TEACHER INFORMATION PACKET

with

PRE- AND POST-VISIT ACTIVITIES

for a

SELF-GUIDED VISIT

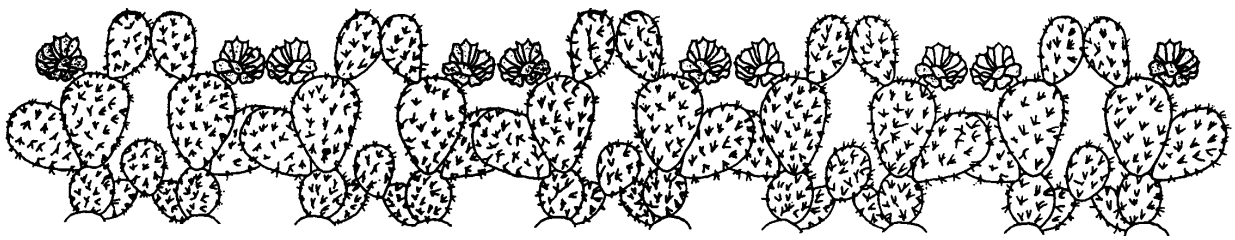
High School Level

Grades 9-12

ARIZONA-SONORA
DESERT
MUSEUM

2021 N. Kinney Road
Tucson, AZ 85743
(520) 883-3025
www.desertmuseum.org

TABLE OF CONTENTS



INTRODUCTION

To The Teacher

Welcome! This booklet has been designed to help teachers, chaperones and students prepare for a Self-Guided Visit to the Arizona-Sonora Desert Museum and to enhance the educational value and enjoyment of the field trip. We recommend that a Desert Museum visit coincide with classroom studies of desert ecology or natural history. We developed this packet of Sonoran Desert information and activities to contribute to your classroom ecology unit; this booklet is not intended to be a complete curriculum on its own. We hope you find this information useful and easy to incorporate into your science curriculum. All materials are designed to be used by high school students and may be duplicated for student and chaperone use. For more information on the Desert Museum and the Sonoran Desert visit our web site at **www.desertmuseum.org.**

This packet contains pre- and post- visit information and activities to accompany the *Explorer's Guide* to the Desert Museum.

- **Pre-visit Information and Activities:** Pre-visit readings and activities provide students with background information on plants, animals, people and environmental conditions of the Sonoran Desert Region. Each section in the reading is correlated to specific Museum exhibits and contains information that will help students successfully complete the *Explorer's Guide*. By completing pre-visit readings and activities, students will be able to more accurately anticipate and understand what they will see at the Desert Museum.

- **Explorer's Guide:** The purpose of the *Explorer's Guide* is to encourage students to make careful observations of plants, animals and artifacts while on their field trip, as well as read exhibits signs. Students should work on the *Explorer's Guide* while touring the Desert Museum.

- **Post-visit Activities:** Post-visit activities give students a chance to synthesize and discuss information learned before and during their trip, and will help students construct their own understanding of the components and ecology of the Sonoran Desert Region. The *Career Focus Activity* introduces students to a variety of careers and job tasks at a natural history institution such as the Desert Museum.

We welcome and value your comments, suggestions and/or questions concerning this packet. The information and activities have been developed and revised based on teacher, chaperone, student and staff recommendations over a number of years. We appreciate your taking the time to complete the **enclosed evaluation form**. If you develop any lessons or activities related to desert ecology and a Museum visit that work well with your students, please send us a copy.

Sincerely,

ASDM Education Department

ARIZONA-SONORA
DESERT
MUSEUM

Objectives

Through the use of these materials and a visit to the Museum, your students should:

- Become familiar with the diversity of life in the Sonoran Desert,
- Understand that all components of a desert ecosystem are important and interconnected,
- Describe plant and animal adaptations that help each survive and thrive here,
- Become aware of differences between the desert grasslands, mountain islands and riparian corridors within the Sonoran Desert region,
- Describe environmental changes in this area over geologic time using fossil evidence,
- Become familiar with the cultures of indigenous people from this region,
- Describe some effects humans have had on the Sonoran Desert region,
- Develop an appreciation of the intrinsic value of the desert and list ways we can conserve it,
- Become aware of the career opportunities at a natural history institution such as the Desert Museum.

Arizona Academic Atandards Correlation

The student reading and activities in this booklet combined with a Self-Guided Visit to the Desert Museum correlate with the following Arizona Academic Standards in Science: 3SC-P5, 4SC-P6, 4SC-P7, 6SC-P4, 6SC-P5.

PRE-VISIT INFORMATION

Teacher Information

There are two components to this section:

A. ***Suggested Resources*** is a brief list of a books, pamphlets, organizations, and web sites containing more information on deserts including the Sonoran Desert Region. All are recommended by our Education Department staff and some are available in our gift shop. ASDM publications are included and may be ordered using a purchase order or credit card by calling the publications manager at (520) 883-3028.

B. ***Natural History Information*** includes a reading, *The Sonoran Desert*, which provides teachers, students and chaperones with general information on plants, animals, people, and environmental conditions of this area. Please make copies for teachers, students and chaperones before visiting the Museum. All information is correlated to specific Museum exhibits and is in part, intended to pique student's curiosity about some of creatures and artifact they will see on their field trip. Plant and animal adaptations, animal classification, desert characteristics, plant/animal interactions, habitat and niche, life cycles, and conservation are some of the science themes stressed, along with the cultural diversity of the region. A glossary of vocabulary terms, review questions, extension activities, research project, and outdoor observation activity are included. Extension activities provide for inter-disciplinary, research and critical thinking opportunities. The purpose of the outdoor observation activity is to have students practice making observations outside the classroom, in preparation for their field trip. Through careful observations, students may be surprised to discover abundant hidden wildlife in their immediate surroundings.

SUGGESTED RESOURCES

Arizona-Sonora Desert Museum Press

To order using a purchase order or credit card, call the publication's manager at (520) 883-3028.

- ASDM , *A Natural History of the Sonoran Desert.* (A comprehensive guide to the plants, animals and geology of the Sonoran Desert Region; excerpts on our web site.) Soft cover $24.95, Cloth cover $55
- Dahl, K., *Wild Foods of the Sonoran Desert.* Paperback $4.95
- Friederici, P., *Strangers In Our Midst, The Startling World of Sonoran Desert Arthropods.* Paperback $4.95
- Hanson, J. and R. Beggy, *Desert Dogs: Coyotes, Foxes & Wolves Desert Holes.* Paperback $4.95
- Ingram, M., *Gardening for Pollinators*. Brochure $3.95, Poster $9
- Laney, N., *Desert Waters, From Ancient Aquifers to Modern Demands.* Paperback $4.95
- Lazaroff, D.W., *ASDM Book of Answers.* Paperback $14.95
- Lazaroff, D.W., The Secret Lives of Hummingbirds. Paperback $4.95
- Merlin, P., A Field Guide To Desert Holes. Paperback $7.50

Other Literature

- Buchmann, S. and G.P. Nabhan. 1996. *The Forgotten Pollinators.* Washington DC: Island Press/Shearwater Books.
- Mc Carthy, C. *Eyewitness Books: Desert.* New York: Alfred A. Knopf, 1991. (Many other books in the *Eyewitness* series contain information on desert species and other science topics geared towards middle school students and older.)
- Nabhan, G.P. 1982. *The Desert Smells Like Rain.* Berkley: North Point Press.
- Underhill, R.M. 1979. *The Papago and Pima Indians.* Colorado: The Filter Press.
- Indian Oasis School District #40. 1980. *When Everything Was Real, An Introduction to Papago Desert Foods.* Sells, AZ

Organizations

- Tohono O'odham Community Action (TOCA). P.O. Box 1790 Sells, AZ. 85634 (520-383-4966)
- Native Seeds/SEARCH. 426 N. 4th Ave. Tucson, AZ 85705 (622-5561)
- Tucson Botanical Gardens. 2150 N. Alvernon Way Tucson, AZ (326-9686).

