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Edentata

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Editors: Mariella Superina, Flávia Miranda, Roberto Aguilar and John M. Aguiar
Assistant Editor: Agustín M. Abba
ASASG Chair: Mariella Superina
ASASG Deputy Chair: Flávia Miranda

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The Newsletter of the IUCN/SSC Anteater, Sloth and Armadillo Specialist Group

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Editors:
Mariella Superina, IMBECU, CCT CONICET Mendoza, Mendoza, Argentina.
Flávia Miranda, Projeto Tamanduá and Wildlife Conservation Society, São Paulo, Brazil.
Roberto Aguilar, Cape Wildlife Center – Humane Society of the US, Barnstable, MA.
John M. Aguiar

Assistant Editor:
Agustín M. Abba, División Zoología Vertebrados, Facultad de Ciencias Naturales y Museo, UNLP, La Plata, Argentina

IUCN/SSC Anteater, Sloth and Armadillo Specialist Group Chair
Mariella Superina

IUCN/SSC Anteater, Sloth and Armadillo Specialist Group Deputy Chair
Flávia Miranda

Layout
Kim Meek, Washington, DC, e-mail: <k.meek@mac.com>.

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Front Cover Photo
Giant armadillo (*Priodontes maximus*). Photo: Carly Vynne.

Please direct all submissions and other editorial correspondence to Mariella Superina, IMBECU - CCT CONICET Mendoza, Casilla de Correos 855, Mendoza (5500), Argentina. Tel. +54-261-5244160, Fax +54-261-5244001, e-mail: <mariella@superina.ch>.

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Letter from the Editor

Edentata is back! After three years of silence, I am proud to share this new edition with you. We are already working on our next edition and will do our best to publish one issue per year. But this will depend on you! We are looking forward to receiving your articles, thesis abstracts, notes from the field, news items, and any other information related to the conservation of xenarthrans that you would like to publish in our Newsletter.

In 2009, our Specialist Group underwent several important changes:

With the beginning of the 2009–2012 period, our Specialist Group has been renamed to the **IUCN/SSC Anteater, Sloth and Armadillo Specialist Group** (**ASASG**). This new name is intended to make it more comprehensible for the general public, which will facilitate promotion of our activities.

Gustavo Fonseca stepped down as our Chair after almost 20 years. This Specialist Group would not exist without Gustavo's dedication to the conservation of xenarthrans, and I can't thank him enough for his excellent job! I am very honored that Simon Stuart, the Chair of the IUCN Species Survival Commission, invited me to take over the Chairmanship from Gustavo, and will do my best to strenghten our Group and promote the conservation of xenarthrans.

I am extremely happy that **Flávia Miranda** accepted serving as our Deputy Chair; it is a pleasure to work with her! **Agustín M. Abba** is our Specialist Group's new Red List Authority. He is of great help during daily operations of our Group, and I am delighted to have him on our team. I have no doubt that our Group will benefit greatly from Flávia's and Agustin's participation!

The list of members has been completely revised. I would like to thank our past members for their dedication to the conservation of xenarthrans. At the end of this letter, you will find **a list of the ASASG members** for the 2009–2012 period. I'm looking forward to working with all of you!

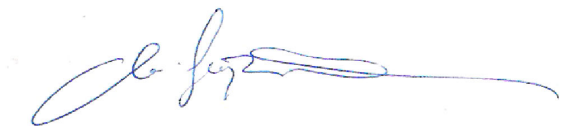
Parallel to the change in the new leadership, the ASASG's headquarters have been moved from Washington, DC to Mendoza, Argentina. I would like to take the chance to thank everyone at **Conservation International** for the invaluable logistical, administrative, and financial support our Group has received over the past years.

Edentata underwent quite a few changes. Some of them are already included in this edition, while others will follow in future volumes. The new **editorial staff** would like to thank the previous editors Gustavo Fonseca, Anthony Rylands and John M. Aguiar, for their work. Due to financial and ecological reasons, we have decided to convert Edentata into an electronic journal. Please help us spreading the news about Xenarthra conservation by sending this **electronic version** to your colleagues!

We also have a new website, <http://www.xenarthrans.org> — please read more about it in the News section of this edition!

And last, but not least, I would like to extend my special thanks to our former coordinator **John Aguiar**; he's been of invaluable help over all these years.

Enjoy this new issue of Edentata!



