**VOLUME 7, NO. 3 Fall 1989**



Climb Every Cactus
BCI's Sonoran Desert Bat-Cactus Project concludes its first field season in Mexico. . .
Fleming, Theodore H.

**BCI's Sonoran Desert Bat-Cactus Project concludes its first field season in Mexico. . .**

*by Theodore H. Fleming*

The sun had been down for over half an hour when I reached the base of a tall, rocky hill that was to be my radio-tracking station for the night. I had just walked over a mile across gravelly desert flatlands. Looking up the steep slope in the gathering darkness, I stopped to catch my breath and thought out loud, "How am I ever going to get up this hill?" Pushing aside thoughts of encounters with rattlesnakes, I scrambled up, using my collapsible antenna and folding beach chair as crutches, struggling to maintain my balance on the patches of loose talus. Once I reached the top, a desert breeze dried my sweaty shirt as I set up my telemetry receiver and antenna to check the locations of our radio-tagged bats.

Rugged cactus-covered hills lay on my right, and behind me stretched sparsely vegetated desert flatlands punctuated by scattered hills. To my left the street lights of Bahia Kino blinked in the distance several miles away, and beyond lay the shimmering waters of the Sea of Cortez. Having spent most of my research career studying the ecology of fruit-eating bats in tropical forests, I was enjoying the work in a new habitat--the Sonoran Desert. This time, I was studying a different kind of bat-plant interaction: the pollination of three species of columnar cacti by the endangered lesser long-nosed bat, *Leptonycteris curasoae* (formerly *L. sanborni*).

Understanding the relationship between *Leptonycteris* and the cacti will play a vital role in conservation planning for the Sonoran Desert ecosystem. Bat Conservation International initiated the study because long-nosed bat populations in Mexico and Arizona have apparently declined in recent decades. Bat researchers, such as Hector Arita and Don Wilson, have pointed out the urgent need to study the biology and behavior of *Leptonycteris* and its importance as a pollinator of Agaves and other plants (*BATS*, December 1987). This includes some of the most conspicuous plants in the Sonoran Desert--giant columnar cacti, which also provide homes and food for many other kinds of animals.

With the aid of a National Geographic Society grant to Bat Conservation International, Merlin Tuttle and I began in mid-April 1989 what we expect to be a long-term study of the foraging behavior of *Leptonycteris* and the pollination biology of cardon (*Pachycereus pringlei*), saguaro (*Carnegia gigantea*), and organ pipe (*Stenocereus thurberi*). We chose to work in the desert around Bahia Kino in Sonora, Mexico, because of its high density of columnar cacti. Beginning in early spring, the cacti bloom in a predictable order with some overlap, the cardon first, followed by saguaro, and last by organ pipe. *Leptonycteris* is a migratory bat that feeds principally on nectar and follows the blooming of its food plants.

Setting up a project to research the little-studied bats and plants presented unique challenges and gave us some surprises during our first 11-week field season. Our goals

were ambitious, but with the help of an enthusiastic and hard-working group of volunteer field assistants (see page 8), we were able to accomplish most of them. At the beginning of each week, Peg Horner, my chief field assistant, and I assigned tasks. Our objectives were to determine the relative importance of nocturnal (primarily bats) and diurnal (birds and bees) pollinators to the plants' ability to produce fruit and set seeds, to document at what times the plants flower and produce their highest quantities of nectar, and to observe who visited the flowers. Finally, we wanted to obtain preliminary data on the foraging behavior of *Leptonycteris*.

By radio-tracking the bats from a different series of hills each night as they approached or left their feeding areas, we were able to learn a great deal about their feeding habits. Setting mist nets near the entrances of an abandoned mine and a cave, we captured bats as they came to rest and digest their meal of nectar and pollen. We caught eight females (nearly the total number of *Leptonycteris* that we handled in the entire field season) and glued a tiny (0.9 grams) radio transmitter to their backs before releasing them. The transmitters would fall off each bat, leaving it unharmed, three to four weeks later. For two weeks, we spent nights determining where these individuals were feeding in relation to their day roosts, how often they changed feeding areas, and how long they fed each night.

Although we had expected the bats to feed close to their day roosts, most fed more than 12 miles away. Six of them roosted by day on Isla Tiburon (Shark Island), a wildlife sanctuary in the Sea of Cortez, approximately 12 miles due west of our study area. We learned that each bat uses the same route night after night and that they are very precise in the time they arrive and depart from their mainland feeding areas (around 10:00 P.M. and 2:00 A.M., respectively). Why these bats choose to travel such long distances, when apparently suitable day roosts in caves are unoccupied on the mainland, is currently unknown, but the reason probably involves rearing young in predator-free and appropriate maternity roost sites. Many bat species need very specific temperature and humidity conditions to rear their young.

