Arizona-Sonora Desert Museum Newsletter Summer 1989

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PLEASE RETURN

Mountain Islands

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Arizona-Sonora Desert Museum Newsletter
Volume 10, Number 2 Summer, 1989

The Arizona-Sonora Desert Museum
Co-Founded in 1952 by
Arthur N. Pack and William H. Carr

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sonorensis is the Latin, scientific term indicating the species classification of many plants and animals of the Sonoran Desert region.

Cover photo: The beauty of fall color is captured at Cave Creek in the Chiricahua Mountains, one of the "mountain islands" so much a part of the Sonoran Desert Region. When temperatures reach near freezing, plants retrieve all nutrients they can back into their stems. When the green pigment chlorophyll is withdrawn, other pigments are revealed, resulting in the colors of fall as seen in this maple. Photo by Peter Kresan.

We apologize... In the last issue of sonorensis, *Docent Susan Small was incorrectly identified in a photo caption on page 5. We apologize, Susan!*

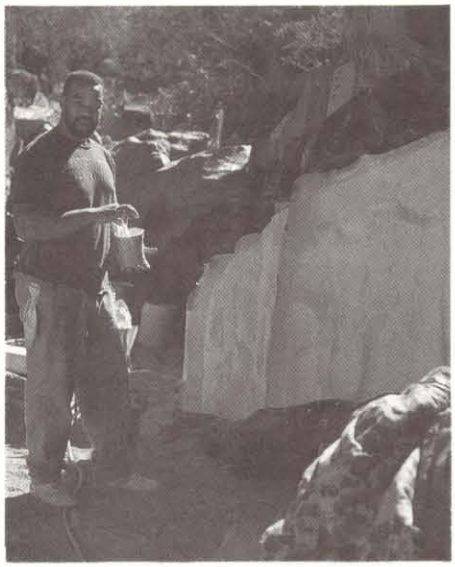
MUSEUM NEWS

Parade Magazine Lists ASDM as one of "10 Best"

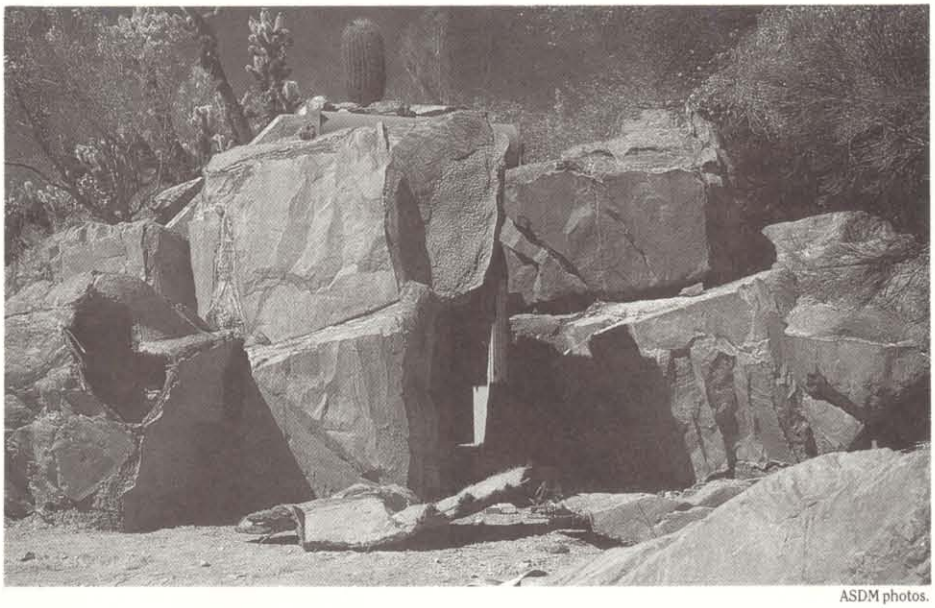
The Arizona-Sonora Desert Museum is one of the "10 best" zoos in the nation, according to a poll published in the Sunday, March 26, 1989 edition of *Parade*, the Sunday Newspaper Magazine. In seeking to identify America's 10 best (and worst) zoos, *Parade* interviewed experts and distributed questionnaires to 200 zoo professionals and 200 animal welfare activists. ASDM ranked among the top 10, based upon the results. *Parade* is read by an estimated 65 million people each week. Also, the March, 1989 issue of *Town & Country* magazine featured ASDM in an article on the "resurgence of American zoos" as one of the top six in the nation, and *Modern Maturity*, the publication of the American Association of Retired Persons ran a story in the April–May, 1989 issue highlighting the Museum as one of the "finest" in the country.

April, 1989 ends with most members in ASDM history

As of April 30, 1989, the Desert Museum had more memberships on record than at any time in its history — 18,054! That means more than 45,000 individuals are involved with and support the Museum. During this fiscal year, the Museum has been using a grant from the Institute of Museum Services to implement a new member campaign. With

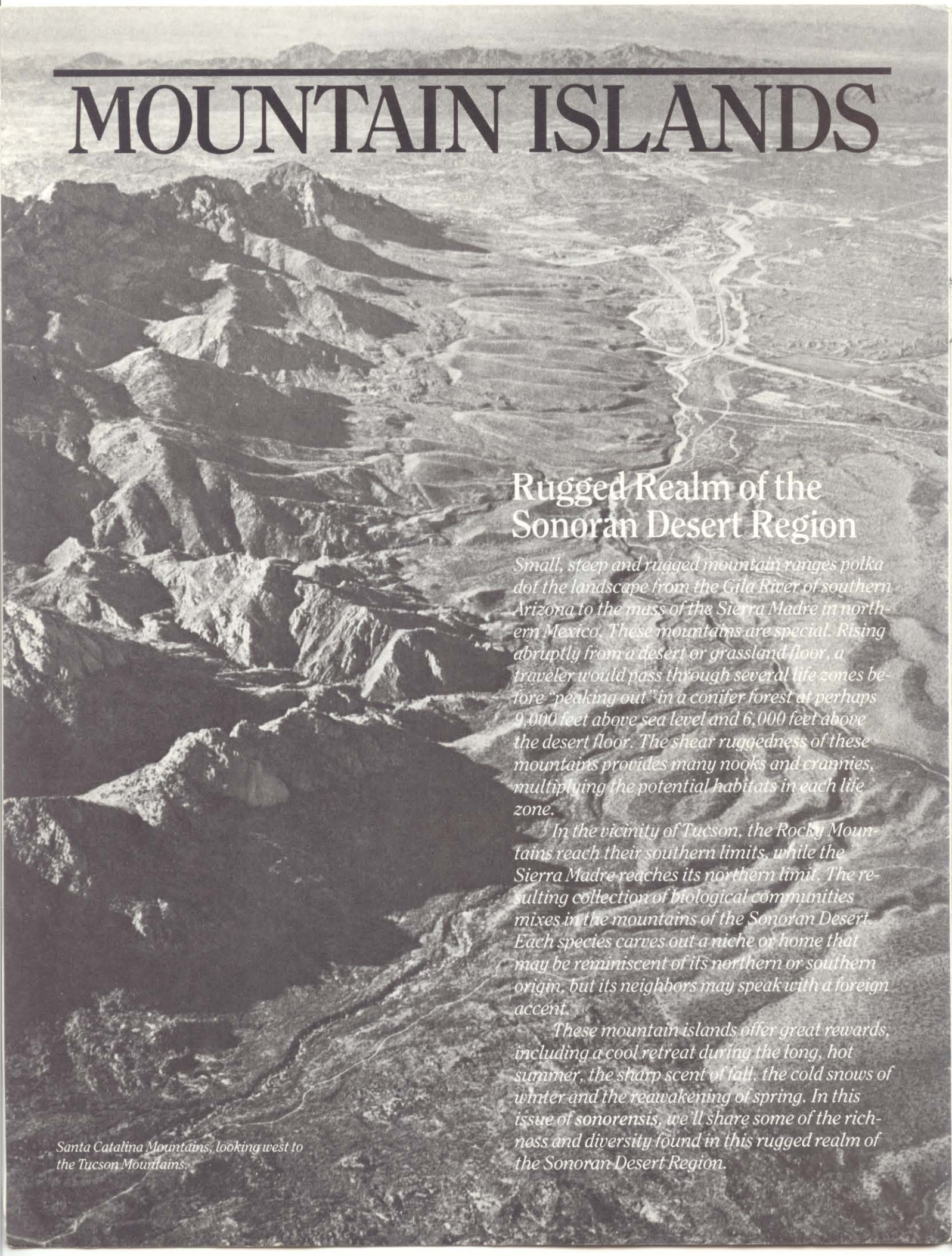


Can you find the puzzle piece? Curtis Bishop (left) of Santa Rita Enterprises applies the final coats of latex to living rock, forming the mold for artificial rockwork at the entrance of the renovated Life Underground exhibit. The final concrete cast is a mirror image of the original rock, and is present in the photo below. Work on the Life Underground exhibit began in February this year and will be completed this summer.



ASDM photos.

MOUNTAIN ISLANDS



Rugged Realm of the Sonoran Desert Region

Small, steep and rugged mountain ranges polka dot the landscape from the Gila River of southern Arizona to the mass of the Sierra Madre in northern Mexico. These mountains are special. Rising abruptly from a desert or grassland floor, a traveler would pass through several life zones before "peaking out" in a conifer forest at perhaps 9,000 feet above sea level and 6,000 feet above the desert floor. The shear ruggedness of these mountains provides many nooks and crannies, multiplying the potential habitats in each life zone.

In the vicinity of Tucson, the Rocky Mountains reach their southern limits, while the Sierra Madre reaches its northern limit. The resulting collection of biological communities mixes in the mountains of the Sonoran Desert. Each species carves out a niche or home that may be reminiscent of its northern or southern origin, but its neighbors may speak with a foreign accent.

