



SONORENSIS

Arizona-Sonora Desert Museum

CONSERVATION
WITHOUT BORDERS

Winter 2005

Introduction

Conservation Without Borders

Christine Conte, Director
Center for Sonoran Desert Studies, Arizona-Sonora Desert Museum

We have a hyphenated name and we fly two flags.

Both the hyphen in Arizona-Sonora Desert Museum and the flags of Mexico and the United States of America recognize what one of this Museum's founders, Bill Carr, expressed more than 50 years ago: "Nature knows no political boundary."

Today, as in the early days of the Museum, we recognize that Arizonans and Sonorans share one natural heritage, one that was here long before any of us existed, and one that will exist long after we are gone. It is known for its saguaro-studded desert lowlands, but it also embraces grasslands, wetlands and rivers, mountain ranges and canyons, as well as the Gulf of California (or Sea of Cortez). Traversing the political borders between our two countries, this heritage is an interconnected richness of plant and animal life that makes our region unique, fascinating, and incomparably beautiful.

This issue of **sonorensis** celebrates more than a half-century of collaboration between the Desert Museum and the people of Sonora, Mexico—in research, education, and conservation. The *Arizona-Sonora* in our name represents a belief, deeply rooted in our institutional history, that to act on one side of the border and not on the other is useless. It is our hope that this issue will bring you a deeper understanding of, and appreciation for, the vital role of our work in Mexico, and with our Mexican partners, in achieving the Museum's mission—inspiring people to live in harmony with the natural world by fostering love, appreciation, and understanding of the Sonoran Desert region.

Why Mexico?

About two-thirds of the land portion of the Sonoran Desert, and three-quarters of its biodiversity, reside in Mexico. When we add to that the related ecosystems that the Museum studies and interprets in Mexico—mountain oak woodlands, pine forest, tropical deciduous forest, thorn scrub, and the Gulf of California—we realize that the vast majority of species and habitats that the Museum seeks to understand and protect lie south of the border. ▶



Cross-Border Conservation in the 21st Century: Center for Sonoran Desert Studies

Today, to better meet our goals of cross-border collaboration and conservation, we're crossing some borders of our own. The Museum's new Center for Sonoran Desert Studies is an idea rooted in the past but facing the future. It is an integrated conservation science and education center fulfilling a dream dating to 1953.

"An objective, also from the beginning, has been to establish an American Desert Scientific Research Center at the museum for the study of all phases of natural history in this, possibly the most interesting of all the natural faunal and floral regions... and ... the most neglected in respect to large scale natural science research, investigation and interpretation particularly as it relates to animal life."

(William Carr. *Arizona-Sonora Desert Museum: Trailside Zoological and Botanical Gardens*, April 1953)

The Museum's new interdisciplinary Center breaks down internal borders by integrating the former departments of education and conservation science. Organized around program areas rather than departments—Gulf of California, Alamos-Tropical Deciduous Forest, Invasive Species, Youth and School programs, etc.—it brings together the scientists and educators best suited to the project, from within the Museum and from the greater scientific and education community on both sides of the border. This means that each project, from conception through implementation, will be designed to integrate research, education, and conservation goals rather than adding education components as an afterthought, or visa versa. A new education center, complete with a 250-seat auditorium is under construction, which will greatly assist in our efforts to enhance the curriculum, content and learning as we integrate our resources. Establishing the Center for Sonoran Desert Studies also renews our commitment to conservation. Education is a powerful conservation strategy, inspiring not only a conservation ethic but timely, collaborative and well-informed action.

Each of the articles in this **sonorensis** is authored by Center for Sonoran Desert Studies staff. Several are co-authored by at least one Mexican partner. All speak to the biogeographic scope of our work. By fully integrating scientific research, education, and conservation under one roof, and by reinvigorating our commitment to partnerships on both sides of the border, we will inspire people to live in harmony with the natural world and carry our founders' dream into the twenty-first century.



Two Flags

The international status of the Arizona-Sonora Desert Museum was officially recognized on Memorial Day, 1954, when the Honorable Ignacio Soto, then Governor of the State of Sonora, presented us with a flag of the Republic of Mexico. "At the entrance to the Museum were two flagstuffs. We ran up the flag of the Republic of Mexico and, together with the flag of the United States of America, it has been raised every day since... We believe we have the only truly recognized international outdoor museum of its type in America, established as it is practically upon the international boundary line."

(The Desert Speaks, a Desert Museum newsletter, p.19, 1975)



Lesser Long-Nosed Bat

CONSERVATION, RESEARCH, AND EDUCATION

As the intense heat of day in the Sonoran Desert gives way to cooler evening, you may hear the flutter of wings as bats fly to the flowers and fruit of columnar cactus for a meal of rich nectar, pollen, and fruit. The evening skies are foraging grounds to two species of nectar bat in the Arizona desert—the lesser long-nosed bat (*Leptonycteris curasoae*) and the Mexican long-tongued bat (*Choeronycteris mexicana*). The lesser long-nosed bat, which is a federally listed endangered species, spends its summers in the desert and surrounding mountains or “sky islands” of Arizona.



One of few species of bats that undergo long-distance migrations, the lesser long-nosed bat is a true marathon runner of the bat world. In early summer these bats move from central Mexico to northern Mexico or southern Arizona, probably due to resource pressures and the need for critical roosting sites—driven by necessity, like our nomadic human ancestors. Along the way, they must find enough forage plants to fuel their long journey and they must have caves or mines to roost in. Each year hundreds of thousands of female lesser long-nosed bats migrate thousands of miles to give birth to their young and take advantage of warm, humid roosts and the abundant nectar and fruit available in the Sonoran Desert. After the long migration north to their maternity roosts, the females give birth in early summer. After learning to fly, the young bats follow their mothers to columnar cacti and succulents for a dinner of nutrient-packed nectar and fruit. Once the intense Sonoran Desert heat ebbs and fall encroaches, the bats head southward, back to their wintering

grounds in central Mexico.

Lesser long-nosed bats are important pollinators of columnar cacti like saguaro, organ pipe, and cardón, as well as succulents like the agave. These bats are also important seed dispersers. For these reasons, lesser long-nosed bats are instrumental in the reproduction and ultimate survival of these plant species and their natural

After the long migration
north to their maternity roosts,
the females give birth
in early summer.

communities. But over the last decade, biologists have been concerned about the health and welfare of these important pollinators. Since lesser long-nosed bats specialize on a certain kind of food, they may also be more vulnerable than other bats that feed on a variety of foods.

