Distribution, Habitat Use, and Status of the Desert Tortoise in Mexico

by

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Abstract. We recorded 17 new localities of the desert tortoise (*Gopherus agassizii*) in Mexico based on specimens and 10 additional sight records, increasing the known range by about 48%. The range includes most of Sonora except the northwestern corner and parts of the Sierra Madre Occidental and northern Sinaloa (south as far as El Fuerte). The northern and eastern limits of the range in Sonora are generally defined by the 800-m contour, but occupied habitats in southern Sonora and northern Sinaloa are only as high as 300 m. Tortoises seem to be absent between Guaymas and Alamos, Sonora. We do not consider Baja California a part of the tortoise's range. In Mexico, desert tortoises occur on slopes, bajadas, and the sides of arroyos and seem to be absent from valley floors and other flat areas. Tortoises may be more abundant and have a less patchy distribution at intermediate elevations (300–500 m) than at lower elevations and on coastal mountains. Only in two areas does human use of tortoise meat seem to have reduced the abundance of tortoises. The wide expanse of tortoise habitat, the largely inaccessible area, and the difficulty of finding tortoises on steep and densely vegetated slopes deter human use of this species. Steep rocky slopes also protect the tortoise and its habitats from intensive agriculture and vehicular traffic.

Key words: Anthropogenic effects, biogeography, *Gopherus agassizii*, habitat use, Sinaloa, Sonora, desert tortoise.

Although as much as one-third of the desert tortoise's (*Gopherus agassizii*) range is in Mexico (Patterson 1982), the distribution and ecological requirements of this tortoise are poorly documented. The distribution of desert tortoises in Mexico was summarized by Auffenberg and Franz (1978; 22 localities), Smith and Smith (1979; 43 localities), and Patterson (1982; 28 localities). Based on these reports, the distribution in Mexico includes extreme

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northern Sinaloa and most of the state of Sonora except the northwestern corner and parts of the Sierra Madre Occidental immediately adjacent to the Chihuahua border. The only extensive ecological observations of desert tortoises in Mexico were made on the large gulf island of Tiburon (Bury et al. 1980; Reyes Osorio and Bury 1982).

In response to concerns for the protection and management of the species, we initiated a field study of the desert tortoise in Mexico. Here we describe the geographic distribution, characterize the use of habitats, estimate the population status from observed relative abundances, and comment on the human use of the desert tortoise in Mexico.

Nomenclature

We retain the customary use of *Gopherus* as the genus of all gopher tortoises. Although Bramble (1982) presented a strong argument for the use of a new generic name, *Scaptochelys*, for *Gopherus agassizii* and *G. berlandieri*, it is not clear that these two species are more closely related to each other than to other taxa (Crumly 1987, 1994). Thus, we also refrain from the use of *Xerobates*, a senior synonym of *Scaptochelys*, as suggested by Bour and Dubois (1984). Until this point is resolved and the importance of Bramble's distinctions are further evaluated, we prefer the conservative approach of grouping all four living tortoises in North America in the genus *Gopherus*. We also use the *-ii* termination for *agassizii* following the original description (cf. Auffenberg and Franz 1978). This is in accordance with the ruling in the International Code of Zoological Nomenclature (International Union of Biological Sciences 1985).

Materials and Methods

We obtained museum records from summaries by Smith and Smith (1979) and Patterson (1982) and previously unreported records from collections (Arizona State University and the Museum of Southwestern Biology, University of New Mexico). We plotted localities on maps by hand. Several undocumented sight records in the literature—for example, those in Patterson (1982)—do not add appreciably to the distribution of the tortoise and were not plotted. The sight record by Ives (1964) was imprecise and was not used. Literature records by Van Denburgh (1922) and Reyes Osorio and Bury (1982) were included as valid sight records.

We searched beyond the known distributional limits and corroborated our findings with local residents. We conducted fieldwork in northwestern Mexico in August–September 1983 during summer rains and the anticipated period of maximum tortoise activity. Searches for tortoises and their signs were made with and without the help of local residents by walking in habitats with 2–5 people spaced 5–10 m apart. We spent short periods (1–8 person-hours) at any one locality.

