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Observations and Morphometric Data on the Namaqualand Speckled Tortoise, *Homopus signatus signatus* (Gmelin, 1789), in South Africa

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ABSTRACT. – Morphometric measurements of *Homopus signatus signatus* were taken during two separate visits to the Namaqualand region of South Africa. Ranges of carapace length and body weight were 39.1–103.0 mm and 15.0–163.0 g for females and 40.6–87.5 mm and 14.0–96.0 g for males, representing new range limits for the species. Presumably because of high ground temperatures (≥ 26°C), tortoises were inactive during the months of December–January and appeared to be aestivating predominantly in east facing crevices. Tortoises were always solitary and were only found in crevices.

KEY WORDS. – Reptilia; Testudines; Testudinidae; *Homopus signatus*; tortoise; ecology; habitat; aestivation; allometry; crevice; kopje; morphometrics; Namaqualand; South Africa

The Namaqualand speckled tortoise, *Homopus signatus signatus*, endemic to southern Africa (Fig. 1), is the smallest land tortoise in the world, with adult females rarely exceeding 100 mm and males even smaller (Boycott and Bourquin, 1989; Boycott, 1989). The habitat of *H. s. signatus* is the semi-desert woodland region of Namaqualand in northwestern Cape Province. Namaqualand is divided into four geographical regions based on specific geological features (Le Roux and Schelpe, 1988). Tortoises are only found in association with rocky outcrops called kopjes (Fig. 2) that are scattered throughout the species' distributional range (Loveridge and Williams, 1957). This approximately 50 km wide region is termed the Namaqualand Klipkoppe (Le Roux and Schelpe, 1988) and extends approximately 300 km from the town of Vioolsdrif in the north, on the Namibian border, to the town of Nuwerus in the south. The granite kopjes and mountain ridges are separated by flat, well drained sandy soils.

Few data are available on *Homopus signatus signatus*. Only descriptive (Branch, 1988; Boycott and Bourquin, 1988; Duerden, 1907; Hewitt, 1935), taxonomic (Bour, 1988; Boycott, 1986), and distributional (Greig and Burdett, 1976; Loveridge and Williams, 1957; Iverson, 1992) data are reported in the literature; morphometric data and field observations have not been reported. The objective of this study was to obtain morphometric and ecological data for *Homopus s. signatus* within a selected study site during the mid-summer season of December–January in Namaqualand.

On the basis both of direct observation and the opinions of officers of the Cape Department of Nature Conservation, it appears that *H. s. signatus* is not currently endangered and is still fairly common within its restricted microhabitat. Possible threats to populations include: habitat alteration due to mining developments, grazing practices, and reported human predation.

Tortoise populations are threatened worldwide and it is imperative that base line morphometric and observational studies be initiated to unravel basic biological dynamics on poorly known tortoise taxa such as *H. s. signatus*. It is through these preliminary investigations that comprehensive long term management plans can be initiated to insure the future survival of these inconspicuous tortoises.

METHODS

Fieldwork was conducted during two separate visits to South Africa (3–20 January 1991 and 5–21 January 1992). A single kopje was selected near the town of Springbok. The predominantly east-facing kopje consists of a xeric, mixed woodland of approximately 6000 m^2 and is separated from other kopjes by a sandy plain. This area was chosen because it appeared to be free from direct human disturbance such as housing and farming and was easily accessible.

Tortoises were located opportunistically throughout the daylight hours (0700–1900 hrs) by searching the kopje and examining crevices, at times with the aid of a flashlight. When a tortoise was discovered, a thermometer (ReTemp Digital TM99-A) was placed on the ground in the sun, 30 cm from the entrance of the crevice to record ground temperature. Height of crevice opening was taken from floor to ceiling. Crevice orientation relative to general compass direction (N, S, E, or W) was also noted.

Tortoises were carefully removed and cloacal temperatures were recorded immediately. Measurements of several shell parameters were taken using a modified tortoise ruler (Devaux, 1988) and included: straight carapace length (CL), straight plastron length (PL), maximum carapace width (CW), maximum carapace depth (CD) (Meek, 1982). Body weight (BW) was recorded to the nearest gram using a digital scale (Ohaus Lume-O-Gram), periodically rechecked for accuracy.

Each tortoise was marked by placing a small amount of typewriter correction paste (Wite-Out™) on the 4th right costal scute, sequentially writing a three digit number on the paste with an India ink pen (All Weather Pen™), and sealing the area with epoxy resin cement (Devcon™ epoxy). This harmless technique has been used very successfully with desert tortoises *Gopherus agassizii* in southern Nevada (D. Duncan, *pers. comm.*) and has a 4–6 year life span. Tortoises were then replaced as found.