Surveys in the mid-1970s and early 1980s in northern and central Mexico and the southern United States indicated low numbers of these bats at roosts. The limited numbers and acknowledged over-harvesting of agave—one of its

major food sources—stressed the importance of protecting this species. The long-term decline in the population of lesser long-nosed bats could have a significant effect on the Sonoran Desert ecosystem. We were encouraged when the U.S. Fish and Wildlife Service (USFWS) added the lesser long-nosed bat to the federal endangered species list in 1988, and the Mexican Federal government listed them as threatened in 1994.

FORECAST FOR THE LESSER LONG-NOSED BAT
A USFWS recovery plan in 1994 listed conservation actions necessary for the recovery of the lesser long-nosed bat. Arguably, the most significant actions called for protecting, monitoring, and surveying roost sites for the species; by placing many roosts under both federal and state protection, the recovery plan resulted in a healthy increase in the bat's population. In Arizona and Mexico annual surveys of known roosts are now conducted each year by biologists from private organizations, universities, and federal and state agencies. In Arizona several studies have also been initiated on agave ecology, effects of fire on habitat, roost protection and enhancement, foraging ecology, and the effects of low-flying military aircraft on bats in roosts and during foraging.

In 2002, the Lesser Long-Nosed Bat Recovery Cooperative was formed, with members from the Arizona-Sonora Desert Museum, National Autonomous



University of Mexico, Bat Conservation International, Arizona Game and Fish Department, U.S. Fish and Wildlife Service, National Park Service, USDA Forest Service, University of Arizona, and independent biologists working together to protect and gain additional knowledge on the lesser long-nosed bat. This group of experts meets at least once a year to discuss research and other actions needed to maintain healthy progress in the recovery of the lesser long-nosed bat.

In 1995, the Programa para la Conservación de los Murciélagos de México (PCMM) was established after a group of international bat experts expressed concern about declining bat populations. The objectives of PCMM are to protect migratory, endemic, and endangered species of Mexican bats and to maintain their evolutionary and ecological roles and status. Research, environmental education, and conservation are the heart of PCMM. The Arizona-Sonora Desert Museum, Bat Conservation International, Institute of Ecology of the National Autonomous University of Mexico, Arizona Game and Fish Department, U.S. Fish and Wildlife Service, and other organizations and professionals from both Mexico and the United States collaborate with and participate in PCMM.

Over the years, the Arizona-Sonora Desert Museum has worked closely with biologists and educators in Mexico and the United States on projects devoted to

pollinators, including our bat pollinators. We also participate in the annual simultaneous surveys of important roosts in Arizona, New Mexico, and Mexico. From these projects we have gained reams of information on migratory routes, floral biology, new roost discoveries, foraging pat-

Lesser long-nosed bats are important pollinators of columnar cacti like saguaro, organ pipe, and cardón, as well as succulents like the agave.

terns, roost-protection projects, and improved population census techniques. They led to natural history presentations in schools in both Mexico and Arizona. And from the wealth of information yielded in these studies, we and our partners created an educational brochure on pollinators and a field



guide to Sonoran Desert pollinators. The efforts of hundreds of dedicated biologists, educators, and conservationists have contributed to better conditions and improved the outlook for the lesser long-nosed bat. Many roosts are protected, populations are stable or increasing, public attitude towards bats is improving, and research continues to fill the gaps for the ecology of this important bat. Protection of roosts, migratory corridors, and habitat will continue to dominate the conservation picture for this nectar-feeding bat. A key component of this success is the collaborative spirit and international and interinstitutional interactions, making the effort to recover this species of bat an example of what can be achieved when personal interests are set aside. Although the road is still long, progress has been made.

We will also continue efforts to protect the ecological functions of the entire ecosystem, thereby enhancing the health of its flora and fauna across the desert landscape. The future is bright, with many organizations and agencies in both the United States and Mexico collaborating on research and education to ensure the successful future and continued conservation for the lesser long-nosed bat.

SPREADING THE *Word* ON MIGRATORY POLLINATORS

Yajaira Gray, Conservation Outreach Coordinator,
Arizona-Sonora Desert Museum

The publication of *Forgotten Pollinators* by Gary Nabhan and Stephen Buchman a decade ago set off an alarm in many minds about the gravity of declining pollinator populations. Still the public, both here and Mexico, is largely unaware of the critical services pollinators perform for our society or the seriousness of their decline. For some, pollen is only a nasty character in a television ad for allergy medicines—something to be eliminated or treated. They do not consider that pollination is essential for much of the food we eat and an irreplaceable function in the very web of life.

At the Desert Museum we are working to stem the loss of migratory pollinators (like birds, bats, and butterflies) that fly between Mexico and the southwestern United States, because growing evidence shows their continued decline is having serious consequences for natural communities in the Sonoran Desert, as well as for productivity of agricultural lands in the Southwest. In 1999 we established the Migratory Pollinators Program and have since been collaborating with U.S. and Mexican partners on a variety of research and educational projects we hope will turn the tide. For two of the key migratory species—lesser long-nosed bats and rufous hummingbirds—our data collection on their status and the plants they feed upon supplies critical information to develop conservation strategies. But that alone is not enough.

To contribute effectively to the survival of these migratory bats, birds, and butterflies, and therefore to health of ecological communities in the Sonoran Desert, it is crucial to educate teachers, students, and the general public living along the migratory routes about the important role of pollinators. The Desert Museum has developed two strategies to accomplish this goal. One is to provide formal education through teacher-training workshops, school presentations, hands-on activities, field trips, and research projects in communities located along cross-border riparian corridors (the Santa Cruz and San Pedro Rivers) and the Gulf of California coast (Guaymas, San Carlos, Desemboque, Punta Chueca, Puerto Peñasco). The Museum has, so far, reached 250 teachers in 150 schools in this border region, emphasizing the importance and value of pollinators and presenting key information about pollination biology, migratory routes, conservation status and threats to the species of concern.

