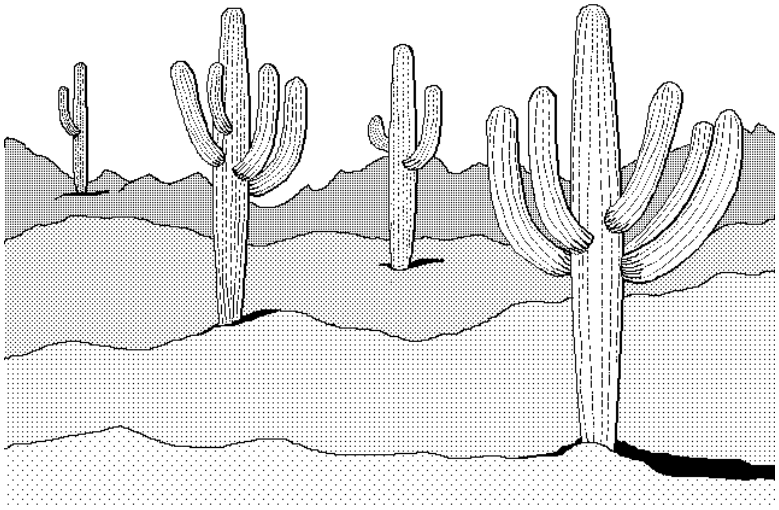
SAGUARO STORY

ACTIVITY:

The saguaro cactus is the symbol of our Sonoran Desert. Students learn about the life history and the importance of the saguaro cactus to our desert environment through a variety of activities: observations of the cactus at the site, specimens of saguaro parts such as the skeleton and bird nest "shoes", and velcro-board stories they help tell.

LOCATION:

CESC staff will inform you of the location of this activity.



EQUIPMENT AVAILABLE:

Saguaro skeletons (at center site)
Cross section of saguaro stem
Bird nest "boot"
Saguaro seeds
Saguaro harvest collecting pole (small sample)
Tags along the "Saguaro Search" trail
Illustrations for velcro board story
Velcro board
Puppets: Saguaro and owl, bat
10 Plastic lizards, snakes, arthropods
Books: Cactus Cafe
Cactus Hotel
Desert Giant

EQUIPMENT BROUGHT FROM SCHOOL:

None

ASSIGNMENT FOR GROUP LEADERS A FEW WEEKS PRIOR TO TRIP:

Leader reads all the material about the center.

DIRECTIONS FOR GROUP LEADERS ON TRIP DAY:

Check the contents of the activity box.
Take it to the activity center area.

THE LESSON:

Introduction: (About 5 minutes)
After the group is seated, ask the students to look around the area and notice all the saguaros. Ask: "What do you already know about the saguaro cactus?" Take a few minutes for responses. This will be an introduction to the lesson, plus it will help you in assessing how much the students already know about the saguaro.

Saguaro Search Nature Walk: (About 15 minutes)
A short trail has been marked with tags attached to plants. Each tag poses a question that may be answered by examining the area. Students may be sent individually or in small groups to read the questions and think about the answers, however they must stay on designated trails.
Note: questions and answers are attached to this lesson. However, questions may change with the seasons.

Regroup and spend a few minutes discussing the discoveries made on the trail.

The Saguaro Story Board: (About 10 minutes)
A velcro board and a variety of pictures guide the students in learning how the saguaro cactus is a very important part of our desert environment. A "script" is attached to this lesson plan, but you are welcome to adapt it.

The part of the story that involves the living cactus is done on the board. The part that involves the saguaro after death may be done on the saguaro skeleton using the plastic arthropods, snakes, and lizards.

An actual saguaro bird nest cavity, saguaro seeds, and a model of the fruit collecting pole are in the kit. Students may examine these during the story.

You may also use the saguaro/elf owl puppet and bat puppets to illustrate the story as well.

Conclusion: (About 10 minutes)
You may conclude the lesson by reading from one of the three books in the kit. If time is limited, show selected pictures from the books and ask students to review what they have learned by commenting on what story the picture tells.

CLEANUP:

After the last group, replace all materials in the box; return it along with the velcro board to Biznaga cabin.

Attachments: Questions from tags and possible answers.
Saguaro board script
Information pages about the saguaro

These are the questions on the Saguaro Search tags. The questions are in regular type. Possible responses (not included on the tags) are in italics. Note: The tags may change with seasonal changes.

