OCCURRENCE AND ACTIVITY BUDGET OF THE LEOPARD TORTOISE *GEOCHELONE PARDALIS*, IN NORTHERN TANZANIA

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ABSTRACT

Occurrence and activity budget of the leopard tortoise, Geochelone pardalis *were studied in northern Tanzania between October 1993 and June 1996. Tortoises occurred most frequently in short grass (51.5%) and along roads and track verges (33.9%), but only occasionally in the bush undergrowth (6.7%) and shambas (3.6%). Walking (46.3%) and feeding (37.2%) were the most frequent activities. Resting was observed only occasionally (13.6%) while courtship (1.9%) and drinking (0.9%) were rarely recorded. Activity budget differed significantly between the age classes and habitats, but not between the sexes. Juveniles walked more frequently (59.3%) than other age classes. Walking was most frequent along roads and tracks (68.8%). Adult tortoises rested more frequently (18.7%) than other age classes but the difference was not significant. The proportions of individuals resting in the various habitats differed significantly, with resting being most frequent in the shrub undergrowth (93.3%). Juveniles were observed feeding less frequently than other age classes but the difference was not significant. Feeding was recorded in all habitats, but it was least frequent in the shrub undergrowth.*

INTRODUCTION

Few quantitative data have been published on the activity and behaviour of most of the tortoises (Swingland & Klemens 1989). This is primarily due to the difficulty of studying the animals which have a very narrow activity pattern and which occur at low densities characteristic of many tortoises (Swingland & Klemens 1989). Broadley (1989) has made a review on the activity and behaviour of the leopard tortoise. Individuals probably live singly and come together for breeding. Like most tortoises, leopard tortoises are more active during the wet season, being very difficult to find during the dry season when they presumably aestivate (Broadley 1989). Leopard tortoises are active in the morning and evening when it is cool but seek shelter to avoid excessive heat at noon (Greig & Boycott 1980, Grobler 1982). Details on the relative frequency

of tortoise activities and their occurrence in the various habitats are lacking. The study reported here examined the frequency of various leopard tortoise activities and the factors influencing them.

METHODS

Field observations were made in Tarangire, Lake Manyara and Serengeti National Parks and neighbouring villages in northern Tanzania between 1993 and 1996 (Kabigumila 1998a). Most of the area lies within the Somalia-Masai floristic region (White 1983) which is dominated by extensive *Acacia-Commiphora* deciduous bushland and thicket, and with edaphic grasslands on the Serengeti plains. The climate in these areas is typically semi-arid, with a bimodal rainfall regime. The "short rains" fall in November-December and the "long rains" in March through May. Observations were made during the rainy season when leopard tortoises are active (Broadley 1989, Kabigumila 1998b).

Searches for leopard tortoises were made by carefully examining the appropriate habitats such as grass, shrub undergrowth, termitaria, under rocks and logs, burrows, and road edges. Other records were obtained from tortoises sighted while driving at moderate speed (30-40 kph) or walking through the study area (Malan & Branch 1992). This method may be biased if the road system is not representative of the area (Norton-Griffiths 1978). However, the road system and tracks traversed most of the habitats. Most observations were made in the morning between 08.00 and 12.00 h when tortoises are most active (Kabigumila 1998b).

Altmann (1974) and Martin and Bateson (1986) have reviewed the techniques used to study the activity and behaviour of animals. The focal animal- and scan sampling techniques which are commonly used in some behaviour studies could not be applied in this study because preliminary observations showed that leopard tortoises were too shy and difficult to find in the time available. Therefore, a variant of the "first feed technique" (Croze 1974) was used to study the activity budget of tortoises by recording what the animal was doing when first sighted. Five categories of tortoise activity were recorded: resting (head and limbs retracted into the carapace), walking, feeding, drinking and courtship (male following female with or without butting her rear).