These mountain islands offer great rewards, including a cool retreat during the long, hot summer, the sharp scent of fall, the cold snows of winter and the reawakening of spring. In this issue of sonorensis, *we'll share some of the richness and diversity found in this rugged realm of the Sonoran Desert Region.*

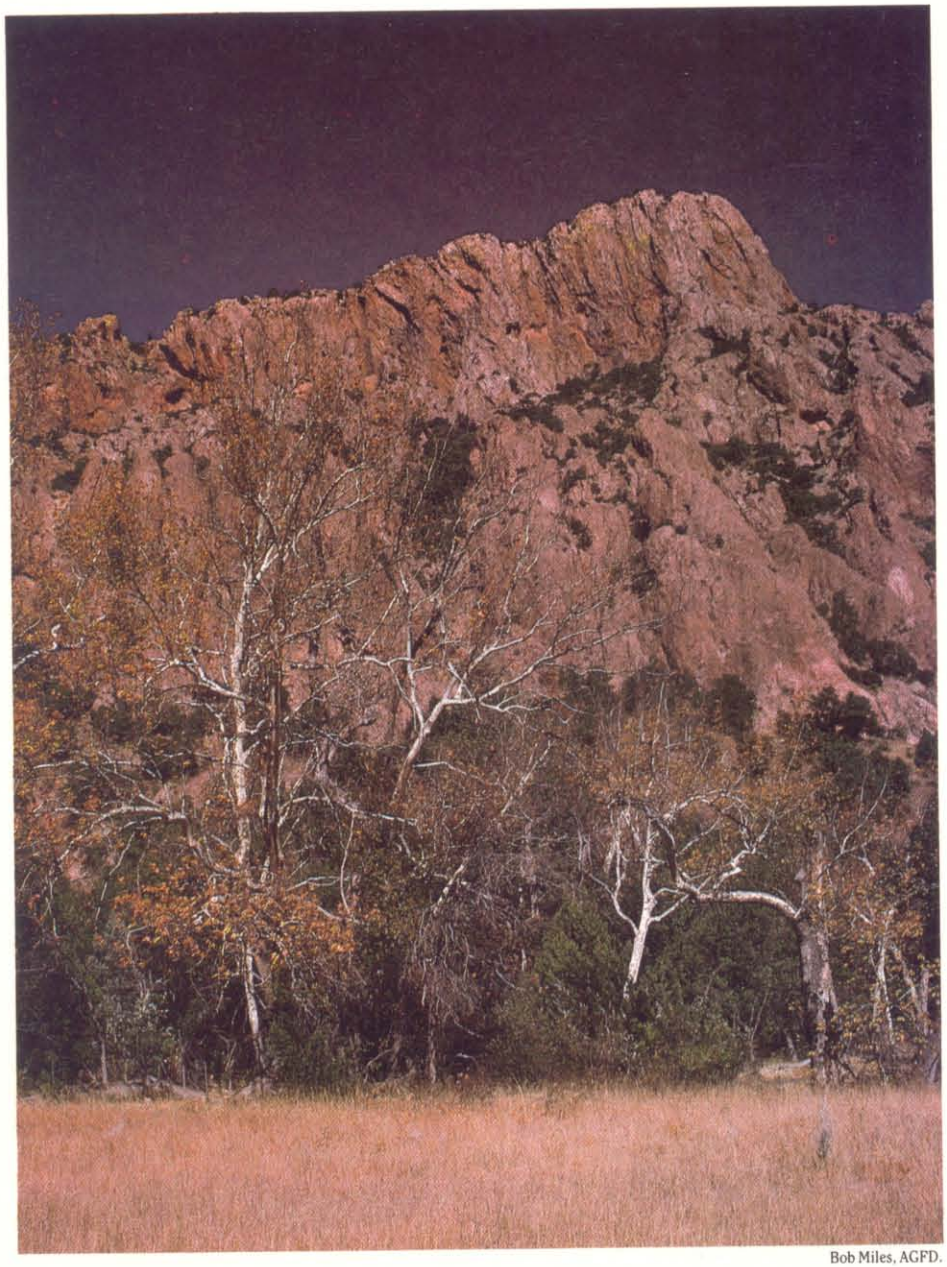
Santa Catalina Mountains, looking west to the Tucson Mountains.

The Geologic Origin of "Mountain Islands" in the Sonoran Desert

by Dave Thayer, Curator of Earth Sciences

Most of the Sonoran Desert lies within the Basin and Range physiographic province. This province is characterized by parallel mountain ranges and basins, all trending approximately north to south. The basins are filled up to several miles deep with debris eroded from the surrounding mountain ranges. Several of these ranges approach or exceed 10,000 feet in elevation. The basins average less than 2,500 feet above sea level in the Sonoran Desert.

Our "mountain islands" provide great habitat diversity for living organisms. However, the ranges are separated by hot desert basins, leaving them in partial biological isolation from each other. The diversity of habitat and the insular character of the ranges promote the rich variety of animal and plant life that we exhibit at the Desert Museum. But how did this unique physiography develop?



Bob Miles, AGFD.

Chiricahua Mountains.

Historical Perspective

The story unfolds in four chapters, corresponding to the four geologic eras of Earth's history. In a nutshell, here is the most important event of each era in shaping the Sonoran Desert.

Precambrian Era. About 1,700 million years ago, a great mountain range formed in this region, and then eroded completely away, back down to sea level. Eroded rocks of those mountains' roots (mainly schist and granite) form the "basement" for much of the Sonoran Desert.

Paleozoic Era. From about 550 to 250 million years ago, inland seas came and went many times, leaving behind thick layers of sediments. These hardened into limestone, sandstone, and shale, covering the Precambrian basement and resembling the layers of the Grand Canyon.

Mesozoic Era. From 250 to 65 million years ago, the flat-lying layers of

Peter Kresan.

Paleozoic rocks were disrupted by increasingly intense igneous (molten rock) activity. Volcanoes erupted at the surface while large bodies of granite formed deep beneath the surface.

Cenozoic Era. This era dates 65 million years ago to present. A renewal of igneous activity occurred in the middle of this era. Afterward, the Basin and Range disturbance gave our landscape its distinctive character during the period from about eight to 15 million years ago.

Now we will focus on the variety of Sonoran desert mountains, and see how each formed and where the various ranges fit into the four chapters of Earth history.

Mountain Varieties

Sonoran Desert mountains formed in one or a combination of three ways:

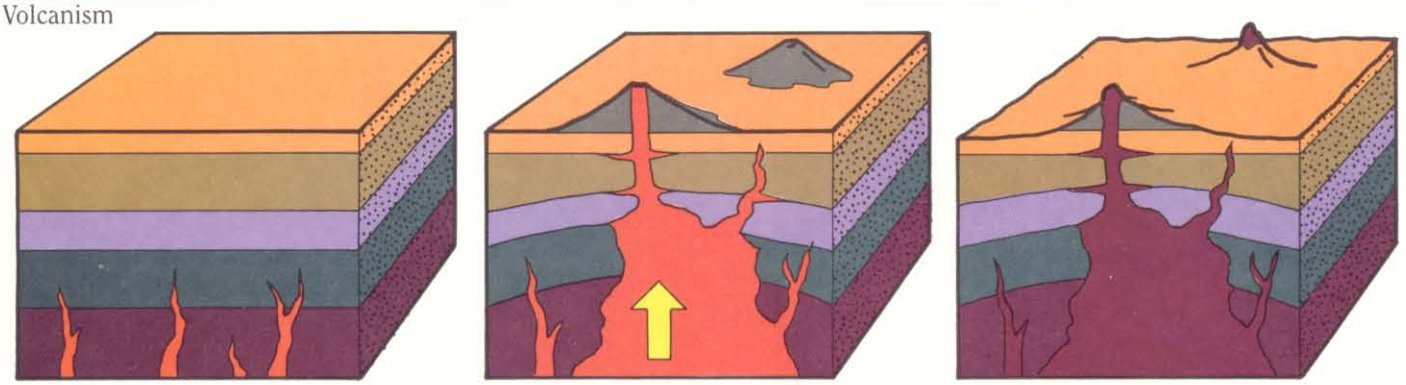
1. Volcanism — Pinacate and Tucson Mountains
2. Plutonism — Santa Catalina and Santa Rita Mountains
3. Block Faulting — Most of the Sonoran Desert mountains to some extent.

As most of Earth's mountains were also formed in one of these three ways, it is worthwhile to compare them. Keep in mind as we proceed that most mountain-building processes on Earth result directly or indirectly from plate tectonics, the global movements of rigid sections of the crust. Also, gravity is continuously at work, pulling denser rock masses toward the core, while lighter rocks "float" or are thrust upward, enhancing a mountain's elevation. Finally, erosion sculpts and degrades all mountains, slowly wearing them down to sea level.

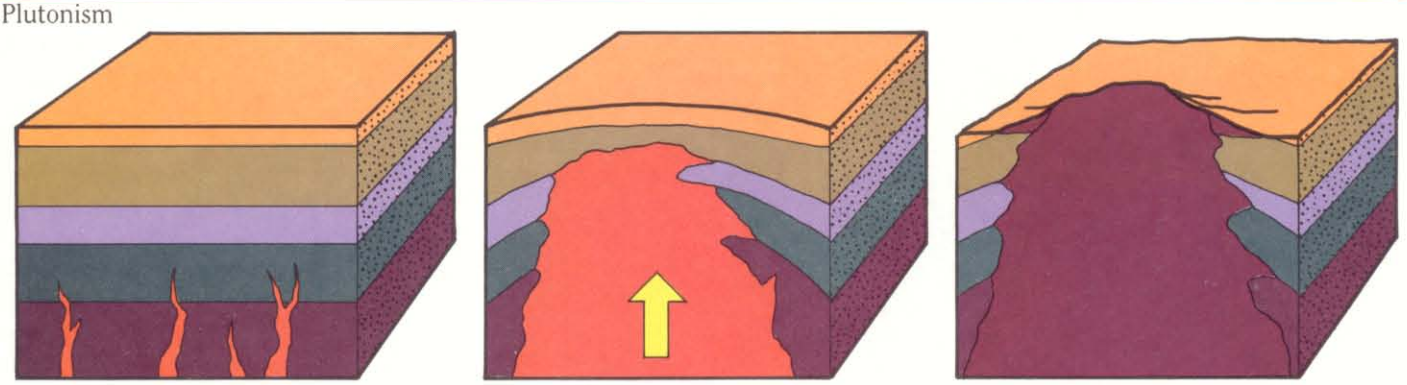
Volcanism

Perhaps the easiest kind of mountain to understand is the volcano, a heap of erupted lava and cinders. Volcanoes are the surface expression of more extensive igneous activity that usually originates several miles below Earth's surface. As huge chambers of molten magma are subjected to internal stresses, magma may be forced upward to the surface. There it erupts as rivers of lava, fountains of cinders and clouds of gas and ash.

