curved		Sutures: Features			
Ornamentation: hispid		costate, striate, reticulate		spinose, projections, fistulose		keeled	
Order: (Mikh.)		Family: (L+T)		Genus: (L+T)		Species:	
Period:							

search Clear *click on an image to see all images of that genus*

Gaudryina rugosa
wall: agglutinated
elongate / tri-/bi- to uni-/biserial
Ch Form: brick
Ap Position: basal
Ap Form: slit, --
Sut.: depressed / straight / --
-- / -- / --

Gaudryina mayeriana
wall: agglutinated
elongate / tri-/bi- to uni-/biserial
Ch Form: brick
Ap Position: basal
Ap Form: slit, --
Sut.: depressed / straight / --
-- / -- / --

Spiroplectinella deperdita
wall: agglutinated
elongate / tri-/bi- to uni-/biserial
Ch Form: brick
Ap Position: basal
Ap Form: slit, --
Sut.: depressed / straight / --
-- / -- / --

Gaudryina mayeriana (d'Orbigny, 1846) 1 more

Class: Rotaliata Subclass: Textulariana Order: Lituolida Family: Verneuilinidae
Taxon Profile

found at Vienna-Nussdorf Vienna Basin Austria

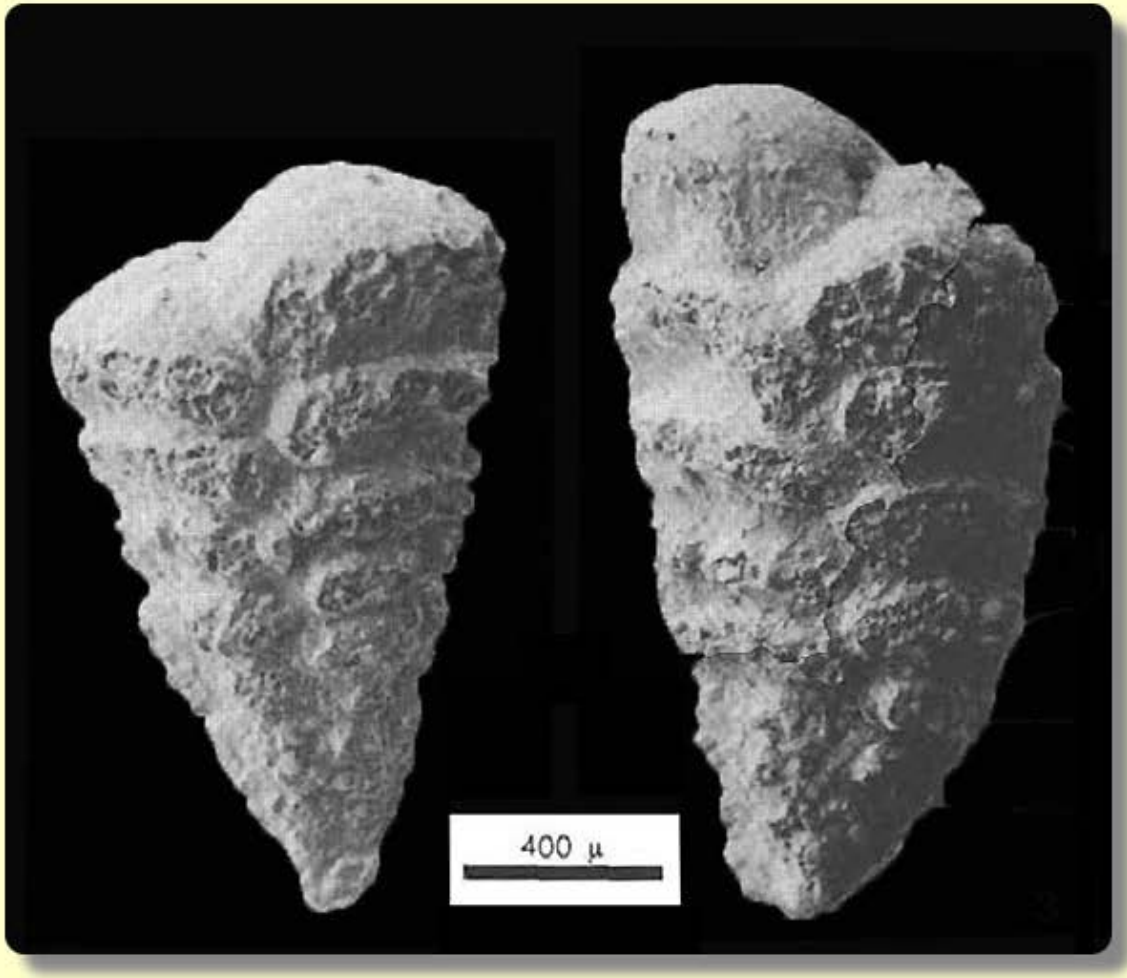
Geological Time: Miocene Neogene
Badenian
lectotype
image courtesy of the Geological Survey of Austria
Geological Survey of Austria

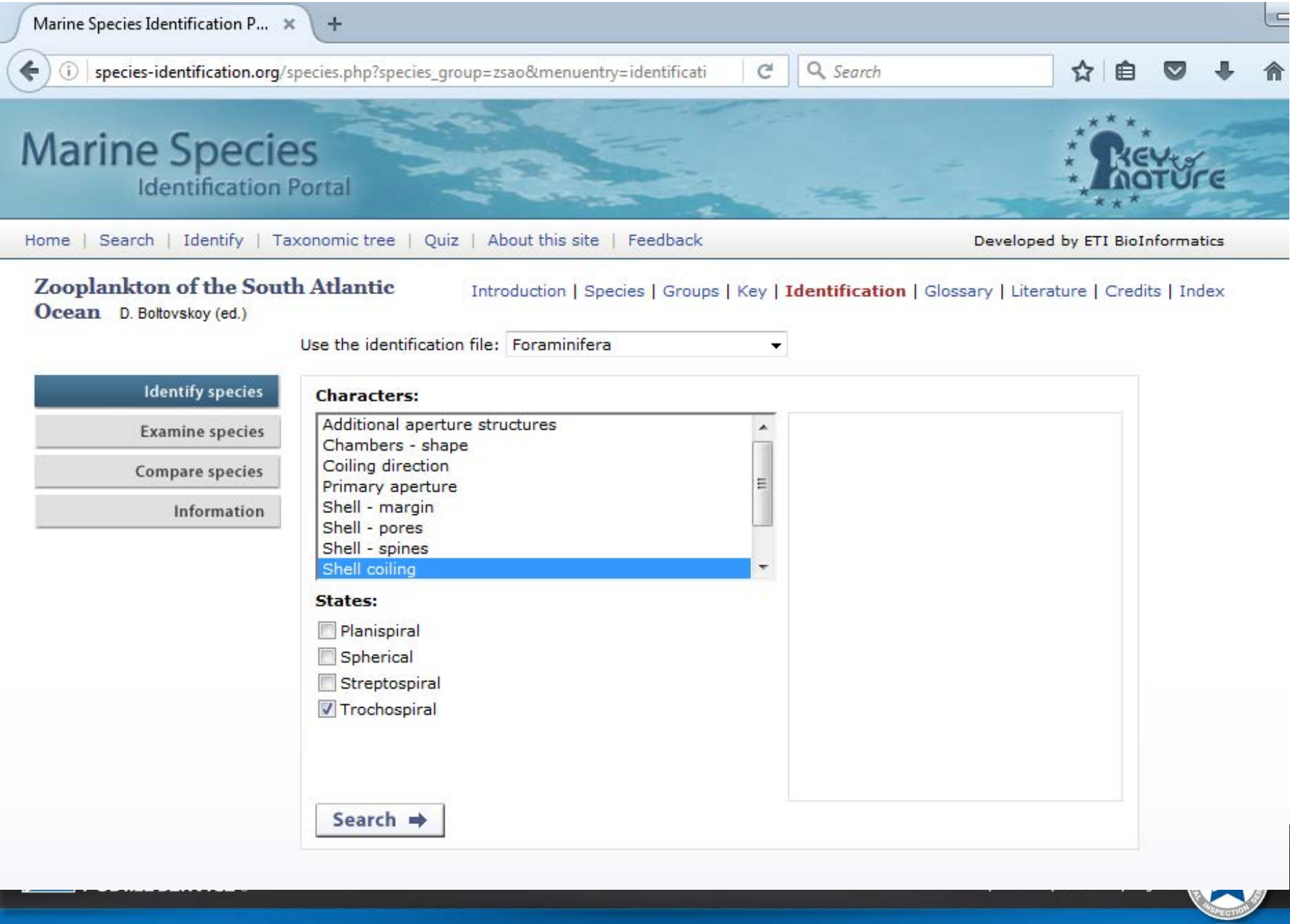
View of a specimen of *Gaudryina mayeriana* (d'Orbigny, 1846)