COMPARE This is a barrel cactus. In which ways is it different from a saguaro cactus? *Possible responses: smaller, shorter, spines are red, spines are curved, pleats are deeper, flowers are not white, fruit is yellow.* In which ways is it the same as a saguaro cactus? *Possible responses: spines, green, waxy skin, both cactus*	**YOUNG SAGUAROS** Look around for young saguaros. Where do we usually find little saguaros? *Under cover of another plant* Why do you think this is so? *Tiny saguaros (and other young plants, too) dry up in the hot sun. The seeds that happen to fall in a shady place have a better chance of growing in the cooler habitat.*
COMPARE This is a cholla cactus. In which ways is it different from a saguaro cactus? *Possible responses: smaller, shorter, jointed stems, spinier, looks more like a bush.* In which ways is it the same as a saguaro cactus? *Possible responses: spines, green, waxy skin, both cactus*	**HOLES IN THE SAGUAROS** Look at the round holes in the saguaros. Where do we usually see the holes? High or low? *High on the stem.* Who made the holes? *The Gila Woodpecker or the Flicker* How are they used? *Birds use them for nesting. When the woodpeckers are through with them, other birds, especially small owls will take them over for nesting.*
LOOK AND THINK Look at the hill ahead of you. Look at the saguaros growing on the hill. On which side do you see many saguaros? *The sunny (south) side.* On which side do you see only a few saguaros? *The shady (north) side.* Why do you think there are more saguaros growing on one side than the other? *Saguaros grow best in warm, sunny places, and do not grow as well in cool, shady places that may have freezing temperatures in winter.*	**SPINES** Most kinds of cactus have spines. Take a close look at the spines of a saguaro. How do they grow on a cactus? Do they grow in clusters (groups) or alone? *Saguaro (and all cactus) spines grow in clusters from a central part called the areole. Non-cactus plants, such as the ocotillo, usually have single thorns growing along the stem.*

SAGUARO STORY "SCRIPT"

This script may help you with the story of the many interrelationships of the saguaro and the animals and plants of the Sonoran Desert. Please adapt this any way you wish.

Ask questions so the students do most of the story telling.

Envelope #1 contains these pictures:	**Envelope #4 contains these pictures:**
saguaro seedling creosote bush young saguaro adult saguaro	saguaro flowers bat moth bee butterfly cactus fruit
Envelope #2 contains these pictures:	**Envelope #5 contains these pictures:**
javelina squirrel packrat desert tortoise cactus beetle rabbit Gambel quail	coyote kit fox skunk ant kangaroo rat saguaro and woman collecting fruit
Envelope #3 contains these pictures:	
Gila woodpecker elf owl screech owl cactus wren dove red-tailed hawk	

Note: Phrases in brackets [ ] tell which pictures to place on the board.
Phrases in parentheses ( ) are possible responses from the students.

Script:
You are going to help me tell the story of the saguaro...how it grows and how important it is for so many desert animals.

Use the pictures from Envelope #1 and #2 for this part of the story:

Lets begin with the first days of a baby saguaro.
[Place the seedling picture on the board.]

Saguaros start out as tiny seedlings, much smaller than this picture.
Do you think many of them will survive? Why not?
(animals eat them, too hot, too dry, wash away in a summer storm, winter freezes)

Therefore, many do not live for more than a few days or months because of the weather or animals.

Which animals might eat a baby saguaro?
[Place animals from envelope #2 on the board as children say their names.
If they mention animals in envelope #5, ask them to remember that name for a later part of the story.]

When we look for young saguaros, where do we usually find them?
(under a bush)
[Place the creosote bush on the board with a young saguaro under the branches. Lift up the creosote bush to reveal the young saguaro.]

Why are we more likely to find young saguaros under other plants?
(shade, hidden from animals)

Saguaros that begin life under the shade and protection of another plant or even a crack in a rock have a better chance of survival. They're shaded from the hot sun, hidden from hungry animals, etc.

So very slowly our saguaro grows tall and arms grow out of it's middle when it is about 70 or 80 years old.
[Place the adult saguaro on the board.]

Use the pictures from envelope #3 for this part of the story:

What do you see on our saguaro?
(holes)

Who made them?
(birds, woodpeckers)
[Place these pictures on the board.]

