At completion of this module, you will be able to:

- explain the importance of collections in scientific research
- manipulate data in a spreadsheet program
- create properly plotted and labeled graphs
- analyze data to test hypotheses about climate effects of butterfly phenology

Collections Discussion

Natural history collections contain physical specimens collected by a scientist, carefully preserved, and stored in a museum, university, or research collection space, much like books in a library. These collections serve as warehouses for all kinds of biological data such as phenology, taxonomy, evolution, and ecology of the species (e.g., Robbirt et al. 2011, Jacquemyn et al. 2015). Each specimen has information beyond the physical object itself. A specimen contains valuable metadata (e.g., collection date, location, habitat, images) and is accessible for repeatable, iterative, and expanded observations when physical verification is needed, new questions arise, or new investigative techniques are developed. For example, recent technological advances allow researchers to use specimens to study past biological phenomena such as molecular variation, historical environmental conditions, presence of environmental toxins, and host parasite assemblages; topics or approaches that were generally not imagined when the original specimen was collected. Natural history collections provide a source of biodiversity data that is unequaled in temporal, geographic, and taxonomic complexity and unique in its ability to allow researchers to verify and expand the data by returning to the physical specimens on which they are based.

You may or may not be aware, but Georgia Southern's Department of Biology houses several collections. The United States National Tick Collection is housed in the Natural Sciences Building (Statesboro campus), and the Georgia Southern University-Savannah Science Museum Herpetology Collection is located in the Biological Sciences Building (Statesboro campus). Our department maintains active herbaria on both the Statesboro and Armstrong campuses, containing more than 45,000 total vascular plant specimens. Finally, there are small collections of invertebrates, fishes, birds, and mammals for teaching purposes. In the Biological Sciences Building we have a major collection of approximately 500,000 pinned and 20,000 alcohol-preserved insect specimens. These collections may be used by faculty, students, and even the public. Take a look at this video that addresses how students view the usefulness of collections:

https://www.youtube.com/watch?v=rL7kAv323Bk&feature=emb_logo

1) Have you ever visited a natural history collection? If so, which one(s)? If not, which would you like to visit? (1 point)

2) Based on the video, list at least 3 specific types of data that can be obtained from collection specimens. (1 point)

3) What do you think some pros and cons are to using data from collection specimens? (2 points)

4) Respond to specific thoughts/information posted by (at least) 1 classmate. (1 point)

Citations:

Jacquemyn, H. and M.J. Hutchings. 2015. Biological flora of the British Isles: *Ophrys sphegodes*. Journal of Ecology 103:1680-1696.

Robbirt, K.M., A.J. Davy, M.J. Hutchings, and D.L. Roberts. 2011. Validation of biological collections as a source of phenological data for use in climate change studies: a case study with the orchid *Ophrys sphegodes*. Journal of Ecology 99:235-241.

Butterfly Phenology Assignment

What is Phenology?

Phenology is the study of the timing of cyclical events in an organism's life cycle, such as the flowering of plants, emergence of worker bees from the hive, or the migration of birds. The timing of critical life stages can be triggered by external environmental clues such as seasonal temperature change, day length, or precipitation. As global weather patterns alter or fluctuate due to **climate change**, an organism's phenology may shift in response to a change in triggers. If species that interact closely respond to triggers that are no longer synced (occur at the same time), their interaction may be disrupted. This is known as an **ecological mismatch** and can impact organisms across trophic levels (Winder and Schindler 2004, Both et al. 2006). For example, warmer spring temperatures often result in earlier emergence dates for temperature sensitive insects. If production of their plant nectar source is triggered by day length, the flowering time may not change in sync with the pollinator flight. If the emergence dates of their insect pollinators are not triggered by the same cue as the plant nectar source, the pollinator may not have food to fuel reproduction and the plants can lose a pollinator that is an important component of their reproductive success (e.g., Robbirt et al. 2014).

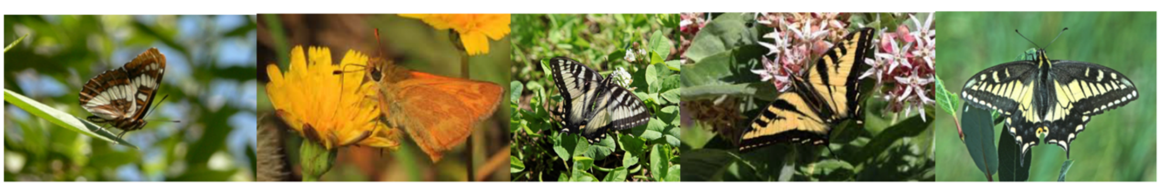
Can Climate Change Disrupt Phenology?

To address the impacts of climate change on phenology we need to examine long-term historical patterns and trends in both the environmental conditions and phenologies of the species of interest. We need current and historical data on when and where species occur, the timing of phenological events (e.g. emergence, flowering dates, peak flight), and key environmental variables that can initiate phenological transitions (e.g. temperature, precipitation). This means we need long-term data for both the organisms we study, and the ecosystems they occupy. No problem! We are in the data rich era of science. **Environmental data** and **data from natural history collections**, professional scientists, and long-term weather stations provide the information that is necessary to investigate phenological changes.

Using Data from Natural History Collections data and Weather Stations to Test Hypotheses

For this week's assignment, we'll use the earliest collection date each year of butterfly specimens as a proxy for phenology. That is, the date that the adult butterfly was collected signifies a date that the butterfly was in flight. The relatively short lifespan of butterflies allows us to use their collection date to study how their phenology may have changed over time and relative to abiotic variables such as temperature. We'll use data from an online natural history collections database, iDigBio. This database provides us the opportunity to peek into the past, in this case as far back as the 1930s, to see the species (see photos below for examples), dates, and localities of butterflies that were collected.

Callophrys augustinus *Coenonympha tullia* *Cupido amyntula* *Euchloe ausonides* *Glaucopsyche lygdamus*



Limentis lorquini *Ochlodes sylvanoides* *Papilio canadensis* *Papilio rutulus* *Papilio zelicaon*

You will use a dataset previously downloaded from an online natural history collections database, iDigBio to construct graphs and answer questions about whether temperature affects butterfly phenology. Download the Word and Excel files to begin the assignment.

Citations:

Butterfly phenology research conducted by Kharouba and Veland (2015) using specimens collected in British Columbia, Canada, provided the inspiration for this activity.

Literature Citations:

Both, C., S. Bouwhuis, C.M. Lessels, and M.E. Visser. 2006. Climate change and population declines in a long-distance migratory bird. Nature 441:81-83.

Kharouba, H.M. and M. Veland. 2015. Flowering time of butterfly nectar food plants is more sensitive to temperature than the timing of butterfly adult flight. Journal of Animal Ecology 88:1311-1321.

Robbirt, K.M., D.L. Roberts, M.J. Hutchings, and A.J. Davy. 2014. Potential disruption of pollination in a sexually deceptive orchid by climatic change. Current Biology 24:2485-2489.

Winder, M. and D.E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. Ecology 85:2100-2016.

Data Sources:

iDigBio portal of natural history collections records for butterfly specimen data (www.idigbio.org/portal/search)

Environment and Climate Change – Canada for surface air temperature data of British Columbia (https://www.ec.gc.ca/dccha-ahccd/default.asp?lang=en&n=1EEECD01-1)

Adapted from Dr. Debra Linton.

Image Sources:

All butterfly images are from Wikimedia Commons