the first specimen is the lectotype

The identification is based upon:
Papp, A., Schmidt, M.E., 1985: The Fossil Foraminifera of the Tertiary Basin of Vienna Revision of the monograph by Alcide d'Orbigny (1846). in Abhandlungen der Geologischen Bundesanstalt, Band 37. Plate , Fig. 174

The classification is reviewed by the providing scientist




Marine Species Identification P...
species-identification.org/species.php?species_group=zsao&menuentry=identificati
Search
Marine Species
Identification Portal
Home | Search | Identify | Taxonomic tree | Quiz | About this site | Feedback
Developed by ETI BioInformatics
Zooplankton of the South Atlantic Ocean D. Boltovskoy (ed.)
Introduction | Species | Groups | Key | Identification | Glossary | Literature | Credits | Index
Use the identification file: Foraminifera
Identify species
Examine species
Compare species
Information
Characters:
Additional aperture structures
Chambers - shape
Coiling direction
Primary aperture
Shell - margin
Shell - pores
Shell - spines
Shell coiling
States:
Planispiral
Spherical
Streptospiral
Trochospiral
Search

Marine Species
Identification Portal

Zooplankton of the South Atlantic Ocean D. Boltovskoy (ed.)

Use the identification file: Foraminifera

Gezocht naar:

Chambers - shape: Conical
Coiling direction: Left
Shell coiling: Trochospiral

Globorotalia crassaformis (100%)
Globorotalia truncatulinoides (100%)
Dentagloborotalia anfracta (67%)
Globigerina bulloides (67%)
Globigerina falconensis (67%)
Globigerinella calida (67%)
Globigerinella siphonifera (67%)
Globigerinita glutinata (67%)
Globigerinita uvula (67%)
Globigerinoides conglobatus (67%)
Globigerinoides ruber (67%)
Globigerinoides sacculifer (67%)
Globorotalia inflata (67%)
Globorotalia menardii (67%)
Globorotalia scitula (67%)
Globorotalia tumida (67%)
Globorotalia ungulata (67%)
Globoturborotalita rubescens (67%)
Globoturborotalita tenella (67%)

Zooplankton of the South Atlantic Ocean D. Boltovskoy (ed.)

Globorotalia crassaformis

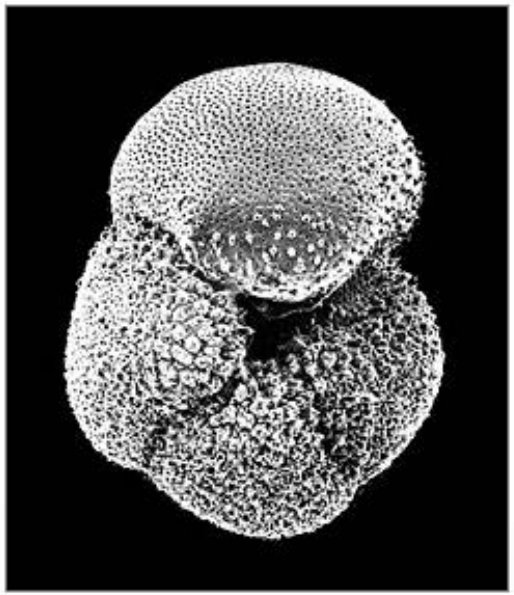
Description
Classification
Synonyms
Literature
Multimedia
Map
Links

(Galloway and Wissler, 1927)

Trochospiral, non-spinose, with 4-5 chambers in last whorl, rather open umbilicus and usually calcite crust. Spiral side flat, apertural side lower than in *Globorotalia truncatulinoides* (more conical in latter). Aperture extraumbilical, no lip. Periphery rounded and only slightly keeled on last and penultimate chamber in adult specimens. Resembles *Globorotalia inflata*, but with more angular outline.

Ref.: Parker (1962), Parker and Berger (1971), Lidz (1972), Rögl (1974), Zougary-Jaadi and Pujol (1987).

Distribution: Tropical to subtropical, normally not present south of 30°S (Van Leeuwen, 1989). Although only a minor constituent of typical deep-living planktic foraminifers, it has an interesting habitat. It shows frequency maxima at the eastern edge of the Angola-Benguela Front (17°10 S, 8°54 E), and at the Equator, both areas of high productivity (Berger and Herguera, 1992). As previously reported by Jones (1967), its greatest abundance is observed in the equatorial oxygen minimum zone between 100 and 300 m (abundance of species 6 , Globorotalia crassaformis 4). Van Leeuwen (1989) noted a peak in sediments off the

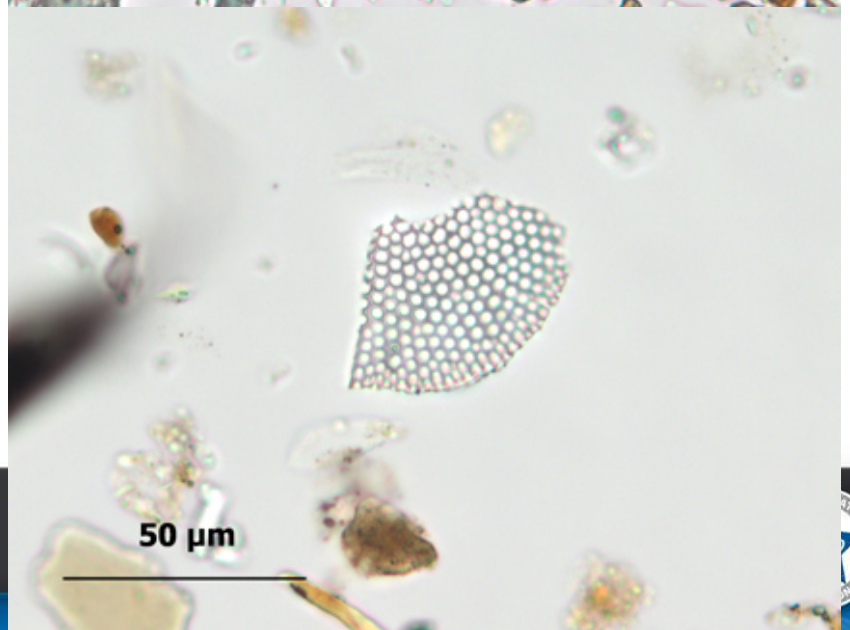


<< **Previous species** | **Next species** >>

Foraminifera Interpretation

- Fossils – geological maps
- Modern – climate, salinity, published data on distributions

