# Peek into Plant Diversity using Herbarium Specimens

This resource developed by the California Phenology Network, 2020.

## Learning Objectives

* Use an online database to search and explore biodiversity specimen data
* Interpret biodiversity information from historical specimen labels
* Differentiate between types of data on specimen labels
* Relate information on labels to broader patterns in specimen collection over time and space

## Introduction

#### What are herbarium specimens?

An herbarium is an institution that houses and preserves an organized collection of dried, pressed plant specimens that have been collected for scientific study. Each herbarium specimen is carefully mounted to a sheet of archival paper, and a label is affixed to the paper that describes where, when, and by whom the plant was collected. The label often includes information about the habitat in which the plant was found, what other species were in the area, and what the plant looked like before it was pressed. Each properly curated herbarium specimens has a unique identification number (called an “accession number”) that is assigned to it by the herbarium that houses it.



**Left:** An herbarium specimen collected by a graduate student as part of a floristic inventory. **Right:** Close-up image of the specimen label.



#### Why do we collect herbarium specimens?

Herbarium specimens are critical to our understanding of where and when plants occur, what they look like, and how they might be changing in response changes in climate, air quality, and land use. For example, scientists have discovered that the distributions of many species in California have been shifting to higher elevations over the past 100 years, likely driven by a warming climate (Wolf et al., 2016). Maps of plant distributions, field guides used to identify plants, and scientific illustrations of plant species are all produced in part from herbarium specimen data.

Scientists regularly discover new species from herbarium specimens as well (Bebber et al., 2010), and specimens can preserve a record of what plants once occurred in an area, but have since been extirpated or even gone extinct (Pearson, 2020). Specimens have also been used to track the introduction of species into new areas (Delisle et al., 2003). More recently herbarium specimens have been used to study associated organisms such as fungi (Daru et al., 2019; Heberling et al., 2019) and herbivores such as insects (Meineke et al. 2019). The appearance and biological material of herbarium specimens offer a wealth of uses yet to be discovered.

#### Where are herbarium specimens?

Herbarium specimens are stored in large cabinets and carefully maintained by curators, collections managers, and often volunteers and students. (For a sneak peek inside an herbarium, watch [this video](https://www.cpalms.org/Public/PreviewResourcePerspectivesVideo/Preview/166547)). There are over 3000 herbaria worldwide, holding more than 390 million herbarium specimens and counting. You can find an herbarium near you by visiting this site: <http://sweetgum.nybg.org/science/ih/>.

**Left:** Layla Aerne Hains, collections manager of the San Diego Natural History Museum, stands in front of part of the SD herbarium. **Right:** Larry Hendrickson, botanist for the Colorado Desert District of the California Department of Parks and Recreation, displays a cactus specimen in the herbarium at Anza-Borrego Desert State Park

More recently, scanned images of herbarium specimens, along with the information on their labels, can also be found online through databases of “digitized” specimens. Thanks to efforts by faculty, staff, volunteers, and students like you, data on millions of specimens have been made available in databases such as iDigBio (<https://www.idigbio.org/>), GBIF (<https://www.gbif.org/>), and CCH2 (<http://cch2.org/>).

“Digitizing” herbarium specimens—taking photographs of herbarium specimens and transcribing their label data into a digital format—is a huge and important task. In this activity, you will contribute to science by helping digitize herbarium specimens from California herbaria. **Thank you!**

