**Module 3 Instructional Plan**

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| **General Information** | |
| **Lesson Title:** What on Earth is an Herbarium? | |
| **Overview:** The goal of this activity is to introduce students to herbarium specimens and why they are an important source of information. The emphasis of this activity is on examining the types of data that specimens provide and how this data can be used to answer questions in biology (e.g., species distributions, ecological interactions, genetics) and anthropology (ethnobotany). | |
| **Subject(s):** Biology, Botany | |
| **Grade Level/Setting:**  Grades 9-12/ Biology or Ecology Science classroom | |
| **Prerequisite Skills/Prior Knowledge:**  Previous knowledge of museums and different types of scientific institutions will be helpful. | |
| **Three Dimensions** | |
| **Disciplinary Core Ideas:**  Life Sciences: LS4 - Biological Evolution: Unity and Diversity | |
| **Science & Engineering Practices:**  Obtaining, Evaluating, and Communicating Information  Analyzing and Interpreting Data | |
| **Crosscutting Concepts:**  Structure and Function | |
| **Integration:**  Students will examine a variety of plant specimens, each from a different country. They will collect information from these specimens to answer various prompts about ecology, geography, and anthropology. Students will then create their own illustrated herbarium specimen and share with their classmates. Students will evaluate herbaria and natural history collections as sources of useful information, and begin to consider how the structure of herbarium specimens and the information contained on them best conveys this information as a historical record. | |
| **Standards and Objectives** | |
| **NGSS Performance Expectations:**  Not applicable. | |
| **Tennessee Science Standards:**  EVSC.ETS2.2- Research and communicate information on an environmental science career. Analyze the role of society, engineering, technology, and science in that career  ECO.ETS2.2- Research and communicate information on a career in ecology. Analyze the role of engineering, technology, and science in that career | |
| **Learning Objective(s):**   1. **The learner will:** 2. Explain what an herbarium is and its importance for both the scientific community and general public. 3. Describe how herbarium records are collected and used by botanists.   **Guiding Question(s):**  What is an herbarium, and why should we care? | |
| **Materials/Resources** | **Technology** |
| * Vocabulary list (**Handout 3.1**) * What in the World is a Herbarium? (<https://www.youtube.com/watch?v=lK5Fdsr16Ps>) * Unladylike2020: Ynés Mexía   <https://tn.pbslearningmedia.org/resource/ull20-ynes-mexia/unladylike2020-video/>   * Plant Research at a Herbarium   <https://tn.pbslearningmedia.org/resource/stn15.sci.lifesci.herbariums/plant-research-at-a-herbarium/>   * Herbarium specimen worksheet (**Handout 3.2**) and key * Craft materials (legal sized paper, coloring pencils, markers, etc.) to prepare a mock herbarium specimen | * Internet access (e.g., computer or cell phone) |
| **Safety Concerns** | |
| There are no safety concerns for this activity | |
| **Academic Language** | |
| **Vocabulary:**  Ecology: habitat, climate, phenology, herbivory  Plants: reproductive vs. vegetative material  Additional terms: natural history, herbarium (pl. herbaria), museum, curate (curation), specimen, transcribe, digitize, DNA, eDNA | |
| **Other Language Demands:**  Syntax: Linnaean taxonomic hierarchy, binomial nomenclature  Discourse: class discussions and/or written responses to guiding questions | |

**5E Instructional Strategies and Learning Tasks**

* + - 1. **Engagement**

Questions to discuss prior to activities:

* What is “natural history,” and why is it important for us to learn about?
* What is a natural history collection?
* What is a museum? How are these similar or different from one another?

Students will view a 5-minute video (“**What in the World is a Herbarium**?”) about one of the largest herbaria in the entire world, The New York Botanical Garden, to see how a large herbarium works. They should also watch “**Plant Research at a Herbarium**,” which is also about The New York Botanical Garden Herbarium. As they watch the videos, they should listen for vocabulary terms and provide definitions in **Handout 3.1: Vocabulary list**. The teacher can discuss herbarium terminology used in the video afterwards to make sure students understand the vocabulary.

