Plant Stories

Tour guides find one of the best ways to get people of any age interested in plants is to tell them stories about plants.

Epiphytes and Parasites --Everyone seems to know what a parasite is especially when it pertains to animals. For example, fleas and ticks take blood from their hosts; likewise, mistletoe sinks its roots into the bark of a host tree to take sap because it is a plant parasite. However, epiphytes simply live on top of another plant, but they take their moisture and nutrients from the air. Bromeliads (including Spanish Moss), orchids, succulents, ferns, etc. can be seen growing as epiphytes in the rain forest. How do birds and animals help epiphytes acquire a location in the canopy?

Bromeliads-- Epiphytes have to find ways to survive in the trees. Bromeliads typically form a cup that serves to collect rainwater for the plant's use; however, animals take advantage of this tiny pool of water. In the rainforest of South America the tiny poison dart frogs, which live in the trees, and mosquitoes use these pools. Eggs are deposited in the water and the larvas develop in the pool so the frogs and mosquitoes can reproduce. Waste products from these tiny organisms dissolve in the water and are taken in by the plant to furnish nutrients for the plant's growth. An ecosystem is a web of interdependence: you have plants and animals dependent on each other to supply their needs.

Spanish Moss a Plant Freak! —Tillandsia usneoides is a tree dwelling epiphyte, which reveals its relationship to the bromeliad family when it flowers. It has no roots; the stem and leaves are covered in absorptive scales that make the plant unique. Birds help distribute the plant by using it for nesting material. By the way, the plant is not a moss and it doesn't come from Spain.

Sausage Tree -- In Africa the fruit of the sausage tree is eaten by large animals such as elephants. The fruit supplies food for the elephant, but the elephant also helps out the tree by distributing its seeds. Usually the seeds are not digested; they merely pass through the elephant's system and are planted in "fertilizer," the manure. (Typically fruits are eaten by animals,

but the seeds are not digested. This is one of the ways that epiphytes are "planted" on branches. In fact some plant seeds need the scarring from digestive juices to ready them for germination.) If the fruits simply fell from the tree, the seeds could only take root around the parent tree where their fight for sunlight, nutrients, and water would make it much harder for the seedlings to survive. This tree's flowers are pollinated at night by bats that are attracted by a scent of the dark red flowers. The scent is the important factor, but most night insect pollinators are also attracted by white or light colored flowers like the Burgmansia.

Pollinators -- The sausage tree's flower is pollinated at night by bats, which are mammals. Remember that the shape, color, and fragrance of a flower are not designed for our benefit. Flowering plants generally have to attract a pollinator to their flowers to fertilize them and thus enable them to produce seeds. So the shape, color, and scent are tailored to get the attention of especially insects or birds. By the way, birds aren't sensitive to smell so fragrance indicates an insect pollinator. And not all flower scents are pleasing to our noses. Stinky plants such as Aristilocea and swamp cabbage usually attract beetles or flies. Even the time of day that the plant produces the fragrance is geared to the feeding habits of the pollinator. Some scents are strongest during the day and some are released at dusk. Trumpet shaped-flowers are usually pollinated by butterflies or humming birds which have the equipment to reach down the throat of the flower and reach the nectar. Nectar is an important food source for birds and insects (also some bats—Sausage Tree, and rodents—Australian Banksias) so it is the inducement produced by the plant to reward the creature for visiting the flower. As many people know humming birds are especially attracted to the color red. Birds and insects have different sensitivities to color, but we aren't the only ones attracted by bright colors of flowers. Remember color, shape, and fragrance of the flower is the only way a plant has of getting the attention of a passing pollinator, and nectar or pollen is the reward for stopping to pollinate the plant.

Sex in the Garden —Ok, now that I have your attention; many flowering plants must have the help of a pollinator, who in its rush to get to the nectar, transfers pollen (male part of the flower) located on the anther of the stamen to the stigma of the pistil (female part). This causes fertilization and seed begins to develop. Pollen grains are fussy about germination so they will only grow on the stigmata of the same species or related species.

When they pollinate a related species hybrid plants are produced. Ideally the pollinator brings pollen from another flower or other plants (cross-pollination). This helps produce genetic diversity. By the way, wind pollinated flowers (such as grasses, trees like elm, oak, birch, beach, etc. and weeds like plantain, sagebrush, horseweed, etc.) are relatively inconspicuous. Animal pollinated flowers tend to be showy, colored and scented because they have to attract the attention of the animal.

Flower Shape to Fit the Pollinator—Dish or bowl shaped flowers have their stamens and stigmas freely exposed (like buttercup, poppies, magnolias, single roses, camellias, water lilies, etc.) attract insects like flies, beetles and wasps that crawling insects touch all parts with their bodies. The gullet type (Penstemon, snapdragon, Mimulus, Slavia, etc.) is a tubular form in which the sex organs are restricted to the upper side. Bees favor the lower lip as a landing site before pushing into the flower. The tube form (fuchsia, impatiens, bromeliads, etc.) is similar to the gullet but the nectar is more inaccessible so moths or birds need a beak or proboscis to reach the nectar.

More Sex in the Garden —Nature seems to favor cross-pollination; it does introduce more variability. Sometimes the individual plants bear separate male and female flowers (like Torey Pines where the female cones are near the top of the tree and the male cones are nearer the bottom thus helping to prevent self-fertilization from wind blown pollen). In addition, some plants have separate sex plants. One example, Ginko Baloba trees have separate male and female trees.

