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DIFFERENTIATION OF THE SOUTHWESTERN TORTOISES (GENUS GOPHERUS), WITH NOTES ON THEIR HABITS

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CONTENTS

The true land tortoises of the southern United States and northern Mexico comprize three species of the genus *Gopherus*. The gopher tortoise, *G. polyphemus*, of the southeastern states, is said to range into the Carolinas and westward towards the Mississippi. It digs burrows, lays spherical eggs, is less than half as high as long, and lacks a lateral flare of the posterior part of the carapace. The desert tortoise, *G. agassizi*, occurs in southeastern California, western Arizona, and the southern tips of Nevada and Utah, and in Sonora, Mexico. Like the gopher tortoise, it lays spherical eggs, digs burrows, and is less than half as high as long; but the carapace flares posteriorly, being widest at about the fifth neural scute. It is apparently confined to regions where the creosote bush (*Larrea divaricata*) abounds. Occupying territory between these two species, but not coming in contact with either unless with *G. agassizi* in Mexico, is the smaller Texas tortoise, *G. berlandieri*, found south and southwest of San Antonio and into Nuevo Leon and Tamaulipas, Mexico. It is apparently confined to districts where prickly pear (*Opuntia* sp.) is found. It lays elongated eggs, possibly does not burrow, has a posterior flare like that of *G. agassizi*, is over half as high as long, and has a proportionately larger head; and the nuchal scute is reduced or wanting. There is frequently a yellow stripe across the snout behind the nostrils and a yellow spot behind each orbit. Other distinctions are discussed herein. Little is known of the very young.

Twenty-one specimens of *G. berlandieri* were collected April 10 to 15, 1960, near Hebbronville, Jim Hogg County, Texas. Various sizes and both sexes were taken in order to experiment on color perception and to determine the size and shape of eggs and the proportions and gross anatomy of adults and thus determine secondary differences between this and the other two species. In this paper *G. berlandieri* is compared to *G. agassizi*.

The temperature at Hebbronville was in the 90's F. by day, and the tortoises were beginning to emerge from hibernation. It is said in Hebbronville that the tortoises hibernate by squirming into the soil, leaving the top of the carapace exposed. A letter from Mr. V. W. Lehman, Wildlife Manager, King Ranch, July 29, 1960, states, "We know that it utilizes burrows for both shelter and hibernation, but there are so many coyote, skunk, armadillo, opossum, and badger dens in the Rio Grande Plain that there is small purpose for the tortoise to make additional excavations." Mr. Lehman's observations may explain why this tortoise has not developed the shovel-like forelegs of *G. agassizi*. I cannot agree that opossums dig.

It is generally agreed that members of this genus cannot swim. A recently published statement that *G. polyphemus* enters the water voluntarily and swims purposefully is unconfirmed. The other two species seem helpless in water.

In Hebbronville there is a rumor that the tortoise destroys quail eggs, but Mr. Lehman writes, "I can state with certainty that the tortoise is not a predator on quail eggs as is often supposed." In the Texas Field Trials for hunting dogs, the score of the dogs is not reduced for "pointing" tortoises, which possibly smell like quail. The local name for the tortoise is "sand terrapin".

Eggs

According to the literature, the eggs of *G. berlandieri* are elongate, but no measurements or ratios appear. Eggs of *G. agassizi* and *G. polyphemus* are nearly spherical. A captive *G. berlandieri* laid three eggs June 8, 1960, buried almost vertically about an inch below the surface and tightly packed. The order of deposition of these is not known. Another egg was found on the surface June 19, another July 9, and another July 13. All eggs were hard and all were nearly circular in cross section except No. 5, which was noticeably flattened, with transverse diameters of 32 and 34 mm. The egg was squeezed and appeared to be hard and firm. Yet this egg when remeasured July 15 was found to have become nearly circular in section. The eggs are white and smooth with a fine granular surface detectable by scratching with the fingernail. The yolk is visible and settles when the egg is tilted. These eggs were sterile, indicating that copulation had not occurred prior to hibernation or as late as early April.