When possible, we examined recent kitchen middens near dwellings for tortoise remains and interviewed local residents. Interviews were generally unstructured and leisure and mostly in Spanish. We focused on information about the presence, habits, and abundance of tortoises and the local use of tortoises as food and pets. We used information only from people who could distinguish tortoises from the local aquatic turtles (*Kinosternon* and *Trachemys*), box turtles (*Terrapene*), and forest terrapins (*Rhinoclemmys*). Some people were initially evasive but cooperated once they understood we wanted information rather than an enforcement of regulations. Most were aware of the Mexican government's ban on taking tortoises.

Some tortoise signs, such as bones, scats, and clear tracks, are unequivocal evidence of tortoises. Burrows and pallets are less certain indicators of tortoises, although their shapes and positions in the habitat are often distinctive (Luckenbach 1982; Germano et al. 1994). In our work, bones were collected and cataloged as museum specimens; other types of signs were recorded.

Results

Distribution

Smith and Smith (1979), in the most complete summary of desert tortoise distribution in Mexico, cited records from 26 quadrats formed by trapezoids that are 30′ of latitude or longitude on a side.

Patterson (1982) added one more reliable record in another quadrat. We found tortoises in an additional 13 quadrats, largely in the outer limits of the known range. Desert tortoises or their signs have now been found at 74 sites in Sonora and Sinaloa, Mexico (Figure).

The Mexican range of the desert tortoise is contiguous to the occupied range in Arizona along approximately 150 km of the United States–Mexico border in northern Sonora (Figure). The northeastern range limits in Sonora are roughly defined by the 800-m contour, and contact with southern Arizona populations occurs in the low hills around and west of Sonoyta, Sonora, and the Organ Pipe Cactus National Monument, Arizona. High montane outliers of the Sierra Madre Occidental cover much of north-central and northeastern Sonora, and this area is not inhabited by the desert tortoise. Tortoises generally occupy the foothills to an elevation of 800 m, although they have been recorded as high as 1,050 m at Rancho La Palma northeast of Vaviacora, Sonora.

The eastern limits of desert tortoises in Mexico are sharply defined by the abrupt change from lowland Sinaloan thornscrub to Madrean evergreen woodland at about 800–1,000 m (Figure). Tortoises may occasionally be found in the lower margins of this woodland vegetation zone. The westernmost locality in Sonora is in the Pinacate lava flow, 135 km east of the Baja California border with Sonora.

Distributional limits defined by elevation and topography were identified between Moctezuma and Nacozari de García (about 800 m elevation),