For each sighting, records were made of sex and midline straight-line length (CL) of individual(s) and the activity when first spotted. Tortoises were categorised into three age classes using CL as an index of age (Andrews 1982, Kabigumila 2000). Occurrence of tortoises in the various habitats was recorded under the following categories: short grass (<25 cm), medium tall grass (25-35 cm), tall grass (>35 cm), litter, bush undergrowth, road/track edges, *shambas* (crop fields), termitaria, logs, and pond edges. Cover of the herb layer was estimated subjectively as the proportion of the ground covered by vegetation (Mueller-Dombois & Ellenberg 1974) within 1-m radius of the

animal. The data were analysed to show the occurrence of leopard tortoises in relation to cover in the various habitats, and the frequency of various activities.

RESULTS

Occurrence in the habitats

Most tortoises (51.5%, n = 478 sightings) were found in short grass and somewhat fewer were found along roads or track verges (33.9%) (Fig. 1). Some tortoises were also found in the bush undergrowth (6.7%) and *shambas* (3.6%). Only very rarely were tortoises seen in tall grass, under logs or at ponds. Percentage cover in the habitats ranged from 50.9±4.9% in short grass to 92.1±15.3% in the medium tall grass and 97.1±4.0% in the bush undergrowth (Fig. 2). The difference in percentage cover between the three habitats was significant (Kruskal-Wallis test, H = 37.555, d.f. = 2, p = 0.000). Inter-habitat comparisons showed a significant difference (Tukey test, Q, p<0.001) except in bush undergrowth *versus* medium tall grass.

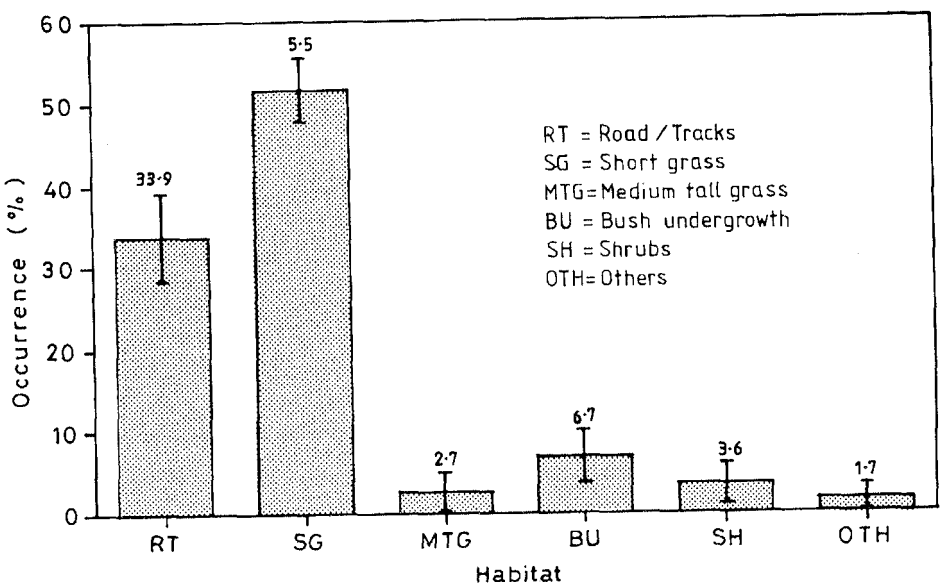

Fig. 1: Occurrence of leopard tortoises in the habitats. Northen Tanzania, 1993-1996. RT: road/track; SG: short grass; MTG: medium tall grass; BU: bush undergrowth; SH: *shamba*; OTH: others.

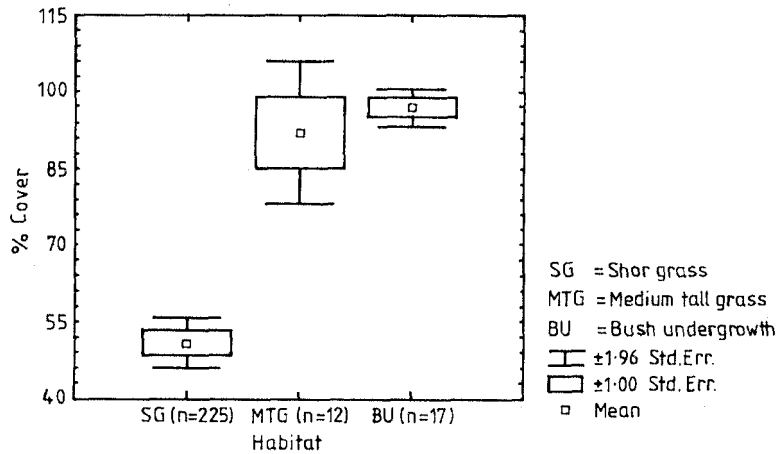

Fig. 2: Comparison of percentage cover between the habitats. Northen Tanzania, 1993-1996. SG=short grass; MTG=medium tall grass; BU=bush undergrowth. *n* = number of cover records

