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ECOLOGY OF A POPULATION OF
DESERT TORTOISES, GOPHERUS AGASSIZI,
IN WARD VALLEY, CALIFORNIA

SPRING, 1980

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ABSTRACT

Desert tortoises (Gopherus agassizi) were studied for 60 days during spring, 1978, on a permanent study site in Ward Valley, California.

- 1) Density is estimated to be 63 tortoises/km² (= 160 tortoises/mile²).
- 2) Distribution is unequal, with fewer tortoises in the rock outcrops or rolling hills. Density for these areas is estimated at 31 tortoises /km² (=80 tortoises/mi²). Density on the flats is estimated to be 77 tortoises/km² (=200 tortoises/mi²).
- 3) Reproduction is high, reflected by a high percentage of tortoises under 100 mm MCL, 24.6%, and a high percentage of young Immature tortoises, 14.8%. Rainfall and resultant food availability is discussed as a reason for high reproduction.
- 4) Mortality is estimated at 3.4 tortoises/year (= 2.1%/year).
- 5) Females were observed to have a prominent pygal tip while that of males pointed straight down or was tucked under.
- 6) Aspects of growth, activity, burrowing behavior, movement, feeding behavior, intra- and inter-specific behavior are discussed.
- 7) The vegetation of the site was sampled to determine present composition, biomasses, frequencies, volumes (for perennials) and cover (for annuals).

INTRODUCTION

Data on the desert tortoise, Gopherus agassizi, was collected in spring, 1980, on a permanent study site in Ward Valley, California. The study was conducted primarily to determine absolute density, age structure and sex ratios and secondarily to examine behaviors. In addition, the vegetation was sampled to determine absolute and relative frequencies, volumes and densities for perennial species and absolute and relative frequencies, covers and biomasses for annuals.

Burge (1977b and 1980, in prep.) studied the population dynamics and behaviors of a population of desert tortoises 27 km northwest of this site. Green and Hicks performed similar studies on two populations of tortoises in Ward and Cadiz valleys under contract with the Desert Plan Staff (DPS) of the Bureau of Land Management (BLM) in 1978. Nicholson, also under contract with DPS, walked transects in Ward Valley in 1978 to determine approximate tortoise densities.

STUDY AREA

Location. The study site is located in Ward Valley, San Bernardino County, 32 km east-southeast of Essex (off Interstate Highway 40) and 34 km southwest of Needles (Figure 1). It is located in T 7N and R 20E on the Stepladder Mts. 15' topographical map and extends from the western

Figure 1. Location of Ward Valley study site.

border of S28 to the eastern border of S27 and from 0.3 km south of the northern limits of these sections to 1.1 km south. Rock cairns mark the plot corners.

Habitat. The site is situated on a bajada with a westerly slope of 2.3% and an average elevation of 646 m (2120 feet). Granitic and basaltic rock hills in the southwest corner of S28 and the northeast corner of S27 rise 49 m above the plain with slopes of 24-73% (Appendicies V and XIV. Gently rolling hills extend easterly from the rock outcrop in S28 for 0.9 km; steeply rolling hills extend westerly and southerly from the rock outcrop in S27 for 0.6 km and easterly, past the plot, for 3.2 km.

Three wide (20 to 150 m), east-southeast to west-northwest, sandy washes, replete with small islands in several portions, transect the plot. One lies in the southwestern one-third of S28 and two are in the eastern one-half of S27. The northern border of the plot in S28 and the southern one-half of the plot, from the rolling hills in the east to those in the west, is replete with shallow (banks less than 10 cm high), narrow (0.5 to 2 m wide) watercourses.

With the exception of the rock outcrops, slightly hard (consistence when dry) coarse-sandy loam (U.S.D.A., 1960) covers the surface. Decomposed granite is added in the rolling hills, along with many granitic and basaltic boulders and small rock outcrops. A few large (50 X 75 m) patches of desert pavement a present in the southeastern quarter of S28.

The flatter area primarily consists of a moderately dense (plants separated by 0.5 to 2 m) Ambrosia dumosa - Larrea tridentata community with Yucca schidigera (App. XIV). Volume decreases but diversity increases in the rolling hills to include Eriogonum fasciculatum, Opuntia acanthocarpa, Encelia farinosa, E. virginensis, Dalea Fremontii, Eriogonum inflatum, Ferocactus acanthodes and Machaeranthera tortifolia. However, Encelia farinosa is predominant on the west-facing slope of the large rock outcrop in S27. In the large rock outcrops, the community changes radically to consist primarily of Nicotiana trigonophylla, Baccharis brachyphylla, Physalis crassifolia, Hofmeisteria plurisetata and Haplopappus Gooddingii.

Shrubs are largest and most dense in the areas of greatest runoff and Fouquieria splendens, Acacia Greggii, Salazaria mexicana and Cassia armata are common in the large washes (App. XIV). Where the ground is replete with tank tracks, dwarfed Larrea tridentata is the sole perennial.

The understory is dominated by Pectocarya spp.; Cryptantha spp. are subdominant on the flats. The diversity of annuals is excellent, and common species include Lotus tomentellus, Plantago insularis, Schismus sp., Bromus rubens, Chorizanthe spp., Lepidium lasiocarpum, Lesquerella Palmeri, Streptanthella longirostris, Chaenactis spp. and Eriogonum spp. By casual observation, it seemed to me that L. tomentellus is most dense and possibly subdominant along the western border of the plot.

Wind generally issued from the south-southeast through the west and from the north. Speeds averaged 3.6mps (8 miles per hour) with 10 days of windspeeds greater than 8.9mps (20 mph). Rain occurred on 1, 23, 28, 29 and 30 April and 1, 10 and 22 May. Total rainfall during the study was 70.6 mm (this figure taken from the United States Climatological Survey for Needles). Air temperature maxima and minima were averaged from tortoise data forms for March through May and were measured at sunrise and midday during June (Table I). March lows could not be determined due to insufficient data.

Table I. Average air temperature maxima and minima and change in day length for the duration of the study.

Month	T _{air} (°C)		Day Length (PST)	
	Minimum	Maximum	Sunrise	Sunset
March	Undetermined	19.3	~0520	~1740
April	18.6	22.3	~0510	~1800
May	16.9	~29.0	0500	1818
June	19.6	35.4	0448	1840

Human Influence. The study area receives very little vehicular use. A rarely-travelled, dirt pipeline road travels east to west, 1 km north of the plot. A well-hidden and disused jeep trail extends from this road through the plot center. Two sets of 4WD tracks, fresh this spring, were present in one wash.

Many tank tracks from Army maneuvers in 1942 (Blumenson, 1972) and the 1960's crisscross the northwest corner of S27 and part of the northeast corner of S28 (Appendix XIV). The paucity and stunted habit of the perennial vegetation indicates severe destruction of the shrub layer by maneuvers. Annuals have revegetated the tracks and if it weren't for the lack of regrowth of the ubiquitous, soil-encrusting, black lichen, the tracks would be difficult to distinguish in many instances.

METHODS AND MATERIALS

Tortoises were sought for 60 days (64 person-days) from 24 March to 14 April, 23 April to 11 May, 22 to 26 May, 1 to 4 June and 6 to 15 June. Searching hours were ca: a) 0800 to 1700 h (PST) for March and early April (9 hours); b) 0700 to 1200 h and 1330 to 1815 h for late April and early May (9 - 10 hours); and c) 0515 to 1130 h and 1500 to 1900 for late May and June (9.5 hours).

The plot was covered by systematically walking short transects, ca 0.2 km in length and spaced ca 10 m apart (that distance determined by vegetational density). Ultimately they covered a rectangular section of the plot, the width of which was determined by the time allocated to searching each day and the number of tortoises found (it required ca 20 minutes to examine a new capture). This method was felt to be most effective because (1) it was unlikely that a

tortoise would travel so quickly as to avoid being sighted either on the forward or return transect; the short transect length encouraged rapid return by the researcher, and (2) it enabled the researcher to view an area from various angles. To avoid duplicate searching, the daily area covered was mapped. Flagging of tall perennials every 0.1 km and the mapping of landmarks, plus a topographical map assisted in the accuracy of determining locations. The plot was covered slightly more than two times during the 60-day period.

Upon discovery of a tortoise, it was initially observed without disturbance, when possible, to determine behavior. Subsequently, several measurements were taken and recorded on forms provided by the BLM (Appendix VI). The first measurement taken (in an effort to obtain an accurate measurement prior to the tortoise's voiding) was the weight of the individual, determined by placing the tortoise in a metal pie pan and supporting this in a nylon net attached to a 6 kg Chatillion or 100 or 300 g Pesola scale. If the tortoise voided, the amount, color, viscosity and presence of insolubilities were noted. In addition to weighing the tortoise, the following measurements were taken, using Brown and Sharpe calipers: maximum carapace length (MCL); width a marginals 3 (posterior), 4 (middle) and 7-8 (seam); greatest width and its location; height at mid-central 3; plastron length from notch to notch (PL N); and maximum plastron length (PL T). Care was taken to leave the tortoise on its carapace for minimal periods as its breathing appeared to be labored in this position and because

the chance of causing torsional problems (intestinal twisting) was decreased (Berry, personal communication). Evidence of parasites or new growth was noted and the growth rings were counted. In addition, the sex was noted (for individuals over ca 180mm MCL) and the gular condition and shell wear were described and drawn. Injuries and anomalies were described, drawn and photographed. Photographs were also taken of the carapace and left costals 3 and 4. I would like to suggest that photographs also be taken of the plastron in future studies as individual differences are very distinct here. Behaviors before, during and after handling, were recorded. Temperatures were taken with a Schultheis thermometer, the bulb of which was manually shaded, one meter above the ground (T_a), one centimeter above the ground (T_{1cm}) and on the ground surface (T_{gs}). Cloud cover, wind direction and wind speed (the latter using the Beaufort technique) were recorded. The location of the tortoise was noted and mapped (Appendix I). Finally, each tortoise was consecutively numbered by notching in accordance with the Desert Tortoise Council notching system (Appendix VIII). In addition, the number was drawn on the anterior and posterior portions of the carapace with a waterproof, felt-tip marker to enable the investigator to identify an unobtainable tortoise in a burrow.

After releasing a tortoise, the immediate vicinity within a radius of 50m was searched in order to locate the tortoise's burrow or pallet. (This procedure was reversed

if a fresh burrow or pallet was located prior to observing a tortoise.) Length of the burrow and two lengths for a pallet, one from the interior end to the edge of the overhang and the second from the overhang edge to the end of the "apron", were measured. Height, width, soil cover, vegetal cover, direction, slope, co-occupants, curvature (determined with the aid of a mirror) and the distance and direction from the tortoise were also recorded, length measurements being taken with a collapsible pole and a tape measure. The burrow or pallet was then marked with a rock cairn to aid in identification when observing future use.

Upon recapturing a tortoise, mapping and measuring for weight and MCL were repeated in order to observe changes. Additionally, presence of new growth, parasites and behavior were observed.

All shells or parts encountered were photographed in situ and collected subsequent to searching the area within several meters of the initial discovery for all remains. Shells were labeled (number, site, date, principal investigator's name) and, if possible, measured with respect to plastron and carapace lengths, widths at marginals 3-4, 7-8 and the point of greatest width. Sex, possible mortality factors, condition of the skeleton and scutes, and the location of the remains were noted. All data were recorded on forms provided by the BLM (Appendix VII) and the specific location of the shell was mapped (Appendix II).

The belt transect method, suggested by the BLM, was

used to sample vegetation. Perennial vegetation was sampled along two permanent transect lines (marked by large rock cairns at each terminal corner) through homogeneous vegetal communities on 8 and 9 April and 12 June. Annual vegetation was sampled between the 1st and 5th of both April and May; 13 samples along each perennial transect line were taken each month.

All mammalian predators and raptors and their sign were noted and mapped. All predator scat were examined for tortoise remains.

RESULTS AND DISCUSSION

Population Parameters

Density. One hundred forty-two tortoises were captured. This figure is undoubtedly less than the actual density due to tortoise mobility and obscured visibility, especially for tortoises under 100mm MCL (Karl, 1979a; Burge, 1977b; Grubb, 1971). Only half of the subadults and adults were recaptured at least one time, which indicates, according to Fitch (1967), that many members of the population were yet to be captured. Although the proportion of recaptures to total captures increased in each daily census as the study progressed, it was only 0.77 by the end of the study (Figure 2).

If the curve of absolute density is extended (by estimation) to the point where recaptures equal captures, then the population estimate is 59 to 64 tortoises per square kilometer (150 to 165 tortoises/mile²).

Figure 2. Progressive proportion of recaptures (R) to total daily captures (T) for consecutive 5-day intervals during the study period (curve B) compared to absolute density increase per consecutive interval (curve A).

As the plot was covered only twice, a standard mark-recapture calculation (e.g. Lincoln Index; Marten Regression Method, 1970; Hayne modified Lincoln Index, 1949) could not be applied. However, a Schnabel (1938) calculation, which uses cumulative, daily population estimates and

is unaffected by day to day fluctuation in searching (e.g. number of hours worked, reduction of tortoise activity due to inclement weather) on a short-term basis, indicated a population density of 67 to 77 tortoises/km² (= 175 to 200 tortoises/mi²). A basic assumption of the Schnabel computation is that random stations are resampled several times. On the tortoise plot, this was not true. New areas were searched daily, resulting in a low proportion of recaptures to total daily captures and a resultant high estimate of the population density. A more appropriate method of sampling the plot would be to randomly (to compensate for clumping) sample small areas on the study site several times apiece.

Another factor which would influence the population estimate would be the number of unmarked tortoises found near the border during the final days of the study, due to immigration from uncensused areas outside the plot. This would decrease the recapture to total daily capture ratio, thus increasing the density estimate. Sixteen new tortoises were found from 1 June to 15 June; 11 (68.8%) were found within 200m of the border. The time spent searching the border area was approximately equal to that nearer the plot center (although ca one-third of the latter area was in low-density portions of the plot). The upper limit of the computed density estimate is probably slightly high as a result. The final density estimate, combining all fac-

tors is ca 63 tortoises/km² (= 160 tortoises/mi²). Berry (personal communication) estimated the density at 39 tortoises/km² (= 100 tortoises/mi²).

The rocky and foothill areas cover ca 35% of the plot. If tortoise density there is equal to that on the flat areas, then 35% of all captures should have been here; instead, only 17% occurred here. Density on the flat area (which extends several miles to the north and west) is ca 77 tortoises/km². In the rolling hills (which extend a few miles to the east of the plot), the density is estimated at 31 tortoises/km² (= 80 tortoises/mi²).

Distribution. Tortoise sign was moderately low in the foothills and extremely low in the boulder outcrops. Only the scat of three tortoises plus two tortoises and two burrows (one with a tortoise) were found in the latter area. Reasons for the lack of tortoises in the hilly areas include:

- 1) Fewer tortoises were found than were actually present due to obscured visibility and difficulty of walking in the rocks. However, searching lines were closer than normal (3-5 m apart) and searching was accomplished during hours of tortoise activity to compensate for these difficulties.
- 2) Burrowing potential in the hills is generally poor. The soil is denser than on the flats and often overlays boulders. In the rock outcrops, burrowing is impossible and coversites can only be provided

by overlapping rocks; two such burrows were found. Burge (1979) suggested that tortoise densities were higher in rocky outcrops than on the surrounding flats in a section of Arizona because there were many coversites provided by boulders. Although the soil on the flats was friable, burrowing into the soil was apparently unpreferred to finding cover in the rocks, this despite the fact that tortoises' front legs are specialized for digging (Pritchard, 1979). Aside from burrowing potential, nesting potential (generally observed as involving digging) in the hills is low. Pritchard (1979) noted that a population limiting factor is the availability of suitable soil for nesting.

A thermoregulatory advantage is gained by burrowing into the soil rather than finding shelter under rocks (not including deep caves) during hot weather. McGinnis and Voight (1971) stated that the burrow is the only shelter with non-lethal temperatures during hot days. However, they did not sample rock caves.

- 3) Forage availability is decreased in the rock outcrops over than on the rolling hills and flats. Between the latter two, annual vegetation is similar and the difference in perennial composition is not relevant with regard to forage. However, few

annuals are available in the rock outcrops and there is no record available that the perennials there constitute tortoise forage.

- 4) Moving among rocks expends more energy than moving along flat ground.

It would seem, then, that the benefits derived from living among the rocks and, to a lesser extent, in the rolling hills are few.

Sex Ratio and Age Structure. The sex ratio indicates a large majority of males (Table II). Several researchers have indicated that most reptilian populations have adult sex ratios nearing 1:1, but with a female predominance, sometimes as high as 4:1 (Tinkle, 1961). Tinkle (1967) quoted a 55:45 sex ratio, in favor of females, for Uta stansburiana. Swingland and Lessells (1979) observed that there was a slight differential mortality in males, resulting in an adult sex ratio in Geochelone gigantea Schweigger of 1 male: 1.6 females. Berry (1976) estimated that healthy populations of Gopherus agassizi must not have a predominance of males.

An equal sex ratio at hatching has been recorded by Tinkle (1967) for Uta stansburiana and Swingland and Coe (1979) for G. gigantea. Rohlf and Sokal (1969) offered a range of 1 male : 0.64 females to 1 : 1.59. Tinkle (1961) observed that in one large sample of young Sternotherus odoratus hatchlings showed slightly more than a 2:1 ratio in favor of females. If the sex ratio of G. agassizi

Table II. Sex ratio of live tortoises.

Method of Determining Age Class	Age Class	Number		Ratio
		♀	♂	
By Carapace Length	Subadult	8	9	0.88♀♀ : 1♂
	Adult	23	42	0.55 : 1
By Shell Wear *	Subadult	3	5	0.60 : 1
	Adult	28	46	0.61 : 1

* Obtained from Karl (1979a)

hatchlings was also 1:1, then differential mortality must occur for females at the Ward Valley study site, assuming very good sampling. However, Yntema (1976) showed that a change in nest temperature, during critical incubational development, of as little as 2°C was sufficient to significantly alter the sex ratio of hatchlings for Chelydra serpentina. Year to year variation in weather could influence the nest temperatures. Data for nest temperatures relative to hatchling sex ratio is not available for G. agassizi, so it is difficult to determine if differential sexual mortality actually exists.

This population has a high percentage of tortoises under 100 mm MCL, 24.6% (Table III), and, in view of the fact that 23 of the 27 Immatures are under 135 mm MCL (Figure 3), a high percentage of young Immatures. Berry (1976) indicated that in an undisturbed population, 1-3% of the total population should be less than 60 mm MCL, 5-10% Juvenile II's (i.e. 6-13% under 100 mm), 15-20% Immatures, 15-20% Subadults and 45-60% adults.

The high reproduction in Ward V. would indicate that carrying capacity has yet to be reached. Probably at least one clutch is laid yearly as Swingland and Coe (1978) suggest that breeding or multiple clutches are density related in Geochelone gigantea.

Table III. Age class structure of live tortoises.

Size Class	Number	Percentage of the Population	Adult:Non-adult
Hatchling (no ring)	4	2.8	84:100
Juvenile I ($\leq$ 1 ring, to 60mm MCL)	4	2.8	
Juvenile II (61-100mm)	27	19.0	
Immature (101-179mm)	25	17.6	
Subadult (180-207mm)	17	12.0	
Adult ($\geq$ 207mm)	65	45.8	
Total	142	100.0	

There is not a high percentage of adult females, so the high reproduction is surprising. Possibly, optimum environmental conditions have overridden this reproductively sub-optimum sex ratio. Rainfall, which is directionally proportional to forage production, has been positively correlated to reproduction rates for several species of lizards (Turner, Medica and Smith, 1973; Mayhew, 1966a and b, 1967; Vinegar, 1975; Zwiefel and Lowe, 1966). Swingland and Coe (1978)

Figure 3. Age structure of live tortoises in MCL increments of 5mm. * = The number of tortoises for each increment is shown on one side of central line.

showed that the most important factor influencing annual reproduction in Geochelone gigantea is rainfall. Increased rainfall results in reduced follicular atresia and increased oviposition or egg mass. Although Pianka (1970) agreed that clutch size in several species of lizards is positively correlated to rainfall, he suggested that biotic (predation, competition) rather than climatic factors are more influential in low elevation populations (which would include this site).

If an attempt is made to correlate the age structure of this population to rainfall, one would expect high reproduction 6.5, 1.5 and 0.5 years ago due to high winter rainfalls 7, 2 and 1 years ago (Fig. 4), according to figures recorded for Needles, CA (elevation 141 m). (Although these figures might not equal those of the study site, they probably indicate a precipitation trend). It is also possible that heavy summer rains prior to winters of low rainfall might stimulate increased oviposition the following spring.

Hahn and Tinkle (1964) observed that Uta stansburiana essentially used none of the fat bodies accumulated prior to hibernation for winter survival. Upon emergence from hibernation, high fat body content provided material support for follicle yolking at a time (early spring) when food availability was poor. If Gopherus agassizi behaved similarly, entering hibernation with good fat reserves from high availability of winter annuals following summer rains, then hatching would have been high 2.5 and 4.5 years ago (Fig. 5).

Figure 4. Winter rainfall (October through April) at Needles, CA from 1957 to 1980.

Figure 5. Yearly rainfall for Needles, CA from 1958 to 1979.

