OBSERVATIONS ON BEHAVIOR OF THE LIZARD UTA STANSBURIANA DURING A TOTAL SOLAR ECLIPSE

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It is well known that animals change their behavior during a total solar eclipse. Studies concerning such changes have been performed mainly on vertebrates such as fishes (Pandey and Shukla, 1982), birds (Elliot and Elliot, 1974), rodents (Advani, 1981) and even chimpanzees (Branch and Gust, 1986). Usually, the solar eclipse elicits activities appropriate for sunset (Mohan et al., 1980).

Lizards generally are very abundant diurnal vertebrates in the ecosystems they inhabit (Pianka, 1985). Also, they are good subjects for ethological studies (Carpenter, 1978, 1980) and are an important link in trophic webs (Ortega, 1986). Such are the characteristics of the widely distributed North American side-blotched lizard: Uta stansburiana.

In spite of the ecological importance of U. stansburiana there does not exist any previous reference concerning its behavior during a total solar eclipse. We studied an enclosed group of U. stansburiana at Baja California Sur during the eclipse of July 11, 1991, at noon.

The study was carried out at “El Comitán,” which is located 17 km north of La Paz in the northern part of the Cape Region, Baja California Sur, México. It is a coastal lowland with sandyloam soils and its predominant floristic physiognomic unit is the xerophytic-scrub (León and Troyo, 1985) composed mainly of cacti Pachycereus pringlei, Mammillaria gummosus and, among others, the shrubs Jatropha cneus and Fouquieria diguetti. The average annual temperature in the zone is 23.6°C with a mean annual precipitation of 181 mm (Hastings and Humphrey, 1969). According to the nomenclature of García (1988), the climate is classified as BW (h') wh(e), i.e., very dry, warm and extreme, with two periods of precipitation, the main one in summer (August–September), and the other during the winter (December–January).

On the study site we established a quadrat of 6400 m² where 25 open cans of 5 and 20 l were buried flush with the soil surface. With these pitfalls we captured ten adult U. stansburiana. Five days before the eclipse the captured lizards were placed in an enclosure of 20 m² surrounded by a 40-cm high metallic wall. Inside the enclosure we placed small rocks and bushes to offer suitable microhabitat. Lizards were fed freshly-captured insects.

During the five days prior to the eclipse we recorded the activity of the lizards, mainly at two times: during the same period of time when the eclipse was going to take place on July 11 (1034 to 1314 h) and near sunset (1909 h).

On July 11 we continuously recorded the behavior of the individuals from 0900 to 1400 h. and at 10-minute intervals we recorded environmental characteristics. Air temperature and soil temperature, both in shade and sun, were recorded with a remote sensor electronic thermometer (GIB-3); incident and reflected solar radiation with a pyrheliometer; humidity of the air with an electronic hygrometer; wind speed, and wind direction and speed with an anemometer.

Four observers were strategically placed outside the enclosure. Each of us tallied the behavior of our assigned lizards onto data sheet forms. Each lizard was previously marked with a number painted on its dorsum for easy identification. Behavior of the lizards also was continuously recorded with an 8-mm videocamera. Data recorded by the observers were compared with the video.

In order to compare the activities of U. stansburiana individuals during the eclipse we applied a Chi-square analysis of contingency tables (Everitt, 1977) for each of the following variables: “closing eyes,” “perching in shade,” and “refuging” (combining “burrowing” and “seeking cover under rock”). Two separate statistical tests were performed, one comparing...
the mid-day interval before and during the eclipse (1140 to 1210 h), and one comparing the eclipse interval with the sunset hours the days prior to the eclipse (1840 to 1910 h).

During the five days before the eclipse from 1000 to 1200 h, individuals of U. stansburiana spent most of the time in the shade of bushes and rocks on the soil surface. Average soil and air temperature in the shade was 41.4°C and 36.8°C, respectively. Directly under the sun, average soil temperature was 49.8°C and average air temperature was 39.6°C.

Prior to the day of the eclipse, lizards were observed in their sleeping shelters after sunset, at 0.5 to 2.0 cm below the sandy-loam soil surface, littered with leaves and debris and near or below bushes. At sunset the temperature of the soil averaged 38.7°C and the temperature of the air averaged 51.2°C.