Woodpeckers (Gila woodpecker and northern flicker) use their long, strong bills to carve out large holes in the saguaro. The saguaro forms a hard scab, which heals the injury, just as our bodies form a scab over a wound. The woodpeckers do NOT eat the saguaro, they flick the pieces from their bills, which fall on the ground or stick to the saguaro just above the hole.
[Hold up the actual woodpecker "boot".]

Feel the very hard scab that the saguaro formed. How do woodpeckers use these holes?
(laying eggs and raising young)

After the baby woodpeckers have grown, they leave the nest. Next year they may use the nest hole again, or they may not. So there are many empty saguaro nest holes. What other birds

may use these cavities?

(elf owl, screech owl...and other birds that nest in holes or cavities)

[Place these pictures on the board.]

Other birds nest on the outside of the saguaro where the arms make nice shelves for a nest. Which birds might nest here?

(cactus wren, dove, hawk)

[Place these pictures on the board]

Use the pictures from Envelope #4 for this part of the story:

Have you looked at saguaros in late spring and early summer? What do we see growing on the very tops of the main stem and the arms?

(flowers)

[Attach flower cluster to the top of the main trunk or an arm.]

Do you know when the flowers open? Day or night?

(night or evening)

Flowers open at night, stay open for awhile the next day, then close, never to open again. Other flowers will bloom other nights.

Inside the flower is sweet nectar and yellow pollen.
Which animals would feed on these during the night hours?

[As students name the animals, place these pictures on the board: bat, moth]

Which animals would feed on the flowers in the morning?

[As students name the animals, place these pictures on the board: dove, bee, butterfly]

[Note: many other insects and some other birds will feed from the flowers, too.]

These animals need the flower for food, but they are important for the saguaro, too. As the bat, insect or bird flies from flower to flower the pollen sticks to the animal's face. Then it brushes off into another saguaro flower. This transfer of pollen (from stamen to pistil) pollinates or fertilizes the flower.

This causes something to happen. After the flowers are through blooming, what do we now see on the tops of the saguaros?

(fruit)

[Place the fruit on the top of an arm.]

Use the pictures from Envelope #5 for this part of the story:

Big, red, juicy fruits develop. Many fall to the ground. What animals would eat the fruit?

[Place a fruit on the "ground" on the board]

(most of the animals already on the board plus: coyote, fox, quail, skunk, ant, kangaroo rat)

Do people use saguaros?

(yes, Native Americans make jam and syrup)

[Place saguaro with woman and pole on the board.]

Today we enjoy them because they are such an interesting part of the desert, but years ago the saguaro was a very important part of the lives of the Native Americans.
Every summer groups of Native Americans would go out from their villages and set up camps in the midst of thick stands of saguaros. Each morning they collect the fruit using long poles, made from the woody skeleton of the saguaro.

[Show stick with crossbar.]

Then for the rest of the day they would work at removing the seeds and pulp from the outer husk and cooking the fruit in large kettles over hot fires.

Some Tohono O'odham people still do this, but it is not as prevalent now as it was many years ago when there were no stores and saguaro fruit was an important food source. They also used the woody ribs for roofing.

Now, let's look at all the pictures on our board!

Look at all the animals that need the saguaro for shelter or food. And remember, the saguaro needed shelter when it was very small.

But, what's finally going to happen to our saguaro?

(it will die)

It may live to be 150 or perhaps 200 years old, but as with all living things, it will finally die. But even in death, the saguaro continues to be an important part of our desert.

For this part, use the actual saguaro skeleton and the animals in the plastic box.

First, many insects eat the softer outer and inner parts. But this is what finally remains...a hard wood skeleton. Which animals would find the dead saguaro a good place to hide or live?

In the plastic box are 10 animals:

2 lizards	3 snakes	2 insects	1 spider
1 Gila monster	1 caterpillar	1 scorpion	

[As the students mention these, place them on the skeleton.]

What is finally going to eat the wood?

(termites)

We usually think about termites not being very helpful because they can eat the wooden parts of our homes, but in nature, termites are very important because they are one of the few animals that can eat wood. They eat the dead wood and as they eliminate their waste, they recycle it back to the soil.

Conclude by asking the children to look at all the animals that need the saguaro for survival. And remember that the saguaro has needs, too. It needed protection from the weather and animals when it was small. Animals that feed from the flowers help to pollinate it and therefore cause it to produce fruit and seeds.

Do you think that the saguaro is an important part of our desert?

