INSTRUCTOR GUIDE

Study Question 1: Holocene history of *Fagus* in eastern North America

Good sites for the exercise:
Camel Lake FL
Pigeon Marsh GA
White Pond NC
Clear Pond NC
Cranberry Glades WV
Spring Lake PA
Rogers Lake CT
Sandogardy Pond NH
Gould Pond ME
Maplehurst Ontario
Crawford Lake, Ontario
Green Lake MI
Wolverine Lake MI

Map of *Fagus* "migration" can be found in:

Davis, M.B. 1983. Quaternary history of deciduous forests of eastern North America and Europe. Annals of the Missouri Botanical Garden 70: 550-563. [pdf]

Note the early presence of *Fagus* in the southeastern US and then its rapid advance up the eastern US into New England and Ontario, where it was present by 4000 years ago. By comparison its advance into Michigan slowed between 7000 and 4000 years ago, probably because of the dry conditions limited its expansion westward (this is the prairie period discussed in Study Question 2).

Pollen isochrone maps, like those in Davis (1983), show the range limit of taxa at different time periods. An assumption is made that the timing of the rise in pollen abundance marks the range limit of the tree. The position of different isochrones mark the "migration" history or range expansion of the taxa following deglaciation and it is possible to calculate the rate of migration by comparing the spacing of isochrones over eastern North America.

Pollen Viewer on the NOAA NCDC web page: http://www.ncdc.noaa.gov/paleo/pollen/viewer/webviewer.html provides a series of isopoll maps for *Fagus* and other taxa.

More recent discussions:

Williams, J. W., Shuman, B. N., Webb, T., III, Bartlein, P. J., Leduc, P. 2004. Quaternary vegetation dynamics in North America: Scaling from taxa to biomes. Ecological Monographs 74: 309-334. [pdf]

Pollen isopoll maps make no assumptions about the presence or absence of the species; instead they show areas of pollen abundance. Isopolls contour areas of equal pollen percentages.

McLachlan, J.S., Clark, J.S. 2004. Reconstructing historical ranges with fossil data at continental scales. Forest Ecology and Management 197: 139-147. [pdf]

This paper looks at modern pollen and plant occurrence data to determine how well pollen data indicate the presence of a species.

Study Question 2: Prairie/forest pattern in middle Holocene:

Good sites for the exercise:
Pickerel Lake SD
Kirschner Marsh MN
Upper Graven Lake MN
Bog D MN
Rossburg Bog MN
Kotiranta Lake MN
Lake West Okoboji IA
Chatsworth Bog IL

Grimm, E.C., Jacobson, Jr. 2004. Late-Quaternary vegetation history of the eastern United States. In: Gillespie, A.R., Porter, S.C., and Atwater, B.F. (eds.). The Quaternary Period in the United States. Developments in Quaternary Science vol. 1., pp. 381-402.

(p. 392-393): "About 8000 years ago, the prairie-forest border became established near its modern position. At about 6000 years ago, the prairie rapidly advanced eastward then returned to its modern position at about 3000 years ago. However, this position was a climatic fulcrum throughout the middle Holocene. Prior to 6000 years ago maximal prairie development and aridity occurred to the west, while Ulmus forest and humid climate persisted to the east. Then, after 6000 years ago, prairie retreated and climate became less arid to the west, while maximal prairie and aridity developed to the east. After 3000 years ago, climate became more humid across the entire Prairie Peninsula region…
"The late mid-Holocene period of maximal aridity extended at least as far east as Crawford Lake, just east of Lake Ontario, where it occurred between 5500 and 2000 cal yr BP…
"In Illinois, prairie development was bimodal, first appearing about 9000 cal yr BP, contracting somewhat, then reaching maximal development later 6800-3200 cal yr BP, pinned on the Chatsworth Bog interpretation. Mesic forest prevailed in the driftless region of southeastern Minnesota and northeastern Iowa during the driest part of the prairie period in central Minnesota…

Webb, T. III, Cushing, E.J., Wright, H.E., Jr. 1983. Holocene changes in the vegetation of the Midwest. In: Wright, H.E., Jr. (ed.). Late Quaternary environments of the United

States, volume 2. The Holocene. University of Minnesota Press, Minneapolis, pp. 142-165.

Webb, T. III, Shuman, B., Williams, J.W. 2004. Climatically forced vegetation dynamics in eastern North America during the late Quaternary Period. In: Gillespie, A.R., Porter, S.C., and Atwater, B.F. (eds.). The Quaternary Period in the United States. Developments in Quaternary Science vol. 1., pp. 459-478.

Pollen Viewer on the NOAA NCDC web page: http://www.ncdc.noaa.gov/paleo/pollen/viewer/webviewer.html provides a series of isopoll maps for prairie forbs that show the change in the prairie-forest border during the Holocene.

Other topics for discussion:

- The difference between radiocarbon years and calibrated radiocarbon years (or calendar years) becomes very apparent as different publications and datasets are compared. In calculating a radiocarbon age, one assumes that the specific activity of the ^{14}C in atmospheric CO_2 has been constant through time. However, early in the history of radiocarbon dating it was recognized that atmospheric ^{14}C has varied, and a calibration dataset is necessary to convert conventional radiocarbon ages into calibrated years (cal yr). The difference between the calibrated and conventional radiocarbon dates and the calibration software is available at http://radiocarbon.pa.qub.ac.uk/calib/.

  Note that the most recent papers and also Pollen Viewer use calendar years. Older papers, NOAA NCDC pollen database, and SiteSeer records are in radiocarbon years. This is an unfortunate source of confusion, but it shouldn't detract too much from the value of this exercise.

- The first rise in pollen influx or pollen percentages of a taxon at individual sites is used to infer the local appearance or expansion of the plant. *Fagus* produces a lot of pollen, and it is easy to map the first significant rise in percentage or influx data in most pollen records. *Fagus* percentages and influx data often have a period of very low initial values before the significant rise, and palynologists interpret this tail as either the presence of small isolated tree populations at the site before the main period of tree expansion, or pollen grains that blew long distances from larger populations. This debate continues to the present as discussed in the McLauchlin and Clark (2004) paper.

- Advantages and disadvantages of using isochrone maps versus isopoll maps to infer species ranges.