Gingko Story--About 180 million years ago in the Jurassic Period when dinosaurs roamed the earth the ancestors of the Gingko first appeared in China. Until recently it was believed to be extinct in its native habitat, but it is a widely cultivated tree. It is especially valued for medicinal use (to improve memory) and its tolerance for urban landscapes (with compacted soils, cramped areas, smog, etc.). The only drawback being that the fruit from female trees exude a stench when crushed; consequently, only male trees are wanted. Without DNA testing nurserymen could not tell the sex of their trees until seedlings had matured. Approximately half of their plantings could not be sold so the male trees were expensive.

Cloning or Asexual Reproduction—Most trees and annuals rely upon sexual reproduction but herbaceous perennials store food in underground parts which tend to become detached giving rise to new plants. Daffodils (bulbs), grasses (rhizomes), white potato (stem tubers), sweet potato (tuberous roots), and crocuses (corm) can reproduce vegetatively. Other plants produce runners like the strawberry plant. Some succulents like kalanchoe produce tiny plantlets at the indentations of the leaf margins, which can become independent plants.

Evolution and Sexual reproduction—While asexual reproduction may be a more surefire way to reproduce, it does not have the advantage to adaptability to changes in the environment. Sexual reproduction confers almost unlimited powers of adaptability upon a species and is essential to survival in a changing world. So the plants mentioned above that can reproduce vegetatively also sexually reproduce (a sort of ace up the sleeve). Blue-green alga is the only plant unable to sexually reproduce.

Darwin was right! No two individuals are exactly alike. These variations tend to be inherited. Those creatures best adapted to the environment are most likely to survive to pass on their characteristics to the next generation. This natural selection can bring about the origin of a new species by continually fostering the best-adapted individuals over many generations.

Why can't you plant a banana seed? Well, you can but nothing will grow because the cultivated banana is a triploid (three sets of chromosomes). These plants are sterile because there is an extra-unpaired set of chromosomes. Some plants like Magnolia grandifora are naturally polyploids (but in multiple pairs). And [polyploidy can be artificially induced because the resulting plants have increased size—larger leaves, flowers and fruit, which is especially attractive to agricultural genetics.

Bed and Breakfast Plant —Aristilocea is a vine growing near the entrance to the nursery. The color shape and stench of the flower resembles rotting meat thus attracting flies that crawl down the narrow neck of the flower. Tiny hairs in the neck allow the fly to enter but prevent the fly from leaving. The fly crawls around looking for a way out. Hopefully the fly has

pollen from other flowers so it can deposit pollen on the stigma. When the stigma is stimulated the flower undergoes several changes. Overnight nectar is produced to reward the fly and the hairs in the neck lay flat to allow the fly to crawl out in the morning. Now the flower begins to produce pollen. Because the female part of the flower is fertilized before the male pollen is produced it prevents self-fertilization.

Plant Toxin and the Monarch--There are several strategies that plants use to survive. Numerous plants produce toxins. These plants have improved their chances of surviving because the toxins keep many insects and animals from eating them. However, there always seems to be some creature that has managed to circumvent the plant's defenses. For example, the Monarch Butterfly lays its eggs on milkweed that has a milky sap that contains a plant toxin. The larva feeds on the milkweed and takes in the toxin that the larva and butterfly keep for their own protection. Birds do not like the bitter taste of the toxin and if they eat enough (4 or more Monarchs) they react to the toxin by throwing up. Birds remember what made them sick and avoid the Monarch larva and butterfly. Mimicry helps the Viceroy Butterfly that looks very similar to the Monarch. Birds also avoid eating them even though the Viceroy has no toxin protection.

Life Span Of Plants --All living things have a natural life span so that nothing lives forever. Some plants live only one growing season then they die—we call then annuals. And some plants survive for hundreds of years. Of course--just like people--disease, injury, lack of proper nutrition etc. can shorten the natural life span.

"Dead" Plants Story—There are some truly dead plants in our garden. Plants furnish homes and protection for animals as well as food so we keep some dead plants in the garden. The cork oak in the lawn area is still used by the Acorn Woodpeckers as a granary. Likewise the Monterey Cypress is the home for the Acorn Woodpeckers and two beehives. Some plants look dead at least part of the year; however, they are very much alive. Some of our desert plants such as the ocotillo drops its leaves during the dry season. In the Madagascar section the Plumbago ashylla, leafless leadwort, looks like a bunch of dried twigs until there are white blooms at the ends of the branches.

Why is There a Garden for Madagascar? --Madagascar is an island off the southeastern coast of Africa. Madagascar like Australia are especially interesting areas for studying plant and animal species because these land masses were separated from the rest of the world a very long time ago allowing for unique species to evolve. By the way, have you noticed that plants in similar climates tend to resemble one another? In other words certain plant shapes and strategies work best for certain growing conditions (convergent evolution). Desert plants from the New World look a great deal like those from the Old World, but they are vastly different from those found in a tropical rainforest.

Convergent Evolution—Plants from desert climates look amazingly alike even though they are not related because they have adapted to the same growing conditions. For example, cacti from the New World deserts and Euphorbia species from the Old World deserts look very similar (leafless and thorny), but they are not related. The stems store water and carry out photosynthesis and the spines or prickles are leaf remnants which help protect the plants from being eaten. Euphorbia plants are poisonous (the milky latex sap contains a plant toxin), but cacti produce edible parts (mainly fruits). In addition their flowers are different in form and structure.

Contrasting Foliage —How does a desert look different from a tropical rain forest? Leaves are tiny in size or appear to be lacking. Some plants do shed their leaves during the dry season. Also the thorns of cacti are modified leaf structures. In fact notice all the sharp prickers, thorns, barbs, needles, spines, etc. These desert plants come armed and dangerous. This is a harsh landscape where plants cannot grow lushly to provide food for lots of hungry animals so the plants must protect themselves from being eaten. Some plants also produce plant toxin for additional protection (euphorbias are an example). Also notice that the deep green color of the rainforest is replaced with grayer shades of green. Plants grow more compact and there is more space between plants.