**Extension**: Students may wish to watch a longer video on herbaria. Summer Rayne Oakes made a 40-minute video entitled “Tour an HERBARIUM: Museum of Plants — Ep. 283” where she visits Cornell University: <https://www.youtube.com/watch?v=IKTYQhAS8Jg>

* + - 1. **Exploration**

Students will begin learning about the importance of plant collections through the story of Ynés Mexía, one of the most successful botanists and plant collectors of her time. Begin by showing students a 10-minute video produced by PBS called “Unladylike2020: Ynes Mexía” about the life and achievements of Mexía. Students will then examine six herbarium specimens (high resolution images are provided for students to view). Each specimen is from a country where Mexía collected plants. Species were even named after her in honor of her discoveries. Specimens can be examined in any order; this activity encourages students to organize the data to create a timeline of her expeditions. **Handout 3.2: Historical Specimen Examination Worksheet** (and answer key) will guide students through a reading and web-quest activity after completing the specimen information table.

Specimens include:

* *Mexianthus mexicanus* – Mexico
* *Rudgea mexiae* – Peru
* *Adiantum abscissum* – Brazil
* *Palicourea flavifolia* – Bolivia
* *Euphorbia mexiae* – Mexico (described in Mexia’s travel journal and referred to in Handout 3.2)
* *Saurauia mexiae* – Ecuador (an endangered species)
  + - 1. **Explanation**

Discuss what the students have learned by watching the videos and completing Handout 3.2.

Questions for discussion:

* Ask students to explain the significance of herbaria (and natural history collections in general) for both science and human history.
* What information were the students able to gather from the Mexía’s specimens?
* What was the most interesting or unexpected type of information they learned from the specimens?
* Why do students think Mexía kept such detailed records about her collections?
* At the time she lived, who benefitted from the results of Mexía’s field work? How so? Are we still benefitting from her work today?

Next, the teacher will access the Missouri Botanical Garden’s (MBG) herbarium research portal called “Tropicos” as a demonstration for the class. Follow these steps:

Go to <https://www.tropicos.org/home> (close any pop-up information windows that open).

In the menu, choose “Specimens” and it will redirect to a new page. In the search window that opens, type “Mexia” but leave everything else as-is. Hit “search” and about 5,875 specimen records should populate in the results.

Ask the students what they think these results are. These are all Mexia’s specimens stored in the Missouri Botanical Garden’s herbarium collections.

Click on one of the records linked from the “Coll No” field. A specimen record will open up. It may have an image of the specimen and/or digitized data transcribed from the photo.

Search for the collection number #1594. This specimen has an image and transcribed locality information from the original photo.

Click on the image tab and open the large image. If “download image” is clicked, a high-resolution photo opens slowly in a new window. Click on the magnifying glass to show the tiny details of the plants in the photo.

Scientists can study these specimens without having to see them in person because the images are of such high quality!

Go back to the search results for “Mexia.” In the bar above the results, there is a link called “maps” and choose “Google Maps” to see all of Mexía’s records with geographical data (latitude and longitude) plotted.

Discussion questions:

* What information or new insights does this map provide that the students did not have before?
* Can the students brainstorm new ways to creatively share Mexía’s botanical history using herbarium specimens?
  + - 1. **Elaboration**

Students will now discuss what important information is needed to create a proper herbarium specimen, including what Is needed on the label. As a class or in groups, students will collaborate to list the most important aspects of an herbarium specimen (i.e. specific location, demonstrates the reproductive parts of a plant/identifying structures, scientific name, etc.) The students may reference their Handout 3.2, Ynes Mexia’s specimen images, or the MGB herbarium database. The students will share their ideas with the class and justify their answers. This information will be used for the next and final activity of this module. This may be given as a written homework assignment.

* + - 1. **Evaluation**

Based on what students learned while examining digital specimens, students will make a drawing of an herbarium specimen for their chosen plants including the mock label. Using any craft materials available, they should illustrate what they think their plant would look like if prepared for archival. They will learn proper techniques later; the focus at this point should be what they think is important and notable about their plants. Creativity should be encouraged – this is an undervalued component to preparing specimens! Students will share their mock specimens with each other as a class; encourage discussion about how each student chose to represent their plants and what information they felt should be included on the data label. This could be done as a “museum exhibition” in the classroom or hallway.