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Short communication

Summer diet of the pichi *Zaedyus pichiy* (Xenarthra: Dasypodidae) in Mendoza Province, Argentina

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ABSTRACT

The diet of the pichi armadillo (*Zaedyus pichiy*) was determined based on analysis of stomach contents of 26 dead individuals confiscated from poachers near Cerro Nevado, Mendoza Province, Argentina. Sand accounted for 66 ± 24% of stomach contents' dry weight. Beetles were the predominant food item in 14 and ants in 5 stomachs, while 5 animals had mainly ingested plant material. The remainder had mostly fed on fly larvae and arachnids. Coleoptera (mainly adults and Scarabeidae larvae) and plant material (seeds, leaves, and roots) were found in all stomachs examined. All pichis had fed on ants of different species and stages, suggesting that pichis eat any ant species they can find and actively prey on nests. Scorpions and spiders were observed in over 60% of stomachs but represented a low aggregate percent weight. Vertebrates were rarely found. Based on these results, the pichi of Mendoza Province can be described as an opportunistic omnivore that mainly feeds on insects and seems to be the least carnivorous of all carnivore–omnivore armadillos.

1. Introduction

The pichi (*Zaedyus pichiy*) is a small (approx. 1 kg), poorly known armadillo of diurnal and semi-fossorial habits that lives in arid and semi-arid habitats. It occurs farther south than any other armadillo species, inhabiting firm sandy grounds on open lands from the provinces of Mendoza, San Luis and Buenos Aires, south to the Santa Cruz River in Argentina, and south to the Strait of Magellan in Chile, at altitudes up to 2500 m (Meritt and Benirschke, 1973; Superina, 2008; Wetzel, 1985). Pichis are the only known armadillos that hibernate during winter and can enter daily torpor outside hibernation season (Superina and Boily, 2007). They are heavily poached and used as a protein source in large parts of their range (Fonseca and Aguiar, 2004; Superina, 2008). This depletion of wild populations has recently led to their inclusion in the IUCN Red List of Endangered Species, where they are listed as Near Threatened (Superina, 2006). Pichis have been classified as generalized carnivores–omnivores that "probably eat whatever they can whenever they can" (Redford, 1985, p. 431) with their diet composition varying with season and geographically because of the seasonal occurrence of certain food items. Although their diet includes plant roots and tubers, it was suggested that they forage on the insects parasitizing the roots and not the plant itself (Redford, 1985).

Several studies reported the omnivorous habits of pichis (Keynes, 2000; Krumbiegel, 1940; Krieg, 1961; Meritt, 1973). These studies, however, were based on occasional observations of very few individuals (usually one). The present report is the first detailed, scientific description of the diet of *Z. pichiy* from any part of its range that is based on a large sample size. It should, however, be noted that the information presented here only reflects the summer diet of pichis because samples were only available from a limited time of the year. Although this is the period when pichis are most active, further studies are needed to evaluate their diet in other seasons. The present contribution to the knowledge of pichis will help understanding the role they play in the ecosystem and will help developing conservation strategies for this threatened species.

2. Materials and methods

Individuals examined were confiscated from poachers in the Nevado area, Mendoza Province, Argentina, an extra-Andean mountainous range in the Patagonian Steppe ecoregion (Olson et al., 2001) located 200 km east of the Andes. The arid climate is

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harsh, with temperatures varying between −15 °C and 35 °C. The average yearly precipitation of 320 mm consists of snowfall in winter and summer rains.

