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Authors: Vaz, Vanderson Corrêa, Santori, Ricardo Tadeu, Jansen, Ana Maria, Delciellos, Ana Cláudia, and D'Andrea, Paulo Sérgio

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SHORT COMMUNICATION

Notes on food habits of armadillos (Cingulata, Dasypodidae) and anteaters (Pilosa, Myrmecophagidae) at Serra da Capivara National Park (Piauí State, Brazil)

VANDERSON CORRÊA VAZ^A, RICARDO TADEU SANTORI^{B,1}, ANA MARIA JANSEN^C, ANA CLÁUDIA DELCIELLOS^D AND PAULO SÉRGIO D'ANDREA^E

^ALaboratório de Biologia e Parasitologia de Mamíferos Silvestres Reservatórios, Instituto Oswaldo Cruz/FIOCRUZ, Av. Brasil 4365, 21040-360, Rio de Janeiro, RJ, Brazil. E-mail: vandersonvaz992@gmail.com, dandrea@ioc.fiocruz.br.

^BNúcleo de Pesquisa e Ensino de Ciências, Departamento de Ciências, Faculdade de Formação de Professores – Universidade do Estado do Rio de Janeiro, Rua Dr. Francisco Portela 1470, 24435-000, São Gonçalo, RJ, Brazil. E-mail: rsantori.uerj@gmail.com.

^CLaboratório de Biologia de Tripanosomatídeos, Instituto Oswaldo Cruz/FIOCRUZ, Av. Brasil 4365, 21040-360, Rio de Janeiro, RJ, Brazil. E-mail: jansen@ioc.fiocruz.br.

^DLaboratório de Vertebrados, Departamento de Ecologia, Universidade Federal do Rio de Janeiro, CP 68020, Ilha do Fundão, 21941-902, Rio de Janeiro, RJ, Brazil. E-mail: anadelciellos@yahoo.com.br.

^ECorresponding author

Abstract This is one of the few studies on food habits of armadillos and anteaters in the Caatinga, Brazil. Our aim was to describe food items found in fecal and stomach samples of six species (*Dasypus novemcinctus*, *D. septemcinctus*, *Euphractus sexcinctus*, *Myrmecophaga tridactyla*, *Tamandua tetradactyla*, *Tolypeutes tricinctus*) at the Serra da Capivara National Park, Piauí State, Brazil. For most species, invertebrates – especially Isop-tera and Hymenoptera – were the main food source. Seeds were found in samples of most species studied, including *M. tridactyla* and *T. tetradactyla*.

Keywords: Caatinga, diet, feeding behavior, xenarthrans.

Notas sobre os hábitos alimentares de tatus (Cingulata, Dasypodidae) e tamanduás (Pilosa, Myrmecophagidae) no Parque Nacional da Serra da Capivara (Estado do Piauí, Brasil)

Resumo Este é um dos poucos estudos sobre os hábitos alimentares dos tatus e tamanduás na Caatinga, Brasil. Nosso objetivo foi descrever os itens alimentares encontrados em amostras fecais e estomacais de seis espécies (*Dasypus novemcinctus*, *D. septemcinctus*, *Euphractus sexcinctus*, *Myrmecophaga tridactyla*, *Tamandua tetradactyla*, *Tolypeutes tricinctus*) no Parque Nacional da Serra da Capivara, Piauí, Brasil. Para a maioria das espécies, invertebrados – principalmente Isoptera e Hymenoptera – foram as principais fontes de alimento. Sementes foram encontradas em amostras da maioria das espécies estudadas, incluindo *M. tridactyla* e *T. tetradactyla*.

Palavras-chave: Caatinga, comportamento alimentar, dieta, xenartros.

The orders Cingulata and Pilosa include 31 species in 14 genera and five families (Wilson & Reeder, 2005). These orders are distributed from the southern United States of America to the southernmost tip of Argentina (Gardner, 2008). Most species occur in South America, five in Central America and only

one whose distribution extends to North America (Wetzel, 1982; Eisenberg & Redford, 1999; Gardner, 2008). The large overlap in the range of these taxa is possible due to the great diversity of habits, ranging from fossorial to arboreal species and from carnivorous-omnivorous to insectivorous food habits

(Redford, 1985a). Also, they are able to occupy a wide range of habitats, from dryland to tropical rainforest (Wetzel, 1982; Bonato *et al.*, 2008). Data on the biology and ecology of these taxa, mostly on their food habits, are yet scarce (McDonough & Loughry, 2008). Furthermore, studies on the diet of species are essential to understanding their ecological role in the ecosystem and their geographic distribution (McDonough & Loughry, 2008).

