

Chapter 6

Fullerton Arboretum

INTRODUCTION

Plants are interesting. And, there are so many kinds of them. They live in most parts of the world, and they can look so different from each other. Why? Why does plant anatomy take so many different forms? Could the environment in which they live have anything to do with it? Probably. But, what specific anatomical features actually are responses to stresses and opportunities in the environment? Tough question. We'll let *you* answer it.

In this exercise, you will be challenged to use your powers of observation and some common sense to see plant anatomy as part of a system of interesting solutions to complex environmental problems.

The purpose of this exercise is to address the following general concepts:

- Does a plant's shape and appearance help it survive certain harsh physical conditions?
- What special anatomical and physiological tricks can plants use to minimize their vulnerability to otherwise stressful conditions in their community's physical environment?
- Do plants from a given community share similar anatomical and physiological features that help them survive in their community's physical environment?

THE ARBORETUM

The Fullerton Arboretum is located in the northwest corner of the California State University, Fullerton campus. See the map in the back of this exercise for the location of the arboretum. Following the efforts of Professor Dave Walkington, the arboretum opened in 1979. This 25-acre property contains a wide variety of plants from around the world. The cultivated collection section is located near the entry areas and throughout the central portion of the arboretum. These collections display plant species that have ornamental and horticultural merit. The remaining portions of the arboretum are dedicated to botanical collections that showcase native plants from southern California as well as species from plant communities around the world. The botanical collections are arranged according to their ecological requirements and generally fall into three major groupings:

Arid Zone- (where plants have evolved multiple strategies to evade or resist drought) The Mediterranean like climate of southern California favors this zone and takes up a majority of the arboretum.

Temperate Zone- An environment with alternating warm and dry seasons, with precipitation occurring mostly in the summer. Much of the United States is considered temperate.

Tropical Zone- Where climatic conditions of high precipitation and warm temperatures have reduced abiotic stresses and allowed for the evolution of the majority of the terrestrial plants found on the earth.

INSTRUCTIONS ON HOW TO PREPARE FOR THIS EXERCISE

- (1) **READ THIS EXERCISE BEFORE YOUR FIELD WORK.** It is imperative that you thoroughly read and understand the questions and exercises before you arrive at the arboretum.
- (2) Your instructor will briefly discuss any information needed before you begin your field study. We are not tour leaders, rather resource persons that can help you over the rough spots. We encourage small groups of students to work together on the exercises. Be complete and precise.

How to get there: Consult the map at the back of this exercise.

How to find your way around: Consult Figure 1 below. This map of the arboretum includes important location numbers so you can find your way around.

Bring the following:

- (1) Adequate walking shoes and clothing that fits the weather condition for the day (also sunglasses, hat)
- (2) Clipboard for working on exercises.

Other notes:

- (1) We will meet at the gate entrance to the arboretum.
- (2) Do not pick or break apart plants at the arboretum and be careful not to walk off of the established path areas.

THE WORK YOU ARE SUPPOSED TO DO, AND WHAT YOU WILL TURN IN

We want you to find your way around the arboretum on your own. Consult figure 1 for a map of the arboretum. We suggest moving in a clockwise pattern.

This exercise contains many questions we want you to answer. The questions are organized according to separate plant communities. Find the appropriate community and consider the associated questions. We require you to submit typewritten responses to these questions. Use the provided spaces, or submit on separate sheets. No formal report is required.