Twenty-nine dead pichis were confiscated during two anti-poaching patrols on February 12, 2006 (6 males, 13 females; Group 1) and March 7, 2006 (2 males, 8 females; Group 2). The first confiscation occurred near Cerro Las Tetas (35°34′ S, 68°44′ W), where pichis live at an altitude of approx. 1700 m. The vegetation is a shrub steppe on sandy and basaltic soils consisting of *Neosparton aphyllum* (Verbenaceae); *Ephedra ochreata* (Ephedraceae); *Atriplex* sp. (Chenopodiacea); *Panicum urvilleanum*, *Stipa* spp., *Poa* spp. (Gramineae); *Grindelia chiloensis*, and *Senecio* spp. (Compositae). The second confiscation site, Cerro Las Balas (35°42′ S, 68°37′ W), is situated 18 km south of the first one. The main poaching area around Cerro Las Balas lies between 1950 and 2200 m above sea level. The vegetation is less diverse and consists mainly of *Panicum urvilleanum*, *Stipa* spp., and isolated shrubs of *Adesmia pinifolia*.

We report on a total of 26 stomach samples because contents of three pichis of Group 1 could not be identified (they were too digested) and were excluded from further analyses. Stomach contents were collected during necropsies and fixed in 5% formaldehyde for subsequent analyses. Samples were sifted under running water through a sieve with 1 mm mesh size to separate soil from food items. The soil mixture was further sifted to recover sand and other sediments. Total volume of each sample devoid of soil was measured and food items over 35 mm length were separated prior to extraction of three aliquots of 11.5 ml in which all items were identified and separated into 16 categories (Table 1). The food items were identified under a stereoscopic microscope. All samples were then dried to constant weight at 40 °C and weighed to the nearest milligram. Average dry weight was calculated per type of food item and per animal, and percent aggregate weight was calculated for each item and each group (Korschgen, 1980). Data analyses were performed with a statistical software program (SPSS, version 11.0, SPSS Inc., Chicago, IL, USA). The proportions of sand and food items ingested by pichis confiscated on different dates, and of items ingested by males and females, were compared with Mann–Whitney *U* tests, while the number of food categories ingested by the two study groups were compared with Fisher's exact tests.

In the absence of similar studies on the diet of pichis, we will compare our results with the diet of two other carnivore–omnivore armadillos, the screaming hairy armadillo *Chaetophractus vellerosus* (Greegor, 1980; Soibelzon et al., 2007) and the yellow armadillo *Euphractus sexcinctus* (Dalponte and Tavares-Filho, 2004), although the methods used by these authors differ from ours.

3. Results and discussion

Sand accounted for an aggregate dry weight of 79.19% of the stomach contents in Group 1 ($n = 16$) and 48.17% of the stomach contents in Group 2 ($n = 10$; Mann–Whitney *U* test, $p < 0.001$). The ingested food items are shown in Table 1. Though the predominant food item varied among individuals (Table 2), coleoptera, ants, and plant material were found in all examined stomach samples. This suggests that pichis from Mendoza Province are opportunistic feeders. The proportion of food items ingested was not different between genders (Mann–Whitney *U* test, $p > 0.05$).

Insects were the predominant food item observed in the stomachs of pichis from both groups (Table 1), as found for *C. vellerosus* (Greegor, 1980; Soibelzon et al., 2007) and *E. sexcinctus* (Dalponte and Tavares-Filho, 2004). Subterranean beetle larvae constituted the bulk of the identified Coleoptera. Larvae of the family Scarabeidae were the most frequent larvae ingested by both groups (Table 1). Larvae ingested by Group 2 were considerably larger than those eaten by animals of Group 1. This may partially explain the larger proportion of beetle larvae in the stomach contents of Group 2. Carabid and curculionid larvae were only found in stomachs of Group 2, and tenebrionid larvae had been ingested by all pichis of Group 2 but only 2 out of 16 animals of Group 1. Adult Coleoptera were present in 25 out of 26 samples and represented 4.57% of the aggregate dry weight in Group 1 and 8.02% in Group 2 (Mann–Whitney *U* test, $p > 0.05$). Only one adult beetle could be identified (*Nyctelia laevis*: Tenebrionidae).