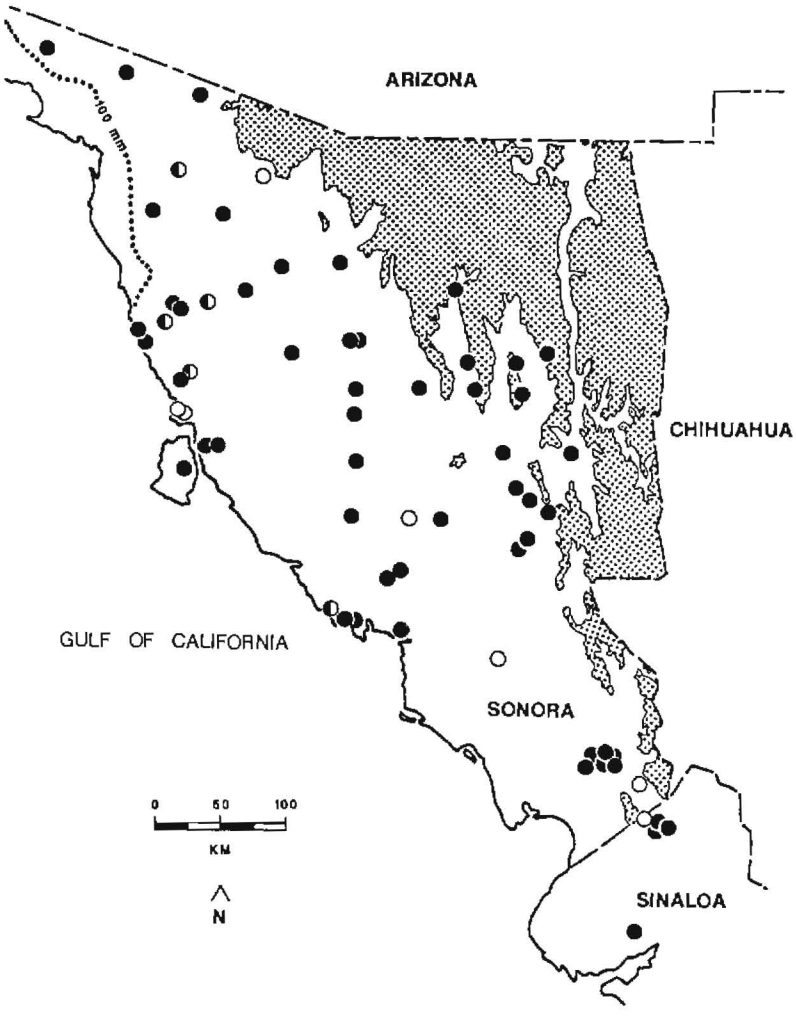

Figure. Northwestern Mexico and the range of *Gopherus agassizii* as defined by published records and new observations. The 100-mm annual rainfall isopleth is shown in the northwest. *Stippled areas* in Sonora are zones of upland vegetation (Brown and Lowe 1980), including semidesert, plains, Great Basin grasslands, Madrean evergreen woodland, and Petran montane conifer forest. *Open circles* = tortoise sign (scat, burrows, tracks) but no tortoises; *half-open circles* = tortoise sightings unsupported by specimens; and *closed circles* = new and historic specimen records.

between Huásabas and El Coyote (1,000 m), north of Arispe (800 m), and between El Fuerte and Estacion Loreto (300 m), Sonora. There is an apparent gap in the range between Guaymas and Alamos, and the only sign we found was a burrow tentatively attributed to tortoise activity. Desert tortoises range at least as far south as the region of El Fuerte, Sinaloa, in the foothills of the Sierra Madre Occidental (Figure).

Habitat Use

Although tortoises were widespread in Sonora and northern Sinaloa, they seemed to be restricted to arroyos, slopes, and bajadas. Throughout the occupied areas of Mexico, we found that desert tortoises were conspicuously absent from valley floors and other flat areas. At a few sites (especially near Ortiz and Santiago, Sonora), residents reported that tortoises were absent from the immediate vicinity but present on nearby mountain slopes. Desert tortoises in Mexico range from xeric habitats near sea level to the lower edges of evergreen oak (*Quercus*) and juniper (*Juniperus*) woodlands at about 800 m elevation.

Based on the number of localities where we found tortoises or evidence of their presence during short searches, fewer animals seemed to be in coastal mountains and low elevations (e.g., Navojoa or vicinity of Guaymas) than at intermediate elevations of 300–500 m. At elevations above 500 m, densities seemed to vary with local features of vegetation, soil, and exposure.

Frequency of Occurrence

In 30 timed searches totaling 88.5 h ($\bar{x}$ = 2.95 h), we found live tortoises in 24% of the sampling periods, skeletal remains in 15%, and tortoise signs in 56%. We found some evidence of occurrence in 60% of the timed searches. We spent about 53.5 h at sites where we saw tortoise or their signs and 36 h at sites where there was no evidence of tortoises.

Human Use of the Desert Tortoise

We documented the human use of tortoises by shells and bones in trash piles and tortoises held in patios and gardens. In interviews with residents, many people reported consuming tortoise meat, albeit infrequently. Only in the vicinity of two moderate-sized settlements (Ures/Santiago and Ortiz/La Misa, Sonora) had tortoise populations probably been reduced by exploitation for food. In these areas, the few people we interviewed had consumed tortoises recently or knew of someone who had. Residents considered tortoises to have been reduced in numbers in recent years but to still be important food sources.

People of the small towns of Santiago and nearby Guadalupe were open and frank in discussing their use of tortoise meat. In their view, other meat was expensive, and tortoises, when available, were suitable for domestic use. They reported that tortoises provided limited quantities of meat and were only irregularly available.

Discussion

In Mexico, the desert tortoise occurs throughout the Sonoran and northern extremes of the Sinaloan biogeographic provinces (Lowe and Brown 1982) but not in the Madrean province. Tortoises occur in four subdivisions of the Sonoran desert–scrub biotic community—Arizona upland, Lower Colorado River Valley, plains of Sonora, and Central Gulf Coast—categorized by biotic differences associated with latitude and altitude (Turner and Brown 1982). Many areas in these subdivisions, especially the hills and mountain slopes occupied by tortoises, are in Sinaloan thornscrub (Turner and Brown 1982) because they have rainfall at the upper limits of desert scrub and exhibit related differences in vegetation. Lowland vegetations include several subdivisions of Sonoran desert scrub, Sinaloan thornscrub, Chihuahuan desert scrub, Sinaloan deciduous forest, and Sonoran savanna grassland (Brown 1982a, 1982b).