The occurrence of tortoises in the four most frequented habitats differed significantly between the age classes with few juvenile tortoises being sighted in the bush undergrowth and *shambas* ($\chi 2$ = 16.468, d.f. = 6, 0.025>p>0.01) (Fig. 3). However, no significant difference between the sexes was detected in their occurrence in the various habitats ($\chi 2$ = 12.544, d.f. = 6, p = n.s) (Fig. 4).

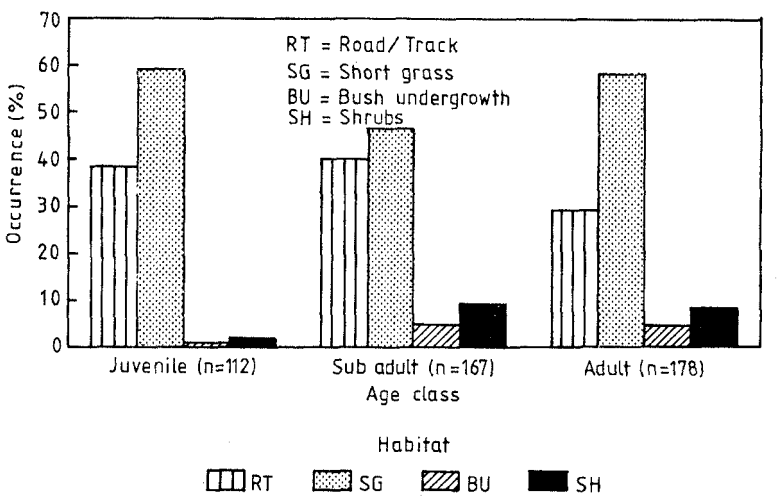

Fig. 3: Occurrence of leopard tortoises in the habitats compared between the age classes. Northen Tanzania, 1993-1996. RT: road/track; SG: short grass; BU: bush undergrowth; SH: *shamba*

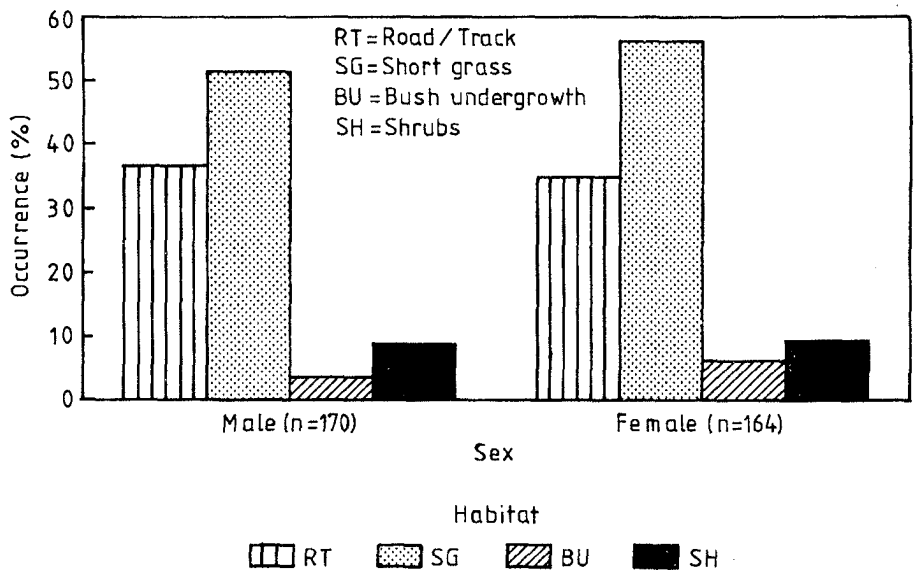

Fig. 4: Occurrence of leopard tortoises in the habitats compared between the sexes. Northern Tanzania, 1993-1996. RT: road/track; SG: short grass; BU: bush undergrowth; SH: *shamba*