Dimensions in mm.	Width-length ratio (using greatest width)	Date laid
1. 49 x 32.5	.66	June 8, 1960
2. 44 x 31	.70	
3. 43 x 31	.72	
4. 50 x 34	.68	June 19
5. 40 x 32 x 34 (40 x 33 on July 15)	.82	July 9
6. 43 x 34	.79	July 13

The average axial difference is about 12 mm. The longest egg is about 29 percent as long as the carapace of the female.

Grant (1936) gave the dimensions of three *G. agassizi* eggs:

Dimensions in mm.	Width-length ratio (using greatest width)
1. 42 x 36.5	.87
2. 42 x 37.5 x 35.7	.89
3. 42 x 36	.85

The average axial difference is about 6 mm. or about half that of *G. berlandieri*, which is about 12 mm.

The maximum clearance between pygal and anals is 19 mm. in the specimen of *G. berlandieri* which laid the six eggs. Even without any fleshy parts of the cloacal region being extended into this constriction during deposition, the space through which the eggs must pass is 15 mm. less than the diameter of the widest eggs. Therefore the eggs of this species must be leathery when laid as is the case in *G. agassizi*.

Una Nichols, who has kept *G. agassizi* in captivity in San Diego, California, for thirty years, stated to me that on six occasions she had seen eggs laid and had immediately handled them. The eggs when first laid are flattened to about a third of their final diameter, but they become hard and nearly spherical in a few minutes.

Miller (1932, p. 190) wrote of the desert tortoise: "The egg which was dropped into my hand felt quite warm . . . five degrees [C.] above the [temperature of] the surrounding air . . . At the moment of deposition the egg is decidedly moist so that the shell appears quite translucent although perfectly hard. It is not like some lizard eggs (*Gecko*), soft at deposition and dependent upon exposure to the air for hardening."

Growth of the Shell

The smaller the openings between the carapace and plastron, the greater the protection from predators. As the tortoise grows, these openings must enlarge to allow for the growth of legs and head, and it might be expected that they would enlarge proportionately. Actually in the desert tortoise, the head clearance, or anterior opening, increases more than proportionally to the length of the carapace. The posterior, or anal clearance, which is used only for excretion, mating, and egg laying, apparently does not enlarge after maturity, remaining smaller than the width of the eggs.

Proportions of Adults

The proportions of an adult male of *G. berlandieri* (carapace 176 mm. long) and those of an adult male of *G. agassizi* (carapace 220 mm. long) show differences that are not so pronounced in the young.

	G. berlandieri	*G. agassizi*
Head length[1] to carapace length[2]	.26	.23
Head width[3] to carapace length	.17	.16
Head width to head length	.65	.68
Anterior head width[4] to head length	.28	.38
Forefoot length to forefoot width[5]	.72	.64
Hind foot length to hind foot width[6]	.82	1.00
Foreleg width[7] to head length	.42	.90

[1] From the end of the fleshy snout to the dissected end of the supra-occipital.

[2] Between the rear of the pygal and (in *G. berlandieri*) the most anterior line joining the ends of the first or second pair of marginals, or (in *G. agassizi*) the anterior end of the nuchal.

[3] At the widest point, just posterior to the orbits.

[4] Just anterior to the orbits. The greater constriction in *G. berlandieri* gives it a Chelydra-like appearance.

[5] Length, from the base of the center claw to the center of the crease that denotes the end of the foot. Width, between the outside bases of the outer claws.

[6] Length, from the base of the second claw, excluding adjoining spines, to the heel, excluding spines. Width, between the outer edges of the bases of the outer claws.

[7] From edge to edge at the widest point, excluding the spines on the outer edge.

COLOR PERCEPTION

Walls (1942) discussed color discrimination in turtles in general, not including *Gopherus*, stating that they are red-green perceptive and, curiously, also violet perceptive, although violet is at the opposite end of the spectrum. He also intimated that they may be blue-yellow colorblind. My experiments with captive *Testudo* in Puerto Rico and *Terrapene* in Indiana and Kansas showed that there is a marked reaction to any red object.