Diatoms



Diatom Resources

- Identification databases
  - Diatoms of the United States
    - https://westerndiatoms.colorado.edu/
- Interpretation
  - “Each species tends to have distinct requirements for temperature, salinity, acidity, oxygen and mineral concentrations.” (2)

TAXA BY MORPHOLOGY ::... ×

https://westerndiatoms.colorado.edu/taxa

Search

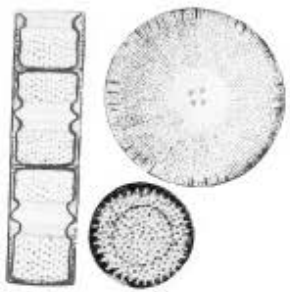
DIATOMS of the United States

HOME ABOUT **BY MORPHOLOGY** GENERA SPECIES CITATIONS GLOSSARY HELP Taxon Search

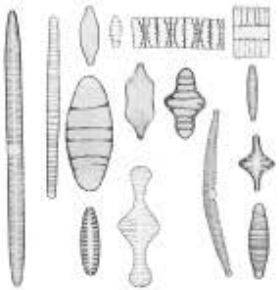
Centric Araphid Eunotioid Symmetrical biraphid Monoraphid Asymmetrical biraphid Epithemioid Nitzschioid Surirelloid

TAXA BY MORPHOLOGY

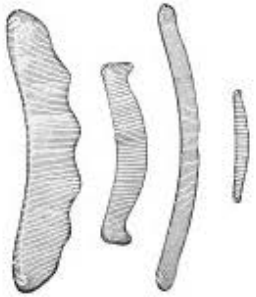
For the purposes of a visual key, we group diatom shapes into nine artificial (not strictly evolutionary) categories to aid in identification



Centric

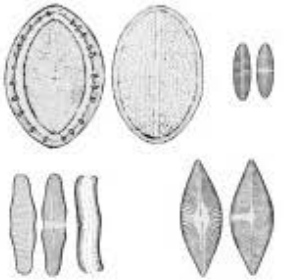


Araphid



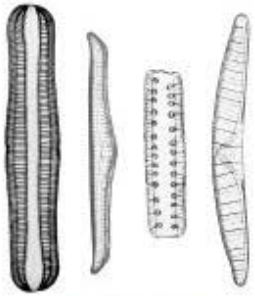
Eunotioid

Symmetrical biraphid



Monoraphid

Asymmetrical biraphid



Epithemioid

Nitzschioid

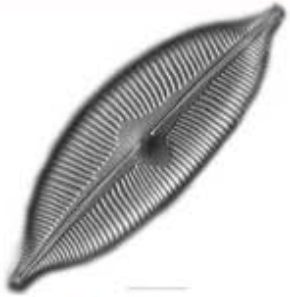
Surirelloid

Afrocymbella

Amphora
4

Brebissonia
1

Cymbella
16



Cymbopleura
32

Delicata

Didymosphenia
1

Encyonema
14

Encyonopsis
18

Entomoneis
4

Gomphoneis
13

Gomphonema
20

Gomphosinica

Gomphosphenia

Halamphora

Kurtkrammeria

Navicymbula

Oricymba

Spaulding, S., and Edlund, M. (2008). *Didymosphenia*. In Diatoms of the United States. Retrieved July 13, 2016, from http://westerndiatoms.colorado.edu/taxa/genus/Didymosphenia

Didymosphenia :: Diatoms ...

https://westerndiatoms.colorado.edu/taxa/genus/Didymosphenia

Search

Didymosphenia

Diatomella

Diploneis

M. Schmidt in A. Schmidt 1899 Category: Asymmetrical biraphid

TYPE SPECIES: *Didymosphenia geminata* (Lyngbye) M. Schmidt in A. Schmidt

Species by Size | Species A-Z | Genus Description | Citations/Links

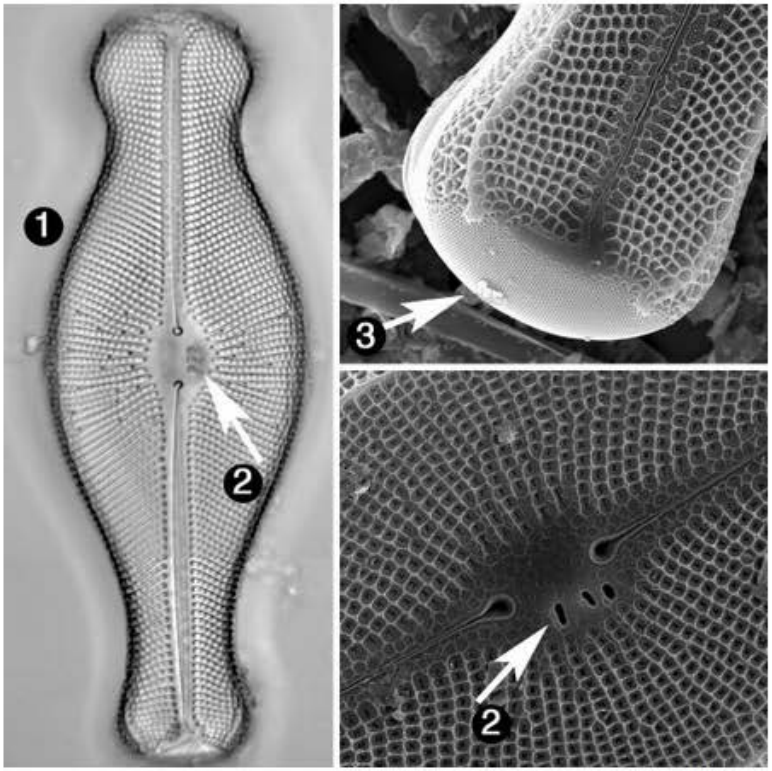


Image Credit: Sarah Spaulding, Danielle Pite

CLASS: *Bacillariophyceae*
ORDER: *Cymbellales*
FAMILY:

1. Valves large and robust
2. Stigmata one to several
3. Apical porefield at footpole, large

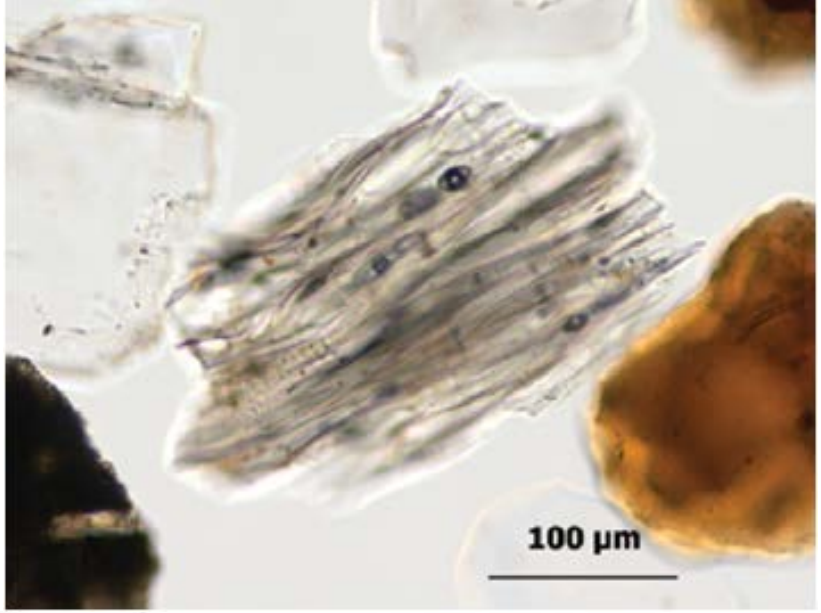
Frustules of *Didymosphenia* are asymmetrical to the transapical axis and symmetrical to the apical axis (although some populations may be slightly to strongly asymmetrical to the apical axis). One to several stigmata are present, a feature that may be variable within a given species. A large apical porefield is present at the footpole. The terminal raphe fissures are deflected prior to reaching the apical porefield. Frustules are wedge shaped in girdle view. A marginal ridge of silica extends along the valve, terminating at the headpole in small spines.

