Livestock Grazing and the Desert Tortoise in the Mojave Desert

by

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Abstract. A large part of the Mojave Desert is not in pristine condition, and some current conditions can be related to past grazing-management practices. No information could be found on densities of the desert tortoise (*Gopherus agassizii*) or on vegetative conditions of areas that had not been grazed to allow managers a comparison of range conditions with data on tortoises. Experimental information to assess the effect of livestock grazing on tortoises is lacking, and researchers have not yet examined whether the forage that remains after grazing is sufficient to meet the nutritional needs of desert tortoises.

Key words: Competition, desert tortoise, domestic livestock, food habits, food requirements, *Gopherus agassizii*, grazing.

Grazing by cattle and sheep has been implicated in the deterioration of habitat of the desert tortoise (*Gopherus agassizii*; Berry 1978; Coombs 1979; Webb and Stielstra 1979; Nicholson and Humphreys 1981). Information from these studies led the U.S. Fish and Wildlife Service (1990) to assert that livestock grazing altered plant species composition, reduced cover of shrubs and perennial grasses, and led to an overall deterioration in the quality of desert tortoise habitat. On the other hand, others (Bostick 1990; Resource Concepts, Inc., Carson City, Nevada, unpublished report; J. Sullins, University of California, Riverside, personal communication) reported that data are not available to assert that domestic livestock harms desert tortoise habitat.

I examined the literature on livestock grazing in the Mojave Desert and evaluated the status of knowledge about the effects of livestock grazing on the desert tortoise. To affect the tortoise, grazing should have some measurable effect on the cover or food supply of the desert tortoise. Grazing may also have an indirect effect by altering the landscape such that factors formerly not important in the Mojave Desert (e.g., wildfires) can now be magnified and affect the tortoise's habitat.

Mojave Desert Vegetation

The Mojave Desert is the smallest of the North American deserts and is generally located north of the Sonoran Desert and south of the Great Basin in extreme southwestern Utah, northwestern Arizona, southern Nevada, and southeastern California. MacMahon (1988) noted that some ecologists describe the Mojave Desert as an ecotone between the Great Basin at a higher elevation and the Sonoran Desert at a lower elevation, but he considers the Mojave Desert sufficiently discrete to warrant

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individual recognition. Approximately 75% of the Mojave Desert is between 610 and 1,219 m in elevation (Shreve 1942). However, elevations drop to 82 m below sea level in the Death Valley National Monument and rise to above 2,000 m on many of the mountain tops (Rowlands et al. 1982).

Based on low precipitation and high summer temperatures, the Mojave Desert is the most arid of the North American deserts (MacMahon 1988). Most weather stations in the Mojave Desert report an average annual precipitation of less than 13 cm; only the marginal fringe receives higher amounts (Shreve 1942). Winter precipitation (October–March) may provide more than 90% of the annual precipitation in the western Mojave Desert, whereas summer thunderstorms provide more than 30% of the annual precipitation at the eastern and southern (Colorado Desert) edges (Rowlands et al. 1982).

MacMahon (1988) described the soils of the Mojave Desert as generally sandy to gravelly, alkaline in flats and dry lake beds and rocky on higher-elevation slopes and mountains. Furthermore, desert soils are low in organic matter and slightly acidic to alkaline at the surface and have calcium carbonate accumulations in the upper 2 m. These soils have long periods of inactivity because of dry, hot conditions and as a group are termed Aridisols.

Death Valley extends from below sea level to above 1,220 m, which makes the description of the plant ecology of Death Valley (Hunt 1966) a good model for a discussion of general plant occurrence in the Mojave Desert. Salt-tolerant saltbush (*Atriplex hymenelytra* and *A. polycarpa*) occupies sites just above the lowest and essentially bare flats, the soils of which are commonly alkaline (Rowlands et al. 1982). As soils become less alkaline at the foot of alluvial fans, creosotebush (*Larrea tridentata*) becomes common and occurs to about 1220 m in the mountains. With increasing elevation, the total plant density becomes greater, and creosotebush occurs with white bursage (*Ambrosia dumosa*) and white brittlebush (*Encelia farinosa*), which grade into pure stands of blackbrush (*Coleogyne ramosissima*). In the elevational band below the blackbrush, the Joshua-tree (*Yucca brevifolia*) is common and essentially outlines the distribution of the Mojave Desert (MacMahon 1985).