Using carapace length ranges for various ages provided by Patterson and Brattstrom (1972), Miller (1955) and Altmann and Dittmar (1962), all tortoises under 120mm MCL could fit into one of the age categories specified by high rainfall. Rainfall was lower than average between 11 and 14 years ago and there are only four tortoises in this age category. However, rainfall was also low 7 to 10 years ago and there is a high percentage of tortoises this age (120 to 135mm MCL). The discrepancy may be attributable to the difficulty of assigning carapace length to a specific age. Rainfall may not be primarily responsible for increased production of tortoises; however, there is a logical correlation between high food availability (due to timely and sufficient rainfall) and high reproductive success.

Reproductive Potential. The size structure of this population shows that most of the large tortoises are of reproductive size and that the percentage of adults, 45.8%, is not too low for healthy reproduction, according to Berry (1976). Also, 61% of the adult females and 61.9% of the adult males were probably in their prime as they showed relatively little shell wear (i.e. distinct rings, no scute sinking, no seam widening). Only 21.4% of the females and 10.9% of the males were presumably old (i.e. scutes sunk on carapace and along midline; wide, deep sutures; smooth marginals' edges). Reproductive senescence has been observed in a few species of turtles (Legler, 1960; Gibbons, 1969; Cagle, 1944, Tinkle,

1961). However, Swingland et al (1979) observed no senescence in Geochelone gigantea. It is not known what percentage of a healthy Gopherus agassizi population normally comprises old individuals; however, the percentages here seem small.

Mortality. Seventeen entire shells or large fragment groups representing one tortoise each, plus 31 small groups of isolated fragments, were found. The highest recovery occurred in adult tortoises (Table IV). When expressed as the percentage of live tortoises found in each size category, the mortality was slightly higher in subadults (17.6%) than in adults (13.8%). The result that there were no shells under 60mm MCL is probably due to low mortality, although lack of ossification of the shell (Berry, personal communication), reduced visibility and complete devouring by predators could also alter shell recovery results.

Table IV. Tortoise skeletal remains.

Size Class	Sex			Total	% of Total	Dead : Live Tortoises
	Und.	♀	♂			
Hatchling	0	0	0	0	0.0	0.0
Juvenile I	0	0	0	0	0.0	0.0
Juvenile II	2	0	0	2	11.8	0.07
Immature	2	0	0	2	11.8	0.08
Subadult	0	2	1	3	17.6	0.176
Adult	1			1	5.9	
	3	1	5	9	52.9	0.138
Total	7	3	6	17	100.0	

The shell wear scheme used to determine approximate age since death, presented by Luckenbach (1976), showed that of the 17 dead tortoises 2 were deceased within the last year, 1 died ca 1 year ago, 3 died 1 to 2 years ago, 1 died 2 years ago and 10 died between 2 and 5 years ago. This results in an annual mortality of 3.4 tortoises ($= 2.1\%/year$). Exposure to the sun decayed shells more rapidly. One shell with solid, but slightly peeling and chipping bones and peeling, faded and loosened scutes had been present at least one year, indicated by the conformational growth of last year's annals to the shell shape.

Bones were more or less white with brown or black stains and occasionally a pinkish cast. Pink interiors were observed in newly disjointed sutures. In juvenile tortoises, the sutures were black-brown.

Small sample sizes precluded forming conclusions regarding differential sexual mortality.

Twelve non-crumbling skeletal groups, representing all age classes, were broken, possibly indicating predation, although tooth marks weren't evident. Five shells were chewed, although the cause of death in two, an adult and an immature, was uncertain as the tooth marks were on the shell periphery on one and on a scute but not on the underlying bone in the other. Of the remaining three tortoises, one, a Juvenile I, was chewed and crushed over the entire one-third of the carapace; the second, a Juvenile II, was found in a canid scat; and the third, a Juvenile II or Immature, had punctures in

an abdominal scute. Two tortoises were found upside down and possibly died of exposure and one Juvenile II was slightly flattened with a broken Vertebral I, possibly due to vehicle or cow crushing (although there was only slight evidence of non-recent livestock grazing).

Mammalian predators at the site included kit foxes (Vulpes macrotis), coyotes (Canis latrans) and bobcats (Lynx rufus). The latter two were sighted and the first was evident by the presence of scat, burrows and excavations. It is probable that the gray fox (Urocyon cinereoargenteus) and the badger (Taxidea taxus) were also present as their ranges extend into Ward V.

Raptors included Burrowing Owls (Speotyto cunicularia), Red-tailed Hawks (Buteo jamaicensis), Golden Eagles (Aquila chrysaetos) and an unidentified buteo. Although not sighted, the ranges of the Great Horned Owl (Bubo virginianus), Swainson's Hawk (Buteo swainsoni), Ferruginous Hawk (B. regalis) and Prairie Falcon (Falco mexicanus) extend into the study area. Ravens (Corvus corax) were also present during the study and have been reported as predators of young tortoises (Woodbury and Hardy, 1948).

Predators influence shell recovery results as they carry shells away from their original locations (Luckenbach, 1976) or devour them completely. The number of incomplete shells may attest either to predator influence or collection by Ravens (Peterson, 1961) or woodrats (Neotoma sp.). Ten

tortoise remains were found in woodrat nests.

Injuries and Disease. Thirteen to seventeen live tortoises had chew marks (e.g. punctures, ragged edges). These occurred primarily on the periphery of the shell. However, one soft tortoise, 80mm MCL, had many punctures along the plastron midline and on one opposing vertebral. One subadult tortoise's forefoot was mangled as well as its shell being chewed. Only three of the chewed tortoises were small, 118, 96 and 80mm MCL.

Eleven tortoises had deep incisions or chips to the bone; on one of these, the chipping was extensive. The side of one tortoise was compressed and deformed. One tortoise had lost the tip of its tail and one had a blackened, deformed toenail. The gular tips were broken off in seven adults, six of which were males.

One old male breathed audibly. The sutures of one, possibly diseased tortoise all exposed bone and another, also possibly diseased tortoise, had indentations with extensive peeling over much of its shell.

Parasites. Ticks, 1.5 to 3.5mm in length, were parasitic on 49 tortoises. Most of the tortoises were Adults, 77.6%; the remainder were Subadults, 18.4%, and Immatures, 6.1%. All of the old tortoises possessed ticks. Ticks numbered from 1 to 100 and were primarily attached to the posterior carapace (100% of the observations), although in 14% they were also on the anterior carapace. Only one tick was not on the carapace; it was attached to the dor-

sal surface of the gulars. Sites of attachment were generally scute sutures (83.7%), although they were also attached to scute centers (45.1%) and in deep chips or exposed bone. The presence of the latter or of new growth did not necessarily stimulate parasite attachment at that site. Of 88 tortoises with new growth, only 28.4% had ticks and only 51.0% of all parasitized tortoises had new growth. Grant (1936), Harbison (1937) and Woodbury and Hardy (1948) noted that ticks attached to shell sutures, exposed bone and soft skin, possibly due to ease of access to the blood supply. No ticks were observed attached to skin during the present study.

Shell Wear. Chipping of the keratinous layer was the prevalent form of shell wear, observed in 80 (56.3%) tortoises; in 31 of these, chips exposed bone. In 35 tortoises (24.6%) there were hairline cracks, most often extending from the plastral midline. Other shell wear included extensive peeling (5 tortoises) and "bubbling" under the shell surface (7 tortoises).

Anomalies. The prevalent "anomalies" included sutures not meeting at the plastral midline (77.3% of all tortoises); pronounced or mottled coloration (67.9%); curves in sutures (83.9%), especially between the vertebrals (35.0%), along the midline (25.5%) and in the anterior pectorals (17.5%); slight to extreme posterior flaring (65.7%); misshapen scutes, such as assymetrical, fused, under- or oversized or overlapping (46.0%); oval shape (21.9%); and prominent scute centers (21.2%). The remaining anomalies, each pre-

sent in less than 13% of all tortoises, included various shapes, viewed dorsally, indentations in marginals 5 and 8, upturned anterior flares, extra or reduced numbers of marginals or costals, recessed or missing nuchal, deformed toenails, scattered lumps of keratin, different eye coloration in the same tortoise, irregularly notched nuchal or pygal and prominent diagonal "foldlines" formed by the corner points of the growth rings and especially prevalent on costal 3 and the pectorals. There was no correlation between tortoise size and most anomalies except that posterior flaring was less pronounced in very young tortoises and the majority of these were richly colored. Also, prominent scute centers were primarily observed in subadult and adult tortoises.

Sexual Differentiation. Females generally had a prominent pygal tip (Figure 6). Of 23 females, from 176 to 230mm MCL, inspected for this feature, all had prominent pygal tips. Of 30 males examined, 26 had prominent areas at the Vertebral 5/pygal suture or above, but the tip of the pygal pointed straight down or was tucked slightly under. Four males had prominent pygal tips, although in three of these the prominence was slight. This feature might be used to determine sex in tortoises under 180mm MCL as both forms were observed in four inspected tortoises as small as 121mm MCL. It could also assist in determining the sex of incomplete skeletal remains when at least the posterior carapace is present.

Figure 6. Sexual differences in the posterior carapace, viewed laterally.

Growth. There were only six tortoises under 180mm MCL for which growth (expressed as the percentage of MCL change and the percentage of weight change) could be examined. One 53.3mm MCL tortoise exhibited the greatest growth rate, increasing 0.38%/day in length from 1 April to 14 June (= 13mm in 64 days) and 1.84%/day in weight (= 40g). The remaining five immature tortoises averaged slightly greater length gain but approximately equal weight gain to that of tortoises over 180mm MCL (Figure 7). It has been shown for several turtle species that growth is rapid in young individuals, decreasing steadily to sexual maturity, at which point it becomes slow (Gibbons, 1967; Graham, 1971; Heatwole, 1976; Medica; Bury and Turner, 1975; Moll, 1973 and 1976; Patterson et al, 1972; Swingland et al, 1979). A 185 mm female exhibited the second greatest gain in weight, 0.92%/day (= 350 g) in 28 days. A 253 mm tortoise gained 0.04% (= 15 g) in only 4 days; however, a 254 mm tortoise gained no weight in 6 days.

No increments $\leq 100\text{g}$ (unless recorded by the Pesola scales) or 1mm were considered due to inaccuracy of the measuring devices.

Figure 7. Average length (•) and weight (+) gain for each size group. Vertical lines represent standard deviation.

The growth rate in length was 0.033%/day (= an average of 6.5mm in 82 days [Medica et al, 1975, found that growth occurred primarily in 82 days between 15 April and 6 July]) greater in adult males than in adult females (Table V). Swingland et al (1979) also observed faster growth for male than for female Geochelone gigantea. There was no sexual difference in adult weight gain (Table VI), possibly because the greater gain in length (probably accompanied by a weight gain) in males was equalled by a weight gain in females for developing follicles. There was no sexual difference in length gain between four subadult females and four subadult males; however, eight subadult females averaged a weight gain of 0.13%/day (= 157g in 82 days) more than the average of six subadult males.

Table V. Percentage of MCL change per day.

Sex	Size Class (mm)	Average MCL (mm)	Average % Change/Day	Standard Deviation	Range	N
♂	>207	242	0.040	0.20	0-0.15	13
	180-207	196	0.080	0.05	0-0.12	4
	>207	218	0.007	0.06	0-0.003	9
♀	180-207	192	0.090	0.06	0-0.14	4
	101-179	175	0.130	0.03	0.11-0.15	2
	101-179	164	0.090	0.06	0.04-0.12	3
Und	<60	53.5	0.380	—	—	1

Three periods of time were used to determine if growth rate changed during the spring season. These were: (a) Group I - ca 1 April to 5 May, with an average of 29 days; (b) Group II - ca 1 May to 15 June, with an average of 23 days; and (c)

Table VI. Percentage of weight change per day.

Sex	Size Class (mm)	Average Weight (g)	Average % Change/Day	Standard Deviation	Range	N
♂	>207	3200	0.14	0.13	0-0.47	31
	180-207	1660	0.23	0.14	0-0.39	6
	>207	2072	0.14	0.10	0-0.32	11
♀	180-207	1477	0.36	0.27	0-0.92	8
	101-179	1385	0.18	0.18	0.05-0.31	2
	101-179	467	0.31	0.20	0-0.41	4
Und	<60	34	1.84	—	—	1

Group III - included at least one-half of both groups I and II, with an average of 66 days. Groups I and II could not be compared directly with regard to length gain because there were no tortoises in Group I except for adult females (Table VII). However, the length growth rate was 0.01%/day (= 1.8mm for 82 days) greater for one Group I, adult female than for three Group II, adult females. With regard to weight gain, sample sizes are small in groups I and II, with the exception of adult males, and the results are inconsistent (Table VIII). For adult males, there was little difference between groups I and II. The Group III totals were larger than either Group I or II totals, possibly due primarily to the very large, Group III growth rates for one juvenile II tortoise. The deletion of the rates for this tortoise reduces the Group III rates to 0.05%/day for length and 0.21%/day for weight; these figures approach those for groups I and II. If the growth rate was irregular during spring, one would expect a difference between groups I and II with an approximate average in Group III.

Table VII. Intraseason change in length growth rate.

Sex	Size (mm)	Group I			Group II			Group III		
		$\bar{x}\%$ Daily Increment	n	S.D. Range	$\bar{x}\%$ Daily Increment	n	S.D. Range	$\bar{x}\%$ Daily Increment	n	S.D. Range
♂	>207		0	—	0.03	8	0.06 0-0.15	0.05	5	0.04 0.01-0.1
	180-207		0	—	0.08	3	0.07 0-0.12	0.07	1	—
♀	>207	0.01	1	—	0.00	3	0.0 0-0.003	0.01	5	0.01 0-0.02
	180-207	—	0	—	0.05	2	0.07 0-0.10	0.13	2	0.01 0.12-0.14
	101-179	—	0	—	0.11	1	—	0.15	1	—
Und.	101-179	—	0	—	0.12	2	0.06 0.08-0.16	0.04	1	—
	≤60	—	0	—	—	0	—	0.38	1	—
Total		0.01	1	—	0.05	19	0.00 0-0.16	0.07	16	0.10 0-0.14

Table VIII. Intraseason change in weight growth rate.

Sex	Size (mm)	Group I			Group II			Group III		
		$\bar{x}\%$ Daily Increment	n	S.D. Range	$\bar{x}\%$ Daily Increment	n	S.D. Range	$\bar{x}\%$ Daily Increment	n	S.D. Range
♂	>207	0.13	12	0.14 0-0.47	0.11	13	0.12 0-0.43	0.23	6	0.09 0.12-0.34
	180-207	0.17	1	—	0.25	3	0.22 0-0.39	0.22	1	—
♀	>207	0.10	3	0.12 0.03-0.24	0.25	3	0.07 0.19-0.32	0.10	5	0.06 0-0.17
	180-207	0.63	2	0.42 0.33-0.92	0.24	3	0.22 0-0.42	0.31	3	0.14 0.16-0.43
	101-179	—	0	—	0.31	1	—	0.05	1	—
Und.	101-179	—	0	—	0.27	3	0.24 0-0.41	0.40	1	—
	≤60	—	0	—	—	0	—	0.84	1	—
Total		0.18	18	0.22 0-0.92	0.19	26	0.16 0-0.43	0.29	19	0.39 0-0.43

As this was not observed, there is probably no intraseason variation in growth rate (although large standard deviations indicate the difficulty of forming conclusions). Medica et al (1975) stated that length growth rate was greatest in the latter part of the season. Maximum primary production this spring in Ward V. occurred during the Group I time period. It is tempting to speculate that the increased weight gain rate for Group I, adult females is due to developing follicles.

Growth rates reported here are for a spring following a winter of high rainfall (Figure 4). Growth would probably be less during springs of low primary production, following winters of low and/or untimely rainfall.

Woodbury and Hardy (1948) noted that it is difficult to assign age to a tortoise by counting growth rings. Probably only one ring is added in a spring, but an additional ring may be added in the fall, especially if there is high production of winter annuals. In mature tortoises, the rings become rubbed and indistinct. Figure 8 shows the approximate size of young Ward V. tortoises compared to their respective number of rings. If one temporarily assumes that one ring equals one year of age, then the age:MCL ratio does approximate that given by Patterson et al (1972), Miller (1955) and Altmann and Dittmar (1962). Thus young tortoises can be relatively accurately aged by their growth rings.

New growth (lightened, flat area between scute sutures) was first observed in April and continued into June, the width of the growth lines widening as the season progressed. However, fewer tortoises exhibited new growth in June (23) than

Figure 8. Growth rings for tortoises under 140mm MCL.

in May (45), indicating that growth slacked off in June. These results are similar to those obtained by Medica et al (1975).

Behavior

Thermoregulation. Tortoises were active primarily between ca 1030 and 1500 h during March, although basking was observed as early as 0830 h, which might indicate earlier activity than was observed (Fig. 9). Active tortoises were observed throughout the day (0745 to 1700 h) in April, although several tortoises were seen in retreat between 1100 and 1500 h. No searching occurred between 1230 and 1500 in May and June, but active tortoises were only sighted in the morning, from 0630 to 1200 in May and from 0545 to 1000 h in June, and in the late afternoon, from 1500 to 1730 h in May and from 1600 to 1800 h in June. Tortoises were found to be equally as active in the late afternoon as in the morning.

Karl (1979b) concluded that ground surface temperature (T_{gs}) is the most reliable indicator of tortoise activity because wind speeds >6.7 m/sec (=15mph) alter air temperatures inconsistently. In Ward Valley, activity coincided with T_{gs} of ca 20 to 43°C, although two active tortoises were observed during T_{gs} of 45 and 45.2°C. Tortoises began retreat, however, at T_{gs} greater than ca 35°C from April to June and were seen in retreat at T_{gs} less than 25°C in May and 29°C in March. Tortoises which emerged for evening activity did so at ca 38°C.

Figure 9. Tortoise activity relative to time of day in March through June. represents active tortoises, represents basking and represents retreat.

Many tortoises were active in windspeeds 8.9m/s (= 20 mph). Two tortoises were active during rain, although one burrowed tortoise was also found during rain.

Two burrowed tortoises were observed in April and June at T_{gs} of 25.3 and 29.2°C at 0630 and 1048 h, respectively. Retreat at preferred activity times and temperatures may be an indication that all tortoises are not active daily (Berry, personal communication; Karl, 1979b).

Activity increased in April and May, 60.0% of all sighted tortoises ($n = 84$) and 57.7% ($n = 71$), respectively, over that in March, 38.1% ($n = 21$). It decreased again in June, 40.9% ($n = 44$).

Burrows may have been used more for midday retreats as

the season's heat increased. In June, 79% (n = 14) of the midday coversites were burrows as opposed to epigeal retreats; in May, 50% (n = 4); and in April, 25% (n = 12). McGinnis and Voight (1971) stated that midday burrow retreats are favored because burrows offer the only sublethal temperatures on days when ambient temperatures exceed the critical maximum. The sample size for evening coversites was even less, but 3 of 3, 7 of 9 and 7 of 8 evening coversites were burrows in April, May and June, respectively. McGinnis et al (1971) noted that burrows are used less frequently as evening coversites as seasonable temperatures increase; tortoises using surface retreats in the evening start foraging at lower body temperatures than those in burrows, resulting in longer foraging time for the epigeal-retreat tortoises.

There was no substantial difference in the lengths of utilized burrows throughout the season. They averaged 0.38 m for April (n = 31) and May (n = 34), 0.46 m for March (n = 15) and 0.64 m (n = 26) for June. Only 16 pallets were found, 81% of these divided equally between April and May. Burge (1978) noted that pallet use was increased in April and May over March and June, but that the use of shorter burrows occurred progressively from March through July.

Burrowing Behavior. With the exception of one burrow, all surface slopes at the entrances to 94 burrows were $\leq 30^\circ$, with an average slope of 10° . The remaining burrow had an entrance slope of 60° . Forty-five per cent (42) had slopes at the burrow entrance (primarily caused by the mounding of

the excavated dirt), but leveled inside. Several of these sloped gently for several centimeters prior to leveling. Burge (1978) noted that the slope changed primarily within the first 40 cm. Karl (1979a,b) also reported gentle slopes, primarily leveling inside. Only 16% (15) remained sloping at the interior terminus, none showing a slope greater than 30° and none showing a steeper slope than that at the entrance. In 37% (35), there was no slope whatsoever.

The average soil cover was 73.3mm (n = 96). The gentle slopes indicate that there was little increase in soil cover at the interior terminus of most burrows.

Fourteen burrows were on islands or in the banks of watercourses. Five of these were in wide washes with substantial runoff, two being dug into banks which were 0.5 to 1 m high. Only three of nineteen coversites in the rolling hills were merely spaces between boulders; the remaining burrows here were dug into the soil. In the rock outcrops, two coversites were found, one of which was a 0.7 X 0.7 m cave and the other a 1 m tunnel. Neither were dug into the flooring (primarily rock) and both were accessible only by tortuous climbing over loose granite on slopes of 20 to 40°. Three burrows were dug under boulders, two were dug under fallen logs and two were dug under Yucca schidigera stems. One mature tortoise (only the tracks were seen) inhabited a fresh kit fox complex and three tortoises occupied former rabbit or kit fox forms (judging from the round shape, tall

height and steep slopes). One subadult tortoise further excavated a rodent burrow and four tortoises, 52.5 to 96mm MCL, were found in old rodent burrows. Rodent holes were found at the ends of two burrows, rodent scat were found in three and the remains of *Neotoma* middens found in four. Bury (1973), Lowe (1964) and Karl (1979a) observed modification of rodent or rabbit burrows by tortoises and the use of rodent holes by small juvenile tortoises. Neotoma sp. moved into three burrows that had been occupied by tortoises this spring so the presence of Neotoma debris in an extant tortoise burrow may indicate that tortoises have re-occupied former burrows rather than further excavating Neotoma burrows.