According to Redford (1985a), armadillos can be divided into four groups following food habits of the species: I) the carnivore-omnivores, including the genera *Zaedyus*, *Euphractus*, and *Chaetophractus*; II) the generalist fossorial insectivores, represented by the genera *Chlamyphorus* and *Calyptophractus*; III) the terrestrial generalist insectivores, mainly the species of *Dasypus*; and IV) the specialist insectivores (specialized in ants and termites), which include the genera *Cabassous*, *Tolypeutes*, and *Prionodontes*. Food preference of armadillos is for termites and ants, but when these items are scarce, armadillos are able to feed on some other arthropods, or even fruits, tubers and small vertebrates, depending on their availability (Gregor, 1985; Redford, 1985a, b; Wirtz *et al.*, 1985; Smith & Redford, 1990; Bolkovic *et al.*, 1995; Anacleto & Marinho-Filho, 2001; Anacleto, 2007).

Anteaters were described as the only truly myrmecophagous Xenarthra species and, according to Montgomery (1985a, b), the main difference among the four extant species is the ratio of ingested ants to termites. His studies suggest *Cyclopes* is strictly arboreal and feeds exclusively on ants. Furthermore, he observed that *Tamandua* has terrestrial and arboreal habits and feeds on termites and ants. The ratio of ants to termites in its diet varies according to prey availability. Recently, the consumption of fruits in wild *Tamandua mexicana* was described by Brown (2011). The terrestrial *Myrmecophaga* feeds mainly on ants, but does not exclude termites from its diet while actively searching for its preferred food item (Montgomery, 1985a; Redford, 1986; Medri *et al.*, 2003).

Located in the Caatinga biome in the semi-arid northeastern Brazilian region, the Serra da Capivara National Park (SCNP) has a high species richness of armadillos and anteaters: *Cabassous unicinctus* (Linnaeus, 1758), *Dasypus novemcinctus* Linnaeus, 1758, *D. septemcinctus* Linnaeus, 1758, *Euphractus sexcinctus* (Linnaeus, 1758), *Tolypeutes tricinctus* (Linnaeus, 1758), *Myrmecophaga tridactyla* Linnaeus, 1758, and *Tamandua tetradactyla* (Linnaeus, 1758) (Olmos, 1995; Superina & Abba, 2010). Roadkills and hunting are among the principal causes of death of these species in SCNP (Miranda & Alencar, 2007). Our aim in this study was to describe the food habits of armadillos and anteaters through examination of dead specimens found at the SCNP, thereby

increasing the knowledge of the ecology of these species at the Caatinga.

The SCNP (08°26'50" – 08°54'23"S, 42°19'47" – 42°45'51"W) is located in southeastern Piauí State, Brazil, at the western limit of the semi-arid Caatinga biome. At approximately 130,000 ha in size, it is the largest protected area located in the Caatinga domain. It is also one of the most important archaeological sites in South America (Emperaire, 1989). Annual average precipitation is 645.7 mm (± 248.3 mm) (meteorological stations of São Raimundo Nonato and São João do Piauí municipalities), with the rainy period occurring from November to April. Annual average temperature is 28.02 °C (± 1.0 °C) (INMET - Instituto Nacional de Meteorologia).

The SCNP is situated at the southern limit of the sedimentary basin of the Parnaíba river, and there are no perennial rivers in the area. Water sources are concentrated in the "boqueirões" (moist areas). The flora of the SCNP is characterized by physiological and morphological adaptations to the xeric conditions typical of deciduous dry vegetation. In one of the few existing studies on the flora of the SCNP, 210 species were recorded (Lemos, 2004). The families Caesalpiniaceae, Fabaceae, Mimosaceae, Bignoniaceae, Euphorbiaceae, and Myrtaceae made up 46% of the recorded species (Lemos, 2004).

Carcasses of armadillos and anteaters were obtained from roadkills and poached animals confiscated in SCNP by rangers of the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), between March 1998 and March 2001. We collected data from carcasses of *D. novemcinctus* (N=14), *D. septemcinctus* (N=2), *E. sexcinctus* (N=3), *T. tricinctus* (N=3), *M. tridactyla* (N=1), and *T. tetradactyla* (N=8). Carcasses were kept frozen at -20 °C until analysis.

