Tested Studies for Laboratory Teaching
Proceedings of the Association for Biology Laboratory Education
Vol. 36, Article 1, 2015

Campus Tree Mapping

Susanne Altermann, Ph.D.

Whitman College, Biology Department, 345 Boyer Ave., Walla Walla, WA 99362 USA
(**altermsm@whitman.edu**)

Students apply vegetative plant morphology terms to the problem of mapping the distribution of a single tree species on a college campus. Students first learn plant vegetative morphology terms through drawing a variety of leaves and then participating in a leaf treasure hunt in groups outdoors. A dichotomous key to common trees is introduced. After some practice with the key, student groups are assigned a tree species. Students annotate a campus map marking all of the sites where the assigned tree species grows.

Keywords: botany, dichotomous key, plant identification

Introduction

The objectives of this series of low-tech botany laboratory exercises include use of vegetative morphology to identify unknown trees, documentation of a known species' occurrence in a limited geographic area, and working effectively in a group. I developed this laboratory activity for a non-majors' general botany course at California Polytechnic State University San Luis Obispo. I have also adapted the exercise for a biology majors' core course. Lab sections usually consist of 24 students each. Students learn the botanical jargon through a leaf gathering treasure hunt that the students carry out in groups outside (30 minutes morphology introduction, 30 minutes hunting, 30 minutes reviewing the results of the hunt). Keying is taught indoors to the lab section as a whole (30 minutes), and then students practice keying four tree species outside individually or in groups, whichever they prefer (30 minutes). Next, the students begin a campus tree mapping project in groups of four, employing their new skill. Tree mapping occurs both within the lab time (30 minutes) and outside of lab time.

To begin, we have a few demonstration twigs to show different types of phyllotaxy and leaf venation in the lab, but most of the students' learning occurs when we draw a few examples on the board (simple, compound, palmate, pinnate). I market this as "learning how to see a plant." Participants form groups of four and are sent out to gather representative twigs with 11 different listed leaf morphologies and arrangements. Next, with the help of 20-24 twigs of the same species, we key out a tree together (the whole class, step by step, reading the couplets out loud) to introduce the dichotomous key. I call on individual students to a) read a couplet out loud, and b) decide whether the specimen in hand conforms to the first or second option in the dichotomous key. Students are required to write down the keying steps, including the evidence they used to make their decision. Then we go outside and key out a few beautiful trees, everyone at their own pace. I deliberately choose easy trees first. For example, in the Ritter key (2011), *Liriodendron tulipifera* (tulip tree) makes a satisfying first keying experience. Next, students break up into groups of three or four. Each group picks a tree species (from a vetted list provided) and start mapping its occurrence on the campus using a paper map. I often tell the groups exactly how many trees they should find in their assigned area, and this helps them stay motivated to keep looking when they think they have found all of their trees.

This activity gets students outside, it gets them talking to each other using botanical jargon, it gets them observing plants that they have been taking for granted, and it gives them a new skill. Students feel empowered to identify plants, they get to know their campus better, and they learn to recognize their mapping tree from close up and from a distance. This last point is especially satisfying, as students are often challenged in science classes to zoom in out and out of different scales. In order to first identify the tree, students have to look at twigs and leaves closely. By the end of the assignment (after mapping 30 or more trees), they are able to identify their tree from yards away as well from close up.

Assessment for this laboratory activity consists of the assigned worksheet and map, and a quiz in which students are required to apply vegetative morphology terms to live twig specimens, and identification of an unknown tree through the use of a dichotomous key.

The exercise can be adapted to a city park if the campus does not have a good diversity of trees.

Student Outline

Exercise 1 – Leaf Collection

New Terms

Alternate phyllotaxy

Opposite phyllotaxy

Whorled phyllotaxy

Pinnate

Bipinnate

Palmate

Simple

Compound

Node

Sessile

Spine

Stipule

Learning Objectives

- Identify a variety of leaf types and leaf features.
- Work effectively in a group.

Assignment

You will go out onto campus with a group of students and collect leaves that are representative of a wide variety of forms. This is a team effort: all students from the group will receive the same score.

Take along a razor blade, scalpel, pair of clippers, or knife. Find and neatly clip off twig samples with leaves representing the following leaf conditions and bring the samples back to lab. Spread out the samples on your lab table and be prepared to present them to your lab instructor. Any single sample may fit multiple conditions listed. Groups that finish early may return outside to correct their leaf collection.