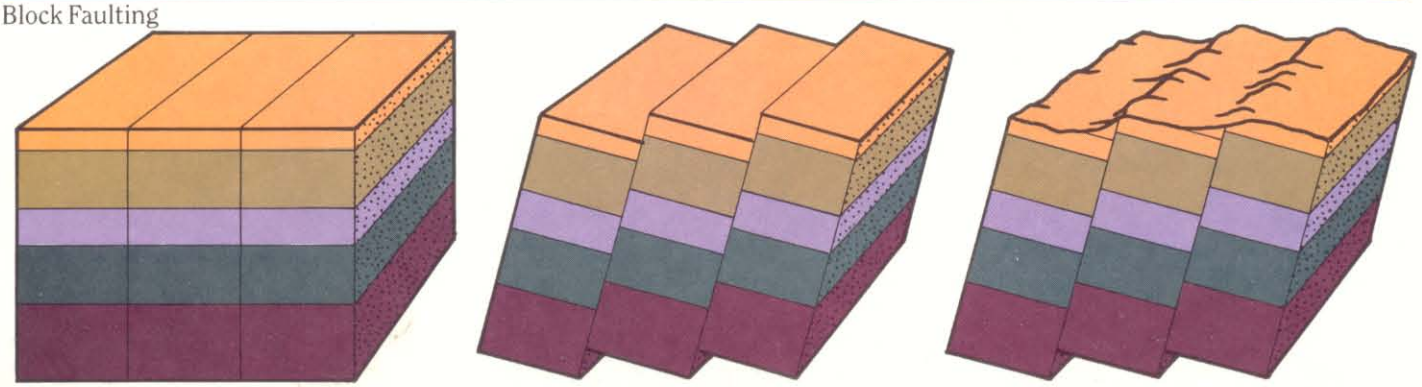
Volcanism



Plutonism



Block Faulting



The style of volcanic eruptions can vary from tame and predictable to catastrophic. The eruptions that formed Santa Clara Volcaño, centerpiece of Sonora's Pinacate Volcanic Field, were of the former category. Analogous to modern eruptions in Hawaii, Santa Clara was relatively easy-going for a volcano. The resulting mountain also parallels the Hawaiian ones — large, low and rounded (though later flanked and crowned by cinder cones), the mountain is aptly called a shield volcano.

All the Pinacate eruptions, including the more violent maar explosions, occurred in the geologically recent past, at the end of the Cenozoic Era.

At the opposite extreme, the Tucson Mountains formed as a series of explosions of unimaginable proportions. The eruptions were analogous to Mount St. Helens, but hundreds or even thousands of times as powerful.

The jumbled chaos that we see today as we drive over Gate's Pass from Tucson to the Desert Museum is the result. We are looking at the eroded remains of a huge caldera, or collapsed volcano. The store-sized to mall-sized blocks of various shades of tan, brown and grey are chunks of the caldera wall that slumped down into the ash pit of the caldera. Everything you see from Gate's Pass Road — even the high mountains — were down in that pit. The Tucson Mountain eruptions occurred at the end of the Mesozoic Era, at the same time as other violent Sonoran Desert volcanoes: the Silverbell and Sierrita Mountains, for example.

At the close of their periods of violence, erosion attacked the volcanoes, creating diverse habitats that soon became home to equally diverse plants and animals.

Plutonism

Plutons are bodies of igneous rock that slowly crystallized from magma while still deep beneath the Earth's surface. Many of the Sonoran Desert's largest mountain islands are built around granite plutons.

A combination of processes brings these deep rocks up to the surface. Perhaps the most important of these processes is isostatic rebound, the tendency for floating objects to seek their own level. Like an iceberg that floats nine-tenths under water, the Santa Catalina, Pinaleño, Santa Rita, and San Pedro Martir Mountains (as examples) have deep granite cores beneath the surface. The granite rose to its present level because it is lighter in weight, on the average, than the surrounding rocks. When you stand at Windy Point on Mt. Lemmon, looking out over the Wilderness Granite, you are seeing the top of a huge rock body that literally floated upward, forcing its way through the surrounding rocks. These surrounding rocks mostly slid off the flanks or top into the basins below. There is mounting evidence that the Tucson Mountains themselves may have slid off the flanks of the top of Mt. Lemmon! While this is still highly conjectural, it illustrates the dynamic movements that are possible, given enough time, in our so-called "everlasting hills."

Peter Kresan.

The shadows of sunset throw high relief on the Tucson Mountains, remains of a huge volcano that once erupted with unimaginable violence.

Block Faulting

Many of our Sonoran Desert mountains were here already, before the Basin and Range block faulting episode of eight to 15 million years ago. But almost all our mountains stand higher above the basins than they did before the episode occurred. Also, new mountains were formed during the period, although these are not as a rule very large. Basin and Range block faulting in the Sonoran Desert was caused by tensional stress in the crust. The causes of this pull-apart stress are not known for certain; but the results are relatively easy to visualize.

Imagine a set of encyclopedias on a shelf. Tilt them all over a little way — you will see that they span a wider area than before. Similar widening occurs as a result of tension in the crust. The cracks separating the leaning books are analogous to the north-south trending faults.

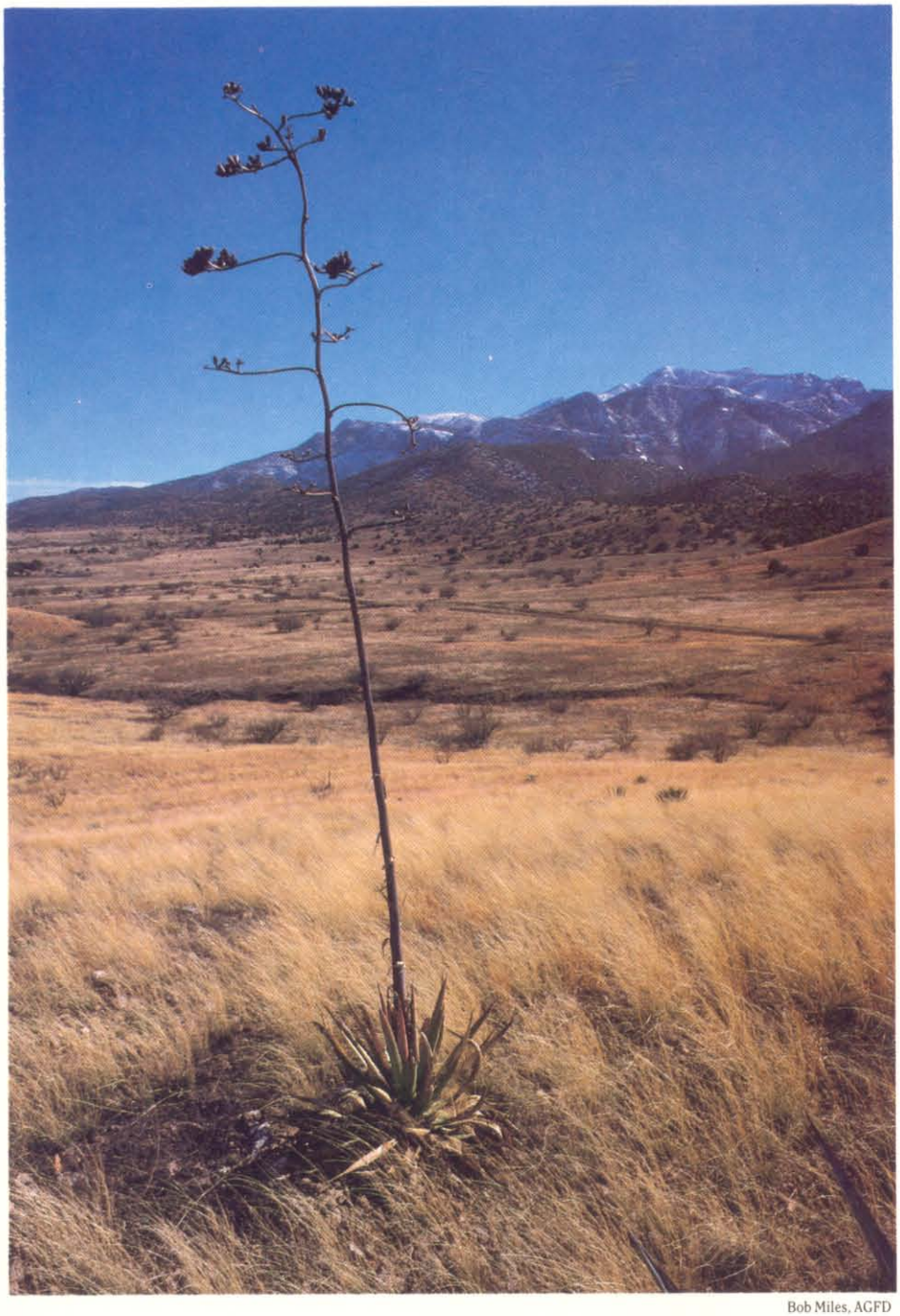
The top of the leaning encyclopedia set is now a zigzag series of ridges and troughs. In the case of the Basin and Range mountains, these troughs have become filled with sediment eroded off the surrounding ridges. Tucson itself sits on two miles of such sediments. On the average, our giant set of mountain-range encyclopedias leans toward the east.

Our Isolated Mountains

The mountains of the Sonoran Desert are linked by a common history, yet now they stand isolated by expanses of desert basins. These form partial barriers to the movements of wildlife, allowing each mountain island to evolve, to some extent, in its own way. The remainder of this issue of *sonorensis* shows some of the results of that evolution on the plants and animals that find their habitats in our volcanic, plutonic or block-faulted mountains. ■

Biodiversity in the Sonoran Desert Region

by Dr. Mark Dimmitt, Curator of Plants



Bob Miles, AGFD

The Huachuca Mountains under the first snow of the season.

The habitats of the world are divided into basic types called biomes. A biome is a very general category of biological community; it is defined by vegetation, but the associated fauna is implied by the term. One classification system distinguishes among them by climatic criteria. Biomes are sufficiently distinct from one another that it is easy to recognize them: tundra, coniferous forest, deciduous forest, Mediterranean scrub (called chaparral in North America), grassland, desert, and tropical forest. (Tropical thornscrub, intermediate between desert and tropical forest, is sometimes recognized as an eighth biome.) Coniferous forest, for example, is dominated by coniferous trees — pines, firs, spruces, etc. The species differ greatly between Alaska, Arizona, and New Zealand, but all coniferous forest has a similar overall appearance, at least when compared to other biomes.