Our second strategy is to provide informal education, such as setting up pollinator gardens or presenting community-based workshops and training sessions for the public. We have worked extensively with Mexican communities in San Lázaro, Hermosillo, Cananea, Nogales, Puerto Peñasco, and also with the San Xavier Community Center (Tohono

O’odham Nation) and the Seri Nation (in coastal Sonora). This year the Desert Museum’s botany department provided technical assistance to the Tumacacori National Historic Park Project to redesign courtyard gardens with a pollinator theme—developing garden blueprints, irrigation system maps, plant lists, and ecological information.

We have also produced bilingual educational materials including brochures and posters, a children’s book, and data-collection forms for pollinators and their floral resources. These materials have been distributed to schools, community centers, businesses, ranchers, libraries, museums, and other key locations along migratory corridors in southern Arizona and western Mexico. Our bilingual book *Pollinators of the Sonoran Desert, a Field Guide* was produced in collaboration with the International Sonoran Desert Alliance (ISDA) and The Bee Works. Soon we will be publishing a bilingual “Pollinator Habitat Garden Kit,” which packages resources and instructions to help elementary school teachers design and plant pollinator gardens with their students. And, as learning and fun are a fortuitous match, we created a migratory pollinators board game and are currently looking for funding to develop it.

Research and education go hand-in-hand in our effort to protect these migratory creatures that work for us. The Desert Museum’s migratory pollinator projects, in both arenas, are often a synergistic effort with other organizations and individuals—especially Bat Conservation International, the Sonoran Institute, the University of Arizona (Udall Center for Studies in Public Policy and Bureau of Applied Research in Anthropology), ISDA, Pronatura Noroeste, Centro Estudios Desiertos y Océanos (CEDO), IMADES, Programa de Conservación de Murciélagos Mexicanos (PCMM), and the Pinacate y Gran Desierto de Altar Biosphere Reserve.



Conservation in Motion

HUMMINGBIRD MIGRATION IN SONORA

Hummingbirds capture our imagination with their dazzling jewel-like colors, unique flight ability, and fearless personalities. You cannot ignore their zest for life or their endless energy as they zip from flower to flower like miniature rainbows with wings. Hummingbirds occur only in the New World, with 330 species from the tip of South America to southern Canada. Sixteen of them occur in Sonora in northwestern Mexico. In tropical latitudes, where plants flower all year, there is little need for them to migrate, but in areas with more pronounced seasons, hummingbird ranges are more dynamic as they search for nectar-rich flowers.

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and **Eduardo Gómez-Limón**, Biological Consultant, Monte Sonorense, A.C.

Brightly colored flowers and shimmering hummingbirds do a wild evolutionary tango as hungry pollinators follow sequential flowering seasons along pathways on local to continental scales. For some species, the seasonal shift in range can be simple elevational movements up and down a mountain. In Sonora, broad-billed hummingbirds (*Cynanthus latirostris*) feed on ocotillo (*Fouquieria splendens*) in the desert in April and on sages (*Salvia* spp.) in the oak woodland of a 'sky island' mountain in August. Some species, like violet-crowned hummingbirds (*Amazilia violiceps*), simply expand their ranges modest distances, from Sonora into Arizona, in the summer months. Other hummingbirds found in the United States migrate thousands of miles twice a year. Rufous (*Selasphorus rufus*), broad-tailed (*Selasphorus platycercus*), black-chinned (*Archilochus alexandri*), and other hummingbirds migrate from wintering grounds in Colima and Jalisco in western Mexico to summer breeding grounds in the Pacific Northwest, Canada, or Alaska. Prior to migration, hummingbirds become voracious eating machines, and can gain as much as 25 to 50% of their body weight in fat in just a matter of days. Fat reserves fuel the long journey, yielding twice as much energy and water as carbohydrates and proteins. It is almost mind-boggling that a hummingbird can fly 500 to 600 miles for 20 to 24 hours without stopping to refuel!

Conservation

Conserving a migratory species is like trying to paint a moving target. Hummingbirds live in different geographic areas at different times of the year, and habitats critical to their survival can be threatened anywhere along their migratory routes. Many birds migrate along coastal areas, where resort and housing developments, shrimp farms, and coastal highways limit rest sites available in natural habitats. On the coastal plain of southern Sonora and most of Sinaloa, vast areas of foothills thornscrub and tropical deciduous forest have been cleared for large-scale commercial agriculture.



photography by Donald Knight

photography by Donald Knight

Top: Anna's (Calypte anna)

Above: ??

Right: ?? Costa's (Calypte costae) or Anna's (Calypte anna)



In the Sonoran Desert of central Sonora, large areas of desertscrub have been converted to African buffelgrass (*Pennisetum ciliare*) pastures. Clearly, there is a need for the study and protection of these important pollinators.



© Donald Knight



Above: ??

Left: Broad-billed (*Cyanthus latirostris*)

Hummingbird Research at the Museum

On a bright day in April 2000, Rubén Coronado, a tall, fit 65-year-old rancher with a kindly, sun-weathered face, and his four-year-old granddaughter Clarissa watched with rapt fascination as newly banded hummingbirds in their hands shook their feathers and flew away. Ruth Russell had completed detailed measurements of about a dozen birds captured in mist nets and traps, and was sharing the wonder of hummingbirds with our hosts at Rancho La Palmita.

This exhilarating introduction of ordinary folk to extraordinary jewels of flight took place on one of 15 field trips to observe rufous hummingbirds in Sonora between

1999 and 2003 during the Migratory Pollinator Program (MPP) funded by the Turner Foundation and the National Fish and Wildlife Service, and run by the Desert Museum with the help and cooperation of many others (see www.desertmuseum.org/pollination/).

Each year, the rufous hummingbird travels from southern Mexico to Alaska and back, the longest bird migration relative to body length. Skilled hummingbird watchers Bill and Lorene Calder, Steve and Ruth Russell, Susan Wethington, Lee Rodgers, Desert Museum staff, Sonoran collaborators, and many others observed these charismatic marathoners in areas from Hermosillo to Yécora along an elevational transect from Sonoran desertscrub through foothills thornscrub and tropical deciduous forest to oak woodland, and pine-oak forest in the Sierra Madre Occidental. MPP crews visited each area during the spring and late summer migrations, as well as in winter and early summer, and they observed all kinds of hummingbirds to better understand the dynamics of local hummingbird communities.