Creosotebush is characteristic of the three hot deserts of North America (MacMahon 1988). In the Mojave Desert, creosotebush is the dominant plant and occurs in pure or mixed stands and in densities of very few to perhaps 1,000/ha on over 70% of the land area (Hunt 1966; Vasek and Barbour 1977). Creosotebush grows where drainage is good and the salt content of soils is low (Hardy 1945), where some organic matter is present (Vasek 1980a), and where the roots can reach soil moisture (Johnson et al. 1975). Individual stems of creosotebush may be more than 100 years old, and clones have been estimated to be 9,400 years old (Vasek 1980b). Because of the long life of the plant, considerable litter accumulates and forms an organic layer that is richer in nutrients than between shrubs and serves as suitable habitat for many herbaceous species.

The diversity and cover of perennial grasses are low in the Mojave Desert (Humphrey 1974), where the dominant perennial grass is big galleta (*Hilaria rigida*). This species occurs in the southern Great Basin, throughout the Mojave Desert, and in the Sonoran Desert. Big galleta grows at elevations below 1,220 m and in the Mojave Desert seems to grow best in nonalkaline and well-drained soils where water is more abundant (Shreve 1942; Schlesinger and Jones 1984). Thus, big galleta often is at the edges of roads and washes in lower elevations (Humphrey 1974) and between and under rocks in upper elevations. Cover of big galleta varies greatly among locations and was less than 1% at a study plot in the Ivanpah Valley in the Mojave Desert (P. A. Medica, C. L. Lyons, and F. B. Turner, University of California, Los Angeles, unpublished report) and over 18% in Canyonlands National Park where precipitation exceeded 25 cm (Kleiner and Harper 1977).

When winter precipitation is sufficient, desert annuals may produce from less than 10 to more than 600 kg/ha of biomass (Turner and Randall 1989), the greatest amount of grass and forb biomass in the Mojave Desert. At the Nevada Test Site, seeds of winter annuals germinated en masse when about 2.5 cm of precipitation fell between September and March (Beatley 1967). Stem elongation does not occur until late March when temperatures are warmer, and flowers develop from April through May. When precipitation is adequate in winter, the period from germination to senescence may last 8 months; however, when precipitation does not occur until late winter, the entire life cycle

of winter annuals may be compressed into 6–10 weeks (Beatley 1967).

Survival of seedlings is related to precipitation and ranged from 27 to 77% during a 3-year period at the Nevada test site (Beatley 1967). Turner and Randall (1989) found that the biomass of annuals increases with precipitation, and their model, based on 11 growing seasons, predicts that annuals produce 141 kg/ha of biomass under average conditions (12 cm of winter precipitation).

Exotic annual plants were probably introduced into the Mojave Desert from the Mediterranean region in the late 1800's (Aschmann 1976) and have increased in abundance because they can tolerate heavy grazing. One of the more common and increasingly abundant species is foxtail brome (*Bromus rubens*), which is ecologically similar to native annuals and is frequently the dominant annual under shrubs. It is always in close association with native winter annuals (Beatley 1966), but foxtail brome has a wider moisture tolerance for germination and can better survive periods of high soil moisture tension than native annuals (Beatley 1966). Recent analysis indicates that foxtail brome increased in one of Beatley's plots from 14.0 plants/m^2 in 1969 to 2,034 plants/m^2 in 1988, years of similar precipitation (Hunter 1990).

Because of low precipitation, which results in a scarcity of fine fuels (i.e., grasses), fire apparently has not played an important role in the Mojave Desert plant ecology (Humphrey 1974). Creosotebush and white bursage are too sparse and the creosotebush canopy is too open to carry fire. However, the increased abundance of exotic annual grasses such as foxtail brome (Hunter 1990) could increase the susceptibility of the Mojave Desert to fire.

Range Management in the Mojave Desert

History of Livestock Grazing

Large grazing mammals probably did not evolve west of the Rocky Mountains in recent history (Mack and Thompson 1982). The current ecological condition of the Mojave Desert rangelands has probably been affected by domestic livestock that was first introduced by European settlers. However, documentation about herbaceous plants in the Mojave Desert before the introduction of livestock is scarce, and there are no data for comparison with current conditions.