Philodendron leaves in the rainforest area are huge by comparison. Dark green, large leaves are common. Notice the variety of leaf shapes. Most leaves are built to shed water quickly (veins and ridges with drip tips) because the plant "breathes" through pores (stoma) on the leaf surface, and water would block these openings. There are many shades of green in the rainforest some of that may depend on what level of the forest you are looking at. Plants on the floor of the forest are in deep shade so the

undersides of the leaves may be red to help the plant absorb more sunlight. Plants are growing literally on top of each other (epiphytes). There is more plant and animal diversity in a tropical rainforest than any other place on earth.

Hong Kong Orchid Tree —In the 1880's a botanist discovered this tree growing in a garden in Canton, China. Now you can find this tree all over the world, but all cultivated trees came from this single tree. It is represented on the flag of Hong Kong.

Lotus --Lotus (found in the pond in the Bamboo Garden) has leaves similar to the shape of nasturtiums. In China you can see beds of lotus cultivated next to rice fields. Chinese cuisine uses the lotus root, which has holes like Swiss cheese. They also eat the seeds. These seeds have a hard seed coat because rivers and streams disperse the seeds.

Pandas and Bamboo —As you know pandas eat bamboo in their native China. Most bamboo is monocarpic meaning that the plant flowers and produces fruit once then it dies. In bamboo this life cycle extends to all members of the same species producing a massive dieback. Of course the bamboo will survive because so much seed has been produced, but in the meantime whole forests of bamboo are gone. In the great die back of 1983 pandas in China were threatened with starvation. An adult panda needs to eat over 40 pounds of bamboo a day. Part of the problem is the wild reserves for native plants and animals are so small that animals can't move to another area of the forest when dieback occurs.

Genetic Time Clock of Bamboo—Each species of bamboo will come to flower at the same time all over the world. By the way, normally bamboo is reproduced vegetatively. Each species has a unique life span (as short as 20 years to as long as 120). Scientists suspect that each seed contains a genetic clock working on a photochemical mechanism. The flowering of bamboo is a dreaded event in Asia. Now pandas face starvation from lack of food, but throughout Asian history the flowering of bamboo brought tragedy to humans because the abundant seed increased the rat population leading to pestilence and famine.

Monocarpic Plants—These plants only flower and fruit once in their lifetime. Bamboo is one example and another is agave (century plant). The agaves produce a huge bloom stalk that seems to exhaust the plant; consequently, it dies (it also may have tiny plants at the base called "pups"). By the way, aloes and agaves can look very similar except the bloom stalk on aloes are very short by comparison and aloes bloom repeatedly.

Endangered Plants —Some plants are endangered for the same reason that animals are endangered to the point of becoming extinct. Loss of habitat is a significant reason. California coastal native plants have been paved over or crowded out by non-native plants. We have killed off so many plants and animals that some populations have become too small to sustain themselves.

Camptotheca acuminata —These trees were native to China but now possibly extinct in the wild. We have a group of these trees at the entrance to the bamboo garden. Research in the 1990's has shown a valuable cancer treatment from this plant. A group of chemicals termed camptothecins, which have some human toxicity, also have anti-viral properties. By the way, there was a large grove of these trees in central California but it was plowed down before its medical usefulness was proven.

Botanical Gardens and Zoos—What is a botanical garden? A botanical garden does for plants what a zoo does for animals. Quail Botanical Garden grows and reproduces rare and unusual plants from all over the world. The garden serves to educate the public about plants while protecting genetic diversity. Plants are shared with other institutions through the index seminum (a seed sharing program).

Cochineal Story—Cochineal insects look like a white fungus growing on Opuntia (in the Native People/Plant Area). Red dye made from these tiny insects was very important during the 18th Century. Natural plant dyes usually give dull or drab colors so brighter colors were unusual, highly desired, and expensive. Great Britain showed its power and wealth by dressing its army in bright red coats derived from the red dye of the cochineal insect. American colonists even referred to the British army as "Red Coats" during the American Revolution.

Hunters' use of Sage —Sage had many uses for Native Peoples. Sage has a wonderful scent that hunters used. Before leaving on a hunting trip the hunters would rub sage on their skin. Most animals have a great sense of smell and humans have a unique smell that animals have learned to fear. Rabbits, deer, etc. could smell the hunter and run away before the hunter could get close enough to kill them. Using sage on their skin helped hunters to mask their human odor because animals did not fear the scent of sage.

Tea Tree —Leptospermum scoparium, tea trees, come from New Zealand. These small shrubby trees got this common name because Captain Cook brewed the leaves into a tea to prevent scurvy among his crew. (Before modern medicine most herbal medicines were made into a tea, which should not be confused with the refreshing beverage we call tea.) The Maori call this plant manuka that they use as an antibacterial and analgesic. Manuka is also used as an essential in aromatherapy.

Cork Oak Tree —This grove of trees was planted in the 1950's. The outer bark is the source of cork that we use for corks in wine bottles, corkboards, and many other uses; it is even used on the space shuttle. It is lightweight, fire resistant, slightly elastic, and floats in water. The outer bark of the tree is dead material like your hair or fingernails so it doesn't hurt the tree to remove it. About every 8-10 years the bark can be harvested. Our trees have never been harvested. The bark can get up to 20cm thick.