On one September morning we sighted twelve species visiting Texas betony (*Stachys coccinea*), which reflects the remarkable diversity of hummingbirds in the Sierra Madre during fall migration. We also recorded the unusual appearance of the desert Costa's hummingbird (*Calypte costae*) in pine-oak forest, and saw Berylline (*Amazilia beryllina*), white-eared (*Hylocharis leucotis*), broad-billed, and Costa's hummingbirds nesting.

The results of the MPP identified three northward migration corridors used by rufous hummingbirds in the spring: the **Gulf Coast Corridor** along the Gulf of California, the **Plains of Sonora Corridor** through the Sonoran Desert in central Sonora, and the **Foothills Corridor** through foothills thornscrub in the low hills at the base of the Sierra Madre farther east. During the southward migration in August and September, rufous hummingbirds use Pacific coastal and Rocky Mountain corridors, although large numbers also pass through at

low elevations in the Sonoran Desert region between those nectar corridors. Overall, about 1,000 observations greatly improved our understanding of hummingbird migrations through Sonora, but they also showed that the location of corridors and timing of movements are variable. Hummingbirds were observed to visit 98 species of plants in Sonora, 46 of them along the eastern Sonora transect. Although red-flowered species were most commonly visited, hummingbirds also went to many plants with yellow, purple, and white flowers (as is typical of the tropics). As you might expect, the numbers of species in hummingbird communities, as well as competition for nectar flowers, increased when migrants passed through.

The gears of the Museum's MPP also included significant educational components. A total of 67 presentations on migratory pollinators and Sonoran Desert natural history have been given to more than 1,500 students in 22 schools along potential hummingbird migration corridors in Sonora. And observations at feeders by students, teachers and Museum staff added important hummingbird migration data.

The successes of the Migratory Pollinators Program were the result of collaboration or support from many individuals and organizations on both sides of the border—universities, conservation organizations, Native American tribes, foundations, private groups. Many others provided valuable advice or technical support, including our science and public partners.

Through research and education in the Sonoran Desert region, the Desert Museum and its Sonoran partners will continue to learn about migratory pollinators, to teach the public about hummingbirds and their role in pollination, and to encourage conservation through identification and protection of important patches of nectar food plants and migratory stopover habitats.

Right: ??



photography by Donald Knight



Where the Desert Meets the Sea

Early Conservation Work in the Sea of Cortez

WHEN WILLIAM CARR AND ARTHUR PACK FOUNDED THE DESERT MUSEUM IN 1952, THEY RECOGNIZED THE SEA OF CORTEZ (GULF OF CALIFORNIA) AS AN INTEGRAL PART OF THE SONORAN DESERT. IN FACT, THE SEA OF CORTEZ DIVIDES THE LAND PORTION OF THE SONORAN DESERT INTO TWO HALVES, THE BAJA CALIFORNIA PENINSULA ON THE WEST, AND THE STATES OF ARIZONA AND SONORA TO THE EAST. THE SURFACE AREA OF THE GULF IS ROUGHLY THE SAME SIZE AS THE LAND SURFACE AREA, EACH ABOUT 100,000 SQUARE MILES—THUS, THE SONORAN DESERT IS ACTUALLY HALF MARINE. IN FACT, IT IS THE ONLY NORTH AMERICAN DESERT THAT IS MARITIME IN NATURE. AND, WERE IT NOT FOR THE SEA OF CORTEZ AND ITS HIGH EVAPORATION RATE, WE WOULD NOT HAVE THE MOISTURE-LADEN AIR THAT PRODUCES THE SUMMER MONSOONS THAT CHARACTERIZE THE SONORAN DESERT, DRIVING ITS EXTRAORDINARY PRODUCTIVITY AND BIODIVERSITY AND SETTING IT APART FROM THE OTHER DESERTS OF THE NEW WORLD.

RICHARD G. BRUSCA

EXECUTIVE PROGRAM DIRECTOR, ARIZONA-SONORA DESERT MUSEUM



IN 1959, EXECUTIVE DIRECTOR BILL WOODIN AND EXHIBITS DIRECTOR MERV LARSON BEGAN MAKING TRIPS TO THE GULF OF CALIFORNIA TO COLLECT MARINE ANIMALS FOR A PLANNED SEA OF CORTEZ EXHIBIT. IN 1960, MERV BEGAN TO RELY ON IKE RUSSELL'S BUSH PILOT EXPERIENCE TO FLY HIM TO REMOTE PLACES SUCH AS PUNTA LIBERTAD TO COLLECT TIDEPOL ANIMALS FOR THE MUSEUM'S FLEDGLING MARINE EXHIBIT PROTOTYPE. THE EXHIBIT PLAN THAT MERV AND BILL HAD IN MIND WAS CALLED "GULF HALL." ALTHOUGH FINANCIAL CHALLENGES KEPT GULF HALL FROM BECOMING A REALITY (SO FAR!), RESEARCH IN THE SEA OF CORTEZ PERSISTED.

EARLY ON, THE MUSEUM ALSO HAD A CONSERVATION MISSION IN THE GULF. IN 1946, LEW WALKER, AN ORNITHOLOGIST AND THE MUSEUM'S ASSOCIATE DIRECTOR AT THAT TIME, BEGAN VISITING ISLA RASA IN THE CENTRAL GULF OF CALIFORNIA. HE WAS ASTONISHED TO DISCOVER THIS SMALL ISLAND, NO MORE THAN ONE SQUARE MILE IN SIZE, WAS HOME TO OVER A MILLION BREEDING ELEGANT TERNS, ROYAL TERNS, AND HEERMANN'S GULLS—ONE OF THE DENSEST BIRD POPULATIONS IN THE WORLD. IN FACT, ISLA RASA HOUSES 95 PERCENT OF THE WORLD'S BREEDING INDIVIDUALS OF HEERMANN'S GULLS AND ELEGANT TERNS. LEW WAS ALSO SHOCKED TO LEARN THAT EGG POACHERS HAD ALSO RECENTLY DISCOVERED THE ISLAND. OVER THE FOLLOWING DECADE IT BECAME CLEAR TO LEW AND TO OTHERS AT THE DESERT MUSEUM THAT THIS EGG GATHERING COULD COMPLETELY ELIMINATE ALL OF THESE SEABIRDS FROM ISLA RASA, AND PERHAPS THE WORLD!



