

Climate and Adaptations at the Fullerton Arboretum

Summary of Activity: Investigate different implementations of key plant traits in plants from different climate settings. Assess plant traits in terms of their usefulness in the context of their environmental surroundings. Properly apply the terms, “climate” and “evolutionary adaptation.” Develop general theoretical understandings about plant traits in different environmental settings.

Skills to be Developed

1. Knowledgebase. Develop and enhance student understandings of the concepts of climate and evolutionary adaptation.
2. Empirical science. Students observe and accurately sketch different implementations of selected plant traits.
3. Situational awareness. Students consider plant traits in the context of ongoing plant operations and prevailing environmental conditions.
4. Synthesis. Students are challenged to apply inductive logic to predict the utility of unfamiliar implementations of plant traits in different climate settings.



What Students Will Turn in for Credit: 1) This packet with sketches and accompanying explanations; and 2) Quiz.

Individual living things maintain operations by:

1. Exploiting opportunities in their surrounding environment that support the continuation of operations.
2. Avoiding stresses in their surrounding environment that suppress, damage, or halt operations.

For example, when you get hungry (stress), you may seek opportunities in your surrounding environment to relieve that stress – and avoid the threat of diminished performance. If the sandwich shop is across a busy street, you must cross the street in order to exploit sandwiches there and receive a rewarding result. But passing cars pose a threat to you. If you get hit by a car while crossing the street, the resulting stress could overwhelm your body’s ability to maintain operations. Opportunities often come with a price. Success happens when opportunities can be exploited while minimizing exposure to or impact from associated stresses.

Plants and, generally, all living things maintain operations in their particular environments because they exploit opportunities and avoid / reduce stress in their surroundings. They maintain operations as a consequence of their inherited traits.

But as there are many kinds of natural environments, each with its own mix of opportunities and stresses, there is no single mix of traits that is optimal in all environments. As a result, we see specialized traits on living things that seem to be consistent with their surroundings. For example, light colored leaves in hot arid climates reflect sunlight and help reduce heat uptake, reducing water loss. Large surface roots in the tropical rain forest quickly gather nutrients yielded by decomposing leaves. Biologists have noticed these specializations and have a word for them – “adaptations.”

Adaptations

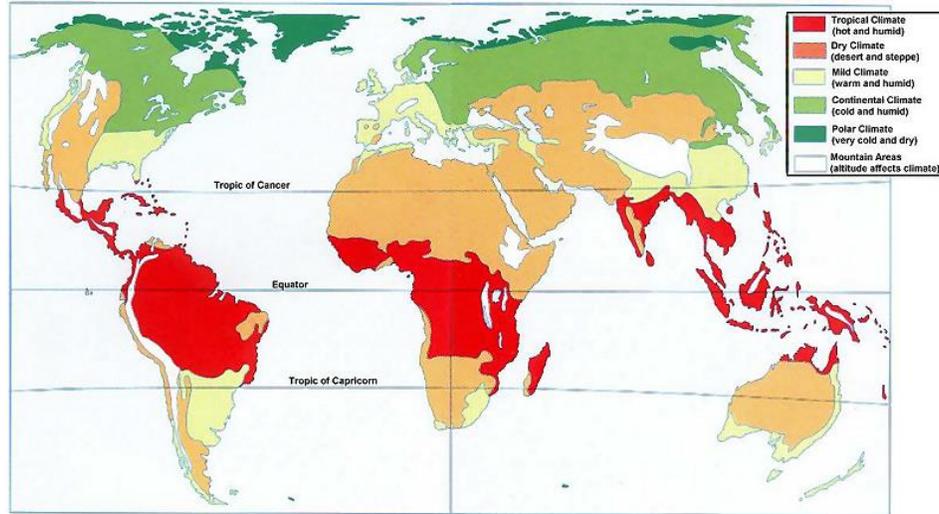
An adaptation is a trait that meets the two following conditions: 1) it maintains or increases the fitness of an individual (supports progress towards sexual maturity, supports contribution toward reproduction); and 2) it is the result of many generations of evolution by natural selection. The second condition often is assumed by naturalists in their haste to explain everything. Establishing the actual evolutionary history of a given trait CAN be done, but it is a laborious, difficult and time-consuming process. Nonetheless, as is the tradition in field biology, “useful traits” that we can observe in the field today often are referred to as

“adaptations.” We carry on that tradition, but with the understanding that we use the expression, “adaptation” in a casual sense.