There is little doubt that livestock grazing has changed the vegetative composition of the Mojave Desert during the past 140 years because numbers of livestock in the western United States were high during the late 1800's (7.6 million cattle in 1886; U.S. Senate 1936) and again during World War I and were unregulated. In 1934, the Congress passed the Taylor Grazing Act, and some semblance of grazing management began.

As more knowledge about range-plant ecology was gained, range management systems became more sophisticated and were incorporated into allotments managed by the Bureau of Land Management (BLM). However, the strict application of grazing systems has not been universally applied because of the increased costs to the individual rancher (Vale 1975). Nonetheless, most ranchers and BLM recognize the importance of managing the range to maximize the production of continual high-quality native forage.

Since 1955, the number of animal unit months (AUMs) allocated to BLM lands in Arizona, California, Nevada, and Utah decreased by 50% (BLM public land statistics, 1961–85). Decreases in AUMs since the early 1940's may be even greater if the 85% cut in AUMs at the Beaver Dam Slope in Utah (Hohman and Ohmart 1978) is typical of the West in general. Despite these cuts in the use of western rangelands by livestock, much public rangeland is still in only fair or poor ecological condition.

A review of 102 BLM environmental impact statements (EIS) revealed little change in condition between 1985 and 1989 (Wald and Alberswerth 1989); however, this is to be expected because the recovery of heavily used arid rangelands probably requires decades. The five EISs that pertain to the Mojave Desert provide the following analysis of condition: 1) in the California Desert Conservation Area Plan, 42% of the area is listed in poor–fair condition, although 93% of the allotments at higher elevations were in fair condition; 2) in the Clark EIS, 85.5% is listed in poor condition; 3) in the Esmeralda–Southern Nye EIS, only 16.9% is listed in fair or poor condition; 4) in the

Hot Desert EIS, 88% is listed in fair or poor condition; and 5) in the Cedar–Beaver–Garfield–Antimony EIS, 62.7% is listed in poor or fair condition. Despite decreased grazing pressure during the past several decades, the ecological condition of the range has not rapidly improved.

An analysis of exclosures and other protected areas revealed that perennial–grass cover in deserts has increased with protection from grazing (Shreve and Hinckley 1937; Gardner 1950; Waser and Price 1981; Durfee 1988). The rate of succession is controlled to a large extent by the moisture conditions of the substrate (Sampson 1919); thus, one expects deserts to improve very slowly after reductions in livestock numbers. However, the ecological condition may never improve as long as exotic annuals are a permanent component of the flora (W. Burkhardt, University of Nevada, personal communication).

Grazing by Livestock in the Mojave Desert

We do not know the status of desert tortoise populations or vegetation before livestock began grazing the Mojave Desert, and only few studies have been conducted on the effects of grazing on Mojave Desert vegetation. Most of the literature addresses the Great Basin, the Sonoran Desert, and the Great Plains.

Cattle and sheep are the dominant domestic livestock in the Mojave Desert. Domestic sheep grazed on the Beaver Dam Slope in Utah until the 1950's (Hohman and Ohmart 1978), but only cattle graze the area now. Much of the Mojave Desert in Nevada is grazed by only cattle. Cattle generally are not herded, and their distribution on an allotment is restricted by fences, availability of water, and rugged terrain. Development of watering locations by BLM and ranchers have probably changed the distribution of cattle during the past several decades. The California Desert Conservation Area Plan (U.S. Bureau of Land Management, California Desert District, Riverside, California, unpublished data) designated use of the desert for cattle and sheep. Sheep are generally herded daily in the direction of food, water, and bedding areas (Nicholson and Humphreys 1981).

Grazing allotment plans generally allow livestock use in tortoise habitat during winter and spring (U.S. Bureau of Land Management, California Desert District, Riverside, California, unpublished data; U.S. Bureau of Land Management, Stateline Resource Area, Las Vegas, Nevada, unpublished data; U.S. Bureau of Land Management, Dixie Resource Area, Cedar City, Utah, unpublished data; U.S. Bureau of Land Management, Las Vegas District, Las Vegas, Nevada, unpublished data; U.S. Bureau of Land Management, Las Vegas District, Las Vegas, Nevada, unpublished data), when plants can usually tolerate more grazing pressure. These habitats are usually at lower elevations in what is termed ephemeral or sometimes ephemeral–perennial range (U.S. Bureau of Land Management, California Desert District, Riverside, California, unpublished data). After the use of these ranges, livestock is moved to higher perennial ranges where grasses are more abundant and diverse. When annual vegetation on ephemeral ranges exceeds defined amounts (224 or 293 kg/ha), extensions to the grazing permit may allow livestock to graze those ranges longer into spring. However, the proper use of ephemeral ranges is still judged by levels of use of perennial plants. These levels of use are generally 45–55%, depending on the key species. The Bureau of Land Management assumes that the general condition of the range improves under these levels of use.

