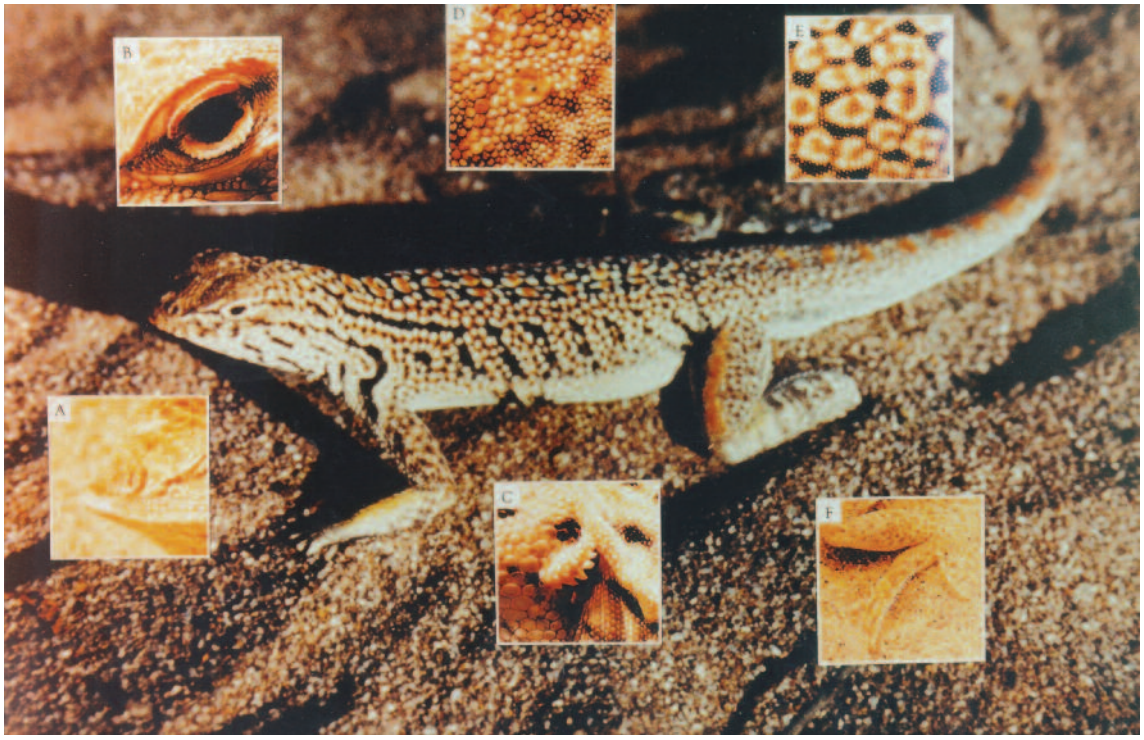

Photos courtesy of the Chihuahua Ecology Institute Regional Center

The Chihuahuan Sand Lizard
A Masterpiece of Adaptation

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The study of the adaptation of reptiles to extreme conditions like those in deserts not only helps us understand how they survive, but also to visualize which of their strategies we could use in the near future to adapt ourselves to a world going through an increasing process of desertification.

Uma paraphygas is an endangered species of endemic Mexican lizard, which lives exclusively in sand and gypsum dunes, and inhabits a very small part of the south eastern region of the state of Chihuahua as well as on the banks of the Laguna del Rey in western Coahuila. Both these areas are located in a place called the Bolsón de Mapimí in the middle of the Chihuahua Desert.

The Chihuahuan sand lizard is a key link in the ecological network of dune ecosystems. That is, even though other Sauria cohabit with it, they can also inhabit different kinds of ecosystems, so, when an important environmental change takes place in the dunes, they simply emigrate somewhere else. This is not the case of

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the sand lizard since, ecologically speaking, it is subject to the islands of sand and must therefore adapt to the changes there or perish. For that reason, it is possible to find and establish close links between the evolution of its habitat and its populational behavior.

Since it is such a specialized organism (it only inhabits dunes), certain important upsets in these ecosystems (the elimination of vegetation, being trampled on by cattle, contamination, etc.) will be reflected in the instability of these Sauria. Thus, in our studies, we have found that in some groups of this organism, several of their populational characteristics tend to remain stable (for example, density, survival and mortality rates, biomass, etc.). This is as long as humans do not considerably alter their habitat.

Thus, when we see certain Sauria populations dwindle because of the effect of humans, we are able to have a kind of fauna-qualitative indicator of the damage caused by man to the habitat. We can also establish a longer term relationship between processes like the natural compacting of the sand in the dunes and the lower density of Sauria at these sites. This would be an indirect fauna indicator of this natural process of desertification, in which there would be a probable correlation between a greater compacting of the sand and a lesser density of these animals. In other words, it acts as an indicator of the "health" of these kinds of habitats, operating as a kind of "desert-o-meter."

Characteristics of These Sauria

The sand lizard feeds on different kinds of arthropods like ants, beetles, grasshoppers and flies, thus contributing to the regulation of arthropod populations, in addition to being the most representative of the species of the dune ecosystems. The lizard is most active in spring and summer between 9 and 11 a.m. and 4 and 6 p.m.

One interesting fact is that they move very quickly across the dunes and can "swim" through the sand. This ability is the result of the following adaptations that make it impossible for sand to enter their bodies through their mouths, nostrils, eyes and ears (see illustration at the beginning of this article):

- when they close their upper mandibles, they include the lower mandible;
- they have sluice-like scales on their upper and low eyelids; and

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- they also have fin-like scales that open and close against the ear when they move through the sand.