The Saguaro Cactus

Saguaro Story Activity Center Leaders: Here is some background information about saguaros. This is probably more than you need (or want to know) about saguaros, but it may help in answering students' questions and giving you ideas of points you would like to emphasize with your groups.

EVOLUTION OF THE SAGUARO

The saguaro (and the cactus family in general) is a newcomer to the plant kingdom. The saguaro has the most northern distribution of the columnar cactus.

67 to 30 million years ago: Early members of the cactus family appear.

30 to 10 million years ago: Tropical and subtropical cactus on both northern and southern sides of the tropics evolve in tropical and subtropical forest and scrub environments.

10 to 3 million years ago: There is widespread expansion of semiarid and arid subtropical scrub, with development of large columnar cactus in areas bordering the tropics in North and South America. Modern species of cacti appear.

3 to 1.7 million years ago: With an increasing dry climate and winter cooling, modern desert species appear.

Cooler temperatures select for greater stem mass and the giant columnar cactus within the cooling subtropical and desert scrub evolve.

8000 years ago to present: With the retreat of the last glaciers, cactus species moved northward into their present positions.

MORPHOLOGY (form and structure)

The adult saguaro averages 12 meters (40 feet) tall, trunk 30 to 60 cm (1 to 2 feet) in diameter. A young plant may be unbranched for years, then branches begin to appear at a point about 2.2 to 2.7 meters (7 to 9 feet) from the ground.

Areoles (the small, circular areas in cacti that bear the spines) are arranged along the ridge of the outer folds of the cuticle. They are spaced about an inch apart.

15 to 30 spines grow from the areoles. They provide some shade on smaller plants which have a denser spine cover. They probably do not provide much protection from animals. The lower trunks of older saguaros lose their spines and develop a dark, bark-like surface.

As is true of all cactus, the cuticle is a layer of tough, waxy tissue, which acts as a deterrent to water loss (transpiration). The stomata, the small pores through which the plant transpires, are sunken, which also aids in reduction of transpiration.

The next layer inward consists of chlorophyll-containing cells. Photosynthesis (process of food-production) takes place here.

Most of the interior consists of water storage cells.

The accordion-like pleats of the main stem and the arms allow for expansion and contraction according to the amount of water being stored in the plant. From 75% to 95% of the total weight of the saguaro may be water.

Towards the center of the plant are 13 to 22 woody cylindrical ribs. These are arranged in a circle and run the length of the plant and expand into the arms.

The roots are shallow and spread in all directions. They grow less than 4 inches below the surface, but spread out to a distance about equal to the height of the plant. A few roots grow down a short distance, but are not considered to be taproots.

A crested form, the "cristate" saguaro is rare. The cause is not known. This fanning of the top of the main stem, and occasionally an arm, does not seem to harm the plant. Flowers and fruit grow from the crest.

RANGE AND DISTRIBUTION

Range

The range of the saguaro closely coincides with the boundary of the Sonoran Desert with the exceptions of California and Baja California, Mexico.

In Arizona, the saguaro grows in the southwestern part of the state, with the general northern boundary of Lake Havasu-Wickenburg-Roosevelt Dam, and the general eastern boundary being Globe and southward to the Rincon Mountains, running through the eastern unit of Saguaro National Monument.

In California a small population is found near the Colorado River.

In Mexico it is found in the state of Sonora only. It does not grow on the peninsula of Baja California.

Elevation range is from sea level to about 1200 meters (4000 feet).

Distribution

The saguaro is not evenly distributed. It is primarily found growing in rocky or gravelly soils of foothills, canyons, and valleys.

Its distribution is determined by freezing, therefore elevation and the direction of the slope face are critical factors. A south-facing slope may have a large population of saguaros, while the north-facing side of the same hill will have very few.

DISPERSAL, GERMINATION, SEEDLING SURVIVAL

Dispersal

The seeds mature just prior to the summer rains. They fall to the soil while in the flesh of ripe, open fruits, or in bird droppings. Summer rains soften and dislodge the seeds and transport them to downslope sites, where they may lodge in litter beneath other plants, or between rocks. Animals also disperse seeds via their droppings.

Seed Consumption

A large part of the seed crop is consumed by mammals, birds, and insects. Some seed-eaters destroy the seeds during digestion. These are: white-winged dove, mourning dove, kangaroo rat, and pocket mouse.