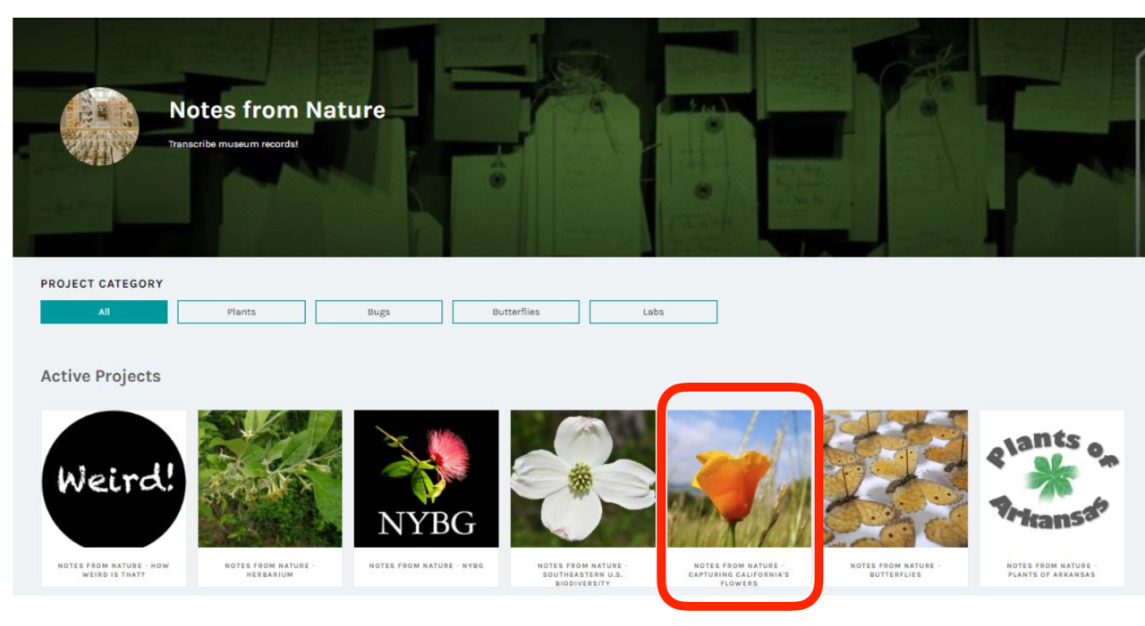
## Getting Started: Accessing Notes from Nature and CCH2

Using the following protocol, you will explore herbarium specimen images in the online transcription platform, Notes from Nature, and you will help transcribe data from the specimen labels into appropriate fields of each specimen’s online record. You will also compare the data you find in Notes from Nature to specimen data that already exist in an online database, CCH2. Questions and instructions that require your input are **in bold**.

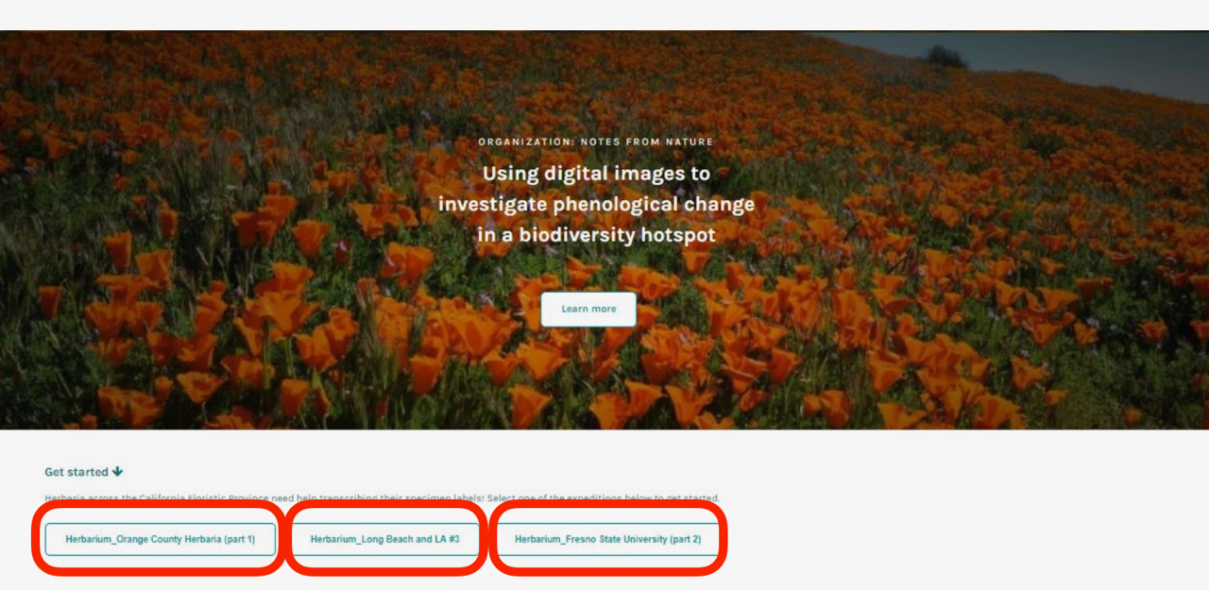
1. Open a web browser and navigate to [NotesFromNature.org](https://www.zooniverse.org/organizations/md68135/notes-from-nature).
2. Click the Register button in the top right corner of the page to create an account. Do not register if you are under the age of 18. Follow your instructor’s directions for what your username should be. **Write your username below.**



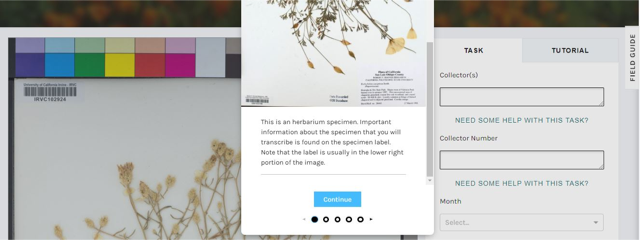
1. Return to the home page (you can just enter [NotesFromNature.org](https://www.zooniverse.org/organizations/md68135/notes-from-nature) into the browser again). Make sure you are logged in. Your username should show up in the top right corner of the page where the Register link once was.
2. Scroll down until you see the orange poppy icon with the label *Notes from Nature – Capturing California’s* *Flowers*. This will take you to the project homepage.



