Databasing and Georeferencing of specimens using EXCEL and GEOLOCATE
Below are 12 groups included in our herbarium. Dr. Hardy has selected these to be more or less equal in size to one another (i.e., about 35 specimens). Please select one (first come first serve) and then database (using Microsoft Excel) and map as accurately as possible (assigning it the latitude / longitude in decimal degrees) these specimens. Deliver via email both the Excel spreadsheet of all your specimens databased, plus a GEOLOCATE .xml file containing the map that GEOLOCATE generated for your data by the beginning of class on March 9.

Objectives
1. For you to learn how a herbarium is organized and the types of important biogeographical data they contain.
2. For you to learn how to use Excel and issues in database management.
3. For you to learn about the developing field of biodiversity informatics and innovative georeferencing and mapping techniques.
3. For you to be aware of potential downstream applications of such a database.
4. For you to sleep at night dreaming of wonderfully pressed herbarium specimens and specimen labels that provide clear and detailed locality data.
5. (Longterm) For MU botany to learn a bit about the history of the flora of the Lower Susquehanna River Valley over the last ca. 150 years, by getting the complete collection databased and georeferenced to at least county-precision.

Instructions for databasing your specimens (using Excel)
1. To start, you must database your specimens using the Excel spreadsheet provided on our class website (herbarium-spreadsheet-template.xls).
　　1a. The columns (data fields) must be in this exact order, particularly later when you attempt to open a comma or tab delimited version of your spreadsheet in GEOLOCATE.
　　1b. If georeferencing one specimen at a time, you will not be using the green fields (i.e., Corrected, Error, Multiplot). These are used by GEOLOCATE only when doing multiple records at once.
　　1c. The pink columns below are Lat (latitude), Lon (longitude) and Precision (how precise the coordinates). Lat and Lon are generally not given on the specimen (b/c most collectors did not have a GPS) and you will have to obtain from GEOLOCATE (see below). The "Precision" (i.e., low, medium, or high) is something given by GEOLOCATE when you georeference.
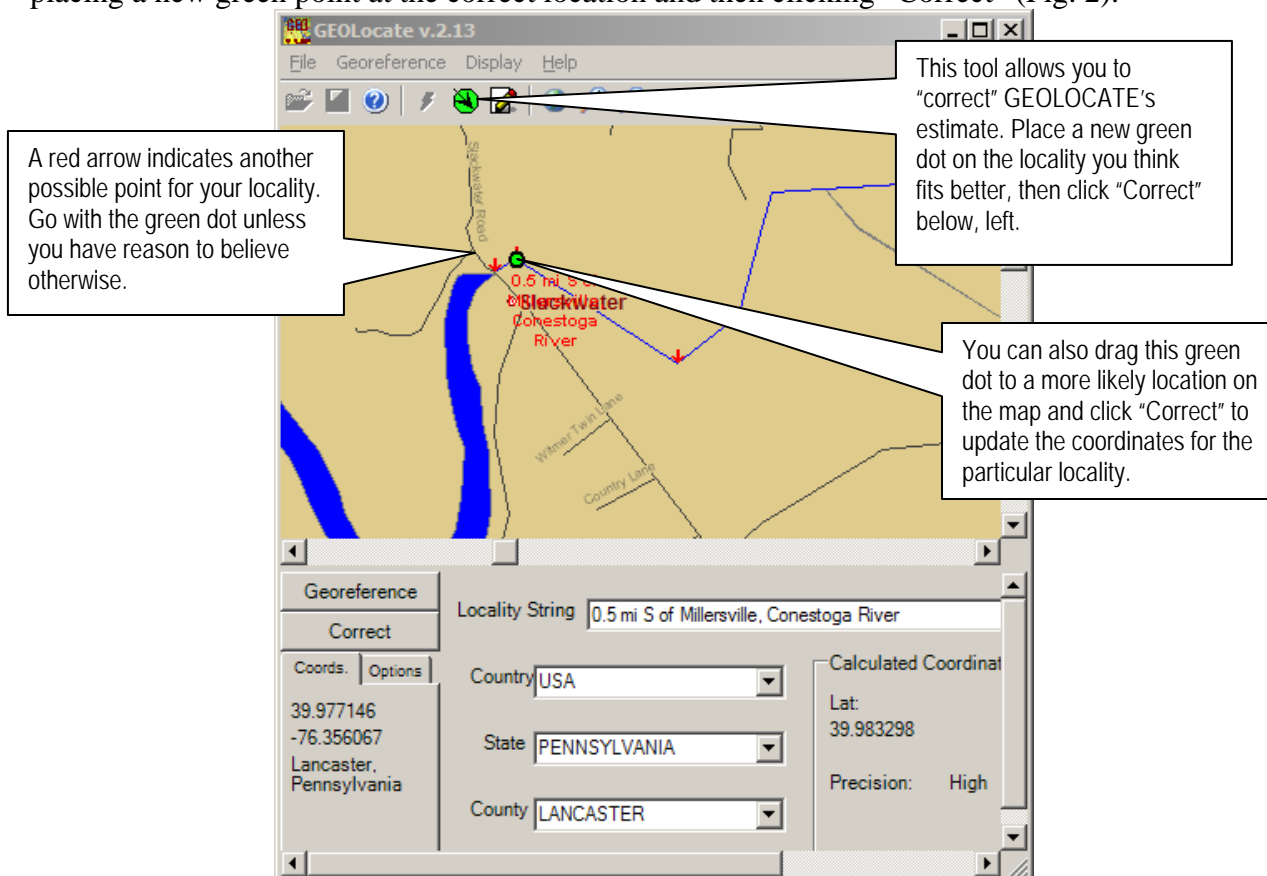
C	D	E	F	G	H	I	J
State	County	Lat	Lon	Corrected	Precision	Error	MultiPlot
PA	Dauphin	40.19972	-76.7314		medium		
PA	Lancaster	40.01037	-76.1289		low		
PA	Northumberland	40.79333	-76.4632		high		

Fig. 1. Excerpt image from the a sample spreadsheet,
showing the fields (columns) obtained from GEOLOCATE:
these are Lat, Lon, Corrected, Precision, Error, and Multiplot.