An adaptation is label that we apply to a trait ALWAYS in the context of its surrounding environment. In this exercise, we will characterize the surrounding environment in terms of climate.

Climate

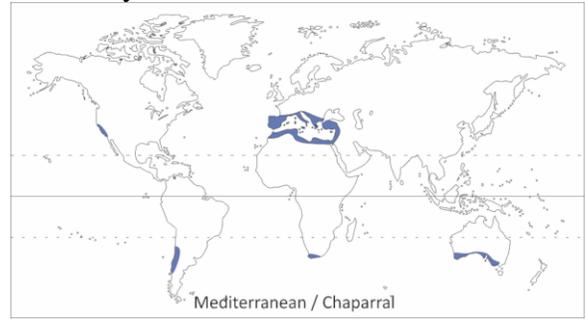
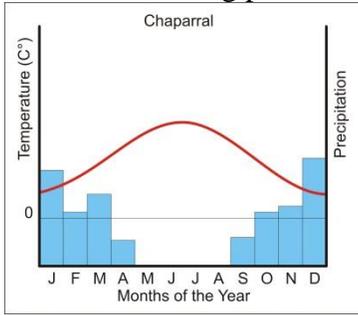
A description of the patterns of weather for a region throughout the year – often expressed in terms of temperature, rainfall, and day length.



World Climate Zones

	Climate of the Chaparral Ecosystem	Climate of the Desert Ecosystem	Climate of the Tropical Rain Forest Ecosystem	Climate of the Coast Redwoods Ecosystem
Seasons	WSSF	WSSF	Rainy / Not-so-rainy	WSSF
Seasonal Temperature Pattern	Cool winter. Warm spring and fall. Hot summer.	Cool to cold winter. Warm spring and fall. Very hot summer.	Hot all year long	Cool to cold winter. Chilly spring and fall. Cool summer.
Seasonal Sunlight Pattern	Long day length in summer. Short day length in winter.	Long day length in summer. Short day length in winter.	Bright and sunny days all year long.	Long day length in summer. Short day length in winter.
Annual Rainfall	14 inches	7 inches	Over 100 inches	40 inches to 100 inches
Seasonal Rainfall Pattern	Rain mostly between October to April. Drought the remainder of the year.	Rain mostly between October to April. Drought the remainder of the year.	All year. Some months more than others.	Rain mostly between October to April. Low rainfall in other months.
Most Stressful Circumstances	End of summer – drying out. Fire.	End of summer – drying out.	Shortage of soil nutrients. Shortage of growing space due to crowding. Shortage of solar access.	Low rain during summer. Drying, high elevation atmosphere. Fire.
Special Opportunities	Space made available because of reduced competition from less hardy trees.	Space made available because of reduced competition from less hardy trees.	Warm, rainy, sunny weather all year round.	Mild temperatures and abundant seasonal rain.

Climate of Chaparral Ecosystem – Cool mild winters with about 14 inches of rain, followed by hot summers and long periods of drought. Cool moist in winter, hot and dry in summer.

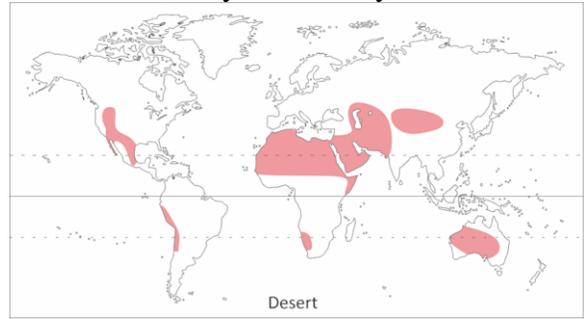
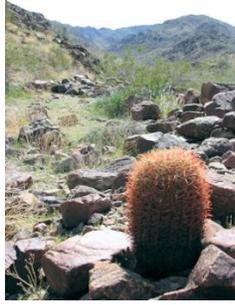
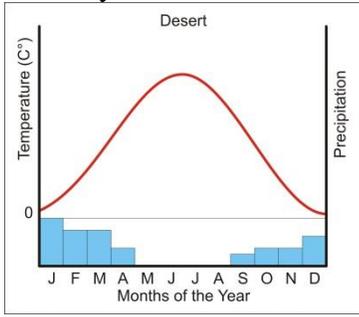