Tortoises preferred to construct burrows or pallets under shrubs. Of 96 burrows examined for location with regard to shade or visual protection, 49% (47) were under shrubs and in partial shade during the day. Those that were not constructed under the overhang of any perennial vegetation, but did receive some shade, constituted 19.8% (19) and those that were under bushes and received total, continuous shade totaled 15.6% (15). Only 15.6% were completely in the open. There was no apparent increase in shaded sites with increasingly hot temperatures during the season. Likewise, there was no evident month to month change in burrow preference regarding the portion of the day during which the burrow was shaded (for burrows which received partial daily shade). These results are probably due to the thermal protection pro-

tection provided by the burrow interior, regardless of protective shade. McGinnis et al (1971) showed that the air temperature 1 m inside a tortoise burrow (the location of which was not stated) during late May changed little during the day. Their measurements indicate that shade is of little importance relative to burrow temperature (for burrows of adequate depth) and is thus not a factor in burrow site choice (although Burge, 1978, suggested that it was). Possibly the soil is looser under shrubs due to water retention, notwithstanding the visual obscurity provided.

The species of perennial vegetation over 62 burrows was examined. The predominant cover species was Larrea tridentata (56.5%), followed by Ambrosia dumosa (29.0%), Yucca schidigera (17.7%) and Krameria Grayii (14.5%), shown in Table IX. Fifty-five burrows were on the flatter area of the plot, where Ambrosia dumosa was the most dense species. The affinity for constructing burrows under Larrea tridentata is probably a reflection of its relative density as well as (especially with regard to A. dumosa) its larger volume, which provides more protective cover. Plant size may have been the reason for the preference of Yucca schidigera over smaller shrubs of comparable or greater density (App. XIII). The remainder of the shrub choices does not indicate a preference.

Northerly-, southerly- and westerly-facing apertures (especially the latter) were most preferred; southeasterly-fac-

Table IX. The perennial vegetation over 62 burrows, compared to the relative density of each species.

Species	Number of Burrows Found Under Species	%	Relative Density	
			Flats	Rolling Hills
<u>Larrea tridentata</u>	35	56.5	9.0	—
<u>Ambrosia dumosa</u>	18	29.0	19.2	10.6
** <u>Yucca schidiqera</u>	11	17.7	0.5	—
<u>Krameria Grayii</u>	9	14.5	2.7	—
<u>Eriogonum fasciculatum</u>	4	6.5	0.5	15.9
<u>Acacia Greggii</u>	3	4.8	—	0.2
<u>Ephedra nevadensis</u>	2	3.2	—	—
<u>Stephanomeria pauciflora</u>	1	1.6	—	4.1
* <u>Baccharis brachyphylla</u>	1	1.6	—	1.3
<u>Opuntia ramosissima</u>	1	1.6	—	—
* <u>O. acanthocarpa</u>	1	1.6	—	0.2
<u>Krameria parvifolia</u>	1	1.6	1.1	2.7
* <u>Encelia</u> sp.	1	1.6	—	1.3
<u>Salazaria mexicana</u>	1	1.6	—	—
* <u>Eriogonum inflatum</u>	1	1.6	—	5.6
<u>Dyssodia porophylloides</u>	1	1.6	—	0.4
<u>Lycium Andersonii</u>	1	1.6	—	—

* = occurred in rolling hills

** = three burrows were in rolling hills

ing openings were least preferred (Figure 10). Auffenburg and Weaver (1969) found that southerly-facing apertures were most common for Arizonian tortoises; Karl (1979a) similarly

reported that southerly to westerly directions were most preferred in the western Mojave Desert. The sample size for each direction was too small ($= 0-8$) to determine if there was a directional change from month to month, although the advantages of earliest solar irradiation would be derived by tortoises in easterly-facing burrows, thus provided a longer activity period over tortoises sequestered in burrows of other aperture directions.

Figure 10. Aperture directions of 104 burrows.

Of 106 burrows, only 9 were not straight. Five curved to the right and four curved to the left. Burge (1978) also noticed turns in a few burrows.

The width of the burrow indicates the approximate size of the tortoise inhabiting it (Karl, 1979a, b). Of 108 burrows, the average of the burrow width at the entrance compared to the carapace length of the associated tortoise was 119.5% (range: 59-288%). One tortoise had to tilt to enter her burrow.

Few tortoises were found in the same burrow on successive captures. Burrows which were associated with specific tortoises were often found unused at a later date. Additionally, several times I found several burrows in a small area (e.g. 5 in a 200 X 300 m section), but no tortoises. These observations indicate that tortoises occupy several burrows apiece. In fact, 18 tortoises were observed to change burrows once, 5 changed twice and 1 changed 3 times. Up to three burrow changes per tortoise were also observed by Karl (1979a). Burge (1978) observed several changes in primary coversites; however, most of these were non-burrow coversites. She also noticed inter-year fidelity to specific burrows.

Hatchling Behavior. One hatchling was observed without disturbance for 1.5 hours on 5 May. He was initially observed exiting from a shallow cavity in the ground at 0839 h and T_{gs} of 31.2°C. He walked 3 m across open ground to a large boulder, where he remained motionless, in the shade, until 0951 h, with the exception of the period from 0916 to 0926 h, when he moved into the sun and remained motionless until he returned to the boulder. At 0951 h, he walked 3 m, grazing, to a rodent hole in a shrub, which he entered at 1003 h

after scratching twice with a forefoot. He remained close to shrubs two-thirds of the time during this journey, but the close spacing of the shrubs made it impossible to determine if this was coincidental. As heating and cooling rates are relatively fast in very young tortoises (Voight, 1975) it is likely that this hatchling maintained an optimum metabolic rate by his brief movements into the sun. Travelling in the open for such short periods is also a reason for the increased difficulty in sighting this size tortoise.

Movement. The greatest straight line distance between capture points (SLD) was moved by an adult male, 1000 m in 18 days. For tortoises captured more than one time for which the cumulative SLD's were much larger than the distance between the original capture and final recapture points, 8 males averaged cumulative SLD's of 745 m (standard deviation = 490) and 3 females averaged cumulative SLD's of 500 m (standard deviation = 22). Heatwole (1976) and Burge (1977b) reported that males have larger home ranges than females. An error associated with correlating SLD to sex or size when captures and recaptures are several days apart (the average interval during this study was 26 days) is that large, undetected movements can occur between captures. For example, 1 adult female moved 300 m in 1 day and 1 adult male moved 400 m in 1 day. However, it seems reasonable that if SLD's are similar regardless of the time interval between captures, then an approximation of the average distances

travelled by tortoises can be obtained. The mean SLD for adults (the only size class for which the sample size was moderately large) was <275 m (Table X). However, wide variation occurred, resulting in large standard deviations. This precluded forming conclusions about movement relative to size or sex. Swingland et al (1978) reported that movement was directly proportional to size in Geochelone gigantea.

Table X. Average straight line distance moved between capture points. Range is in brackets []; standard deviation is in parenthesis ().

Size Class	Sex		All Individuals
	♀	♂	
Adult	188 (85) [0-375] n=22	271 (194) [0-1000] n=38	244 (168) [0-1000] n=61
Subadult	100 (77) [0-225] n=10	408 (310) [75-750] n=6	216 (244) [0-750] n=16
Immature	75 (35) [50-100] n=2	625 n=1	190 (187) [50-625] n=8
Juvenile II			25 (35) [0-50] n=2
Juvenile I			100 n=1

Feeding Behavior. Lotus spp, especially Lotus tomentellus, were apparently preferred as they were eaten in 63% of 46 observed feedings by 21 tortoises. In addition, in one instance,

a tortoise walked over Schismus sp. (which he sniffed), Plantago insularis, Cryptantha spp., Eriogonum spp. and Euphorbia polycarpa and only ate one of the scarce Lotus sp. plants in the area. In another instance, a tortoise ate three of the four nearby Lotus sp. plants available to the exclusion of other plant species. Between 7 and 14 June, 36 moderately fresh scat and 1 fresh scat were examined for content; 34 (89.2%) contained Lotus sp. pods, 2 (5.4%) contained Opuntia basilaris glochids and 1 (2.7%) had a grass floret. Karl (1979b) also observed a preference for legumes, especially Lotus salsuginosus. This preference may be due to the succulent nature of Lotus spp. None of the other observed forage species, save for the Opuntia basilaris, were succulent.

Lotus spp. (primarily L. tomentellus) had the fourth greatest average importance value for the entire plot. It was also the most frequently encountered species in the rolling hills in early May and only slightly less frequently encountered than Pectocarya spp. and Plantago insularis here in early April. Also, its relative cover was only slightly less than Chorizanthe brevicornu (which had the highest relative cover) in early May in the hills. However, it otherwise had consistently less cover than Pectocarya spp. and Cryptantha spp., and, in early May on the flats, Eriogonum spp. (Appendix XIII). It was also far less frequently encountered on the flats than these three genera. So, although borages and sometimes Eriogonum spp. were primarily predomi-

nant with regard to cover and were most frequently encountered on the flats (ca two-thirds of the plot), they were far less preferred than Lotus spp.

Table XI. Forage species of 21 tortoises. In all cases, the plants were green.

Species	Number of Plants Eaten	Plant Part Consumed; # in () Is # of Times Eaten
<u>Lotus tomentellus</u>	12	Aerial parts (9)
<u>Lotus</u> sp.	16	Leaves (2); aerial parts (14)
Possible <u>Lotus</u> sp.	1	Undetermined
<u>Cryptantha augustifolia</u>	6	Aerial parts (6)
<u>Astragalus</u> sp.	2	Aerial parts (2)
<u>Pectocarya</u> sp.	2	All aerial parts, including green fruit (2)
Possible <u>Pectocarya</u> sp.	2	Undetermined
<u>Amsinckia tessellata</u>	1	Flower
<u>Cryptantha gracilis</u>	1	Undetermined
Possible borage	1	Undetermined
<u>Opuntia basilaris</u>	1	1/2 of a 12 X 10 cm pad and possibly the fruit
<u>Stephanomeria exigua</u>	1	Leaves

Except for three instances, all observations of feeding on plants occurred between 5 April and 8 May when most annuals were flowering (Pectocarya sp. was primarily dried by 8 May). The remaining three sightings were on 8 and 15 June and were of Cryptantha augustifolia and a possible bor-

age. At this time, C. augustifolia, a few remaining Lotus sp., Chaenactis carphoclina and Eriogonum deflexum were the only green annual species. Thus, it would appear that there is a tendency to feed on green plants, rather than dried ones. When Lotus sp. is unavailable, tortoises probably feed on most other available species. Swingland and Coe (1978) described Geochelone gigantea as a "broad-spectrum, opportunistic herbivore ... (consuming) virtually all litter".

All available forage was not eaten. Two tortoises walked over Plantago insularis, Pectocarya spp., Cryptantha spp., Chorizanthe rigida, Euphorbia polycarpa, Stephanomeria exigua, Chaenactis spp. and Astragalus acutirostris (which was smelled by one tortoise), as well as Lotus sp., and ate nothing. These sightings occurred on 27 April and 3 May, when all of these plants were green. In another observation, a tortoise walked within 4 cm of 2 small Lotus sp. plants and over another, but ate 2 other Lotus sp. plants. In nine instances, tortoises ate only a portion of several Lotus sp. plants, dropping detached portions on the ground in two instances. Only one plant was entirely devoured. It is possible that Lotus sp. plants which were not eaten were simply not noticed. Tortoises seem to use vision as a primary sensory mode, looking more or less straight ahead with some head turning. It was also suggested by Manton (1979) that vision is the primary stimulus for food location. Dur-

ing late spring when many of the annuals were dried, a tortoise was observed repeatedly "sniffing" at, but not eating, several Euphorbia polycarpa plants, the sole green, prostrate plant species in an area which lacked Lotus sp. Perhaps the tortoise was visually stimulated by the similarity of the species habit to that of Lotus sp., but found it to be E. polycarpa instead by olfaction (if the "sniffing" is olfactory).

Borages, consumed in 26.1 to 28.3 per cent of the observed feedings, were not always chosen as forage when recognized. In one instance, a tortoise ate from four Cryptantha augustifolia plants (devouring all of two), but avoided two others after "sniffing" each.

Three tortoises, a Subadult and two juvenile II's, were observed eating dirt. The former ate dirt from shallow, scraped areas, ca 10 cm in diameter, several of which were present in a 10 m circle. He ate many bites of the packed dirt, remaining at a "feeding" site up to 3.5 minutes at a time. He may have ingested a rabbit pellet as a few of these were present in one depression. Occasionally he scraped the dirt with a forefoot. Tortoise tracks could not be discerned in the bare dirt patches, although there were punctures and some single, linear scrapes. The second tortoise ate dirt in a similar manner, possibly ingesting some of the ubiquitous black lichen, and eating Lotus sp. in between eating dirt. One of the dirt-feeding sites, 11 by 7 cm, had many short, narrow, often parallel scrapes. The third tortoise

ate loosened dirt at one spot for six and one-half minutes. Geophagy has been observed by Karl (1979a) and Sokal (1971).

One tortoise ate part of a kit fox scat which was completely composed of hair.

Courtship and Coition. Copulation was observed on three occasions, 6, 14 and 25 April. Males were 257.5 to 269.5 mm MCL and all were young adults, judging from their shell wear (rings distinct or nearly so, hatchling plate present on posterior costals of one tortoise). Females were 222.5 to 237 mm MCL and all appeared to be past their "prime" (with sinking scutes and widening sutures); one tortoise was old (scutes sunk, sutures wide, smooth marginals' edges). All pairs were already copulating when found. In one couple, the male remained mounted for seven minutes. (Karl, 1979a, previously described the position and movements of mounted males, identical to this male's.) During this time, the female remained still, initially, only a few seconds at a time and pivoted often. Just prior to the male's dismount, she was pivoting constantly. The male from the second pair dismounted almost immediately after being sighted. Both dismounted males lay next to the females and head-bobbed for a few seconds. Both females walked away from the males only a few seconds after the males dismounted and began to graze. One male remained in place two minutes prior to turning away from the female and walked a few meters away. The second male head-bobbed until the female was eight meters away, at which

point he stopped bobbing, turned and walked away.

One mating area was dry with a few concentric $1/4$ circles and several tiny depressions. The mating area of another pair was moist but had no well defined rings or depressions from the male's pygal or feet. The third pair both had moist anal areas.

On 28 March, 2 tortoises were in the same burrow, the 218 mm (in middle adult years, judging by shell wear) female sideways and in front of the 257.5 mm male (one of the males found copulating, above). On 25 March, a 259 mm male (in middle adult years) was following a few centimeters behind a 212 mm female (young adult).

Activity During Handling. There was a much higher percentage of active tortoises under 180 mm MCL, 49.2% (n=59), than over 180 mm MCL, 12.6% (n=142). The highest proportion of very active individuals for an age class occurred in tortoises under 60 mm MCL. One hatchling attempted to bite. Generally, individual behavior did not change during successive recaptures.

Tortoises voided amber, orange, pink or clear urine. Precipitates were light brown, lavender, pink or white, the white precipitates often creamy and the colored curdled. Sometimes precipitates were mucilagenous and the consistency of cooked, shredded albumin. Precipitates were present in 56.9% of 137 voids. There was an increase in the presence of insolubilities in the voids during June and March (50.0% each month) over April (38.5%) and May (38.2%). Of 12 times

when the urine was relatively viscous, 6 occurred in June. The June increases in precipitates and viscosity may be indicative of decreased water intake because of decreased green forage in June. Light feeding (due to general inactivity) in March may be responsible for the lack of insolubilities in the urine then. Nagy and Medica (1977) noted that osmotic concentrations in bladder urine increased from May to June. High osmotic concentrations result in large quantities of gelatinous urate precipitates and dark brown urine (Minnich, 1977). Females, only, voided on fewer occasions with approaching summer (Table XII). Also, the only large change in voiding behavior of individual tortoises occurred in June in adult females; 14 tortoises which had voided on a capture prior to June did not void on recapture in June (although 2 females changed to voiding behavior in June). Nagy et al (1977) observed that breeding females retain water. This would be especially important as osmotic concentrations increased with drying forage.

Table XII. Per cent of captures each month which voided, relative to sex.

Month	♂	♀	Undetermined
March	20.0 (n=10)	85.7 (n=7)	100 (n=5)
April	48.8 (n=41)	63.6 (n=22)	95 (n=20)
May	68.2 (n=22)	76.2 (n=21)	85.2 (n=27)
June	57.9 (n=19)	46.2 (n=13)	91.7 (n=12)

Smaller tortoises voided more often during handling than larger ones (Table XIII). Adult females voided more consistently than adult males.

Table XIII. The percentage of tortoises of each sex and size which voided during handling.

Size Class Sex	Adult	Subadult	Immature	Juv. I	Juv. II	Hatchling
♂	45 (n=80)	76.9 (n=13)	100 (n=2)			
♀	64.3 (n=42)	76.5 (n=17)	50 (n=4)			
Und.			88.5 (n=26)	89.7 (n=29)	100 (n=7)	100 (n=2)

The greatest volume voided during a capture (expressed as the percentage of body weight) was by tortoises under 100 mm MCL (Table XIV). There was little difference between immature tortoises of undetermined sex (for those of determined sex, the sample size was too small to formulate comparisons) and subadult and adult females. However, subadult and adult males voided less than females.

Six scats were excreted by five tortoises. They ranged from 12.1 to 27.8% of the carapace length. Four of the scats were examined for content. All had fine (≤0.5 mm in diameter) and/or medium-sized (ca 1 mm in diameter) stems; pods were present in 3 and a rodent scat was in 1 other.

An adult female tortoise excreted a stone, ca 15 mm in diameter, and weighing slightly less than 2 g (dry weight).

Table XIV. Average volume voided for each age class. Range and sample size are in parentheses ().

Size Class Sex	Adult	Subadult	Immature	Juvenile II	Juvenile I- Hatchling
♂	0.75 (0.02-2.7) (n=37) 1.22	0.52 (0.1-2.1) (n=11) 1.04	4.1 (n=1) 0.8		
♀	(negligible to 5.5) (n=26)	(neg.-3.8) (n=12)	(0.2-1.4) (n=2)		
Und.			1.27 (0.3-4.1) (n=23)	(0.6-13.9) (n=24)	(2.9-15.2) (n=6)

Other Data

Vegetation. It was occularly apparent that the annual vegetation was not yet at its peak on 25 March; little was in bloom. However, most annuals peaked in April. Large decreases in biomass and cover and small decreases in frequency were evident between 5 April and 5 May (Table XV). For those species whose combined, relative importance value for both months was >10 , only Chorizanth brevicornu, in the rolling hills, and Eriogonum spp., on the flats, increased in frequency, biomass and cover from April to May. Although the cover of Chaenactis spp. increased from April to May on the flats, the biomass and frequency changed little. Chorizanth brevicornu, Eriogonum maculatum, Cryptantha angustifolia and Plantago insularis, along with several minor (in importance value) species (Eriogonum deflexum, Chorizanth

ble XV. April (1-5) and May (1-5) compared on of absolute values for cover, biomass and frequency for transects on the flats (Transect ID) and in the rolling hills (Tr.I).

Transect I						
Species	Cover (#/ha)		Biomass (g/m ²)		Frequency	
	April	May	April	May	April	May
<u>Pectocarya</u> spp.	58800	2400	280	10	1.00	0.54
<u>Lotus</u> spp.	7480	2500	16	9	0.77	0.77
<u>Chorizanthe brevicornu</u>	100	3900	1	10	0.077	0.31
<u>Plantago insularis</u>	5125	1650	7	1	0.85	0.54
<u>Cryptantha</u> spp.	2300	1700	7	8	0.54	0.23
All species in transect, combined	81455	13500	351	45	5.6	3.2
Importance Value						
	April	May	April	May	April	May
	56.6	18.7	56.6	18.7	75.3	29.9
	9.2	20.7	9.2	20.7	20.5	19.4
	0.6	19.9	0.6	19.9	17.8	200.0
	8.1	10.3	8.1	10.3	100.0	100.0
	4.8	13.0	4.8	13.0	200.0	200.0
	100.0	100.0	100.0	100.0	200.0	200.0
Transect II						
<u>Cryptantha</u> spp.	29800	13380	47	85	1.23	1.3
<u>Pectocarya</u> spp.	45800	3900	156*	9	1.0	0.62
<u>Eriogonum</u> spp.	2200	15800	5	35	0.54	0.92
<u>Chaenactis</u> spp.	5400	9000	8	7	0.69	0.77
All species in transect, combined	103600	52580	324	166	6.14	5.7
	21.1	33.1	21.1	33.1	54.2	44.1
	36.2	7.9	36.2	7.9	26.5	18.7
	4.1	22.4	4.1	22.4	100.0	100.0
	6.3	12.4	6.3	12.4	200.0	200.0
	100.0	100.0	100.0	100.0	200.0	200.0

*Due to researcher's error, biomass was overlooked. Biomass recorded is estimated from a comparison of cover to the cover and biomass for Pectocarya spp. in Transect I.

rigida, Nemacladus rubescens) were in full flower and foliage in early May. By this time, Pectocarya spp. had dried. The only green annuals in late May and early June were occasional Lotus spp. and Cryptantha spp. (both of which were drying) Chaenactis carphoclina, Eriogonum deflexum and E. maculatum. Lotus spp. did not decrease in cover or frequency between the April and May samplings, but plants were beginning to dry in May, as reflected by decreased biomass. On the flats, cover increased slightly (Appendix XIII), probably due to the small sampling length (50 m) covered in each sampling period and the possible resultant small pockets of homogeneity. One fault with this sampling technique is that it extends over a very short length and even if it is transected through a homogeneous community, some heterogeneity occurs in the transect which influences the resultant importance of each species. If the transect were longer, either with more sampling plots or by skipping every other 2X2 m plot (maintaining the same number of sampling points but extending the transect line), then the expression of homogeneity from the transect would be greater.