1. Select an “expedition” by clicking on one of the buttons below “Get Started.” Depending on what expeditions are available, you may see more or fewer buttons than are shown in the screenshot below.



1. When you first enter the expedition, a pop-up window will guide you through a tutorial on how to transcribe specimens. Carefully read through this tutorial so you know how to get started. Click the Continue button at the bottom of each page to progress through the tutorial.

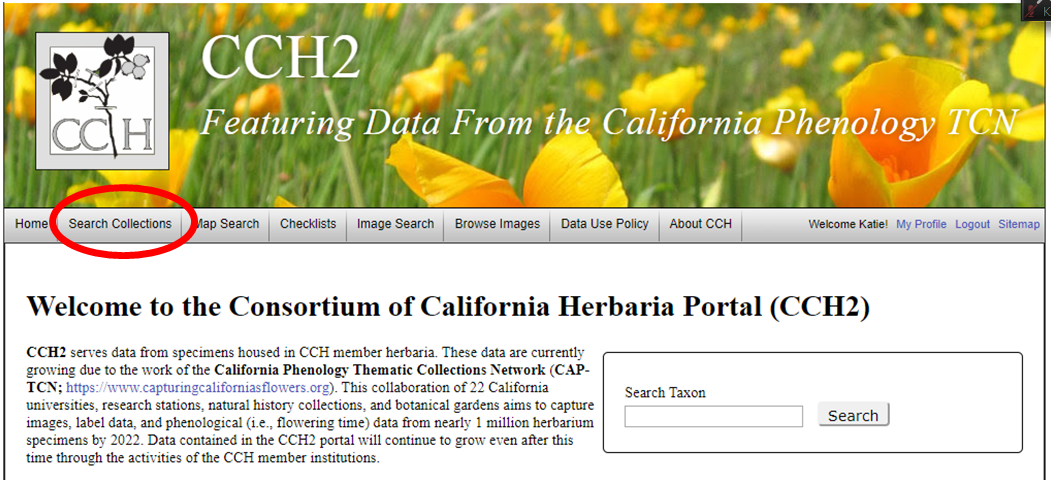


## Activity 1: Your First Transcription

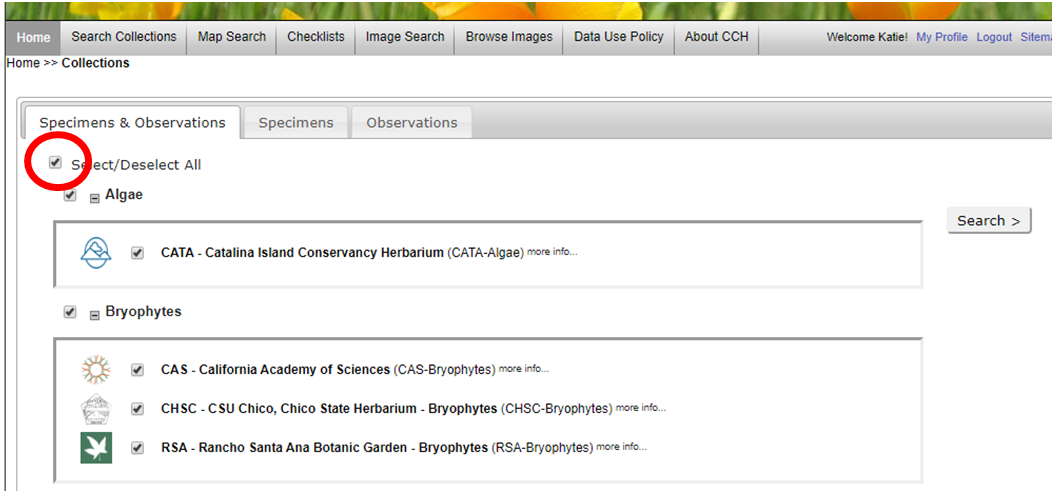
1. Start transcribing your first specimen according to the instructions provided in the tutorial. *Note that what you enter in the fields will be tracked, so it is in your best interest to transcribe the information accurately.* **What is the scientific name of the first specimen you are transcribing?** (You can copy and paste it here after you have transcribed it into the appropriate field in Notes from Nature).
2. **When was your specimen collected?**
3. **Who collected your specimen?**
4. **In what country, state, and county was your first specimen collected? Is this location close to or far from where you are right now?**
5. **To what herbarium does this specimen belong?** Hint: you will find this information on the specimen’s barcode, usually in the top left corner of the specimen. For example, the specimen with the following barcode is from the CSU Fresno Herbarium.