From the available carcasses, we analyzed sixteen fecal and six stomach samples of armadillos, and four stomach contents and five feces of anteaters (TABLE 1). Stomach contents and feces were kept in bottles with water to dissolve the material and prevent their contamination by fungi. Samples were washed under running tap water through a sieve with mesh screen of 1.0 mm². The material retained on the sieve was placed in a glass container filled with a solution of water and detergent, to separate soil particles from plant and animal material. Afterwards, the contents were air dried and analyzed under a binocular magnifying glass (ZEISS Stemi SV6). Observed items were grouped into the following categories: vertebrates (scales, hairs, and bones), invertebrates (exoskeleton), fruits (seeds), soil, and not identified (N.I.). Food items were identified at family level when possible.

Considering all species in each family, a total of 14 types of food items were identified in the fecal

samples of armadillos, while in stomach samples the number of food items identified was ten. For anteaters, the number of food items identified was six and three in fecal and stomach samples, respectively (TABLE 1).

Beetles and ants were found in all stomach and fecal samples of all armadillo species. Vertebrates (lizards) were found in samples of *D. novemcinctus* and *E. sexcinctus*. Remains of lizards of Sincidae and Tropiduridae families were found in samples of *E. sexcinctus*. Fruits were found in samples of these two species and also in *D. septemcinctus* samples. Plant parts (leaves and kindling wood) were present in 68% of the total samples (N=22) for Dasypodidae and 86% contained soil particles (TABLE 1). Arachnids, Millipedes and seeds of Vitaceae were observed only in stomach contents, while seeds of Asteraceae and Cyperaceae, and insects of the order Dermaptera, occurred only in fecal samples of armadillos.

Ants and termites were the most frequent food items in stomach and fecal samples of anteaters.

Beetles were found only in the fecal samples of *T. tetradactyla*. Among seeds, the Poaceae was the only family occurring in both types of samples, while seeds of Cyperaceae and Euphorbiaceae were found only in fecal contents. Although we have collected only one fecal sample for *M. tridactyla*, this sample contained more different types of seeds than those of *T. tetradactyla*. Unidentified plant parts were present in 55% of nine samples, and soil in 44% (TABLE 1).

This is one of the few studies on food habits of armadillos and anteaters of the Caatinga, contributing to the understanding of the biology and current status of this group in its northeastern distribution in Brazil. Our results corroborate the findings of previous studies in which armadillos in general were characterized as opportunistic feeders, while anteaters, as expected by their specialized morphology, behave as specialist insectivores (Redford, 1986). However, apart from insects, we also found seeds of Poaceae, Cyperaceae, and Euphorbiaceae in the samples from anteaters.

TABLE 1. Number of samples containing food items found in fecal and stomach contents of armadillos and anteaters studied at Serra da Capivara National Park, Piauí State, Brazil. Fec = fecal content; N.I. = not identified; Sto = stomach content.

	<i>D. novemcinctus</i>		<i>D. septemcinctus</i>		<i>E. sexcinctus</i>		<i>T. tricinctus</i>		<i>M. tridactyla</i>	<i>T. tetradactyla</i>	
	Fec. N= 11	Sto. N= 3	Fec. N= 2		Fec. N= 2	Sto. N=1	Fec. N=1	Sto. N=2	Fec. N=1	Fec. N=4	Sto. N=4
Vertebrates											
Lizards	-	-	-	-	-	-	-	-	-	-	-
Scincidae	-	-	-	1	-	-	-	-	-	-	-
Tropiduridae	1	-	-	-	1	-	-	-	-	-	-
N.I.	-	-	-	1	-	-	-	-	-	-	-
Invertebrates											
Araneae	-	1	-	-	-	-	-	1	-	-	-
Chilopoda	-	1	-	-	-	-	-	1	-	-	-
Coleoptera	8	3	1	1	1	1	1	2	-	2	-
Dermaptera	1	-	-	-	-	-	-	-	-	-	-
Hemiptera	-	1	-	1	-	-	-	-	-	-	-
Hymenoptera	8	2	2	2	1	1	1	1	1	4	4
Isoptera	10	3	1	-	-	-	1	1	1	2	4
N.I.	2	-	-	1	-	-	-	-	-	-	-
Seeds											
Asteraceae	4	-	-	-	-	-	-	-	-	-	-
Cyperaceae	1	-	-	-	-	-	-	-	1	-	-
Euphorbiaceae	3	-	-	2	1	-	-	-	1	-	-
Poaceae	5	2	-	1	1	-	-	-	1	-	1
Vitaceae	-	-	-	-	1	-	-	-	-	-	-
N.I.	5	1	1	1	1	-	-	-	-	2	1
Plant N.I.	9	1	1	2	-	-	1	1	1	2	2
Soil	10	1	2	2	1	1	1	2	-	3	1
TOTAL	13	10	6	11	8	5	7	6	6	6	6