Other important aspects are a particularly conspicuous pineal eye at the top of the head that detects the amount of sunlight the animal receives; granulated scales that imitate the coloring and texture of the sand and constitute very effective camouflage and also reduce friction when the animal swims in the sand; and comb-like scales on the toes of the feet that give the lizard more traction to move through the sand.

The Objectives of Our Research

The study of the sand lizard in the Chihuahua Desert is important mainly because it offers the opportunity to develop a model to study the response of populations with very little genetic variability, a very small geographic distribution and subject to a single kind of habitat, to the fragmentation and modification of their habitat due to the growth of agriculture, extensive cattle raising and the rapid increase in human settlements. An important theoretical aspect of the study of this lizard is that its scant genetic variability and the low population density make it possible to use it as a model to study short-term genetic-evolutionary changes; among other things, observers have noted that in many organisms these characteristics accelerated evolutionary changes in the genome.

However, this species has been studied very little although it requires permanent populational monitoring since, as I said before, it is closely associated with the evolution of the dunes and is a species that serves as an indirect indicator of the processes of desertification (whether by natural means or due to human action) that occur in these places. Therefore, our general objective has been to propose a conservation strategy for certain dune ecosystems where it lives. For that it was necessary:

a) To estimate the survival and fertility rates for individuals of different age groups and calculate the replacement rate in each generation;
b) To estimate the seasonal density and biomass and monitor the inter-annual fluctuations in some populations, inferring which factors might be regulating these characteristics;
c) To calculate the areas of activity for individuals of different age and sex groups and deduce the populations' social structure.

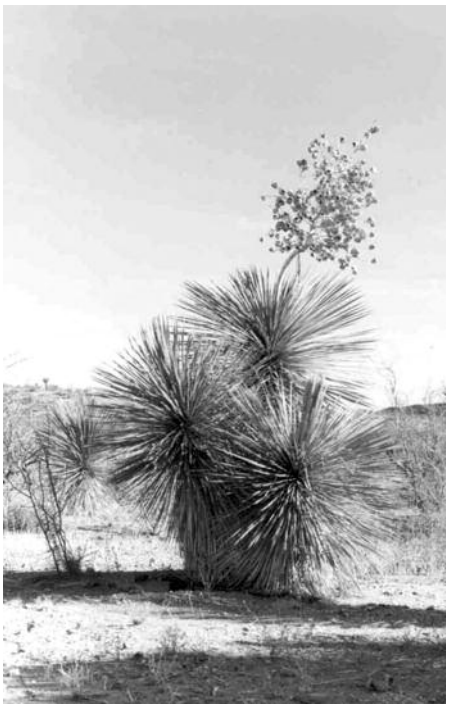
With this information, essential parameters like the population growth rate and the "final" or stable age structure were calculated. In this way, we were able to calculate the reproduction rate per capita and detect whether the populations were increasing or decreasing. We have also analyzed how these characteristics have been affected in years of higher and lower rainfall. This will make it possible to take better founded conservation measures to preserve some if not all of the ecosystems where this species lives.

The survival, mortality and per generation replacement rates prove that the populations seem to be balanced in density despite the strong inter-annual environmental oscillations they are subject to, in addition to the processes of growing desertification that have been seen in the Chihuahua Desert.

We believe that some of the species' adaptive strategies that may be favoring this stability are the following: very rapid sexual maturation in females (at nearly six months); high indices of food source diversity (they can consume up to 28 different kinds of arthropods); occasionally they reproduce during winter (when there are females with eggs in their oviducts during this period); greater winter activity among young specimens that may be favoring a greater chance at feeding and growing in the absence of adults that might injure them; a drop in the number of potential predators; and, finally, the males of these species have a larger range of activity than the females (233 square meters versus 56 square meters). The females, who are highly territorial, probably guard potential nesting grounds in micro-habitats (mounds with plants like *Larrea tridentata* and several species of acacias) with greater quantities of food.

Conservation Efforts

The first conclusion we can draw from our study is simple: human pressure on the sand lizard's habitat



constitutes the greatest danger given that the dunes it inhabits are not at all diverse and have little plant coverage, making them very fragile. For that reason, the information gleaned is crucial for later formalizing a conservation project in several areas where the lizard's habitat exists.

The density results, which fluctuate between 23 and 42 adults per two hectares, the calculation of their areas of activity and the definition of the populations' social structure have given us an idea of the minimum space (40 hectares) and the environmental structural diversity of the different areas that should be protected.

Another strategy for conservation of these ecosystems has been to disseminate in academic circles the fact that dunes of continental origin in desert areas like the Bolsón de Mapimí are paleo-climatic evidence, indicators of the climatic evolution throughout the recent Quaternary period. Encouraging the study of these ecosystems in different institutions aids in establishing an information bank that will be an indicator of the evolutionary processes of these sand environments in this part of the Chihuahua Desert.

Thus, a holistic conservation strategy for the dunes that would involve different parts of society includes the following:

a) Genetic variability. The results of the genetic variability studies (mitochondrial-DNA) of several populations will be used to select the ones with the greatest genetic variability as the high priority areas. Selecting the populations with the greatest genetic variability offers the opportunity of their responding more favorably to an important environmental change and adapting to it. If a low variability population is selected, there will be a lower range of responses to an important environmental change, which could lead to rapid extinction.
b) Detecting the main sources of sand, its displacement and compaction, as well as the places in which human activity has affected the dunes the most. With this information, actions can be carried out that favor the continuity of the dunes' natural dynamic.
c) Ecological information about the species to precisely determine the characteristics of the areas to be preserved, areas that could be classified as sanctuaries.
d) Permanent monitoring of the populations to detect medium- or long-term changes.
e) Including local inhabitants. This implies developing an environmental educational program to foster understanding of the fragility and importance of these ecosystems. VM