D. geminata is common in North America and in the Upper Great Lakes. It is locally abundant in some lakes and streams, at times producing high biomass. The large volume of mucilaginous stalks of *D. geminata* may cover surfaces and foul water intake pipes, reaching nuisance proportions. It is invasive in New Zealand and expanding its range in regions of the Northern Hemisphere. This genus is more closely allied to the cymbelloid diatoms than to the gomphonemoid groups, as has been previously reported. Lake Baikal, in Siberia is considered a hotspot of diversity for *Didymosphenia*.

Tephra Database

- Hosted by Washington State University
  - http://cahnrs.wsu.edu/soe/facilities/geolab/service/
- Determination of volcanic source / eruptive event
- Windfall distribution of ash known for some events

Tephra Database



Sample: Bowen SFI-1

number of records searched: 1716

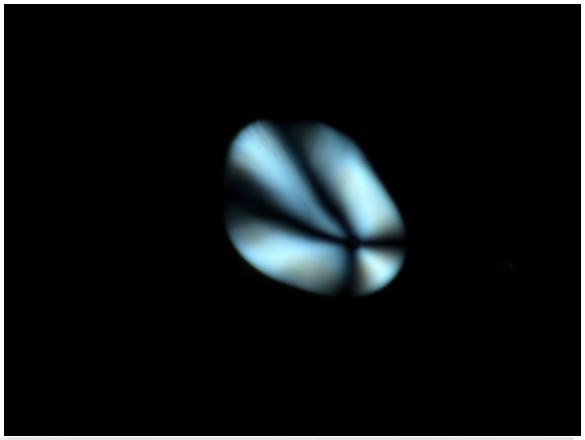
Glass composition of sample:

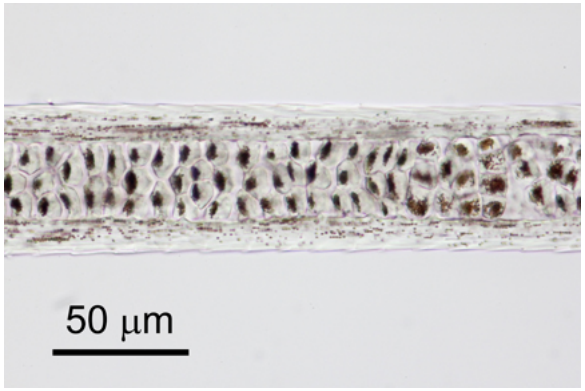
SiO2	TiO2	Al2O3	MgO	CaO	BaO	MnO	Fe2O3	Na2O	K2O	Cl	Total
76.73	0.07	12.83	0.04	0.55	0.00	0.00	1.12	3.82	4.76	0.08	100.00
weighting factor (only for oxides in bold type)											
1	0.25	1	0.25	1			1	1	1		

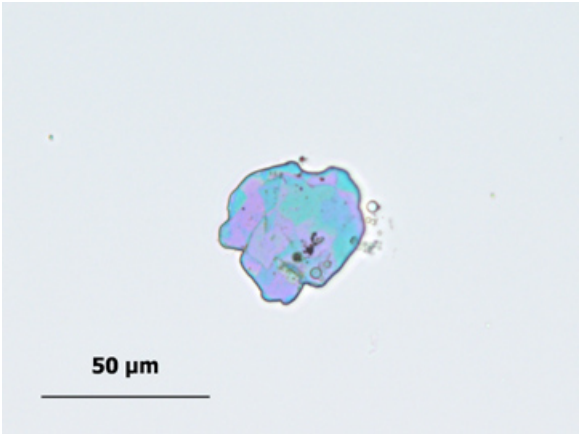
Similiarity Coefficients for 15 closet matches

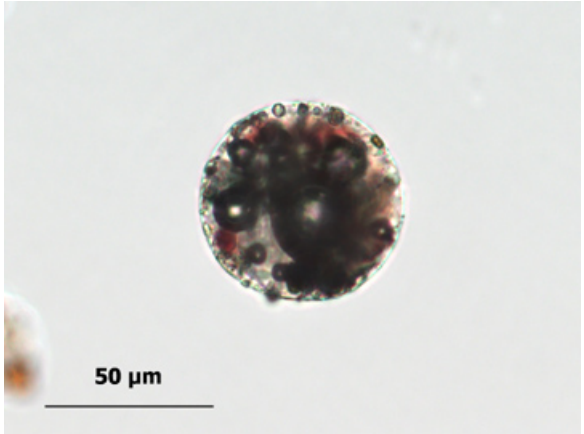
SiO2	TiO2	Al2O3	MgO	CaO	Fe2O3	Na2O	K2O	sim coef weighted avg	rec#	Std	Date	State	Source/Age
0.998	0.857	0.997	1.000	0.982	0.982	0.976	0.985	0.982	1196			CA	Mono Lake Tephra #2
0.996	0.714	0.992	1.000	0.982	0.973	0.992	0.971	0.975	736			CA	Mono Craters 1200 BP ?
0.999	0.857	0.999	1.000	0.965	0.964	0.967	0.973	0.974	859			CA	Mono Craters
0.999	1.000	0.995	1.000	0.965	0.903	0.967	0.968	0.969	469			NV	Mono Craters 1200BP ?
0.998	1.000	0.991	0.750	0.982	0.966	0.946	0.975	0.968	116 s			CA	Mono Craters
0.999	0.875	0.991	0.800	0.917	0.982	0.992	0.971	0.965	1306			CA	Mono Craters ?
0.998	0.857	0.996	1.000	0.982	0.889	0.953	0.973	0.962	467			NV	Mono Craters 1200BP ?
0.997	1.000	0.995	0.750	0.982	0.893	0.970	0.973	0.961	860			CA	Mono Craters
0.998	0.857	0.995	0.750	0.982	0.896	0.957	0.977	0.955	468			NV	Mono Craters 1200BP ?
0.990	1.000	0.972	1.000	0.917	0.848	0.962	0.994	0.951	1434 s			CA	Dibekulewe ash bed, ~510 KA
0.998	0.751	0.998	0.789	0.951	0.907	0.974	0.968	0.951	1464 s			UT	Mono Craters 14,270 +/- 60 14C yr BP