Acorn Woodpeckers--Our grove of Quercus suber supports a group of Acorn Woodpeckers. These birds live in social groups of 10-15 adults. They make holes in the trees to store their acorns that are the staple of their diet. Huge trees are called granaries that can hold 3,000 acorns. These birds work together to rear the young and protect their acorn storage from intruders. The dead Cork Oak in the Lawn area still serves as a granary.

Dragon's Blood —For medieval European Christians, dragon's blood was one of the most prized products in the physician's medicine cabinet to treat a wide assortment of ailments. Clever tradesmen gathered the secretions from trees, including the red sap from Dracaena draco, to market as dragon's blood. It also had a number of industrial uses including the

manufacture of paints and varnishes (Stradivarius supposedly used it for his violins).

Yucca and Agave Pollinators—Yucca flowers rely on a tiny moth to gather their pollen and carry it to exactly the right spot on another flower. The flowers cannot develop seed without the help of the moth. In return the moth lays her eggs on the flower and the caterpillars eat some of the Yucca seeds. Nectar drinking bats have long bristly tongues to get at the sweet reward deep inside the flower as pollen collects on their heads to be transported to the next flower.

Plant Names —Many plants have common names, but these can be confusing because these names can vary from place to place and refer to more than one plant. The botanical names are derived from Latin or Greek to describe the plant. On the plant labels are the Genus (similar to your last name) and species (like your first name). Just as people look like their relatives, plants often look similar to other plants in the same Genus.

Plant Taxonomy—People have tried to sort plants into groups by how they are related by decent. Natural classification is based on the reproductive parts of the plants because the environment too readily modifies the vegetative parts. For example euphorbias and cacti look very similar but their flowers indicate they are not related. In the 18th century Linnaeus started the binomial nomenclature system whereby every plant and animal was given a group name (genus) and individual name (species) that is still today. A species is a group of plants or animals with many characteristics in common and breed freely among themselves.

Papyrus Story—This plant grows along the Nile. The Bible refers to "bulrushes" in the story about Moses. Ancient Egyptians didn't have trees to make paper but they did have papyrus for their scrolls. The stems have a spongy pith in the center, which is cut into flat strips. These strips are soaked in water and rolled out to flatten further. These strips are laid side by side then more strips are laid crosswise of the first layer. These are pressed together until dry to make paper. It was a multipurpose plant. Ancient Egyptians used other plant parts for cordage, sandal making, construction of boats, and sometimes ate the rhizome for food.

Ancient Cycads—The fossil record indicates that cycads lived about 250 million years ago during the Triassic and Jurassic periods in America, Europe, Asia, even Greenland and Antarctica which indicates that these last two locations had a much warmer climate during these periods. Even though they may resemble ferns or palms they are more closely related to conifers such as pine, fir, and spruce (other cone producers) and the Chinese ginkgo. There are over 100 species in 11 genera. All species are considered endangered mostly due to loss of habitat. Many aboriginal people have made bread out of the starch inside the stem, but special care must be made to first remove the neurotoxins or nerve poisons. The seeds have a fleshy seed coat that may also be eaten by animals with the seeds left behind in animal dung. There are separate male and female plants with some cones reaching 80 pounds.

Smells like a Lemon —Strange as it seems certain plants can mimic the flavors and odors of unrelated species. They actually contain the same flavor chemicals. For instance, limonene, the chemical that makes lemons taste lemony is also found in lemon thyme. Mints and scented geraniums are also flavor impersonators.

Seeds are Storehouses of Plant Life—The survival and dominance of flowering plants comes from the seed, which can travel thousands of miles in space and/or decades in time. Seeds are able to endure conditions that would kill the actively growing plant. Fifty years after its parent dies, a weed may sprout in cultivated land thousands of miles from its home. A seed waits until conditions are favorable for sprouting. Seeds are filled with concentrated food, especially those known as cereals have fed the development of civilization. Seeds contain more proteins, minerals, and vitamins than other parts of plants. Scientists have bred new varieties of plants to suit our needs, but nature favors only those seeds that are best adapted for life in a competitive, hostile world (weeds are excellent plant survivors). Seeds are colonizers—this is the time in the life cycle when a plant has an opportunity to travel and scatter widely. However, in order to travel a seed needs to be as compact as possible but include all the bare essentials: a protective covering, food, and a miniature embryonic plant.

Seed Travel—Since seeds cannot travel on their own they must have help from an inanimate or animate force. Wind helps seeds with wings (a

number of trees) or parachutes (dandelions are especially efficient). Water aids floating seeds. Some parents give their offspring a flying start (such as impatiens, members of the pea family, etc.). Animals help to scatter seed while collecting and eating seeds and fruits; even devouring the fruits helps because the seeds pass through the animal and are eliminated at some distance from the parent plant. Mistletoe berries, which birds eat, have sticky seeds that adhere to their beaks. Birds rub their beaks against the bark of trees to rid themselves of these seeds, which is the ideal place for this plant parasite to germinate. Animals also pick up hitchhiker seeds like burrs or track seeds around on their muddy feet.

Seed Coat Protections—Typically the seed coats of tropical plants are relatively fragile because the temperature and moisture conditions are great for germination year round (so ripe seeds germinate immediately). For many seeds the proper timing means everything, the seeds of some plants living in a forest need to be exposed to light in order to germinate. When a tree dies and opens a place on the forest floor then dormant seeds react to the improved sunlight and sprout. Weed seeds can remain dormant under layers of soil, but when the ground is turned over exposing the seeds the light spurs them into action. Similarly a plant hormone prevents germination of many seeds from temperate climates. Seeds from deciduous trees such as magnolia, cherry, apple and peach; conifers; and weeds like crab grass won't germinate until after a period of moist, cold weather (fall/winter). To germinate seeds need an adequate water supply, air, a certain temperature range, a certain planting depth, and sometimes an exposure to light. Desert plants typically have a tough seed coat. When heavy prolonged rain, not brief showers, cause the desert washes to fill up with rough rapids the abrasion of the seed case enables the seed to germinate only when there is enough water. At the other extreme some seeds need scorching by fire to stimulate germination, which works in areas periodically burned by lightning.