Photo by Michael Nolan

Above: Dolphin.



Photo by Michael Nolan

Above: Gray whale (Eschrichtius robustus). Below: ???





ECHINO (*Ophiothrix spiculata*).



MOL (*Octopus bimaculatus*).



CNID (*Lophogorgia stems*).



MOL (*Periwinkle*).

Finally, in 1961 Merv Larson and Lew took Joseph Wood Krutch and Roger Tory Peterson to Isla Rasa, where they produced a film to help build broad public support for the idea of protecting the island. In May 1964, after years of intense effort (including a visit to Mexico City to talk to President López Mateo) and with the help of Mexico's Dr. Enrique Beltrán, Subsecretary of Forestry and Game, and

Dr. Rodolfo Hernández-Corzo, Director

General of Wildlife, the government of Mexico declared Isla Rasa a migratory waterfowl sanctuary—one of the first ecological preserves in all of Mexico.

Throughout the 1980s the Desert

Museum financially supported research by U.S. and Mexican scientists on Isla Rasa through its Roy Chapman Andrews fund.

Today's Desert Museum in the Sea of Cortez

In 2001, I was hired by the Desert Museum to lead their research and conservation efforts, and to reinvigorate the Museum's Sea of Cortez program. About this same time, two major Gulf initiatives were coming to fruition. A 10-year effort to catalog every known animal species from the Sea of Cortez was nearing completion—a project spearheaded by myself and Dr. Lloyd T. Findley (of CIAD, Centro de Investigacion en Alimentacion y Desarrollo, Guaymas). This “all-species” database (known as the Macrofauna Golfo project) is the first ever to compile a complete list of animals, and their associated ecological and distributional data, for a major

region of the earth. Simultaneously, World Wildlife Fund's (WWF) Mexico Program, and several other Mexican groups, began a series of “expert workshops” to develop conservation priorities for the Sea of Cortez. The *Macrofauna Golfo* database thus took on even more importance, and the entire data set was made available to the conservation planning groups. The Desert Museum played a key role in the WWF-led conservation planning initiative, both with the database and with our expertise derived from so many years of work in the Gulf region.

The Desert Museum also played an important role in providing support needed to establish the Reserva Islas del Golfo de California, which now protects every island in the Sea of Cortez. Emerging from this new federal reserve was a plan for a nature center in Kino Bay, which is the gateway for boaters and sport fishers to access the ecologically important islands of the central Gulf. Again, the Desert Museum was invited to serve in an advisory capacity, and we eventually





Breeding elegant tern colony, Isla Rasa.



Sea lion.



Beached jumbo squid.



Jumping manta ray.

developed two of the key exhibits at the Kino Bay Nature Center—one on the Sonoran Desert and the other on tidepool life.

The *Macrofauna Golfo* database continues to be mined and analyzed, and many scientific and popular publications have derived from it, including a new Arizona-Sonora Desert Museum ***Seashore Guide to the Northern Gulf of California***. For the first time, conservation managers in the Gulf region are able to extract lists of species for their reserve or management area—everything from worms to whales, and sponges to sea birds, all in one source.

In June, 2004, the Desert Museum hosted the largest conference on the Sea of Cortez ever convened (www.gulfconference.org), with over 400 attendees, most of whom were presenters. For five days, Gulf specialists from Canada, the United States, Mexico, and a number of other Latin American countries presented talks on every aspect of the Sea of Cortez. In addition,

two separate conservation workshops took place in concert with the conference, one on the Colorado River Delta (hosted by the Sonoran Institute) and another on the estuaries of the Gulf (hosted by the Desert Museum and The David and Lucile Packard Foundation). Through partnerships with World Wildlife Fund, Conservation International, The Nature Conservancy, The David and Lucile Packard Foundation, and others, over \$250,000 was raised to support the conference and provide travel scholarships for nearly all of the Mexican participants (more than half the audience!). The estuaries project is determining conservation priorities for protecting these vitally important wetlands throughout the Gulf.

Future Plans

A significant interpretive piece still missing from Desert Museum grounds is a Sea of Cortez exhibit

(the “Gulf Hall” that Bill Woodin and Merv Larson envisioned). However, staff and trustees are now discussing how this marine component of the Sonoran Desert might be best interpreted at the Museum. Next year, in an effort to conserve through consumer education, the Museum plans to publish a “sustainable seafood guide” for the Gulf of California, working with partner organizations in Mexico. In addition, a proceedings volume from the Gulf Conference is now underway (to be co-published with the University of Arizona Press), a checklist of the 5,000 species of invertebrates known from the Sea of Cortez will be published next spring, and our research on coastal ecosystems and conservation in the “marine Sonoran Desert” continues to grow. We will keep you posted! **S**





Pennisetum ciliare W of Tucson, AZ



Pennisetum ciliare fire in AZU, Mex 2 NW of Caborca, Son.



Limestone hills east of Caborca, Son. Pennisetum ciliare invasion, area burned.

Political borders attempt to regulate the passage of people and products across a manmade division. Rarely do they follow natural ecological barriers. The United States-Mexico border in the Sonoran Desert region is no exception—it arbitrarily bisects contiguous desert lands. Ecologically, the border does not exist. Species cross every day, on their own or with human assistance, on wind, wing, or foot, on shoes, clothes, tires, and machinery, as contaminants in agricultural products or seeds, or in packaging materials.

BIOINVADERSⁱⁿTHE BORDERLANDS

Today, some 600 species of plants and animals found in the Sonoran Desert are nonnative exotics—organisms that settled here from beyond their normal range. Of these, a small number have become invasive species.

Invasive species are exotic species that cause or are likely to cause economic or environmental harm, or harm to human health. Invasive species aggressively spread into a new environment if it closely matches their place of origin and lacks natural controls or competitors that limit them. Their costs are huge—lost production and control programs in the United States alone cost nearly \$140 billion annually.

Though invasive species are only a fraction of the total species in our region, their potential impact is enormous. Buffelgrass (*Pennisetum ciliare*), an Old World grass spreading on both sides of the border, illustrates the magnitude of the issue. The U.S. Department of Agriculture brought this drought tolerant grass to North America in the 1930s, introducing it in Texas and Arizona for cattle forage and erosion control. It was introduced from Texas seed into Mexico in the 1950s, and ranchers began seeding it in the state of Sonora in 1958.

