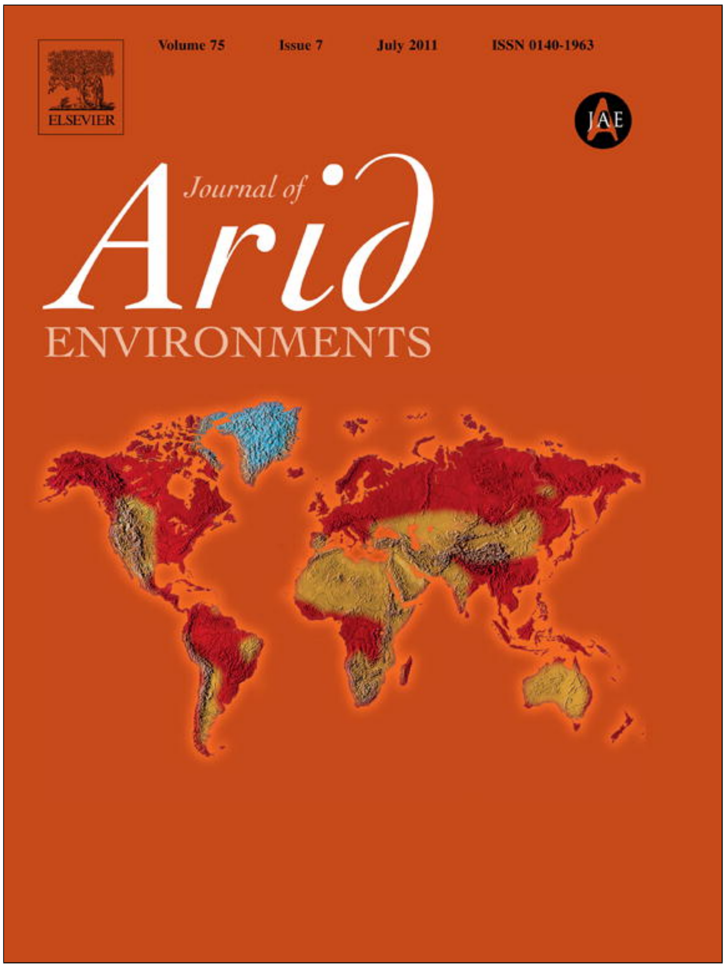
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Short Communication

First evidence of scavenging behaviour in the herbivorous lizard *Uromastyx aegyptia microlepis*

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ABSTRACT

In this study, we provide the first evidence of scavenging behaviour in the spiny-tailed agamid lizard (*Uromastyx aegyptia microlepis*), a species which heretofore has been considered a strict desert herbivore. We examined 294 faecal samples collected in the desert of Qatar and found that 84% of the faeces ($n = 247$) contained exclusively plant material. Grains of barley (*Hordeum vulgare*) were present, suggesting that *Uromastyx* can benefit from the food provided to livestock when wild plants are scarce. We also found remains of invertebrates, vertebrates and stones in the lizard faeces. The type of vertebrate remains found suggests scavenging behaviour and some flexibility in feeding behaviour where food resources are scarce. Overgrazing by camels and goats in the area may affect food availability for *Uromastyx* populations, suggesting the need for conservation measurements in the Qatar desert.

1. Introduction

Scavenging is a widespread phenomenon in vertebrate communities, and is usually viewed as a random and opportunistic behaviour that requires specific circumstances to occur (Cramer, 2008). Unfortunately, most studies on scavenger assemblages have presented an oversimplified view of carrion foraging (Selva and Fortuna, 2007). However, the high diversity of carrion resources and consumers, the differential predictability of the carcass types, and the stressful environmental conditions, contradict this conventional view (Selva and Fortuna, 2007). Scavenging is an important behavioural strategy used to overcome temporal fluctuations in food resources in species living in arid and harsh environments (Amor et al., 2010).

Optimal Foraging Theory predicts flexibility in feeding behaviour allowing species to survive in harsh environments where food resources may be scarce and unpredictable in space and time (Barrette et al., 2010). In dry and harsh environments some lizard species and populations cannibalize juveniles and eggs (Castilla and Van Damme, 1996), consume marine crustaceans (Castilla et al., 2008), or noxious prey (Castilla and Herrel, 2009), to obtain the food needed to meet their energetic requirements.

Lizards of the genus *Uromastyx* are considered to be specialized herbivores (Foley et al., 1992; Herrel and De Vree, 2009). However, few studies exist on the food and feeding habits of the spiny-tailed lizard (*Uromastyx aegyptius microlepis*) in the field except for few studies conducted in Arab countries (Kevork and Al-Uthman, 1972; Robinson, 1995; Cunningham, 2000) or under captive conditions (Dickson, 1965). Preliminary studies suggest that *U. a. microlepis* consumes insects, lizards and other food sources in both the field and laboratory (Kevork and Al-Uthman, 1972; Throckmorton, 1978; Robinson, 1995; Cunningham, 2000).