All pichis had ingested ants of different species and castes. *Solenopsis patagonica* was the most common ant, followed by *Pheidole*

Table 1
Food items found in stomachs of *Zaedyus pichiy* collected near Cerro Nevado, Mendoza, Argentina.

Food item	Group 1[a] ($n = 16$)		Group 2[b] ($n = 10$)	
	Aggregate percent weight[c]	No. of stomachs[d]	Aggregate percent weight[c]	No. of stomachs[d]
Coleoptera				
Adults	4.57	15	8.02	10
Carabidae larvae	0.00	0	0.09	4
Scarabeidae larvae	13.89	9	51.77	9
Tenebrionidae larvae	0.22	2	8.11	9
Curculionidae larvae	0.00	0	0.01	2
Unidentified larvae	0.08	1	0.38	3
Arachnida	2.25	8	1.55	8
Plant material	17.24	16	1.85	10
Ants	15.30	16	15.33	10
Fungi	0.45	1	0.00	0
Diptera	28.41	4	2.22	2
Vertebrata	0.32	1	3.18	1
Nematoda	Trace	1	0.00	0
Phasmatodea	0.00	0	0.73	2
Unidentified insects[e]	0.03	2	Trace	1
Unidentified material[f]	17.24	16	6.77	9

[a] Confiscated on February 12, 2006.
[b] Confiscated on March 7, 2006.
[c] Estimated after removal of sand.
[d] Number of stomachs that contained the food item.
[e] Includes chitin fragments that could not be assigned to any taxon.
[f] Small organic particles.

Table 2
Predominant food item ingested by *Zaedyus pichiy* based on percent weight of the stomach content devoid of sand.

Food item	Group 1[a] ($n = 16$)	Group 2[a] ($n = 10$)
Coleoptera adults	3	0
Scarabeidae larvae	3	7
Tenebrionidae larvae	0	1
Arachnida	1	0
Plant material	5	0
Ants	3	2
Diptera	1	0

[a] Number of stomachs in which the food item represented the largest proportion of all ingested items.

aberrans, *Dorymyrmex jorgenseni*, *Dorymyrmex tener*, *Dorymyrmex richteri*, unidentified *Dorymyrmex*, *Camponotus* sp., *and Pogonomyrmex* sp. species, and unidentified species of the Subfamilies *Formicinae* and *Myrmycinae*. The fact that all stomachs contained several (up to 7) ant species suggests that pichis are opportunistic ant feeders. Workers were the most common caste, but winged stages, soldiers (mainly of *Pheidole aberrans*), pupae, and eggs were also observed. Pichis may have ingested workers when finding a trail while foraging aboveground, but the presence of eggs and pupae in most stomachs indicates that they had also attacked anthills. Indeed, we have often observed wild pichis foraging on anthills and tracks of pichis near anthills with signs of predation. The observation of eggs and larvae of different species in a single stomach indicates that pichis may consecutively prey upon several nests.

It was surprising to find specimens of *Paradoxomorpha* sp. (Phasmatodea), locally known as "chinche molle", in two pichi stomachs. They are seasonally abundant and relatively large (the ingested specimens were 7 cm long), but secrete repugnant or caustic chemicals as a defense mechanism. The fact that both pichis had also fed on large quantities of other items (*Paradoxomorpha* accounted for less than 4% dry weight in both cases) suggests that they did not prey upon Phasmids due to the unavailability of alternative food sources.