Silk Tree Has A Very Tough Seed Coat—(Albizia julibrissin) Some seeds of this tree were collected in China in 1793 and stored in the British Museum of Natural History. In 1940 during an air raid on London the seeds got wet and the seeds germinated after 147 years in dormancy. (from Stone)

Fruits and Nuts—Plants offer fruits as inducement to animals being soft, sweet containers for seeds whereby the animal digests the pulp and voids the seed some distance from the parent. Nuts have hard exteriors that some animals eat. Fortunately these animals (like squirrels and rats) usually have a hoarding instinct and they cache more than they collect. Plants produce abundant fruits and nuts to ensure that a small proportion of seeds will survive to germinate.

From Coconuts to Orchid Seeds—Although both come from tropical habitats they obviously meet very different needs. The coconut is one of the world's largest seeds because they are designed for dispersal by ocean currents to barren beaches where the developing plant requires a substantial food source to establish itself. Wind currents spread orchid seeds that are the smallest in the plant kingdom, each no bigger than a particle of dust.

Leaves As Tiny Food Factories—Photosynthesis (meaning: light, a putting together) transforms water, air, and mineral salts through the use of sunlight to produce proteins, fats, and carbohydrates. Access to sunlight is vital for leaves so they are designed to be green, flat, and thin. Succulents have thick fleshy leaves because they are used for water storage and transpire less. Leaves are usually arranged on the stem in a spiral manner. In other plants the leaves are arranged in crossed pairs (a pair north and south then a pair east and west). In trees the complex arrangement of the canopy allows for maximum sunlight exposure to all the leaves (creating a leaf mosaic). However, leaves can receive too much sunlight. In hot dry regions plants must protect leaves from excessive exposure. In Australia the leaves of the Eucalyptus trees hang down vertically with only their thin edges directed toward the sun. By the way, plants with variegated foliage (green with white patches) have reduced photosynthetic area so they are not as efficient at making food; therefore, they need more sunlight than their uniformly green kin.

Sizes and Shapes of Leaves—There is a vast array of shapes and sizes to fit the climatic conditions. Most leaves are symmetrical in form. Tropical Rain Forests boast the largest size leaves. Arid regions and cold climates are almost always smaller. Conifers trees are especially adept at dealing with dry and/or cold climates where water loss through leaves can mean extinction. The amount of wind also plays a part in shaping leaves.

Deeply divided or multiple leaflets (like palms) help a plant deal with the tearing forces of wind. Trees in temperate climates spread the risk by producing a vast number of small leaves.

Leguminous Plants and Nitrogen—All plants need minerals especially nitrates, phosphates, and potassium which are found in commercial fertilizers. Some members of the Fabaceae family (beans, peas, clover, soybeans, alfalfa, etc.) are especially equipped to take nitrogen to build amino acids that are building blocks of proteins. Actually a bacteria found in some soils attach themselves to the roots of legumes forming a nodule. The bacteria obtain nitrogen for its host and the plant supplies food and water for the bacteria. This mutually beneficial relationship is called symbiosis. These crops don't need nitrogen fertilizer; in fact these plants can be plowed under to enrich the soil.

Mycorrhiza—This soil fungus has a similar symbiotic relationship with forest trees (such as pine, beech, birch, and oak). The fungus lives among the roots of the tree absorbing mineral salts with great efficiency, which it shares with the tree—therefore the fungus is especially beneficial in poor soils. The tree roots supply the fungus with carbohydrates. Another type of mycorrhiza enables orchid seed to successfully germinate. The seeds are so small that the fungus provides the necessary nutrients to the developing embryo.

Climatic History in Tree Rings—Some trees grow to be very old some redwoods have lived for 4,000 years. The trees rings can give a very accurate record of the growing conditions during the tree's life. The wider, lighter bands show the growth during the growing season (spring and summer) and the dark ring indicates dormancy (winter). By the way, tropical rainforest trees do not have annual rings because the cambium is actively growing all year.

Where to Find Xerophytes—(Greek meaning dry, plant) Cacti and other desert plants are typical xerophytes which have adapted to the dry conditions by having leaf structures with thick or scaly cuticles and stomata that open (for transpiration) only at night when water loss is minimal. Epiphytes in a tropical rainforest are also xerophytes because of the small amount of available moisture in a windy treetop. Sand dunes are another unexpected habitat for xerophytes such as beach grass and sea oats.

In addition, alpine plants deal with the desiccating effects of rocky soils and wind.

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Dormancy as a Strategy for Drought—Xerophytes share certain characteristics with other plants that must deal with seasonal water shortage. During the winter, roots take up less water than during the warm season. Tiny needle-like leaves help protect evergreen conifers from water loss through the transpiration process. Large leafed deciduous trees survive by going dormant. Likewise many wild flowers of the desert (such as the California poppy) survive by shortening their lifecycle to a couple of months (ephemerals) and going dormant as seeds.