Mariella Superina, Editor in Chief

IUCN/SSC Anteater, Sloth and Armadillo Specialist Group Members 2009–2012

Chair
Mariella Superina, Dr.med.vet., Ph.D. in Conservation Biology
Chair, IUCN/SSC Anteater, Sloth and Armadillo Specialist Group
Editor in Chief, Edentata
Assistant researcher CONICET
IMBECU - CCT CONICET Mendoza
Casilla de Correos 855
Mendoza (5500)
Argentina
E-mail: <mariella@superina.ch>

Deputy Chair
Flávia Miranda, M.Sc. Ecology
Ph.D. Student in Applied Ecology, University of São Paulo
Projeto Tamanduá / Anteater Project
Wildlife Conservation Society – WCS
Global Health Programs
Av. Agua Fria 269
Água Fria, São Paulo, SP 02333-000
Brazil
E-mail: <flaviamiranda@yahoo.com>
Website: <www.tamandua.org>

Red List Authority
Agustín M. Abba, Doctor in Natural Science
Assistant Researcher CONICET
División Zoología Vertebrados
Facultad de Ciencias Naturales y Museo, UNLP
Paseo del Bosque s/n
La Plata (1900)
Argentina
E-mail: <abbaam@yahoo.com.ar>

Members
John Aguiar, USA
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Food Habits of Wild Silky Anteaters (*Cyclopes didactylus*) of São Luis do Maranhão, Brazil

Flávia Miranda
Roberto Veloso
Mariella Superina
Fernando José Zara

Introduction

None of the four extant anteater species is currently considered to be threatened with extinction (IUCN, 2007; Aguiar and Fonseca, 2008). However, the destruction and fragmentation of their habitat is advancing swiftly throughout their common distribution, and may already have caused local extinctions (Fonseca and Aguiar, 2004; Fallabrino and Castiñeira, 2006). Similarly, fragmentation may expose wild populations to new parasites and infectious diseases, while also increasing the risk of transmission between human and animal populations (Aguirre *et al.*, 2002).

Local extinctions can have damaging effects on ecosystems by causing interruptions in key ecological processes, eventually compromising their integrity. Similarly, they can lead to the loss of populations that are especially important for the genetic diversity of a species, such as isolated populations that have evolved — or are evolving — into different subspecies (Frankham *et al.*, 2002).

The silky anteater (*Cyclopes didactylus*) is the smallest extant anteater, with a body length of approximately 35 cm and a tail length of 20 cm, and a body weight of approximately 500 grams. Its exclusively arboreal and nocturnal habits (Montgomery, 1985a) may explain why it is one of the least-studied of the xenarthrans. *C. didactylus* has recently been removed from the Myrmecophagidae and is now classified in the monotypic Cyclopedidae (Gardner, 2005). Its range includes the tropical forests of Central and South America, but the species is divided into northern and southern populations by the Andes, which present a significant barrier to its distribution. The silky anteater's low metabolic rate, low body temperature (around 33°C) and its reduced ability to thermoregulate all limit its distribution to forests below 1500 m (McNab, 1985). In the northern part of their distribution, individuals have golden fur, but farther to the south this coloration becomes greyer, with a dark dorsal line (Dickman, 1984). An isolated population has been reported from coastal northeastern Brazil (Fonseca and Aguiar, 2004), separated from the Amazonian populations by the xeric Caatinga landscape. Although populations are affected by rapid deforestation and habitat loss throughout its range (Novaes, 2007), the silky anteater is classified as Least Concern by the IUCN (Fonseca and Aguiar, 2004; IUCN, 2007).

Information on their ecology is scarce. Although silky anteaters are predominantly arboreal, they do not have an opposable hallux. Each forelimb bears two digits with strong curved claws that allow them to firmly cling to branches; their strong prehensile tail is used for support, especially when they are using their claws for defense or to rip open ant nests. Information on the food habits of silky anteaters is limited to Best and Harada (1985) and Montgomery (1985b), who argue that their main food item seems to be ants, although Best and Harada (1985) also observed a low number of beetles in fecal samples. These studies involved individuals from the two main segments of the species' distribution (represented by Manaus and Barro Colorado Island, respectively); the isolated population of silky anteaters in Brazil, however, has not yet been thoroughly studied. As part of an ongoing project on the ecology and health of this small coastal population, we had the opportunity to examine the gastrointestinal contents of two recently deceased individuals. The results presented here contribute to the knowledge of this elusive species, and will help in understanding their habitat needs and in developing conservation strategies.

Materials and Methods

Study area

Maranhão is the second-largest state in Brazil, with approximately 330,000 km^2 of land area and 640 km of coastline. The island of São Luis, on the state's northern coast, is a narrow peninsula of 905 km^2 between the Rios Mearim and Itapicuru; it is cut off from the mainland by a narrow channel, the Estreito da Carapanã ("Mosquito Strait"). There are three towns and several villages on the island, in addition to Maranhão's capital city of São Luis. It has a moist tropical climate; most of its yearly precipitation of 2083 mm falls between January and June. The dry season lasts from July to December, but is most intense in September, October and November; the ambient temperature during this time varies between 24–30°C. The vegetation is diverse and consists of uncultivated environments of secondary growth composed mostly of grasses and shrubs of *Baccharis* spp. (*capoeira*), interspersed with babassu palms (*Attalaea speciosa*) and jucúm palms (*Bactris setosa*). Açaí palms (*Euterpe edulis*) and buriti palms (*Mauritia flexuosa*) can be found in humid areas. Marshlands

and a diverse flora of native fruit trees also exist on the island (Novaes, 2007), and narrow rivers lined with mangroves are present throughout.