Biome definitions are classifications imposed on nature by humans to aid communication and understanding. They are not absolute realities, and there are other systems. Another basic classification uses the dominant life form without regard to climate. A forest biome under this system is a dense expanse of trees with overlapping canopies. An arctic spruce forest is very different in species composition than a tropical rainforest, but anyone can recognize either as a forest. A woodland is still dominated by trees, but there is open space between canopies. Scrub is dominated by shrubs and/or small trees. Tundra, grassland, and desert finish this list.

The biome type that occurs in any location is determined primarily by temperature and precipitation, acting as limiting factors. Tundra is determined almost entirely by the extremely long, cold winters of the polar regions. Deserts are determined primarily by low precipitation (combined with high potential evaporation). Forests, by comparison, have ample water. Northern coniferous forests are limited by cold, whereas wet tropical forests are not limited by either tempera-

ture or precipitation (in this case, space — available sunlight — is the limiting factor for which plants must compete).

In the eastern United States, huge areas are dominated by one or two biomes. The Great Plains is almost all grassland, with patches of forest or woodland along river courses and in infrequent uplands such as the Black Hills of South Dakota. Most of the country east of the Mississippi is forest (or was before the arrival of Europeans), with a little grassland such as the Everglades and coastal marshes.

In the Sonoran Desert region, much smaller than the above two areas, examples of all the biomes can be found. In fact, the state of Arizona lacks only tropical forest. Five of them can be seen by driving the Mount Lemmon highway in the Santa Catalina Mountains on the north edge of Tucson. Beginning in the desert at the bottom of the mountain, a drive takes you through grassland, chaparral, woodland, and finally forest. If Mt. Lemmon were 2,000 feet higher, there would be tundra near the summit, as there is on the 12,600 foot San Francisco Peaks near Flagstaff.

The communities of southern Arizona

The transect from the Avra Valley (20 miles west of Tucson) to the summit of Mt. Lemmon is the model for our life zone exhibit at the Desert Museum, located between the aviary and the demonstration desert garden. It is also the model for the journey described below. On Southwest mountains at other latitudes the elevations of the communities and some of the communities will vary.

The desert "sea" surrounding the mountains

The Avra Valley is the eastern-most limit of the Lower Colorado Valley subdivision of the Sonoran Desert. It is characterized by great expanses of flat valleys and bajadas dominated by creosote bush. Trees are confined to the channels of dry washes, and saguaros are sparse. Average annual rainfall is from five to eight inches. The Arizona Upland subdivision is encountered next from the Tucson Mountains to the lower slopes of Mt. Lemmon. It is characterized by dense stands of saguaros, and trees on the rocky slopes as well as in the valley floors and along washes. Annual average rainfall is 10 to 14 inches.

Bob Miles, AGFD

Oak trees can be found in the mountain islands of our region between approximately 4,000 and 6,000 feet elevation.

Grassland community

At about 4,000 feet the desert community yields to something else. Many of the desert shrubs and cacti are still present, but the ground between them is now clothed with abundant grasses. Grassland is a semi-arid community. Water is limiting, but not as severely as in deserts. Grassland biomes typically receive 12 to 15 inches of rain per year, mostly in summer. This isn't much more than the Arizona Upland receives, but keep in mind that it's also cooler at the higher elevation. It's too arid for trees; if they occur at all, they are mainly in drainages. Fire appears as a major force in the ecology of this and most of the higher communities. During the dry season the dense cover of grasses frequently burn from early summer lightning strikes. The grasses are mostly perennials which quickly resprout from their roots, but the seedlings of most woody plants are killed. This along with the aridity maintains the dominance of grasses over other life forms.

There is no pure grassland on Mt. Lemmon. The shallow, rocky soil inhibits a dense growth of grasses, so some desert plants can survive to create an intermediate community called desert-grassland. Some of the same grasses as are found in the Great Plains grow here. Among the grasses are found ocotillo, sotol (*Dasylirion wheeleri*), cane cholla (*Opuntia spinosior*), beargrass (*Nolina microcarpa* — not a grass), mesquite, juniper, agave, and yucca. Some of these are coming up from the desert, and others down from the woodlands above.

Woodlands

Above 5,000 feet, oaks and pines become conspicuous elements in the landscape. Unlike in the desert below, the summers are noticeably less hot, the winters experience frequent frosts, and the landscape is more or less green the year round. It is still a semi-arid community, but the period of water stress is much shorter and less severe than in the desert. Typical precipitation is 15 to 20 inches per year. In southeastern Arizona the community is Madrean evergreen woodland, after the Sierra Madre where it originated. Part of it is also called Mexican oak-pine woodland.

The dominant oaks are Arizona white oak (*Quercus arizonica*), Emory oak (*Q. emoryi*), silverleaf oak (*Q. hypoleucoides*), and Mexican blue oak (*Q. oblongifolia*).

All are nearly evergreen, shedding their leaves in the spring just before new growth appears. They may also lose their leaves in very dry years. The conifers are Chihuahuan pine (*Pinus leiophylla* var. *chihuahuana*), Apache pine (*P. engelmannii*), and alligator juniper (*Juniperus deppeana*). The last is one of a few junipers that are easily identified, being distinguished by the squarish-plated bark which gives it its name.

Chaparral

In between desert grassland and woodland are isolated patches of a scrub community. Chaparral (and Mediterranean scrub communities elsewhere in the world) is almost the only major vegetation which receives predominantly winter rainfall. This biome exists mostly west of the mountains from El Rosario, Baja California to northern California. It used to be widespread in western North America. The uplift of the Sierra and Cascade ranges cut off much of the winter rains in the interior of the continent, and today only relictual areas of chaparral persist east of these mountains.

Almost all chaparral plants are shrubs, and they usually grow close together, forming a closed canopy. Most species are densely branched, with small, evergreen, leathery, resinous leaves. The resins reduce water loss during the long, hot, dry summers. They also render chaparral explosively flammable, so the chaparral community must be particularly adapted to fire. In fact, it apparently cannot persist without periodic fire. After about 50 years without being burned over, most chaparral shrubs become senescent and begin dying. The seeds of most chaparral species cannot germinate until they have been scorched by fire, or at least until they are exposed to barren soil in full sun. Eventually the community is replaced by woodlands.

The remnant chaparral in Arizona is depauperate, having only a small fraction of the species found in coastal chaparral. Here two shrubs form most of the cover: scrub oak (*Quercus turbinella*) and manzanita (*Arctostaphylos pringlei* and *A. pungens*). Others include mountain mahogany (*Cercocarpus ledifolius* and *C. betuloides*), sugar sumac (*Rhus ovata*), squawbush (*Rhus trilobata*), buckbrush (*Rhamnus spp.*), and Apache plume (*Fallugia paradoxa*). Most of these species also occur in coastal chaparral, evidence that this community was once much more widespread and continuous.

Unlike coastal chaparral, interior chaparral receives significant summer rainfall. This may account for the absence of at least some of the coastal species. Many chaparral plants are so adapted to summer drought that they die of fungus diseases if they receive summer water. This makes them tricky to grow in cultivation.

U of A photo.

Above 9,000 feet in the Pinaleño Mountains, plant communities are dominated by spruce-alpine fir forest.

Coniferous forest

Between 6,000 and 7,000 feet, pines and other conifers become prevalent, and continue to the top of Mt. Lemmon. Precipitation ranges from 18 to 26 inches per year. Because of its seasonal distribution (winter and summer, with the same dry foresummer as in the desert below) there is still some water stress at times, but this habitat is quite mesic compared to Tucson. (The only truly mesic habitats in the Southwest are riparian communities with permanent water.)

As in all biomes, several different communities can be recognized, depending on elevation, slope, and other minor factors. At the lower part of the conifer zone are extensive, often pure stands of ponderosa pine (*Pinus ponderosa*). At about 7,500 to 8,000 feet, fir forest appears, dominated by Douglas fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*). Quaking aspen (*Populus tremuloides*), a common tree of cold, northern climates, is also present. Above 9,000 feet is found spruce-alpine fir forest, consisting of Engelmann spruce (*Picea engelmannii*) and alpine fir (*Abies lasiocarpa*).

The trip up Mt. Lemmon or any other transect is not nearly as neat as our idealized exhibit or the preceding description, because elevation is not the only variable along the way. Soil type has

a significant influence on water availability; coarse soils drain better and thus hold less water after rains. The road winds around between north and south slopes. South facing slopes are drier; because they face the sun they are hotter, so there is consequently more evapo-transpiration. Canyon bottoms carry cold air drainage as well as water runoff; this cooler, wetter microhabitat allows mesic communities to extend to lower elevations than they can elsewhere.

Why is our region so biologically diverse?

The temperature and precipitation which are the major determinants of vegetation are in turn determined by latitude, elevation, slope exposure, proximity to large bodies of water, prevailing winds, and position on a continental land mass. The Southwest acquires some diversity by straddling a mid-latitudinal band on the west side of the continent. The midwestern and eastern U.S. cannot have a desert. There are no mountains high enough to form a rain shadow desert, and horse latitude deserts form only on the west edges of continents near 30° latitude. Similarly, the conditions which support chaparral (mild, rainy winters, summer drought) occur only toward the west sides of continents north of the desert belt.

The rest of our diversity is caused by the West's great elevational topography — i.e., our high mountains. Going up a mountain has the same effect as going poleward. With each 1,000 feet increase in elevation, the temperature decreases by about 3° F. Precipitation also increases up to about 6,000 feet. Above this elevation moisture availability continues to increase for some distance, because lower temperatures reduce evapo-transpiration. (However, the summits of very high mountains are arid as well as extremely cold.)

What is a mountain island?

The base elevation of our region is mostly below 2,500 feet; up to 4,000 feet in southeastern Arizona. At this latitude such elevations support arid biomes, i.e., desert or grassland. Mountains in this region support more mesic (the opposite of xeric, or arid-adapted) communities above about 5,500 feet. To a pine tree or a mountain king snake, the desert at the foot of its mountain is just as hostile a habitat as an ocean. Therefore high mountains in this region are true islands in a biological sense: their communities are isolated from one another by uninhabitable expanses.