Data were organized and statistically analyzed using Cricket Graph™ and StatWorks™. Student's *t*-tests and Chi-square tests (Sokal and Rohlf, 1981) were performed to compare male and female data and to test for statistical differences.

RESULTS

During the two visits, it took 280 field hours to locate 71 tortoises (males $n = 27$, females $n = 44$) resulting in a mean discovery rate of 0.25 tortoises/hour. Twelve tortoises were located in 1991 and 59 in 1992. No tortoises marked in January 1991 were located during the January 1992 visit.

Shell parameters and body mass data for all tortoises are given in Table 1. Ranges of carapace length and body weight were 39.1–103.0 mm and 15.0–163.0 g for females and 40.6-87.5 mm and14.0-96.0 g for males, representing new range limits for the species. Figure 3 represents the size-class distribution of the study population which reveals that the tortoise population of this kopje includes more adult females than either males, hatchlings, or juveniles. Allometric data comparing body mass to straight carapace length are represented in Fig. 4. A Chi-square test indicates significant difference between the number of females located compared to all tortoises ($P < 0.05$, $x^2 = 4.94$, df = 69).

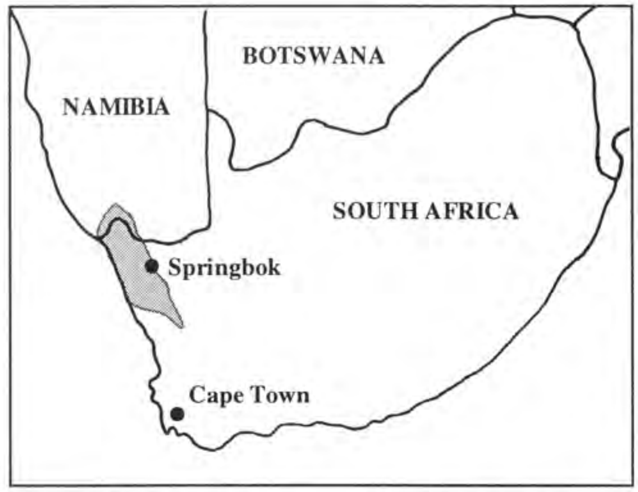

Figure 1. Map of southern Africa with shaded portion defining the range of *Homopus signatus signatus*, showing the location of the study area at Springbok, Namaqualand, northwestern Cape Province, South Africa.

All tortoises encountered were within crevices and alone (Fig. 5). Typical crevices were composed of a loose dolomite rock slab resting on top of a solid dolomite base ≥ 2400 cm^2 in area, and there was usually a light scattering of loose sand throughout the chamber. A Student's *t*-test indicated no significant difference in the opening height of crevices occupied by males and by females ($P > 0.05$, $t = 0.09$; df = 69). Entrance orientations were most commonly ($n = 39$) exposed to the east. Although most occupied kopjes

Figure 2. A typical kopje microhabitat for *Homopus signatus signatus* near Springbok, northwestern Cape Province, South Africa, showing sparse plant growth in January.

Table1. Morphometric data for selected shell parameters of *Homopus signatus signatus* from study population at Springbok, northwestern Cape Province, South Africa. CL = straight carapace length (mm), PL = straight plastron length (mm), CW = maximum carapace width (mm), CD = maximum carapace depth (mm), BW = body weight (g).

	Male (n = 27)			Female (n = 44)		
	Mean	SD	Range	Mean	SD	Range
CL	73.9	10.9	40.6–87.5	78.9	16.6	39.1–103.0
PL	57.7	8.8	31.6–67.4	66.8	15.0	30.2–86.7
CW	49.2	6.6	34.4–57.9	29.6	4.1	21.2–35.7
CD	27.5	3.5	18.0–33.4	31.7	7.2	15.2–43.2
BW	64.9	20.5	14.0–96.0	70.0	29.2	15.0–163.0

faced eastward some had westerly exposed crevices which also contained tortoises. Sixteen males (59%) and 27 females (61%) were aligned with their shell orientation parallel to the crevice entrance [side of shell seen when viewed from outside the crevice], while 11 males (41%) and 17 females (39%) faced directly away from the crevice opening and had their shells wedged into the back of the crevice [back of shell seen].