In a north–south direction, Sinaloan thornscrub is increasingly prevalent as tortoise habitat, and in extreme southern Sonora and northern Sinaloa desert tortoises occupy mesic and luxuriant habitats in Sinaloan deciduous forest. These communities and their subdivisions reflect latitudinal (north–south) and altitudinal gradients (predominantly west–east) of increasing moisture and moderated temperatures.

Rainfall in the Sonoran desert scrub varies by an order of magnitude (40–400 mm annually), but most areas receive between 100 and 300 mm (Turner and Brown 1982). Desert tortoises are not found in areas receiving less than 100 mm of rain. Presumably, tortoises occur on slopes and in montane habitats because of the local increased rainfall and potentially moderated temperatures. The surrounding habitat is generally inhospitable.

In northwestern Sonora, the boundary of the tortoise coincides closely with the 100-mm annual precipitation isopleth (Figure). The only coastal-plain record south of the Guaymas area is near Los Mochis in Sinaloa; this record is on a major highway and should probably be viewed with skepticism because it may have been a transplant. Further surveys are needed in the area.

Desert tortoises occupy narrow ribbons and disjunct patches of Sinaloan thornscrub associated with hills, isolated mountains, and mountain ranges in northern and central Sonora. Larger, more continuous expanses of habitat occur in eastern and southern Sonora, which probably support the highest density of desert tortoises in Mexico (based on information from interviews and frequency of our encountering tortoises and tortoise sign).

This habitat use is in marked contrast to the valley floor habitats typical of tortoises in the Mojave Desert (Berry 1989). Desert tortoises frequent rocky slopes and higher elevations in the eastern Mojave Desert (Bury et al. 1994) and in the Sonoran Desert in Arizona (Germano et al. 1994). Failure to survey mountain slopes and arroyos in Mexico would have resulted in few sightings and markedly different conclusions than those reported here.

The gap of about 150 km between the Guaymas and Alamos regions in the known range of the tortoise seems to be real because the highway and adjacent roads traverse a flat agricultural area. However, the sparse foothills in this region have not been well surveyed.

Repeated statements that the desert tortoise occurs naturally in Baja California (Cuesta Terron 1920, 1921; Schmidt 1922; Smith and Taylor 1950; Ernst and Barbour 1972) are not supported by specimens and are probably unwarranted (Auffenberg and Franz 1978; Smith and Smith 1979). The combination of aridity and sandy soils in the Colorado River delta seems to delineate the western distribution of the species in this area. Across the United States–Mexico border in southwestern Arizona and extreme southeastern California, desert tortoises are restricted to isolated colonies in small desert mountain ranges (Patterson 1982).

Recently, Ottley and Velazques (1989) described a new tortoise from near La Paz, Baja California Sur. However, Crumly and Grismer (1994) question the distinctiveness of this form and suggested that current evidence of the tortoise in the lower peninsula was either an important range extension or an introduction of *G. agassizii*.

The Sinaloan deciduous forest extends much farther south than the range of the desert tortoise as presently understood, and a narrow band of tortoise habitat may exist along the foothills for much of the length of Sinaloa. In the deciduous forests, however, the nearly continuous vegetative cover—including trees, vines, forbs, and low shrubs—is a deterrent to locating tortoises and signs. Further surveys of tortoises are needed south of the Rio Fuerte and northeast of Los Mochis in Sinaloa where suitable habitat may occur in some of the isolated mountain ranges on the coastal plain.

Tortoises seem to be absent from areas without topographic diversity, which may explain some voids in the distribution of the tortoises and provide a guide for future searches. Higher elevations are probably not limiting in Sonora because the tortoises reach an elevation of 1,300 m in central Arizona (Burge 1979) and 1,500 m in eastern California (Luckenbach 1982) and southern Nevada (Bury et al. 1994). Exposure, aspect, and soils probably influence altitudinal limits for the species. The factors that limit the tortoises to markedly lower elevations in the southern portions of the range are unclear.