Activity budget

Walking and feeding were the most frequent activities accounting for 46.3% and 37.2% of the sightings (n = 309), respectively (Fig. 5). Resting was observed only occasionally (13.6%) while courtship (1.9%) and drinking (0.9%) were rarely recorded. Comparison of the most frequent activities (≥10.0%) was made between the various age classes (Fig.6). The difference between the age classes was significant (X^2 = 10.189, d.f. = 4, $0.05>p>0.025$), with juveniles most frequently walking. Comparison between the sexes showed no significant difference (X^2 = 5.351, d.f. = 2, p =n.s) (Fig. 7). Comparison was also made between the various habitats (Fig. 8), and the difference in the frequency of the various activities between them was very significant (X^2 = 137.17, d.f. = 6, $p << 0.001$).

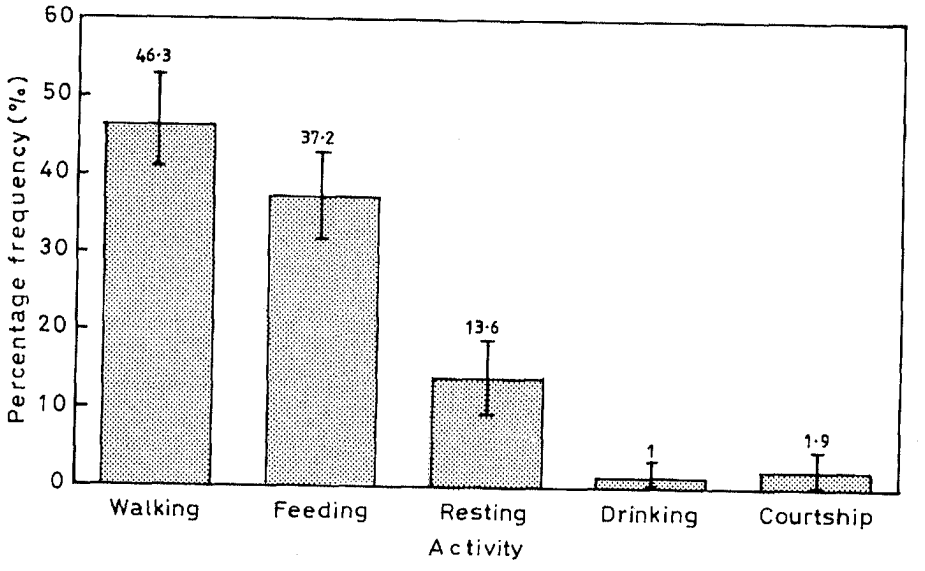

Fig. 5: Frequency (%) of activities recorded in leopard tortoises found in northern Tanzania (n = 309 tortoise sightings) between 1993 and 1996