Sample collection and analysis

Two dead specimens of *Cyclopes didactylus* were received by the Centro de Triagem de Animais Selvagens in Maranhão (CETASMA/IBAMA), an agency of the Brazilian government dedicated to rehabilitating animals rescued from the wildlife trade. According to the locals who had delivered them to the Rescue Center, the animals were found in forest fragments on the island of São Luis do Maranhão (02°31' S, 44°16' W; Fig. 1).

Intestinal contents and feces were collected during necropsies and preserved in 70% ethyl alcohol. They were shipped to the Morphology and Biochemistry Laboratory of the Universidade Estadual Paulista (UNESP) São Vicente, in the state of São Paulo, for analysis. The composition of intestinal contents and feces was analyzed under a dissecting microscope based on characteristics of size and shape, following Palacio and Fernández (2003). Following examination, the specimens were conserved by IBAMA, the parent agency of CETASMA.

Results

The gastrointestinal tract of the silky anteaters contained fragments of formicid ants belonging to four genera: *Camponotus, Dolichoderus*, *Pseudomyrmex* and *Solenopsis* (Table 1), as well as trace fragments of ant nests.

All the ants identified from the gastrointestinal tract of one silky anteater, and 18.5% of the ants found in the intestines of the other, were of the genus *Camponotus*. This genus comprises over 1000 species, with at least 400 of them living in the Neotropics. Many *Camponotus* species are arboreal and nocturnal (Dejean *et al.*, 2003; Delabie *et al.*, 2003), although they may be found foraging during the day. All known species are omnivorous (Hölldobler and Wilson, 1990; Fernández, 2003a).

One morphospecies of *Dolichoderus* accounted for 26% of the gastrointestinal contents of the first specimen. Sixty-four of the 164 described species are