ROBIN KROPP, EDUCATION SPECIALIST,
ARIZONA-SONORA DESERT MUSEUM

PHOTOGRAPHY BY
MARK DIMMIT

Left: *Pennisetum setaceum*



Pan Quemando Mts., SE end buffelgrass.



Limestone hills east of Caborca, Son. Pennisetum ciliare invasion, area burned.



Pennisetum ciliare invasion, SE corner of Samaniego Hills, AZ. NPCI buffelgrass.

Buffelgrass presents a laundry list of harmful impacts. It outcompetes native vegetation for water and soil nutrients. It grows thickly and fuels deadly fires to which native desert vegetation is not adapted, then resprouts vigorously. Eventually it depletes soil fertility. From populations on both sides of the border, it has created homegrown infestations, spreading from roadsides and cleared fields into the desert.

What do the United States and Mexico both stand to lose? Ecologically, the Sonoran Desert is one of the most diverse arid ecosystems in the world, home to species found nowhere else. Buffelgrass converts this biodiversity into a monospecific, African-like savanna.

Economically, the impacts vary. In our country, the loss of iconic species like saguaros and colorful annual wildflower displays represents a potential loss of millions of dollars in the tourist and building industries, along with an increased cost for fire management. In Sonora, one million hectares have already been converted to buffelgrass and two million more are susceptible to clearing, following state recommendations for planting and propagating buffelgrass. This represents one-sixth of the total land area of the state. Eventual impoverishment of soils will impact land productivity and will not be reversible without substantial investment.

So far, the cross-border spread of buffelgrass into wildlands has been limited. As populations expand, however, potential for spread throughout the region increases. In Sonora and Arizona, ecologists are studying the spread and effects of buffelgrass and making recommendations to mitigate its impact. Desert Museum researchers, in collaboration with Mexican colleagues, are part of this charge.

Though the number of invasives in the Sonoran Desert is small, in time just a few species can have a dramatic—or tragic—impact. In these borderlands, there is an increasing groundswell of understanding about the impact of invasive species. We share this ecosystem, and we must meet the threat together, because invasive species respect no borders. Find out more about the Desert Museum’s work on invasive species on our website at: www.desert-museum.org/invaders/.

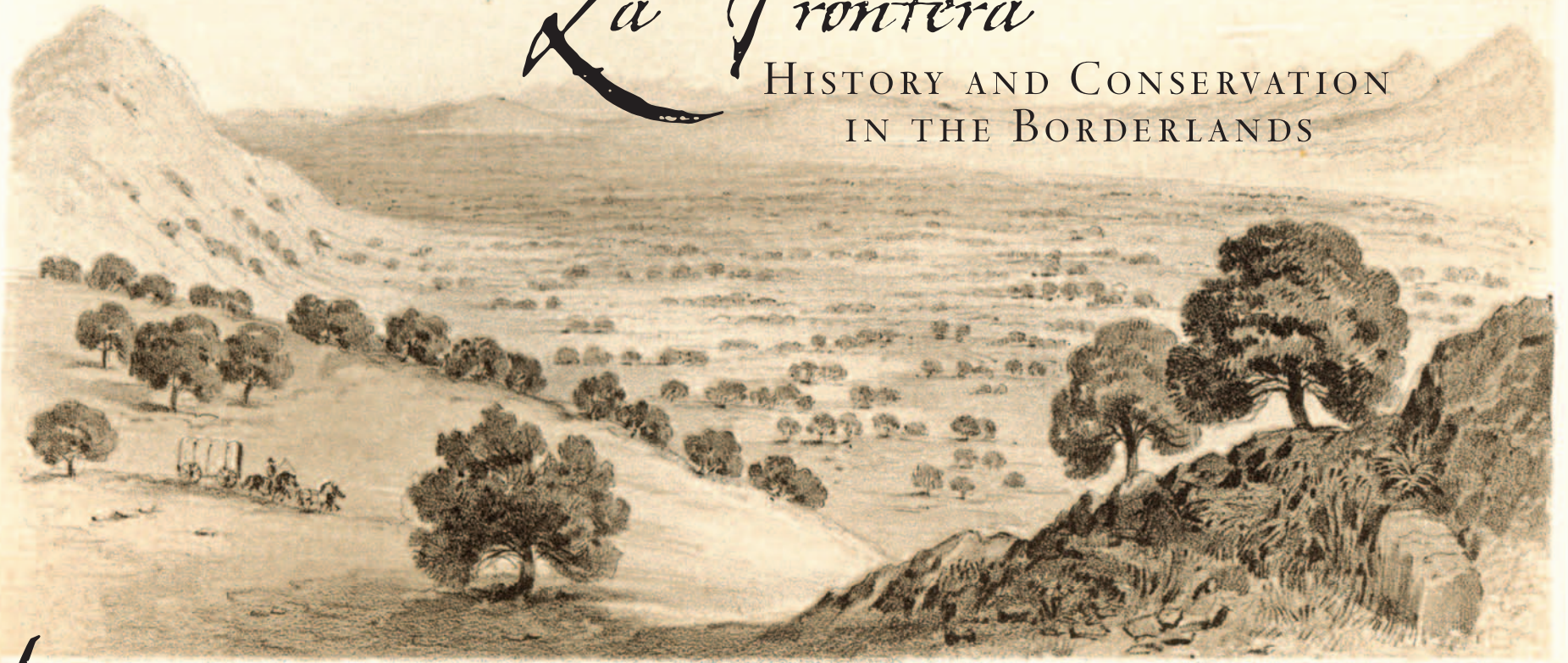
Right: *Pennisetum ciliare*



THE FORGOTTEN FLORA OF

La Frontera

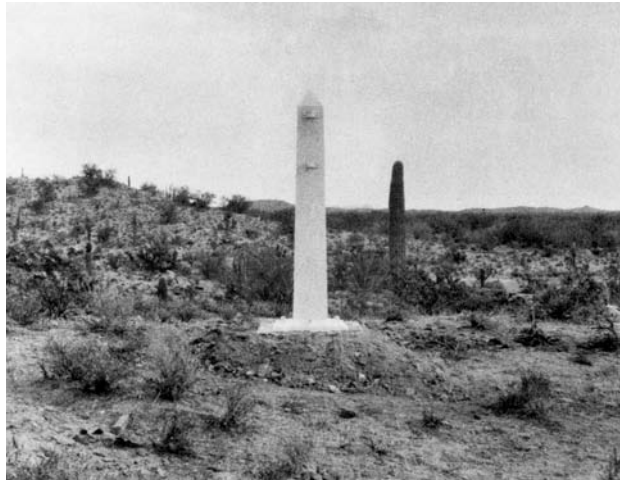
HISTORY AND CONSERVATION
IN THE BORDERLANDS