Considering these observations, it can be questioned whether all species of the genus *Uromastyx*, are entirely herbivorous. Given the harsh desert environment in which these animals live, plasticity in

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feeding behaviour depending on seasonal or geographical variation in food resources seems likely. In this study we explored the hypothesis that the herbivorous spiny-tailed lizard, *U. a. microlepis*, a species living in dry desert areas may behave as an omnivorous species under conditions of limited food availability. To do so, we examined the diet of this species based on faecal pellets collected in the desert of Qatar.

2. Materials and methods

The spiny-tailed lizard (*U. a. microlepis*), commonly called "dhub or dabb" in Arabic, is a big (mean male body mass of 1.600 g), heliothermic and actively foraging herbivorous lizard that inhabits deserts and semi-deserts of Qatar, North Africa and the Middle East (Naldo et al., 2009). The study was conducted in the south of Qatar (Al-Kharrara), in an area characterized by high aridity (average annual mean temperature of 31 °C, and 81 mm rainfall/year) and the presence of grazing ungulates such as dromedary camels (*Camelus dromedarius*), domestic goats (*Capra aegagrus hircus*) and sheep (*Ovis aries*).

We choose two different zones in an open sandy desert area without trees (except for two dry *Acacia*), few bushes (*Lycium shawii*, *Tetraena qatarensis*, *Indigofera intricata*), and several perennial herbs (Table 1). We collected a total of 294 pellets between 12 March and 20 April 2010.

Dhub faeces are easy to recognize in the field because of their elongated shape, large size, and the presence of a white-yellowish drop of urea on one side. We are confident that the faeces collected in the field were from dhubs and not from other species because of their size and because they were collected near confirmed *Uromastyx* burrows. In addition, no other big lizard species are present in the study area (own observations and camel farmers, pers. comm.). Other species of lizards that we observed in the area had a small body size (<10 cm) and produce faeces smaller than 2 cm. They included *Mesalina brevirostris*, the yellow spotted agama (*Trapelus flavimaculatus*), the Baluch ground gecko (*Bunopus tuberculatus*), Slevin's sand gecko (*Stenodactylus sleveni*), the Gulf sand gecko (*Stenodactylus khobarensis*), and the snake-tailed fringe-toed lizard (*Acanthodactylus opheodurus*).

We only collected big faeces between 5 and 10 cm in length. Each faecal pellet was examined individually after removing stones that were attached to them, and we searched for the presence of animal remains. Invertebrate species were determined to the taxonomic level of order. Mammal and reptile remains could not be identified. We used the facilities of the biology laboratory at Weill Cornell Medical College in Qatar to examine the faecal contents.

The objective of this study was not to make comparisons between zones since there was no replication of study areas. However, considering the different nature of the study areas (Table 1) we used Chi square tests to compare the occurrence of different items between the two zones. We used SPSS V13 (SPSS Inc. Headquarters, Chicago, Illinois 60606).

Table 1
Main characteristics of the study zones in Al-Kharrara, Qatar.

	Study zones	
	1	2
Coordinates	24°56′10.70″ N 51°12′44.10″ E	25°55′48.40 N 51°13′21.65″ E
Altitude (m.a.s.l.)	46	41
Date of collection	20 March–15 April	12 March
No. of collection days	3	1
no. of collected feces	159	135
Plot size	230 × 70 m	12 × 10 m
No. of burrows	20	3
Dhub size (cm)	>40 cm	>40 cm
Plant diversity	>40 species	<20 species
Distance to the main road	900 m	20 m
Distance to camel farm	150 m	3000 m

3. Results

Our results show that most faeces (84%, 247 of 294) contained exclusively plant material (fruits, seeds, flowers, leaves and stems). However, we found invertebrate remains (heads, legs and several parts of the exoskeleton) from *Coleoptera* (mainly Tenebrionidae), *Hymenoptera*, *Lepidoptera*, and spider webs in 13% of the excrements (39 of 294). Vertebrate remains (bones and reptile skin) were found in 4% of the excrements (11 of 294) (Table 2). The bones consisted of one ungulate phalange (length = 34.2; width = 23.6; mass = 0.62 g), three pieces of flat bones probably from mammals (16.3 by 12.1 mm; 13.1 by 7.4 mm; 9.2 by 6.8 mm), and one tubular bone of an unidentified species of vertebrate. Reptile remains consisted of dhub-shed skin and pieces of lizard skin of different sizes.

We found sand and little pebbles in many of the faeces. Stones bigger than 0.03 mm were found in 7% of the faeces ($n = 21$) (Table 2), ranging from 0.03 to 0.54 g (mean = 0.20 g; sd = 0.150; $n = 17$). A small piece of plastic was also found in one faecal pellet. We considered their ingestion as accidental in agreement with other authors (Kevork and Al-Uthman, 1972).