Cook (1977) found that defoliation (by sheep) was less harmful in fall, winter, and early spring than in late spring and summer on Great Basin ranges that contained several perennial species common to the Mojave Desert: winterfat (*Eurotia lanata*), Indian ricegrass (*Oryzopsis hymenoides*), and bottlebrush squirreltail (*Sitanion hystrix*). Vigor of these plants depended on the season and intensity of use; 50% defoliation of plants during late spring and summer was too severe, and 50% defoliation in winter would sustain optimum vigor (Cook 1977). On the Beaver Dam Slope pasture of the Beaver Dam Slope allotment, levels of use of perennials did not seem to be related to the percentage of the remaining annual vegetation after cattle were removed from the allotment (U.S. Bureau of Land Management, Dixie Resource Area, Cedar City, Utah, unpublished data).

Food Habits of Livestock

Few detailed analyses of food habits of cattle have been made in the Mojave Desert. Grasses characteristically dominate cattle diets; however, in a study in the Piute Valley, Nevada, diets of cattle consisted largely of shrubs during the dormant season and herbaceous annuals during the spring growing season (Burkhardt et al., unpublished manuscript). Specifically, fecal samples collected during the dormant season were dominated by white bursage (30%), littleleaf krameria (*Krameria parvifolia*; 14%), big galleta (12%), blackbrush (11%) and Nevada ephedra (*Ephedra nevadensis*; 7%). During the growing season, fecal samples were dominated by redstem filaree (*Erodium cicutarium*; 27%), six-weeks annual fescue (*Vulpia octoflora*; 23%), wooly plantain (*Plantago patagonica*; 11%), foxtail brome (9%), desert globemallow (*Sphaeralcea ambigua*; 7%), and sixweeks grama (*Bouteloua barbata*; 6%). As the ephemeral plants disappeared during summer, the cattle resumed a diet of perennial shrubs and grasses.

Forage plants of sheep consist more of forbs and shrubs and less of grasses (Hansen et al. 1976; Nicholson and Humphreys 1981). An examination of feeding sites at the Kramer study plot in California showed that sheep made heavy use of perennial and annual forbs *Machaeranthera*, *Eriogonum*, *Dalea*, white bursage, *Astragalus*, *Grayia*, western fiddleneck (*Amsinckia tessellata*), desert dandelion (*Malacothrix glabrata*), redstem filaree, and *Chaenactis* (Nicholson and Humphreys 1981). Ninety-two percent of the white bursage plants were browsed in a light-use study site, but little use was made of Indian ricegrass, winterfat, or split grass (*Schismus arabicus*).

Desert Tortoise

Desert Tortoise Food Habits

Probably more research (Burge and Bradley 1976; Coombs 1979; Nicholson and Humphreys 1981; Luckenbach 1982; Turner et al. 1984) in the Mojave Desert has been conducted on food habits of desert tortoises than on food habits of sheep and cattle combined. Studies of food habits at seven locations in the Mojave Desert revealed considerable variation in the dominant plant species eaten by tortoises: *Plantago* in southern Nevada (Burge and Bradley 1976), *Cryptantha* spp. in southern Nevada (P. A. Medica et al., University of California at Los Angeles, unpublished report), foxtail brome in Utah (T. C. Esque et al., U.S. Fish and Wildlife Service, Fort Collins, Colorado, FY91 unpublished report) and in northwestern Arizona (Hansen et al. 1976), split grass in southern California (Nicholson and Humphreys 1981), *Aristida* spp. in northwestern Arizona (Hansen et al. 1976), and slim tridens (*Tridens muticus*) in Utah (Hansen et al. 1976). The intake of individual plant species in one site may vary by availability from year to year. In the Ivanpah Valley, for example, grasses comprised 3.6–33.0% and annual forbs comprised 5.0–18.6% of the diet during a 2-year study (Turner et al. 1984). The second year was a drought year and forbs and grasses produced less than 10 kg/ha (almost 100% forbs) in contrast to 87 kg/ha (97.7% forbs) in the previous year, and the consumption of grasses and forbs by tortoises was low. As an alternative food source, cacti (especially *Opuntia* spp.) comprised 86.9% of the diet during May and June.