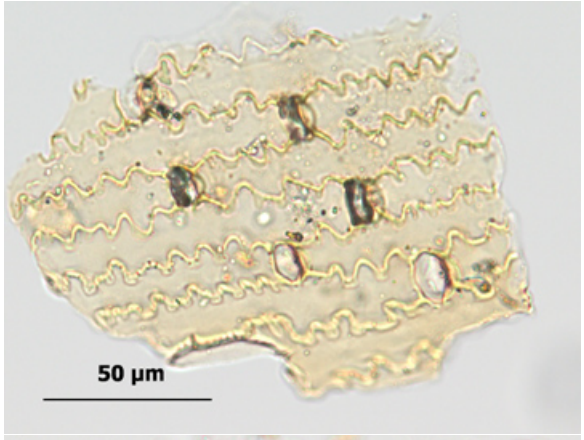
Other Particles

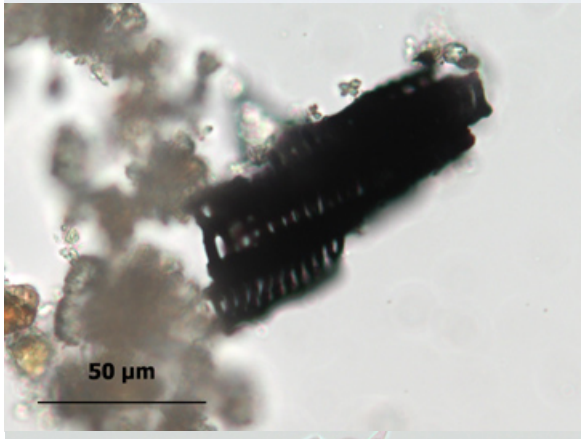


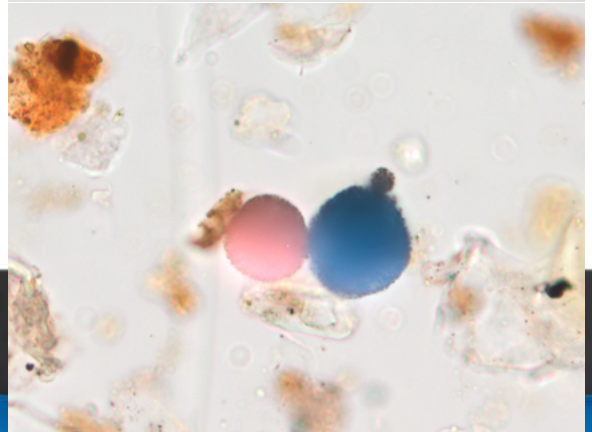


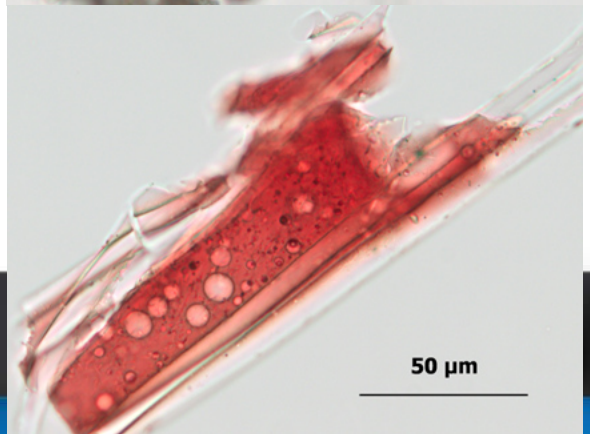






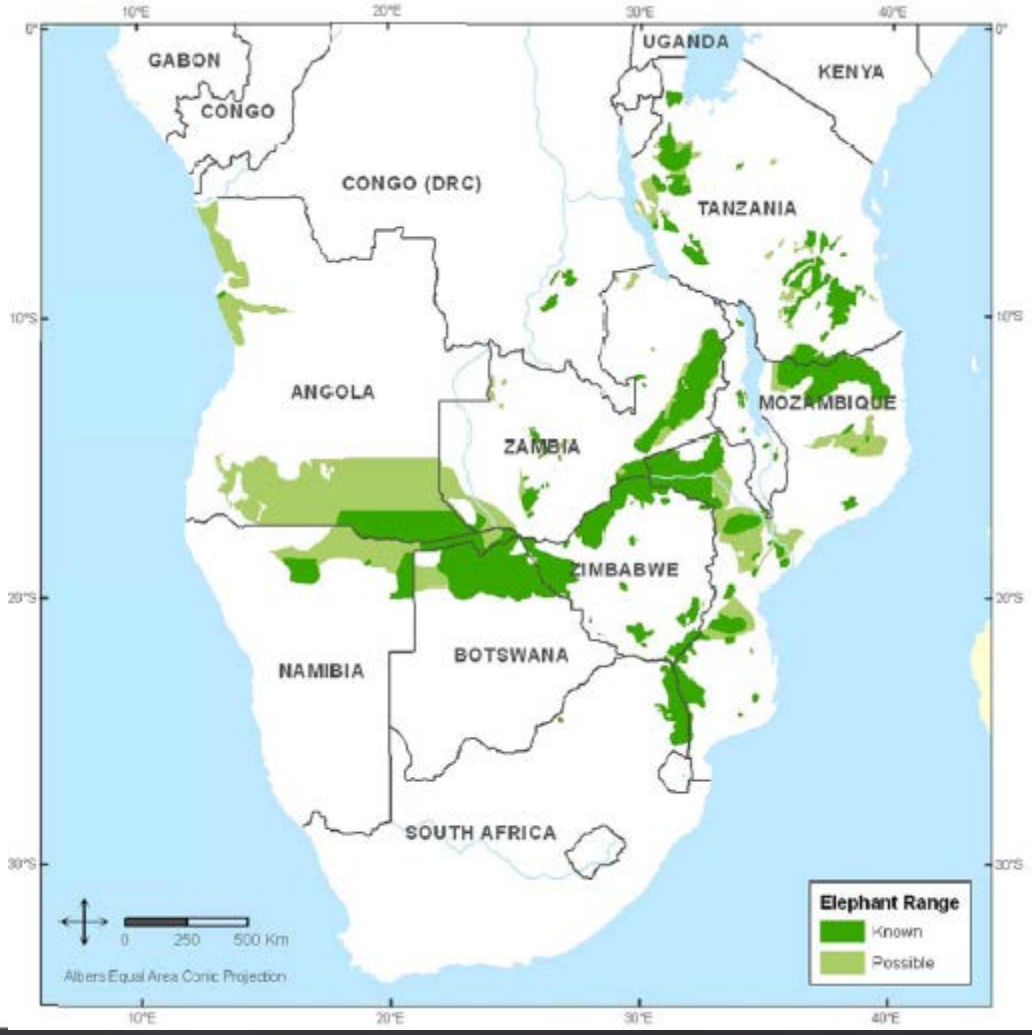






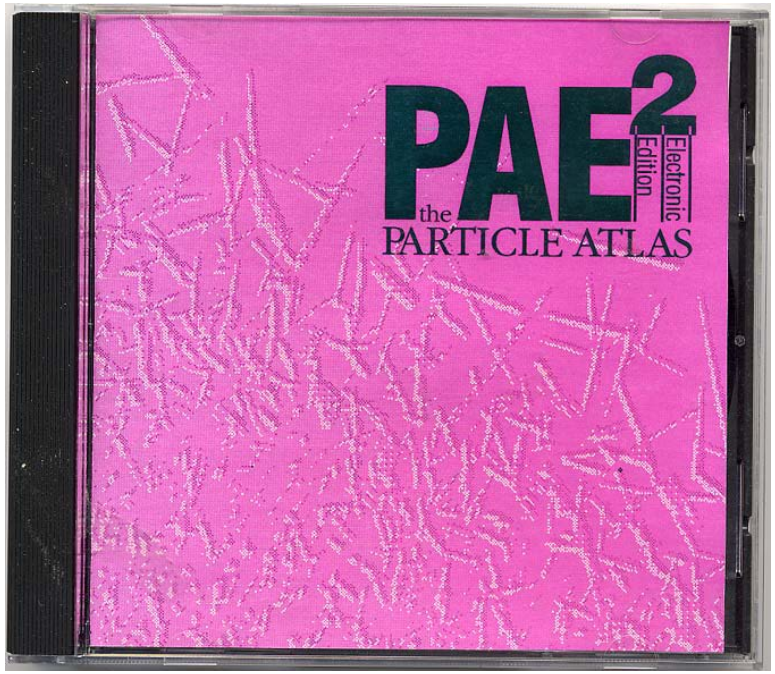
Other Particles

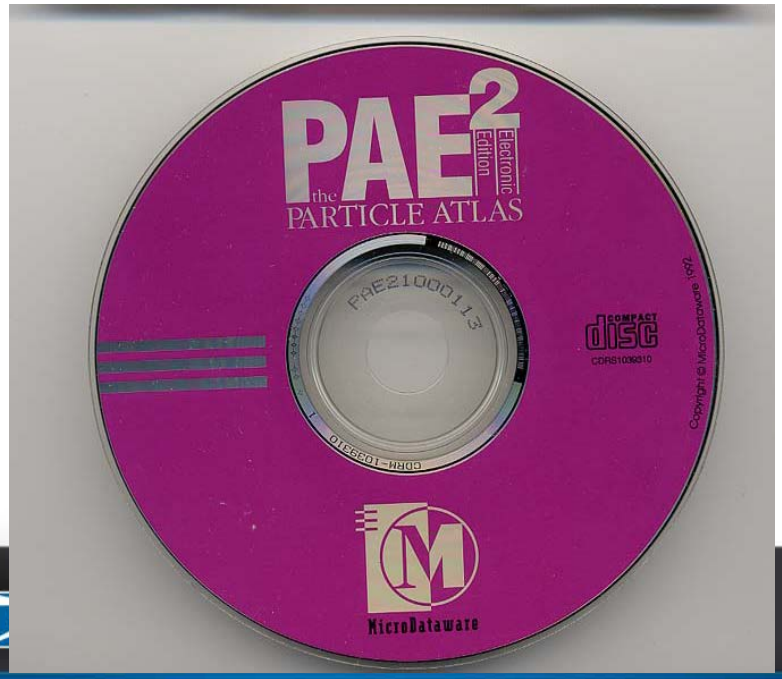
- Road dusts
- Industrial dusts
- Land cover
- Land use (cultivated, developed)
- Population density
- Animals (elephants, birds)
- Insects
- Non-human DNA