In other animals, the seeds pass undamaged. These are: round-tailed and Harris' antelope ground squirrels, Gambel's quail, curve-billed thrasher, cactus wren, Gila woodpecker, flicker, brown towhee, white throated wood rat, cactus mouse, long-nosed bat, coyote, and javelina.

Harvester ants, Pogonomyrmex sp., play a primary role in limiting numbers of seeds.

High densities of these ants are commonly associated with stands of adult saguaros. They remove and consume large numbers of seeds.

Germination

Germination requires contact of the seed with free water and exposure to light. Seeds germinate only in the summer, principally in mid-July to mid-August, during the summer rains. Successful germination depends on high moisture and warm temperatures.

Seeds require light for germination. Buried seeds will germinate quickly when exposed to light by rains, animal digging, etc.

Survival

Most of the seedlings are eaten or uprooted by animals, die from exposure to the sun, are washed away by summer monsoons, wither from drought or freeze in the winter cold. Those that survive are concealed beneath shrubs, rocks, or debris.

Seedlings are 90% water. Insects, insect larva, and rodents are primary consumers of seedlings, especially during the dry months of May and June, in the seedlings' first year.
Seedlings that sprout during July and early August usually attain sufficient size and volume during summer to survive, unless eaten. Few seedlings from late August or September germinations survive.

Freezing limits survival of seedlings, as well as older plants.

It is estimated that the survival of seedlings in the first year is less than 1 per 1000 seeds.

GROWTH, AGE, HEIGHT

The stages of growth:

The development of the saguaro is extremely variable from one individual to another and from one location to another. The figures given are averages.

Bulbous seedling (0 - 1 year)

At germination, the seedling is a globular mass of succulent tissue.

Fine, hair like spines develop within a few days followed by growth of tubercles (small swellings on the stem), each bearing a cluster of short, soft spines.

Tuberculate juvenile (1 -7 yrs.)

At one year the oval stem is 40% above ground, 60% below ground. The above ground portion has 8-16 well defined tubercles, each bearing a single cluster of approximately 6 stiff spines growing from a small mass of short, felt-like hairs surrounding the areole.

At age 2 (.51 cm. above ground) above ground part of stem increases to 50% of total stem height; tubercles increase to about 24; spines are bristle like.

At age 3 (.73 cm. above ground) above-ground part is 60% of total stem and assumes a spherical form. Spines are thicker and stiffer.

Spherical juvenile (7 years)

Rib development (fluting) occurs at about age 7 (2.92 cm. above ground).

The plant develops lateral roots 10 cm. or more outward from the base.

Clubform juvenile (8 - 37 yrs.)

The stem becomes increasingly columnar. At 14 years (17.4 cm. high) 85% of stem is aboveground.

The dense crown of stout spines shades the growing tip of the young plant, reducing water loss and providing a barrier to animals. Short woolly hairs beneath the spines cover the apex, further reducing moisture loss and protecting the plant against insects. Both sets of spines function as a thermal barrier that protects the delicate apex against freezing.

Clubform adult (37 - 51 yrs.)

At 37 (206.7 cm.) 98% of the stem is aboveground. Additional ribs develop with expanding girth of the upper stem. Ribs on upper stem increase to 15 or 20. Central spines increase in length and diameter.

Bowling Pin adult (51 - 85 yrs.)

At about 51 years, (321.1 cm. height) a bowling pin form is attained. The development of ribs continues at a reduced rate, resulting in 17 to 20 upper stem ribs. The spines change during this period of growth. Central spines gradually reduce in length and diameter, resulting in spines on the upper stem being short (1 to 3 cm.), slender, needlelike. A felt like mass of woolly hairs surrounding each areole increases. This dense mat protects the apex from freezing, and also protects the reproductive structures, which emerge from the areoles at the upper portions of the stem. Flowers appear anywhere from 35 to 65 years of age.

At 65 (561.8 cm. in height) the saguaro normally bears one or more short branches, usually originating from areoles 100 to 200 cm. below the growing tip, at a height of 350 to 450 cm. above ground. This is the point of maximum stem girth. At this age the plant has developed a maximum number (18 to 22) of central stem ribs.

Branched adult (85 +)

The plant has reached its ultimate adult form. Curved branches closely resemble the upper central stem. The upper stem diameter decreases with upward growth of central stem, and mature branches and upper stem gradually taper towards the tips.