Video (often available at public libraries or through your school)

- Saguaro, Sentinel of the Desert. *(The Best of Nature)*

Web sites

- Arizona-Sonora Desert Museum: www.desertmuseum.org
- Desert USA: www.desertusa.com/animal.html
- Tucson Herpetological Society: www.azstarnet.com/~bsavary/circanim.html
- Sonoran Desert Conservation Plan: www.co.pima.az.us/cmo/sdcp
- The Nature Conservancy: www.tnc.org

ARIZONA-SONORA
DESERT
MUSEUM

THE SONORAN DESERT

Natural History Information
for Teachers, Chaperones and Students

WHAT IS A DESERT?

We often hear of the desert as being a "harsh environment" where plant and animal life must "struggle to survive." To humans, the desert heat and drought do appear to be harsh, and desert life does seem to be a struggle. However, desert species are adapted to desert conditions. Thousands of organisms live a normal existence here. If the desert environment were hostile to life, life here would not exist in such abundance and diversity.

All deserts have little usable moisture. Available water depends on the length and intensity of rains, rate of evaporation, and the nature of the soil. What truly characterizes a desert is not how much annual rainfall it receives, but the ratio of precipitation to evapotranspiration. Evapotranspiration is the process by which water is lost from the earth's surface via evaporation of water and transpiration (the release of water vapor through plants). In a desert, precipitation is much less than the potential evapotranspiration. Other characteristics of deserts include intense sunlight, the unpredictabe timing and amount of rainfall, windy conditions, and great variations between day and night temperatures.

In order to understand why dry deserts exist, let us take a closer look at air movement. As the sun heats portions of the earth, it warms the air above the ground. Warm air is lighter than cold air; therefore, it rises, while cold air sinks. Warm air is able to hold more moisture than cold air. As warm, moist air rises, it cools and the moisture it contains condenses, resulting in rain. As cool dry air sinks, it becomes warmer and drier. This vertical (up and down) motion of air currents creates global air circulation patterns, local winds, and influences rainfall.

We categorize the world's deserts into two main types based on the conditions that create them: horse latitude deserts (in high-pressure zones, see fig. 1) and rain shadow deserts (on the leeward side of mountains, see fig. 2). High-pressure zones form when cold-dry air piles up above the land. The pressure comes from the weight of all that air. As the weight pushes this dry air down, it becomes warmer and even drier. The result is a mass of dry hot air that takes away moisture from the land, creating deserts. Mountains keep precipitation away by intercepting moist air (fig. 2). As wet-warm air moves up a mountainside, it cools and the moisture it contains condenses dropping precipitation on the windward side. The air is dry by the time it reaches the leeward side resulting in desert conditions. The Sonoran Desert is a combination of a rain shadow desert in the northern limits and horse latitude desert at 30°N latitude.

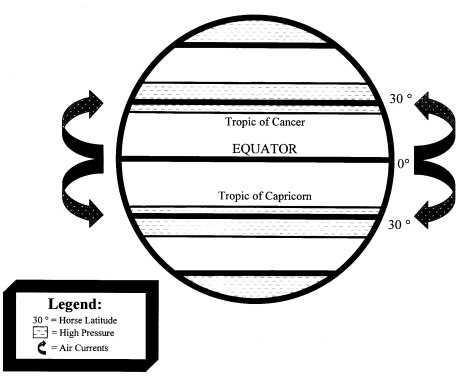


Fig. 1: Horse Latitude Deserts
At 30° latitude in both the northern and southern hemispheres, the west coasts of all continents have deserts. Warm, dry descending air causes high-pressure zones.

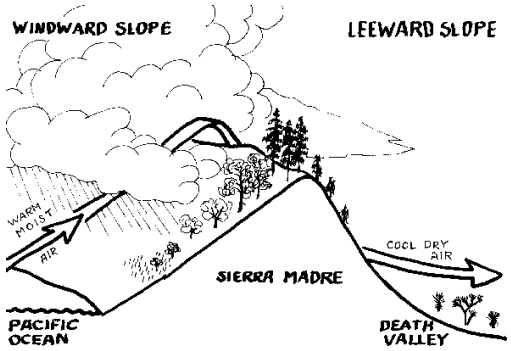
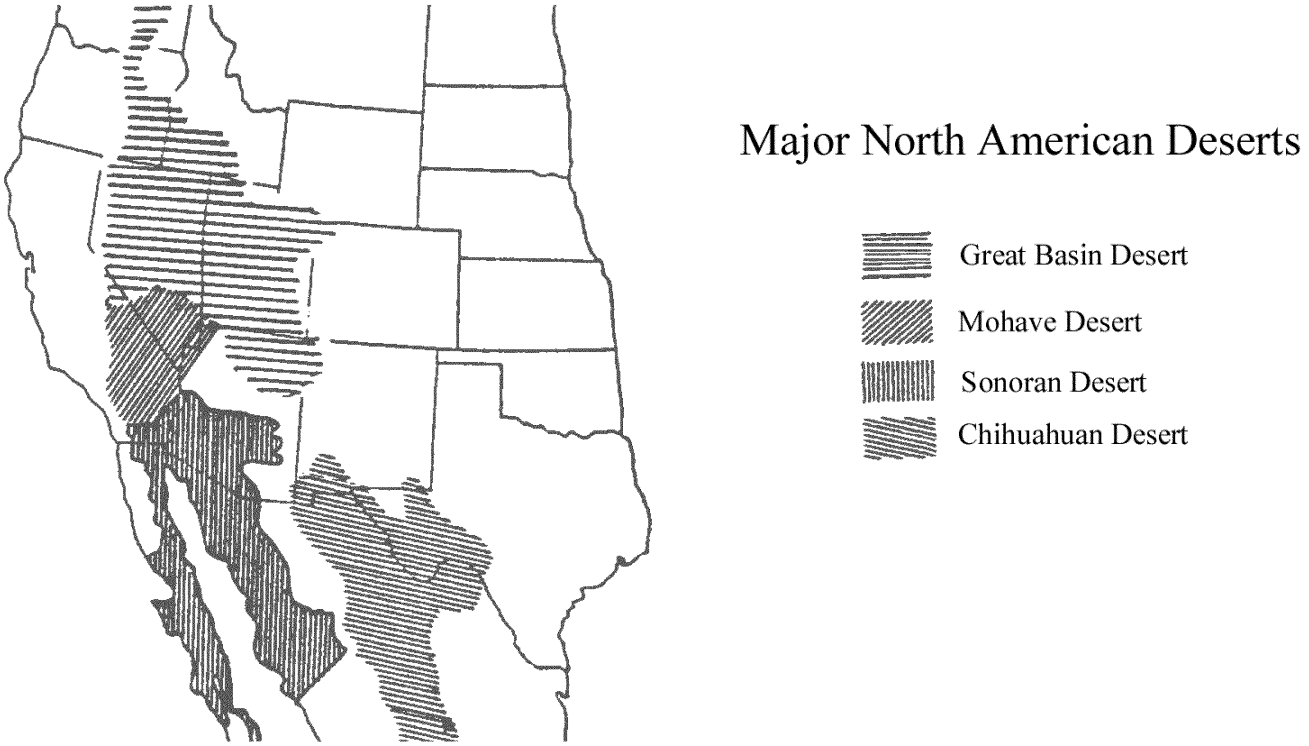