In September of 2002, in one facet of the Migratory Pollinators Project, botanists from the Desert Museum and the Universidad de Sonora (UNISON) ventured to northern Sonora to observe hummingbirds and collect their food plants. Their collections from Chihuahuan desert scrub near Agua Prieta and grasslands near Santa Cruz proved enlightening; few Sonoran specimens or literature references existed for many common Arizona plants. The flora of *La Frontera* within 50 kilometers of the Arizona border had been forgotten—the result of a complex history of culture, exploration, and politics.

The Spanish influence in Mexico began in 1519 with the Hernán Cortés expedition. Twenty-odd years later, the Coronado Expedition reached Sonora, and miners and missionaries soon followed. From 1687 to 1711, the Jesuit Priest Eusebio Kino established missions across Sonora into Arizona, including the venerable San Xavier Mission on what is now the Tohono O’odham Nation in Tucson. By the mid and late 1700s, world exploration was well underway, and biological oddities were reaching European natural history museums, amazing and amusing

Old World aristocracy. Swedish botanist and taxonomist Karl von Linné and his students described new plants from around the globe. However, Spanish interests in plants were more practical. Old World wheat, olives, and figs were introduced into the New World, while corn, potatoes, and tomatoes were carried to Europe. Unfortunately, few scientific collections were made. Botanical explorations of *La Frontera* in northern *Nueva España*, as Mexico was known at the turn of the seventeenth century, would wait another 150 years.



In 1851-52, John Bartlett led the U.S. Boundary Commission expedition to survey the new U.S. Mexico border. The view in this painting entitled "Valley leading to Santa Cruz, Sonora" published in 1854 is across the present San Rafael Valley toward Santa Cruz, Sonora. Here the Santa Cruz River begins its southward flow and crosses into Sonora. Image courtesy of the University of Arizona Library Special Collections.



Original image of Monument 172 along Arizona-Sonora border just east of Quitobaquito in Organ Pipe Cactus National Monument taken between 1892-1894. Courtesy of Raymond M. Turner and Diane Boyer, U.S. Geological Survey. In the 1995 image, note how much denser the vegetation had become and the differences in land use reflected on both sides of the border.

COLLECTING ALONG A NEW BOUNDARY

When the Mexican-American War ended in 1848 and the California Gold Rush exploded in 1849, thousands of European Americans traveled through *La Frontera*. A major route through La Frontera began at the Santa Rita Copper Mines (now Silver City, New Mexico), headed south through Guadalupe Pass in the Peloncillo Mountains, southwest into Sonora near Agua Prieta, and then west to Santa Cruz and Nogales.

The expeditions to survey the United States-Mexico boundary (1848-1855), and the subsequent Gadsden Purchase (1883) were the first systematic biotic inventories in the borderlands. In 1851 near Santa Cruz, Mexico, boundary survey botanist Charles Wright collected a gentian (now *Gentianella wrightii*), which is now a very rare species. It was an area rich in flora and fauna at the time. In 1855, zoologist C.B.R. Kennerly described the San Pedro River northeast of Cananea, saying "[it is] backed up into a series of ponds by beaver dams and is full of fishes." Later, Kennerly heard that tigras (jaguars) were common near Santa Cruz, and he killed a grizzly bear near Nogales.

In the nineteenth and twentieth centuries, an all-star cast of botanists built the collections of borderlands flora. In addition to Charles Wright, John M. Bigelow, Charles C. Parry, Arthur Schott, and George Thurber contributed to the boundary surveys. In southern Arizona, professional collectors John G. Lemmon, Samuel Parish, Cyrus Pringle, and Edward Palmer were active in the 1880s, followed by academic botanists James W. Toumey, Marcus E. Jones, John J. Thornber, Leslie N. Goodding, Forrest Shreve, and others through 1940. Today we remember these botanists by the countless plants named in their honor. After 1940, many University of Arizona (U of A) and Arizona State University botanists made important contributions to the Arizona flora.

The flora of La Frontera in Sonora has received less attention. In 1890, Carl V. Hartman collected plants in northern Sonora on the Lumholtz archeological expedition to Chihuahua (see sidebar). In the 1930s, Shreve, Ira L. Wiggins, and Howard S. Gentry collected in Sonora, but well south of the border. In the late '30s and early '40s, Stephen S. White (University of Michigan) made extensive collections in the Río Bavispe area near the border. In the early

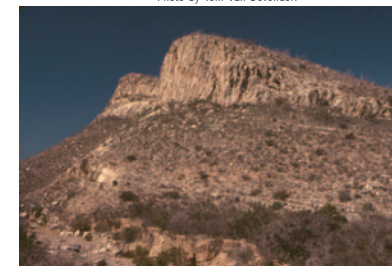
'50s, Joe T. Marshall collected plants during a survey of the birds of the pine-oak forests in northeastern Sonoran 'sky islands.' In the 1970s, Paul S. Martin and his students from the University of Arizona Desert Laboratory collected in the Magdalena palm canyon and near Cucurpe. And in 1992, Richard S. Felger, Mark Fishbein (U of A), and Florentino Garza S. (Secretaria de Medio Ambiente y Recursos Naturales, SEMARNAT) surveyed plants in the Sierra de los Ajos east of Cananea. The outstanding exception to the overall meager records for *La Frontera* south of the border is the superb survey of plants of the western borderlands in the Gran Desierto and Pinacate Region of northwestern Sonora by Richard Felger, the flora for which was published in 2000.

