INCIDENCE OF INJURIES AND MORTALITY IN THE LEOPARD TORTOISE, *GEOCHELONE PARDALIS*, IN NORTHERN TANZANIA

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ABSTRACT

*Observations were made of injuries and mortality in the leopard tortoise (*Geochelone pardalis*) in northern Tanzania between October 1993 and June 1996. Tortoise injuries were more frequent at unprotected (15.3%) than at protected sites (4.7%). Fire was the most frequent cause, accounting for 44.0% of the injuries. Of the animals encountered, 12.9% were found dead. Dead animals were encountered more frequently at protected (25.4%) than at unprotected sites (8.3%). Carapace injuries (6.8%) and road kills (5.1%) were the only causes of mortality identified. Mortality was higher in adults (13.9%) than in immature animals (5.5%), and in females (13.9%) than in males (6.4%). Mortality was more frequent at the Arusha Region (46.8%) than at the Mara Region sites (7.6%).*

INTRODUCTION

Although details on the biology and management of the leopard tortoise (*Geochelone pardalis*) have recently emerged (Broadley 1989, Rall & Fairall 1993, Kabigumila 1998a, Lambert *et al.* 1998), very little is known about their incidence of injuries and mortality. The study reported here was made with a view to providing baseline information for monitoring the ecology of leopard tortoises in northern Tanzania.

METHODS

Observations were made in Tarangire and Lake Manyara National Parks (Arusha Region) and Serengeti National Park (Mara Region), and adjacent villages in northern Tanzania between October 1993 and June 1996.

For each tortoise sighted, midline straight-line lengths of the carapace were measured and sex recorded (Lambert 1993). Tortoises were categorised into three age classes using carapace length as an index of age (Andrews 1982, Kabigumila 2000). The number of carcasses was recorded and where possible the cause of mortality was assessed by examination of carcasses. The number of tortoises with tooth or claw-marks, carapace dents and fire scars was also recorded.

RESULTS

The percentage of injured tortoises differed significantly between protected (4.7%, n=85) and unprotected sites (15.3%, n=314) ($\chi^2 = 6.61$, d.f. = 1, $0.05>p>0.010$). Fire accounted for 44.0% of the injuries (n=52), and left the carapace gnarled after the scutes had peeled off. Carapace dents (probably inflicted by blunt objects or by being tossed about) and gashes (inflicted by predators) accounted for 30.0% and 26.0% of the injuries, respectively.

A total of 59 carcasses accounting for 12.9% of the tortoises recorded over the study period (n= 458) were found, and information on age class and sex was obtained from the 38 tortoises which had intact carapaces. The percentage of carcasses differed significantly between protected (25.4%, n=114) and unprotected sites (8.7%, n=344) ($\chi^2 = 21.320$, d.f.=1, $p<0.001$), and between the age classes ($\chi^2 = 9.735$, d.f.=2, $p<0.001$). The highest proportion of carcasses was recorded in adults (13.9%, n=166), compared to 6.7% in subadults (n=163) and 3.7% in juveniles (n=108). The difference between the sexes was also significant ($\chi^2 = 4.93$, d.f.=1, $p<0.020$), with a higher proportion of carcasses in females (13.9%, n=108) than in males (6.4%, n=156). Comparison between the Arusha and Mara Region sites showed a significant difference ($\chi^2 = 73.393$, d.f.=1, $p<0.001$), with a higher proportion of carcasses being found at the Arusha (46.8%, n=62) than at Mara sites (7.6%, n=396).

Only 13.6% of the carcasses (n=59) could be attributed to known causes such as road kills (5.1%), carapace wounds (6.8%), and predation (probably by ground hornbill (*Bucorvus cafer*)) (1.7%). All the tortoises with carapace wounds or signs of healing were found near human settlements.