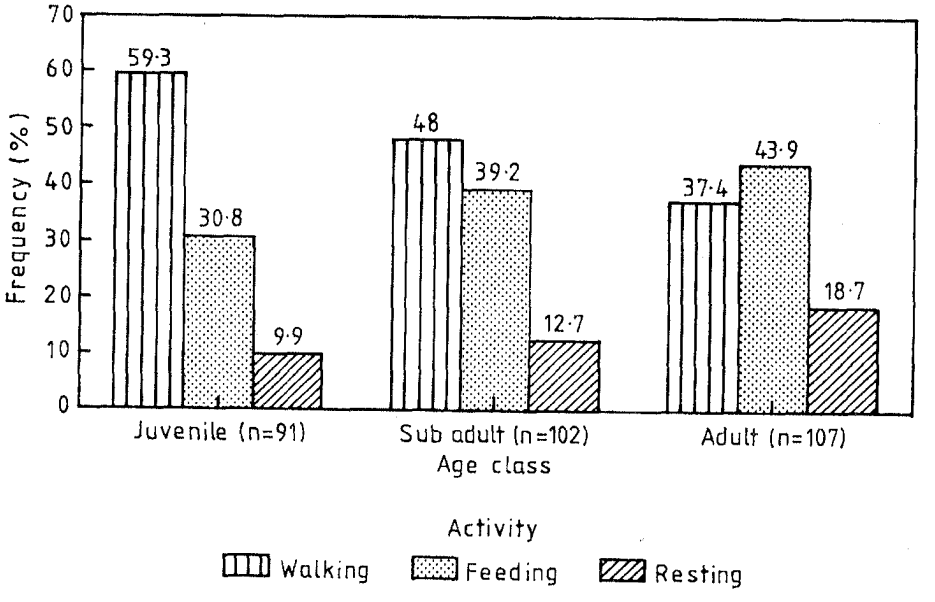

Fig. 6: Frequency (%) of activities compared between the different age classes in leopard tortoises recorded in northern Tanzania between 1993 and 1996

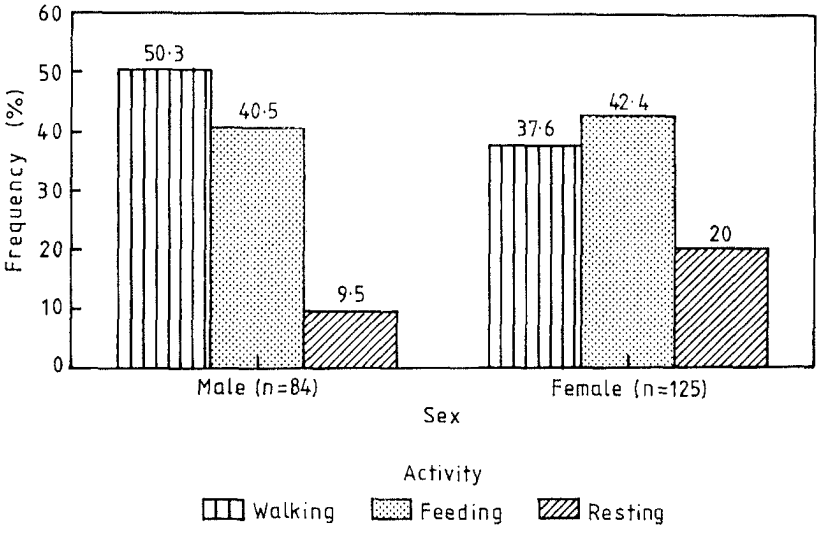

Fig. 7: Frequency (%) of activities compared between the sexes in leopard tortoises recorded in northern Tanzania between 1993 and 1996

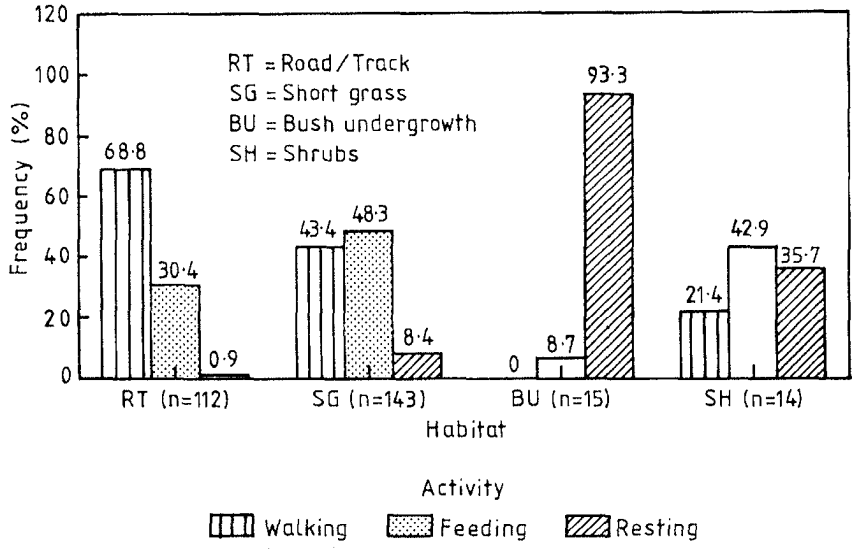

Fig. 8: Frequency (%) of activities recorded in leopard tortoises compared between habitats. Northen Tanzania, 1993-1996. RT= road/track verges, SG= short grass, BU= bush undergrowth, SH= *shamba*

Juveniles were found walking more frequently (59.3%, $n = 91$) than other age classes: the proportions of individuals walking was significantly different between the various age classes ($X^2 = 9.514$, d.f. = 2, $0.010>p>0.005$) (Fig.

