

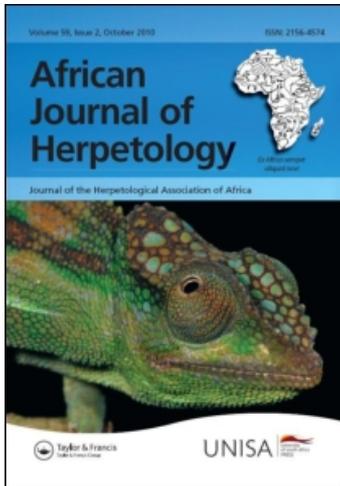
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Short communication

Observations on diet and drinking behaviour of Radiated Tortoises (*Geochelone radiata*) in southwest Madagascar

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Abstract.—Radiated Tortoises (*Geochelone radiata*) fed on 29 species of plants comprising 18 families. Grasses comprised 58.1% of observed plant diet followed by *Opuntia* at 7.6%. All other observed plant feedings were less than 5% each and together comprised a total of 23.3% of the diet. Animal derived matter and miscellaneous items comprise 11.0% of the diet. Diet was compared with that of the Leopard Tortoise (*Geochelone pardalis*) in South and East Africa. *Geochelone radiata* was also observed drinking freestanding water after rains. Water was imbibed through the external nares from small shallow pools (*ranovato*) that collected in crevices on flat rocks. This paper presents only preliminary observations on *G. radiata* diet. To obtain a full understanding of dietary requirements, more intense studies must be undertaken which include fecal analysis, germination trials, and a measure of relative abundance of plant life found in the habitat.

Key words.—*Geochelone radiata*, tortoise, diet, drinking, Madagascar.

The Radiated Tortoise or *sokatra* (*Geochelone radiata*) is one of four species of tortoises endemic to Madagascar (Juvik 1975; Ernst & Barbour 1989). The tortoise's natural distribution is limited to xeric spiny forest of southwestern Madagascar (Iverson 1992) in the regions of the Mahafaly and Karimbola Plateaus. Very little is known about the biology of this species in natural populations. A study was undertaken from 1998-2000 to examine reproduction, distribution, status and conservation of this species (Leuteritz 2002; Leuteritz & Ravolanaivo in press). This paper deals with ancillary information on the diet, which was recorded from focal observations of wild Radiated Tortoises. Behaviours of all tortoises encountered were recorded and in the case of feeding behaviour, plant samples were collected and brought to the Arboretum d' Antsokay,

Tulear, or Departement Flore, Parc Botanique et Zoologique de Tsimbazaza, Antananarivo, Madagascar for identification.

Radiated Tortoises are primarily herbivores and were observed to feed on 29 different species of plants comprising 18 families (Table 1). Of the five species of the genus *Geochelone* that occur in Africa and surrounding islands not much detailed information is available on their feeding preferences with the exception of Leopard Tortoises (*Geochelone pardalis*) in Africa. Three feeding studies were conducted (two in South Africa and one in East Africa) on Leopard Tortoises (Milton 1992; Rall & Fairall 1993; Kabigumila 2001), indicating that they fed on 42 families of plants. Interestingly, of these, 11 belong to the same families (with seven genera) as plants eaten by *G. radiata* (Table 2). Only one species of grass (*Cynodon*

Table 1. Observed food items ingested by wild Radiated Tortoises (*Geochelone radiata*) in southwest Madagascar. bo = bone, car = carcass, fa = faeces, fl = flowers, fr = fruit, ha = hair, le = leaves, sh = shell, st = stem

Plants	
Acanthaceae	<i>Duellia albopurpurea</i> (fl) <i>Ecobolium linneanum</i> (st) <i>Pseudoruellia perrieri</i> (le, st) <i>Ruellia poissonii</i> (le, fl) <i>Ruellia</i> sp. (le, st, fl)
Anacardiaceae	<i>Operculicarya pachypus</i> (fr) <i>Poupartia caffra</i> (fr)
Bignoniaceae	<i>Fernando madagascariensis</i> (fl, le)
Burseraeae	<i>Commiphora</i> sp. (le)
Cactaceae	<i>Opuntia</i> sp. (le, fr)
Combretaceae	<i>Combretum grandidierii</i> (le)
Commelinaceae	<i>Commelina lyallii</i> (le)
Crassulaceae	<i>Crassula humbertii</i> (le)
Didieraceae	<i>Allaudia comosa</i> (le, fl)
Euphorbiaceae	<i>Croton arenicola</i> (le) <i>Croton boiteaui</i> (le) <i>Euphorbia stenoclada</i> (le) <i>Euphorbia</i> sp. (dried le)
Fabaceae	<i>Bauhinia grandidieri</i> (le)
Poaceae	<i>Cynodon dactylon</i> (le) <i>Eragrostis ciliaris</i> (le) South American species (le)
Liliaceae	<i>Asparagus madecarnus</i> (le, st)
Naceae	<i>Diospyros nyriophylla</i> (le, fr)
Papillonaceae	<i>Chadtia grevei</i> (fl)
Solanaceae	<i>Lycium tenue</i> (fr)
Verbenaceae	<i>Clerodendrum perrieri</i> (fr)
Zygophyllaceae	<i>Zygophyllum depauperatum</i> (le, st, fr) <i>Zygophyllum madecassum</i> (le)
Animals	
Class: Gastropoda	
Elicidae	<i>Elix</i> sp. (sh) <i>Lychnus</i> sp. (sh)
Class: Osteichthyes	
	Unidentified fish vertebrae
Class: Reptilia	
	<i>Geochelone radiata</i> (fa) Unidentified lizard (dried car)
Class: Mammalia	
	<i>Bos</i> sp. (fa, bo) <i>Capra</i> sp. (dried car/ha, fa, bo) <i>Felis sylvestris</i> (dried car/ha) <i>Canis familiaris</i> (fa) <i>Cryptoprocta ferox</i> (dried car/ha)
Class: Aves	
	Unidentified bird fa
Other:	
	Charcoal Sand