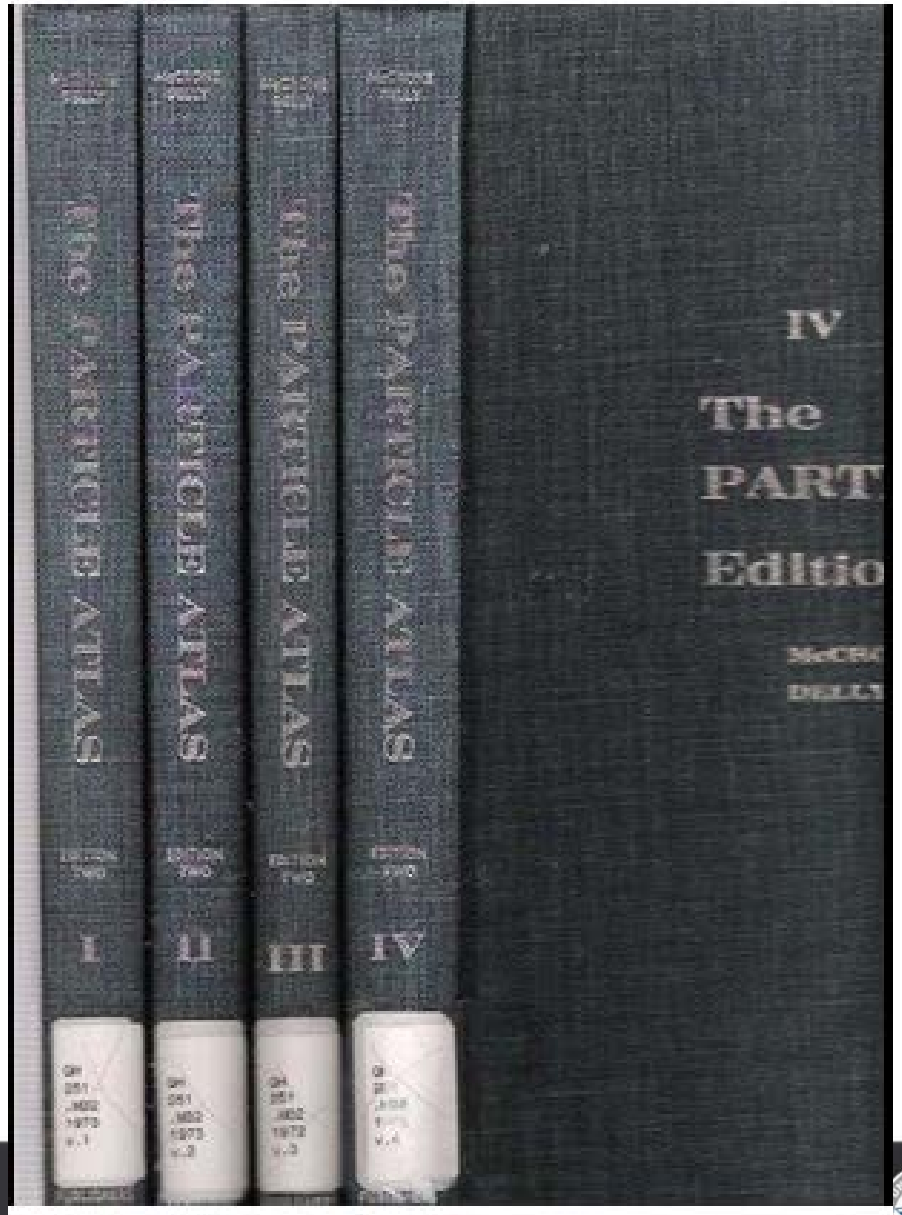


Particle Databases

- The Particle Atlas
  - Searchable based on particle attributes, hardcopy and CD versions
- McCrone Atlas of Microscopic Particles
  - On-line resource, http://www.mccroneatlas.com/


PAE2
Electronic Edition
the PARTICLE ATLAS


PAE2
Electronic Edition
the PARTICLE ATLAS
PAE2100113
COMPACT disc
MicroDataware


The PARTICLE ATLAS
I
II
III
IV
IV
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The Particle Atlas