Food Requirements of Desert Tortoises

The forage needs of a large population of desert tortoises is relatively small and may be met during years with lower than average precipitation. If tortoises eat from 201 g/kg body weight/year (Marlow 1979) to 4.52 g/kg body weight/day (Nagy and Medica 1986), then 96.5 tortoises/km^2 (density of desert tortoises at the Desert Tortoise Natural Area in the western Mojave Desert) require from 0.39 to 1.59 kg/ha forage per year (Resource Concepts, Inc., Carson City, Nevada, unpublished report; J. Sullins, University of California, Riverside, personal communication). Even during 1981, a year of very little rainfall, forage production was 0.7 kg/ha (Turner et al. 1984). Tortoises ate cacti, but females still reproduced, laying an average of 1.1 clutches (in contrast to 1.6 clutches during 1980 when rainfall was about twice that of 1981). However, the mortality of radio-tagged adults was significantly higher than during the year of average precipitation.

Forage quality is probably of greater importance than forage quantity, but requirements by the desert tortoise for energy and other nutrients have not been determined. The quality and abundance of curing or senescent forage may be the critical determinant in the nutrition of the tortoise. Nagy and Medica (1986) found that during spring when they were eating succulent, high-quality vegetation, desert tortoises were in a negative energy balance. Presumably this was due to the high water content of plants that satiated the tortoises before they had ingested enough nutrients to meet energy requirements. A prolonged decline in nutrient availability may have been responsible for osteologic lesions and higher than normal mortality in tortoises from the Beaver Dam Slope (J. L. Jarchow and C. J. May, Arizona Game and Fish Department, Phoenix, unpublished report). Studies of the nutrition of tortoises, however, have not been published, and deficiency levels of protein have not been established.

Effects of Grazing by Livestock on the Desert Tortoise

Grazing by livestock has been implicated as a factor in decreasing populations of desert tortoises (Berry 1978; Coombs 1979). Some argued that, because livestock has been detrimental to the range, it has had a similar detriment on desert tortoises (Berry 1978). The effects of grazing on desert tortoises, however, have not been studied in a quantitative or scientifically rigorous manner. References have been made to the early research on desert tortoises on the Beaver Dam Slope (Woodbury and Hardy 1948), but these researchers did not investigate the effects of grazing on tortoise populations and only offer the opinion that livestock grazing may cause range deterioration. The primary evidence that grazing by livestock harms desert tortoises relates to an overlap in food habits of livestock and tortoises. One study—on the Beaver Dam Slope, Utah—revealed an overlap in food habits of cattle and desert tortoises when forage was grouped by class (grasses, forbs, and shrubs; Coombs 1979). In that study, foxtail brome was heavily used by cattle and tortoises. Other important plant species for the desert tortoise (tridens and redstem filaree) comprised little of the diet of cattle (Coombs 1979). A later study on the Beaver Dam Slope, Arizona, revealed the greatest degree of dietary overlap in April 1977 when both cattle and tortoises ate plantain (*Plantago* sp.) and foxtail brome and in April 1978 when both ate plantain, redstem filaree, and split grass (*Schismus* sp.; J. Hohman and R. D. Ohmart, Center for Environmental Studies, Arizona State University, Tempe, unpublished report). During other months when cattle were still on the range, dietary overlap was not as great. Researchers did not measure the amount of forage available to tortoises after cattle were removed from the range to determine whether forage was in short supply for tortoises. In the Piute Valley, Nevada, the abundance of desert tortoise sign was qualitatively related to grazing pressure (C. Mortimore and P. Schneider, Nevada Department of Wildlife, Reno, unpublished report).

A recent analysis of soils in the Piute Valley, however, revealed that the abundance of tortoises was more closely related to soil conditions than forage production (R. W. Wilson and R. D. Stager, Bureau of Land Management, Las Vegas, Nevada, unpublished report). The investigators categorized soils on perceived needs for burrow construction and found that the three soil types categorized as best contained higher densities of tortoises and burrows than soil types of poorer quality for burrow construction but of higher forage production.