Self-defense Strategies of Plants--

1. physical deterrents such as spines, thorns, stinging hairs, and chemicals that irritate the skin
2. protective growth habits—camouflage such as Lithops (living stones)
3. chemical deterrents such as poisons, unpleasant-tasting substances, and compounds that upset the herbivore's reproduction—The intended target of these toxins are voracious insects. Given time some insect will adapt to circumvent the plant's defenses. Many animals are attracted to the sweet taste of plants so some plants produce tannins (found in oak leaves and acorns), which give the plant a bitter taste. The mint family produces aromatic herbs for us, but at least some of these essential oils work as insect repellents. Ferns and gymnosperms produce a molting hormone that interferes with an insect's development. (Synthetic juvenile hormone is now used to control insect pests.) In the California chaparral Salvia leucophylla and Artemesia californica give off volatile toxins making a toxic cloud around the plant. Root toxins keep other plants from growing and competing (guayule trees, Parthenium argentatum).
4. partnerships with ferocious ants that drive away herbivores and often eliminate competing plants. A Central American Acacia tree gives food and shelter to armies of ants in return for protection from animals.
5. chemicals that kill or inhibit the growth of diseases (bacteria, viruses and fungi) Some plants can produce antitoxins to fight off these diseases. Phytoalexin is our main weapon in breeding resistant varieties of plants.

How Light Affects Plants--Have you ever noticed that plants lean toward the light? Unequal growth is a plant's response to a one-sided light source—phototropism (Greek meaning light, turning). In addition some seeds will not germinate without exposure to light. The leaflets of most members of the pea family (Leguminosae or Fabacae) close up at night. This may be a biological advantage to cut down on transpiration (water loss) at night and maximize the leaf surface to light for photosynthesis during the day. The silk tree (Albizia julibrissin) is an example. Fall color in trees is produces by clear, sunny days and cool nights. So if fall weather turns damp, gray, and foggy the beautiful colors will not develop. Among other things light develops anthocyanin, the red pigment in leaves and even apples. Without the light the leaves and apples will not turn red. Some plants also react to the length of day—photoperiodism. Short-day plants flower when the day length reaches a critical time. Chrysanthemum will not bloom when days are longer than 14 hours (in the fall). Actually the length of darkness has a more critical effect. Chrysanthemums, poinsettias, kalanchoe, etc. can be brought to flower by adjusting the length of night. Long-day plants flower only when the day length reaches a critical minimum. Spinach will boom only when the days are 13 hours or longer. We can not grow spinach, wheat, or barley in the tropics where the day in 12 hours long because these plants need more than 12 hours of day to flower and set seed.

Temperature Regulates Plant Growth—Some plants bloom only in the spring and others only in the fall. Since day length is the same in the spring and fall, plants are reacting to more than the length of daylight. Spring bloomers come into flower after a period of cold and fall plants must have a warm period.

Geotropism—This is a plant's response to gravity. Roots grow down and shoots grow up.

Roots—Roots are used by the plant for support and to acquire water and nutrients. Buttress roots help to support a thin trunk of a tree in the rain forest, or shallow rooted trees like Swamp Cypresses, which also develop "knees"(erect tapering growths which take in air). Mangroves use stilt roots for support in muddy swamps. Aerial roots are produced by Banyans, which

have roots descending from branches (a large one can shade an entire village in India). These roots resemble stems above ground. Some plants in the daisy family (this family has a number of weeds) reduce competition by exuding root toxin. Shasta Daisies can even continue the assault as cut flowers by causing other flowers in an arrangement to wilt.

Bottle Tree of Australia—Has a rather strange thick trunk because it is used for water storage. Elephant trees in the New World Desert have a similar adaptation.

Giant Redwood—These trees have soft spongy bark which can be 24 inches thick making the tree fireproof.

Powers of Regeneration—Plants can regrow leaves, branches, roots, etc. In fact the removal of material will stimulate growth. Even roots can be grown from leaves (African violets, begonias, succulents, etc.) or parts of stem (willow branch). Numerous plants can sprout from the remaining roots when the stem and leaves are removed (dandelions to plum trees).

Orchids—(Greek meaning testicles because Mediterranean orchids typically have a pair of rounded tubers resembling testicles). The medieval doctrine of signatures believed that plant structures resembling a part of the human body meant they would have some curative or tonic effect upon that part. So orchid tubers were in great demand as an aphrodisiac, and the orchid was a symbol of sex. There are about 35,000 species of orchids so it is one of the largest plant families. They are pollinated by insects, which are frequently attracted by scent. Amazingly some orchids can even change their scent to attract different insects; however, orchid scents are usually extremely specific for one kind or group of insects, which helps to prevent cross-breeding. The variety of color and structure of orchids flowers is ingenious. For example, one orchid flower resembles the female fly including scent so that a male will attempt to mate with the flower thus pollinating the orchid.

Ethylene Effects—Ethylene affects almost every aspect of plant growth (seed germination, growing shoots, onset of flowering, and ripening of fruit). People usually know that even very small amounts of ethylene

induce the ripening of fruit. Anthony Huxley (p.121 Plant and Planet) noted that at a large carnation show with a small exhibit of apples the ethylene given off by the apples was enough to wilt every carnation by late afternoon.

How are plants similar to us? We normally don't think of plants moving, but they do bend or rotate toward a light source—but they do it very slowly. In the seed stage plants are highly mobile. They grow and reproduce. They have a sort of circulatory system (you can see the veins on a leaf), and they produce hormones to encourage or inhibit growth. Plus they "breathe" by transpiration.

Do Plants Feel? Well, if you mean that plants can be aware through physical sensation—Yes! Plants are sensitive to light and gravity as well as chemical and temperature stimuli. There have also been reports (in the 1970 the Russians among others) of plants showing electrical changes interpreted as emotional reactions and even telepathic capabilities, but these are not substantiated (some British researchers got similar results from a damp cloth). Conflicting research has also been done on the effects of vibration on plants (like talking to your plants or playing music for them).