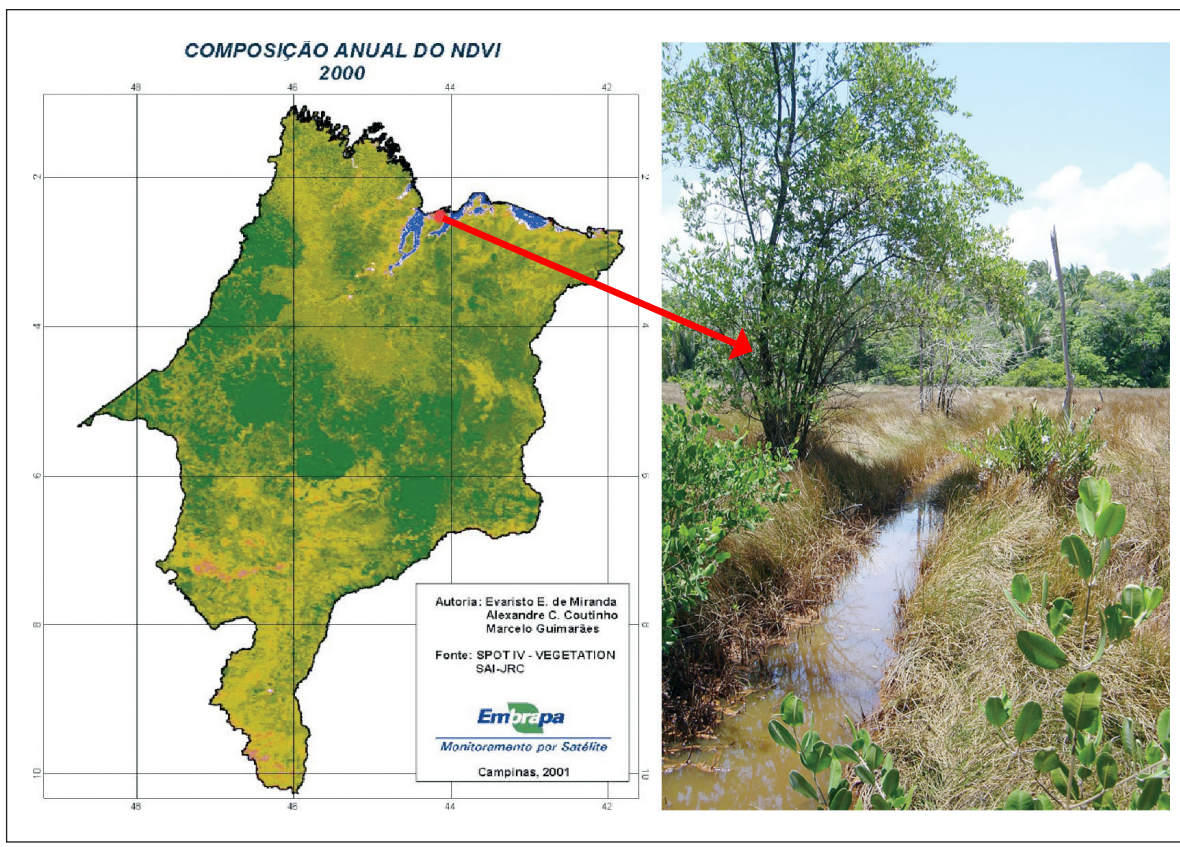

Figure 1a. Approximate locality for the silky anteaters analyzed in this study. **1b**. Typical habitat of silky anteaters in Maranhão. (Map by Embrapa; photo by Flávia Miranda.)

Neotropical (Cuezzo, 2003). These ants are mainly arboreal and very active in tropical forests, especially in rainforests (Cuezzo, 2003). They can be very abundant in some trees, and may be found with ant-gardens, in which ants actively propagate selected seeds (Dejean *et al.*, 2003; Delabie *et al.*, 2003). They are considered omnivores (Hölldobler and Wilson, 1990; Cuezzo, 2003) and can be active during the day or at night.

The genus *Pseudomyrmex* (subfamily Pseudomyrmicinae) represented only a modest proportion (7.4%) of the gastrointestinal contents of the first specimen. These ants can be found in tropical wet forests, savannas, and occasionally in cold regions (Ward, 2003). They usually live in the arboreal substrate, where they make their nests in dead branches (Ward, 1991, 2003; Delabie *et al.*, 2003). Some are obligate inhabitants of myrmecophilous plants, such as *Triplaris brasiliensis* (Hölldobler and Wilson, 1990; Ward, 2003) and some species tend scale insects (Coccoidea; Ward, 2003).

Ants of the genus *Solenopsis* (subgenus *Diplorhoptrum*) accounted for almost half of the identified food items of the first specimen; these ants are usually found in leaf litter (Fernández, 2003b). Giant anteaters (*Myrmecophaga tridactyla*) of the Pantanal of Nhecolândia have been reported to ingest large quantities of these ants (Medri *et al.*, 2003).

Discussion

The gastrointestinal contents of these two silky anteaters were comprised largely, if not entirely, of arboreal ants. The best-represented genera were *Camponotus* and *Dolichoderus*, which are among the six most abundant ant genera of the Neotropical rainforest canopy (Torbin, 1991), and *Solenopsis*, which are commonly found on trees and with ant-gardens (for a review, see Huxley and Cutler, 1991). *Solenopsis* (subgenus *Diplorhoptrum*, thief ants) is a conspicuous group in leaf litter that needs taxonomic review (Fernández, 2003b) to clarify the biology of its South American species. However, *S. (Diplorhoptrum) picta* and *S. (D.) corticalis* from North and Central America are arboreal and inhabit coastal and mangrove areas (Thompson, 1989), similar to the potential *Cyclopes* habitat on Ilha São Luis. Given the scant knowledge of the silky anteater's behavior, we do not know whether these individuals ingested *Solenopsis* while foraging in the forest canopy, or whether they sometimes descend to the ground and thus may have fed upon them in the leaf litter. We also suspect that *Pseudomyrmex* ants were rarely ingested because they are aggressive, fast-moving and solitary foragers that may be difficult to capture; this would support the findings of Best and Harada (1985).

In contrast to our observations, however, and the findings of Montgomery (1985b), the feces of *C. didactylus* that Best and Harada (1985) collected in the vicinity of Manaus also contained very small amounts (0.1%) of coleopteran fragments. In addition, the silky anteaters studied by both Montgomery (1985b) and Best and Harada (1985) had fed on a greater diversity of ants than our study animals. Although Best and Harada (1985) suggested that a silky anteater opportunistically ingests any ant it can find, our findings suggest that the diet of silky anteaters on the island of São Luis is very specific, potentially consisting only of arboreal ant species.

The ecological advantage for *Cyclopes* to consume only arboreal ants appears to be in terms of biomass. Ants are more abundant than other arthropods in the forest canopy (Adis *et al.*, 1984) and can contribute to more than half of the total arthropod dry weight (Torbin, 1991). Ants obtain most of their energy from nectar and pollen, and the canopy ants could effectively function as primary consumers (Torbin, 1991). A predator feeding exclusively on arboreal ants could thus obtain most of its energy close to the base of the trophic pyramid. Our conclusion is supported by the findings of Montgomery (1985b), who determined that for the *Cyclopes* of Barro Colorado Island, the ant species ingested in the dry season differed only slightly from those consumed during the wet season, suggesting that the silky anteaters fed only on a certain subset of available ants. Moreover, only 12% of

TABLE 1. Number of morphospecies and percentage of ant genera found in the gastrointestinal tracts of two specimens of *Cyclopes didactylus.*

	Specimen 1		Specimen 2	
Genus	No. Morphospecies	%	No. Morphospecies	%
Camponotus	2	18.5	2	100
Dolichoderus (= Monacis)	1	26.0	—	—
Pseudomyrmex	2	7.4	—	—
Solenopsis (Diplorhoptrum)	1	48.1	—	—

the ant morphospecies found in *Cyclopes* stomach contents had also been ingested by sympatric *Tamandua mexicana*, indicating that the silky anteaters did not feed on all ant species that exist in the area.