Pectocarya spp. and Cryptantha spp. are important annuals on the entire plot (Table XV). Diversity is evident between the rolling hills and the flats as Lotus spp. and Plantago insularis are especially important in the former and Eriogonum spp. and Chaenactis spp. are more important on the flats. Although biomass and frequency vary little between the two areas, with the exception that biomass in the rolling hills

was much less than that on the flats in early May, cover is much greater on the flats.

Euphorbia polycarpa is the dominant perennial over the entire plot (Table XVI). However, in the shrub layer, Larrea tridentata and Ambrosia dumosa are dominant on the flats and Eriogonum fasciculatum and Ambrosia dumosa are dominant in the rolling hills. Only 9 species were present in the transect on the flats; however, 23 were transected in the rolling hills. Not only is diversity greatly increased in the latter area, but density and frequency are high relative to the flats. However, the volume of the shrubs on the flats is much greater, reflected by a far taller and thicker shrub layer there.

Most perennials bloomed between mid-April and early May, with the exception of Acacia Greggii, which was just beginning to leaf then, and Krameria spp. and Ferocactus acanthodes, all of which bloomed in early June.

Table XVI. Major perennial species in each transect.

Species		Density (#/ha)	Volume $\times 10^8$ (cm ³ /ha)	Frequency	Importance Value
Transect II	<u>Euphorbia polycarpa</u>	6150	0.0009	0.38	31.0
	<u>Larrea tridentata</u>	850	10.43	0.3	26.3
	<u>Ambrosia dumosa</u>	1800	2.755	0.46	21.7
	All species	9400	22.1	1.38	100.0
Transect I	<u>E. polycarpa</u>	12150	0.0193	0.64	20.0
	<u>Eriogonum fasciculatum</u>	4450	1.9095	0.60	18.0
	<u>A. dumosa</u>	2950	1.1024	0.64	13.4
	All species	28100	8.433	3.84	100.0

SUMMARY

One hundred and forty-two tortoises were captured. Density is estimated at 63 tortoises/km² (= 160 tortoises/mi²). It is suggested that censusing be more frequently performed on small, random areas of the plot rather than the entire plot for determining density by the Schnabel technique.

Fewer tortoises were found in the rolling hills and rock outcrops and an estimate of 31 tortoises/km² (= 80 tortoises/mi²) for these areas and 77 tortoises/km² (= 200 tortoises/mi²) for the flats is made. Reasons for the lack of tortoises in the rock outcrops include decreased burrowing and nesting potential, thermoregulatory disadvantages, decreased food availability and increased energy expenditures.

The size structure yields 45.8% Adults, 12.0% Subadults, 17.6% Immatures, 19.0% Juvenile II's, 2.8% Juvenile I's and 2.8% Hatchlings. Reproduction is high, reflected by a high percentage of tortoises under 135 mm MCL, indicating that carrying capacity has yet to be reached. The percentage of adults is not low and only 21.4% of the females and 10.9% of the males are old and possibly senile. The sex ratio of adults yields only 0.55 females : 1.0 male to 0.61 females : 1.0 male. High winter rainfall (which would be responsible for high spring primary production) 7, 2 and 1 years ago and high summer rainfall (which would provide high production of winter annuals and allow for heavy fat deposition prior to

hibernation) 2.5 and 4.5 years ago may have been influential in the population increase. There was, however, high reproduction 7 to 10 years ago, when rainfall was low. It is possible that this discrepancy is attributable to the difficulty of assigning carapace length to a specific age.

Seventeen skeletal remains, representing one tortoise each, plus thirty-one small groups of isolated fragments were found. Highest recovery was in adults, 52.9%. Mortality is estimated at 3.4 tortoises/year ($=2.1\%/year$). Small sample sizes precluded forming conclusions regarding differential sexual mortality.

Females were observed to have a prominent pygal tip, while that of males was pointed straight down or tucked under.

Greatest growth was by a 53.5mm MCL tortoise, $0.38\%/day$ in length and $1.84\%/day$ in weight. The growth rate in length was $0.033\%/day$ greater for adult males than for adult females. However, there was no sexual difference in weight gain, possibly because the weight gain accompanying length gain in males equalled the weight gain accompanying developing follicles in females. This hypothesis may be borne out by the observation that there was no length growth rate difference between subadult males and females but subadult females gained $0.13\%/day$ more in weight than subadult males. No intraseason variation in growth rate was observed. New growth was first observed in April but slacked off in June.

For young tortoises, it was determined that one ring approximately equals one year of age.

Tortoise activity coincided with ground temperatures of ca 20 to 43°C, although tortoises were observed in retreat at temperatures >35°C and <29°C. Tortoises began activity at ca 1030 h in March, becoming active increasingly earlier with warming weather, as early as 0545 in June. Midday retreats occurred in April (1100 to 1500 h), May (1200 to 1500 h) and June (1000 to 1600 h). Activity ceased by 1500 h in March, 1700 h in April, 1730 h in May and 1800 h in June. Tortoises were equally active in the morning as in the late afternoon. Activity was greatest in April and May.

Burrows seemed to have been preferred retreat sites during midday as the season progressed and during the evening. However, 81% of 16 epigeal retreats (the time of day of use was not determined) were found in April and May. Burrow lengths remained relatively constant throughout the season, 0.38 to 0.64 m.

Most burrows were constructed under shrubs, probably due to the visual obscurity provided there as well as the possibility of looser soil. The predominant cover species was Larrea tridentata (over 56.5% of 62 burrows), probably due to its large volume, as its relative density was less than that for Ambrosia dumosa, which was the second greatest cover species (over 29% of the burrows). Burrow location did not change from month to month. Northerly-, southerly- and westerly-facing apertures were most common.

Tortoises occupied several burrows apiece; up to three burrow changes per tortoise were observed.

One hatchling was observed for 1.5 hours. It remained primarily in the shade, possibly for maintenance of optimum metabolic rate.

The greatest SLD was moved by an adult male, 1000 m in 18 days. The mean SLD for adults was 275 m, with wide variation.

Lotus spp., primarily Lotus tomentellus, was the most preferred forage species (possibly due to its succulence) although it had only the fourth greatest importance value for the entire plot. Green plants were preferred forage over dried ones. Geophagy was observed in three tortoises.

Copulation was observed on 6, 14 and 25 April by males 257.5 to 269.5 mm MCL and females 222.5 to 235 mm MCL. All males were young adults and females were past their prime; one female was old.

Small tortoises were more active during handling, voided more often than and voided larger percentages of their body weight than large tortoises. Females voided more often and a larger percentage of their body weight than males. Urine viscosity and precipitates increased during June.

Peak blooming and foliage occurred in mid-April. By early May, most perennials were through blooming and many annuals were drying. The biomass and cover of annuals decreased extensively from early April to early May. Perennial's diversity is much greater in the hills than on the flats. In the shrub layer, Larrea tridentata is the most important species on the flats

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and Eriogonum fasciculatum the most important species in the rolling hills; Ambrosia dumosa is second to both in importance value. Pectocarya spp. and Cryptantha spp. have the greatest importance value for the entire plot. However, Lotus spp. and Plantago insularis are important in the rolling hills and Eriogonum spp. and Chaenactis spp. are important on the flats. A suggestion is made that the transect be lengthened to accomodate pockets of heterogeneity.

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Appendices I-V.

I. Locations of live tortoises.

II. Locations of skeletal remains.

III. Locations of predator sign.

IV. Vegetation.

V. Geomorphology.

100 m

Interval is 20'.

Boundaries are heavy lines.

Appendix II. Locations of skeletal remains.

75.

— = 100 m

u r interval is 20'. 36

ot boundaries are h g y lines.

S28

S27

- = Coyote burrow
- = Kit fox burrow
- = Burrowing Owl burrow
- = Fresh burrow
- X = Predator sighted
- ⋯ = Predator excavations

S27

- = Larrea-Ambrosia-Yucca schidigera community
- = Very diverse upper story (Eriogonum fasciculatum and Ambrosia slightly dominant)
- o Contour lines are heavy lines.

- = Fouquieria, Salazaria, Acacia
Lycium, Cassia
- = Predominantly Encelia farinosa
- = Physalis, Baccharis, Nicotiana
Hofmeisteria, Haplopappus Gooddingii

S28

S27

C

C

C

Appendix V. Geomorphology.

--- = Watercourse

▨ = Major Wash

— = 100 m

Contour interval is 20'.

Plot boundaries are heavy lines.

S28

75.

S27

Appendix VI. Standard form for
recording live tortoise data.

A. Kar!
Spring '86

Gopherus agassizi

Site land V
Co. San Bdo.
AKS 27T7N R 20E
Elev. 2120'

No. 08
Sex ♀
Date 3/26
Time (PST) 1103

(shaded) Ta 14.6 (1m); 15.4 (1cm); T_{gs} 21.6 °C
wind/cloud cover N 13 mph / 4 gray

Behavior Poss. walking (facing ESE, ca 12 m
E of bussey). Dog may have scared it into
"hiding" 1st. Was shut down when I found it.
Location 0.75, 1.6 W

≥ 20 rings.

MCL 202.5 mm
M3(post) 132.5
M4(mid) 144
7-8(seam) 149.5
Gr W @ 158.5 6 post 6
Ht (mid central-3) 99.5
Pl N 129.5
Pl T 199
Wt(g) 1650

minus +35, -29 g
adjusted 1656

Photo: Car. 9
close-up 10 (Lc3+4)
other

Gular cond. Good, mod deep notes.
Shell wear over

Injuries 2nd pt. fore foot

badly mangled rear foot. 3 outer toenails
Anom. over

Parasites N?
New growth NO
Voided ✓

During 1-Prior to diving weighing.
Amount 0.35 g 21-29 g
Color Amber-brown
Insol. NO
Finish @ 1137

Note site of epoxied
number. NO

8

Burau - Faces S. 25° slope Under &
 L-178 min completely shaded & hidden by 0.8m
 W-232 Amherstia. Next to 5m Laure clone
 H-102
 Sx-40

Scat at burrow exit. - length = 29mm. Also, appears to
 have ingested snake or lizard skin.

Shell wear - Nearly full hatching plate in C+54,
 V5, mags. 7 + post. No hatch.
 plate in V1, casts 2, mags 1 + 2
 Almost non-existent pygal notch.

Difficult to count rings
 ? - Outer ~~corner~~ post corner of left humeral
 is chipped off.

Anom. - Very richly-colored ~~encrusted~~, very
 dark in large areas around seams.

201ke oval w/ ant. portions of mags. 8
 indented

Prominent pygal tip

Centers of casts 1 + 4 are raised.

Forward seam on post. nodal seam.

Anal. tips a little upturned.

Post seam don't meet at midline.

Midline betw. anals is offset to rt.

Appendix VII. Desert Tortoise

Shell Data Card.

DESERT TORTOISE SHELL DATA CARD				DATE OF CARD 4.27.80		RECORDER A. Kail		CARD NUMBER 31	
DATE FOUND 4.14.80 4.27.80		COLLECTOR A. Kail		SHELL NUMBER 31		SEX ♀		MUSEUM —	
ELEVATION 2140'		GEOMORPHOLOGY Bajada		SOIL TEXTURE PARENT MAT'L coarse sandy sand		OTHER HABITAT USES —		VEGETATION Larrea, Ambrosia Yucca schottlandii	
TOPOGRAPHIC QUAD		NAME Step ladder mts				COUNTY S. Blvd.		STATE CA	
SCALE 15'	TOWNSHIP 7N	RANGE 20E	SECTION 27	SUBDIVISION 0.635 (SW 1/4) 187E		SITE NAME Unit V			
CONDITION OF SKELETON			ENTIRE		LEG BONES		COLOR OF BONE Mostly white but some in black-stained.		
AGE OF BONE: SOLID			BROKEN Very slight		PELVIC/PECTORAL GIRDLE		OTHER Mostly is in two. Ridden. Picture is of all pieces (except ribs) collected. Only 19. parts of plastron on right & where it is in place. At least this season's plastron around 1 place		
PEELING & CHIPPING			DISJOINING		HEAD				
CRUMBLING			DISJOINTED		VISCERA				
CONDITION OF SCUTES			NONE		POSSIBLE MORTALITY FACTORS				
NORMAL COLOR					UNKNOWN; NO MARKS				
ADHERED TIGHTLY TO BONE					PREDATOR, CHEW MARKS				
PLASTRON/CARAPACE SCUTES OFF			✓		BULLET HOLES				
SCUTES LOOSE & PEELING					VEHICLE				
SCUTE FADED, GROWTH RINGS PEELING			✓		OTHER				
TORTOISE REMAINS IN PREDATOR SCAT									
LIMB OR HEAD PRESENT ONLY									

MEASUREMENTS *	UNITS mm	H Und	MAX. P.L. 192.5+	MIN. P.L. 177*	C.L. Und	3-4 MW @ seam Und	7-8 MW @ seam Und	greatest W @ Und
P: PLASTRON	H: height	L: LENGTH	C: CARAPACE	M: MARGINAL	W: WIDTH			

KEY

- ☒ : pieces present, intact
☒ : pieces present, nonintact fragments (est. location)
☒ : predator chew marks
☐ : not present

SCUTES

BONES

* indicate measurement of bone-bone or scute-bone with *; estimate age class if no measurements are taken

Appendix VIII. Desert Tortoise Council
notching system.

#361

Appendix IX. Live tortoises,

Appendix 12: Live Forecaster

Spring 1980
Wood V, CA
T 770; 205; 8

Tortoises

Date	Tort No.	SEX	*MCL (mm)	PL N	PL T	Width M3 (post)	Ght. Width / 6	Weight (g)	Distinguishing Features
3/24	01	Und	106.5	91	104.5	72.5	84.5 / post 5	2469	Ant. & post. femoral seams don't meet at midline. Sharp post. curves near outside of ant abd seam. Oval shape w/ margs. 8' slightly placed. Height - 51mm
2/25	02	♀	201	182	189.5	138	169.5 / post 7	1520	2nd inner horn (under finger) of pl. forefoot is long & curved in same a 1st. 2nd deep w/ some sinking (starting) pygal tip prominent. Nuchal recessed. Ant. V3 seam w/ peaks anteriorly. Fem. & abd. seams don't quite meet at midline. Small lump of scute material on ant. anterior corner of ant. abd. Chipping on dorsal gular surface. Midline offset between hum. & post. abd. Ant. seam slightly offset (don't meet at midline). Chip to bone center of pl. 2nd w/ crack to ant. seam. Slightly colored. Crack from post. left gular seam into hum. from both ant. abd. seams into and scute and ant. post. scute into post. scute. Lump of scute between plates w/ depression into left plate (4th V3). Crack from Lm 4 into L.C.1. Ant. anal seams & all post. seams don't meet at midline. Richly colored.
3/25	05	Und	100	91	99	70	78 / mid 8	215	Height - 92 Gulars are very concave on ventral surface. Midline slightly offset at ant. pacts. Ant. seams don't quite meet at midline. Richly colored.
3/25	06	♂	188	188.5	184	128	146.5 / mid 8	86	Height - 48.5 Voided 25g. Gular very clipped, uneven, short, no notch. Ant. fem. depressed as if by clawing. Left anal clipped off at tip. Depressed in anterior & midline area of base from 14 - slightly deformed on rt. side. Ant. post. seams don't meet at midline. Very dark.
3/25	07	♀	213	186	203.5	142	165 / mid 8	93	Dark. Anal tips upturned. Chip to bone along midline of ant. abds. Post. midline bet abds. is deformed into left abd. Feet, abd. & anal seams don't meet at midline.
3/24	08	♀	202.5	179.5	199	132.5	158.5 / post 6	1656	Almost no flare Rt. forefoot is badly mangled. Pect. seams don't meet at midline. Ant. VI seam pacts nuchal. Oval tort. w/ indent. In ant. margs. 8. Anal tips slightly upturned. Richly covered. Centers of costs 104 & pygal tip prominent. Midline below anal is offset to rt.
3/26	09	♀	216	188	209	144	164 / post 8	2090	Ght. width is actually 165 G mid 6 towards center of scute but ght edge width is 162. Voided 60g. Gulars very inturbed. Extra lump of scute material at post. midline bet. pygal tip, vent. 124, cost 1 - 3, hum. from scute center. Richly colored. Anal & pacts midline are slightly offset. Chip to bone on ventral surface of gular.
3/27	10	♂	253.5	244	267	181.5	226 / mid 8	3770	Puncture near center of each hum. An elderly tort, some sinking on plastic & carap. V3 is "widened" towards rear in left, post. corner. Both gular slightly longer, both gulars nearly flat. "Indur" foamed on left forefoot is deformed. Med. well. Flared.
3/27	11	♂	260.5	240	261	178	211 / mid 8	3515	Post. prime w/ slight creep & plastic. Sinking (pleth. indicates that knee should be more sinking on carapio) & deep carap. seams. Deep crack from Lm 5/6 into abd. & from Rm 4 into post. Midline slightly wiggly post. abdo. and ant. femoral. Dark tort. Slight milled near ant. hums. on midline. Abds. post. hum. & ant. femoral "fo" has prominent. Puncture on midline below abds. & fems. V2/3 seam curves. Gulars curve left, nearly flat. Midline wiggly bet. abds. & fems. Long nuchal curve in nuchal - V1 seam.
3/28	12	♂	257.5	235.5	258	180.5	207 / mid 8	2840	Voided 20g. Ant. post. seam & post. abd. seams don't quite meet at midline. Anal tips upturned. Nuchal - VI seam has ant. curve. Prominent pygal. Dark.
3/28	13	♀	218	196	216	148.5	172 / mid post 8	2020	Chip to bone in periph. ventral surf. of tort anal. Rm 9 & 10 have wavy edges & Rm 10 has a "crack" (depressed line w/ healing) from edge. Ant. post. seams don't quite meet at midline. Nuchal slightly asym. Lm 1 joins it ant. to Rm 1. Also curved area at left post. edge of nuchal curves extending into V1. Dark. Post. scutes upturned, esp. rt.
3/28	3	♂							
3/28	14	♂	269.5	256	276	183.5	216 / mid 8	3890	Chip to bone in periph. ventral surf. of tort anal. Rm 9 & 10 have wavy edges & Rm 10 has a "crack" (depressed line w/ healing) from edge. Ant. post. seams don't quite meet at midline. Nuchal slightly asym. Lm 1 joins it ant. to Rm 1. Also curved area at left post. edge of nuchal curves extending into V1. Dark. Post. scutes upturned, esp. rt.
3/28	3	♂							
3/29	15	Und	96	90	96	68	77 / post 5	455	Voided 59g. Deep pred. Chowing in cost 1-2, Lm 5 (scute broken & deformed into tort). & 6n pleth. to bone in post. interior line bet. & ant. L. abd. Richly colored. Ant. seams don't quite meet at midline, esp. ant.
3/29	16	♂	244	229	248	173.5	198 / mid post 8	229	Voided 40g. On most carapace seams where is deep chipping, often to bone. Lacks diagnosed not injured. Midline and ant. post. seams very wiggly. Gulars curve rt. & are a little short for a ♂. Post. carap. tucked under. Nuchal is there w/ plate in seam w/ V1. Slight curve rt. of center on V2/3 seam. margs. 1 narrow.
3/31	17	♀	212	204	225	95.1	174 / post 7	94	Voided 115g. No seams meet at midline on pl. 2nd. No nuchal & hts may 1, 2, 3, 4, 5. Tort is small & deformed. Anal tips very upturned, pygal tip prominent. Left anal foot - 2nd shell nail. Anal is extra leg curved. Left forefoot flattened and deformed. Post prime. Quite normal on periphery & in seam area to dark on pl. 2nd.