Previous studies revealed desert tortoises as common in foothills and in arroyos on the Isla Tiburón (Reyes Osorio and Bury 1982) in contrast to conclusions that tortoises faced extinction there (Smith and Smith 1979). Our surveys increased the known range of the desert tortoise in Mexico by about 48% and highlighted the association of tortoises with mountain slopes.

Our success in finding tortoises (24% of surveys) and tortoise sign (56%) was remarkably similar to the results of Burge (1979) in upland habitats in Arizona: tortoises at about 24% and sign at 55% of the transects. Burge's overall success in finding

any sign of tortoises (44% in Arizona) was slightly lower than ours (60% in Mexico).

Human Use of Tortoises

Tortoise populations adjacent to large population centers such as Hermosillo, Guaymas, and Caborcas probably have experienced long-term harm, including direct human exploitation, habitat degradation, road kills, predation by domestic dogs, and use as pets. However, we found evidence of tortoise populations on hillsides and mountain slopes near each of these cities, which suggests that some tortoise populations have survived despite perturbations by humans. For example, we found tortoises on a small isolated mountain beside the main highway 48 km north of Hermosillo, Sonora. The area is a popular rest stop for truck drivers and other motorists between Hermosillo and the border towns to the north. The continued existence of the tortoise in such an accessible location suggests that hillsides present a significant deterrent to the capture of tortoises or that hunting pressure is not great.

Clearly, some tortoise populations in rural areas with extensive human activity declined more than tortoise populations in rural areas with less human traffic. Tortoises near villages, large ranches, and roads may be vulnerable to capture, but populations farther from settlements come in less contact with hunters and people searching for livestock.

Near Santiago, local residents captured tortoises opportunistically (usually tortoises were found crossing roads or by ranch hands on nearby ranches). Much of the surrounding area was sparsely populated or unpopulated, and much tortoise habitat remained on steep slopes at considerable distances from ranches, roads, and villages. Thus, even if tortoises were extirpated in localized areas by human activity, other tortoise populations may persist in the immediate vicinity.

No residents we interviewed knew of anyone who gathered tortoises as a principal activity, although some men apparently had more interest and ability in collecting tortoises than others. Thus, the capture and use of tortoises remain opportunistic and limited by local economics, customs, and the proximity of tortoises to areas of human activity. When tortoises become scarce, people cease hunting them. The steep, rocky slopes inhabited by tortoises in the Sonoran Desert and in Sinaloan thornscrub increase the energy and time of the search for tortoises and reduce the harm to tortoises by hunters.

We were told that some residents of Alamos, Sonora, collect desert tortoises for sale to foreign tourists and for direct shipment to the United States and Europe. These activities are illegal. However, such collections may reduce local populations (i.e., those next to roads) because of the high economic incentives offered by foreign pet markets.

Locality Records

We do not repeat the localities given in Smith and Smith (1979) and Patterson (1982). Museum acronyms are ASU (Arizona State University, Tempe) and MSB (Museum of Southwestern Biology, University of New Mexico, Albuquerque).

Sinaloa

Specimens. MSB: Jipago, 3 km E Presa Miguel Hidalgo; Rancho San Pedro, 20 km NE El Fuerte.

Tortoise sign. 10 km N El Fuerte (burrow).

Sonora

Specimens. MSB: 3 km N Noria Agualareña; Cerro Carrizal near Santiago; 48 km N Hermosillo; Mina Mendosa, 3 km NE La Aurora; Mina Esmeralda, Tehuibabi; 8 km N, 3 km W Guaymas; Ortiz; Rancho Seco, 13 km N La Misa; 42 km S Hermosillo; Agua Caliente, 23 km N Tasajera; Ejido San Ignacio, 118 km N Kino–Hermosillo Highway on road to La Libertad; 55 km NE La Libertad; 17 km N Highway 2 on El Arenoso road; La Cienega, 60 km SE Caborca; 1 km N Minas Nuevas, 9 km NE Alamos. ASU: Agua Marín, 11 km W Alamos; 19 km W Alamos; 4 km NW Alamos; Tepustete, 11 km NW Alamos.

Sight records of tortoises. 37 km NE of La Libertad; 75 km NE La Libertad; 54 km NW Caborca; San Pedro Bay (Van Denburgh 1922); Rancho Los Mochos, 10 km NE San Ignacio.