Yuccas and Moths—The female yucca-moth is attracted by the nocturnal scent of the flower. It collects pollen and fertilizes the stigma while laying eggs in the flower. The ovules are stimulated to become abnormally large and form food for the emerging moth larva. There are plenty of ovules left to develop into seeds. The moth climbs down the stem and pupates in the soil. The adult moths emerge when the yuccas in their area are in bloom. The moths emerge over 3 seasons thus insuring that the moth larva will have food and shelter, and the moth guarantees the pollination of the yucca. This is a symbiotic relationship or mutualism. These relationships are so complex and improbable that it is difficult to understand how they developed.

Weeds are just survivalists—Plants become labeled as weeds (plants in the wrong place) usually because they are both aggressive and lack specialization. Animals, especially man, have greatly aided the dispersal of weeds. Even botanical gardens have been responsible! Annual weeds are usually self-pollinating because they do not depend upon pollinating insects that might not be available. They can also bounce back faster after a

disastrous year. They profusely produce seeds that have mechanisms to allow for germination over many years and when circumstances are suitable. Perennials weeds rely on vigorous vegetative spread both above and below ground to keep the competition at bay. Weeds are the first plant volunteers in disturbed ground. One person's weed is another's wildflower.

No plant can completely take over! It may seem that some weed will take over the world, but no plant is successful enough to occupy more than a tiny fraction of its possible total habitat. External factors restrict a plant's potential distribution.
These are (1)climate—huge variations in temperature that come from latitude or altitude, plus the length of day, or the amount and seasonal distribution of rainfall, and the regular occurrence of natural fire;
(2)the physical and topographic features—whether the landmass is a vast continent or under the oceanic influence, and the presence of mountains especially whether the location is on the windward or leeward side or the ridge;
(3) the soil—from light sandy soils to heavy clays the soil texture affects plants, the presence or absence of soil micro fauna and flora, degree of acidity, the presence or absence of other minerals such as a tolerance for salt;
(4)the influence of other organisms including other plants—the absence of serious pests and predators allows the plant to survive. The introduction of rabbits to Australia had a disastrous effect on plants. Grazing animals have had similar results.

So there is a huge complexity of factors. Consequently a South American jungle community will not be the same as a Malaysian one, but it may share certain basic characteristics.

Ants and Plants—In Africa a species of acacia tree provides food and lodging for ants, which in turn protect the tree from grazers including giraffes by swarming and biting. Ants also have relationships with various other plants especially epiphytes. Ants collect debris around the roots or seeds while making a nest to their mutual benefit. Ants also pollinate some flowers.

Plants and Human Civilization—Temperate climate zone encouraged seed based agriculture, which has a more nutritionally balanced diet than the tropical climate based on root vegetables. Annual seeds,

largely grasses like wheat and barley, allowed people to travel widely. Root crops tend to be perennial so people stayed in one location. Domestication of plants made important changes. For example, humans wanted seed heads that remained intact for harvesting; constant selection has led to present-day maize that has no natural method of seed dispersal. As soon as humans started planting crops we began breeding plants to meet our needs. Monoculture (where all the crop is derived from a single plant variety) has the potential for disaster from disease or pests. Variability is the secret to surviving such disasters. Travel and trade have dispersed plant species around the world. The Americas benefited from old-world plants including, citrus, rice, sugar cane, bananas, yams, various peas, wheat and most of the European cereals. Europe received potatoes, tomatoes, maize and tobacco.

The Good, the Bad, and the Ugly—Everyone seems to know and recognize adult ladybugs as our friends in the garden by eating aphids, but most people do not recognize ladybug larvae, which also have a voracious appetite for aphids. Caterpillars (butterfly larvae) will eat your plants but it is the price you must pay for having beautiful butterflies. Then there are the insects that just ruin your garden without any apparent redeeming quality. Whiteflies, Mexican Fruit Fly, Fire Ants, Yellow Jackets, etc. are just some of the unwanted bugs. One of our local pests illustrates the danger of introducing a plant from another country without the ecosystem that supports it. Our eucalyptus trees are under attack from the red gum lerp psyllid. Eucalyptus trees were brought here from Australia in the 1860's. Without any local pests or diseases the trees naturalized to the point of displacing native species of trees. However, in 1998 the red gum lerp psyllid had arrived to prey on the trees and ravaged them because their natural predator was absent. In Australia tiny wasps are a biological control for the red gum lerp psyllid and now they have been imported. Using pesticides affects useful insects like honey bees and ladybugs but also insect predators like birds and bats so the goal is to use methods to control the populations of bugs without destroying the balance in nature.

Euphorbia lathyris is being grown on an experimental basis in Southern California. Ten barrels of oil per acre can be harvested. As fossil fuel is depleted alternatives are needed. Euphorbia species are hydrocarbon-producing plants where the oil is contained in the milky white juice called latex.

Jojoba—Simmondsia chinensis also called Goatnut because goats, sheep and Native People ate these large nuts that are rich in oil. At one time the nuts were sold in Los Angeles drug stores as a hair restorer. The nuts were boiled and the released oil was rubbed into the scalp. The oil is a promising substitute for whale oil.

Toyon--Hetermeles arbutifolia California Holly or Christmas Berry has red berries, which are somewhat bitter when fresh so the Native Peoples either roasted or boiled the berries before eating them.

Barberry or Mahonia—Berberis fruits are acidic and can be used to make a drink or they can be dried for winter use. The roots can be crushed and boiled to make a yellow dye.

Sugar Bush and Lemon Berry—Rhus ovata and Rhus integrifolia The ripe berries are covered with a sour-sweet, sticky substance which was used to flavor water.