Growth rates

Ages 0 - 6: Growth is less than 1 cm. per year, then accelerates.
Ages 40 - 60: Peak growth rates of 11 to 13 cm. per year, then tapers off as more energy is diverted into branches and reproduction.
Age 100-150: 8 cm. per year
Age 150 + : 5 cm. per year

Seasonal growth

Growth of adults begins with the monsoons and continues through the rainy season (late June through September) and ends with the October-November drought. There is water uptake in winter, but little or no height growth.

Growth in damaged saguaros

Drooping branches is a result of freeze-caused injury.

Arms may grow near a damaged area, even though it is not at the usual height from the ground.

REPRODUCTION

The timing of flower and fruit production is controlled by the arrival of warm spring temperatures and increasing daylight.

Flowering dates and times for fruit maturation is variable year to year depending on temperatures. In an "average" year in Tucson, the first buds appear the last half of April; the blooming peak is the last week of May and the first week of June. Fruit peaks from the last week of June to the second week of July.

Flowers may be seen every month of the year, but few fruits develop outside the normal period, and it is unlikely there is any germination from those.

Flowers open during evening hours and remain open until mid-day on the following day. Flowers remain open longer on cooler or cloudier days. A flower blooms only one night.

Pollination occurs primarily during the night and early morning. Bats, insects, and birds feed on the pollen and nectar. The fruit matures about 37 days after the bloom.

A saguaro's first flowers appear when the plant is at the approximate height of 2.2 meters (7.2 feet) and about 35+ years old. The first blooming may result in only one to two fruits.

The number of fruits increases with age, and production is commonly 100+ fruits per year by the time a plant is 4.5 meters.
Mature fruit weighs 50 g (1.8 oz.) and contains about 2250 seeds.

Based on estimated average production of 200 fruits per year, a healthy saguaro produces 40 million viable seeds during its 100-year reproductive life span. For a population to maintain itself or grow, one of the 40 million seeds must germinate and survive to an age when it becomes reproductive.

Armbuds emerge when the saguaro is 4 to 5 meters tall. As early as the third spring after the buds appear, and when they are only 15 cm in length and diameter, they begin to produce fruits.

DEATH AND DECAY

The saguaro is a cold-intolerant species. Catastrophic freezes are the primary cause of adult deaths in Arizona and northern Sonora. Saguaro die-offs are a natural response to normally occurring climatic events.

Infant mortality

The greatest mortality is during the first year. The tiny, succulent, weakly rooted seedlings are subject to a variety of destructive agents. They are consumed by insects and rodents, uprooted by birds, rodents, and other mammals. Erosion, drought, and freezing are other causes of death.

At the beginning of the second year there is a reduction in death. Root growth, increased water storage, and not being as susceptible to animal damage are factors. Freezing is the primary cause of death.

The greatest vulnerability to freezing occurs during the first four years, and declines to the seventh year, when the rate levels off. The increase in stem diameter reduces freezing.

Adults

The mortality rate sharply increases during the 60th to the 85th year at 5.1 to 8 meters in height. Natural deaths of large adults are mainly climatic...freezing, lightning, wind, and fire. Freezing is the primary cause of adult deaths in the northern part of the range.

Animals

Few adult deaths occur as the result of damage of soft tissues by woodrats, jackrabbits, and bighorn sheep, but the damage does weaken the plant, thereby increasing vulnerability to destruction by freezing or wind.

Nest holes drilled by woodpeckers are rapidly sealed off with callus tissue and do not injure the plant, but structurally weaken the stem. 150 to 200 year old saguaros may have 50 holes and there seems to be only minor impact. Larger, re-excavated holes increase the probability of wind breakage and make the stem more vulnerable to freezing.

Neither bacteria nor insects are among the confirmed causes of adult mortality. Freezing causes dead tissue and bacteria and insects help in the decomposition of that dead tissue. The damage is primarily freezing.

The rot myth

Bacterial disease is NOT among the confirmed causes of mortality. There is no evidence that any microorganisms have ever been a significant cause of death, or that any death of a healthy saguaro can be attributed to bacterial action.

In the 1940's scientists believed a bacterial disease was affecting saguaros. Studies, experiments, and actual removal of "infected" saguaros occurred. We now know that freezing is the primary cause of death, but because as many as nine years may elapse between lethal freeze damage and the final collapse of the dead plant, freezing was not associated with the bacterial breakdown of the freeze-killed tissue. Streams of black fluid are the result of bacterial breakdown of freeze-killed tissues.