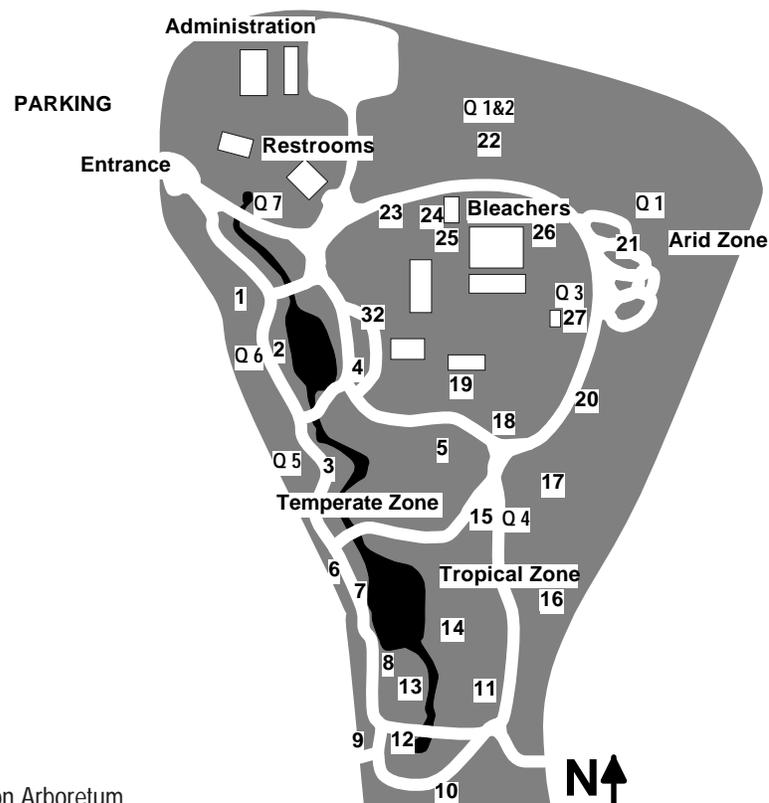


Figure 1. Site map of the Fullerton Arboretum.

TABLE I
ADAPTATIONS FOR PLANTS IN ARID ENVIRONMENTS

ADAPTATION	SURVIVAL VALUE
1. Light-colored leaf / stem surfaces (covered with fine white / tan-colored hairs)	Reflects excessive sunlight, making for a "cooler" leaf, and reducing water loss by evapotranspiration The light-colored hairs and surfaces provide a "thermal barrier" or a cooling effect as water vapor loss occurs.
2. Whitish or bluish covering that rubs off the surface of some leaves and stems	A waxy material (cutin) that helps retard excessive water loss, much like a layer of wax paper.
3. Leaves aromatic (with a pungent / acrid fragrance from essential oils and resins).. Smell a little like Vick's Vapo Rub, or salad herbs.	Chemicals that help retard water loss. They also help fires burn more vigorously during wildfires.
4. Leaves with small surface areas; often needle-like and brittle.	Reduced surface area helps the plant conserve its internal water supply. Less surface area means less area is exposed to the drying atmosphere.
5. Leaves with wrinkled, or with very uneven surfaces.	Surface area is greater than for leaves of the same dimensions whose surfaces are smooth and flat. But not all of the leaf is exposed to <u>direct</u> sunlight. Much of the leaf is shaded...by the wrinkles. This design allows for more photosynthetic cells to be crammed into the leaf, yet, by shading, helps reduce water loss by evapotranspiration.
6. Leaf margins are curled under or rolled. The leaf is not perfectly flat.	The leaf surface is exposed to less direct sunlight, than for a flat, smooth leaf of the same dimensions. This reduces water loss from the leaf.
7. Leaves oriented vertically on the plant.	Pointing straight up helps reduce the leaf's exposure to direct sunlight. Also, this angle reduces the intensity of exposure where sunlight does hit. The result is a cooler leaf, and reduced water loss.
8. Leaves succulent or fleshy in texture.	These plants take up and store extra supplies of water when it is available (during the rainy season) and then use it to stay alive during dry seasons. An excellent way to survive droughts.
9. Plants that have no leaves, but have replaced them with stems that are succulent and photosynthetic.	Common in cacti. Water accumulation stores water for later, drought. Elimination of leaves reduces the surface area, and water loss.
10. Cacti tall and vertical.	Elevates the stem for exposure to cooling air currents, away from very hot, summer, soil surface temperatures.
11. Cacti with obvious ridges.	An irregular surface area with an accordion-like appearance equates to less surface area exposed to direct sunlight and drying winds for a lower water vapor loss. This feature also allows for rapid swelling with quick water uptake and storage during infrequent rainy periods.
12. Leaves, or cacti with spines	Spines interrupt wind flow across the body of the plant. This reduces the plant's exposure to drying winds and reduces water loss from evaporation. Spines also act as heat conductors, or "cooling fins". As cool breezes blow by, the air picks up excess heat from the spine, cooling the leaf or cactus. This is not an evaporative heat loss system like, say, when you sweat. Spines also protect the leaf or cactus from being eaten.

(2) Coastal Sage Scrub Community (#22 on figure 1)

Scattered throughout southern California is a vanishing community known as coastal sage scrub or soft chaparral. The community consists of an open scrub environment dominated by California sagebrush, black sage and California buckwheat. One hundred years ago southern California was covered with 2.5 million acres of coastal sage scrub. Today only 10% remains with much of this endangered habitat fragmented by development. Remaining habitat can be found on low-lying hills and coastal valleys from Ventura to San Diego. Some 75 rare, threatened or endangered plants and animals are found within the coastal sage scrub. The tiny gray-colored California gnatcatcher is perhaps the most famous member of this community. Having been placed on the federal threatened species list, the gnatcatcher will most certainly slow home building in Orange and San Diego Counties.