The lack of information on the ant fauna of Ilha São Luis does not allow us to evaluate whether silky anteaters feed on all available arboreal ants, or if they selectively ingest certain species. Half of the ant genera in our samples (*Camponotus* and *Pseudomyrmex*) are solitary foragers, which conflicts with Montgomery's (1985b) observations that silky anteaters only forage on nests and covered ant trails, but not on individual ants. It is important to note that no termites have been identified in any dietary study of *Cyclopes* carried out to date (Best and Harada, 1985; Montgomery, 1985b; this study). Silky anteaters thus seem to have a much more specific diet than *Tamandua* or *Myrmecophaga*.

Conclusions

The present study suggests that the diet of *Cyclopes* inhabiting Ilha São Luis is based on a limited diversity of food items, mainly arboreal ants, although it is clear that more samples need to be analyzed to confirm this first approximation. Deforestation is advancing swiftly through the study area (Miranda, personal observation), which could soon put at risk the silky anteater's habitat and food resources. Further studies on the ecology of this nocturnal mammal are urgently needed, and the implementation of conservation units that can support the survival of these species should be encouraged. Environmental education programs should be initiated to involve the local population and teach them the importance of preserving the biodiversity of the Amazon biome.

Acknowledgements

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Flávia Miranda, Projeto Tamanduá and Wildlife Conservation Society, Av. Água Fria, 269 Apt. 133B, 02333-000 São Paulo, São Paulo, Brazil, **Roberto Veloso,** Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – CETAS, São Luis do Maranhão, Maranhão, Brazil, **Mariella Superina,** CCT Mendoza – IMBECU, Ruiz Leal s/n Parque Gral. San Martin, 5500 Mendoza, Argentina, and **Fernando José Zara,** UNESP – Campus do Litoral Paulista, Unidade de São Vicente, Praça Infante Don Henrique s/n, 11330-900 São Vicente, São Paulo, Brazil.

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Observations of Intraspecific Aggression in Giant Anteaters (*Myrmecophaga tridactyla*)

Kolja Kreutz
Frauke Fischer
K. Eduard Linsenmair

Giant anteaters (*Myrmecophaga tridactyla*) are wide-ranging, typically solitary animals. Interactions between conspecifics are rarely witnessed, and aggressive behavior has only been described twice before in the recent scientific literature (Shaw *et al.*, 1987; Rocha and Mourão, 2006).

In northeastern Roraima, Brazil (02°49'N, 60°39'W), small plantations of the non-native *Acacia mangium* (black wattle) are readily accepted as foraging habitat by giant anteaters. This creates unusual population densities in these artificially forested areas (Kreutz, 2007), and due to the greater opportunity for intraspecific encounters, it provides excellent conditions for the study of social interactions.

On 5 December 2005 one of us (KK) was observing a single foraging anteater when it suddenly halted and ran away. This was an unexpected behavior: When becoming aware of a potential threat, anteaters usually assess the situation by raising their head to scent the air and eventually flee subsequently. Even though there was no major disturbance, the animal did nothing of that sort, but suddenly ran into the understory and vanished from sight after approximately 30 meters. A few moments later it entered the forestry track close to the observer, chasing another anteater (Fig. 1a). The two animals re-entered the understory after another 20 meters and were soon out of earshot. During the next five minutes the animals twice came into sight, and then remained on the forest track, running alongside the plantation border. This time the observer followed them in full stride for about 1.7 km, which they did not notice (or at least did not react to), until they finally entered an open part of the plantations.

When one of us (KK) arrived some 30 seconds later they were already involved in intense fighting, which allowed approaching and observing the scene from close up. By that time the animals were wrestling on the ground, each trying to pin the opponent's limbs and to wound thorax, abdomen or the extremity directly (Fig. 1b). One apparent tactic was to secure this extremity with one forepaw while attacking the inner side of the elbow-joint with the claws of the free paw. The animals were not randomly slashing at each other, but making well-aimed attacks trying to penetrate sensitive points with their claws.

Several times they interrupted their combat to circle each other, roaring and grunting, threatening each other with head- and claw-lifting postures (Figs. 1c, 1d). During these interruptions two very different roles became obvious: the original pursuer, evidently dominant, stood on all four legs with its tail piloerected and carried high. It pranced aggressively on its forelegs, occasionally showing the broad side and wagging its brushy tail. Meanwhile, the other animal sat on its haunches and kept its tail flattened on the ground, continuously screaming and roaring.