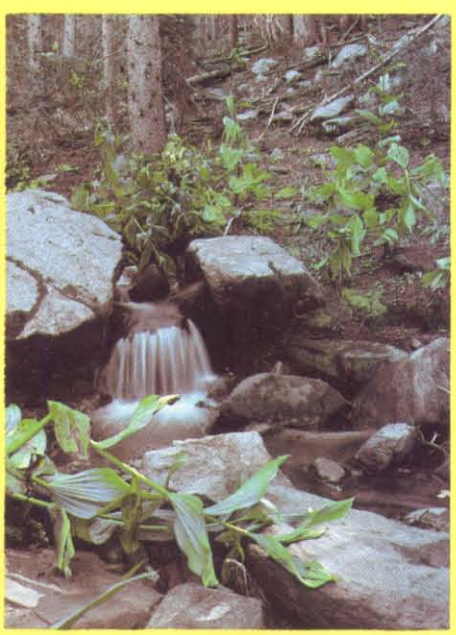
In these isolated mountain communities the frequently small populations of their component species are free to evolve independently, because there is little interbreeding with populations on other mountains. Random genetic drift as well as adaptation to the slightly different environments of each mountain may result in endemic races, subspecies, or species. Also, once widespread species may become extinct on some mountains but not on others, again resulting in rare or endemic taxa.

A region of biotic overlap

Southern Arizona is a region where several biotic communities overlap, adding further to our already great diversity. The Sonoran Desert is southern in origin; most of its flora and fauna are derived from the tropical forests of Mexico. It extends to a short distance north of Phoenix. Madrean evergreen woodland is a Mexican warm-temperate community which reaches its northern limit in the Santa Catalina and Pinaleño Mountains, though some of its species reach the Mogollon Rim. Chaparral evolved in southwestern North America; now southern Arizona is its eastern outpost, left behind when the climate changed. Our grasslands are the western limit of Great Plains communities. Lastly, the mountaintop conifer forests are the southern limit of cool-temperate communities of the Rocky Mountains; these barely reach into northern Mexico. The conifers, oaks, and other plants of the high mountain communities are some of the same species found in Canada, and are completely different from those in the Madrean woodlands.

Interactions between the mountain islands and the desert

Mountains don't simply increase our diversity by providing more habitats. They also enrich the surrounding desert and grasslands some distance from their bases. Some of the precipitation which falls on them forms streams which flow through the desert below, supporting the riparian communities which were the subject of a previous *sonorensis*. These desert riparian areas are not just extensions of the mountains. There are a number of species of both plants and animals which occur only at lower elevations, and constitute distinct riparian communities. Another influence occurs during the monsoon season. Mountains spawn many more thunderstorms than flat terrain. Some of these storms then drift across the desert valleys, bringing more rain than would occur if the mountains weren't there. ■



Mountain cienegas (Spanish for marsh) *are important habitats characterized by perennial springs and yearlong saturated soils. Cienega vegetation is herbaceous, dominated by sedges, rushes, buttercups and water-demanding violets, onions and many other plants restricted to wet soils.*

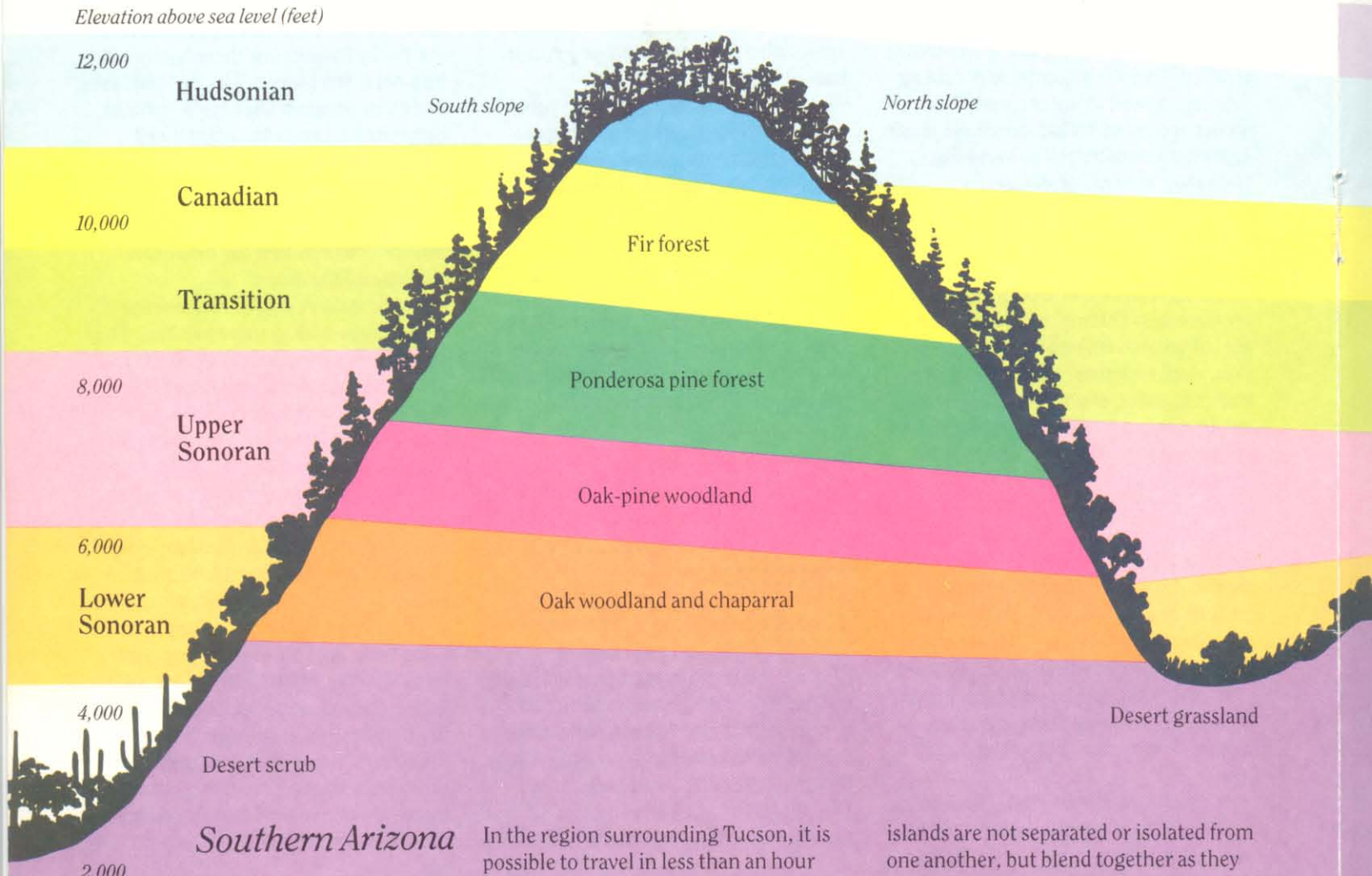
Water in mountain cienegas sometimes surfaces because of accumulated snowmelt in bowl-shaped watersheds. Other springs surface at points associated with steepening gradient in the mountains.

These mountain wetlands can sometimes be characterized as mountain meadows. They support a unique, bog-like vegetation that draws a richer variety of fauna than the surrounding conifer forest.

Emerald Spring Cienega, Pinaleño Mountains.

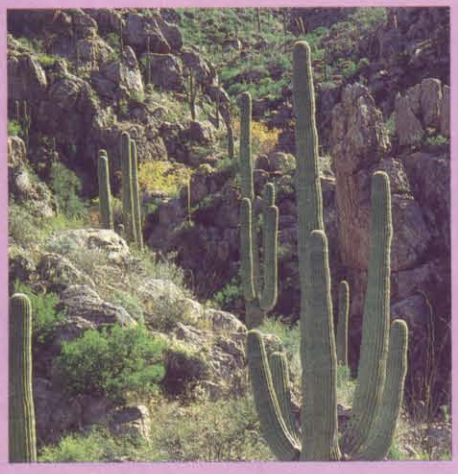
Bob Miles, AGFD.

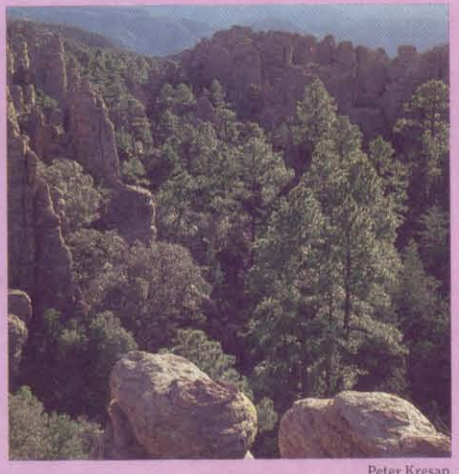
FROM SAGUAROS TO



Southern Arizona

In the region surrounding Tucson, it is possible to travel in less than an hour from cactus to pine forest. Generally speaking, each 1,000 foot rise in elevation is equivalent to moving some 300 miles toward the nearest pole. The regions of different flora found in the mountain islands are not separated or isolated from one another, but blend together as they ascend. On the cooler, less sunny north slope, these bands appear at somewhat lower elevations than on the warm, sunny south face.