2. For any specimen, if species ID is unknown, but the genus is known, then indicate a "sp." for "species" in the specific epithet field.
3. If "Collector" is unknown, indicate by "unknown".
4. If Collector is known, yet there is no collection number, then indicate "s.n." for collection number. This is a Latin abbreviation for "no number". Thus, a James C. Parks collection with no number is "Parks, James C." followed by "s.n." in the next column.
5. If you are unsure of any label information (i.e., the hand-writing is too difficult to read), then indicate so with your comments recorded in square brackets.
    For example, "Carson Creek [Databaser is unsure about "Carson," could be "Larson."]".
6. Stamp your specimen sheet at the bottom left corner "COMPLETE" using stamps available in the herbarium. If stamps are not available, write your initials and the date at the bottom of the herbarium sheet, in the middle.

Georeferencing using GEOLOCATE

1. I recommend georeferencing for each specimen individually; however, there are ways to enter all text locality information first, followed by automated batch georeferencing. The GEOLOCATE manual is available in the herbarium.
2. Open GeoLocate and, if necessary, "*Georeference > Switch to user input*".
3. Enter all locality information for the specimen and hit "Georeference" to get latitude and longitude.
4. Check for accuracy. Verify every point. GEOLOCATE provides a way to edit ("correcting") mapped points by clicking and dragging the green dot on the map to the correct locale or by placing a new green point at the correct location and then clicking "Correct" (Fig. 2).

This tool allows you to "correct" GEOLOCATE's estimate. Place a new green dot on the locality you think fits better, then click "Correct" below, left.

A red arrow indicates another possible point for your locality. Go with the green dot unless you have reason to believe otherwise.

You can also drag this green dot to a more likely location on the map and click "Correct" to update the coordinates for the particular locality.

Hardcopy atlases and gazetteers are available in herbarium if GEOLOCATE is unable to locate the locality.

If no specific locale is given, but you know the county or the state, then place cursor over that locale in the GEOLOCATE map viewer window and record the coordinates for the center point of that county or state. IF this is the case, indicate the level of accuracy as "low, county center" or something like that.

5. Once all specimens have "lat" and "lon" down to at least the county-level, save your file from Excel as a ".csv" file (a special type of text file, via "*FILE > Save as*").

Mapping & Inserting electronic images of your GEOLOCATE maps into a Microsoft WORD document

1. In GEOLOCATE, "*FILE > Import*" (not "open") your ".csv" file for each genus (typically genus unless otherwise instructed) to be mapped (should do this separately for each taxon). Although spreadsheets can include all taxa, it is necessary to make separately temporary ".csv" files for each taxon (only specimens for that taxon) for import into GEOLOCATE for mapping.

   MAKE SURE YOU KEEP THE ORIGINAL, COMPLETE FILE (I.E., WITH ALL SPECIES, ALL SPECIMENS GEOREFERENCED) FOR DELIVERY TO ME.

2. Map the specimens using "*FILE > Plot all*".

3. Save the GEOLOCATE file using "*FILE > Save*". The native format for GEOLOCATE is an XML.

3. Enlarge GEOLOCATE window to full screen. Keyboard the "shift + print screen" or simply "print screen" key combination to copy the screen to your clipboard, and then paste it into your MS WORD document. Format the picture in WORD (double click on the image to open relevant menu) to show only the map area (i.e., crop away anything else on the image). There are other ways to get images from the screen. But an explanation of these many ways is declined here.

4. Save your WORD document.

Instructions for final products

1. Send via email your final georeferenced spreadsheet (.xls or .csv format is fine).
2. Send via email a GEOLOCATE .xml file of your report.
3. Print out map of your specimens from Geolocate directly or from WORD.

All of this by the beginning of class on 9 March.

These are together worth 10 points and will be graded based on completeness, quality, and accuracy.

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Ferns & Fern Allies

1. Group 1: *Asplenium*
2. Group 2: *Anthyrium, Azolla, Dennstaedtia, Gymnocarpium, Lygodium, Marsilea*, and *Salvinia*
3. Group 3: *Dryopteris intermedia, D. goldiana, D. campyloptera*, and *Dryopteris* hybrids.
4. Group 4: *Dryopteris marginalis*.
5. Group 5: *Onoclea* and *Phegopteris*
6. Group 6: *Osmunda*, *Polystichum*, and *Pteridium*
7. Group 7: *Thelypteris, Vittaria, Woodsia, and Woodwardia*
8. Group 8: *Trichomanes* (non PA)
9. Group 9: *Trichomanes* (PA)
10. Group 10: *Lycopodium* sensu lato.
11. Group 11: Equisetum laevigatum, E. arvense, and E. hyemale
12: Group 12: *Adiantum, Equisetum fluviatile, E. variegatum, E. sylvaticum*, and the general Equisetum folder.