There were perhaps five such interruptions during which the dominant animal would retreat further each time, but always return to deliver heavy blows with its foreclaws and begin fighting again. Interestingly, after the fifth interruption the original pursuer (the apparent victor) left the scene, leaving behind its exhausted and heavily bleeding opponent. In contrast to the ritual fights witnessed by Shaw *et al.* (1987) and Rocha and Mourão (2006), this fight left serious marks on both animals.

The entire encounter had lasted approximately 20 minutes. It was not possible to identify the cause or purpose of the fight, nor the gender of the combatants. Further studies on the territoriality of the species will be necessary to improve our understanding of the triggers and potential function of this intense aggression in giant anteaters.

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Kolja Kreutz, Frauke Fischer and K. Eduard Linsenmair, Department of Animal Ecology and Tropical Biology, Biocenter of the University of Würzburg, 97074 Würzburg, Germany, e-mail: k-kreutz@gmx.net.

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a

b

c

d

Figure 1. Aggressive interactions between two giant anteaters. The initial pursuit **(a)** was followed by a wrestling phase **(b)** with interruptions of posing and beating **(c & d)**. Note the piloerection of the pursuer's tail during the chase and the particularly flat hair and tail of the other animal **(a & d)**.

Contribución al Conocimiento de la Distribución del Oso Hormiguero Gigante (*Myrmecophaga tridactyla*) en Argentina

Guillermo Pérez Jimeno
Lucía Llarín Amaya

Introducción

El oso hormiguero gigante (*Myrmecophaga tridactyla*) es un animal de hábitos solitarios, excepto en la estación reproductiva (Eisenberg y Redford, 1999). Durante los últimos 200 años, según Parera (2002), su rango de distribución ha disminuido debido a la intensa modificación del hábitat. La supervivencia a largo plazo de esta especie se ve amenazada por diversos factores tales como la baja capacidad de fuga, alta especialización en la dieta, baja tasa reproductiva y cuidado prolongado de su cría, degradación de su ambiente, atropellamientos por automóviles y fuegos espontáneos o intencionales, así como la alta presión cinegética (Fonseca y Aguiar, 2004).

El límite septentrional de distribución se encuentra en Belice y Guatemala (Wetzel, 1985; Emmons y Feer, 1997; Eisenberg y Redford, 1999; Gardner, 2005), aunque según Parera (2002) ya es raro en esta zona. Hacia el Sur la especie alcanzaría Uruguay, Gran Chaco de Bolivia, Paraguay y Argentina para Gardner (2005); el Chaco paraguayo y provincias del norte de Argentina según Eisenberg y Redford (1999); norte de Argentina y Uruguay, según Emmons y Feer (1997); para Wetzel (1985) habita hasta el norte de Argentina y sur de Brasil, a lo que Fallabrino y Castiñeira (2006) agregan que en Uruguay podría estar extinto.

La distribución histórica en Argentina, según Yepes (1928), era desde el noreste de la provincia de Salta hasta Misiones. Cabrera y Yepes (1940) lo citaron para zonas bastante aisladas del Chaco salteño, y gobernaciones de Formosa, Chaco y Misiones.

Con el objetivo de determinar la distribución actual de la especie en Argentina se contrastan datos bibliográficos al respecto, con datos de colecciones de museos de ciencias naturales e instituciones zoológicas del país, como así también de entrevistas realizadas a diversas personas que residen dentro del área de distribución evaluada, o bien que están relacionadas de alguna forma con la especie en estudio.

Métodos

Inicialmente se realizó una búsqueda bibliográfica sobre la distribución y/o presencia de *M. tridactyla* en Argentina. Asimismo, durante los años 2005 y 2006 se consultaron las colecciones de diferentes museos de ciencias naturales y zoológicos de este país, solicitando información de material o individuos que posean localidad de origen conocida y con ingresos en el período 1996–2006. Entre los primeros se consultaron: Museo de Ciencias Naturales "Dr. A. Gallardo" de la ciudad de Rosario, Santa Fe; Museo de Ciencias Naturales "Dr. F. Ameghino" de Santa Fe; Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata de la ciudad de La Plata; Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" de Buenos Aires; Museo de Ciencias Naturales "Fray José O. Bersia" de Villa Allende, Córdoba; y Museo de Ciencias Naturales "Bartolomé Mitre", provincia de Córdoba.

Los zoológicos consultados fueron: Jardín Zoológico de la Ciudad de Buenos Aires; Jardín Zoológico y Botánico de La Plata; Zoológico de Florencio Varela; Estación Zoológica Experimental de Santa Fe; Jardín Zoológico de Mendoza; Reserva Experimental de Horco Molle (REHM), Tucumán; Jardín Zoológico San Francisco de Asís, Santiago del Estero; y Estación de Fauna Autóctona (Secretaría de Medio Ambiente, Subprograma Recursos Faunísticos), Salta.