	Useful Plant Traits	Why are they useful? How do they help the individual maximize the exploitation of opportunities while minimizing exposure to stresses?
Chaparral	Low, ground covering growth pattern.	
	Small leaves	
	Vertically oriented leaves	
	Light colored leaves	
	Spine-tipped leaves	

Sketches of Useful Plant Traits (pick two examples of the above traits and sketch them)

Chaparral Trait	Chaparral Trait
How it works	How it works

Climate of Desert Ecosystem – Cool, sometimes cold winters with about 7 inches of rain, followed by extremely hot summers and long periods of drought. Cool moist in winter, very hot and dry in summer.

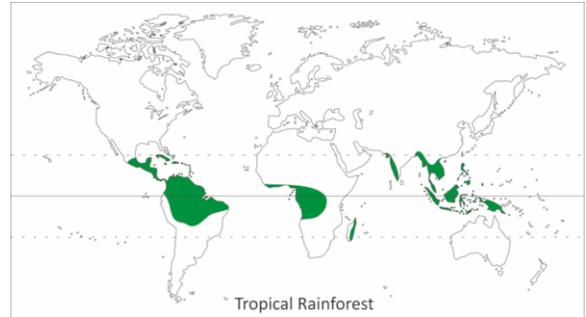
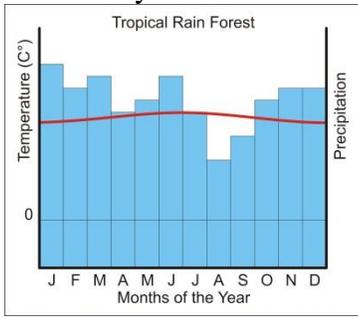


	Useful Plant Traits	Why are they useful? How do they help the individual maximize the exploitation of opportunities while minimizing exposure to stresses?
Desert	Tall, vertical growth pattern	
	Photosynthesis in stems	
	No leaves	
	Water storage in modified stems	
	Clusters of dangerous spines on stems	

Sketches of Useful Plant Traits (pick two examples of the above traits and sketch them)

Desert Trait	Desert Trait
How it works	How it works

Climate of Tropical Rain Forest Ecosystem – Hot and rainy throughout the year. Rain every month of the year, up to 100 inches per year. Summer-like conditions all year long. No winter-spring-summer-fall seasonal cycle.

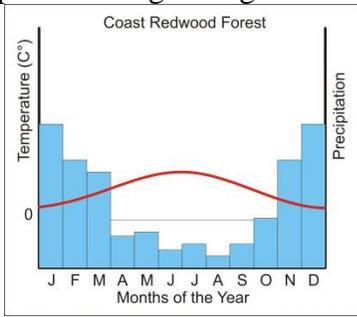


	Useful Plant Traits	Why are they useful? How do they help the individual maximize the exploitation of opportunities while minimizing exposure to stresses?
Tropical Rain Forest	Large, shallow roots	
	Large leaves	
	Tall, and very large growth	
	Umbrella-like canopy top	

Sketches of Useful Plant Traits (pick two examples of the above traits and sketch them)

Tropical Rain Forest Trait	Tropical Rain Forest Trait
How it works	How it works

Coast Redwood Forest Climate – Cool to cold winters, cool to warm summers. Rains mostly between October and April; little rain in summer months. At least 40 inches of precipitation per year. Frequent exposure to fog throughout the year.



Source: Wikimedia Commons



Source: USGS

	Useful Plant Traits	Why are they useful? How do they help the individual maximize the exploitation of opportunities while minimizing exposure to stresses?
Coast Redwood Forest	Tall – up to 100 feet tall.	
	Conical hair brush growth pattern	
	Abundant needle-shaped “leaves”	
	Thick, spongy bark	

Sketches of Useful Plant Traits (pick two examples of the above traits and sketch them)

Coast Redwood Forest Trait	Coast Redwood Forest Trait
How it works	How it works