300g Pasale state. Unless otherwise stated weight is measured 1 g.c. Chit. Lion Sign. 00 15

Spring 1980
Grand V, CA
I 7 N, R 20 E

To ses

Date	Tank No.	Sex	MCL	PL N	PL T	Width M3 (post)	Gst. width / 6	Ht.	Wt.	Distinguishing Features
3/30	18	♂	263	244	264	180	214 / mid post 18	104	3370	No seams meet at midline on plastron. Narrow front w/ some flaring in post. Some on V2/3 seam to 4/5 - narrow. Old foot but not ancient. Pygal tip well under. V2/3 seam in rt. corner is slightly anterior to appropriate position. In periphery of ant. post. seams.
3/30	19	♂	248	234	257	172	203 / mid post 18	101	2850	Voided 4/4 midline betw. fems + left ant. post. seam are missing. Left ant. post. inside is deformed, nub-like. Abd. spect. seam don't meet at midline. Pygal tucked under. Scute tentacle prom. Good post. + ant. flaring w/ upturning. Nuchal deformed - at 2 miss post. prime.
3/30	20	Und.	70.5	63	68	49	56 / post 18	32.5	66	Voided 3/3. Post. seams don't meet at plate. Curve in midline in post. abds. Very pale w/ only slightly dark seam areas. Pygal notch assign. midline - off betw. abds. (V2/3 do not meet fems, midline). Dark brown seam area on carapace. Slight post. plate.
3/31	21	Und.	75	66.5	72.5	52	59 / mags 4, 7, 8	36	90	Voided 4/5 prior to winging. 2 after. Foot in post. hole midline into 2 hum. Raising a nuchal in left hum. ab. Nub. fems don't meet at midline. On either side of nuchal (which is small) is a protruding narrow scute. Slightly flared.
3/31	22	♂	279	241	263	188	216 / post 18	121	3880	Pronounced "bold lines" on plastron. Gack from midline into each abd. Very prom. scute centers on carapace. V2/3 pygal is very included on seam area. Post. inf. pygal tip prom. Good post. flaring w/ hint of upturning. Tort. is in prime or just past prime.
4/1	30	Hatch	52.5	48	49	39	44.5 / post 6	24	32	Voided 3/3. Post. post. seams don't meet at midline. Picked-looking nuchal.
4/1	23	♀	174	156	175	115	134 / post 18	79.8	1090	Voided 2/3. Abds. tips slightly upturned. Early abds. Very narrow & slightly upturned nuchal. Seams meet at midline. Ant. rt. post. seam has curve in periphery.
4/1	24	♂	163	151	164.5	114	128.5 / mid post 18	79	950	wt. is after vnt. vnt. 18. Tort. they voided 2/5. Rt. anal short. Lm 7. Rm 7. Rm 9. Rm 11. Rm 12. Rm 13. Rm 14. Rm 15. Rm 16. Rm 17. Rm 18. Rm 19. Rm 20. Rm 21. Rm 22. Rm 23. Rm 24. Rm 25. Rm 26. Rm 27. Rm 28. Rm 29. Rm 30. Rm 31. Rm 32. Rm 33. Rm 34. Rm 35. Rm 36. Rm 37. Rm 38. Rm 39. Rm 40. Rm 41. Rm 42. Rm 43. Rm 44. Rm 45. Rm 46. Rm 47. Rm 48. Rm 49. Rm 50. Rm 51. Rm 52. Rm 53. Rm 54. Rm 55. Rm 56. Rm 57. Rm 58. Rm 59. Rm 60. Rm 61. Rm 62. Rm 63. Rm 64. Rm 65. Rm 66. Rm 67. Rm 68. Rm 69. Rm 70. Rm 71. Rm 72. Rm 73. Rm 74. Rm 75. Rm 76. Rm 77. Rm 78. Rm 79. Rm 80. Rm 81. Rm 82. Rm 83. Rm 84. Rm 85. Rm 86. Rm 87. Rm 88. Rm 89. Rm 90. Rm 91. Rm 92. Rm 93. Rm 94. Rm 95. Rm 96. Rm 97. Rm 98. Rm 99. Rm 100. Rm 101. Rm 102. Rm 103. Rm 104. Rm 105. Rm 106. Rm 107. Rm 108. Rm 109. Rm 110. Rm 111. Rm 112. Rm 113. Rm 114. Rm 115. Rm 116. Rm 117. Rm 118. Rm 119. Rm 120. Rm 121. Rm 122. Rm 123. Rm 124. Rm 125. Rm 126. Rm 127. Rm 128. Rm 129. Rm 130. Rm 131. Rm 132. Rm 133. Rm 134. Rm 135. Rm 136. Rm 137. Rm 138. Rm 139. Rm 140. Rm 141. Rm 142. Rm 143. Rm 144. Rm 145. Rm 146. Rm 147. Rm 148. Rm 149. Rm 150. Rm 151. Rm 152. Rm 153. Rm 154. Rm 155. Rm 156. Rm 157. Rm 158. Rm 159. Rm 160. Rm 161. Rm 162. Rm 163. Rm 164. Rm 165. Rm 166. Rm 167. Rm 168. Rm 169. Rm 170. Rm 171. Rm 172. Rm 173. Rm 174. Rm 175. Rm 176. Rm 177. Rm 178. Rm 179. Rm 180. Rm 181. Rm 182. Rm 183. Rm 184. Rm 185. Rm 186. Rm 187. Rm 188. Rm 189. Rm 190. Rm 191. Rm 192. Rm 193. Rm 194. Rm 195. Rm 196. Rm 197. Rm 198. Rm 199. Rm 200. Rm 201. Rm 202. Rm 203. Rm 204. Rm 205. Rm 206. Rm 207. Rm 208. Rm 209. Rm 210. Rm 211. Rm 212. Rm 213. Rm 214. Rm 215. Rm 216. Rm 217. Rm 218. Rm 219. Rm 220. Rm 221. Rm 222. Rm 223. Rm 224. Rm 225. Rm 226. Rm 227. Rm 228. Rm 229. Rm 230. Rm 231. Rm 232. Rm 233. Rm 234. Rm 235. Rm 236. Rm 237. Rm 238. Rm 239. Rm 240. Rm 241. Rm 242. Rm 243. Rm 244. Rm 245. Rm 246. Rm 247. Rm 248. Rm 249. Rm 250. Rm 251. Rm 252. Rm 253. Rm 254. Rm 255. Rm 256. Rm 257. Rm 258. Rm 259. Rm 260. Rm 261. Rm 262. Rm 263. Rm 264. Rm 265. Rm 266. Rm 267. Rm 268. Rm 269. Rm 270. Rm 271. Rm 272. Rm 273. Rm 274. Rm 275. Rm 276. Rm 277. Rm 278. Rm 279. Rm 280. Rm 281. Rm 282. Rm 283. Rm 284. Rm 285. Rm 286. Rm 287. Rm 288. Rm 289. Rm 290. Rm 291. Rm 292. Rm 293. Rm 294. Rm 295. Rm 296. Rm 297. Rm 298. Rm 299. Rm 300. Rm 301. Rm 302. Rm 303. Rm 304. Rm 305. Rm 306. Rm 307. Rm 308. Rm 309. Rm 310. Rm 311. Rm 312. Rm 313. Rm 314. Rm 315. Rm 316. Rm 317. Rm 318. Rm 319. Rm 320. Rm 321. Rm 322. Rm 323. Rm 324. Rm 325. Rm 326. Rm 327. Rm 328. Rm 329. Rm 330. Rm 331. Rm 332. Rm 333. Rm 334. Rm 335. Rm 336. Rm 337. Rm 338. Rm 339. Rm 340. Rm 341. Rm 342. Rm 343. Rm 344. Rm 345. Rm 346. Rm 347. Rm 348. Rm 349. Rm 350. Rm 351. Rm 352. Rm 353. Rm 354. Rm 355. Rm 356. Rm 357. Rm 358. Rm 359. Rm 360. Rm 361. Rm 362. Rm 363. Rm 364. Rm 365. Rm 366. Rm 367. Rm 368. Rm 369. Rm 370. Rm 371. Rm 372. Rm 373. Rm 374. Rm 375. Rm 376. Rm 377. Rm 378. Rm 379. Rm 380. Rm 381. Rm 382. Rm 383. Rm 384. Rm 385. Rm 386. Rm 387. Rm 388. Rm 389. Rm 390. Rm 391. Rm 392. Rm 393. Rm 394. Rm 395. Rm 396. Rm 397. Rm 398. Rm 399. Rm 400. Rm 401. Rm 402. Rm 403. Rm 404. Rm 405. Rm 406. Rm 407. Rm 408. Rm 409. Rm 410. Rm 411. Rm 412. Rm 413. Rm 414. Rm 415. Rm 416. Rm 417. Rm 418. Rm 419. Rm 420. Rm 421. Rm 422. Rm 423. Rm 424. Rm 425. Rm 426. Rm 427. Rm 428. Rm 429. Rm 430. Rm 431. Rm 432. Rm 433. Rm 434. Rm 435. Rm 436. Rm 437. Rm 438. Rm 439. Rm 440. Rm 441. Rm 442. Rm 443. Rm 444. Rm 445. Rm 446. Rm 447. Rm 448. Rm 449. Rm 450. Rm 451. Rm 452. Rm 453. Rm 454. Rm 455. Rm 456. Rm 457. Rm 458. Rm 459. Rm 460. Rm 461. Rm 462. Rm 463. Rm 464. Rm 465. Rm 466. Rm 467. Rm 468. Rm 469. Rm 470. Rm 471. Rm 472. Rm 473. Rm 474. Rm 475. Rm 476. Rm 477. Rm 478. Rm 479. Rm 480. Rm 481. Rm 482. Rm 483. Rm 484. Rm 485. Rm 486. Rm 487. Rm 488. Rm 489. Rm 490. Rm 491. Rm 492. Rm 493. Rm 494. Rm 495. Rm 496. Rm 497. Rm 498. Rm 499. Rm 500. Rm 501. Rm 502. Rm 503. Rm 504. Rm 505. Rm 506. Rm 507. Rm 508. Rm 509. Rm 510. Rm 511. Rm 512. Rm 513. Rm 514. Rm 515. Rm 516. Rm 517. Rm 518. Rm 519. Rm 520. Rm 521. Rm 522. Rm 523. Rm 524. Rm 525. Rm 526. Rm 527. Rm 528. Rm 529. Rm 530. Rm 531. Rm 532. Rm 533. Rm 534. Rm 535. Rm 536. Rm 537. Rm 538. Rm 539. Rm 540. Rm 541. Rm 542. Rm 543. Rm 544. Rm 545. Rm 546. Rm 547. Rm 548. Rm 549. Rm 550. Rm 551. Rm 552. Rm 553. Rm 554. Rm 555. Rm 556. Rm 557. Rm 558. Rm 559. Rm 560. Rm 561. Rm 562. Rm 563. Rm 564. Rm 565. Rm 566. Rm 567. Rm 568. Rm 569. Rm 570. Rm 571. Rm 572. Rm 573. Rm 574. Rm 575. Rm 576. Rm 577. Rm 578. Rm 579. Rm 580. Rm 581. Rm 582. Rm 583. Rm 584. Rm 585. Rm 586. Rm 587. Rm 588. Rm 589. Rm 590. Rm 591. Rm 592. Rm 593. Rm 594. Rm 595. Rm 596. Rm 597. Rm 598. Rm 599. Rm 600. Rm 601. Rm 602. Rm 603. Rm 604. Rm 605. Rm 606. Rm 607. Rm 608. Rm 609. Rm 610. Rm 611. Rm 612. Rm 613. Rm 614. Rm 615. Rm 616. Rm 617. Rm 618. Rm 619. Rm 620. Rm 621. Rm 622. Rm 623. Rm 624. Rm 625. Rm 626. Rm 627. Rm 628. Rm 629. Rm 630. Rm 631. Rm 632. Rm 633. Rm 634. Rm 635. Rm 636. Rm 637. Rm 638. Rm 639. Rm 640. Rm 641. Rm 642. Rm 643. Rm 644. Rm 645. Rm 646. Rm 647. Rm 648. Rm 649. Rm 650. Rm 651. Rm 652. Rm 653. Rm 654. Rm 655. Rm 656. Rm 657. Rm 658. Rm 659. Rm 660. Rm 661. Rm 662. Rm 663. Rm 664. Rm 665. Rm 666. Rm 667. Rm 668. Rm 669. Rm 670. Rm 671. Rm 672. Rm 673. Rm 674. Rm 675. Rm 676. Rm 677. Rm 678. Rm 679. Rm 680. Rm 681. Rm 682. Rm 683. Rm 684. Rm 685. Rm 686. Rm 687. Rm 688. Rm 689. Rm 690. Rm 691. Rm 692. Rm 693. Rm 694. Rm 695. Rm 696. Rm 697. Rm 698. Rm 699. Rm 700. Rm 701. Rm 702. Rm 703. Rm 704. Rm 705. Rm 706. Rm 707. Rm 708. Rm 709. Rm 710. Rm 711. Rm 712. Rm 713. Rm 714. Rm 715. Rm 716. Rm 717. Rm 718. Rm 719. Rm 720. Rm 721. Rm 722. Rm 723. Rm 724. Rm 725. Rm 726. Rm 727. Rm 728. Rm 729. Rm 730. Rm 731. Rm 732. Rm 733. Rm 734. Rm 735. Rm 736. Rm 737. Rm 738. Rm 739. Rm 740. Rm 741. Rm 742. Rm 743. Rm 744. Rm 745. Rm 746. Rm 747. Rm 748. Rm 749. Rm 750. Rm 751. Rm 752. Rm 753. 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Rm 1003. Rm 1004. Rm 1005. Rm 1006. Rm 1007. Rm 1008. Rm 1009. Rm 1010. Rm 1011. Rm 1012. Rm 1013. Rm 1014. Rm 1015. Rm 1016. Rm 1017. Rm 1018. Rm 1019. Rm 1020. Rm 1021. Rm 1022. Rm 1023. Rm 1024. Rm 1025. Rm 1026. Rm 1027. Rm 1028. Rm 1029. Rm 1030. Rm 1031. Rm 1032. Rm 1033. Rm 1034. Rm 1035. Rm 1036. Rm 1037. Rm 1038. Rm 1039. Rm 1040. Rm 1041. Rm 1042. Rm 1043. Rm 1044. Rm 1045. Rm 1046. Rm 1047. Rm 1048. Rm 1049. Rm 1050. Rm 1051. Rm 1052. Rm 1053. Rm 1054. Rm 1055. Rm 1056. Rm 1057. Rm 1058. Rm 1059. Rm 1060. Rm 1061. Rm 1062. Rm 1063. Rm 1064. Rm 1065. Rm 1066. Rm 1067. Rm 1068. Rm 1069. Rm 1070. Rm 1071. Rm 1072. Rm 1073. Rm 1074. Rm 1075. Rm 1076. Rm 1077. Rm 1078. Rm 1079. Rm 1080. Rm 1081. Rm 1082. Rm 1083. Rm 1084. Rm 1085. Rm 1086. Rm 1087. Rm 1088. Rm 1089. Rm 1090. Rm 1091. Rm 1092. Rm 1093. Rm 1094. Rm 1095. Rm 1096. Rm 1097. Rm 1098. Rm 1099. Rm 1100. Rm 1101. Rm 1102. Rm 1103. Rm 1104. Rm 1105. Rm 1106. Rm 1107. Rm 1108. Rm 1109. Rm 1110. Rm 1111. Rm 1112. Rm 1113. 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Site	Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width M3 (mm)	MAX. WIDTH	Height mm	Weight (g)	Distinguishing Features
4/5	36	♂	270	245.5	263.5	184.5	212 / mid 8	104	3600	Mid. old test. Left gular tip bent back. Nochel is fused to Rm1 along edge. Longish narrow point. Most good post. Flaring. Lm10 & wings 11 upturned. Left ant. post seem to stop close in. Nochel. Post. seems almost neck meet.
5	37	♀	221	197	222.5	145.5	174.5 / post 8	103	2175	Voided 21.5. Rpt. gulars clipped up. Post. Nochel. Seams don't meet at midline. V2/3 & V3/4 seams curve forward. Nochel tips very upturned. Richly curved. Nochel. Mid. well defined from base. Most neck. Seams prominent.
1/6	38	♂	265	233	259.5	177.5	194 / post 8	107	3120	Dark seam areas w/ slight mottling across midline in ant. hums. & post. abds. & Plastron "foldlines" prom. esp. ant. post. Only slightly flared. Deep chipping to base in many spots, in Lm10, 11, ppg8, VS, Rm 9, 10, 11. Pygal tip tucked under.
4/6	39	♀	237	218	238	157	186 / mid-post. 8	102	2460	Post. post. seams don't meet at midline. Slightly flared. Old tort. Pygal tip prom.
4/6	40	♂	236	218	246	181	212 / post 7	113	3570	Wt. is after mid of 2-5 sub. Voided a 2nd time 6 mls. Ant. post. "foldline" from wings. 11, esp. left, are narrow; also wings to curve in midline betw. fems. Post. seam. Don't meet at midline. Pygal tip very tucked under. Well flared.
4/6	41	Und	100	90	96	69.5	78 / post 8	49	221	(1983) Voided 29. Extra narrow wing. Next to Pygal. Abd. seams don't meet at midline. Richly colored. Mod. well flared.
4/7	42	Und	76	70	74	53	60.5 / post 5	33	86	(1983) Richly colored. Oval w/ mod. good post. Flaring. V3/4/5 seams slightly lopsided
4/7	43	♂	248	219	248	171	202 / mid 8	105	3420	Voided 46.9. On rt. forefoot outer 2 nails fused. Pygal tip tucked under but w/ only mod. prom. Only anal seams meet at midline. Left ant. post. seem curves forward in pariplegy well flared. V3/4 has curve in center of seam. Gulars tucked out.
4/7	44	♂	224	212	230	151.5	176 / mid-post 8	97	2450	Voided 109. Abd. seams don't meet at midline. Richly colored. Anal. tip upturned. Ant. portion of wings 6 indented. V1/4, pygal tip prominent wings 10, 11, 2, 3 upturned. Mod. post. flaring.
4/7	45	♀	185	166.5	187.5	123	144 / mid-post 8	188	1430	Voided 20.9. 9 pairs tapering + 20 gfm. Poss. old gash on post. rt. corner at V1, V2 also deepened here as well. Richly colored. Oval w/ slight post. flaring & upturned wings 12. Plastron "foldline" well defined. Midline betw. post. is offset. Ant. abd. seams don't meet at midline.
7/8	46	Und	145	105	113	79	89.5 / mid 8	52	425	Voided 59. Post. seams don't meet at midline. Well flared post. Margo, 2 & 10 slightly upturned.
4/8	47	♀	222.5	208.5	227.5	145	183.5 / mid 8	96.5	2300	Voided 61.9. Anal & ant. post. don't meet at midline. Gulars curved by key slightly. Nochel very wide at base, well webbed. Margo, 1 & 10 upturned. Mottled carapace. Extant. post. flaring.
4/8	48	Und	106	95	103	70.5	83 / mid 6	51.5	420	Voided 49. Ant. post. seams don't meet at midline. Round tort. w/ good post. flaring. Very richly colored carapace w/ slight mottling.
1/8	49	♀	222	189.5	217	148.5	175 / post 7	102	2475	Voided 20.9. Pygal tip prominent. Very slight post. flaring. Post. post. seams don't meet at midline. Post. primo.
1/9	50	Und	93	83	90	61.5	72 / post 8	45	330	Voided 22.9. Richly colored. Well flared. V1/V2 seams curves forward. Post. post. seams don't meet at midline.
4/9	51	Und	111	101	110	78	88.5 / post 5	55	465	Voided 19.9. Ant. post. seams & ant. hums. don't meet at midline. Only 10 margo. Left side & Rm 11 very narrow.