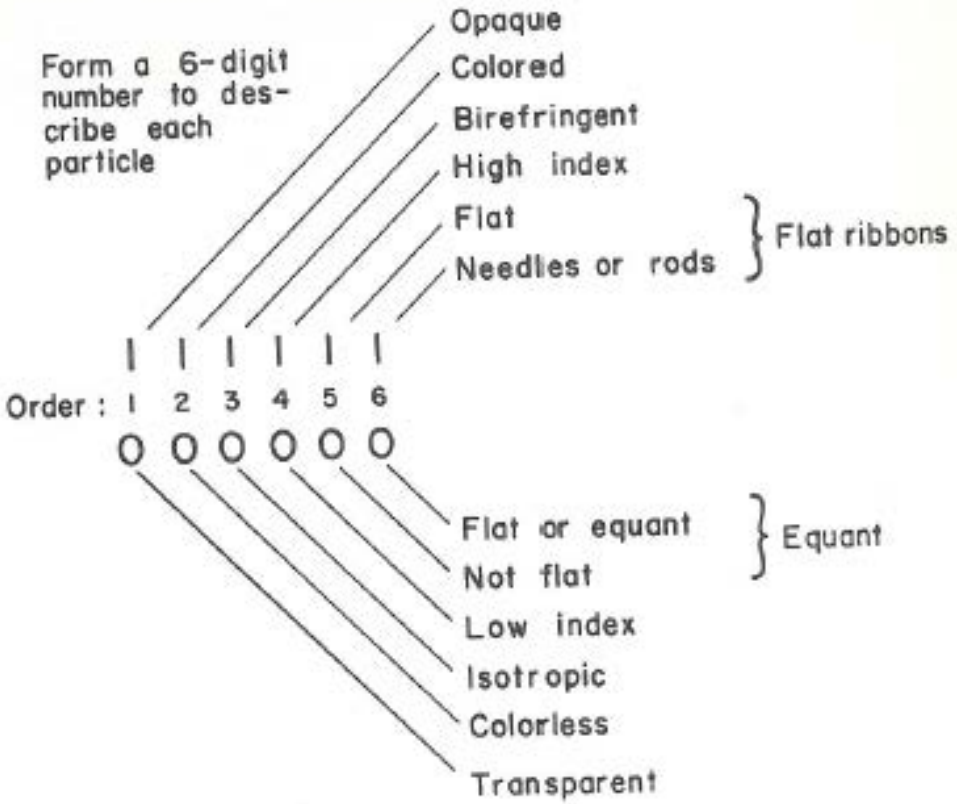


Figure 334. The meaning of the six-digit code as used for particle description.

Each of the six positions of the six-digit code is assigned a numerical value as follows.

1	1	1	1	1	1
32	16	8	4	2	1

The binary code for a given classification is then the numerical sum of the values for those positions of the six-digit code filled by the figure 1. The following examples illustrate the equivalence between the binary and six-digit codes.

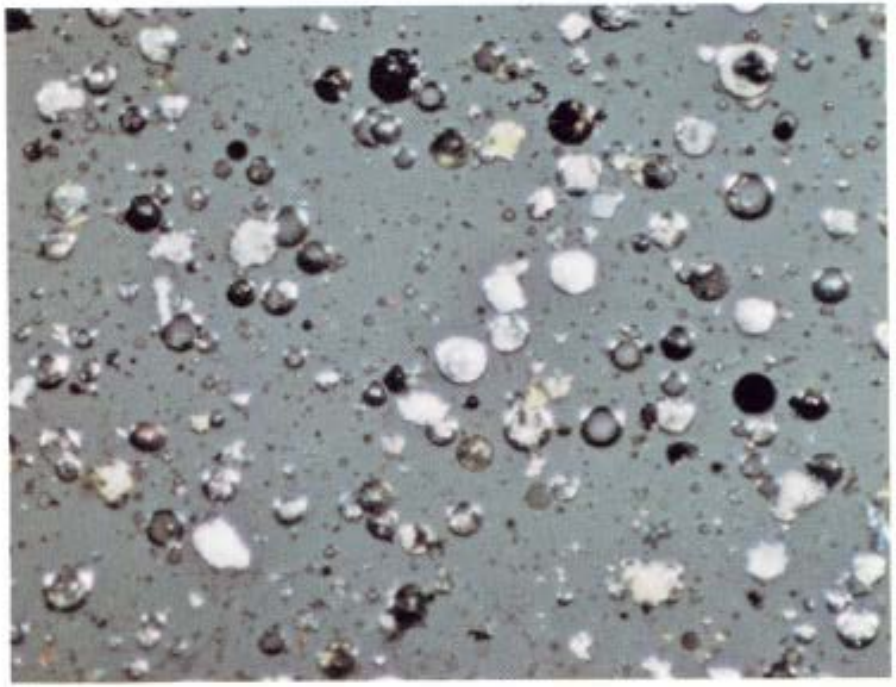
100000 = 32	100010 = 34
010000 = 16	110011 = 51
000100 = 4	100001 = 33
000001 = 1	001100 = 12

The Particle Atlas

570 COAL FLYASH, PULVERIZED FUEL

0:000000 16:010000 32:100000

This breaching sample indicates appreciable temperatures; many of the large glassy spheres are clear indicating that they became very hot and fluid so that the gas bubbles could escape.



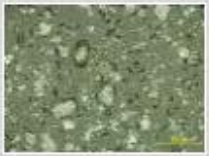
570 Top light, slightly uncrossed polars 125X

Search Results

Your search returned 1 results.

Modify This Search

Current Characterizations



32: Boric Acid

H_3BO_3 [$B_2O_3 \bullet 3H_2O$]

8:001000, 10:001010

Page: 1 of 1

Rows: 1 - 1 of 1

McCrone Atlas of Microscopic ...

www.mccroneatlas.com/viewer/index.asp?PARTICLE_ID=63&MODE=OVERVIEW&

Search

McCRONE ATLAS
OF MICROSCOPIC PARTICLES

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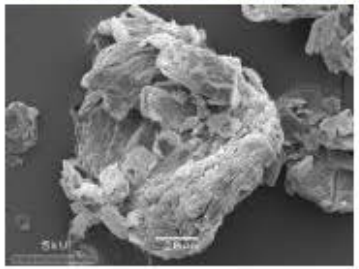
OVERVIEW | DATA | PLM | SEM | EDS | FTIR | RAMAN

Overview



32: Boric Acid

H_3BO_3 [$B_2O_3 \bullet 3H_2O$]