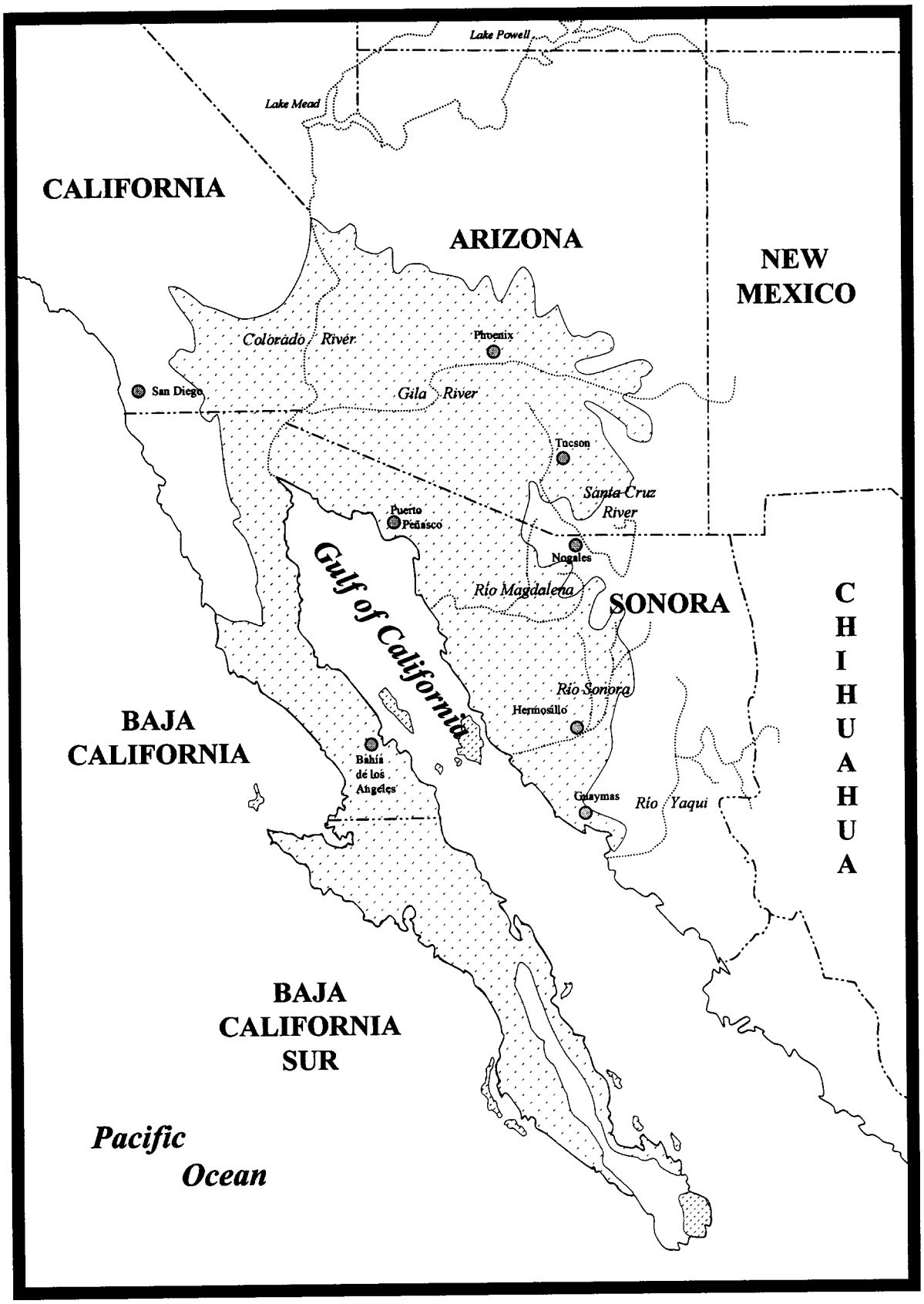
Fig. 2: Rain Shadow Deserts
Moist air crossing a landmass loses its moisture while passing over mountains, resulting in desert conditions on the leeward side.

THE NORTH AMERICAN DESERTS

The North American Desert system consists of some 440,000 square miles in the western United States and northern Mexico. It consists of four deserts that differ somewhat in climate and vegetation. You can find all four deserts in Arizona (fig.3).



THE SONORAN DESERT



THE SONORAN DESERT

The Sonoran Desert covers approximately 100,000 square miles and, most of it is a low, hot desert, with an elevation ranging from 3,500 feet to below sea level (fig. 4). Winters are mild and summers are hot. Precipitation varies in different regions, ranging from 1- 14 inches (2.5- 36 cm) per year. The time of the year for rainy seasons vary; in the Tucson area, rainfall tends to occur bi-seasonally, falling in both the late summer and winter.

The Sonoran Desert is quite lush when compared to most other deserts of the world. Columnar cacti (saguaro and organ pipe) and legume trees (mesquite, palo verde, acacia, etc.) visually dominate its vegetation. The Sonoran Desert is quite diverse, containing over 2,000 species of flowering plants alone!

We divide the Sonoran Desert into six subdivisions, based primarily on vegetation differences. You can find information on these subdivisions in the Orientation area at the Desert Museum.

The Arizona-Sonora Desert Museum displays only the plants and animals of the Sonoran Desert Region. This region includes the desert itself and the non-desert communities found adjacent to- or within the desert. These other communities include riparian corridors (lush areas along streams), pine-topped mountain islands, desert grasslands, and tropical deciduous forests.

LIFE IN THE DESERT

The Sonoran Desert contains a diversity of plant and animal life adapted to the desert. An **adaptation** is any physical, physiological or behavioral trait or characteristic that helps an organism survive and reproduce in its environment.

ANIMALS

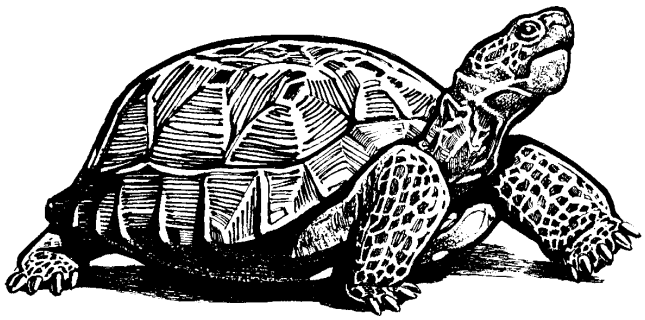
Along with **adaptations** for food gathering, defense, movement, and hiding, desert creatures have evolved a variety of drought- and heat-reducing strategies. Let us take a closer look at some of these strategies exhibited by different groups of animals.

REPTILES

The body temperature of vertebrate animals is regulated in one of two ways: **ectothermy** or **endothermy**. Sometimes we call these conditions "cold-blooded" or "warm-blooded," but these terms are misleading because they imply that the animals' blood or body temperature is in a warm or cold state. Endothermic animals (most birds and mammals) maintain a constant body temperature, while the outside environment (and animal's behavior) determines the body temperature of ectothermic animals (most invertebrates, reptiles, amphibians and fish).

Since all reptiles are ectothermic, their body temperature fluctuates in response to changes in the environmental temperature. In order to maintain a safe temperature range, a reptile moves around within its habitat. When the environmental temperatures become extreme reptiles become dormant. In summer, they **estivate** by becoming dormant in response to extreme heat. In winter, they **hibernate** by becoming dormant in response to extreme cold. In the cold of winter, most Sonoran Desert reptiles hibernate to some extent. They do so because temperatures are too low for them to find, capture, and digest food.

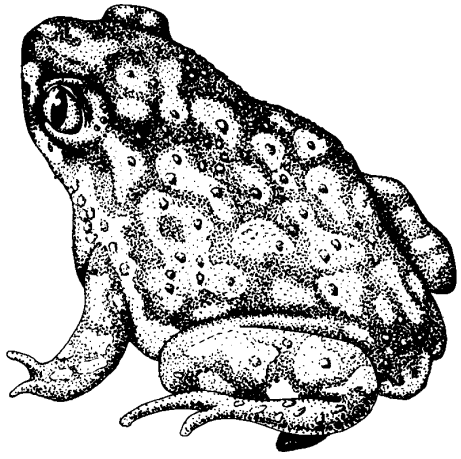
The desert tortoise digs a burrow and hibernates through the cold winter. It also remains inactive in burrows during times of intense summer heat until the monsoon rains arrive. This estivation period has as much to do with the scarcity of green plants to eat during these hot dry periods as it does with heat avoidance. The tortoise is a herbivore and can live without water, but will drink if water is available. The desert tortoise may release its bladder liquids if threatened. Like many reptiles, it eliminates body waste (uric acid) in a semi-solid form, thus helping it conserve water.