We found significant differences between zones in the occurrence of invertebrates, vertebrate remains and stones in the diet ($Chi^2 = 15.6$; $df = 2$; $P < 0.001$). We conducted a separated test including only animal remains, and the results remained significant ($Chi^2 = 13$; $df = 1$; $P < 0.001$). A higher percentage of invertebrates was found in the faeces of zone 1 (15%) than of zone 2 (11%). The presence of vertebrates was only detected in zone 2, and the percentage of faeces with stones was higher in zone 2 (Table 2).

4. Discussion

Our study suggests that the spiny-tailed lizard, which is thought to be a specialized herbivorous lizard, is sometimes a scavenger. We conclude that they are scavengers rather than predators of

Table 2
Animal content and presence of stones in fresh faeces of *Uromastyx aegyptia* collected during March–April 2010 in two zones of Al-Kharrara (South Qatar). Indicated are the number (n) of faeces where some prey type was found and the percentage (%). The total number (N) of faeces examined in each zone is also indicated.

	Zone 1 ($N = 159$)		Zone 2 ($N = 135$)		Total ($N = 294$)	
	n	%	n	%	n	%
Invertebrates						
Coleoptera	20	13	9	7	29	10
Lepidoptera	1	0.6	1	0.7	2	0.7
Hymenoptera (not id)	1	0.6	2	1.5	3	1
Hymenoptera (ant)	1	0.6	0	0	1	0.3
Arachnida (spider web)	1	0.6	3	2	3	1
Total	24	15	15	11	39	13
Vertebrates						
Dhub shed skin	0	0	2	1.5	2	0.7
Lizard skin	0	0	3	2.2	3	1
Mammal hair	0	0	2	1.5	2	0.7
Mammal bone-phalange	0	0	1	0.7	1	0.3
Mammal bone-flat	0	0	2	1.5	2	0.7
Bone-empty tube	0	0	1	0.7	1	0.3
Total	0	0	11	7	11	4
Stones > 0.03 g						
Total	6	4	15	10	21	7

vertebrates because the mammal bones found in the excrements were old and seemed to correspond to large dead animals. Some farmers in Qatar believe that adult dhubs can kill juvenile sheep with their spiny tails, but this is unlikely. Bird feathers have been found in the stomach of dhubs from Iraq (Kevork and Al-Uthman, 1972). Whether dhubs consume live, injured or dead birds or lizards is unknown. Other studies have also reported that dhubs consume reptiles and shed skin (Kevork and Al-Uthman, 1972).

The scavenging behaviour of dhubs has never been reported in the literature. This may be because only few studies have been conducted under natural conditions (Kevork and Al-Uthman, 1972; Robinson, 1995; Cunningham, 2000). However, dhubs have been reported to consume intact sheep droppings (up to 18 found inside one stomach) and date kernels in the field (Kevork and Al-Uthman, 1972; Cunningham, 2000). In captivity dhubs also consume dates, dog food (Throckmorton, 1978), eggs and eggshells (Castilla and Richer, personal observations). It is thus not surprising that dhubs may behave as scavengers in the field, at least under circumstances of reduced food availability. Some species behave as scavengers only when the food source in their home range or close to their nests is not sufficient (Amor et al., 2010).

In our study, we found vertebrate remains in the faeces of zone 2, which was close to the main road. Carcasses near roads are usually detected much faster than those far from roads, and scavengers may benefit from the availability of dead animals along roads that result from collisions with vehicles (Lambertucci et al., 2009). However, roads are also considered risky places for many species, and the actual increasing number of new roads in Qatar (Richer, 2008) will probably result in higher dhub mortality.

Our results also showed that invertebrate remains were found in 13% of the faeces. Insects are generally considered to be part of the diet of juvenile dhubs (El-Sherif and Al-Thani, 2000). However, in our study we examined excrements of adult lizards only, indicating that adults do indeed ingest invertebrates. Our results are not surprising since different percentages of insects of different taxa (tenebrionid and carabid beetles, ants, nymphs of grasshoppers, mantis) have been reported for *U. microlepis* by other authors (Kevork and Al-Uthman, 1972; Al-Hazmi, 2001).

Despite our results indicating that dhubs show scavenging behaviour, their diet is composed predominantly of plants. Grains of barley (*Hordeum vulgare*) were also present in 22 faeces of zone 1 which was located near a camel farm. These observations suggest that lizards can benefit from the food provided to camels by farmers either directly or through the consumption of undigested seeds from cattle excrements. This suggests that wild plants may be limited in the study zone. Overgrazing by camels and goats is a major environmental problem worldwide and is likely to affect other herbivores including dhub populations. Some authors have claimed that competition for food plants between lizards and livestock can threaten the populations of the spiny-tailed lizards living near farms (Cunningham, 2000). Qatar has the highest density of camels in the Middle East and the third highest amongst surveyed North African countries (Richer, 2008). Conservation measurements related to livestock management should be implemented in the Qatar desert in order to help preserve the populations of *U. a. microlepis*.

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