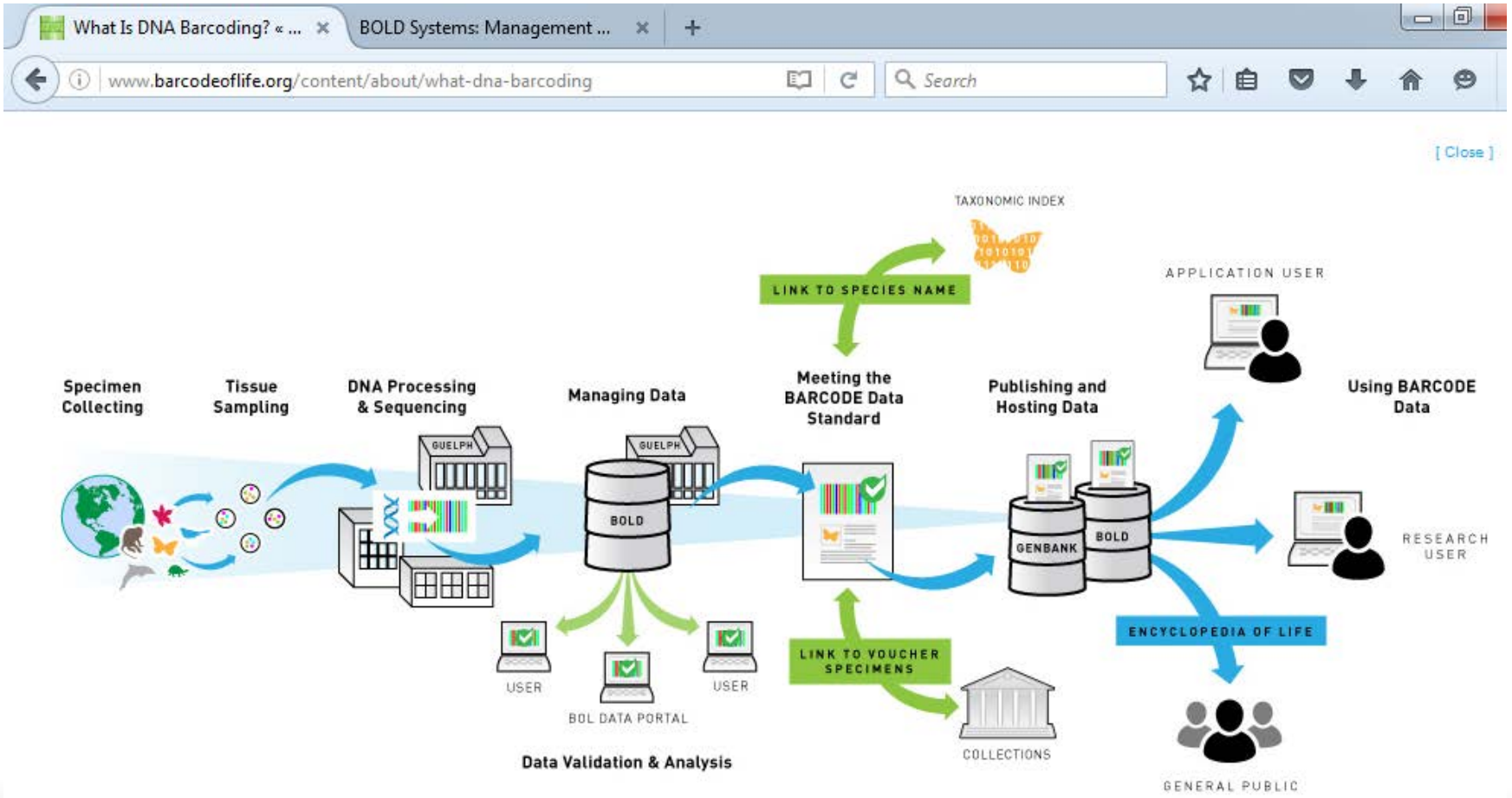
Rev. 1.0

Boric acid, also called boracic acid, or orthoboric acid, H_3BO_3 [$B_2O_3 \bullet 3H_2O$] is a colorless (white),transparent, crystalline solid made by adding hydrochloric or sulfuric acid to a solution of borax (**AMP:37**), and crystallizing. Boric acid is used as a preservative and weak antiseptic; in the tanning industry it is used for deliming skin by forming water-soluble calcium borates; it is also used as a flux in brazing and soldering. PLM, Microchemical Testing, FTIR, and Raman are all useful techniques used in the identification of this material.

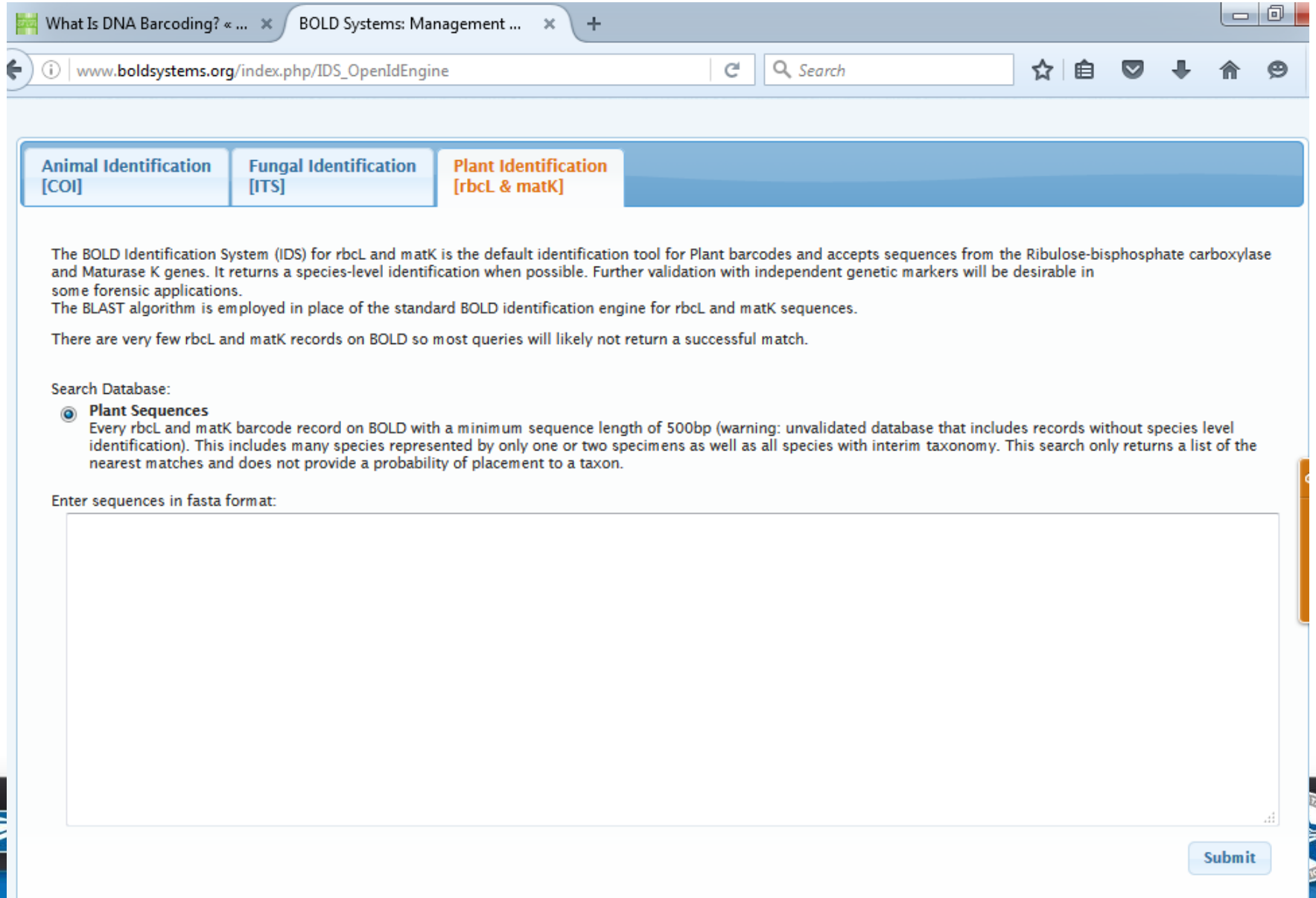
print

save to sample storage

Barcode of Life
http://www.barcodeoflife.org/



Barcode of Life Database



Applications to Traditional Trace Evidence

- Identification of non-traditional particle types
  - Consultation with experts often necessary
- Interpretation of significance of particle types
  - Geographic distribution in area of interest
  - Common, broadly distributed?
  - Rare, sparsely distributed?
- Would benefit from research

Conclusions

- Databases of value for identification
  - Many resources for a wide variety of materials, some free
- Databases of value for interpretation
  - Many relevant publicly available GIS datasets and other resources exist
- Application of these databases to traditional trace evidence
  - Expand range of identified materials
  - Aid in interpreting significance

References

1. F.J. Goodman, M. Bush, D. Masters et al. PIGLT: A Pollen Identification and Geolocation System for Forensic Applications 2015 IEEE International Symposium on Technologies for Homeland Security (HST)
2. Brasier, M.D. *Microfossils*; George Allen & Unwin: Boston, 1983