Based on the above paragraph and your experience at the Arboretum, discuss the values of preserving remaining coastal sage scrub habitat.

(3) Composting Exhibit (just across the road from site #21)

A. How does the composting process actually work?

B. What positive environmental benefits might occur if cities in southern California became involved in commercial composting projects?

(4) Tropical Zone (# 15 on figure 1)

Ecologists have long-recognized that the interacting factors of temperature and precipitation are paramount in determining the type of plant community that can be supported in a given geographic location. You have already worked with an array of adaptations that enable plants to survive in arid environments. We will now turn to an ecological system on the opposite end of the spectrum- the tropical zone.

Plan on spending some time at site #15. Here you will find three towering trees; the Ombu and two fine specimens of Cordia. Note the stratification of vegetation here and the Bromeliad plants and orchids that are growing on tree crotches and branches.

Carefully examine several different tropical species and design a simple chart, or drawing that summarizes the morphological adaptations that might be indicative of tropical-type vegetation. You might consider tree height, leaf size and shape, root systems, fruit/flower sizes and any other characteristic that you feel describes tropical vegetation. Indicate and describe the feature, then briefly explain why the feature could be helpful.

(5) Redwood Grove (#3 on figure 1)

The Coast Redwood, *Sequoia sempervirens*, occurs naturally near the coast from the Oregon Border south to San Luis Obispo County. This location keeps these unique trees watered year around with precipitation depositing 60-80 inches with fog drip adding another 12-15 inches. Among the tallest trees in the world (365 ft.), the Coast Redwood is an important lumber crop with the wood prized for its color and termite resistance. Pristine examples of this forest type are found only in Redwood National Park and in a handful of state parks.

Carefully observe the small groves present at the arboretum.

- Make a sketch of the tree.
- List and explain five features that apparently enable this water-loving species to survive in generally-arid southern California.

Here is an alternative scenario. Imagine that you are standing on a mountain at 7000 feet and these are Giant Sequoia trees (which are somewhat similar in appearance). High elevations are drying environments because the air is so thin. This imposes drying stresses on the things living in such places. In addition, it is cooler and there is less precipitation than in the lower elevations of the Coast Redwood rain forest. But the mountains frequently are swept by clouds. Winters include accumulations of very deep snow.

- Sketch the tree (if you haven't done so already)
- What are the stresses that this environment imposes on the tree and the forest ecosystem overall?
- Based on the anatomy of these trees, how might the tree cope with these stresses?

(6) Carnivorous Plant Bog Community (#2 on figure 1)

An assortment of carnivorous plants are represented by the genus *Sarracenia spp.*, commonly known as pitcher plants. These carnivorous or insectivorous plant species are herbs that grow in marshes or boggy areas in many temperate and tropical locations. Here, the poorly drained soils generally lack adequate levels of nitrogen. The “pitcher” is formed by a single entire leaf. Insects are attracted by combinations of color and sweet odors. After climbing into the pitcher, the insect eventually falls to the bottom of the elongated tube on the lower portion of the leaf. Here it is retained by downward-direct hairs. Digestion is accomplished by digestive enzymes. The poorly-drained bogs appear to lack the nitrogen. The digestion of the protein-rich insects provides a rich nitrogen source.

A. Are these plants autotrophic, heterotrophic or both? Explain.

Hint: All ecosystems, whether terrestrial or aquatic, have organisms that fall into the two following groups:

- 1) the autotrophic organisms are self-nourishing (auto, meaning self; trophic, meaning nourishment) and;
- 2) the heterotrophic organisms that must feed on other organisms (hetero, meaning other).

B. Why would you suspect that carnivorous plants live in this stressful habitat? Think carefully on this one and give at least two answers.

(7) Drought-Tolerant Slope Planting (near the entrance, past the waterfall)

The probability of sporadic and continued drought years for southern California is very high. One of the definitions of a true desert is an area receiving precipitation totaling 10 inches or less on an annual basis. Our semi-desert coastal plain of southern California receives an annual precipitation that averages only 17 inches. Therefore, the difference between a desert and semi-desert precipitation category is but a few inches and a couple of good storms. The unpredictability of precipitation along with the massive population base in southern California has reinforced the idea that we can no longer take our water for granted. Multiple drought years have seen our water rates escalate along with an increased likelihood of water rationing. Much of our water demand is satisfied by water delivered through massive aqueduct systems from distant locations that all have negative environmental effects.

Over that past several decades we have imported water-loving plants from the east coast and from tropical/subtropical locations for landscaping throughout southern California. Indeed, upwards of 60% of all water used by residences in the area is for landscape watering. Sadly, this is the same water that we drink, cook with and bathe in — a sad waste of expensive, high quality water!