6). Also, walking was most frequent along road or track verges (68.8%, n = 112) but was not recorded in the bush undergrowth (Fig. 8). The proportions of individuals walking in the various habitats was significantly different (X^2 = 37.846, d.f. = 3, p<0.001).

Adult tortoises rested more frequently (18.7%, n = 107) than other age classes but the difference was not significant (X^2 = 3.478, d.f. = 2, p=n.s). However, there was a significant difference in the proportions of individuals resting in the various habitats (Fig. 8) (X^2 =19.909, d.f. = 1, p<0.001): resting was most frequent in the bush undergrowth (93.3%, n = 15) and occurred rarely in other habitats.

Drinking was observed only on three occasions (1.0%, n = 309) in which two adults and one sub adult tortoises were found drinking at ponds. Courtship was observed only on three occasions in which the male was following the female while butting the posterior of the carapace of the female with his head; no copulation was observed. Attempts to record the activity in detail failed because the animals were very shy and walked away on noticing the presence of the observer. All the sightings were made in the afternoon during the short rains.

DISCUSSION

Occurrence in the habitats

Leopard tortoises were found mostly in short grass and along road or track verges, but rarely in tall grass. Tortoises were easier to detect in these habitats because of the sparse cover and especially if they were walking and/or in courtship. Additionally, short grass and road verge habitats offer less obstruction to movement of active tortoises than tall grass. It is possible that some tortoises, particularly juveniles, were missed in the tall grass and bush undergrowth due to the dense cover and cryptic coloration of the species. A low detection rate of juveniles has been reported by other workers for leopard tortoises (Wilson 1968) and other species including *Aldabrachelys elephantina* (Bourn & Coe 1978), *Gopherus flavomarginatus* (Morafka 1982, Tom 1994), *G. berlandieri* (Rose & Judd 1982), *G. agassizii* (Osorio & Bury 1982), and *Testudo hermanni* (Meek 1985, Swingland & Stubbs 1985). However, it is possible that leopard tortoises were most frequently found in short grass and along road verges because such habitats supported an abundant supply of succulents (e.g. *Cissus rotundifolia*, *Commelina africana*, *C. forskalaei*) and short grasses (e.g. *Dactyloctenium aegyptium*, *Tragus berteronianus*) which dominated the tortoise diet (Kabigumila 1998b). Milton (1992) has also attributed the occasional use of road verges by leopard tortoises to the abundance of ephemeral plants growing there.

Some tortoises were sighted in the bush undergrowth where they presumably sought cover for shade and shelter from predators while resting. (M. Rall

pers. comm.) made similar observations on Naval Hill in South Africa. She noted that during the midday hours, leopard tortoises crept deeper under shrubs that provided sufficient shade from the high summer temperatures.

Tortoise occurrence in the various habitats varied significantly between the age classes, with few juveniles being sighted in the bush undergrowth and *shambas* suggesting that the preferred habitats might vary with age. The paucity of juveniles in the *shambas* is probably due to frequent human disturbance or predation by dogs and cats (Kabigumila 1998b). Variation in habitat preference with age has been shown in *T. hermanni* (Stubbs & Swingland 1985) and *G. flavomarginatus* (Tom 1994). The difference in habitats of the various age classes can be attributed to differences in thermal inertia, water balance, physiological strength, and susceptibility to predation between adults and juveniles (Tom 1994). Smaller tortoises heat faster and have a higher rate of evaporative cooling relative to their body mass than larger tortoises (Judd & Rose 1977, Lambert 1981). In addition, smaller tortoises also have less ossified shells and are more susceptible to predation than adult animals.

Tortoise occurrence in the various habitats did not vary with sex, suggesting that the sexes might have similar habitat preferences. Stubbs & Swingland (1985) have also shown this for *T. hermanni* in the Massif des Maures, France. However, differential occurrence between the sexes has been reported in *A. elephantina* due to females tending to stay at nesting sites after the breeding season (Gibson & Hamilton 1983).