Figure 1 shows the changes in the environmental factors recorded during the eclipse. Sudden drops occurred in incident and reflected solar radiation, smooth decrements occurred in air and soil temperatures, wind speed increased slightly and wind direction changed little during the time when the sun was totally blocked for 6 minutes, 42 seconds.

In general the lizards modified their pattern of behavior during the eclipse to that typical of the end of the day. Three lizards proceeded to perform the same activities as during sunset: that is, they buried themselves below the soil surface. Another individual sought refuge under a rock. However, the rest only became mo-

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**Figure 1**—Environmental characteristics recorded at the study site during the total solar eclipse. Vertical bar denotes center of 6.7-min duration of totality.
tionless with eyes closed and their body flat to the soil.

After the sun reappeared the three buried individuals performed the same activities as during the early morning hours. However, because of the sudden increase of temperature and radiation (Fig. 1), in a very short period of time they returned to mid-day behavior.

"Closing eyes" behavior was performed by significantly more lizards during the eclipse than during the same interval of time on the days before the eclipse (1140 to 1210 h; Table 1). The proportion of lizards "closing eyes" during the eclipse was not significantly different than the proportion during the evening hours the days before the eclipse. Likewise, significantly fewer lizards perched in shade during the eclipse compared to the days before (when all ten lizards were perched in shade at that hour), and the number showing this behavior during the eclipse did not differ from the number showing it during the evening hours the days before (Table 2). Although four of the ten lizards sought refuge during the eclipse, this proportion did not statistically differ from that during the same time interval during the days prior to the eclipse, when none of the ten lizards did so (Table 3). This proportion seeking refuge during the eclipse, however, did not differ from the proportion seeking refuge during the evening interval of the days before the eclipse.

Thermal conditions during a solar eclipse are similar to evening thermal conditions; however, the temperature decline before the eclipse is sharper than at sunset (Grenot et al., 1993). Also, the rise of temperature is considerably more abrupt after the eclipse than during the dawn. Lizards, as ectotherms, alter the degree and kind of behavior according to the ambient thermal environment (Carrasal and Diaz, 1989; Grant, 1990; Castilla and Bauwens, 1991). Search for adequate nocturnal refuges also depends on thermal conditions (Kennedy, 1991).

<table>
<thead>
<tr>
<th>Behavior</th>
<th>(Mid-day) 1140–1210 h</th>
<th>(Evening) 1840–1910 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closing eyes</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Not closing eyes</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

1 Heterogeneity chi-square (corrected for continuity) of both rows and columns 1 and 2: $x^2 = 5.95$, $d.f. = 1, P < 0.05$; of both rows and columns 2 and 3: $x^2 = 0.20$, $d.f. = 1, P > 0.05$.

2 Averaged over 5 days and rounded to nearest whole integer.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>(Mid-day) 1140–1210 h</th>
<th>(Evening) 1840–1910 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perching in shade</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Not perching in shade</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

1 Heterogeneity chi-square (corrected for continuity) of both rows and columns 1 and 2: $x^2 = 4.16$, $d.f. = 1, P < 0.05$; of both rows and columns 2 and 3: $x^2 = 0.20$, $d.f. = 1, P > 0.05$.

2 Averaged over 5 days and rounded to nearest whole integer.
1959; Congdon et al., 1982; Grenot et al., 1993).

Like other animal species (Delyle, 1973; Lascar, 1975; Mohan et al., 1980), during the total solar eclipse *U. stansburiana* individuals performed the same behavior as they normally do at the end of the day. However, probably because of the short duration of the eclipse, not all individuals attained a sleeping shelter before the sun reappeared.

En la parte norteña de la Región del Cabo, Baja California Sur, México, observamos el efecto de un eclipse total de sol sobre la conducta de la lagartija *Uta stansburiana*. Cinco días antes del eclipse 10 individuos adultos fueron colocados en una exclusión al aire libre de 20 metros cuadrados conteniendo su hábitat natural. Sus actividades fueron observadas principalmente durante el periodo de tiempo en el cual el eclipse tendría lugar durante el 11 de julio de 1991, y durante el crepúsculo. Durante el eclipse las lagartijas efectuaron la misma conducta que usualmente sería observable durante la puesta de sol. Sin embargo, probablemente debido a la corta duración del crepúsculo, no todos los individuos alcanzaron un refugio para dormir.

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**LITERATURE CITED**


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