1. In another tab in your browser, conduct an image search (Google Images, Bing images, etc.) for photographs of your plant species in the wild by copying and pasting the scientific name into the search bar. **What similarities and differences do you see between the appearance of your herbarium specimen image and the “wild” photographs of your species?**
2. **Are there reproductive parts (e.g., flowers or fruits) on your herbarium specimen image?** (Hint: you may be able to get familiar with what flowers and fruits of your species look like by looking at the wild photos first)
3. In another tab in your browser, navigate to Calflora (<https://www.calflora.org/>). This is an online database of plant species that occur in California.
4. Look up your plant by entering its scientific name in the Plant Name field on the home page. **Is your species native or non-native to California?**
5. **Why might it be important to understand where native plants occur by collecting herbarium specimens?**
6. **Why might it be important to understand where non-native plants occur by collecting herbarium specimens?**
7. In another tab in your browser, navigate to [cch2.org](http://cch2.org/portal/). This is an online database of herbarium specimens that are housed in California herbaria.
8. Click the Search Collections tab.



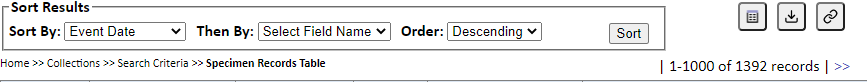
1. On the resulting page, make sure that the Select/Deselect All button is checked and click the Search button.



1. On the resulting page, copy and paste the scientific name of the first herbarium specimen you are transcribing into the Scientific Name field. Then click the Table Display button to view the results of your search as a data table.



1. Look at the top right corner of your search results, where it says | 1 – [some number] of [some number] records |. **How many specimen records of your species were found?** (Hint: this will be the number before the word “records”).
2. Sort the CCH2 records by selecting Event Date from the dropdown menu in the top left corner, then Descending after Order. Click the Sort button.



1. Look back at your answer to question 8. **How many specimens in CCH2, if any, were collected during the same year as the specimen you are transcribing in Notes from Nature?**
2. Look back at your answer to question 9. **Were any of the specimens collected in the same year as your Notes from Nature specimen also collected by the same person as your Notes from Nature specimen?**
3. Click on the Maps tab in CCH2.



1. Click Display coordinates in Google Map to view a map of where specimens of your species have been collected. **Take a screenshot of this map and paste it below.**
2. Look back at your answer to question 10. **Have specimens of your species been collected near or within the county in which your Notes from Nature specimen was found, according to the CCH2 database?** If not, you may have just helped to expand the known distribution of this species by transcribing the label data of this specimen. Awesome job! If your specimen IS known from this location already, you have still contributed valuable information about when and where this species occurs. Fantastic!

## Activity 2: Similarities and Differences

Adapted from [Mast and Ellwood, 2016](https://wedigbio.org/sites/default/files/files/wedigbio_exercise_2016.pdf), [CC-BY-NC SA](https://creativecommons.org/licenses/by-nc-sa/2.0/)

1. Return to your Notes from Nature tab and finish transcribing your specimen.
2. Transcribe the label data from five new specimens and reflect on what you saw. Keep the following questions in mind and answer them after you have transcribed the five specimens.
   1. **In what ways were the specimen labels similar among the set of five specimens that you transcribed? In what ways might these similarities facilitate research?**
   2. **In what ways did the specimen labels differ among the set of five? Why might these differences exist? In what ways might these differences facilitate research?**
   3. **What did you see on the specimen labels that you did not understand?**
   4. **What was one thing that you expected to see on a specimen label that did not appear on them? Why might this information be absent?**