The most common heat avoidance technique among desert creatures is **nocturnal** activity. During the heat of summer, most snakes and geckos are primarily active during the cool evenings rather than the hot days. Some lizards, such as the desert iguana and western whiptail, can tolerate very high temperatures. Have you ever seen a lizard stand with its body raised high above the desert soil? This is a behavioral adaptation to avoid the hot desert surface, which can be upwards of 40°F warmer than the surrounding air temperature.

Look for reptiles at the following exhibits: Reptiles, Desert Grasslands, Desert Tortoise, Lizard enclosures and Chuckwalla. Remember if it is too hot or too cold, reptiles may be out of sight. You can find active lizards and snakes in the Reptile and Invertebrate building.

AMPHIBIANS



Amphibians are the smallest class of living vertebrates. They are ectothermic and most numerous in warm, moist environments. Some of the many Sonoran Desert amphibians include the Tarahumara salamander, Sonoran Desert toad, red spotted toad, canyon tree frog, and Couch's spadefoot toad.

Those amphibians that have adapted to the arid climate of the Sonoran Desert region have done so primarily through the ability to estivate and hibernate. They burrow deep into the ground and remain dormant during dry periods. When the warm summer rains provide the right conditions for mating and reproduction, they dig their way out to the surface. Some Sonoran Desert amphibians remain dormant for most of the year! And a few are active throughout the year.

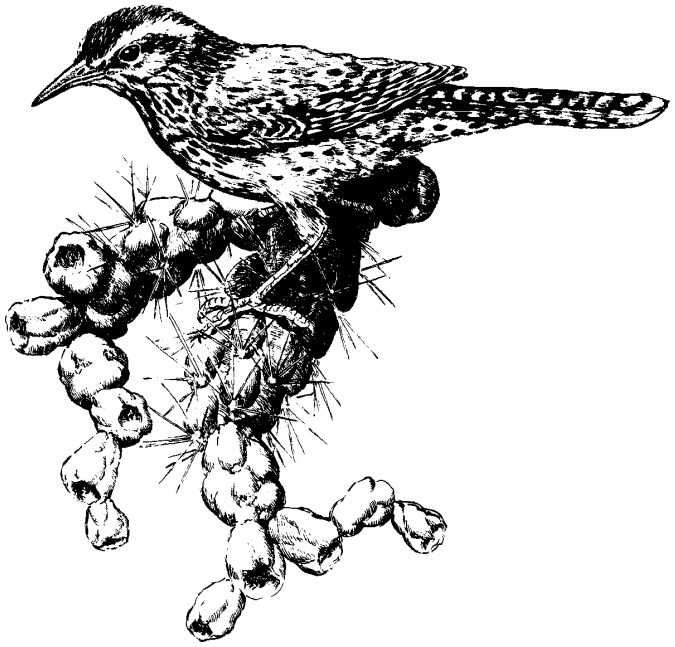
With the amphibians' emergence begins the frenzied activity of calling, mating, and depositing eggs. Water evaporates fast from the temporary rain pools in which so many desert amphibians

breed. Most lay their eggs in gelatinous (jelly-like) masses or strings in or near water. The eggs must develop rapidly into larvae (tadpoles), and the larvae metamorphose into froglets. In desert spadefoot toads, the entire metamorphic process happens in two weeks or less, an adaptation to avoid death in drying out pools of water. The young spadefoot toadlets leave the pool to dig their own burrows and wait until the next season of summer rain.

You can find the largest concentration of amphibians in the Fish and Amphibian exhibit near the Museum entrance. Be sure to read the excellent interpretive signs. Look carefully at other exhibits to locate hidden amphibians.

BIRDS

One factor which somewhat reduces heat stress in birds is their naturally high body temperature; this means they are a bit slower to feel the heat than other animals. When it does become hot, a bird will disperse body heat into the environment by fluttering its throat to evaporate water through its respiratory tract and mouth. Therefore, a bird that has an open mouth and appears to be panting is cooling its insides!

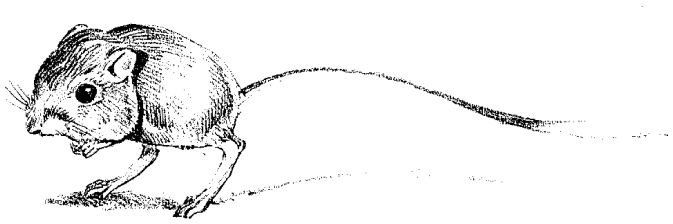


Birds can escape drought by flying to water. Some species, such as the black-throated sparrow and Gambel's quail, seem to be able to survive with little or no free water. However, even these birds will drink water if available. During dry periods, these and other bird species will meet their need for moisture by eating succulent plants and/or insects. Like reptiles, a bird's best water conservation technique is the white stuff it excretes – semi-solid uric acid. Unlike most mammals, birds do not need much water to eliminate waste.

To learn more about birds visit the aviaries (labeled "birds" on the map) or hummingbird exhibit. Check the schedule at the Orientation area for bird interpretations. If you are lucky you might get to see the Harris hawk, kestrel, or barn owl free-flight demonstrations, presented by docents throughout the day.

MAMMALS

Some mammals, such as the kit fox, avoid the heat by spending the hot, summer days in a cool burrow, becoming active during the **crepuscular** and nocturnal hours. Many species of rodents also spend most of their daily lives in burrows underground. On a summer day when the surface of the earth may reach 150 degrees and the humidity is less than 10%, a burrow may be a comfortable 80°F with about 45% humidity. Most of these animals are nocturnal, hunting and feeding once the sun has set. Layers of fat and hair insulate a mammal's body also helping it maintain an even body temperature.



The kangaroo rat is extremely well adapted to the desert. It does not need free water or moisture from succulent plants. Feeding mostly on dry seeds, the kangaroo rat gets all the water it needs from **metabolic** processes. Powerful kidneys concentrate its urine to a semi-solid paste. A clever and complex respiratory system also helps it reduce respiratory water loss. Much of the water that it does lose evaporates into the air of its burrow. The seeds that it stores (and later eats) absorb the moisture.

The jackrabbit has an interesting physiological adaptation to desert survival. Its ears are much larger than they need to be simply to hear; their equally important function is to act as heat radiators. The thin-skinned **membranes** of the ears are full of blood vessels. Blood from deep inside the rabbit's body moves through the ears and radiates the body heat out into the cooler environment. The effectiveness of this process is dependent upon the jackrabbit's behavior. When it is hot, the animal settles in the shade to dissipate heat into the cooler surroundings. Javelinas also spend the hot days in the shade, often near a water source, where it is cooler with lots of mesquite shade.

Of the large mammals, the desert bighorn sheep is one of the few capable of experiencing a body temperature rise of four to five degrees without stress. Because the bighorn's large body mass requires a great amount of heat to raise its temperature, it can tolerate the desert summer quite well, seeking shade and remaining quiet during the hottest hours. At night, when the air cools, the desert bighorn dissipates this extra heat back into the environment.

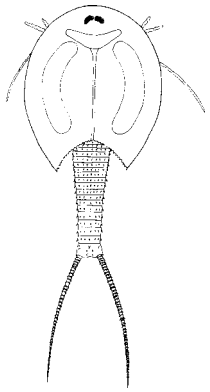
Have you ever wanted to peek at a kit fox inside its burrow? In the Life Underground exhibit, you can observe a number of burrow- and crevice-dwelling creatures and learn more about the advantages of this adaptation. Look on your map to locate other mammal exhibits including the coyote, javelina, mule deer, cats, and bighorn sheep. To find out which mammals live near streams, visit the Riparian Corridor. In the Mountain Woodland you can see and learn more about mountain lions, gray wolves, black bears, porcupines and Mexican gray wolves.