Tortoise sign. Moradillas, N La Misa (burrow); Cerro Blanco, 22 km SE Desemboque del Seri (tracks, pallet ?); 33 km S Desemboque del Seri, 3 km E coast road (scats); 4 km W cerro Noche Buena, 15 km N Punta Chueca (tracks); 46 km NE Altar (burrows); near Guirocoba, 37 km SE Alamos

(burrows); Agua Caliente, 17 km N, 5 km E Esperanza (burrow).

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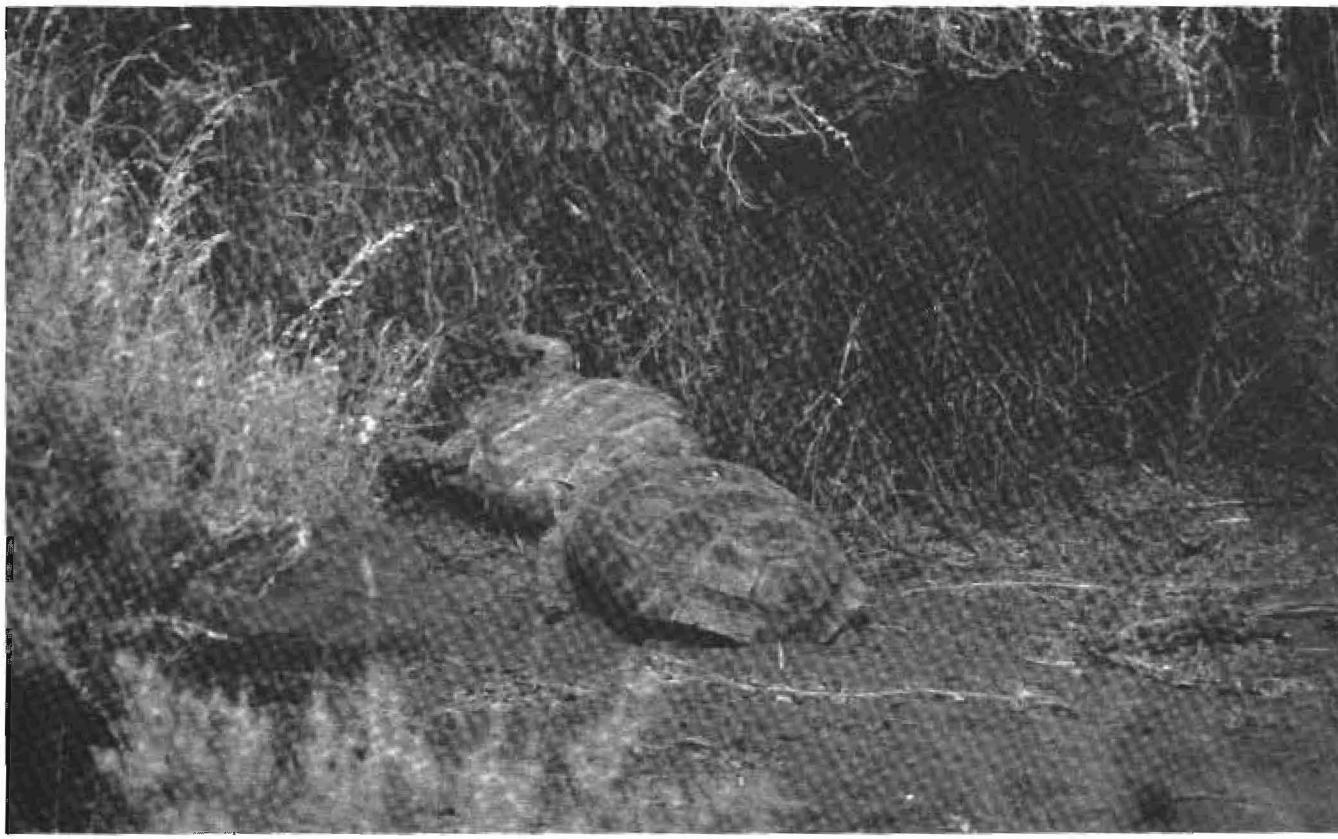

Agonistic behavior between two female desert tortoises (*Gopherus agassizii*) in southwestern Utah. Fights between females are rarely observed in the wild. *Photo by T. C. Esque.*