One of the pleasures of this project was that our schedule called for us to be in the desert during the most comfortable times. Flowers of cardon and organ pipe cacti open just after sunset and close by the middle of the next morning, before air temperatures become uncomfortably high. In contrast, flowers of saguaro open around midnight and stay open until noon or later the following day. Except for a few occasions, we were able to avoid working at the hottest times of the day.

An all-night job was measuring the rates at which flowers produce nectar. We examined two blossoms on each of four plants, bagging them with fine nylon netting before they opened, to prevent potential pollinators from taking the nectar. Every two hours until the flowers closed, we used a calibrated syringe to measure the nectar each flower produced. Our reward was the opportunity to savor what the bats themselves found so delectable.

On paper, the task of measuring nectar sounds straightforward. But in reality, like everything we had to do when working with flowers of GIANT cacti, we had to work on extension ladders; flowers were found anywhere between five feet and nearly 23 feet above the ground. Further complicating matters, the cacti were often widely spaced, meaning we had to haul the ladders hundreds of feet between plants. We quickly learned to mark our route to avoid getting lost among the towering columns that, in the dark, looked much the same. Novice cactus workers were understandably apprehensive the first time they climbed 20 feet up a cactus in the face of a stiff wind. Fortunately, no one fell, nor was anyone impaled on the thousands of spines that awaited a misstep.

These efforts taught us that the highest nectar production occurs between 8:00 and 10:00 P.M. in cardon and organ pipe. Saguaro has two periods of peak production--between midnight and 2:00 A.M. and between 8:00 and 10:00 A.M. This suggests that cardon and organ pipe are very dependent upon nocturnal pollinators, while saguaro appears to rely upon two different sets, both nocturnal and diurnal.

Observing night pollinators visiting the flowers was less physically demanding than the nectar work but still presented a challenge--trying to stay warm and awake while staring at a group of open flowers. Night temperatures usually dropped below 68$DG F (20$DG C). When combined with a stiff breeze, this felt "freezing" to those sitting motionless on the desert floor. We quickly discovered that catching naps in the refuge of our field vehicle, a dusty borrowed International Travelall, was preferable to sleeping under the stars--no matter how much dust encrusted the seat.

From sundown to dawn, a team of two traded between observing flowers through a night-vision scope, meticulously recording every time a moth or bat visited each flower, while the other napped, ready to relieve the one doing observations two hours later. A night-vision scope enables researchers to "see" in the dark and is a type of electronic "telescope" that amplifies existing light levels thousands of times to produce a sharp image in brilliant shades of phosphorescent green. The next morning, we watched the same flowers through binoculars and recorded bird and bee visits until the buds closed.

*Leptonycteris* visits to flowers were sporadic, but exciting, events. Most occurred between midnight and 2:00 A.M. Groups of three to five bats at a time often visited cardon flowers but only single individuals or pairs visited saguaro and organ pipe. Before actually pollinating a flower, the bats make wide circles around a plant, conspicuous enough to arouse a sleepy observer because *Leptonycteris* are very noisy, swift flyers, their strong wingbeats making distinctive "whooshing" sounds. After circling the plant several times, the bats flew up to open flowers to "check them out" (perhaps assessing nectar levels by odor). Visits usually lasted less than one second during which a bat plunged its head deeply into a flower while getting a tongueful of nectar and a faceful of pollen, thus ensuring pollination when the bat visited a flower on another plant. It would then visit the same blossom again or others on the plant before disappearing from view. When the bats arrived in groups, they usually fed at different flowers but occasionally visited the same one in rapid succession.

Our largest and most time-consuming project was the series of experiments done to compare the relative importance of nocturnal and diurnal visitors as pollinators of the three cacti. We used the same technique for each kind of cactus and subjected flowers to one of six day and night experiments, designed to exclude some potential pollinators and allow access to others. Some flowers were designated as controls and received no treatment, and others were constantly bagged to check for the possibility of self-pollination. Three times a day we worked with 15 to 20 flowers--in the late afternoon before the flowers opened, before dawn, and in late afternoon of the following day after they had closed. With a desert floor full of easily collapsed rodent burrows, swaying plants, aggressive spines, hungry honeybees, and occasional rattlesnakes, we were kept alert as we made our rounds. We became experts at climbing ladders in all terrain day or night. The experiments were repeated until we had a sample size of at least 20 flowers per treatment; we then checked their condition (by now immature fruits) once a week.