ARTHROPODS

Some **arthropods**, including several species of flies, beetles and spiders, do not avoid the heat at all. They either have techniques for cooling which we do not understand, or can tolerate body temperatures much higher than any vertebrate known. Others remain dormant as eggs or in their pupal or larval stages, buried beneath the surface of the ground in a cooler, moister environment. Here they wait for the soaking rains to soften the soil. When the moisture level is just right, eggs will hatch or pupa will emerge in their adult forms.

Other arthropods must avoid periods of high temperatures. Scorpions and most spiders are nocturnal. The black widow comes out of her crevice to hang in her web at night. The hunting spiders—wolf spiders, tarantulas, and trap-door spiders—live in underground burrows by day and emerge at night to feed, as do many of the flying insects.

The tadpole shrimp and fairy shrimp exist as eggs during the drought in the dried mud below the desert surface. When the rains come, forming temporary rainpools, the eggs soften and hatch. These creatures quickly mature and reproduce, laying new eggs. These eggs can survive in the dried soil for many years, waiting for a rainpool to form.



You can find Arthropods throughout the museum, both in and outside exhibits. You also can find much interpretive information in both the Reptile and Invertebrate building and portions of the Desert Grassland.

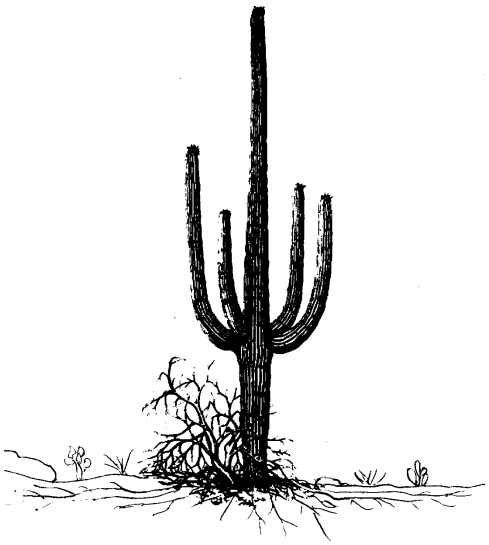
PLANTS

Imagine yourself stuck in one place in the middle of the desert, unable to move. You have to eat and drink water, protect yourself from the heat of the summer and the cold of the winter, deal with drought, and avoid becoming someone's lunch; all without moving an inch! If you can imagine all that you can begin to relate to what being a desert plant must be like. It seems harsh… because we are not well adapted to desert life. However, like desert animals, desert plants have evolved a number of adaptations that help them thrive in the sunny, arid desert.

Desert plants have root systems that are adapted for desert survival. Many desert plants, such as cacti, have huge masses of shallow roots extending out from the plant in all directions. After the slightest rain, these roots quickly absorb water. Other trees and shrubs grow very deep roots. The roots of mesquite, in occasion, may extend 100 feet or more to a constant source of groundwater.

All green plants make food through the chemical process of photosynthesis. Photosynthesis involves gaseous exchange between the plant tissues and the outside environment. This exchange takes place through minute openings called stomates. This process results in some water loss through transpiration. Most adaptations of desert plants are associated with transpiration.

Desert plants have very small stomates. They also have fewer stomates than non-desert plants. In many cacti, stomates lie deep in the tissue of the plant. Most plants open their stomates during the day, but cacti and many other succulents open their stomates during the night, when temperatures are lower and humidity is higher, thereby reducing water loss.



A large surface **transpires** a lot of water when exposed to the drying effects of sun and wind. Many desert plants have evolved small leaves that reduce this water loss. Some plants, such as ocotillo and palo verde, drop their leaves during times of drought to further reduce water loss. The leaves of the creosote bush and stems of ocotillo have a thick, waxy covering, which also helps prevent water loss.

Succulents, such as agave and cacti, soak up water when it is available and store it in the tissues of their fleshy leaves and stems. They survive periods of drought by using this stored water. Some plants, like the saguaro, have pleats or folds that

enable them to expand as they take up water. Pleats contract as they use the stored water. The spines on the stems of many cacti help reduce moisture loss by breaking the drying wind and casting shadows on the plants. Sometimes spines and toxic acids protect these plants from hungry animals.

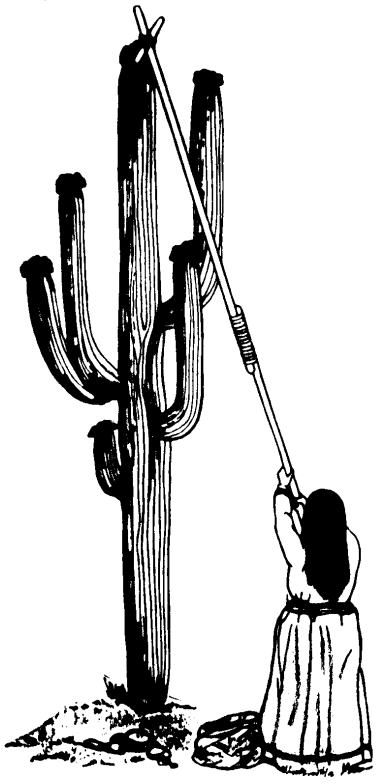
Annual desert wildflowers avoid the drought by spending the dry seasons as seeds. Years may pass before they sprout. When the right amount of rain falls, these short-lived wildflowers germinate, grow, flower, and produce seeds.

When you visit the Museum, carefully examine the fascinating Sonoran Desert plants and identify their adaptations. Pay special attention to interpretive signs in the Cactus Garden and the Convergent Evolution exhibits. A wildflower exhibit is housed in the Reptile and Invertebrate building. The Pollination Gardens highlight plant-animal interactions and interpret methods plants have evolved to attract pollinators.

PEOPLE OF THE DESERT

Different groups of people have lived in the Sonoran Desert Region for thousands of years. The Hohokam culture is thought to have emerged in the desert sometime before 300 BC. Unlike previous cultures in this region, the Hohokam was the first to introduce agriculture and domesticated animals. They built villages along rivers where they raised corn, squash, beans and cotton. They gathered much food from the desert including cactus fruit and mesquite pods, and hunted many desert animals. They developed a unique ceremonial and traditional system.

The Tohono O'odham (Papago), Hia c-ed O'odham (Sand Papago), and Akimel O'odham (Pima) have lived in the Sonoran Desert for hundreds of years. In the past, they gathered all their food, medicine and water from the desert. Today, many tribal elders still know which plants are good to eat and good for medicine. Some O'odham still use traditional methods to grow desert-adapted crops, including squash, tepary beans, dippergourds, corn, watermelon, and devil's claw. Basket weavers still gather beargrass, yucca and other plants to weave baskets.



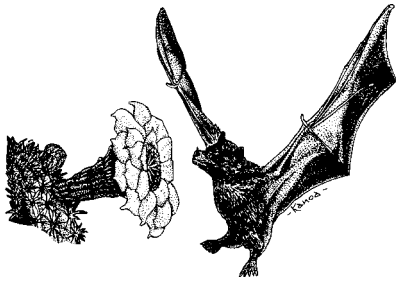
The Seri Indians currently live in two villages by the Gulf of California in Sonora, Mexico. They are a fishing-gatherer people, traveling between seasonal camps during different times of the year. Tribal fishermen have an extensive knowledge of the animals and plants of the sea. Seri women still gather some food and fiber from the desert. Like O'odham baskets, Seri baskets made from local plants are valued worldwide.

For thousands of years, many other tribal groups have lived and traveled throughout the Sonoran Desert, and many still live here today. Many tribal members still visit sacred Sonoran Desert sites and important resource gathering areas as their ancestors had done for hundreds, perhaps thousands, of years.

Throughout the Museum, you can rest under traditional shade ramadas. O'odham basketweavers are often giving demonstrations under the Yucca Ramada. Some docent presentations, especially those on plants, include information on traditional use of desert resources. You can find interpretative information on Desert People in the Earth Sciences cave, Hohokam Agave Field and Mammoth Kill Site.