Thus, following the U.S.-Mexico Boundary Survey, *La Frontera* was largely neglected for another 150 years by American botanists passing through northern Sonora en route to more attractive tropical areas, as well as by Mexican botanists based in Mexico City, 2200 kilometers to the south.

BOTANICAL EXPLORATION IN THE 21ST CENTURY

Fortunately, that long drought of botanical exploration is ending. In the last five years, Museum and UNISON botanists have been very active in *La Frontera* from Agua Prieta to Sásabe, collecting and depositing about 2000 plants specimens into herbaria in Arizona and Sonora, in Mexico City, and elsewhere. Collection data for many rare plants were provided to the Centro de Datos para la Conservación database at the Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora, and also to The Nature Conservancy for its Apache Highland Ecoregional Assessment,

Photo by Tom Van Devender.



Many new Sonoran plants and southern range extensions have been found in unusual habitats in *La Frontera* such as the Chihuahuan desertscrub at Rancho La Calera near Agua Prieta.

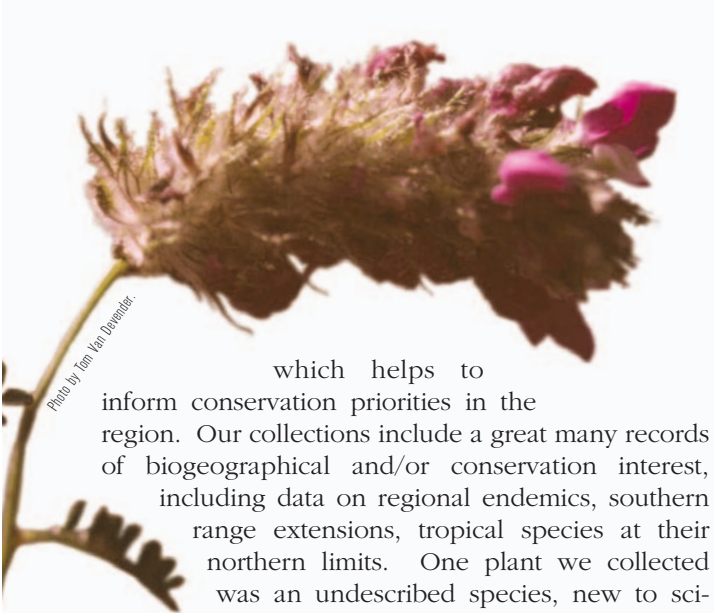


Photo by Tom Van Devender.

which helps to inform conservation priorities in the region. Our collections include a great many records of biogeographical and/or conservation interest, including data on regional endemics, southern range extensions, tropical species at their northern limits. One plant we collected was an undescribed species, new to science (*Anoda* sp. nov.), an herbaceous flowering plant in the mallow family.

New Sonoran records of Gentry indigobush (*Dalea tentaculoides*, a candidate for the endangered species list) and species of special concern, including bigflower bluestar (*Amsonia grandiflora*), Bartram stonecrop (*Graptopetalum bartramii*), and Wiggins milkweed vine (*Metastelma mexicanum*), will help the U.S. Fish and Wildlife Service evaluate their status. While the 2002 Mexican endangered species list is still evolving, peripheral U.S. species with limited distri-



Photo by Tom Van Devender.

Left: *Gentry indigo bush* (*Dalea tentaculoides*) is a rare plant known only in two localities in Arizona and three in northern Sonora. Surveys of known populations and potential habitat in Sonora will help the U.S. Fish and Wildlife Service evaluate a petition to list it as an *Endangered Species*.

Right: The *Santa Cruz beehive cactus* (*Coryphantha recurvata*) was found to be much more common than thought in Sonora in recent surveys.



Photo by Tom Van Devender.

butions in Mexico are potential candidates for future listing. In addition to putting native flora on the table for possible protection, we provided records and specimens of exotic species collected to Mexican weed scientists. Recent Desert Museum collections in *La Frontera* added 39 new native and 12 non-native species to the flora of Sonora. On both sides of the border

we are growing knowledge, and with knowledge, the ability to make reasoned plans for a sustainable future.

These recent forays by the Museum and its Mexican partners have highlighted the floristic richness and biogeographical importance of this area to the scientific and conservation community. More exciting discoveries are sure to come.

Left: *New localities for plants of conservation interest in the United States and Mexico, such as the bigflower bluestar* (*Amsonia grandiflora*), have been found in *La Frontera* in the last five years.



Photo by Tom Van Devender.

The distribution of the *Santa Rita claret cup cactus* (*Echinocereus* cf. *santaritensis*) in Sonora is not well known. It is part of a complex group of red-flowered hedgehog cacti whose taxonomy is being studied.

Ditmar's Lizard



Tom Van Devender,
Senior Research Scientist, Arizona-Sonora Desert Museum

In spite of its size, a horned lizard can be intimidating with its bizarre, spiky form and reptilian stance, and of the fourteen recognized species in North America, Ditmar's lizard holds its own in awesome outlandishness.

When Carl Lumholtz led an archeological expedition through northern Sonora en route to Chihuahua in 1890, his fellow travelers were undoubtedly fascinated by the peculiar creature they encountered, as it found its way into their collections. By the early 1900s several specimens of this unusual, massive-headed lizard were exhibited at the Bronx Zoo, and in 1906 Leonhard Stejneger formally described it as a new species, *Phrynosoma ditmarsii*, in honor of the Curator of Reptiles there, Raymond Ditmar.

Decades later, in 1969, Michael D. Robinson of the University of Arizona retraced the route of the Lumholtz expedition through northern Sonora under a grant from the Desert Museum's Roy Chapman Andrews Fund. He also rediscovered the Ditmar's or rock horned lizard—first in the Sierra Manzanal southeast of Cananea and then in the Sierra Baviácora in the Río Sonora Valley 130 kilometers to the southeast. While most horned lizards species are found in hot arid habitats, both of these areas are in oak woodland. Then in March of 1983 Bob Perrill, a Desert Museum botanist, photographed a rock horned lizard southeast of the Río Yaqui on the Yécora highway. This remarkable observation is about 160 kilometers south-southeast of the Sierra de Baviácora and in tropical deciduous forest.

As the rarest lizard in the Sonoran Desert, the rock horned lizard warrants protection.

SONORENSIS

Arizona-Sonora Desert Museum

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