Alternatively, in a 2-year study designed for evaluating the effects of grazing in the Ivanpah Valley, plant biomass, tortoise weights, and tortoise reproduction did not differ between a grazed site and a recently constructed cattle exclosure (Turner et al. 1981; P. A. Medica, C. L. Lyons, and F. B. Turner, University of California, Los Angeles, unpublished report). In view of the long recovery time of desert sites, differences after only 2 years of protection from grazing are unlikely.

One analysis of the effects of grazing by cattle on desert tortoises (Bostick 1990) suggests that cattle may have a beneficial effect on desert tortoises. This analysis suggests that the numbers of desert tortoises declined as cattle AUMs decreased during the past 50 years and that tortoises are more adapted to ranges that are in poor condition than ranges in good condition. This analysis, like previously cited reports suggesting that cattle negatively affect desert tortoise habitat, lacks experimental evidence.

An analysis of the effects of grazing by sheep on desert tortoises suggests that the decline of

tortoises roughly parallels reductions in grazing pressure by sheep and that tortoises continue to decline in areas that have not been recently grazed (Resource Concepts, Inc., unpublished letter). Grazing by sheep has been evaluated in California (Webb and Stielstra 1979; Nicholson and Humphreys 1981). Webb and Stielstra (1979) reported that after sheep passed through the site, 100 g/cm^2 [probably m^2] of forage remained, whereas 260 g/cm^2 [probably m^2] was available in an adjacent (<1 km away) site. Perennial vegetation was more abundant in the ungrazed than in the grazed plot before sheep grazed the site, and the cover of individual perennial shrubs was decreased by 16–19%. A reduction of biomass by 61.5% probably indicates a real decrease in biomass, but this decrease may not have been totally accurate because of the inherent differences in the perennial vegetation of the grazed and ungrazed plots and the lack of measurements before and after grazing. After sheep made a second pass through the grazed plot, an estimated 10–25% of the annual plant biomass remained. If 10% remained and the plots were identical, approximately 260 kg/ha remained after sheep had grazed the area twice.

At a study plot in California, the cover of live annual plants decreased from 24 April to 22 May by 40.8% in a site not grazed by sheep, by 49.6% in a light-use site, and by 69.2% in a heavy-use site (Nicholson and Humphreys 1981). The decrease in the no-use site represented the normal maturing of annual plants, whereas the 69.2% decrease in the heavy-use site probably reflected maturing as well as removal by sheep. Many of the annual forbs eaten by tortoises were also eaten by sheep; western fiddleneck, redstem filaree, and desert dandelion were the species with greatest overlap. Sheep also damaged tortoise burrows in the same study plot: 4% were totally destroyed and 10% were damaged (86% of these were in the areas with moderate-to-heavy use by sheep). Burrows that had more shrub and soil cover seemed to have been unaffected by sheep (Nicholson and Humphreys 1981).

Research Needs

The purpose of this review was to examine known factors of the plant ecology in the Mojave Desert and the effects of livestock on the plant ecology and the desert tortoises. Considerable research has been conducted on the distribution of plants in the Mojave Desert, on the life history of the creosotebush, and on the relation between desert annuals and annual precipitation. Essentially no researcher has yet evaluated the effects of livestock grazing on the productivity or availability of perennial grasses in the Mojave Desert, but research revealed that the activities by livestock (primarily sheep) reduced the cover of shrubs and annual forbs. Desert tortoises seem to prefer grasses and forbs, and the overlap between the diets of livestock and the desert tortoises has been documented. However, researchers have not yet investigated whether desert tortoises alter food habits to compensate for livestock grazing or if desert tortoises are nutritionally limited by livestock grazing.

For the scientific management of desert tortoise habitat, the effect of livestock on desert tortoises must be rigorously evaluated. The following questions have to be addressed: (1) What in situ nutrients (when and how much) are required for the growth, reproduction, and long-term survival of desert tortoises? (2) How many tortoises can exist on a given piece of habitat that is in excellent ecological condition (what is the carrying capacity)? (3) Does the use of the range by livestock change the availability of critical nutrients that affect tortoises? (4) Does currently accepted proper use of the range by livestock change the plant composition in such a way as to either lower the ecological condition of the range or reduce the availability of nutrients for desert tortoises? Too many scientifically unsupported statements have been made about the effects of livestock grazing on desert tortoises. Answers to the stated questions will improve our ability to manage desert tortoise habitat.