PROTECTING THE SONORAN DESERT

The Sonoran Desert region is home to many native plant and animal species. Some, like the desert pupfish and giant saguaro are **endemic**, not found anywhere else on earth! Most species of Sonoran Desert plants and animals are protected or regulated by law.



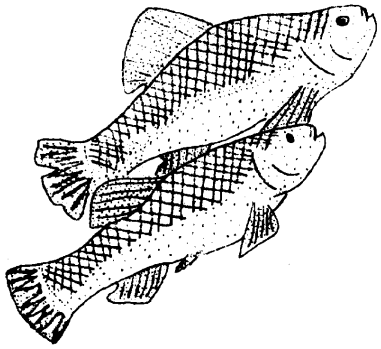
The federal Endangered Species Act was written to protect America's wildlife. When the population of a species begins to decline, the species may be listed as a **Threatened Species**. If its numbers become so low that it is in danger of becoming extinct, it will be listed as an **Endangered Species**. Threatened and endangered species are protected by this law.

Lesser long-nosed bat (Endangered)

Sonoran Desert plants are also protected by the Native Plants Act. In most cases, it is against the law to remove native plants, including their flowers, fruits and seeds, from the desert. It is even illegal to take dead cactus skeletons from the desert.

One of the major reasons why animals and plants become threatened, endangered and extinct is because the areas in which they live are changed in such a way that it is destroyed or fragmented. **Habitat** destruction and fragmentation occurs as wilderness is turned into cities, housing developments, ranches, or mines, and as people drive off-road vehicles through the undeveloped desert. As groundwater is pumped out of the ground for drinking water, streams and water holes become dry. Fish, amphibians, and other animals that depend on these wet areas loose their habitat and may disappear. In essence, their habitat is completely destroyed or it becomes so small that it no longer supports the species.

Pima County planners are trying to come up with better development plans for new houses and shopping areas. Part of this Sonoran Desert Conservation Plan includes leaving open spaces for wildlife. Water conservation is an important step we can all take to conserve ground and surface water. Learning more about conservation issues and joining local conservation groups. Can you think of other ways you can help protect our beautiful desert?



Endangered Desert Pupfish

The Desert Museum has some Threatened and Endangered species on display. When you visit, look for signs identifying these animals. The Museum also has established successful captive breeding programs for some of these species.

REMEMBER…

In the study of natural history and the environment, the terms "good" and "bad" do not apply. A plant, animal, the climate, or a geologic feature is neither good nor bad…but they are important. Living things are all part of a community filling a **niche** within a complex web of life. To truly understand the workings of our planet, we must attempt to remove many of our subjective thoughts and feelings. Good, bad, special, or enemy, are terms that get in the way of an objective look at the natural world.

For more information on the Sonoran Desert and Desert Museum, visit our web site at www.desertmuseum.org

GLOSSARY

Adaptation - any physical (shape and size of body parts, placement of blood vessels, etc.), physiological (rate of metabolism, production of concentrated urine, etc.) or behavioral (use of burrows, folding leaves, etc.) trait that enables an organism to survive and reproduce in its environment

Arthropod - largest group of animals, characterized by having a segmented body, jointed appendages, and an exoskeleton (hard outer covering)

Crepuscular - animal active at dawn and dusk

Decomposer - organism that breaks down dead plant and animal materials into their components (e. g. bacteria)

Diurnal - active during the day

Ecology - study of the inter-relationships between plants, animals and their environment

Ectothermy - animals that maintain a steady body temperature by moving to where it is cool or warm

Endemic – restricted in range to a limited geographical area

Endothermy - animals that maintain a steady body temperature by metabolic means

Estivation - period of severely reduced activity in response to summer climate

Food Chain - flow of energy; food from plants to animals that eat plants, to animals that eat animals, to organisms that eat dead things

Habitat - area in which a plant or animal naturally lives; it includes necessary food, water, shelter and space

Hibernation – period of severely reduced activity in response to winter climate

Interrelationships - interactions that exist among living and non-living things

Larva - form of an organism that is immature; very different from the adult

Membrane - thin body layer

Metabolism - sum of all the chemical reactions within cells; the storing and releasing of energy by chemical means

Niche - role an organism plays in its community, especially its position on the food chain

Nocturnal - active during the night

Photosynthesis - chemical process in plants whereby carbon dioxide and water, in the presence of sunlight and using chlorophyll, are combined to produce basic sugars

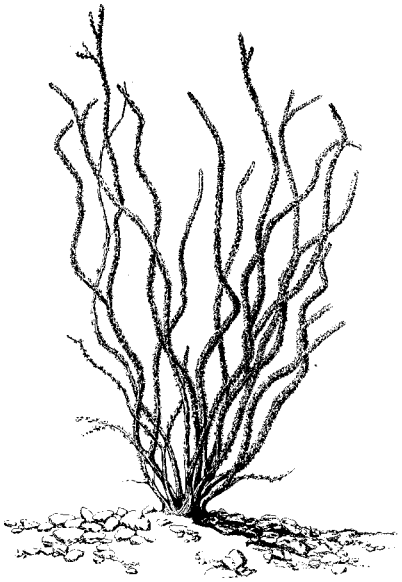
Pollination - movement of pollen from the male to the female part of a flower

Pupa - stage of metamorphosis in which the tissues of an insect are reorganized from a larval to an adult form

Succulent - plants such as cacti that store water in fleshy leaves, stems or roots

Stomates – specialized openings in a plant's leaves that allow for gaseous exchange; analogous to the nose in humans

Transpiration – evaporation of water through stomates; the movement of water through plants from the roots through their stems out the stomates into the atmosphere; it functions in moving nutrients up the plant, CO_2 down the plant, and as a cooling process similar to sweat in humans



Name _____ Date_____

REVIEW QUESTIONS

Instructions: Read The Sonoran Desert and answer the following questions.

1. List six characteristics of a desert climate.
2. Clearly explain the two geographic conditions that cause dry climates. Use diagrams with your answer.
3. Do you live in an Arizona desert? If so, which one?
4. Describe the physical characteristics of the Sonoran Desert.
5. In which two countries is the Sonoran Desert found? Is Nogales in the Sonoran Desert?
6. Will you find Bengal tigers at the Arizona-Sonora Desert Museum? Why or why not?
7. How are estivation and hibernation similar and different? Give an example of an animal that estivates and one that hibernates.
8. Where might you find a gecko (type of lizard):
   a. during the winter ? Why?
   b. on a hot summer day at noon when the temperature is 110°F? Why?
   c. on a summer morning when the temperature is 80°F? Why?
9. How are desert tortoises adapted to live in the desert?
10. Where would you find most desert amphibians much of the year?
11. The desert spadefoot tadpole hatches from an egg and goes through metamorphosis in less than two weeks. Why is this rapid metamorphosis important in the desert?
12. List and describe four adaptations of desert birds.
13. What are some advantages to spending a hot, dry day in a burrow?
14. How are bighorn sheep adapted to the desert?
15. Compare and contrast the life cycle of a spadefoot toad to that of a tadpole shrimp.
16. List and describe five adaptations of cacti to the desert.
17. How do annual desert wildflowers avoid the drought?
18. List ways the Hohokam, O'odham, and Seri have used the resources of the desert.
19. Explain why some species of native plants and animals are threatened or endangered in the Sonoran Desert Region.
20. What is being done to protect native plants and animals? What can you do to help?

EXTENSION ACTIVITIES

1. Invent a well-adapted desert animal. Diagram your animal and describe its behavioral, physical, and physiological adaptations to life in the Sonoran Desert.
2. Invent a well-adapted desert plant. Diagram your plant and describe its adaptations to life in the Sonoran Desert. Be sure to consider roots, stems, leaves, flowers and seeds.
3. Compare your family's current lifestyle to that of an O'odham family living in the Sonoran Desert 250 years ago. Describe differences in homes, methods of travel, gathering and preparing food, clothes, water use, entertainment, and curing illness. You may need to do some research.
4. Imagine experiencing a day in the life of a tarantula or saguaro; being a palo verde beetle undergoing metamorphosis or a kestrel searching for prey; walking along a riparian corridor or on the shores of the Gulf of California. Before or after the trip to the Museum, write and illustrate a desert story based on field observations, research, and Museum exhibits.