Además se realizaron entrevistas a diversos investigadores, funcionarios de áreas protegidas y autoridades de fauna ubicadas dentro del área de distribución histórica de la especie. Todos estos datos se confrontaron con los publicados previamente.

Por haberse obtenido información por fuera de los límites de distribución citados en la bibliografía, se procedió a recorrer dichas zonas (3500 km. aproximadamente, entre rutas provinciales, nacionales y caminos rurales), con intención de recabar información *in situ*. Se relevó parte de las provincias de Misiones; norte de Corrientes; este de Formosa; noroeste de Santa Fe; centro, este, oeste y norte de Santiago del Estero; noroeste de Tucumán; este de Salta; y suroeste y este de Chaco. En cada localidad visitada se realizaron entrevistas a los habitantes, concentrándose en la presencia de la especie y entrevistas particulares a quienes dijeron haber observado a *M. tridactyla* tanto directa como indirectamente (observando huellas, entre otras evidencias).

Resultados

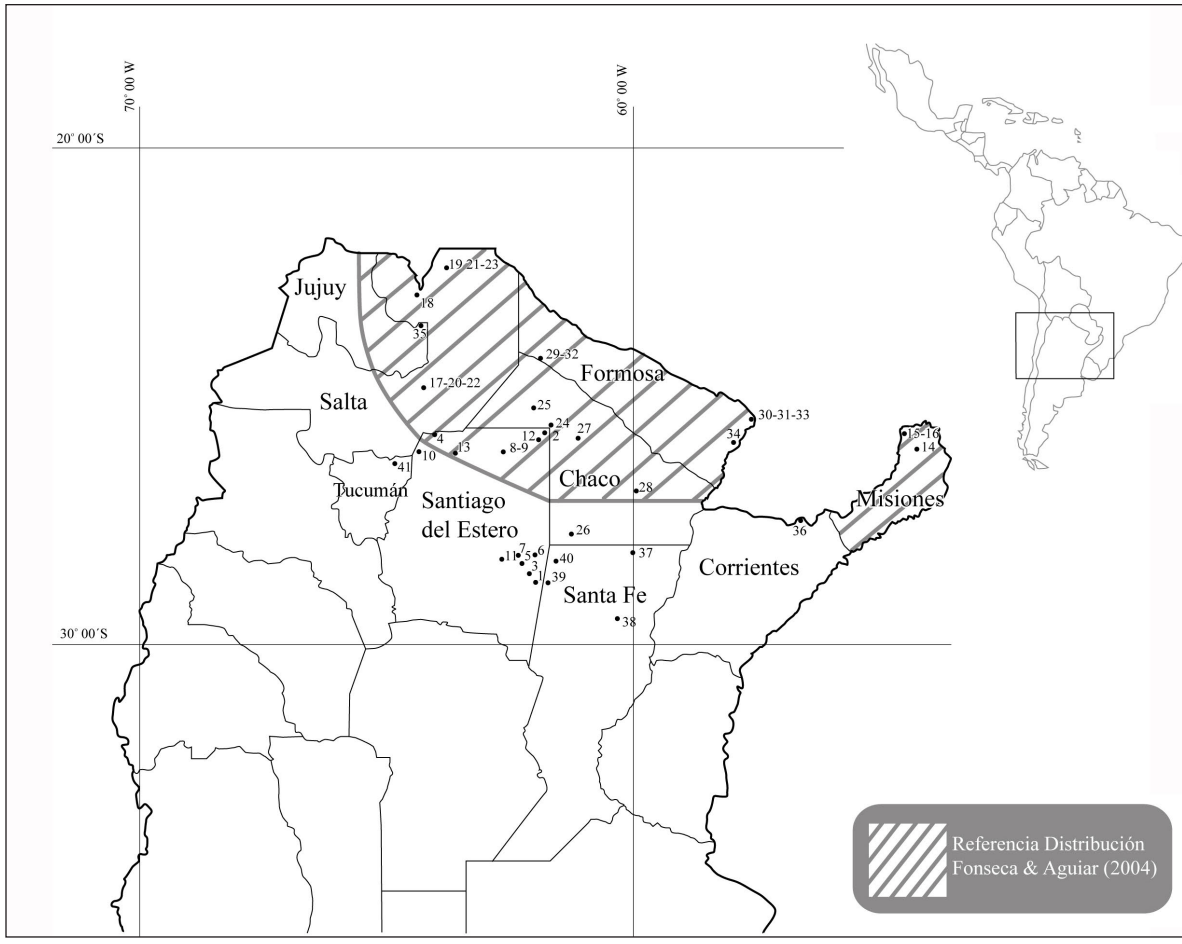
De la revisión bibliográfica se escogieron las publicaciones de mayor actualidad sobre la distribución de *Myrmecophaga tridactyla* en Argentina. Para Wetzel