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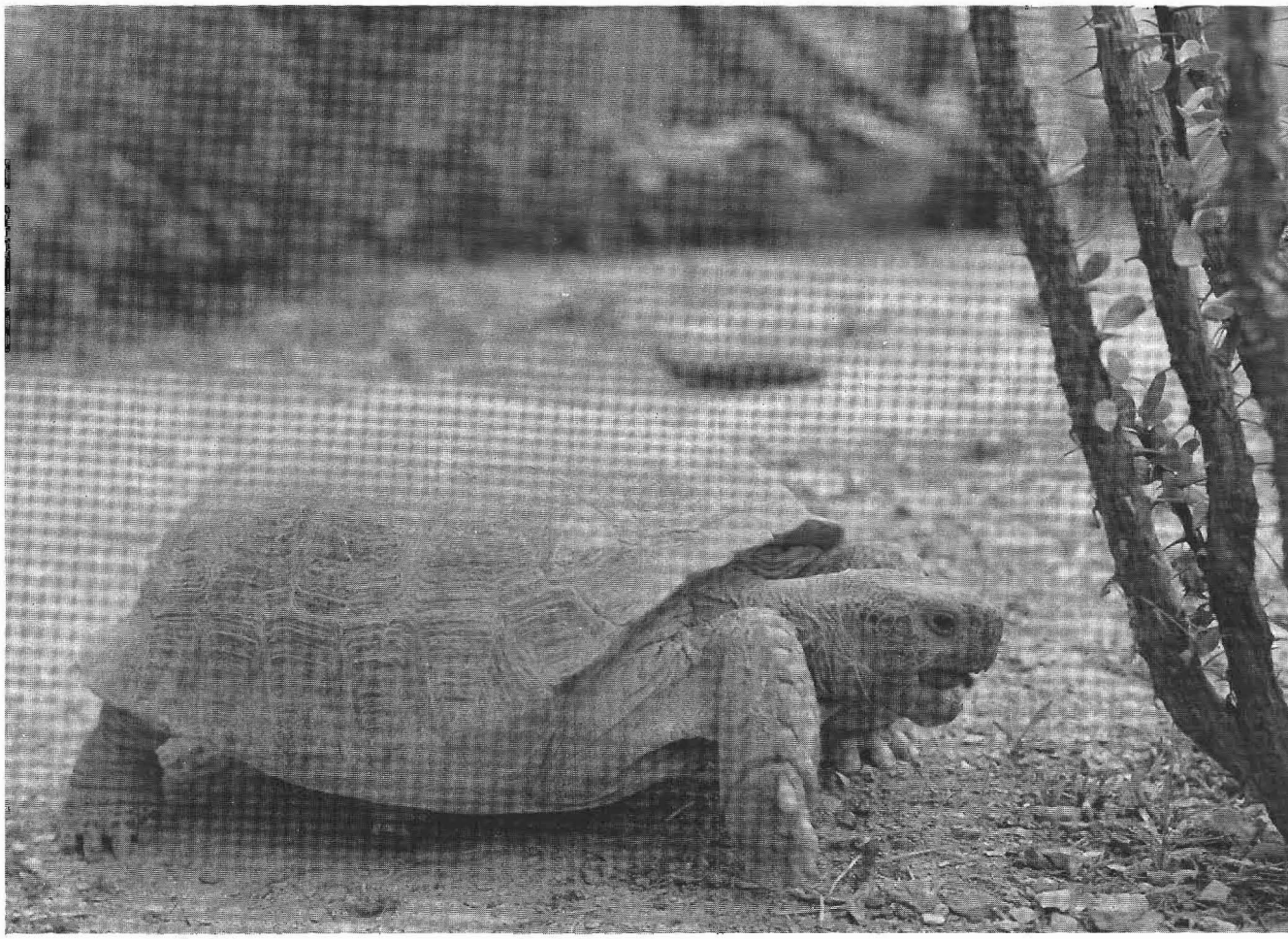

Adult Bolson tortoise (*Gopherus flavomarginatos*) at Mapimi MAB Reserve, Durango, Mexico. *Photo by D. E. Biggins.*