Ward V.
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Date	Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width M3 (mm)	MAX. WIDTH / G	Height mm	Weight	Distinguishing Features
4/10	52	♂	268	254	279	167	214 / post. 8	111	3600	Nuchal turns right. V4/V5 prominent. Well rubbed. Left gular broken off. Chip to bone in LM9. Much peeling on carapace.
4/10	53	♀	211	195	215	133	169 / post. 8	93	1900	Voided 15g. V4/RC4 area raised. Left anal clipped at point. Well worn. Much peeling on plastron.
4/10	54	♀	187	171	191	125	141 / post. 5	84	1300	V1 + V3 raised. Ant. abd. seams don't meet at midline.
4/11	55	♂	180.5	166	188.5	121	138 / mid 5	85	1310	Voided 5 ml. Bone shows on LM11. Pect. seams don't meet at midline. V1 prominent. Rt. side of V3 is raised
4/11	56	Und	49.5	47	47	36	43 / mid 6	26	29	Voided 2g. Appeared skinny. 1 ring.
4/11	57	Und	53.5	50	50	39	44.5 / mid 6	27	34	Voided 1g. LCL + RCL depressed. 1 ring?
4/11	58	Und	55.5	49	49	40	47 / post 5	28.5	39	Voided 1 ml + scat. 1 ring.
4/12	59	♂	219.5	202	225	135	176 / post 8	95.5	2100	Voided ~5 ml. RM9 - chip to bone. Labeled - crack from midline. Ant. pect seams don't meet at midline. Nuchal, ptd. nuchal. Only 3 left as V5 extends to left. Mottled midline. Good condition.
4/12	60	♂	254	230	243	178	201 / post 7	97	3210	Voided 8 ml. Well worn. Midline betw. pects. extends into rt. pect. V3 seam wavy. RM9 - chip to bone. Mhgs 1 raised in post. pect.
4/12	61	♂	263	243	263	179	213.5 / mid 8	107	3350	Well worn; depressed in ant. plastron (Homs). Post. abd. seams don't meet at midline. LCL, RC2, V5, chips to bone. Pect. punctures from pect. RC2. V4 prominent.
4/13	62	♂	264	245	269	193	220 / mid 8	114	3770	V4/V5 raised. Raised in seam areas of V1, V2, V3 (but not sunk in scute centers; tort. has well-defined rings).
4/13	63	Und	94	84	90	68	75 / post 7	43.5	180	Voided 3g.
4/14	64	Und	72	64	67	52	61 / mid 6	35.5	89	Voided ~1 ml
4/14	65	♂	277	265	282	190	222 / mid 8	113.5	4300	Voided 19g. Well rubbed. Homs. depressed. V4 raised. Rt. abd. has old wound LM8/9 - clipped away in seams. Midline betw. pect. curves into R. pect. LCL is raised in upper portion.
4/14	66	♀	221	200	228	149	174 / mid 6	90	2040	Voided 15 ml. RM4 - chip to bone. V1 + V4 raised. Hairline crack in nuchal. Mottled carapace.
4/14	67	Und	80	72	78	55	65 / post 6	38.5	110g	Voided 3 ml. Pect. marks by small pect. on V2, plastron. Post. pect seams don't quite meet at midline.

ate	Tortoise #	Sex	MLL (mm)	PL H (mm)	PL T (mm)	Width M3 (mm)	MAX. WIDTH / G	Height mm	Weight (g)	Distinguishing Features
4/24	68	♂	206	184.5	203	136.5	155 / post 7	91	1630	V3/4 seam very wavy. Deep diagonal line from post left corner of V into V1. Very richly colored. Well-defined plastral parts. Hairs on V1 midline. Both humi + post. R. humi are wavy. Post. ped. + post. hum. seams meet. Pygal tip mod. prominent. Medial ant. plastral. Voids 15 ml. Only anal seams meet at midline. Left post tip is chipped off. Post prime w/ sinking along midline in plastron. Only 10 left margins. (No m. R. forefoot, 4/5 humi is reduced to blk; may be injury. Very well-flared. v. very prominent. R. mid. metted.
4/24	69	♂	242	243.5	262	174	214 / mid-post 8	107	3295	Voided 17 ml. Ant. post. seams don't meet at midline. Curve in midline at abd. area. Humi, 4/5 are combined at their top only. Richly colored. Oval. Pygal straight down. Post. hum seams curve up sharply in periphery.
4/25	70	♂	253	235	253	167	193 / post 6	113	3290	Dark post. Slightly mottled. Anal tips upturned. Only anal seams meet at midline. Flat carap. Prominent pygal.
4/25	71	♀	226	197	222	149	176 / mid-post 8	98.5	2100	Well-defined plastron folds. Concave in center of gularia on ventral surface. Curve in left side of V5/4 seam. Mod. wide anterior. Slight post. flaring.
4/25	72	Und	109.5	97	108	76	86 / post 5	54	300g	Very mottled plastr. Well-flared post. w/ slight upturning. Anal tips long. Post. + abd seams don't meet at midline. Medial 3 has (g.) single notch. Mod. wide anterior. Medial/V1 has curves.
4/25	73	Und	117	109	118.5	83	Und	Und	350g	Voided 2 g. Oval. On RCL is cracked chipped + deformed. L. post. ant. set has curved (posteriorly) in periph w/ deep chipping fur. Left forefoot has distinct nail plus a fused nail mass. Post. seems slightly off at midline.
4/25	74	Und	86	78	83	59	71 / mid 6	44	149	Voided 8 ml. No seams meet at midline. Anal tips upturned. Wide anterior. Dark carap. w/ slight mottling. Deep chipping in post. nuchal.
4/25	75	♀	223	207	224	144	172 / post 8	102	2060	
4/25	14	♂							3615	
4/25	47	♀							2155	Voided ~ 8 ml.
4/26	76	♀	184	159.5	177	121	141 / post 8	85	1310	Abd. seams don't meet at midline. Well-flared post. Pygal + tip slightly prominent. Dark carapace + richly colored plastron w/ some mottling. Anal tips upturned.
4/26	77	♂	286	272	285	197	225 / mid 8	120	4720	Post. post seams don't meet at midline. Curve in midline between femora. Mod.-well flared. Pygal is divided into 2 even scutes by vertical central. Getting old-seams deep, sunken, extensive peeling.
4/26	78	Und	100	92	98	67	78 / mid 6	48.5	215	(75) Voided ~ 8g prior to weighing. No abd. seams meet at midline. Rich colored. Oval w/ slight post. flaring. 7 rings.
4/26	79	Und	107.5	98	106	74.5	84.5 / post 8	52	288	(85) Voided ~ 3g prior to weighing. Post. post seams don't meet at midline. Richly colored. Lm 7 slightly narrow V2 is compressed in right, anterior corner.
4/27	80	♂	198.5	182	200	135	154 / post 6 + 7	94	1680	Ant. post + ant. fem. seams don't meet at midline. Richly-colored. True from midline in R humi, both fems. Anal tips upturned. V4 very prominent. Others slightly. Oval, almost no post. flaring.
4/27	81	♂	231	212	236	156	178 / mid-post 8	100	2320	Voided 25g. Pred. showing on R post, R abd, R fem, R m 4 + 5. Ant. post. in post. well-defined. Very richly colored w/ some plastral mottling. Ant. post. seams curve in periph. Long, narrow nuchal. Mod. flaring. Slightly prominent can except costs.
4/27	19	♂							3000	

Spring, 1980
Ward V.
TAN R 20

Tortoises

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Date	Tortoise #	Sex	MCL (mm)	PL M (mm)	PL T (mm)	Width M3 (mm)	max. width	Height (mm)	Weight (g)	Distinguishing Features
4/28	82	♀	176	155	169.5	120	135.5 / post 7	88	1180	Voided 16 ml. Chip to base on central surface of gular. Lm1, Lm4, Lm6, Lm7, Lm8. Deep incision in R abd in post. paraph. V2, Lm1, Lm2, Lm3 are cut & deformed. Richly-colored & mottled pleuron. Oval w/ no post. Chipping. Narrow ant. beam. Ant. post. seems don't meet at midline. Deep folds in ant. plates.
4/28	10	♂							3740	
4/29	35		207						1740	moderate new growth
4/29	83	♂	254	239	253	175	202.5 / mid 8	109.5	3510	Voided 33 ml. Tiny "v" notch in nuchal. Chip to base RC 3/4. "Deep" along midline area of humeri to post. abdo. Post. post. seems don't meet at midline. Curve in periph. of ant. post. seems. Dark eyes. Slight midline sinking line post. prima.
4/29	84	♀	200	182	203	130	156 / mid 6	96	1900	Voided 31 ml. Curve in center of V2/3. Post abd. seems don't meet at midline. Deep chipping, some to base on ventral surface of gular. On from post seem into R. abd. Oval (no post. flaps). 1/2 nuchal. Mottled carapace.
4/30	85	♂	237.5	245	242	164	186.5 / post 8	106	2760	Voided 47 g. On left forefoot, "index" nail is enlarged. Nuchal is long & narrow, right Lm1 has 19. nd. Chip in edge. Post hum. 6 post. abd. seems don't meet at midline. Several areas (left ant. C & ant. plates) where there is peeling w/ deep area chip to base in Rm1, Rm8, Lm1, Lm2. Nuchal curves rt., asym.
4/30	29								3180	
6/1			258						3500	
5/1	13								2120	Voided 22 ml.
5/1	86	Und	131.5	116	128	88.5	106	61	480	Voided ~5 ml. Rt. gular slightly wider than left. Left side of tort. is deformed Lm5/6, Labd. + L. post. area old deep cut. Richly colored. Ant. post. seems don't meet. Rm 5-6 pushed in along edge. Rm2 & Rm 10 pointed & narrow. Excessive peeling on carapace for blue wear. V4 prominent. Voided ~20 ml, then ~10 ml.
5/2	45								1410	
5/2	87	♂	255	235	256.5	173.5	205 / mid 8	105	3380	Voided ~20 ml. Midline wavy & no seams meet at midline. Left ant. a slightly blunt tip. Lm2 reduced in width. Mod. post. flaring w/ some upturning of rays 1, 2, 3 & 10. Nuchal slightly off center to left. Pygal/V5 is prominent. Tip is straight down. Post. prima.
5/2	88	♂	212	188	213.5	132	155 / post 6	99	1970	Voided 18 g. Post seems don't meet at midline. Curve in midline at post. hums. Nuchal/V4 V3/V4 V3/LC2 seems wavy. Pale pleth. (seam area, but not dk. brown). Very light eyes. Some midline mottling. Richly-colored carapace. V1 & pygal tip slightly prominent. Over/narrow ant. & slight pygal seam wavy. Left gular tip slightly chipped. Prominent pectoral "foldline". Left anal and femoral are much reduced & deformed. V3/4 seems don't meet at midline.
5/2	89	♂	188	169.5	195	134	153 / post 8	88	1450	
5/2	95	♂							4310	
5/2	16	♂							3135	(After 10 void). Voided 10-15 ml.
5/3	90	♀	195.5	175	193	126.5	155.5 / mid-post. 8	90	1470	Voided ~8 ml. Ant. post. seems don't meet at midline. Have curve in periphery. Richly-colored. Slight post. flaring. Pygal tip prominent.
5/3	91	♀	204	177	193	134	155 /			Rm 4/12 post area deformed, old-cut. Gular are chipped to base on ventral surface. Nuchal is chipped off on rt. side. Deep chipping on

Spring, 1980.
Ward, V.,
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Date	Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width M 3 (mm)	MAX. WIDTH / G	Height (mm)	Weight (g)	Distinguishing Features
5/3	92	♂	231	208.5	223.5	161	181 / mid 8	104	2460	Pygal tip tucked under. Midline wavy. L. fem / anal chipped away at seam + there is deep chipping in both. Deep chipping and punctures in R h. nuchal old-chipped off at rt. side. Left gular tip broken off a chip, no dorsal surface in seam. Richly colored carap. w/ some mottling.
5/3	93	♀	219	197	217	143	164 / mid-post 8	100	2020	Voided 40ml. Post. seams don't meet at midline. Line down center nuchal. V2 + V3 - centers prominent. Pygal tip mod. prom. Slight post. flaring.
5/3	94	Und	106	96	105	74.5	86.5 / post 5	49	(Pos) 250	Deep notch in nuchal. Post. anal seams don't meet at midline.
5/3	95	Und	92	85	91	64	72 / post 5	44	(Pos) 170	Richly colored. On rt. forefoot, the outer toenail is missing + next 2 are reduced.
5/3	96	♀	219	201	221.5	153	183 / mid-ant. 8	103	2440	Voided 24 ml. Nuchal is very short, chipped in post. Lmi chipped a edge; gular short, deeply chipped (esp. dorsal surface) along w/ ant hum. chipping. No seams meet at midline. Post prime. Mod. well-flared. Pygal tip prominent. Anals' tips upturned.
5/4	45								1860	Right eye has ylw. ring around pupil; left eye is very dark throughout.
5/4	97	Und	134.5	121.5	136	90.5	104.5 / post 7	62.5	500	Post. + abd. seams don't meet at midline. Mod. flared. Pygal tip prom. Richly colored carap. V3/4 seam wavy.
5/4	98	Und	128.5	115	127	89	99 / post 5	62	480	12-13 rings. Ant. ped. + post. abd. seams don't meet at midline. Nuchal V1 seam wavy. Ural but mod. well flared post. Deep chipping in 2e1, RC2
5/4	100	Und	50	46.5	49	38	44.5 / mid 6, post 5	27.5	33	Voided 5 ml prior to weighing. Ant. ped. seams don't quite meet at midline. Very soft. No ring going to get.
5/5	2	♀	2						1710	After voiding ~15 ml.
5/5	99	♀	235	206	230	151	181 / post 8	103.5	2460	Voided 22 ml. Anal, abd seams don't meet at midline. Midline curves. post hums. Rt. post seam ant. also curve in periphery. Chipping in R. Pygal tip prom. Well-flared post. Dark carap. Anals' tips slightly upturned.
5/5	101	Und	131.5	118	131	88	105.5 / post 8	63.5	500	Voided 89, incl. 2 stones. Only anal seams meet at midline. Crack from midline to puncture-type depression in L abd. V1/V2 s. is cracked as is V4/5. Very richly colored, esp. carap. Nuchal upturne mod. well post. flared.
5/5	102	Und	112	103	113	81	89 / post 7	55	330	Only 10 margs. on both sides. Costs. 4 also a little narrow, esp. 6e. Curves in periphery of ant. post. seams. Post. post. seams don't meet at midline. V1/nuchal is very wavy; cracks (longitudinal) in nuchal.
5/6	33								3010	
5/6	34								3700	
5/6	103	Und	90	82	—	60	67 / mid-post 8	43	(Pos) 245	Voided ~3 ml. Nuchal is wide + split vertically on left side. V1/2 of seams curve, latter is offset center to left. Richly colored carap. On but mod. well-flared.

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Ward V.
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Date	Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width M3 (mm)	MAX. WIDTH / G	Height mm	Weight	Distinguishing Features
5/6	104	Und	111	100.5	110.5	76	87.5 / post 6	53.5	320	V1/2 + v2/3 seams curve forward. Post abd. seams don't meet midline. Richly colored. Oblong-oval w/ almost no post. flaring.
5/6	105	♀	208	188	206	139	163 / mid-post 8	91.5	1800	Post. & abd. 850-post abd. seams don't meet at midline. Met. fold in ant. med. along abd. midline and post. left abds. seam. V1 prom. Pygal tip 1 mod. well-flared. Richly colored. V4/5 seam is slightly ant. of normal p. in ant. corner. Guler from seams in left post. left fem. rt. fem.
5/7	106	Und	118	107.5	118	80	90 / post 8	60	390	V-notch in pygal. V2/3 seam v3/4 curve, v4/5 (slightly) source cap is punctured in Lm 5/6, 7, R abd. 12CL is curved slightly & peeling r-12 is concave in anterior. Post. abd. seams don't meet at midline. Guler are concave along midline on ventral surface.
5/7	49								2390	
5/7	25	♀							2390	Voided ~35g.
5/8	107	♀	250	237	257	160.5	191 / mid 8	123	3590	Voided ~30g. Post. prime. Post. seams don't meet at midline. Ant. point ventrally. Nickel / V1 seam wavy. Ant. post. seams curve in pery. Curve in midline at post. hms. Prom. pygal tip. Oval but mod. well flared.
5/8	108	♂	249.5	236	256	175	204.5 / mid 8	106.5	3380	Voided 72 ml. Plastron "folds" very well defined. Richly colored tort. Post. seams don't quite meet at midline. Mod. well-flared. V5 pygal area v prom. w/ pygal tip tucked under. V4/5 area sunk. mod. lopsided to left w/ joining it ant. to Rem. Guler from midline into L abd. LCV-chip to bone. Post. seams don't quite meet at midline. Richly colored. mod. well flared. Bubbling under abd. scutes.
5/8	109	Und	97	87	92.5	65.5	73 / post 8	43	193	
5/8	45	♂							3530	11.1 ml ~10 ml
5/9	500	Und	55	52	54	42.5	48 / post 5	27.5	42	(Ps) Voided 2 ml. Skin to weighing. Skin inside shell around hind area is rich. Wide ant. Very richly colored carap. Sunk in abds along midline. V1/2 seam wavy. Abd. seams don't quite meet at midline.
5/9	501	♂	189	166.5	185	132	148.5 / post 8	90.5	1470	Voided 13 ml. Midline quite wavy & only anal seams meet. Left post. pery. scale "overlapping" abd. scute so seam not well defined. Anal pointed, asp. left & small. Richly colored v3/4 seam has curve in center. LCV is slightly concave into LCV3. Nearly straight-sided but w/ mod. good post. flaring.
5/9	502	Und	121.5	114	125	86	94 / post 8	61	450	Voided 5-10g prior to weighing & 3 g after. Abd. & post. seams don't meet at midline. Smoothed in ant. hump. Pygal tip prom. Richly colored. Oval but well flared. Scute centers of abds. prominent & Ant. plake on mos carapace scutes is subtle.
5/9	120	Und	60	55	57	46	52.5 / post 5	29.5	51	(Ps) Voided 2 ml. Ant. abd. seams don't meet. Uniq. richly colored. Ant. is very wide & rest is oval w/ slight post. flare. No rings but nearly completed ring #1
5/9	110	♂	240	228.5	250	170	204 / mid-post 8	111	3280	Voided 5-10 g. Midline quite wavy and only ant. post. seams meet. Nothing in cap. scute centers. Narrow anterior; but post. w/ good post. flare. Pygal tip tucked under. V1 prom. A little too rubbed to count. V1/2 seam curves. Left anal tip chipped off.
5/10	111	Und	106	96	105	72.5	80.5 / mid & mid 6	50	249	(Ps) Voided 3-4 g. Abd. seams don't meet at midline. Concave on vent. surface of gulers in midline area. Richly colored. Dark longitudinal down center of dorsal surface of left guler. V5 is indented in ant. portion.
5/10	112	Und	141	134.5	142	96	106.5 / mid 8	66.5	640	Voided 8 ml. Ant. post. & post. abd. seams don't meet at midline. Left post. seam is not well defined, post. scute "overlaps" abd. V1/2 seam is in ant. corner. Gulers are very narrow at tip, square tips, no notch.

Spring 1980

Ward V, C.

TAN R208

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Date	Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	width M3 (mm)	max. width	G	Height mm	weight (g)	Distinguishing Features
5/10	113	Und	46	63	65.5	47	57	post 5	33	(P) 81	Voided 2-3 ml prior to weighing; ~3 ml after. Ventral ridge very prom. in V1. Middle area in post. abd. is irregularly concave (wrinkled). Ant. feet. post. 12m seems slightly off at midline. Dark plast. seams + carapace seam areas.
5/10	54	♀	204.5							1530	Voided 14 ml. Mod. extensive new growth.
6/11										1740	Very extensive new growth.
5/10	11	♂								3900	Voided ~30g.
5/3										3940	
6/1	114	♂	221	193	216	142	165	post 8	99	2125	Voided ~4 ml. Ant. abd. from + post. "belts" are well-defined. Very dark w/ mottled scute centers. Snout post. flaring. Ant. of v5 is indented. Pygal is prominent but tip is tucked under. V4 center is prominent.
6/1	115	♂	256	240	260.5	179.5	208	mid 8	107.5	3840	wt is after 1st void of ~15 ml. Then voided + detected 32g. Old tort. Very mottled carapace. On left forefoot 2nd + 3rd nails from outside are short + bld. w/ pygal prom. w/ pygal tip tucked under. Very clipped along ant. 1/2 of midl. belt. Seams don't meet at midline.
6/2	116	♂	221	195	215.5	152.5	167	post 8	101.5	2320	Voided ~25g. Ant. post. + post. 4 "belts" are well-defined. Deep peeling in humer. Gulars but no notch, are "lumpy" + flat. Abd. seams don't meet at midl. Stubby tail. Richly colored. Carapace scute centers prominent. Pygal tip tucked under. Abd. post. flaring.
6/3	117	Und	85	79	84	61	70	post 5	42	(P) 147	Post. abd. seams don't meet at midline. Richly colored. Much bubbling under shell surface. Oval w/ slight post. flaring.
6/3	118	♂	202.5	184	206	190.5	159	mid 8	92.5	1850	Voided 11g. No post. seams meet. Ant. portion of humeral scutes "overhang" post. portion. Midline away between abds. Several punctures + notch in belly. Clipped on left side. Richly colored. RM8 is narrow + the RM8/7 sea. is thin.
5/23/21	Und		46	61	65	52	57	post 6	35	(P) 70	2 rings
5/23/22	Und		82	72	80	58	66	post 7	38	115	3-4 rings. Voided 16 ml.
5/23/23	Und		80	73	77	54	64	post 5+6	39	120	Voided 3 g. 3 rings.
5/22/24	♂		239	213	230	173	199	mid 8	107	3100	Extra lump at keratin in post, int. films. Ring on ventral portion of gulars
5/24/25	♀		217	205	225	147	173	post 8	103	2400	Nuclear cloud off. Chewing on Lm 10. Voided 10 g.
126											
127											
6/1	119	♀	202							1620	Voided ~5 ml prior to weighing + after. Extensive new growth.

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Ward V, CA
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Date	Toad #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width M3 (mm)	MAX. WIDTH / G	Height (mm)	Weight (g)	Distinguishing Features
6/3	82	♀	184						1410	Mod. extensive new growth.
6/4	119	♀	223	195	220.5	144.5	171.5 / mid 6	101.5	2240	Voided 6g. Only post. seam meet at midline. Grock from mid into each abd. + crease in left post. Also lump of scale "head" paraps. of 6 post. nuchal/vi area "damp". LM 7/8 blind together w/ skin so line at lower portion only. Lat 8 narrow.
6/4	7	♀	216.5						2160	Slight new growth.
6/1	126	Und	127	119	127	85.5	98.5 / und post 5	57	500	Voided 10mg prior to weighing + 5mg after. Ant. post. + ant. fem. seam don't meet at midline. Richly colored w/ mottling along gular/hum. V 1/2 seam curves in center; also nuchal/vi seam.
6/1	127	♂	273	252.5	275.5	189	219 / mid 8	120	4200	Voided 4g. Dk. gray tolt. w/ mottling on pleuron. Well-flared. Curves midline in post. hum. + fem. seams. Post. abd. seams don't meet. Forefoot, skin is scraped + turned up on 4th + 5th (to outside) toes. Appal prom. w/ pygal tip straight down.
6/1	83		254						3710	Wt. is after initial hard of ~10mg. Voided 7 g after weighing.
5/25	128	Und	95	86	92	66	74 / post 5	45	200	4 rings. Voided 5 g.
5/26	129	Und	80	69	74	54	63 / post 5, 6	38	130	Voided 4g.
5/26	130	Und	57	54	56	42	47 / post 5, 4, 7	26	47	No rings. Voided 2g.
5/26	131	Und	61	52	54	41	47 / post 5, 4, 6	30	45	No rings.
6/8	132	Und	72.5	66	70	52	58.5 / post 5, 4, 6	36	100	(Pos) Vertical crease in V5/pygal seam. Firm nuchal/vi seam when 2 creases extending into 1. 3 rings. Very richly colored w/ pa spots in center of each dark ocellar scute
6/9	70	♂	258.5						3715	2 Ticks
6/13			200						3600	
6/10	84	♀							1905	Fat.
6/11	133	♂	262	241	267.5	177	203 / post 8	111	3550	Voided ~95. Quite mottled along midline esp. in humerals. Ft. gular slightly more lifted than left. Ft. humeral is a little wider at edge w/ crease running parallel to from gular seam. Pleural folds well-defined. Dark camp. a richly-colored pleural w/ mod. wide ant. + well-flared post. Narrow nuchal.
6/11	134	Und	63	57.5	60	45	51.5 / post 1, 4, post 7	29	54	(Pos) Large pale area along midline in ant. abd. Ring areas dark on ples + richly-colored carapace. Ant. abd. seams barely offset at midline.
6/11	44	♂	240						3080	

Spring 1980
Ward V.