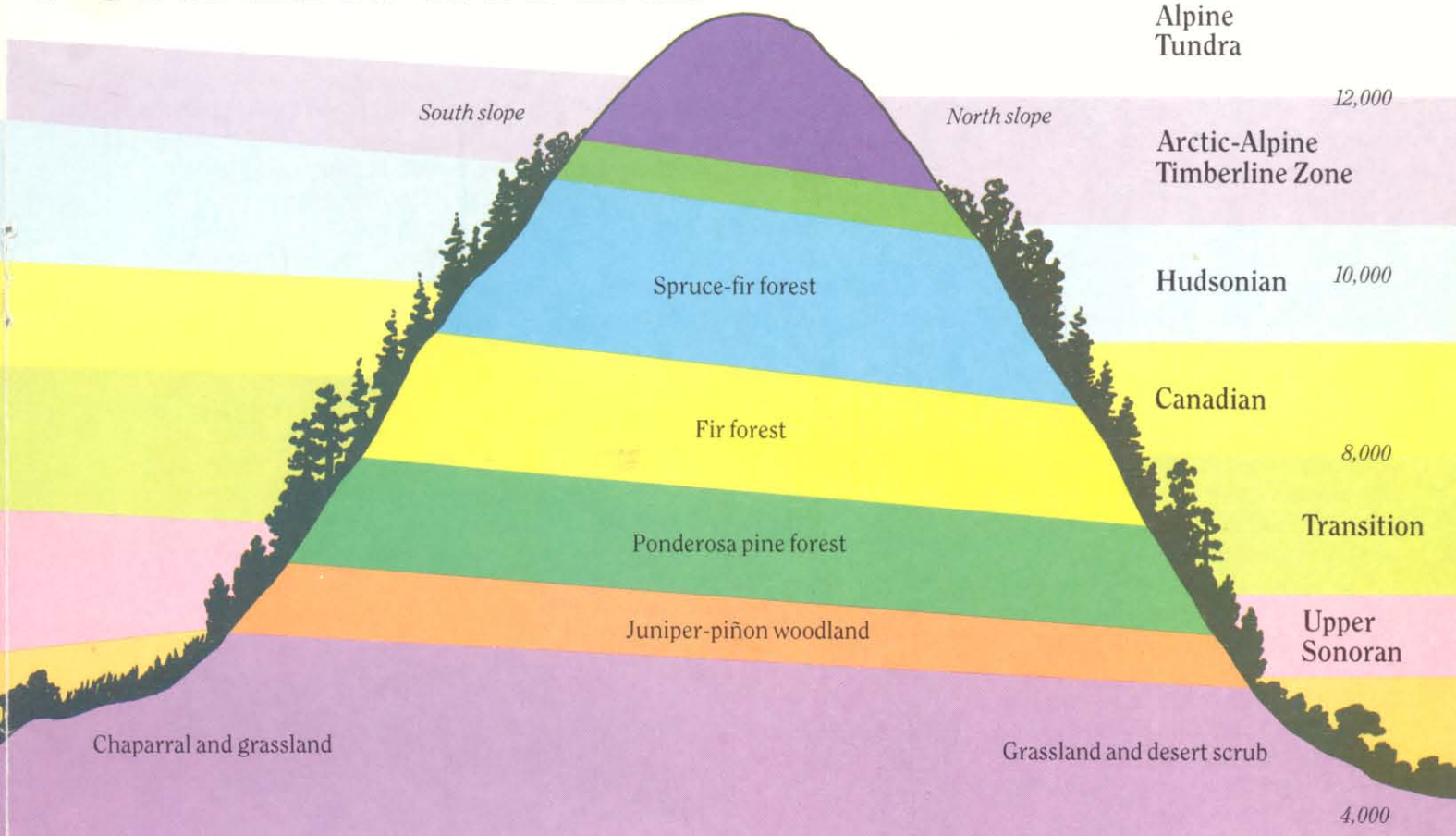




Peter Kresan.

Far left: Dense stands of saguaros and trees on rocky slopes characterize the desert scrub found between approximately 2,000 and 4,000 feet in the mountain islands. Left: Above 5,000 feet, oaks and pines become conspicuous elements, as in Chiricahua National Monument.

PONDEROSA PINE



Northern Arizona

Right: A variety of conifers can be found from 6,000 to nearly 12,000 feet in some cases in the Sonoran Desert mountain islands. Quaking aspen, a common tree of cold, northern climates, is also present. Far right: Above 9,000 feet, spruce-alpine fir forest can yield to arctic-alpine communities, if the correct conditions are present.

Peter Kresan.

U of A photo.

A Mixing of Sources in Splendid Isolation

by Peter Siminski,
Curator of Birds and Mammals

The mountain islands of our region are the home of birds and mammals representing a unique mingling of northern and southern species.

In these ranges the plain titmouse reaches its most southern limit and the bridled titmouse reaches its most northern limit. The plain titmouse breeds abundantly in the pinon-juniper woodlands of the Great Basin. The bridled titmouse breeds abundantly in the oak woodland of the Sierra Madre. As northern pinon-juniper gives way to the southern oaks, plain titmice give way to bridled titmice. This pattern of the northern communities being replaced with the southern communities is often repeated in Sonoran Desert mountain ranges. Mexican chickadees from the south replacing mountain chickadees from the north is another example. Other birds that reach the southern limit of their breeding range include the western tanager, the Virginia warbler, and the black-throated gray warbler. Those that reach their northern limit include the Strickland's woodpecker, the dusky-capped flycatcher, the whiskered owl, and the sulfur-bellied flycatcher.

The steepness of these small mountain ranges also results in changes in communities with elevation. A traveler may see scrub jays at the base of the mountain, gray-breasted jays in the oak-pine woodland half-way up, and Steller's jays in the conifer forests at the top. Whole communities change.

The mountains are also isolated from one another by desert scrub or desert grassland. These arid barriers may effectively isolate animals on one mountain top from the animals on a mountain top just 40 miles away. Most birds can fly over the inhospitable environment; most large mammals can walk the distance, but many small mammals are as isolated from one another as if they were on two islands in an ocean. The Mt. Graham red squirrel is an excellent example. Isolated in a patch of spruce-fir forest high in the Pinaleño Mountains, this red squirrel's nearest neighbor is 65 miles away in the White Mountains. Between these two mountains are many miles of inhospitable arid habitat. From a red squirrel's perspective, they may as well be separated by a raging ocean.

Bob Miles, AGFD.

Spotted owls sometimes occupy the canyons at higher elevation in mountain islands of the Sonoran Desert Region. These were photographed in the Huachuca Mountains.

Bob Miles, AGFD.

The Mt. Graham red squirrel is one of 25 subspecies of red squirrel in North America. The population found in the Pinaleño Mountains of southern Arizona has been isolated from other red squirrels for perhaps as long as 11,000 years.

How did they get there? Scientists believe that in pre-historic times, when the glaciers expanded and contracted in the north, our climate cooled and warmed and the plant communities expanded and contracted accordingly. Perhaps during these cooler periods, the mountain forests of today were more greatly expanded between the mountain ranges, or even continuous. Then the red squirrel populations could mix and interbreed. The last time a Mt. Graham red squirrel saw a neighboring red squirrel may have been 11,000 years ago during the Wisconsin glaciation.

What happens to these isolated mountain populations of small mammals is similar to what happens on oceanic islands that were at one time connected to the mainland. Due to isolation from the main population and due to what biologists call genetic drift, the island population evolves differently than the mainland population. This is why the Mt. Graham red squirrel is a different race from the red squirrels in central Arizona. This is also why the Arizona gray squirrels in the Santa Catalina and Rincon Mountains are different from the Arizona gray squirrels in the Santa Rita, Huachuca, and Patagonia Mountains. Both these populations of gray squirrel are different from the population in central Arizona. The pass between the Santa Catalina and Rincon Mountains is not enough to isolate these squirrels, so they have not evolved apart. However, the arid land between the Rincon and Santa Rita Mountains has sufficiently isolated those populations to evolve two separate races, in some biologist's opinion.

The farther an isolated population is from the main population, the greater is its probability of extinction. The smaller the inhabitable area of the isolated population, the greater is its probability of extinction. This is why the Mt. Graham red squirrel is endangered with extinction.

Some biologists believe this may also explain the distribution of tassel-eared squirrels in Arizona. Although tassel-eared squirrels are abundant in the ponderosa pine forests of the mountains in central Arizona and the pine forest of the Sierra Madre, they are absent from most small isolated mountain ranges in between. These ranges have forests of ponderosa pine, and man-introduced tassel-eared squirrels thrive in the Santa Catalina Mountains and the Pinaleño Mountains. However, the higher probability of extinction in these isolated mountain islands and the lower probability of re-colonization across the arid lowlands, may have eliminated and prevented their existence in these mountain islands, until perhaps, the next ice age.

The bird and mammal fauna of these small, steep, mountain ranges are a natural wonder. They illustrate the mixing of two faunal sources, the abundance of biological communities that result from rapid elevation changes, and the effects of habitat islands on the mainland. ■

Mountain Reptiles, Amphibians, Fishes and Arthropods

of the Sonoran Desert Region

by Howard E. Lawler, Curator, Lower Vertebrates and Invertebrates

Howard Lawler.

Sonoran mountain kingsnakes, besides being the most colorful snake in the mountains of our region, are exceptional climbers, capable of negotiating the irregular bark of vertical pine trees.

The uplift of the great Rocky Mountain and Sierra Madre Occidental ranges gave rise to rich biotic communities. Changes in climate that began 23 million years ago continued through later glacial periods, probably allowing northward movement of Sierra Madrean animals and southward dispersal of Rocky Mountain-Great Plains species. When hotter, drier climates returned to the lowlands, many of these species became isolated in the small, rugged ranges of the Sonoran Desert Region.

For example, Mexican species like the Madrean alligator lizard (*Gerrhonotus kingi*), the Sonoran mountain kingsnake (*Lampropeltis pyromelana*) and the blacktailed rattlesnake (*Crotalus molossus*) dispersed widely during glacial periods. As a result, such generalists are more widely distributed in our region than are specialists like the rock rattlesnake (*Crotalus lepidus*) and the twin-spotted rattlesnake (*Crotalus pricei*). Particularly adapted to rocky canyons and talus rock slides at moderate to high elevations, these species probably crossed lower land bridges during glacials. Now, wider dispersal is not possible due to the warmer, drier conditions in the lowlands.

Isolation and natural selection

Physical isolation is a major influence in the evolution of living organisms. Once separated from ancestral lineages, changes in form, color, physiology or behavior often occur in response to selective pressures in the environment. Depending upon the length of isolation and the extent and nature of other selective forces, such changes may be subtle or more obvious.

Relatively short periods of isolation under similar conditions usually result in minor variations of color, pattern or other physical features. These are sometimes scientifically described as geographic races, or subspecies. When isolation has occurred for longer periods of

geologic time, the changes can be dramatic, producing distinctive species which often differ from their nearest relatives not only in appearance, but also in physiology and behavior.

Adaptation of Reptiles

Most snakes and lizards rely heavily on *procrypsis*, or camouflage, for protection from predators. Here, natural selection reduces conspicuous individuals over time, leaving those less obvious to predators to pass along their genes for concealment. Eventually, the population achieves a degree of background matching sufficient to insure its survival. Rattlesnakes and horned lizards, in particular, are masters of camouflage in their natural environments. Their color, pattern, and behavior are clearly influenced by the specific habitats in which they have evolved.