Collection Rules

- Neatly clip/cut leaf samples. Do not rip twigs from the plants (points may be deducted for samples that were broken or torn from the plant).
- Do not take samples from recently planted shrubs and trees or from small individuals.
- Do not collect sensitive or poisonous plants (your instructor will provide a list).

Collection Tips

- Collect leaves with a node attached.
- Some plants may meet more than one requirement.
- Collect extra leaves, some may be duds!
- Bring along drawings of the leaf morphologies.
- Bring along this list of leaves.

Twigs to Find

Each correct leaf is worth a single point.

1. Simple leaves with parallel venation.
2. Simple leaves with pinnate venation.
3. Simple leaves with palmate venation.
4. Once pinnately compound leaves.

5. Twice pinnately (bipinnately) compound leaves.
6. Palmately compound leaves.
7. Alternate phyllotaxy.
8. Opposite phyllotaxy.
9. Whorled phyllotaxy.
10. Sessile leaves (without petioles).
11. Leaves with stipules.
12. Spines (modified sharp-pointed leaves)—don't confuse with thorns or prickles.
13. Specialized leaves/leaf structures. Include a persuasive argument for what is specialized about your chosen leaf.

Exercise 2 – Plant Identification Using A Dichotomous Key

New Terms

Couplet
Dichotomous key
Identification Key
Prime

Learning Objectives

- Identify unlabeled tree specimens using a dichotomous key.
- Work effectively in a group.

Introduction

One of the fastest and most reliable methods for plant identification is to use an **identification key**. Identification keys are designed to help you identify a plant using readily observable features. In a **dichotomous key**, this seemingly magical feat is made possible by examining the plant closely and selecting one of two mutually exclusive choices in a sequence. It's a process of elimination. At each subsequent step in the key, on the path from unknown to known, you make a choice, advancing toward a progressively smaller group of possibilities that match your unknown plant, until you arrive at the name of the correct species. Using a key is like solving a puzzle and communicating with an expert (without the social awkwardness), all at the same time. It can be fun and liberating.

To progress through a dichotomous identification key, you read a pair of statements called a **couplet**. Each couplet provides two descriptions of a plant or group of plants. Compare each statement with the plant being identified, and choose the statement that best matches your sample.

For example, the two pairs of mutually exclusive statements (two couplets) in the following key distinguish three commonly found trees in California. In this case you are asked if the unknown tree has purple or green leaves, and if the leaves are green, are their undersides white or green.

1. Leaves purple - Purple Leaf Plum (*Prunus cerasifera*)
1' Leaves green
  2. Leaf underside white - Olive (*Olea europea*)
  2' Leaf underside green - Sweetgum (*Liquidambar styraciflua*)

Each paired couplet option begins with the same number followed by a .(**period**) or a '(**prime**) and has the same level of indentation. Determine whether the characteristics of the plant conform best to the first or second option of the couplet. Traits expressed early in the couplet take priority over traits expressed later in the couplet. After you choose one of the two statements, progress either to the name of the plant or to the next stem in the key, indicated by the number physically below the chosen statement (not necessarily the next number in strict numerical order). Always read both statements completely before deciding (the first statement might sound pretty good until you read the second). It is best to examine more than one sample (not just one leaf, but several leaves) before you make your decision. When measurements are given, use a ruler. The first time you use a key, you might practice with a plant whose name you already know.

Assignment

During the lab period, you will use a dichotomous key to identify campus trees, including both angiosperms and gymnosperms. Practice using the key so that you become familiar both with the key and with the terminology used in the key.

Exercise 3 – Campus Tree Mapping

Learning Objectives

- Consistently identify a selected tree species in a variety of outdoor contexts.
- Document the locations of many individuals of a single tree species.
- Work effectively within a group.

Introduction

The commonly planted trees of a university campus provide an excellent opportunity to learn skills in plant observation and identification. A dichotomous key can help you identify a tree for the first time through a hands-on, step-by-step process. With practice, you will be able to identify that tree without a key in hand.

You will be assigned to a group and to a tree species (or group of species) found on campus. You will use a dichotomous key to verify the tree's identity and answer a few questions about your keying process. Most importantly, you will walk through your assigned area of the campus and map all of the locations of your tree.