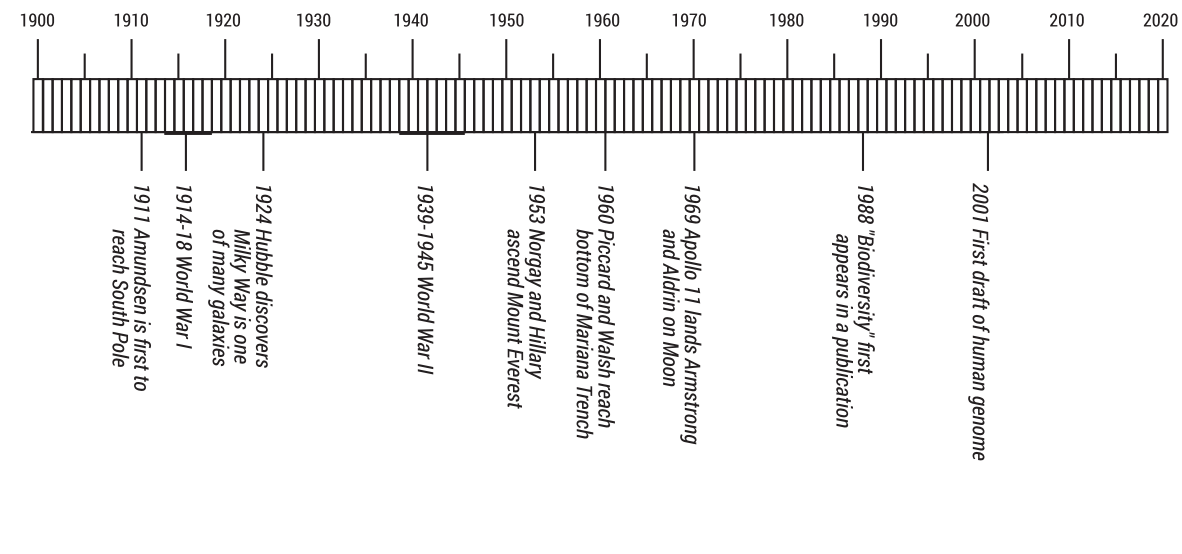
## Activity 3: Specimen Collections in Space and Time

1. Transcribe the label data from ten new specimens. **As you do so, keep track of the scientific name of the specimen, the year in which the specimen was collected, and the state and county in which the specimen was collected in the data table below. Make sure to capitalize the name of the genus (the first word in the scientific name) but not the specific epithet (the second word in the scientific name). In the far right column, indicate whether you see any evidence of herbivory (e.g., damage due to insects or other herbivores).** An example of a specimen with evidence of herbivory is shown below.

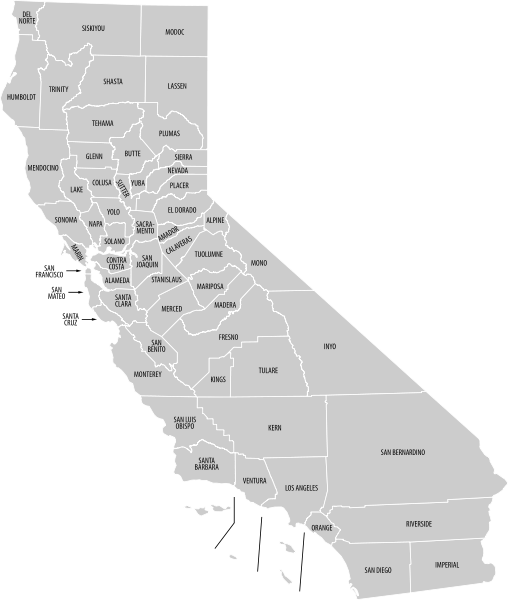


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| **Scientific Name** | **Year of Collection** | **Collection Location**  **(State, County)** | **Evidence of Herbivory? (Y/N)** |
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1. **What might evidence of herbivory on herbarium specimens tell us about the plant or associated organisms?**
2. **Mark the years in which your ten specimens were collected on the timeline below**.



1. **When was the oldest specimen collected? How many years old does that make this specimen?**
2. **What did you notice about the appearance of older specimens, if anything?**
3. **For specimens collected in California, mark the counties in which your ten specimens were collected on the map below.**



1. **Were any of the specimens collected in the same county where you are currently?**
2. **Were there any counties in which more than one of the specimens you transcribed were collected? Which county or counties?**
3. Look back at your answer to question 11. **Place a star on the map above in the county to which your specimens belong (i.e., the county where the herbarium is). Is this county the same as your answer to question 32?**
4. **Are the counties that you indicated in the map above close to the star (the location of the herbarium)? Why do you think this is or is not the case?**
5. Transcribe 10 more specimens, or as many as directed by your instructor. To see how many specimens you have transcribed in total, click your username in the top right corner of the page, then click Home. The number of transcriptions (i.e., “classifications”) you have made will be shown below the circular graph.



### References

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