Dr. Meyer Wiener, of Coronado, California, wrote in a letter of July 17, 1960, "You are perfectly right in assuming that the eyes of turtles are adjusted to diurnal living. The retina consists almost entirely of cones."

My experiments with *G. berlandieri* cover the combination of color perception, olfaction, and taste, which seem to be used in that order. Red appears to be the most attractive color and a red object is immediately investigated, smelled, tasted, and eaten if suitable. Blue, yellow, and white objects appear not to register except as objects and are not sampled unless accompanied by a pleasing smell. Thus peeled bananas in natural color or dyed blue, yellow, or green, are eaten. Flowers and leaves of red hibiscus (*Hibiscus rosa-sinensis*) are readily eaten, but white hibiscus flowers are ignored unless dyed red, when they are immediately perceived and eaten. If dyed blue or green they are eaten only casually with the green leaves. This may indicate that hibiscus flowers are chosen by color and that the taste is agreeable. I cannot detect any odor from this flower.

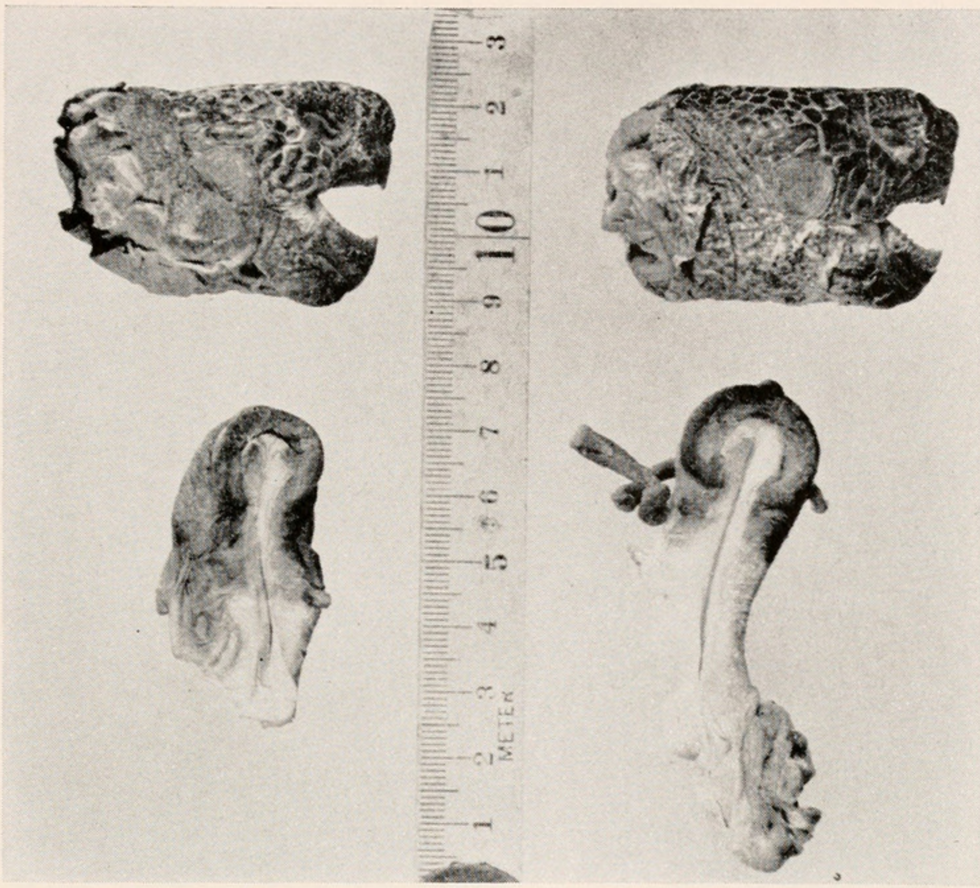

FIG. 1. Head and intromittent organ of *G. berlandieri* (left) and of *G. agassizi*.
Note the near equality of head size of two mature males of substantially different body size (carapace of *G. berlandieri* 176 mm. long; that of *G. agassizi* 220 mm. long). The single intromittent organs differ principally in pigmentation.