Cloacal temperatures did not match ground temperatures in a consistent manner. Figure 6 plots tortoise cloacal temperatures and ground temperatures in relation to time of day when located. There was a significant difference between male and female cloacal temperatures ($P < 0.05$, $t = 2.53$, df = 52), however, there was no significant difference between cloacal temperatures and ground temperatures for both male ($P > 0.05$, $t = 0.716$, df = 25) and female ($P > 0.05$, $t = 0.135$, df = 42) tortoises. Presumably because of high ground temperatures ($\geq 26^{\circ}$C), tortoises were largely inactive.

Low browse vegetation (≤ 10 cm) throughout the kopje was extremely sparse with only occasional dry grasses (Poaceae) scattered between rock fissures and between the sandy plains separating kopjes (Fig. 2). No plants were discovered in bloom on the kopje during either January visit to the study area, although blooms (Asteraceae) were periodically seen along the margins of nearby sandy roads.

Seventy-five percent of the tortoises ($n = 53$) had very variable carapace coloration which consisted of a random orange to rust background with variable radiating black lines in an inconsistent pattern, while 6% ($n = 4$) had a unique coloration of light creamy pink with no black pigmentation. The remaining individuals (19%) had no unusual shell coloration. Only 12% ($n = 9$) of the tortoises mimicked the original rock coloration in which they were located and were not easily detected when placed atop their respective rock crevice.

DISCUSSION

A preponderance of adult female individuals were discovered in the population. This may be due to sampling bias towards females which were much easier to locate in crevices than males because of their larger overall size. The under-representation of males or juveniles may also be due

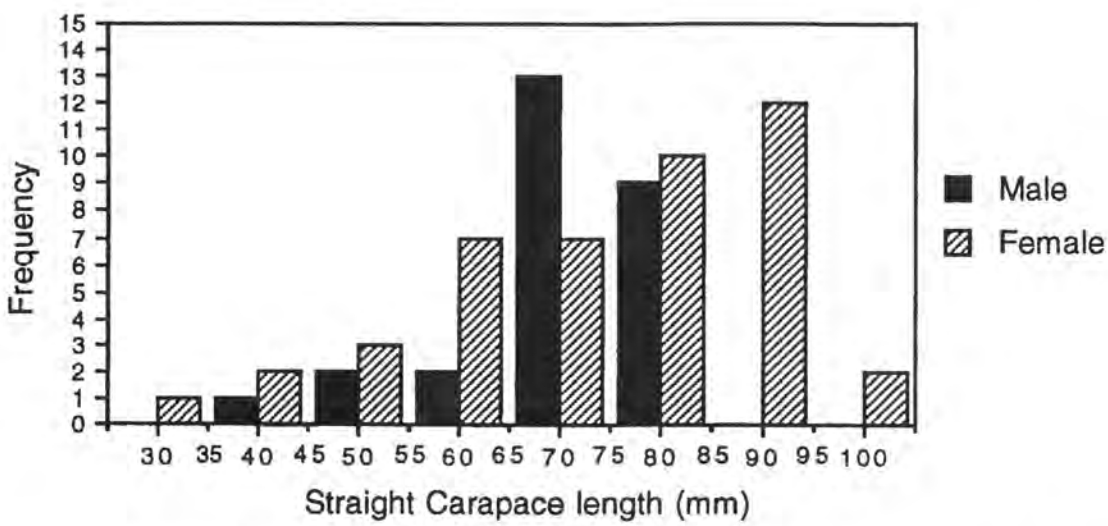

Figure 3. Population size classes of *H. s. signatus* from a single kopje at Springbok, northwestern Cape Province, South Africa.