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Tortoises

date	Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width M3 (mm)	MAX. WIDTH / C	Height mm	Weight	Distinguishing Features
4/11	53	♀	213						1950	
5/12	135	Und	135.5	123	133	95.5	103 / mid 5	71	675	Gular tips + ventral surface have bone exposed. Deep peeling in periphery of rt. pet. + Bl. abd. Bone exposed on chips in Lm 3 + Lms 5 V3/4 seam. has curve off-center to the left. Lump of keratin at post. of gulars on vent. surface. Richly colored. Ca and w/ med. post. flaring.
5/23		♀	210	205	225	149	176 / post 7+8	93	2250	Voided ~1/20.
6/13	17		212						2430	Voided 20-30 mL
5/13			246.5						3000	Rt. side of nuchal + edge of rem. bloody but no apparent wound. 9 ticks
5/24	85	♂	247	218	247	167	189 / post. 8	156	2900	41 ticks
5/13	101								670	Medium new growth.
5/13	107		247.5						5640	
5/13	118		203						1810	Mod-ext. new growth.
5/13	23		190						1440	Poss. recently completed ring.
6/13	89		198						1770	Medium new growth.
6/13	136	Und	103.5	93	102	72.5	80.5 / post 7	54	370	Only anal seams meet at plastron midline. Moderately well flared. Richly colored.
5/14	137	♀	209	189.5	204	141	168.5 / mid-post 8	92	2020	Voided 38 mL. On rt. forefoot, outside 2 nails are stained and 22 outside nail is bent. Rm 11 narrow. Very well-flared post. w/ slight up. Costs 4 + 5 appear raised, poss. shell wear. Indented in m4, 5, 6.
5/14	138	Und	88	79	85.5	63	70 / post. 7	42	145	(R3) Post. abd. seams slightly offset. Single notch in pygal. 1/2 has single dip, not normal double notch. 1/2 seam curves forward in center. Curves in V3/4 seam.
5/14	90	♀	205						1820	Voided 12 mL.
5/14	57	Und	67.5						73	(R5)
5/14	112		150						820	Extensive new growth.
5/14	80		211						2090	

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 Spring, 1980
 Wind V, C

Date	Tortoise #	Sex	MCL (mm)	PL N (mm)	PL T (mm)	Width M3 (mm)	max. width / G	Height (mm)	Weight (g)	Distinguishing Features
5/25	12	♂	261	240	260	182	207/post 8	109	3350	7 - 10's. Mod new growth. Voided 13g.
6/14			262						3735	Moderate new growth
6/15	139	Und	128	118	128.5	91.5	102 / mid 8	61	600	Voided ~4g. Depressed in center of V2, V3, max center of V1, V5. Ant. pecty. Folds well-defined, irregularly - notched, oval. Plastic marked in middle area. Ridges colored.
6/15	97	Und	142						730	mod extensive new growth
6/15	59	♂	230						2540	mod extensive new growth
6/15	75	♀	224.5						2390	
5/25	21	♀	227	197	220	148	178 / —	97	2400	20 ticks Fine new growth
5/25	01	Und	110	99	109	74	80 / post. 5	55	310	2-3 rings
5/26	80	Und	135	120	122	72	109 / post. 8	65	170	
5/26	66	♀	221	197	125	148	175 / post. 6	95	2200	2 ticks Voided 10g.

Appendix X. Skeletal remains.

Appendix 2. Statistical results.

Shells

Spring 1980
Ward V, CA
+ 7 N 120E 7, 28

Date	Shell #	Sex	WCL (mm)	MAX. P.L. (mm)	MIN. P.L. (mm)	Width m 3-4 Seam (mm)	Width m 7-8 Seam (mm)	MAX. WIDTH (mm) / C	Height (mm)	Comments
4/12	20	♂	~220*	210*	199*	170*	181*	181 / 7-8	>100*	9 fragments, 3 peripherals, part of hypoplexian (small portion), one small tooth marks on inside (abd.) one not on bone.
4/13	21	Und.	Subadult	Und.	Und.	Und.	Und.	Und.	Und.	In Niobona nest: 1/2 of hypoplexian + 3 peripherals + 3 fragments, part of one pleural.
4/13	22	Und.	~120	100*	95*	Und.	81*	87 / mid m 6	Und.	Predator chewing on post piece
4/13	23	Und.	Subadult	Und.	Und.	Und.	Und.	Und.	Und.	Entire
4/13	24	Und.	small	"	"	"	"	"	"	In Niobona nest. Small portion hypo- + hypoplexian.
4/13	25A	Und.	83	81	77	63	69.5	70 / mid 8	40.5	fragment group
4/14	25B	Und.	Subad.	Und.	Und.	Und.	Und.	Und.	Und.	
4/14	26	Und.	Sub. → Ad.	"	"	"	"	"	"	
4/24	28	Und.	Adult	Und.	Und.	Und.	Und.	Und.	Und.	In poss. Niobona midden.
4/26	29	Und.	Und. > Juvenile II	"	"	"	"	"	"	One fragment only
4/27	30	♂?	Und.	196*	179*	136*	"	"	"	Carapace broken.
4/27	31	♀	Und.	192.5*	177*	Und.	"	"	"	Nest is in Niobona midden. Plea at least since this season's grow
4/30	32	Und.	Sub. I - 2 wings Und.	Und.	Und.	Und.	Und.	Und.	Und.	In predator scat.
4/30	33	Und.	Adult	"	"	"	"	"	"	Parado of bone p.s.k. 4 frag ments only.
5/3	34	Und.	~100mm	"	"	"	"	"	"	In old Niobona nest. 2 fragments
5/5	35	Und.	Adult?	"	"	"	"	"	"	Fragments in Niobona nest (a few only)
5/6	36	Und.	Adult?	"	"	"	"	"	"	
5/8	37	Und.	Subadult	"	"	"	"	"	"	1 frag.

Appendix XI. Tortoise burrows.

Appendix X: Technical drawings

Site	Tort No.	Height (mm)	Width (mm)	Soil (mm)	Slope	Aperture Direction	Vegetation	Comments
25/80	2	875	295	100	20° entrance level/inside	WNW	To entrance under a small mostly dead Larrea (1m diam) which offers mottled H.M. shade to ca 1100. (Prob. full early A.M. shade)	May curve to rt. at end. (Can't see or determine w/pole.)
25	4	419	246	69	15° level at end	SSW	0.2m S of Larrea (1m diam) offering no shade.	Many new annuals in entrance.
25	5	563	110	31	15° level inside	S	5m S side of Larrea clump, 1m S of most stems but 0.1m E of 1 small stem (0.2m diam.) mottled shade late afternoon only	Tort tilted + nudged in between a granite cobble + a boulder (granite).
25	6					S?	Under a dense <i>Sloanea</i> + <i>Eriog. fasciculatum</i> + <i>Paraphyllum</i> clump (0.6m diam.)	Med. friable soil. On w-facing hill
5	7	210	253	~105	15° at entrance	N	Under flat granite boulder. Several sm. <i>Mammis</i> (0.3-0.5m diam.) are near; nearest is 0.6m WNW + may offer very slight late P.M. shade.	Tort. doesn't fit all the way in yet.
6	8	178	232	~40	45°	S	Under, + completely hidden by 0.8m diam. <i>Ambrosia</i> . Next to (E. of) 5m Larrea clump	On island in lg. sandy wash.
26	9	225	232	38	45°	W	Under dense <i>Euphorbia</i> - <i>Lycium</i> clump (0.6m diam.)	Some packet-midden
27	10	380	270	Yucca	level/inside	W	Art of annuals + scattered bushes surround Tort. shade to ca 1500, then full sun.	
7	11	156	252	90	45°	WSW	Dug under a Yucca shrub. - Yucca stump sp. w/ <i>Opuntia</i> acanth. 0.2m W. Full H.M. shade to ca 1200. mottled shade rest of day.	Tort. barely fits post 2/3 of carapace is bare. Ross. part. of old <i>Neotoma</i> midden.
8	12	864	242	148	5° level/inside	N	At S edge of + under a Yucca <i>Schidigera</i> clump (5 trees, 2 to 3m high). Dead <i>Opuntia</i> (15m diam.) is 1m WSW: shade prior to 1200, then mottled.	May have orig. been a rabbit form. Is a little tall but loose dirt may have fallen from roots.
28	14	885	284	119	20-25° at entrance/inside	S	On N side + under lg. stem of Larrea clump (3m diam.). Total shade all day (slight sun on mound in A.M.)	SE side of entr. Prob. receives full H.M. shade. None after 1000.
9	15	~190	105	18	5°	E	Entr. under courses on an "island" in a 23cm bank. In center of loose <i>Schidigera</i> clump 6 trees, all 2m 3m diam. clump. Directly under no tree. Nearest is 0.3m WNW. Plot of annuals + a tiny <i>Ambrosia</i> at center of Larrea <i>Krameria</i> <i>Grayia</i> clump (2.5m diam.) + receives well-mottled shade all day.	Old redoubt burrow.
30	17	510	260	58	10°	NW	In Larrea- <i>Ambrosia</i> group, the main part of clump is to SE of burrow but overhangs burrow somewhat. Only <i>Ambrosia</i> (0.2-0.3m diam.) is to NW of burrow. Full shade early A.M. mottled rest of day.	Curves to rt. at end but is very narrow, prob. redoubt.
30	20	720?	63	51	10° at entr.	E	Completely in open. Nearest shrub is Larrea. No shade except post. very late P.M.	Old redoubt burrow. This hole is 51m deep but can't determine length used by Tort. width may narrow at 720mm.
31	30	91	58	102	0°	SSW	Under slight overhang (most of) <i>Eriog. fasciculatum</i> + tiny <i>Ambrosia</i> . In sm. sand-wash bank (6cm high). Total shade to ca 1000, mottled to ca 1300. Full sun to ca 1600.	Old redoubt burrow (?)
31	19	292 (Feet)	270 (entr. 15328)	58	15° at entrance/inside	SSW	In a clump of Larrea <i>Ambrosia</i> (3m diam.) All Larrea lies to SSE but overhangs. Total shade to 1100, mottled but decreasing in shade to 1400. Then full shade.	
2	23	225	200	109	5-10° at entr.	W	In a mostly dead <i>Y. schidigera</i> clump in w. side, under a fallen stem. Total shade (from lg) to 1200, then full sun to 1600, then full shade by E. <i>fasciculatum</i> (0.3m diam.) 1m west.	Some <i>Neotoma</i> midden side + other side of clump. Not m. pelleted 140.
3	25	347	263	91	10° at entrance/inside	SSW	Nearest veg. is 12m W, Larrea. This is only influencing (shade) shrub, prob. offering slight (mottled) late P.M. shade	In sm. bank (14cm).
4	26	123	108	36	0°	ENE	Under <i>Encelia</i> (0.5m diam.) + overhang by Larrea (1m diam.). mottled shade all day.	

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Tor-facile

rows

(2) 6

DATE	ASSOC. WITH WHICH TOR-FACILE	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	SOIL CPUS (mm)	APERTURE DIRECTION	SWAY	VEGETATION	COMMENTS
4/14	27	78	150-170	118	27	W	0°	In W side of Yucca along (12 slants, to 3 m high) on N. side of one stem. Full shade to ca 1400, then full sun.	Doesn't look like a tort. burrow. At entrance way to 170 at e.entr. (p. 150 mm). But this tort. is odd-shaped. Tort. prob. built to entrance. Nocturnal. deep 12-15 ft.
4/14	28	368	168	90	40	SW	5° at entr. only	Under a Krameria (Graggii) - shade all day.	
4/14	29	365	275	130	50	NNE	0°	In very open Yucca etc. along all shade. A line larvae (1 m diam.) 1.5 m S of a couple live larvae slant 0.8 m W. Total early A.M. shade only. Dead larvae close 1 m N, Yucca close 0.8 m S to SE.	The entrance way has a little baffle as it curved in (a couple cm. high)
4/15	32	484	288	121	71	S	20° at entr. 0° inside	No shade all day. Dead larvae close 1 m N, Yucca close 0.8 m S to SE.	
4/16	18	~1670 (6 mm)	302	140	510	E	0°	Nearby is Salicornia, 0.8 m SE. Full sun to 1200, then shaded by bank.	Cant determine length used by tort. Noct. seat inside.
4/16	39	250	254	103	100	W	0°	0.3 m E of Encelia viny (0.5 m diam.) + 0.8 m NE of Yucca close. Shade to 0200, full sun to 1600. Only shade is under, on E. side, of perennial comp. Full shade to 0900 (from slope), full sun to 1200, then mottled.	In E-facing part of wash on gentle W-facing slope prob. due to slopes. On W-facing incline.
4/16	40	68	248	100	75	S	0°	In a larvae close near E. side + along S. side. Total shade to 0900, mottled to 1600, then shade at E. side of dead Acacia's branches. Ambrosia in group w/ Acacia but not influential. Mottled shade after 1600 only.	No thru roof.
4/18	16	315	340	120	230	NW	30°		
4/18	46	385	180	85	~19	W	45°		
4/18	22	600	305	135	130	SSW	30° at entr. level inside	Slightly mottled all day. In a larvae close (2 m diam.).	
4/18	47	426	290	98	70	W	15° at entr. only	Nearby shrubs Krameria Graggii. 0.5 m ESE providing mottled shade only.	Alot of animals around entrance way so not well used.
4/19	50	48	92	45	13	W	0°	No influential bush. Nearest bushes are Krameria, 2 m W; LATM, 2 m SW; AMPU, 1 m S.	
4/19	17	570	190	90	100	S	0°	Under S side of Larrea. Roof to branches primarily mottled shade all day.	
4/19	24	92	150	75	40 (Cecropia)	S	45°	In Larrea - Ambrosia group (2 x 1 m). Well-mottled shade to 0900, slightly mottled to 1200 then full sun.	
4/19	53	375	280	130	40	E	—	In open. Afternoon shade from Ambrosia.	2 entrances
4/19	61	195	260	110	90	W	0°	Late A.M. + P.M. shade from Ephedra (1 m diam.). Entr. at base of Ephedra.	
4/19	49	970	260	140	110	WSW	15° level at end.	0.5 m E. of Y. schubertii. Total P.M. shade.	On wash bank.
4/19	25/12	403	260	120	70	SW	10°	On SE side of Krameria (1.5 m diam.) 75° to late P.M. shade.	
4/19	17	160	115	250	250	SW	10°	No shade. 1 m from Larrea.	Looks like an old rabbit burrow

Burrows

103.

Spring, 1980
Caldwell, CA
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Tortoise Burrows

Date	Assoc. with which Tol	Collector	Length (mm)	Width (mm)	Height (mm)	Soil (pH)	Aspect Direction	Slope	Vegetation	Comments
5/7	13	B	378 (+380 of bush)	256	100	32	NW	0	Under + on N side of lg. Eriog. fasciculatum - Krameria fr. group (15m diam) Total shade.	A lg. cavity under a Yucca clone. Rodent droppings inside but not a Noctua nest.
5/7	49	B	200	640	170	3 Yucca stems	W	15° at entrance only	Under a Yucca clone on W side. Full shade to 1300, then full sun.	Curves left at end
5/7	2	B	697	275	160	30	WSW	15-20° level at end	On W side of gp. of 10000. Larrea (25m diam) providing well mottled shade to 0930 only.	
5/7	25	B	374	260	111	40	SW	15°	In 0.5m space below Yucca clone (2 short stems 0.9m w/ Larrea Krameria + Ambrosia gp. (12x2m) on E side of)	Burrow. Slightly overhanging by open Larrea. Full sun to 0800-1400. Full shade AM + P.M.
5/18	107	P	135, plus ~ 0.5m of bush	288	95	15	N	0	Under + on N side of Ambrosia (0.7m diam) w/ Ambrosia on north side also, touching (0.3m diam). Total shade all day.	
5/18	108	B	355	283	140	105	WNW	60° bank at entrance - 100% shade	0.5m W of Larrea - Krameria gp. (1m diam) Total shade to 0800 only.	Appears to have been a previous excavation before "remodeled" by tort., poss. rabbit or kit.
5/19	500	B	65 + 160 of boulder	65	35	10 + 110 of boulder	N	5°	Eriog. fasc. 0.3m NE + Ambrosia 0.4m N. No influence.	Dug by this tort. Under a small boulder, on N side, w/ overhanging ledge. Full shade all day.
5/19	501	B	153	194	100	20	W	0	Larrea 0.8m NNE + Ambrosia (0.8m diam) 1m E. Early AM. Shade from Ambrosia only.	Looks like one of a series of rodent holes which was excavated by tort.
5/19	88	P	—	—	—	—	—	—	—	Merely an indentation in N-facing bank of Yucca clone. No excavation by tort.
5/10	110	B	980	~240	~125	Boulder (15m diam.)	N	0	None	On a hillside (20-40° slope). Tort traverses the nearest slopes, to 400, down into + loose granite on way to flats. (Above is solid boulder). Some Noctua debris + rodent scat inside. Inside is a rock except soil floor. In shade all day from boulders.
5/10	112	P	107	146	78	42	W	0	In NW bend of "U-shaped" gp. of Krameria - Ambrosia (2x1.5m). Full shade 5000 + after 1400.	Is mottled to full sun during midday.
5/10	81	B	276	221	123	70	W	20°	On N side of sm. Larrea (0.6m diam) which offers mottled shade 10-1300 hrs.	Apparently was Noctua nest before tort. as there is much twigs in entranceway + loose dirt w/ at least a short rodent hole at end
5/10	54	B	~270	218	~90	~20	N	0	In an open + much-dead Larrea clone. Well mottled shade to 1100 only.	
5/11	11	P	~100	~250	~100	~40	N	0	On S side + under Acacia (3m diam) which offers well-mottled shade entire day.	
5/11	114	P	62 / ~320	~220	59	12	N	5°	Under Ambrosia (0.6m diam) on NE side.	
5/11	115	B	333	260	141	20	NE	15-20° at entrance, level at end	Under sparse Ambrosia (0.3m diam.) which overhangs entranceway mottled sun to 1700 when full shade.	
5/11	28	B	540	232	115	170	WNW	30° which levels at end	Completely in open	
5/11	29	B	1040	281	140	90	NNE	25° level at end	In open w/ no protection or shade. Nearest bush is Larrea, 0.8m SSE, + Acacia debris, 0.3m NNE.	
5/12	116	B	1230	238	132	80	NW + NNE	20°	Krameria 6. to south (no shade). Larrea (2.5m diam) to W + SW - affects full shade after 1500	Burrow continues past point where tort. has pushed up dirt - poss. a rodent burrow. Curves left slightly at start.
5/13	118	B	326	268	110	30	NW	50° at entrance only	Under + on NW side of Ambrosia (0.8m diam) which provides full shade to 1400 only.	

Spring 1960
Wood V.

Tortoise Burrows

5/2

Date	Assoc. with Tort.	Outlet of Burrow	Length (mm)	Width (mm)	Height (mm)	Top (mm)	Aperture Direction	Slope	Vegetation	Comments
6/3	82	B	523	240	102	109 (w/70)	E	15°	On E side of lg. but loose Yucca close under a fallen log (on E side).	Curio to right. No rat dropping part of an old rat nest on burrow "mound".
6/7	126	B	382	142	70	40	W	10° at entr. level inside	Under lg. Larrea close (4m diam) & receives mottled shade all day.	
6/9	70	B	725	305	143	22	W	15° at entr. level	Larrea (12m diam) 1m east of others early A.M. shade only. No other shrubs.	
6/10	84	B	755	220	105	48	WNW	15° level at end	Nearest shrub is Larrea (1m diam) & receives mottled shade only. Full sun early A.M. shade only.	remained at day
6/11	54	B	1150	227	101	40	NE	15° at entr. level 1/2 way	15m from any shrub + grass. Mottled shade from E. Fasciculation in very early A.M. & Yucca.	in very late P.M.
6/11	44	B	445	228	119	38	W	5-10° slope at entrance only	In Larrea close (3m diam) upper sparse mottled shade. Mottled shade from plant + shade son remainder of day.	
6/11	53	B	540	232	130	25	S	15° at mound	At SE side of Larrea (2m diam) which offers total shade after 1600 only.	Occupied by # 17 previously, on 5/23
6/13	17									
6/13	70	B	810	310	130	80	SW	15° at entr. level 1/2 way	Nearest shrub is Larrea 0.5m NW which provides late P.M. shade.	
6/13	107	B	490	292	130	35	N	0	Under Ambro. - Larrea close (2m diam) 0.5m side. Similar close (1.5m) 0.5m NW. Full shade to 1200, then mottled sun.	Shaded to 1300, then full sun. In short (10cm) bank of runoff.
6/13	118	B	545	250	118	68	WNW	45°	Under + on NW side of Ambro. (0.6m diam) in small mound. Full shade to 1200, full sun > 1400 hrs.	
6/13	23	B	748	200	89	30	SE	5° at entr. only	On SW side of Larrea close (3x 2m) which is open above tort. burrow & offers well-mottled shade to 1100 only.	
6/13	85	B	452	140	30	290	WSW	10° at entrance only	A K. Grayi overhangs entr. (to S) & Larrea (to NW) overhangs it slightly. Well mottled shade from 0900-1400, then full sun.	Tunnelled under old Yucca debris
6/14	137	B	550	232	100	8	N	10° at entr. level 1/2 way	Larrea (1m diam) 0.3m SW but no shade. Total sun all day.	
6/14	35	B	175	242	102	50	W	15° at entr. only	0.5m W. of Krameria - Ambro. Larrea gp. (0.5m diam) which offers mottled shade to 0900 only.	Tort in this burrow
"	"	B	325	238	122	40	WNW	20° at mound only	Mottled shade from above gp. to 1200-1300.	0.3m NE of upper burrow
6/14	90	B	620	220	117	32	SW	15° level at end	On W side of lg. Larrea close which overhangs slightly & offers total shade to 1130, then mottled shade to 1200-1300.	Curio left at end.
6/14	83	B	800	290	120	55	S	15° on mound only	On S side of + under Larrea (2m diam) & receives mottled shade 0800-1130.	Curio slightly left at end
6/14	?	B	1550	270	110	20	W	10°	Under + on W side of Gophero. (0.2m) which gives slight ramp.	only A.M. shade only.
6/14	80	B	410	240	119	40	SW	10°	Larrea (0.5m diam) 0.8m NE. No shade but some dead branches nearby overhang burrow.	Tort doesn't appear tonight but to down hill side.
6/14	12	B	1220	312	142	40	S	30° rat at end	Only shrub is Ambro. (0.2m diam) 0.3m WNW offering mottled shade P.M. A.M.	