What we learned from this year's efforts was this. We first discovered that cardon has a

breeding system that differs substantially from that of saguaro and organ pipe. Instead of having hermaphroditic flowers in which each acts as both male (produces pollen) and female (produces ovules inside a fruit), cardon cacti are functionally only males or only females despite their flowers having both reproductive parts. This kind of breeding system is extremely rare in the cactus family, and finding it in cardon was unexpected. While the discovery was exciting, it played havoc with our experiments because male plants, which rarely set fruit, outnumbered females by about four to one. Because we randomly chose plants for our experimental treatments, most of those we worked with were males that shed their flowers regardless of who did or did not visit them! Next year, we plan to repeat this experiment working only with female plants.

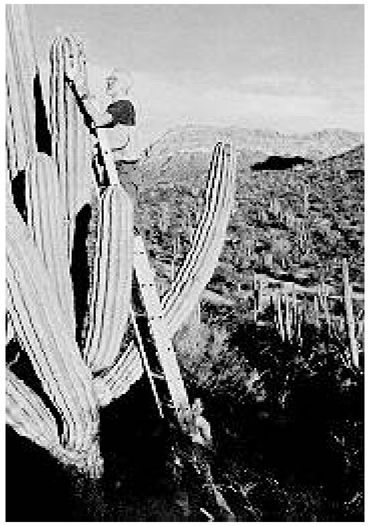
Our second major discovery was that saguaro may be at least as effectively pollinated by bees and birds--primarily black-chinned hummingbirds and gila woodpeckers--as by bats. This should have come as no surprise to us knowing that saguaro continues to produce nectar well past sunrise and has food available for a variety of diurnal animals, such as birds and bees.

Finally, we found that flower drop-off rates in organ pipe were very high, not because of an unusual breeding system but possibly due to the limited availability of nocturnal pollinators (i.e., *Leptonycteris*). Although we need to conduct further experiments to test our suspicions, we believe that the stigmas of organ pipe flowers are receptive to pollen only at night. Because the density of *Leptonycteris* in our study area was low when we conducted our experiment, many organ pipe flowers were never visited by bats. General results from our first field season suggest that *Leptonycteris* is the major pollinator of cardon and organ pipe but not of saguaro at Bahia Kino. The extent of saguaro's dependence on various pollinators may vary among geographical regions.

Although we learned a lot about *Leptonycteris* and giant cacti in our first field season, we have just scratched the surface in our understanding of their ecological interdependence, vital to the survival of this endangered species, and perhaps to the future of southwestern desert ecosytems. As is true in most scientific investigations, our work has raised more questions than it has answered. Pursuing these questions will keep us busy for years to come.

(Bio)
*Theodore H. Fleming is a Professor of Biology at the University of Miami in Coral Gables. His book* The Short-tailed Fruit Bat: A Study in Plant-Animal Interactions *was published in 1988 and summarized the results of a ten-year study.*

---



*On a steep rocky slope in the Sonoran Desert, Peg Horner steadies the ladder for Ted Fleming as he climbs a cardon cactus to check an experiment. PHOTO BY P.A. MORTON*

*To reach the nectar of an organ pipe cactus flower, the long-nosed bat thrusts its head through the blossom, its tongue reaching the sweet reward at the bottom (seen glistening at the base of the cross-section shown below). When the bat withdraws, its face will be coated with pollen, which it then transfers to the next flower it visits. PHOTOS BY MERLIN D. TUTTLE*

*Long-nosed bats were discovered to travel long distances to their feeding grounds at Bahia Kino. Back at their night roost, the bats rest, digest their evening meals, and groom the pollen off their faces. PHOTO BY MERLIN D. TUTTLE*

All articles in this issue:


- On the Cover
- Climb Every Cactus
- Seeing in the Dark
- The Volunteer Experience
- `Ope`ape`a: Hawaii's Elusive Native Bat
- The Project to Save the Hawaiian Bat
- For the Love of Bats
- Marine World Africa USA Gets Involved with Bats
- Survival Anglia and CBS Team Up to Produce Documentary about Bats
- Eighth International Bat Research Conference Held
- BCI Members Boost Book Sales
- National Zoo Bat Exhibit to Open with Lecture
- The perfect gift