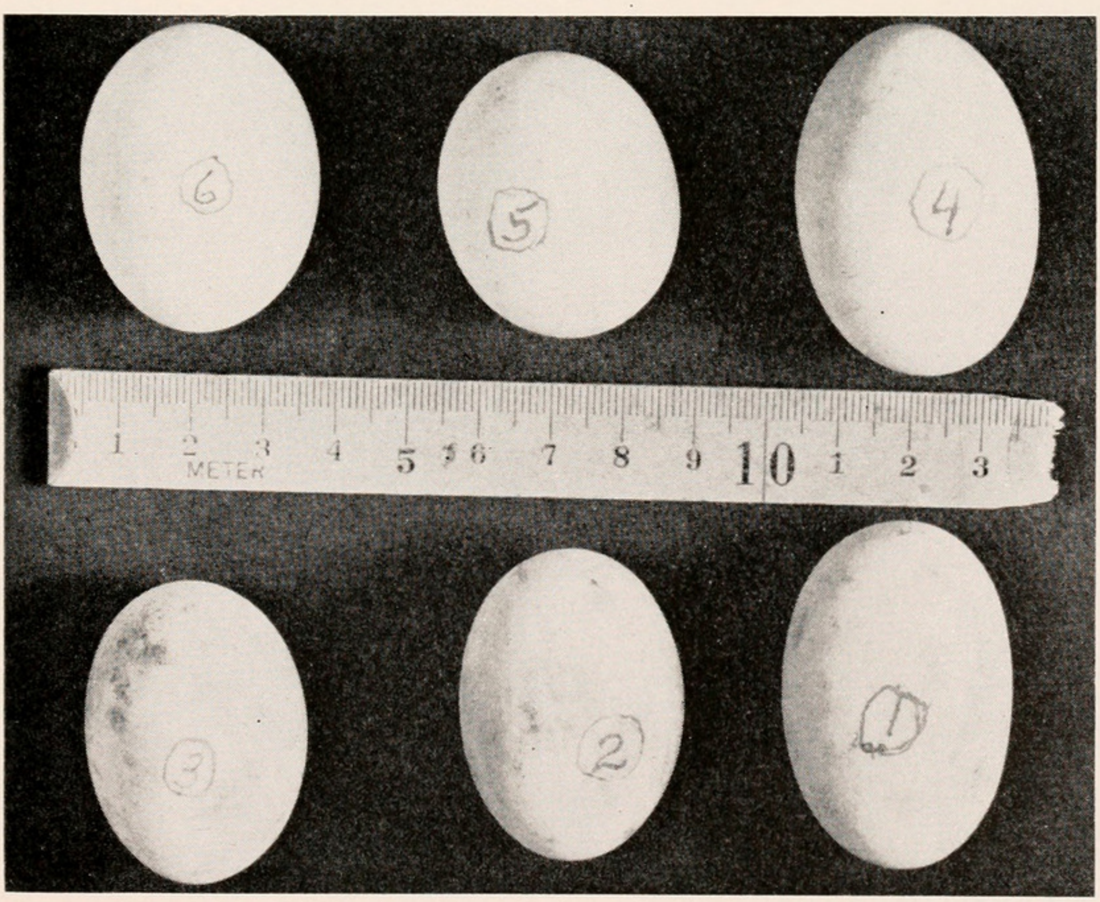

FIG. 2. Eggs of *Gopherus berlandieri*, laid in captivity, June and July 1960.