dactylon) is reported in the diets of both species of tortoises.

A total of 172 identifiable feeding observations were made between 1998 and 2000. Grasses comprised 58.1% of observed plant diet followed by *Opuntia* (cactus) at 7.6%. All other observed plant feedings were less than five percent each and together comprised a total of 23.3% of the diet. Animal derived matter and miscellaneous items (see Table 1) comprise 11.0% of the diet.

Milton (1992), and Rall and Fairall (1993) both emphasized the importance of grass in the diet (69.7-71.0%) of *G. pardalis* in South Africa. This corresponds to the high use of grass in the diet of *G. radiata* in Madagascar. Grasses were found throughout the study site in very limited quantities (< 20%). Yet open areas of short grasses were abundant in the northern disturbed portion (approx. 12%) of the site (near the road and along the goat/cattle paths) as was *Opuntia*. Kabigumila (2001) reports that *G. pardalis* in Tanzania had access to an abundance of grasses yet they did not constitute a large part of the diet. He concludes that it is not only the abundance but also the physical height of the grasses that is of importance. Tortoises in Tanzania fed on short grasses found on road verge habitats where they were relatively more abundant, yet not on the tall grasses which were abundant in the whole area. In Madagascar even outside of the study site, Radiated Tortoise commonly fed on *Opuntia* and short grasses along goat/cattle paths. Disturbed areas may therefore play a significant role in the conservation of tortoises since both species rely on foods found in these areas.

However, *G. radiata* were opportunistic, feeding also on animal matter. The animal matter was never fresh and consisted of bone, shell, hair, dried carcass or faeces (Table 1). Bone was also reported ingested by *G. pardalis* (Milton 1992). The ingestion of bone and mol-

Table 2. A comparison of families and genera of plants eaten by two species of African *Geochelone*: *Geochelone radiata* and *Geochelone pardalis*.

Plants	<i>G. radiata</i>		<i>G. pardalis</i>	
	This study	Milton 1992	Rall & Fairall 1993	Kabigumila 2001
Acanthaceae	X	X		X
Anacardiaceae	X	X		
Cactaceae				
<i>Opuntia</i>	X	X	X	X
Commelinaceae				
<i>Commelina</i>	X			X
Crassulaceae				X
<i>Crassula</i>	X	X		
Euphorbiaceae			X	
<i>Euphorbia</i>	X	X		X
Fabaceae	X	X	X	X
Liliaceae	X		X	
Poaceae				
<i>Cynodon</i>	X	X	X	
<i>Eragrostis</i>	X	X	X	X
Solanaceae	X	X		
Zygophyllaceae			X	X
<i>Zygophyllum</i>	X	X		

lusc shell may help tortoises acquire calcium or other minerals in the diet (see also Esque & Peters 1994, as cited in Okamoto 2002).

Although Radiated Tortoises live in arid habitats and probably derive a large fraction of their water requirements from ingested plants, individuals were also observed drinking freestanding water after rains. Water is imbibed through the external nares from small shallow pools (*ranovato*) that collected in crevices on flat rocks. Tortoise activity increased after rains, even at night (Leuteritz 2003). The drinking behaviour is similar to that reported for Aldabran (*Geochelone gigantea*) and Dessert Tortoises (*Gopherus agassizii*) (Frazier 1971; Medica *et al.* 1980).

The list of plants in Table 1 represents only preliminary observations on *G. radiata* diet. To obtain a full understanding of dietary requirements, more intensive studies must be undertaken, including faecal analysis, germination trials, and a measure of relative abundance of

plant life found in the habitat (Milton 1992; Rall & Fairall 1993; Kabigumila 2001; Loehr 2002). Additionally, livestock are known to compete for tortoise resources (Avery 1998). For future conservation plans, the impact of goats and cattle on tortoise habitats in southern Madagascar should also be addressed, since goats and cattle utilize the same habitat as *G. radiata*.

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