Vertebrates were rarely observed and thus seem to be a less important part of the diet of pichis than of other omnivore armadillos. Only one pichi had ingested a lizard of the species *Liolaemus josei* (Liolaemidae), a species commonly found in the Nevado area. The hair identified in one stomach suggests that at least one pichi had been eating parts of a mammal. In contrast, vertebrates represented between 5.9% and 27.7% of the diet of *C. vellerosus*, depending on the study site and season (Greegor, 1980; Soibelzon et al., 2007), and a 23.3% occurrence was reported in *E. sexcinctus* (Dalponte and Tavares-Filho, 2004). Carrion was not present in any of the studied pichi stomachs. It is possible that the ingestion of carrion is more common than reported here because it is digested faster than other food items and may therefore have been overlooked. Talmage and Buchanan (1954) suggested that armadillos are attracted to the maggots parasitizing on animal carcasses and not to the carrion itself. Indeed, 6 of the evaluated pichis had ingested fly larvae that are commonly found on animal remains. Diptera larvae were ingested by only 4 out of 16 animals of Group 1, but accounted for more than one fourth of the aggregate percent weight of this group (Table 1).

Scorpions and spiders were observed in over 60% of the analyzed stomachs – mainly in animals of Group 2 – but only accounted for a low aggregate percent weight (Table 1). Scorpions of the genus *Brachistosternus* sp. were identified in 4 stomachs, while the species ingested by the remaining pichis could not be identified. One pichi had eaten a tarantula (*Mygalomorpha*). A similar proportion of pichis and of *C. vellerosus* studied by Greegor (1980) in northeastern Argentina had ingested arachnids in the winter months, while arachnids were less common in individuals captured during summer and virtually absent from the diet of *C. vellerosus* of Buenos Aires Province (Soibelzon et al., 2007). *E. sexcinctus* seems to rely less on arachnids; fragments of large spiders were found in only 25% of the stomachs (Dalponte and Tavares-Filho, 2004).

Basidiomycetes (fungi) were identified in the stomach of one pichi belonging to Group 1 based on the presence of spores. Mycelia-like structures were also found in stomachs of 10 other pichis of Group 1, but we classified them as unidentified material because the absence of reproductive structures did not allow a conclusive identification.

The diet of all evaluated pichis included plant material, such as grass seeds, leaves, or roots of different species and flowers of *Grindelia chiloensis* (Compositae). The ingested quantities, however, varied significantly between the two groups ($p < 0.001$). Although we did not study the abundance of dietary items in the two confiscation sites, we suspect that pichis of Group 2 ingested less plant matter because of a higher availability of their preferred food item (insects).

The two groups ingested similar food categories (Fisher's exact test, $p > 0.05$), but the proportions of some food items differed significantly. The interval between the two confiscations (less than a month) is too short to reflect a temporal variation in the diet of pichis. The shifts in diet we observed between groups are therefore probably related to the different geographic locations. The lack of studies on the abundance of invertebrates in these sites does not allow us to evaluate whether pichis of Group 2 ingested more beetle larvae simply because they were more common in their area or because pichis have a preference for larvae and actively search for them. It is, however, interesting to note that pichis of Group 1 inhabited an area with higher plant diversity and ingested a higher proportion of plant material.

Z. pichiy is best described as an opportunistic omnivorous armadillo that mainly relies on invertebrates but also ingests plant material, vertebrates, and arachnids whenever these items are available. Omnivory may allow individuals to deal with seasonal changes in food availability characteristic of temperate regions. If this is the case, more specialist species are expected to inhabit lower latitudes while more generalist ones are expected at higher latitudes. Although data on the diet of armadillos are still scarce, the available information supports this idea. Only two species (*Z. pichiy* and *C. villosus*) inhabit southern Patagonia, and both are omnivores. In contrast, the predominantly insectivorous armadillos mainly inhabit tropical regions, although one of them, *Cabassous tatouay*, occurs as far south as Uruguay (Fonseca and Aguiar, 2004; Redford, 1985). It is therefore possible that *Z. pichiy* and *C. villosus* were able to extend their area of distribution farther south than any other armadillo species because they are able to deal with the large seasonal variation in food availability caused by the varying environmental conditions, while the predominantly insectivore species remained restricted to regions with a relatively constant food availability.

Further studies on the diet of pichis inhabiting different areas, and of samples collected in different seasons, are needed to understand the extent of omnivory of this little armadillo.

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