Among the recorded food items, invertebrates – especially ants, termites, and beetles – were the main food source. Previous studies suggested that these arthropods provide water, fat, and nitrogen sources for the myrmecophagous species (Redford & Dorea, 1984; Redford, 1987). Moreover, this type of prey is an advantage in tropical regions due to its constant availability and the ease with which it can be found (Pulliam, 1974; Montgomery, 1985b).

Seeds were found in samples of most studied species, except for *T. tricinatus*. A greater richness of seeds was recorded for *D. novemcinctus* (TABLE 1). The fruit consumption by armadillos is better described in the literature for *E. sexcinctus*, which feeds on native and also on cultivated species (Dalponte & Tavares-Filho, 2004) and is considered a seed disperser of imbuzeiro (*Spondias tuberosa*) in an area of Caatinga (Cavalcanti *et al.*, 2009). For anteaters, there are some previous records of fruit eating in the wild only for *Tamandua mexicana* (Brown, 2011). Brown (2011) suggested that fruit consumption by anteaters may be common, although its mouth morphology can make the ingestion of seeds difficult, causing the rarity of this food item in its feces. Apparently, this is the first record of seeds in fecal samples of *M. tridactyla*, the diet of which was often described as based mainly on ants and termites (Medri *et al.*, 2003; Braga, 2010), and in fecal and stomach samples of *T. tetradactyla*. Although these records may be considered an indication of fruit consumption by these species, it cannot be determined whether the ingestion of seeds was on purpose, by fruit consumption, or incidentally while feeding on insects.

Dasypus novemcinctus and *E. sexcinctus* were the only studied species that had ingested vertebrates. Lizards as a food item of these species may be associated with their great availability and/or the ease of capture of these animals in the study area, or even with the habit of feeding on carrion, as described by Redford (1985a). Vertebrate predation is well described in the literature mainly for the armadillos of the genera *Dasypus*, *Chaetophractus*, *Euphractus*, and *Zaedyus* (Barreto *et al.*, 1985; Greigor, 1985; Wirtz *et al.*, 1985; Redford, 1986; Dalponte & Tavares-Filho, 2004; Anacleto, 2007; Soibelzon *et al.*, 2007; Superina *et al.*, 2009; Abba *et al.*, 2011a, b). The ingestion of soil and plant parts may be accidental, associated with the foraging behavior of the species, or intentional, for nutritional purposes (Bolkovic *et al.*, 1995). Their ingestion may occur for distinct reasons: i) use of these items to facilitate digestion of prey; ii) as defense mechanism against the release of chemical substances by the prey, acting as absorbent material; or iii) as nutritional complements (Redford & Dorea, 1984; Montgomery, 1985b; Wirtz *et al.*, 1985; Beyer *et al.*, 1994; Bolkovic *et al.*, 1995).

The total of different food items registered in this study, particularly for armadillos, was lower than

the previously recorded by other authors in others biomes, mainly in the Cerrado (Bolkovic *et al.*, 1995; Dalponte & Tavares-Filho, 2004; Anacleto, 2007). However, we recorded new food items for *M. tridactyla*: seeds of three different plant families. The present study also reveals the importance of analyzing stomach and fecal samples together, providing complementary data in investigations on food habits, because some items were only recorded in feces and others only in stomach contents. The difference in the items recorded in the two sample types may be caused by variations in digestibility or mechanical resistance of the item, time of passage through the digestive tract or order of ingestion of each item (Kunz & Whitaker, 1983; Dickman & Huang, 1988; Kronfeld & Dayan, 1998). Besides contributing to the knowledge on the ecology of these species in the Caatinga, this work is one of the few existing studies on the feeding habits of *D. septemcinctus* and *T. tricinatus* (Silva, 2006). Despite the fact that their food habits are mainly insectivorous, the species studied, mainly armadillos, may play a role in seed dispersion at SCNP, zoochory being considered the main form of seed dispersion in the Caatinga (Griz & Machado, 2001).

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