Spiny lizards (*Sceloporus* sp.) and horned lizards (*Phrynosoma* sp.) are good examples of physiological evolution in response to climatic conditions. Species which occur in lower desert habitats reproduce by laying eggs. The short-horned lizard (*P. douglassi*), is adapted to higher elevations (up to 11,300 ft.) and latitudes (southern Canada). It is more cold-tolerant than most other horned lizards and has evolved a viviparous (live-bearing) mode of reproduction. The cooler, shorter summers are less favorable for external incubation of eggs.

The mountain spiny lizard (*Sceloporus jarrovi*) occurs as high as 11,000 feet. It also bears live young, in contrast to other spiny lizards of the region. It is typically seen on rocks and logs in wooded habitats. The males sport a black collar lined with white and are further distinguished by reflective patches of rich blue on the throat and belly. The scales on the back are a dark metallic bronze with black edges, presenting a lace-like appearance. Females are more drably colored and lack the distinctive blue display colors of the male.

The bunch grass lizard (*Sceloporus scalaris*), occupies many of the same macro- habitats as the mountain spiny lizard, but utilizes grassy, terrestrial micro-habitats and is rarely seen on rockpiles or logs. Like the mountain spiny lizard, it is a Sierra Madrean species entering the U. S. only in southern Arizona and New Mexico. It has retained oviparity as the means of reproduction, but substantial embryonic development occurs before the eggs are deposited. Due to this internal development, the eggs are large in relation to the size of the lizard. The bodies of gravid females are noticeably distended before the eggs are laid. Large eggs produce larger, more vigorous hatchlings with increased survival potential. The female selects appropriate incubation temperatures through solar basking. Only one egg clutch is produced per season due to the extremely dry conditions in early summer. Reproductive efficiency is high; the mass of a single clutch of five to 10 large eggs may be 48 percent of the total lizard weight! Desert lizards of similar size usually produce multiple clutches of smaller eggs in greater numbers per season to achieve a similar net recruitment to the population. Bunch grass lizard activity is greatly reduced in early summer. This serves to avoid desiccation, exposure to predators, and limited food availability. The markings and body shape of the bunch grass lizard are ideally suited to provide both camouflage and capacity for larger egg mass. The bunch grass lizard reaches sexual maturity in about eight months. It is active even in winter due to its ability to thermoregulate well above the ambient temperature. This enables a long growing season and early sexual maturity.

R.W. VanDevender.

The bunch grass lizard is a Sierra Madrean species entering the U.S. only in southern Arizona and New Mexico.

The Madrean alligator lizard (*Gerrhonotus kingi*) lives primarily in or near montane riparian canyons. It closely resembles the ridgenosed rattlesnake in color and pattern. This probably represents evolutionary convergence in background matching with the woodland leaf litter in a similar micro-habitat. Prowling among the leaf litter in search of arthropods, it can be quite elusive when pursued. A predator is as likely to catch a section of writhing tail as the lizard. This function, called *TAIL AUTOTOMY*, is found to varying degrees in many lizard groups. Tiny fracture planes in the vertebrae of the tail allow easy breakage and blood vessels constrict quickly to reduce blood loss. The detached tail continues to move, attracting the predator's attention as the lizard (often) escapes. The Madrean alligator lizard is sometimes found as low as 2,400 feet in riparian corridors from the higher mountains.

Rattlesnakes are prominent in the montane fauna of the Sonoran region. The largest of these is the northern blacktailed rattlesnake (*Crotalus molossus*), reaching a length of just over four feet. An ecologically versatile species,

it ranges from dry desert mountains to coniferous forests over 9,000 feet. They are more widely distributed than other Sierra Madrean rattlesnakes because of these broad ecological adaptations.

Populations in desert mountains are more subdued in color and pattern, while those from higher elevations are typically boldly marked with yellow and black. Even these bright colors disguise the snake in the lights and shadows of the rocky, leaf-littered forest floor. Blacktails usually lie quietly when approached and show little fear of larger animals, including humans, rarely rattling or striking. Thus, relatively few bites are inflicted by blacktailed rattlesnakes compared to other larger species.

The Arizona black rattlesnake (*Crotalus viridis cerberus*) is a subspecies of the widely ranging western rattlesnake (*Crotalus viridis*) complex which originated in the Great Plains. It reaches its southern range limits in the Santa Catalina and Rincon Mountains near Tucson, where it is found in chaparral and montane woodland habitats. It is unusual among snakes in demonstrating *METACHROSIS*, the ability to darken or lighten its color, apparently in response to temperature. Darker color absorbs solar radiation while lighter colors reflect it. This is one of several thermoregulatory mechanisms so important to ectotherms inhabiting cooler environments.

The twin-spotted rattlesnake (*Crotalus pricei*), associated mainly with the Sierra Madre Occidental, is smaller than most desert rattlesnakes. The gray ground color conceals these diminutive pit vipers from detection among rhyolite talus. They are often noticed only when their tiny buzz, resembling the sound of a flying grasshopper, is heard.

The dark gray color may also aid in regulation of body temperature by absorbing solar warmth rather than reflecting it. The small body mass reaches a preferred activity temperature quickly. These features are clearly advantageous to an ectothermic animal living as high as 10,000 feet. This ability to be active at lower ambient temperatures, using solar energy as the key, enables them to succeed in the rocky highlands, even during the winter.

The rock rattlesnake (*Crotalus lepidus*), as its name implies, is almost always associated with rocks. It is often found near canyon streambeds where it favors the crevices of granitic outcrops and the talus fallen from them. The rock rattlesnake is a master of crypsis in this micro-habitat, the bands resembling the cracks and fissures of the rocks. Males in many populations have a greenish sheen along the back, closely matching the lichens which decorate the relatively moist, rocky canyons they favor. Rock rattlesnakes accept small rodents, lizards, other snakes, and even centipedes as prey.

In the Sonoran region, the ridgenosed rattlesnake (*Crotalus willardi*) is a Sierra Madrean pine-oak woodland generalist which reaches its northern range limits in southern Arizona, where it is recorded from the Santa Rita, Huachuca, and Patagonia Mountains. Its range extends southward through the mountains of eastern and central Sonora. The brown color and broken pattern effectively conceal it as it moves among the leaves and needles of the woodland floor. The white lines on the face disrupt the outline of the head, blending especially well with bunch grass and pine needles in its primary habitat. Some have suggested that the Apache Indians who inhabited some of the same mountain ranges may have modeled their war paint after the facial markings of the ridgenosed rattlesnake! Its diet includes lizards, small mice, birds, other snakes, and even invertebrates such as scorpions and centipedes. A small species, rarely reaching two feet in length, it is most often encountered in montane deciduous hardwood canyons among rocks and leaf litter, although it inhabits the wooded slopes as well.

The Arizona ridgenosed rattlesnake, banded rock rattlesnake, and northern twin- spotted rattlesnake are protected under Arizona wildlife regulations. They may be legally collected only under a scientific collecting permit issued by the Arizona Game and Fish Department. While not threatened or endangered, these species are highly prized by reptile collectors all over the world. This demand has created commercial incentives which, combined with their well-known specialized habitat preferences, make them particularly vulnerable to unscrupulous commercial collectors. All can be common in localized areas of prime habitat.

The Sonoran mountain kingsnake (*Lampropeltis pyromelana*) is the most colorful snake in the mountains of the Sonoran region. It is tri-colored, with red, black, and cream colors often calling the western coral snake to mind. But the colors of the Sonoran mountain kingsnake are not as neatly arranged in rings as in coral snakes; and the red and black colors are always in contact, separating red from cream. The Sonoran mountain kingsnake has a cream-colored nose, in contrast to the black head and nose of the

Gila trout populations have been severely reduced by introduction of non-native species, habitat degradation and other causes. Propagation in state and federal hatcheries allows restoration within historic ranges under certain conditions.

John N. Rinne, USFS.

western coral snake. Sonoran mountain kingsnakes are generalists in mountain habitats, but are often found in the vicinity of permanent or intermittent streams. They feed chiefly on mountain spiny lizards, but small rodents and snakes are also taken. Sonoran mountain kingsnakes are usually found on the ground, hiding in rockpiles, logs and underground. They are exceptional climbers, capable of negotiating the irregularities of pine bark on a vertical tree without the benefit of branches.

Adaptation of Amphibians

Several interesting and unique amphibians inhabit the cool, often moist montane habitats in the Sonoran Desert region.

The mountain treefrog (*Hyla eximia*) is found above 5,000 feet, usually in coniferous woodland, although it may be found in mesquite grassland scrub in Mexico. Populations are usually situated near permanent water, where breeding congregations form during summer rains. Substantial populations occur north of the Mogollon Rim. Further south in Arizona, it is known only from the Huachuca Mountains. It ranges extensively through the Sierra Madre Occidental of western Mexico.

The barking frog (*Hylactophryne augusti*) is named for its dog-like call. Toad- like in appearance, the skin is relatively smooth and a fold of skin is apparent behind the head. A circular fold of skin on the belly may aid the frog in adhering to rocky retreats. The barking frog presents an unusual posture as it walks on its toes with the body elevated well off the ground.

The western race (*H. a. cactorum*) reaches its northern range limits in the Pajarito and Santa Rita Mountains where it is more often heard than seen. It calls sporadically, making it difficult to locate. Only three specimens from Arizona are known. One of these is presently living at the Desert Museum. Records are limited and its distribution is unclear. Considered endangered in Arizona, its secretive nature may present an inaccurate picture of rarity. The barking frog is a member of the tropical frog Family Leptodactylidae, and is unique among regional anurans (subclass Salientia) in reproducing entirely on land, without dependence on standing water for metamorphosis. The large-yolked eggs are laid during rainy periods, often in moist seepages of limestone caves and fissures. Tadpoles complete metamorphosis inside the eggs and emerge as tiny froglets.

ASDM photo; Peter Kresan.

Ladybird beetles, or "ladybugs," are beneficial insects, feeding on aphids and the eggs and larvae of other potentially harmful insects. They sometimes "swarm" on shrubs, trees and grasses at higher elevations before hibernating for the winter.

Two true frogs (Family Ranidae) are prominent in the mountains of the Sonoran Desert Region. The Chiricahua leopard frog (*Rana chiricahuensis*) is a member of the wide-ranging leopard frog (*Rana pipiens*) complex. A number of distinct species are now recognized to exist within this group, in spite of their superficially similar appearance. The Chiricahua leopard frog is the upland representative, thriving in the vicinity of permanent rocky mountain streams in pine and oak woodlands. It establishes quickly in local artificial ponds and tanks. This frog is considered threatened in Arizona because of habitat destruction, pollution, and the introduction of the bullfrog which is both predator and competitor. Further studies are needed to accurately determine the status of this formerly common upland riparian inhabitant.