Spring, 1980
Ward V.C.

Tortoise Burrows

DATE	ASSOC. WITH NO.	TYPE OF BURROW	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	DEPTH (mm)	APERTURE DIRECTION	Slope	VEGETATION	COMMENTS
5/23	121	B	290	70	40	15	E	-	2 m W of 0.6 m diam, 340 mm high KRCR	Curculat.
5/23	122	B	200	75	50	35	S	-	4.5 m in front of 2 m diam, 1.17 m high larvae	in washbunk.
5/23	17	B	470	200	115	30	N	-	15 mm in front of 980 mm wide, 1 m high larvae	Curculat.
5/24	125	B	220	200	150	45	N	-	105 m behind 110 mm diam, 0.1 m high Ambrosia	
5/25	71	B	230	200	120	20	S	-	Under 16 m diam, 1.2 m high larvae	New burrow.
5/26	66	B	250	190	115	20	WSW	-	450 mm S of 2.3 m diam, 1.1 m high larvae	
5/26	86	B	180	120	75	10	W	-	300 mm N of 1.02 m diam, 2.3 m high <i>Acacia</i> larvae	New burrow. Straight

Appendix XII. Vegetation of
the study site.

to collect the 12% savings

from the 12% savings

Appendix XII. Vegetation of the study site; (a)=annual and
(p)=perennial.

Asclepiadaceae

Asclepias subulata (p)

Funastrum heterophyllum (p)

Boraginaceae

Amsinckia tessellata (a)

Cryptantha augustifolia (a)

C. circumcissa (a)

C. decipiens (a)

C. gracilis (a)

C. holoptera (a)

C. nevadensis (a)

C. pterocarya (a)

C. racemosa (p)

C. utahensis (a)

Pectocarya penicillata (a)

P. platycarpa (a)

P. recurvata (a)

Cactaceae

Echinocereus Engelmannii (p)

Ferocactus acanthodes (p)

Mammillaria microcarpa (p)

Opuntia acanthocarpa (p)

O. basilaris (p)

Cactaceae, continued.

O. Bigelovii (p)

O. echinocarpa (p)

O. ramosissima (p)

Compositae

Acamptopappus sphaerocephalus (p)

Ambrosia dumosa (p)

Baccharis brachyphylla (p)

Baileya pleniradiata (a)

Chaenactis carphoclina (a)

C. Fremontii (a)

C. stevioides (a)

Dyssodia Cooperi (p)

D. porophylloides (p)

Encelia farinosa (p)

E. virginensis (p)

Eriophyllum Wallacei (a)

Haplopappus Gooddingii (p)

Hofmeisteria pluriseta (p)

Hymenoclea Salsola (p)

Machaeranthera tortuifolia (p)

Malacothrix glabrata (a)

<u>Monoptilon bellioides</u> (a)	Cucurbitaceae
<u>Pectis papposa</u> (a)	<u>Cucurbita palmata</u>
<u>Perityle Emoryi</u> (a)	
<u>Peucephyllum Schottii</u> (p)	Ephedraceae
<u>Porophyllum gracile</u> (p)	<u>Ephedra nevadensis</u> (p)
<u>Psathyrotes</u> sp. (a)	
<u>Psilotrophe Cooperi</u> (p)	Euphorbiaceae
<u>Stephanomeria exigua</u> (a)	<u>Euphorbia polycarpa</u> (p)
<u>S. Parryi</u> (p)	<u>Stillingia paucidentata</u>
<u>S. pauciflora</u> (a)	<u>ta</u> (p)
<u>Trichoptilium incisum</u> (a)	
<u>Trixis californica</u> (p)	Fouquieriaceae
	<u>Fouquieria splendens</u> (p)
Cuscutaceae	
<u>Cuscuta</u> sp.	Geraniaceae
	<u>Erodium cicutarium</u> (a)
Cruciferae	
<u>Caulanthus Cooperi</u> (a)	Graminae
<u>Descurania pinnata</u> (a)	<u>Aristida</u> sp. (p)
<u>Draba cuneifolia</u> var. <u>integrifolia</u> (a)	<u>Bromus rubens</u> (a)
<u>Lepidium Fremontii</u> (p)	<u>Erioneuron pulchellum</u> (p)
<u>L. lasiocarpum</u> (a)	<u>Schismus</u> sp. (a)
<u>Lesquerella Palmeri</u> (a)	<u>Stipa speciosa</u> (p)
<u>Streptanthella longirostris</u> (a)	Hydrophyllaceae
	<u>Eucrypta micrantha</u> (a)
	<u>Nama demissum</u> (a)

Hydrophyllaceae, continued.

Phacelia crenulata (a)P. tanacetifolia (a)

Labiatae

Salazaria mexicana (p)Salvia columbariae (a)

Leguminosae

Acacia Greggii (p)Astragalus acutirostris (a)Cassia armata (p)Dalea Fremontii (p)D. mollis (p)Krameria Grayii (p)K. parvifolia (p)Lotus salsuginosus brev-
vexillus (a)L. tomentellus (a)Lupinus concinnus var. Or-
cutti (a)

Liliaceae

Yucca schidigera (p)

Loasaceae

Mentzelia involucrata (a)

Lobeliaceae

Nemacladus rubescens (a)

Malvaceae

Sphaeralcea ambigua (p)

Nyctaginaceae

Mirabilis Bigelovii (p)

Oenograceae

Oenothera brevipes (a)O. refracta (a)

Papaveraceae

Eschscholtzia glypto-
sperma (a)

Plantaginaceae

Plantago insularis (a)

Polemoniaceae

Gilia interior (a)Langloisia setosissi-
ma (a)Linanthus aureus (a)L. dichotomus (a)

Polygonaceae

Chorizanth brevicornu (a)

C. rigida (a)

Eriogonum deflexum (a)

E. fasciculatum (p)

E. inflatum (p)

E. maculatum (a)

E. nidularium (a)

E. trichopes (a)

Resedaceae

Oligomeris linifolia (a)

Rubiaceae

Gallium stellatum (p)

Scrophulariaceae

Mimulus Bigelovii (a)

Solanaceae

Lycium Andersonii (p)

Nicotiana trigonophylla (p)

Physalis crassifolia (p)

Zygophyllaceae

Larrea tridentata (p)

Appendix XIII. Vegetation analysis.

Appendix III. Vegetation analysis.

A. Appendix XIII. Vegetation analysis.

A. Annual vegetation, listed by month and transect, in generically decreasing order of importance value (I.V.)

Species	Transect I													
	April							May						
	Cover Absolute (cm ² /m ²)	Relative %	Biomass		Frequency		I.V.	Cover Abs.	Biomass		Frequency		I.V.	
			Abs.* (g/m ²)	Rel. %	Abs.	Rel. %			Abs.*	Rel.	Abs.	Rel.		
<u>Pectocarya</u> spp.	58800	72.2	280	79.8	1.000	17.8	56.6	2400	17.8	10	21.3	0.538	16.7	18.7
<u>Lotus</u> spp.	7480	9.2	16	4.6	0.769	13.7	9.2	—	—	—	—	—	—	—
<u>L. tomentellus</u>	—	—	—	—	—	—	—	1900	14.1	8	17.0	0.615	19.0	16.7
<u>L. salsuginosus</u>	—	—	—	—	—	—	—	600	4.4	1	2.1	0.154	4.8	3.8
<u>Chorizanth</u> <u>brevicornu</u>	100	0.1	1	0.3	0.077	1.4	0.6	3900	28.9	10	21.3	0.308	9.5	19.9
<u>Plantago insu-</u> <u>laris</u>	5125	6.3	7	2.0	0.846	15.9	8.1	1650	12.2	1	2.1	0.538	16.7	10.3
<u>Cryptantha</u> spp.	2200	2.7	6	1.7	0.462	8.2	4.2	200	1.5	1	2.1	0.077	2.4	2.0
<u>C. gracilis</u>	—	—	—	—	—	—	—	1500	11.1	8	17.0	0.154	4.8	11.0
<u>C. pterocarya</u>	100	0.1	1	0.3	0.077	1.4	0.6	—	—	—	—	—	—	—
<u>Eriogonum</u> spp.	1300	1.6	5	1.4	0.615	10.9	4.6	100	0.7	1	2.1	0.077	2.4	1.7
<u>E. maculatum</u>	—	—	—	—	—	—	—	100	0.7	1	2.1	0.077	2.4	1.7
<u>E. deflexum</u>	—	—	—	—	—	—	—	100	0.7	1	2.1	0.077	2.4	1.7
<u>Lepidium lasi-</u> <u>ocarpum</u>	350	0.4	1	0.3	0.308	5.5	2.1	150	1.1	1	2.1	0.154	4.8	2.7
Tiny unknowns	400	0.5	1	0.3	0.154	2.7	1.2	200	1.5	1	2.1	0.154	4.8	2.8
<u>Nemacladus ru-</u> <u>bescens</u>	—	—	—	—	—	—	—	500	3.7	1	2.1	0.154	4.8	3.5
<u>Astragalus acu-</u> <u>tirostris</u>	2500	3.1	6	1.7	0.231	4.1	3.0	—	—	—	—	—	—	—
<u>Schismus</u> sp.	1300	1.6	4	1.1	0.231	4.1	2.3	—	—	—	—	—	—	—
<u>Streptanthella</u> <u>longirostris</u>	350	0.4	2.5	0.7	0.308	5.5	2.2	—	—	—	—	—	—	—
<u>Amsinckia tessel-</u> <u>lata</u>	500	0.6	11	3.1	0.077	1.4	1.7	—	—	—	—	—	—	—

Species	Transect I, continued									
	April					May				
	Cover Abs.	Cover Rel.	Biomass Abs.	Biomass Rel.	I.V.	Cover Abs.	Cover Rel.	Biomass Abs.	Biomass Rel.	I.V.
<u>Stephanomeria ex-</u> <u>igua</u>	—	—	—	—	—	100	0.7	1	2.1	2.4
<u>Malacothrix gla-</u> <u>brata</u>	—	—	—	—	—	100	0.7	1	2.1	2.4
<u>Bromus rubens</u>	300	0.4	4	1.1	1.4	—	—	—	—	—
<u>Oenothera sp.</u>	200	0.2	2.5	0.7	0.8	—	—	—	—	—
<u>Gilia interior</u>	250	0.3	1	0.3	0.7	—	—	—	—	—
<u>Draba cuneifolia</u>	100	0.1	1	0.3	0.6	—	—	—	—	—
<u>Monoptilon belli-</u> <u>oides</u>	100	0.1	1	0.3	0.6	—	—	—	—	—
Total	81455	100.0	351	100.0	100.0	13500	100.0	47	100.0	100.0
Transect II										
<u>Cryptantha gra-</u> <u>cilis</u>	27600	26.6	40.0	12.3	18.4	80	0.2	1	0.6	4.0
<u>C. pterocarya</u>	2200	2.1	7	2.2	2.7	400	0.8	1	0.6	2.6
<u>C. augustifolia</u>	—	—	—	—	—	11100	21.1	75	45.2	13.5
<u>C. circumcissa</u>	—	—	—	—	—	1800	3.4	8	4.8	2.6
<u>Pectocarya spp.</u>	45800	44.4	156*	48.1	36.2	3900	7.4	9	5.4	10.9
<u>Eriogonum spp.</u>	2200	2.5	5	1.5	4.1	—	—	—	—	—
<u>E. maculatum</u>	—	—	—	—	—	15800	30.0	35	21.1	16.1
<u>Chaenactis sp..</u>	5400	5.2	8	2.5	6.3	200	0.4	1	0.6	1.4
<u>C. carphoclina</u>	—	—	—	—	—	7700	14.6	5	3.0	9.5
<u>C. stevioides</u>	—	—	—	—	—	300	0.6	1	0.6	2.6
<u>C. Fremontii</u>	—	—	—	—	—	1000	1.9	1	0.6	1.4

Species	Transect II, continued													
	April							May						
	Cover Abs.	Cover Rel.	Biomass Abs.	Biomass Rel.	Frequency Abs.	Frequency Rel.	I.V.	Cover Abs.	Cover Rel.	Biomass Abs.	Biomass Rel.	Frequency Abs.	Frequency Rel.	I.V.
<u>Amsinckia tessellata</u>	3500	3.4	50	15.4	0.08	1.3	6.7	200	0.4	1	0.6	0.08	1.4	0.8
<u>Lesquerella Palm-eri</u>	3800	3.7	9	2.8	0.38	6.2	4.2	1600	3.0	5	3.0	0.15	2.6	2.9
<u>Plantago insularis</u>	900	0.9	5	1.5	0.15	2.4	1.6	1300	2.5	5	3.0	0.31	5.4	3.6
<u>Lotus tomentellus</u>	1200	1.1	4	1.2	0.23	3.7	2.0	2400	4.6	1	0.6	0.23	4	3.1
<u>Chorizanthe brevicornu</u>	2800	2.7	5	1.5	0.38	6.2	3.5	600	1.1	1	0.6	0.08	1.4	1.0
<u>Lepidium lasiocarpum</u>	200	0.2	1	0.3	0.15	2.4	1.0	1300	2.5	5	3.0	0.23	4.0	3.2
<u>Schismus</u> sp.	1500	1.4	7	2.2	0.23	3.7	2.4	300	0.6	1	0.6	0.15	2.6	1.3
<u>Bromus rubens</u>	3200	3.1	9	2.8	0.23	3.7	3.2	—	—	—	—	—	—	—
<u>Nemacladus rubescens</u>	—	—	—	—	—	—	—	1300	2.5	1	0.6	0.31	5.4	2.8
Tiny unknowns	800	0.8	6	1.8	0.31	5.0	2.5	—	—	—	—	—	—	—
<u>Chorizanthe rigida</u>	—	—	—	—	—	—	—	500	1.0	5	3.0	0.15	2.6	2.2
<u>Linanthus dichotomus</u>	1100	1.1	5	1.5	0.23	3.7	2.1	—	—	—	—	—	—	—
<u>Oenothera</u> sp.	1000	1.0	1	0.3	0.08	1.3	0.9	—	—	—	—	—	—	—
<u>O. refracta</u>	—	—	—	—	—	—	—	300	0.6	1	0.6	0.08	1.4	0.09
<u>Streptanthella longirostris</u>	200	0.2	5	1.5	0.15	2.4	1.4	—	—	—	—	—	—	—
<u>Monoptilon bellioides</u>	—	—	—	—	—	—	—	300	0.6	1	0.6	0.08	1.4	0.9
<u>Mentzelia</u> sp.	—	—	—	—	—	—	—	100	0.2	1	0.6	0.08	1.4	0.7
<u>Stephanomeria exigua</u>	—	—	—	—	—	—	—	100	0.2	1	0.6	0.08	1.4	0.7

Species	Transect II, continued													
	April						May							
	Cover		Biomass		Frequency		I.V.		Cover		Biomass		Frequency	
	Abs.	Rel.	Abs.	Rel.	Abs.	Rel.	Abs.	Rel.	Abs.	Rel.	Abs.	Rel.	Abs.	Rel.
<u>Eucrypta micran-</u>	200	0.2	1	0.3	0.08	1.3	0.6	—	—	—	—	—	—	—
<u>tha</u>														
Total	103600	100.0	324	100.0	6.14	100.0	100.0	100.0	52580	100.0	166	100.0	5.7	100.0

*Absolute biomass is overestimated for species with less than 5g/m^2 as the scale did not accurately record measurements less than 5 g.

** Due to an oversight, the biomass for Pectocarya spp. was not recorded for April. The figure given in this table is an estimation from the cover for April compared to the cover and accompanying biomass for Pectocarya spp. for Transect I and for May in Transect II.

B. Perennial vegetation, listed in decreasing order of importance value.

Species	Density		Volume		Frequency		I.V.	
	Abs.	Rel.	Abs.	Rel.	Abs.	Rel.		
	(#/ha)	%	(cm ³ /ha)	%				
Transect I								
<u>Euphorbia polycarpa</u>	12150	43.2	0.0193 X10 ⁸	0.21	0.64	16.7	20.0	
<u>Eriogonum fasciculatum</u>	4450	15.8	1.9095 X10 ⁸	22.64	0.60	15.6	18.9	
<u>Ambrosia dumosa</u>	2950	10.5	1.1024 X10 ⁸	13.07	0.64	16.7	13.4	
<u>Stephanomeria pauciflora</u>	1150	4.0	0.8789 X10 ⁸	10.42	0.36	9.4	7.9	
<u>Porophyllum gracile</u>	1850	6.5	0.2343 X10 ⁸	2.78	0.30	7.8	5.7	
<u>Krameria parvifolia</u>	750	2.7	0.5922 X10 ⁸	7.02	0.24	6.3	5.3	
<u>Eriogonum inflatum</u>	1550	5.5	0.0717 X10 ⁸	0.85	0.22	5.7	4.1	
<u>Encelia virginensis</u>	350	1.2	0.6696 X10 ⁸	7.94	0.10	2.6	3.9	
<u>Baccharis brachyphylla</u>	350	1.2	0.6163 X10 ⁸	7.31	0.08	2.1	3.5	
<u>Machaeranthera tortifolia</u>	700	2.5	0.0335 X10 ⁸	0.40	0.16	4.1	2.3	
<u>Stephanomeria Parryi</u>	800	2.8	0.0075 X10 ⁸	0.09	0.14	3.6	2.2	
<u>Gallium stellatum</u>	300	1.1	0.0176 X10 ⁸	0.21	0.10	2.6	1.3	
<u>Encelia farinosa</u>	200	0.7	0.0005 X10 ⁸	0.01	0.04	1.0	0.6	
<u>Dyssodia porophylloides</u>	100	0.4	0.0048 X10 ⁸	0.06	0.04	1.0	0.5	
<u>Acacia Greggii</u>	50	0.2	1.7177 X10 ⁸	20.37	0.02	0.5	7.0	
<u>Cassia armata</u>	50	0.2	0.4248 X10 ⁸	5.04	0.02	0.5	1.9	
<u>Opuntia acanthocarpa</u>	50	0.2	0.1168 X10 ⁸	1.39	0.02	0.5	0.7	
<u>Echinocereus Engelmannii</u>	50	0.2	0.0067 X10 ⁸	0.08	0.02	0.5	0.3	
<u>Mirabilis Bigelovii</u>	50	0.2	0.0038 X10 ⁸	0.05	0.02	0.5	0.3	
<u>Acamptopappus sphaerocephalus</u>	50	0.2	0.0033 X10 ⁸	0.04	0.02	0.5	0.2	
<u>Opuntia echinocarpa</u>	50	0.2	0.0011 X10 ⁸	0.01	0.02	0.5	0.1	
Total	28100	100	8.4328 X10 ⁸	100	3.84	100	100	
Transect II								
<u>Euphorbia polycarpa</u>	6150	0.65	0.0009 X10 ⁸	0.004	0.38	0.28	31.0	
<u>Larrea tridentata</u>	850	0.09	10.431 X10 ⁸	47.2	0.3	0.23	26.3	
<u>Ambrosia dumosa</u>	1800	0.19	2.755 X10 ⁸	12.5	0.46	0.33	21.7	
<u>Yucca schidigera</u>	50	0.01	7.458 X10 ⁸	33.7	0.02	0.01	11.9	
<u>Krameria Grayii</u>	250	0.03	1.044 X10 ⁸	4.7	0.10	0.07	4.9	
<u>Porophyllum gracile</u>	100	0.01	0.1222 X10 ⁸	0.6	0.04	0.03	1.5	
<u>Krameria parvifolia</u>	100	0.01	0.1204 X10 ⁸	0.5	0.04	0.03	1.5	
<u>Acamptopappus sphaerocephalus</u>	50	0.01	0.1220 X10 ⁸	0.6	0.02	0.01	0.8	
<u>Eriogonum fasciculatum</u>	50	0.01	0.0478 X10 ⁸	0.2	0.02	0.01	0.7	
Total	9400	100	22.010 X10 ⁸	100	1.38	100	100	

Appendix XIV. Photographs.

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