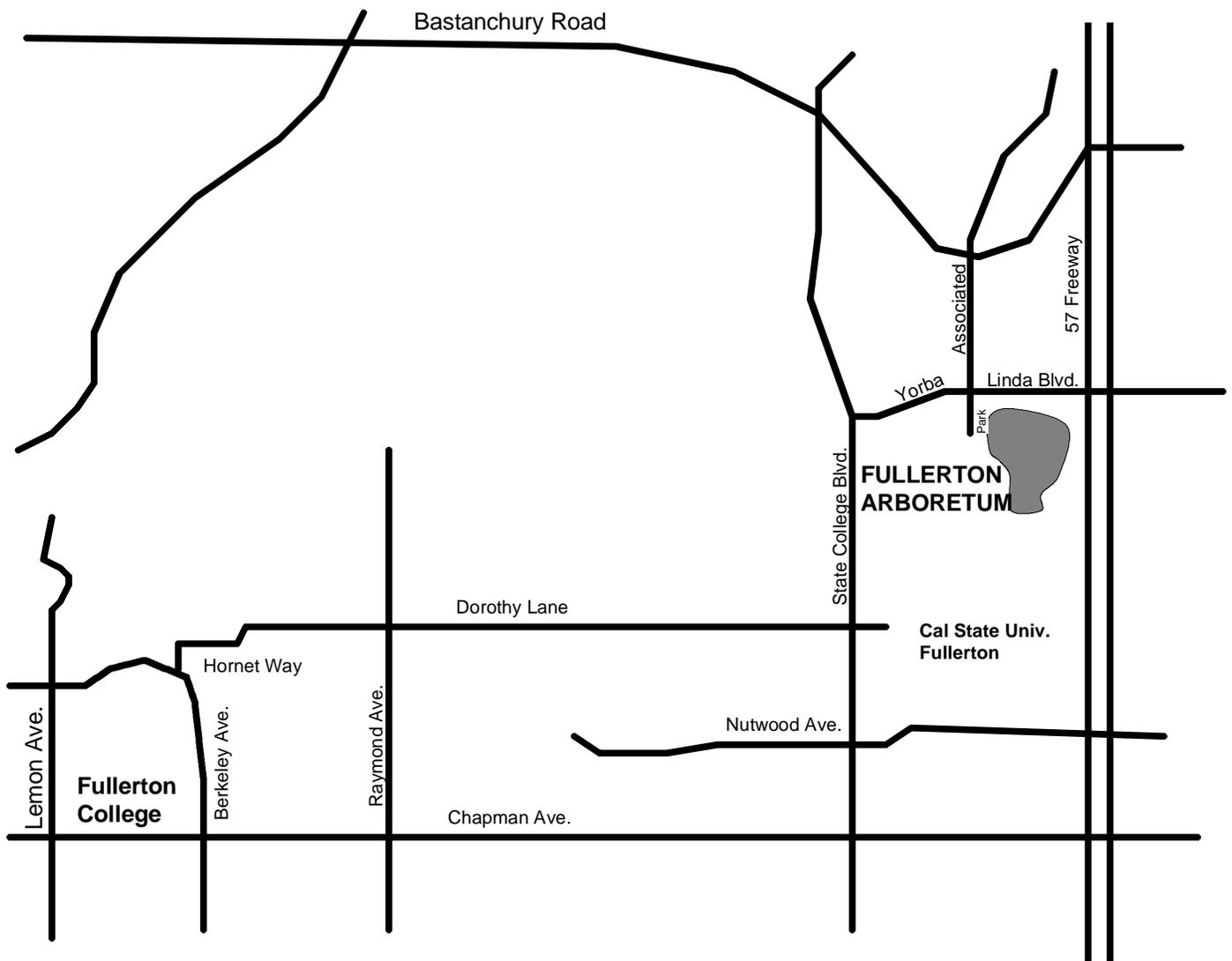
In an attempt to remedy these wasteful practices, “sustainable landscaping” has emerged as a partial solution. Often referred to as xeriscape, drought-tolerant or drought-resistant landscaping, these plant species require relatively little water. Many nurseries stock a wide variety of colorful trees, shrubs, continual ground covers, grasses and flowering herbs. Most of the plants are either native desert, chaparral or coastal sage scrub species. Other candidates are from similar climatic regions of Australia, South Africa and southern Europe. The total or gradual replacement of our water-thirsty plantings with drought-tolerant species is both economical and beautiful.

A. List and briefly discuss the benefits of a drought-tolerant slope planting such as the one before you.

B. What applications other than residential plantings would benefit from drought-tolerant plantings?

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Location map for Fullerton Arboretum