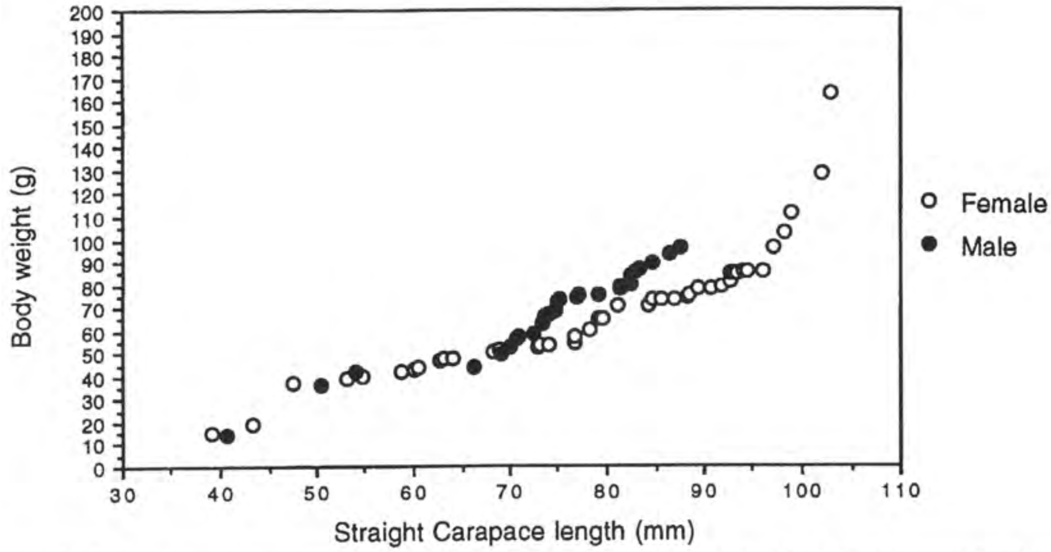

Figure 4. Relationship between straight carapace length and body weight of *H. s. signatus* at Springbok, northwestern Cape Province, South Africa.

to several observational errors. For example, it was not possible to locate every single crevice in a kopje or to turn over every rock slab, and some crevices descended several meters beyond the sight of the observer.

Tortoises never constructed a burrow or altered their crevices significantly. Congeneric species, especially *Homopus areolatus* and *H. femoralis*, are known to excavate into the ground surface near bases of bushes and dry grass tussocks, (A.L. de Villiers, *pers. comm.*). According to Branch (1988) crevices may be occupied by more than one individual, but this was not observed during the present study. It may be that cohabitation of crevices occurs during the breeding season, which is thought to occur during August–September (Boycott and Bourquin, 1988), although Branch (1988) did not indicate the time of year when his observations were made.

The kopje was oriented in an easterly direction, and there are several reasons why west-facing crevices may be considered poor choices for tortoise shelters during the summer season. The tortoises have a diurnal activity cycle and west-facing crevices will not be able to absorb solar energy until afternoon at the earliest. This would limit the time for a tortoise to raise its body temperature sufficiently in order to initiate feeding or digestion. Namaqualand expe-

Figure 5. Female *Homopus signatus signatus* (CL 39.1 mm) found in crevice, Springbok, northwestern Cape Province, South Africa.

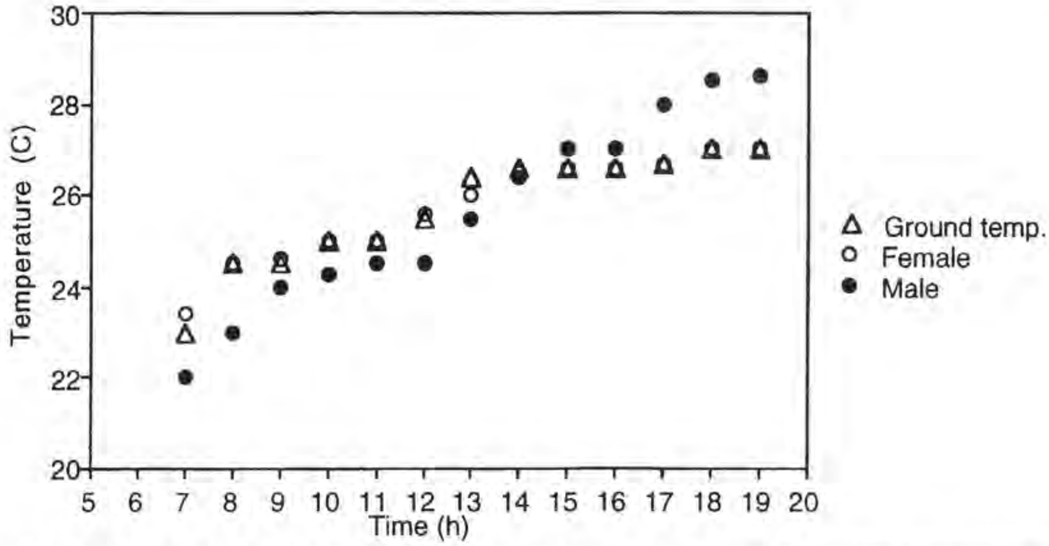

Figure 6. Comparison of ground temperature and *H. s. signatus* cloacal temperature in relation to time of day. Data from study population at Springbok, northwestern Cape Province, South Africa.

riences windy conditions on a regular basis during the summer season when ground temperatures are at their highest (Eliovson, 1990) and wind direction is generally westerly. This could diminish the scarce humidity inside a west-facing crevice. Similar findings of water loss in dry burrows have been reported for snakes and amphisbaenians (Krakauer et al., 1968).