This is not a disease, but decomposition of dead tissue resulting in, but not causing saguaro death.

After death

Woody skeletons can remain as long as 30 years or more after the death of the plant.

INTERRELATIONSHIPS

In the first years of life, the saguaro needs protection from animals, drought, heat, cold, and being washed away by heavy rains. Those seedlings that survive are growing under another plant that acts as a protective cover (a "nurse" plant), or in a rocky crevice, or underneath plant litter. Seedlings are probably eaten by all rodent species and insects.

In larger juvenile and adult plants, rabbits, bighorn sheep, and woodrats eat the plant tissue. Only the white-throated woodrat can subsist entirely on live saguaro tissue. It is able to metabolize and neutralize the poisonous oxalic acids within the tissues, lethal to other animals unless they are able to drink large amounts of water.

The nectar and pollen of the flowers provide food for nectar-feeding bats and moths at night, and other insects and birds in the day. Not only does this provide food for the animals, but results in pollination of the flowers.

The fruit and seeds are eaten by many animals: birds (especially white-winged and mourning doves, Gambel's quail, curve-billed thrasher, cactus wren, Gila woodpecker, flicker, and brown towhee), coyotes, foxes, javelina, rodents (especially antelope and round-tailed ground squirrels, kangaroo rat, white throated woodrat, and cactus mouse), insects (especially harvester ants), and the long-nosed bat. With the exception of the doves, kangaroo rats, and pocket mice, seeds pass undamaged through the digestive system. These animals, then, aid in seed dispersal.

Gila woodpeckers and northern flickers excavate nesting cavities in the main trunk and arms. They excavate other cavities in succeeding years, leaving old nest sites for elf owls, screech owls, purple martins, ash-throated flycatchers, kestrels, and other birds.

The saguaro manufactures a hard, callus tissue as the woodpecker (or any other intruder) damages the tissue, and it can withstand many woodpecker cavities. However, the starling, an exotic, aggressive cavity nester will chase out a woodpecker after it has carved a nest hole. The woodpecker then excavates another nest hole. It may again be chased away by a starling. It is

believed this may cause too many injuries to a saguaro as a woodpecker makes repeated holes, resulting in damage too extensive for the saguaro's healing capabilities.

Larger birds construct nests at the base of an arm, where it joins the main stem. White-winged doves, various species of hawks, and occasionally a cactus wren will locate nests here.

A dead saguaro is shelter and home for many other animals. Many species of insects, spiders, scorpions, snakes, lizards, and small mammals take refuge in a fallen saguaro.

Finally, bacteria decompose the plant tissue and it is once again part of the soil.

THE SAGUARO IN THE TOHONO O'ODHAM AND PIMA CULTURE

The harvest of saguaro fruit was so important to these desert Indians, that it marked the beginning of the new calendar year.

Some still participate in the harvest, but it is no longer the major event it was in the past.

The people would move into the saguaro forests and set up camps during June harvest time. This was an important and happy event. This was the first fresh food of the year and the Indians would eat large quantities of fruit during the three-week camp. Besides eating the food during this time, they would also gather it for later use.

Early in the mornings, everyone was out gathering fruit. Saguaro ribs spliced together, with a short stick attached at an angle at the end, was the tool used to knock the fruit from the saguaro. The pulp was removed from the rind with the thumbs, and tossed into a gathering basket. To split fruit not already opened, they used the sharp edge of the calyx to cut through the rind.

By late morning, the harvest was brought to camp. The pulp was soaked in water to loosen the seeds. The seeds were sun-dried and would later be ground up and then used as a butter-like spread on bread. The pulp was boiled in pots over an open fire. A clear syrup was made by carefully sieving out all pulp. A jam was made by leaving in some of the pulp to give it a thicker consistency. No additives were used!

The jam and syrup were stored in containers for later consumption. This was an important food source. Each saguaro fruit contains about 34 calories, and is high in protein, fat, and vitamin C.

At the end of harvest time an intoxicating beverage was also prepared. This was done by adding water to the juice and placing the mixture over a small fire for about 72 hours allowing the juice to ferment. This wine was then consumed at the celebration following the harvest.

The saguaro ribs were also important products from the saguaro. Besides making perfect fruit-gathering tools (they are used even today), they were used as building materials, especially roofs.