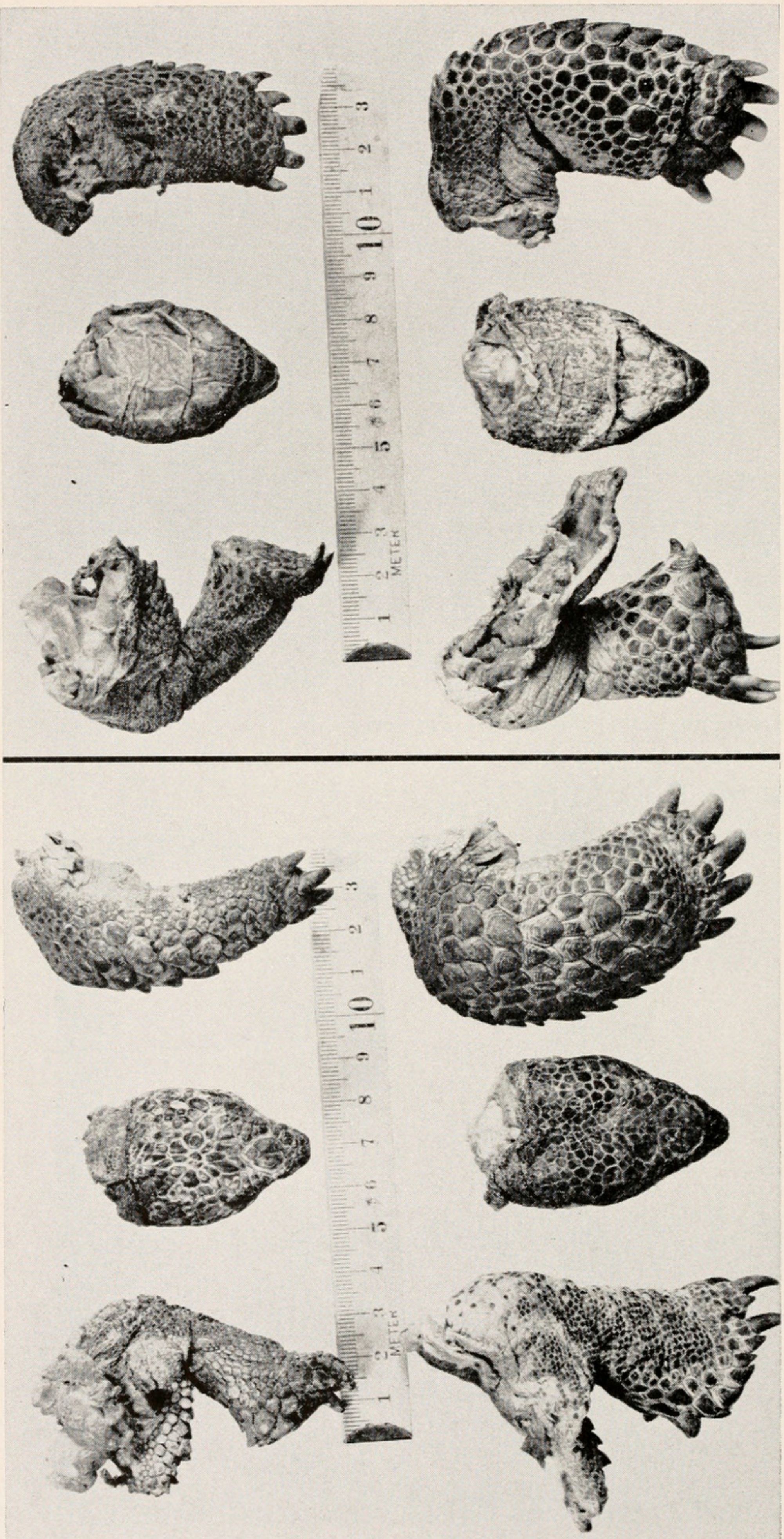

FIG. 3 (left). Top view of hind leg, head, and right foreleg, of *Gopherus berlandieri* (above) and of *G. agassizi*.

Note the pointed snout, the fewer and larger keeled scales on the outer surface of the foreleg, and the fewer heel spines on the hind foot of *G. berlandieri*.

FIG. 4. Lower view of hind leg, head, and right foreleg, of *Gopherus berlandieri* (above) and of *G. agassizi*.

Note the scent glands at the bulbs of the jaw. Also note the large pointed scales high up on the relatively narrow foreleg of *G. berlandieri* and the single flat enlarged scale near the forefoot of *G. agassizi* and the relatively wide foreleg, adapted to burrowing.