The Tarahumara frog (*Rana tarahumarae*) is now considered extinct in Arizona. The last individual was found dead in the Santa Rita Mountains in 1983. Fortunately, sound populations occur further south in Sonora and points beyond in the Sierra Madre. The probable cause of its demise in Arizona is exposure to toxic metals leached from rock and soil by acid rain caused by copper smelter effluents, particularly sulfur dioxide. This theory is plausible because of the proximity of exterminated populations to the copper smelters in Douglas, Arizona and Cananea, Sonora.

The highly aquatic Tarahumara frog is always found a hop or two from water, usually a rocky stream with sporadic "plunge pools". These bedrock depressions hold water during the summer period preceding the monsoons. During such dry periods, Tarahumara frogs may abandon their preference for moving water and gather around these temporary oases.

Although Tarahumara frogs resemble their introduced nemesis, the bullfrog, they are readily distinguished by the presence of dorsolateral folds and indistinct eardrums. Bullfrogs lack dorsolateral folds and have very distinct eardrums. As with leopard frogs, bullfrogs are considered deleterious to Tarahumara frog populations. Tarahumara frogs are unusual among true frogs in apparently lacking a distinctive call.

Salamanders are not well-represented in the Sonoran Desert Region. Most are members of the mole salamander Family Ambystomatidae, the best-known of which is the tiger salamander (*Ambystoma tigrinum*). In the mountains, the prominent salamander is the Tarahumara salamander (*Ambystoma rosaceum*). It inhabits most of the same rocky permanent Madrean streams occupied by the Tarahumara frog. It does not occur in the United States, but reaches the border-

lands in the Sierra de los Pinos just south of Nogales.

Like others in its family, the Tarahumara salamander often demonstrates *neoteny*, in which sexual maturity is reached in the gilled larval form. Water temperature seems to be the principal stimulus affecting metamorphosis. Transformation often occurs when water temperatures rise above about 15° C. (60°F.). The permanently cold streams over much of its range may account for the high incidence of neoteny observed.

Perhaps the most unusual salamander in the Sonoran Desert region is found in the Sierra Madre of Sonora, near Yécora. The Yécora salamander (*Pseudoeurycea belli sierraoccidentalis*), is the northernmost form of a species ranging widely through the Sierra Madre Occidental and Sur of western and southern Mexico. It is a member of the Family Plethodontidae, the lungless salamanders, so named because they lack functional lungs, respiring entirely through their skin. Such salamanders require cool, moist micro-habitats in which to live. The Yécora salamander is restricted to two known localities in Sonora and adjacent Chihuahua where sufficient moisture is retained year-round in the cool forest substrate. Moist soil beneath fallen, often saturated pine and oak logs seems to be the preferred micro-habitat. Subadults have been found inside rain-saturated logs. The Yécora salamander is unique among regional salamanders in laying eggs on land. The larvae complete metamorphosis inside the egg, emerging as tiny terrestrial salamanders.

Adaptation of Fishes

Unique fishes have evolved in the clear, cold, swift waters of mountain streams in the Sonoran Desert region. The majority of Arizona's native fishes are endemic to the Colorado River drainage, which includes the Gila River and its headwaters in the mountains of east-central Arizona and western New Mexico. These high elevation streams gave rise to the now Threatened Arizona trout (*Salmo apache*) and Endangered Gila trout (*Salmo gilae*). Native trouts may have evolved from a primitive oceanic salmonid ancestor when climatic changes allowed freshwater migration from the Pacific by way of the Sea of Cortez.

Like most freshwater trouts, they feed extensively on terrestrial and aquatic insects, especially ants (Hymenoptera), mayflies (Ephemeroptera), true flies (Diptera), caddis-flies (Trichoptera) and beetles (Coleoptera).

Native trout populations have been severely reduced by habitat degradation, and competition and hybridization with introduced rainbow trout (*Salmo gairdneri*) and other non-native salmonids. Fortunately, successful propagation in state and federal hatcheries allows restoration of these species within their historic range when "undesirable" introduced fishes have been eliminated.

Minnows and suckers also inhabit upland waters in the Sonoran region. The roundtail chub (*Gila robusta*) may grow to 50 cm (20 inches) in length. It inhabits medium to large rivers in the Colorado River drainage. Often locally called the "Verde trout", this large minnow feeds on insects, algae and other fish. In Aravaipa Creek, adults of the endemic subspecies, the Gila River roundtail chub (*G. r. grahami*) are considered the top aquatic carnivore there, feeding principally upon smaller fishes.

Closely related suckers are also represented in montane streams. The Sonora sucker (*Catostomus insignus*) and the desert sucker (*Pantosteus clarki*) occur over a wide elevational range from about 1,000 to over 7,000 feet. They are closely related and hybridize in some areas. Their downwardly oriented jaws are adapted for bottom feeding on algae and other plant material, and aquatic insects. Interestingly, the fry of most suckers have upwardly oriented mouths for surface feeding. As they grow, the mouth gradually changes to a ventral position. This allows the larvae to exploit different energy resources, reducing competition with adults of the same species.

Adaptation of arthropods

Insects and other arthropods abound in the mountain habitats. Some are particularly conspicuous because of their color or behavior.

In the mountain canyons of the Sonoran region, countless numbers of the colorful convergent ladybird beetle (*Hippodamia convergens*) often decorate grass clumps and shrubs in warm areas before hibernating for the winter. Ladybird beetles, or "ladybugs," are beneficial insects which feed on aphids and the eggs and larvae of other potentially harmful insects.

Another gaudy group of beetles in these mountains are the shining leaf chafers (*Plusiotis gloriosa; P. beyeri* and others). These extraordinarily beautiful scarabs are light metallic green in color. Some species have gilded outlines along the edges of the body. Feeding on oak and juniper, the adults are well-concealed by day. At night, they fly about, often attracted to blacklights set up by intrepid entomologists. Some authorities believe these beetles are becoming endangered due to overcollecting.

The large, beautiful moths of the Lepidopteran Family Saturniidae are the delight of insect collectors the world over. The Sonoran region mountains are home to a variety of species, most of which feed on oak and other tree leaves as larvae. The often elaborately adorned caterpillars can consume a remarkable volume of plant material prior to pupation.

Scorpions occupy nearly all natural habitats in the Sonoran region. One of these, sometimes called the Peña Blanca scorpion (*Diplocentrus spitzeri*), is commonly encountered in the mountains south of Tucson. It reaches about 50 mm (two inches), and is light to medium brown in color, providing good protection on its leaf-covered woodland substrate. Like all scorpions, it seeks moist micro-habitats and is most readily found during the summer monsoons.

The venom of this scorpion effectively subdues its arthropod prey. It was once thought to possess a venom dangerous to people, but this has not been confirmed. However, defensive stings are locally and temporarily painful. Like other scorpions, it is viviparous, producing relatively small litters of about nine babies.

The living organisms of the montane habitats of the Sonoran Desert region are as diverse and fascinating as their desert counterparts. By comparing and understanding their similarities and differences, we can achieve a broader appreciation of the entire Sonoran Desert region and its complex geo-biotic interrelationships. ■

A Native makes a comeback

They foraged the Chiricahua Mountains of southeastern Arizona in numbers estimated at over 1,000 only 70 years ago. Then they began to vanish, forced from the mountains by habitat destruction and shooting by subsistence-hunting miners and woodsmen. By 1930, they had disappeared from the Chiricahuas completely, forced into a compressed range in the rugged mountains and canyons of Mexico's Sierra Madre Occidental.

Thick-billed parrots (*Rhynchopsitta pachyrhyncha*) are the only species of parrot other than the extinct Carolina parakeet that has ever been native to the continental United States. They are beautiful, raucous, relatively large birds with brilliant green feathers and, as adults, a scarlet blaze of feathers on the face. Today, through the efforts of the Nongame Branch of the Arizona Game and Fish Department and the cooperation of the U.S. Fish and Wildlife Service and U.S. Forest Service, nearly 30 of the birds have been released in the Chiricahuas once again.

First releases occurred in the fall of 1986 when 29 thick-bills took to the pine forests of the Chiricahuas, and then to other locations throughout Arizona. Some were also observed heading south, toward Mexico. Wild thick-bills are very strong, direct flyers, engaging in routine foraging flights of anywhere from six to 12 miles. Tracking the birds — even those with radio collars — was difficult.

Some birds were lost to predation, mostly by raptors, but once they pass through a high-vulnerability phase immediately after release, they have reasonably high survival rates. The thick-bill is by no means a tropical species. It is a bird of temperate conifer and mixed deciduous-conifer forests, feeding primarily on conifer cones and to a lesser extent on juniper berries and acorns. In winter, they inhabit areas with overnight temperatures far below freezing: a parrot of the snow zone.

Most of the parrots in the reintroduction program have been birds confiscated from smuggled shipments coming across the Mexican border. Others were seized in raids on U.S. parrot dealers who engaged in illegal interstate exchanges of endangered species or were unable to demonstrate legal possession of these endangered birds. But, if captive breeding programs can provide high-quality, parent-reared birds, steadier and larger release efforts will occur in years ahead.

In the fall of 1988, two years into the program, Arizona Game and Fish Department officials received reports of two birds with the Chiricahua flock that had pale bills. Could they be young birds? In November, sightings confirmed the birds had distinctly pale bills as they begged food from their parents! Clearly, at least one pair of thick-billed parrots bred successfully in the wild in Arizona in 1988.

The future of the last wild reservoir of these birds in Mexico may be short. Habitat changes brought on by wide scale cutting for lumber and pulpwood, coupled with selective cutting for pulp of dead or dying snag trees essential for parrot nesting, have caused their numbers to drop off rapidly. But, in Arizona's mountain "islands" people are dedicated to watching out for the thick-billed parrot. The Desert Museum exhibits thick-bills as part of the Mountain Habitat, showing them alongside black bears, white-tailed deer and other mountain species. The Museum also participates in a captive-breeding program to supply birds for reintroduction. These cooperative efforts with other institutions and individuals are helping these raucous natives make a peaceful return to their old mountain haunts.

Bob Miles, AGFD.