Despite an intensive search for tortoises away from crevices at different hours throughout the day when air temperatures may have been more favorable for activity, no tortoises were ever observed walking outside of crevices. For those tortoises in which the head was clearly visible within the crevice, each tortoise appeared to be resting with the eyes remaining closed until touched by the observer. Once disturbed, each individual immediately responded by either withdrawing into its shell or trying to escape further within the crevice. It was customary for tortoises when placed outside their respective crevice opening to immediately retreat into the crevice.

It is unclear why no marked tortoises or remains of tortoises marked in January 1991 were recaptured or observed during January 1992. There are several factors that may have influenced this result over the course of the year. Predators could have removed individuals from the population or tortoises may have left the kopje during more favorable climatic conditions. Alternatively, the selected marking technique may have failed or tortoises may have used concealed crevices not discovered by the observer during the study.

Allometric growth curve comparisons of tortoises are well documented for *Chersina angulata* (Branch, 1984), *Geochelone gigantea* (Bourn and Coe, 1978), *G. sulcata* (Cloudsley-Thompson, 1970; Lambert, 1993), *Gopherus agassizii* (Woodbury and Hardy, 1948), *G. berlandieri* (Bury and Smith, 1986), *Psammobates geometricus* (Baard, 1990), *Testudo graeca* (Blasco et al., 1987), and *T. hermanni* (Meek, 1982). Jackson (1980) has suggested that growth curve data in *Testudo graeca* and *T. hermanni* may play a role in assessing the overall health of an individual in captivity. Although the observed correlation of body mass to straight carapace length of *H. s. signatus* in this study was fairly high for both sexes, further measurements are needed to elucidate growth patterns and the effect of reproductive condition.

Tortoise species such as *Gopherus agassizii* (J. Peterson, *pers. comm.*) and *Chersina angulata* (Branch, 1984) may void large quantities of liquid from their cloaca when disturbed, especially when first handled in the field. In this study only four *H. s. signatus* did so when handled. It is possible that tortoises at this time of year did not have sufficient quantities of water stored in their bladders or were unwilling to void this precious water even when under stress.

Several tortoise species such as *Gopherus berlandieri* (Voigt and Johnson, 1976), *G. agassizii* (Woodbury and Hardy, 1948), and *Testudo kleinmanni* (Geffen and Mendelssohn, 1989) enter a state of aestivation during hot drought conditions when food resources become unavailable. *Testudo kleinmanni* in Israel became inactive when air temperatures exceeded 30°C and ground plants withered (Geffen and Mendelssohn, 1989). Eliovson (1990) reported that the hottest, driest periods in Namaqualand occur during the months of December through February, mid-summer for this region. Daily high temperatures usually exceed 30°C and infrequent scattered showers may contribute only 4 mm of moisture during the entire season (Eliovson, 1990). Considering the harsh conditions of Namaqualand at this time of year and the sparse vegetation (Fig. 2) available for the tortoises, it appears that *H. s. signatus* follows an aestivation cycle similar to that of *T. kleinmanni*.

In describing 34 individuals of *H. s. signatus*, Duerden (1907) emphasized that carapace shield coloration typically includes an orange to rust background with black, geometrical, rayed or spotted color pattern. Boycott and Bourquin (1988) indicated that tortoises may take advantage of this cryptic coloration to avoid predation, but in this study, most tortoises were easily detected when placed above their respective crevice. It is unclear if hatchlings or juveniles possess a different color pattern than adults, because none were found during this study. In this study the smallest tortoise found was 39.1 mm and was identified as female with a fairly dark overall color pattern (Fig. 5). When compared to another specimen of 40.6 mm classified as a male, two secondary sex characteristics were evident: short and broad tail and flat plastron as compared to the larger male tortoise. Duerden (1907) states that the color pattern in "very young" *H. s. signatus* is very similar to that of young leopard tortoises, *Geochelone pardalis*. No hatchlings were located in this study for any color comparison.

Boycott et al. (1988) established the average mature carapace length for males at 85 mm and for females 95 mm. As Table 1 shows, new minimum and maximum ranges in carapace length and body weight for both male and female tortoises were recorded in this study. Although it was possible to sex the small tortoises that were located, it remains unclear what size must be attained for reproductive capacity.

It is recommended that future studies on *Homopus signatus signatus* should include observations during other seasons, when natural activities outside of crevices may be more typical. Research projects should not only consider marking more individuals, but should also contribute data on tortoise density and movements, diet, reproduction, and longevity.

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