Spanish Bayonet –Yucca baccata and Yucca schidigera All parts of the plant were used. It was the most important plant in the Southwest for the production of fiber. Green leaves were soaked in water then pounded on a flat rock with a wooden mallet. Whole leaves were often used to tie together the poles making up the framework of their houses. This process was repeated until the white fibers were all that remained. The ripened fruit was usually boiled or roasted then eaten. The stems and especially the roots were pounded to make soap.

Yerba Santa—Eriodictyon californicum The leaves were used to make a tea to cure coughs, colds, sore throat, asthma, tuberculosis, and rheumatism. Fresh leaves are said to be wonderful way to quench your thirst when chewed. The initial bitter taste disappears and is replaced by a sweet, cooling sensation.

Flowers of a fig are some of the weirdest?

Sources

Weird Things You Can Grow by Janet Goldenberg
UsborneMysteries and Marvels of Plant Life by Barbara Cork
Early Uses of California Plants by Edward K. Balls
The Lives of Plants by Doris M. Stone
Plant and Planet by Anthony Huxley

? The flowers of figs are actually in the middle of the fig itself. Fig wasps carry pollen from the male to the female flowers. Usborne (12)

? Photosensitive? Many flowers open and close at certain times of the day. The famous botanist Carl Linnaeus planted a flower clock in his garden where he could tell the time by looking to see which flowers were open. Usborne (13)
? Lichens are two plants an alga and a fungus which live together. Usborne (23) A lichen from Antarctica is thought to be at least 10,000 years old. The most nutritious fruit in the world is the avocado—it contains 741 calories per edible pound.
Lithops and Pleiospilos bolusii resemble rocks or stones, which helps them, hide from hungry animals. A plant strategy for survival.
People assumed that eggplants, tomatoes and potatoes were poisonous because they belong in the nightshade family, which is famous for some very poisonous plants. In England eggplants were once called "mad apples" because people believed that eating them made you insane. Potatoes came to Europe from South America in the 1500's but it took many years and a lot of effort for people to accept them.

Arundo donax 'Variegata' Not a true bamboo, but a giant grass because it does not have a woody stem. **Stems are used as reeds in wind instruments.**

Anigozanthos species Kangaroo Paws are a unique wildflower native to Western Australia.

Acacia nilotica Seedpods are eaten by many kinds of African wildlife from elephants to baboons.

Portulacaria afra Elephant bush's leaves and branches are eaten by elephants and other herbivores.

Geranium vs. Pelagonium Most plants we call geraniums are really pelagoniums. Over 200 species of both these types of plants are native to South Africa.

Acacia galpinii Monkey Thorn Acacia The seed pods are eaten by monkeys and other wildlife who spread the seeds.

Oxalis pes-caprae Bermuda Buttercup is a South African wildflower that can be very weedy (invasive) and has naturalized locally. Pampas grass has also been an invader of our local lagoons.

What is a fynbos habitat?
Leucospermum ‘Red Gem’ is a shrub typical of plants in the fynbos habitat.

Halleria lucida Tree fuchsia has flowers pollinated by sunbirds, African versions of our hummingbirds. So do our hummingbirds visit these flowers?

Theobroma cacao Chocolate is derived from the seeds, which develop in pod-like fruits.

Banksia collinia Collin’s Banksia has large fruits with abundant nectar that attracts small marsupial mice as pollinators.

Chusquea foliosa This bamboo has solid canes or culms. It is very rare in the wild and may be extinct in its native region of Southern Mexico and Costa Rica.

Lampranthus glaucus Yellow Ice Plant is one of a hundred species of ice plant; most are native to the coastal region of southern South Africa. The leaves of ice plant have a high moisture content which helps to retard fires.

Euphorbia ceratocarpa—Spurge has a high moisture content in its foliage so it does not burn easily.

Encephalartos longifolius--Thunberg’s Cycad has female cones that can weigh almost 80 pounds.

Encephalartos eugene-maraisii Waterburg Cycad, this species faces extinction in the wild due to illegal collecting.

Stangeria eriopus Natal Grass Cycad is an unusual cycad in its own family, the Stangeriaceae, and resembles some ferns in appearance.

Zamia furfuracea—Cardboard Palm This cycad has thick leaflets resembling cardboard. Cycads are an ancient plant family so even dinosaurs may have tried to eat theses tough leaves. The leaves only look similar to palms because these plants produce cones and are more closely related to redwoods and pines.

Metasequoia glyptostroboides—Dawn Redwood This ancient tree was only known from fossils until it was discovered in China in 1943. It is rare and endangered in the wild.

Taxodium distichum Bald Cypress were common in swampy forests during the reign of dinosaurs.

Sequoia sempervirens Coast Redwood were very common when dinosaurs roamed the earth.

Crassula ovata 'Gollum' Gollum Jade Plant is named for the twisted character in Tolkien's Lord of the Rings trilogy.

Water conservation strategies in plants

Rosmarinus officinalis--Rosemary has thin leaves to reduce water loss and contains aromatic oils which discourages animals from feeding.

Olea europea—Olive leaves are a gray color which reflects sunlight while the thin shape limits water loss.

Isoplexis canariensis This shrub has evergreen foliage with thick waxy leaves to minimize water loss.

Phlomis fruticosa—Jerusalem Sage is a shrubby perennial with evergreen foliage with fuzzy leaves that discourage animal browsers.

Astralgalus pycnostachys lanosissimus—Ventura County Milkvetch is a perennial that was thought to be extinct in the wild until it was recently rediscovered.

Myoporum floribundum—Slender Myoporum has graceful, drooping branches with fragrant white flowers. It is rare in the wild.

Do we have Aesculus californica—California Buckeye; Prosopis juliflora—Mesquite;