DISCUSSION

Observations in the present study are consistent with those of previous workers (Grubb 1971, Branch 1984, Duck & Sneider 1994, De Silva 1995, Bayley & Highfield 1996) in showing that wild tortoises frequently sustain carapace damage. Fire injuries were the most common. As observed in the present study and in other tortoise populations (Loveridge & Williams 1957, Lambert 1982, Branch 1989), the fire scorched areas of the carapace of some animals were able to heal and generate scar tissue during reparative growth. Bushfires were an important regular, seasonal and largely anthropogenic feature, of savannah ecology of East Africa. The fires are essential for regeneration of many plants (Vesey-Fitzgerald 1973). It has been suggested that leopard tortoises at the Mara sites could be fire-adapted, and that this is achieved through rapid growth and early maturity (Lambert *et al.* 1998). In some parts of South Africa *Psammobates geometricus* has also been said to be fire-adapted (Boycott & Bourquin 1988).

The nature of carapace dents and gashes recorded suggest that humans injured the animals. Children, who were known to harm leopard tortoises feeding on crops, probably caused the injuries, but this was rare (Kabigumila 1998b). In Morocco, Bayley & Highfield (1996) have reported a farm worker picking up two tortoises (*Testudo graeca*) feeding on crops and throwing them forcefully onto a nearby pile of rocks.

Only a few carcasses were recorded in the present study possibly because some of the tortoises, particularly juveniles, could have been eaten whole by predators. Furthermore, some dead animals could have been missed due to the dense cover at some of the sites. Although the sample size is very small and the variables involved too complex to draw valid conclusions, it is possible to speculate on some of the findings. It would appear that conditions in the Arusha Region samples, even within the protected area network, were harsher (e.g. prolonged drought, lack of shade, high ambient temperatures) for tortoises than those in the unprotected areas of the Mara sites. Germano & Joyner (1994) also reported high rates of mortality for *Gopherus agassizii* in a limited portion of their study area. They speculated that starvation, disease, and flooding might have contributed to tortoise deaths. Bourn & Coe (1978) reported significant losses of *Aldabrachelys elephantina* on Aldabra Atoll due to over-exposure and the consequent hyperthermia of animals unable to find suitable shelter during the heat of the day.

Although some tortoises move and forage along road verges, road kills were rare in the study area (Kabigumila 1998a), probably because most motorists carefully avoid hitting the animals (pers. obs.). Newmark *et al.* (1996) examined the frequency of highway mortality in Mikumi National Park, Tanzania. But as they were only assessing the effects on large mammals, tortoises were not mentioned in the study. Further studies in the Park have shown that tortoises are not among the animals commonly affected by the highway (R. Senzota, pers. comm.). This is probably because there are few tortoises in the portion traversed by the highway (pers. obs.). Road kills have also been reported for *T. hermanni* (Stubbs & Swingland 1985) and *T. graeca* (Bayley & Highfield 1996) but only occasionally. However, Bayley & Highfield (1996) raised concern over the increase in agricultural mechanisation and road traffic in the Souss Valley, Morocco, as growing threats to the tortoise populations there. Substantial road mortality has been reported for *G. agassizii* in California (Nicholson 1978, Luckenbach 1982, Boarman & Sazaki 1993) and *Geochelone radiata* in Madagascar (Goodman *et al.* 1994).

All the carcasses showing injuries were found near settlements, suggesting that humans killed the animals. However, this mortality factor could be considered negligible because tortoises are rarely harmed deliberately in the study area due to traditional beliefs and positive attitudes towards tortoises (Kabigumila 1998b). In parts of southern Africa, leopard tortoises are killed because they are believed to compete with livestock for grazing, and to host infectious diseases (Boycott & Bourquin 1988).

Mortality was higher for females than males, possibly because, during nesting, the females might be more vulnerable to predation. However, this does not explain why more females have been recorded in some tortoise populations (*T. graeca*: Lambert 1982; *A. elephantina*: Gaymer 1968), or why in some populations there is no apparent differential mortality between the sexes (e.g. *T. hermanni* populations in Greece (Stubbs & Swingland 1985)). Higher female mortality has also been recorded in France (Stubbs & Swingland 1985) and Yugoslavia (Meek 1985) for *T. hermanni* populations.

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