Assignment

Document each and every individual tree of your species. For a large cluster of your trees, you can mark the map with a dot and a line that says "11 trees," as appropriate. Submit a single map and single worksheet that combines the work of all of your team members' work. It is useful to systematically walk around each building and scan the landscape for your prey. Don't ignore hidden courtyards. Complete this project outside of class time - little or no laboratory time will be allocated to it.

Feel free to assign different sections of the map to individuals in your group, but you will most likely be more effective, have more fun, and learn more if you carry out the mapping together.

Materials

For a class of 20 students, you will need the following supplies: a college campus with a variety of trees, 20 copies of the student outline, 20 tree keys (I use Ritter (2011)), 5 campus maps that are not too busy, a variety of leafy twigs that demonstrate most leaf morphologies, 20 twigs of a single tree species found in the dichotomous key, and 5 pairs of clippers. If the campus does not have a good selection of trees, the activity can be adapted to a local park.

Notes for the Instructor

A practical dichotomous key is essential for this activity. I have found the Ritter key (2011) useful in California, Oregon and Washington. It would not be difficult to have a class develop a vegetative key for the trees of an individual campus. A winter key for woody twigs would also make an interesting class project.

It is important to warn the students not to collect twigs from certain sensitive plants. On the Cal Poly campus, we feel protective of the cycads because they grow slowly. It is also important to emphasize that the students should not damage any of the landscape plants by ripping at the branches.

Safety issues include proper footwear, cuts, slipping, falling, and what to do when a student gets lost. For students with mobility challenges, the first two exercises are easily converted into in-lab activities by having in-class specimens available. For the third exercise (tree mapping), I would work with the student to establish what a reasonable accommodation might be.

Acknowledgements

Lab exercises were adapted from Ritter et al. (2012). Thanks to Matt Ritter for his generosity in sharing his materials. Special thanks to James Kelley for help with the design of these laboratory exercises.

Literature Cited

Ritter, M. 2011. *A Californian's Guide to the Trees Among Us.* Heyday, Berkeley, 153 pages.

Ritter, M, D. Keil, and S. Altermann. 2012. *Botany 121 General Botany Laboratory Manual.* California Polytechnic State University, 85 pages.

About the Author

Susanne Altermann received her Ph.D. in ecology and evolutionary biology from University of California Santa Cruz in 2009. She currently teaches courses on history and diversity of life, symbiosis, pollination biology, plant physiology, and biological case studies at Whitman College in Walla Walla, Washington. Her research interest is the geographic structure of symbiotic partnerships.

Appendix A
Campus Tree Mapping Worksheet

Turn in one map and worksheet per group. Lab Section: _____

Student Group Due Date: _____

List the names of people in the group:

_____ _____

_____ _____

Taxonomy/Classification

Tree's full Latin name (Genus, species, and authority) _____

Common Name_____ Plant Family_____

Our tree is a (mark all that apply):

_____Gymnosperm _____Angiosperm

_____Monocot _____Dicot

Identification

Write out the keying steps on a separate sheet of paper. Document what evidence you used to make each choice. Write only one keying step per line.

Answer the following questions:

1. What was the trickiest keying step? Explain. _____

_____

_____

2. What tree are you most likely to confuse with your tree? Explain. _____

_____

_____

Campus Mapping

Map all the trees of your species in your assigned campus area. Attach map. Use colored ink!

In addition, count the total number of your tree species in your designated area: _____

Group Member Responsibilities

On the back of this sheet, describe the responsibilities of each member of the group. Be clear and specific.

Mission, Review Process & Disclaimer

The Association for Biology Laboratory Education (ABLE) was founded in 1979 to promote information exchange among university and college educators actively concerned with teaching biology in a laboratory setting. The focus of ABLE is to improve the undergraduate biology laboratory experience by promoting the development and dissemination of interesting, innovative, and reliable laboratory exercises. For more information about ABLE, please visit **http://www.ableweb.org/**

Papers published in *Tested Studies for Laboratory Teaching: Peer-Reviewed Proceedings of the Conference of the Association for Biology Laboratory Education* are evaluated and selected by a committee prior to presentation at the conference, peer-reviewed by participants at the conference, and edited by members of the ABLE Editorial Board.

Citing This Article

Alterman, S. 2015. Campus Tree Mapping. Article 1 in *Tested Studies for Laboratory Teaching,* Volume 36 (K. McMahon, Editor). Proceedings of the 36th Conference of the Association for Biology Laboratory Education (ABLE), http://www. ableweb.org/volumes/vol-36/?art=1