Several tortoises were also sighted in the *shambas* suggesting the importance of human-altered habitats in the ecology of leopard tortoises. The tortoises were presumably attracted by the year-round supply of green food plants (e.g. crops and other plants associated with such ecotonal habitats), and availability of shelter and shade in the *Opuntia vulgaris* and *Agave sisalana* hedges, which the local people erected around their homesteads and *shambas*. Here tortoises causeed damage to crops leading to conflict with the farmers (Kabigumila 1998a). In Morocco's Souss Valley, ecotonal habitats are used by *Testudo graeca graeca*, particularly during drought, due to the availability of green vegetation sustained by irrigation water and due to the availability of shade (Highfield & Bayley 1995). In South Africa's Eastern Cape Province, dense *Chersin angulata* populations have been found in ecotonal habitats created by human activity such as agriculture and ranching (Branch 1984).

Activity budget

Observations on activity budget of leopard tortoises were mostly made during the peak periods of activity in the morning hours to maximise sample size. As detectability of tortoises also depends on their activity (Lambert 1981, Stubbs & Swingland 1985), inactive tortoises obscured by thick undergrowth could have been underrepresented (Lambert 1981). Such activities as courtship,

mating and nesting which are known to occur towards the evening (Loveridge & Williams 1957) could also have been missed. Therefore, the present data should be interpreted with caution, and used only as an approximation.

Walking and feeding were the most frequent activities. Since no comparable data were available on other leopard tortoise populations, it is difficult to say if these activities were more or less frequent than expected. However, Hailey *et al.* (1984) reported feeding in *Testudo hermanni* being less common than walking and courtship, while Stubbs & Swingland (1985) have reported feeding being very frequent in the same species.

There was differential activity between the age classes. Lambert (1981) and Hailey *et al.* (1984) have also reported this for *T. graeca* and *T. hermanni*, respectively. They showed that juvenile tortoises tended to be more active in the early morning when it was cooler. This was ascribed to size and thermal inertia, small animals heating faster in the late morning when ambient temperatures become limiting (Lambert 1981, Hailey *et al.* 1984). In the present study, juvenile tortoises walked more frequently than other age classes, suggesting that they were more active in the morning. Activity of leopard tortoises was not significantly different between the sexes suggesting that the activity patterns were similar. However, Mason & Weatherby (1995) have shown that activity differs between the sexes with males tending to walk more frequently than females. Differential activity between the sexes was also reported by Lambert (1981) in *T. graeca*.

Leopard tortoise activity budget varied significantly between the habitats, with feeding and walking being least frequent in the bush undergrowth. This suggests differential use of the various habitats by leopard tortoises. The bush undergrowth was used for resting, thus providing cover both for shade and shelter from insolation and predators. Walking was most frequent along the road or track verges while tortoises were foraging or moving between habitat patches.

Courtship was observed during the short rains, and allowing for 6-7 months incubation period (Broadley 1989), hatchlings would probably emerge during the following short rains. The general pattern of courtship behaviour observed in the present study is similar to that previously described for the species in captivity (Loveridge & Williams 1957). However, the paucity of such observations suggests that courtship period in leopard tortoises is seldom observed in the wild. It is possible that if courtship is relatively short and silent, it could easily have been missed. Esque and Peters (1994) have also reported the paucity of courtship sightings in *Gopherus agassizii*.

CONCLUSION

Leopard tortoises were found mostly in areas with sparse cover probably because they were easier to detect, or because such habitats supported an abundant supply of succulents and grass which dominated the tortoise diet. Tortoise occurrence in the various habitats suggested that the preferred habitats might vary with age. Some tortoises were sighted in the *shambas* suggesting the importance of human-altered habitats in the ecology of leopard tortoises.

Walking was most frequent along the roads and tracks while tortoises were foraging or moving between habitat patches. Courtship was seldom observed. Observations on the activity budget of leopard tortoises were made in the morning. A study, examining the behaviour of tortoises at other periods of the day, than the morning, would provide useful information; depending on the habitat(s) involved, this might be combined with the use of telemetry. National Park rangers and wildlife scouts could be trained to monitor distribution and activity in the tortoises.

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