RESEARCH PROJECT

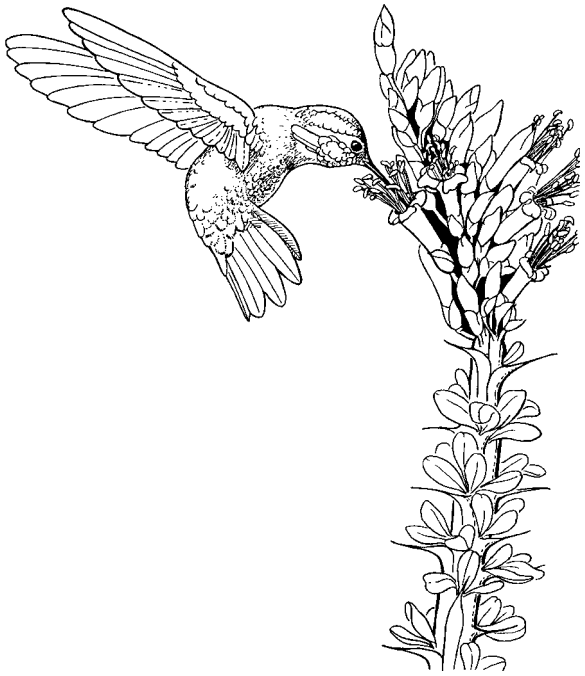
Choose from a variety of fascinating topics related to the Sonoran Desert on which to write a research paper. Some suggestions include:

-- *desert plants or animals, local Threatened and Endangered species, pollination, nocturnal creatures, venomous animals, predators, riparian areas, mountain islands, desert grasslands, climate changes over geologic time, ice age, fossils, megafauna, local dig sites, cave formation, dune formation, water issues, prehistoric people, resource use by Native Americans, Hohokam or O'odham agriculture and architecture, and much more!*

While doing internet research, be sure to visit our web site at www.desertmuseum.org. Write for information to various organizations including environmental organizations, museums, botanical gardens, and State and National Parks and Monuments.

OUTDOOR OBSERVATIONS

Observations taken on school grounds, at a nearby park or within your neighborhood offer many opportunities to sharpen your senses and increase your awareness of the natural world around you. Even in urban areas, animals are prevalent, especially arthropods and birds, and a quiet observer can make many fascinating discoveries.



Choose an observation area. Spend about 30 minutes at different times of the day and year at your site. Some things to look for include animals, animal signs (tracks, scat, etc.), numbers and varieties of plants, and signs of man. Record your observations in a field journal and be sure to date each entry. Use field guides to identify any unknown species and add some drawings. Review your entries periodically and identify seasonal changes and patterns. Present your findings to your class.

POST-VISIT ACTIVITIES

ACTIVITY 1: EXPLORER'S GUIDE AND TRIP DISCUSSION

TEACHER INFORMATION

OBJECTIVES

Students should:

- discuss the trip to the Arizona-Sonora Desert Museum,
- review and discuss the answers students found to the Explorer's Guide, and
- share the information they learned from a docent interpretation and any interesting discoveries they made at the Museum

MATERIALS

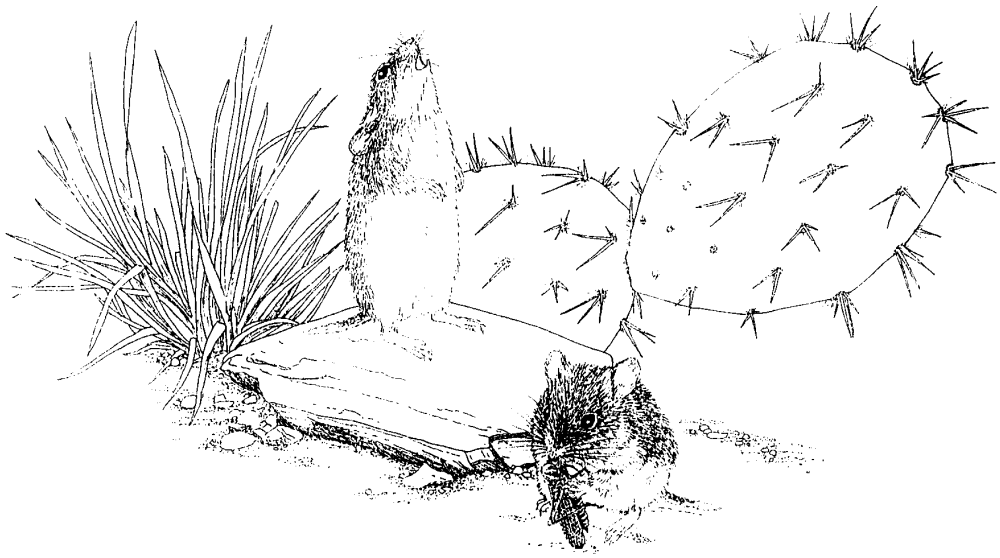
completed *Explorer's Guide*, other notes taken during the field trip to the Arizona-Sonora Desert Museum

DOING THE ACTIVITY

1. Discuss the trip in general with the class.
2. Review and discuss the answers students found to the Explorer's Guide as a class.
3. Divide the class into small groups and have them share the information they learned from a docent interpretation and any interesting discoveries they made at the Museum.
4. Share a subset of the most interesting discoveries made at the Museum as a class.

EXTENSION

- Have students research areas of interest.
- Have students find out about ongoing research projects conducted by Desert Museum scientists. These are mentioned in our website.



Activity 2: CAREER FOCUS ACTIVITY

TEACHER INFORMATION

OBJECTIVES

Students should:

- become familiar with the diversity of careers at a natural history institution such as the Desert Museum,
- analyze sample Museum projects and determine which departments and employees would interact to complete each task, and
- select a career of interest to research

MATERIALS

copies of *Handouts 1 and 2* for each student, dictionaries

VOCABULARY

accounting, botany, docent, finance, geology, herpetology, ichthyology, mammalogy, mineralogy, ornithology, quarantine

DOING THE ACTIVITY

Setting the Stage:

1. Divide the class into groups of two to three students.
2. Ask students to make a list of different types of jobs they think people do at the Desert Museum. Their list might include: animal care, make signs, etc.
3. As a class, generate a list of job titles on the board.
4. Next, have students group the list of job titles into departments. (You may want to give students an example of departmentalization based on the organization of your school district.)
5. After students have thought through their own system of organizing Museum staff, pass out *Handout 1*. Explain to them that their system of organization may be perfectly acceptable, even if it doesn't match the organization presented on the handout. (Note: The job title and department information on this handout is simplified for the purposes of this activity.)
6. Have students review the job titles and Museum departments. If they are unfamiliar with certain job titles, have them look these up in a dictionary. You may need to provide students with general job descriptions for some job titles.

Part 1: Who Does What?

1. Give each student a copy of *Handout 2*. Have them read each task or situation and determine (with their group members) which Museum personnel would be responsible for each task.
2. The answers listed below indicate which staff at the Desert Museum generally completes each task. However, other answers are acceptable; use your own judgment. Review and discuss answers with the class.

Answer Key to Who Does What?

The most pertinent position relative to the task is the one provided as an answer, however, other people with other job titles could also be involved.

1. Education Specialist
2. Herpetology Keeper
3. Shopper
4. Graphic Technician
5. Mammalogy & Ornithology (M & O) Keepers
6. Director of Human Resources
7. M & O Keepers
8. Information Specialist & Web Master
9. Gift Shop Manager
10. Publications Manager
11. Executive Director
12. Food Services Assistant
13. Custodian
14. Docents
15. Mineralogy Collections Manager
16. Director of Conservation & Research
17. Volunteer Coordinator
18. M & O Keepers
19. M & O Records and Quarantine Technician
20. Communications Officer

Part 2: The Big Projects: Working Together

Have students read each project description, then analyze each to determine the steps the Museum might follow and, those departments and personnel that might be involved. Students may need additional clues and guidance.