From experiments with available plants and vegetables, it appears that red hibiscus flowers are the first choice; next are the green pods of black-eyed peas or string beans, next the fruit of *Opuntia* when red-ripe, next the pads of spineless *Opuntia* or the tender pads of spiny *Opuntia*. Sparingly eaten are red or pink canna blossoms, purple iris blossoms, and apples. The apples are more readily eaten if dyed red, but will finally be consumed even after they have dried to a brown morsel. Apparently the smell of dried apple is more pleasing than that of fresh apple. Apples must be quartered, for the tortoise cannot bite or hold a whole one. Slices of fresh onion dyed red are smelled, tasted, and rejected: apparently the smell is not offensive, but the taste is. Lettuce and green cabbage are rejected, but red cabbage or cabbage or lettuce dyed red are sparingly eaten. They struggle to eat the sweet coarsely fibrous covering of the seeds of the queen palm (*Arecastrum romanzoffianum*). Watermelon, beets, red roses, fuchsias, red plums, red beef, white bread dyed red, cantaloupe unless dyed red, all were ignored. When the red is eaten off a red-dyed cantaloupe or banana, they become less attractive. Brushing food that is not particularly liked with vanilla extract had no effect. Frequently when an animal is not eating normally, it can be induced to eat its usual foods if these are flavored with vanilla.

Experiments were made in the dark with an ordinary electric bulb. The tortoises moved about slowly a couple of feet beyond the lighted area and then returned. With a red bulb the reactions were the same except that white straws etc., appearing bright red, were closely inspected, probably as potential food.

DEATH BY DIRECT INSOLATION

On July 20, 1960, a healthy male of *G. berlandieri* was exposed to direct sun in a carton 12 inches deep. It hurried around inside the carton with great agitation for ten minutes and then stopped with its head in a two-inch strip of shade. The temperature in the shade adjacent to the carton was 103 degrees F. Twenty minutes later it was dead and rigid, and it may have died immediately after coming to a halt. The remaining tortoises, in the shade at 103 degrees F., were not affected.

BEHAVIOR IN CAPTIVITY

The Texas tortoise seems more sensitive to the sun than is *G. agassizi*, as shown by its endeavor to get into shade. Its activity is limited to short periods in the morning and afternoon during optimum temperature and light conditions. Doubtless these periods would be longer in the field if the animal were hungry, but captives do not eat daily, sometimes skipping two days. It is more sensitive to darkness than are chickens and immobilizes while there is still light enough for a person to read a newspaper. The spot or corner selected to spend the night is usually the same for the various individuals. If moved from the selected spot after dark, some will make a blundering effort to move, whereas others will spend the remainder of the night where placed.

Digging seems to be of two kinds. They can squirm down into the soil, aided by the recurved marginals which act like little plows, lifting the dirt upwards; or they burrow, flicking the dirt out with the forefeet and pushing it out with the hind feet.

Apparently undesired grass and twigs are eaten because the tortoise is unable to discard them because of its clumsiness.

While climbing in attempting to escape or find shelter, the Texas tortoise may frequently fall wrong-side-up. Because of the domed carapace, it is usually somewhat tilted to one side. The first act is usually to urinate and then lie quietly for some seconds. Then the snout is pressed against the ground; the upper foreleg is flailed to overcome inertia so as to rotate the body towards the snout. The lower foreleg can then be moved next to the snout, and the lower hind leg is used to pry the body over.

No attempts to mate were seen although the temperature was in the 90's F. for a week in July and then up to 104 the following week and in the 90's the last week of July. They were penned outdoors with shelter and water but were not seen to drink.

Care in Captivity

Many captive desert tortoises have died because of unfavorable conditions. They will not eat except in broad daylight and at an optimum temperature of from about 80 to 90 degrees F. Food that can be bitten off of larger pieces is preferable to chopped food. Lettuce and apples are not a whole food, whereas green string beans, the pads of *Opuntia ficus-indica,* and the fruit of any *Opuntia,* are whole foods and readily eaten. Some other fruits and vegetables are eaten if dyed red with an odorless tasteless vegetable dye, which may be applied with a pastry brush. Captive tortoises must have shade, and they must be supplied with water unless *Opuntia* or other succulent food is eaten. They must also be allowed to burrow or furnished with low shelter.

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