Title: Species distributions in response to environmental gradients in the Upper Midwest of the United States - an example using the Neotoma database.

Short Summary: Pollen and ostracode records are used here to examine the migration of the prairie-forest border during the Holocene in the Upper Midwest. Using the Neotoma database, we can explore the modern geographic distribution of prairie and forest vegetation (represented by pollen data) and freshwater ostracodes (microscopic aquatic crustaceans), and then track the shifting boundary of the prairie forest border over the most recent 10,000 years using pollen and the remains of ostracodes preserved in a lake sediment core.

Learning goals:
Learn to use the Neotoma database and plot species distributions
Explore species distributions across the prairie-forest ecotone in Minnesota
Describe the major climatic gradient(s) in Minnesota
Explain the relationship between species distributions and climate
Understand the use of climate proxies to interpret the past
Interpret stratigraphic diagrams
Speculate on how the distribution of vegetation and ostracodes might change in response to future climate change

Part 1: Plot pollen distributions:

Plot three pollen taxa. *Artemisia* grows in dry/warm climates, *Pinus* in cold/wet climates, and *Ambrosia* is cosmopolitan.

*Artemisia* from 1000 to 500 years BP (before present), at an abundance of >10%
*Pinus undiff* + *Pinus banksiana/P. resinosa* from 1000 to 500 years BP, at an abundance of >10%
*Ambrosia* from 1000 to 500 years BP, at an abundance of >0%

Instructions to plot data:
2. Click on Explorer
3. In the Search dialog box, under Age Range type “1000” as the oldest and “500” as the youngest, select *Artemisia* as Taxon, and “>10%” as Abundance from the drop down menu
4. To change your symbols (color/shape), select the “View Current Search Layers” button on the button bar and click on the color.
5. Add the *Pinus* data. Use the same Age Range as above, select Pinus undiff. and >20% abundance
Questions:
What do you think the distribution of these organisms is responding to?
How does climate vary north to south across Minnesota?
How does climate vary east to west across Minnesota?
(north-south temperature gradient; east-west precipitation gradient)

(Good maps of temperature and precipitation gradients across the U.S. can be found at
the PRISM website http://www.prism.oregonstate.edu.normals/)

(This combination of temperature and precipitation gradients leads to a strong
southwest-northeast climatic gradient in Minnesota. You can see the distribution of
prairie and forest in the Google Hybrid satellite image base map)

Plot another taxon on the map:
1. Add the Ambrosia data for the same Age Range above, with >0% abundance.
2. To change the base map, click on the “View/Change Base Map” button on the button bar
   and select “Google Hybrid”.

Question:
Of the three taxa you have just plotted, which appear to be the most sensitive to their
environments, the restricted taxa or the cosmopolitan taxa? Why?

Part 2: Plot ostracode distributions

Plot three ostracode taxa. Non-marine ostracodes have demonstrated preferences for specific
ranges of major ion composition and concentrations. Fabaeformiscandona rawsoni is tolerant of
more saline water, whereas Candona ohioensis prefers dilute conditions. Cypridopsis vidua is a
cosmopolitan taxon.

Plot ostracode data. To do this, open the Search dialog box (the binoculars button)
1. Select the Taxa/Age Range in the menu
2. Leave the Age Range blank

Choose Add each of the taxa below in the Taxon box to add them to your map:
Fabaeformiscandona rawsoni
Candona ohioensis

Be sure to look at the distributions of the above two taxa prior to adding the taxon below.
Cypridopsis vidua
Question:
Are the ostracodes responding to the same environmental factors as the plants are? Why or why not?
(Yes and no. Ostracodes are not responding to the amount of precipitation DIRECTLY, but warm temperatures and low rainfall cause evaporation of water, leading to higher salinity in the lakes in southwestern Minnesota relative to northeastern Minnesota.)

Additional Taxa - Here are taxa that show the same relationship to the P/F border as the pollen and ostracodes:

**Diatoms:**
- *Suirirella ovata* (saline)
- *Cyclotella glomerata* (dilute)
Be sure to look at the distributions of the above two taxa prior to adding the taxon below.
- *Amphora ovalis* (cosmopolitan)

**Mammals:**
- *Geomys bursarius* (prairie dog - prairie, but present across Minnesota)
- *Antilocapra americana* (pronghorn - prairie)
- *Glaucomys sabrinus* (flying squirrel - forest)
Be sure to look at the distributions of the above taxa prior to adding the taxon below.
- *Odocoileus virginianus* (white tailed deer - cosmopolitan)

Part 3: Apply present-day knowledge of pollen and ostracode distributions to understand past migration of the prairie-forest border. This can be done using a pollen record (as a proxy for vegetation) and an ostracode record, both from Elk Lake, Grant Co., MN. (The ostracode stratigraphic diagram can be found under “References and Resources” on the exercise webpage)

To view the pollen stratigraphic diagram in Neotoma:
1. Open the “Search” dialog box.
2. Select “Advanced”
3. Choose “pollen” as the Dataset Type
4. Under “Metadata” enter Elk Lake as the “Site Name”. Note that there are two Elk Lakes, you want to select the one just west of Alexandria, MN.
5. Click on the point on the map.
6. Click on the “ELKGR-89_Core A Core B” hyperlink
7. Select the “Diagram” tab
8. Ensure the 5x exaggeration box is unchecked
9. Select “Draw”

Review the pollen and ostracode stratigraphic diagrams.
Questions:
Do you think the prairie-forest border maintained the same position throughout the Holocene?
What evidence supports your argument?

What do these past records imply about past climatic conditions?

What does this suggest for future distributions of vegetation and ostracodes?