Answer Key to The Big Projects: Working Together

The following answers are examples of posible ways in which the task at hand is managed, however, other possible answers can be correct.

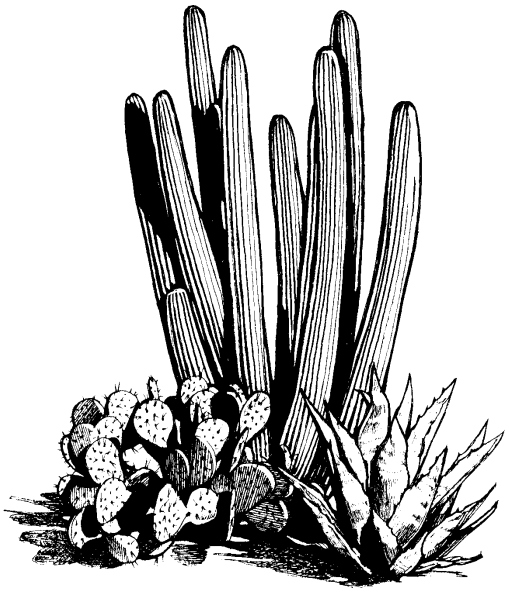
Coati Exhibit

- The Director of Living Collections presents the idea as a written proposal to the Executive Director.
- The Executive Director authorizes the project and directs the appropriate departments to become involved in the creation of the new coati exhibit
- The Director of Development & Membership involves his/her department (Membership & Donor Services Coordinator, Communications Officer) by searching for funding to carry out the project.
- The Finance Department (Director, Accounting Manager, Bookkeepers) sets-up accounts to keep track of the money used to create the new coati exhibit
- The Department of Mammalogy & Ornithology (Collections Manager, Keepers, Director of Living Collections) determines the built-in equipment necessary to care for the coatis
- The Department of Botany (collections manager, horticulturist and gardeners, Director of Living Collections) determines what plants should be in the exhibit and the built-in equipment necessary to care for them
- The Department of Design & Planning (Director, Graphic Designer, Graphic Technician) designs the exhibit to be functional and aesthetically pleasing
- Independent contractors build the exhibit alongside the Maintenance Department with supervision from the Design & Planning Department

- Horticulturist and Gardeners add the plants
- The Directors of Education, Natural History, and Design write and design the signs
- The Directors of Development & Membership and Guest Services plan a special opening day for the public to come and see the coati troop in their new exhibit home
- The Department of education prepares the Docents for the opening day events
- M & O Collection Managers and Keepers release the coati troop into their new exhibit
- The Departments of Guest Services and Maintenance coordinate all efforts during the opening day events

The Basket Weavers Conference

- The Director of Conservation & Research presents the idea as a written proposal to the Executive Director
- The Executive Director authorizes the project and directs the appropriate departments to become involved in the creation of the *Basket Weavers Conference*
- The Director of Development & Membership involves his/her department (Membership & Donor Services Coordinator, Communications Officer) by searching for funding to carry out the conference
- The Finance Department (Director, Accounting Manager, Bookkeepers) sets-up accounts to keep track of the money used to carry out the conference
- Staff under the Director of Conservation & Research contacts the participants for the conference and coordinate their travel, room and board, etc.
- The Department of Development & Membership plans and enacts the advertising for the conference events
- The Directors of Development & Membership and Guest Services plan a day for the public to come and take part on special events of the conference
- The Department of education prepares the Docents for the conference day events
- The Departments of Guest Services and Maintenance coordinate all efforts during the conference



Name _____ Date_____ ***Handout 1***

CAREER FOCUS: Simplified listing of departments and job titles at the Arizona-Sonora Desert Museum

Administration
- Executive Director
- Associate Director
- Director of Human Resources
- Administrative Secretary

Design & Planning
- Director
- Exhibit Writer
- Graphic Designer
- Graphic Technician

Development & Membership
- Director
- Communications Officer
- Membership & Donor Services Coordinator

Finance
- Director
- Accounting Manager
- Bookkeeper

Guest Services
- Director
- Volunteer Coordinator
- Ticket Window
- Custodians
- Food Services Supervisor
- Food Services Assistants
- Security Guards

Gift Shop
- Manager
- Cashiers

Maintenance
- Manager
- Electrician, carpenter, plumber
- General Technician

Warehouse
- Purchasing Agent
- Shopper

Publications
- Publications Manager

Education
- Director
- Administrative Assistant
- Reservations Coordinator
- School and Public Programs Manager
- Docent Program Manager
- Education Specialists
- Information Specialist and Web Master
- Docents (volunteers)

Science Division

Science Management Team
- Director of Conservation & Research
- Director of Natural History
- Director of Living Collections

Research & Science Outreach
- Senior Research Scientist
- Outreach Project Manager

Department of Botany
- Collection Manager
- Horticulturists
- Gardeners

Department of Earth Sciences
- Geology Collections Manager
- Mineralogy Collections Manager

Department of Herpetology
- Collections Manager
- Keepers

Department of Invertebrate Zoology & Ichthyology
- Collections Manager
- Keepers

Department of Mammalogy & Ornithology
- Collections Manager
- Records & Quarantine Technician
- Keeper

Plus lots of volunteers in every department!

Name_____ Date_____ ***Handout 2***

PART 1: WHO DOES WHAT?

Instructions: There's a lot to do at the Desert Museum! Read each situation description or task listed below. Refer to the Museum job list (*Handout 1*) and determine which Museum personnel would be responsible for each task. Write their job title(s) in the space provided.

1. Writing educational activities for students visiting the Desert Museum.
   _____
2. A rattlesnake is discovered on the Desert Loop Trail and needs to be removed.
   _____
3. Picking up wood, paper towels and office supplies in town.
   _____
4. Putting new signs in the Pollinator Gardens.
   _____
5. A bird on exhibit seems sick.
   _____
6. Advertising, interviewing, and hiring a new employee in the Botany Department.
   _____
7. Cleaning the bird cages
   _____
8. Putting new information for students on the web site.
   _____
9. Purchasing new books for the gift shop.
   _____
10. Editing the new book *A Natural History of The Sonoran Desert.*
    _____
11. Participating in an exchange program between a proposed museum in the desert of Israel and Jordan, and the Arizona Sonora Desert Museum.
    _____
12. Preparing food for Museum visitors.
    _____
13. Keeping the paths swept and clean.
    _____
14. Presenting educational information on skulls and fossils to Museum visitors.
    _____
15. Purchasing new minerals for the Museum's mineral collection and display.
    _____
16. Meeting with Seri Tribal Elders to discuss conservation efforts for the San Esteban Chuckwalla.
    _____
17. Training volunteers to help Museum staff and greet visitors.
    _____
18. Feeding the otter.
    _____

19. A slightly injured hawk is brought to the Museum. It needs to be observed for 60 days before it can be put with the other birds. Who monitors it and keeps records of its progress?
    _____
20. Submitting press releases to publicize a special event at the Museum.
    _____

PART 2: THE BIG PROJECTS: WORKING TOGETHER

There are a lot of long term projects going on the Desert Museum. It's very important that our staff members are able to communicate well with each other and work together to get these jobs done.

Instructions: Read the project descriptions below. Refer to *Handout 1* to help you complete the following:

1. Identify and outline the steps that need to be followed in order to complete each project.
2. Determine and list which departments and personnel might be involved in each step of the project.

Project 1: Coati Exhibit

The new coati exhibit is finally completed! It took a lot of work from many different departments and lots of funding from generous donors.

Project 2: The Basket Weavers Conference

In the winter of 1999, basket weavers from different tribes throughout the southwest held a four-day conference at the Desert Museum. On the last two days, this event was open to the public, and visitors were able to meet with weavers and learn how they make baskets from native plants.