(1985), la especie habita las provincias de Salta, Formosa, Chaco y Misiones. Según Chebez (1994) se distribuye en las provincias septentrionales: Misiones, Formosa, Chaco, este de Salta, noreste de Santiago del Estero y probablemente, norte de Corrientes. Parera (2002) lo cita para las provincias de Formosa, Chaco, este de Salta, norte de Santiago del Estero y porción oriental de Jujuy, y aclara que antiguamente alcanzaba hasta los 31°S de latitud. Díaz y Barquez (2002) mencionan que ocupa las provincias de Chaco, Formosa, Misiones, Salta y Jujuy, noreste de Santiago del Estero y probablemente norte de Corrientes.

En el *"Edentate Species Assessment Workshop"* se elaboró un documento sobre el estatus de conservación y distribución de todas las especies de xenartros (Fonseca y Aguiar, 2004). En este documento se designa el límite meridional para la distribución de *M. tridactyla*, ubicándolo en las provincias argentinas de Misiones, Formosa, centro y norte de Chaco, este de Salta y norte de Santiago del Estero, marcando como límite más austral aproximadamente los 27°S. Recientemente, Vizcaíno *et al.* (2006) lo citan para las provincias de Chaco, Formosa, Jujuy, Misiones, Salta, Santiago del Estero y Tucumán. Por último, se recogió como evidencia una nota del Diario Norte de Resistencia, Chaco, de fecha 3 de mayo de 2002, en que se publicó que en la localidad de Castelli (25°57'S, 60°37'W) de esa provincia, un oso hormiguero mató a un cazador.

Del total de museos argentinos consultados sólo el "Dr. F. Ameghino," de Santa Fe, registra un ingreso de material de la especie en la última década. Esta institución recibe un cuerpo proveniente de Bandera, Santiago del Estero en agosto de 2003, catalogado como MFA-ZV-M.O.602 (Pautasso, 2007; Virasoro, *com. pers.*).

Las instituciones zoológicas consultadas aportaron datos de ingresos de diez ejemplares: dos al Zoológico San Francisco de Asís, Santiago del Estero (Santillán Ger, *com. pers.*); cinco a la Estación de Fauna Autóctona, Salta (Herrera, *com. pers.*); dos más al Zoológico



MAPA 1. Distribución del oso hormiguero gigante (*Myrmecophaga tridactyla*) en el norte de Argentina, según datos bibliográficos y consultas a funcionarios, científicos y pobladores. Área sombreada: distribución propuesta por Fonseca y Aguiar (2004).

de Florencio Varela, Buenos Aires (Quagliata, *com. pers.*); y uno al Jardín Zoológico y Botánico de La Plata, Buenos Aires (Galliari, *com. pers.*). Los datos de localidades y años de ingresos se exponen en la Tabla 1.

Se consultó a distintos investigadores y pobladores. La información aportada por ellos se presenta en el Apéndice 1. De las consultas a los pobladores rurales se consideraron solamente los datos que resultaron de mayor veracidad. Las referencias de la presencia de la especie se presentan en la Tabla 1. Los docentes y alumnos de la Escuela Rural Nº 1120 "Alfonsina Storni," zona rural Logroño (29°06'S, 61°42'W), Santa Fe, dijeron no haber visto osos hormigueros ni tenían referencias de esta especie en la zona. El Sr. Carlos Acosta, El Fisco de Fátima (26°50'S, 64°30'W), Santiago del Estero, asegura que desde hace años ya no existe en la zona, lo que fue confirmado por dos cazadores locales pocos kilómetros al sur.

TABLA 1. Se presentan los datos obtenidos en relación a la distribución del oso hormiguero (*Myrmecophaga tridactyla*) en Argentina. **SdE** = Santiago del Estero; **MS** = Misiones; **SL** = Salta; **CH** = Chaco; **FM** = Formosa; **JJ** = Jujuy; **CR** = Corrientes; **SF** = Santa Fe; **TU** = Tucumán. **PN** = Parque Nacional; **RP** = Ruta Provincial; **PP** = Parque Provincial; **RPr** = Reserva Provincial. Para mayor información, ver Apéndice 1.

Ref.	Año	Localidad, Departamento	Prov.	Coordenadas	Tipo de Registro	Fuente
1	2003	Bandera, Belgrano	SdE	28°52'S, 62°16'W	espécimen de museo	Virasoro, C.; Pautasso, A., M.C.N. F. Ameghino
2	2004	PN Copo, Copo	SdE	25°38'S, 61°46'W	avistaje	Peretti, J. P., Red Yaguareté; Denapole, L., LICMVS-UNCR
3	2000/01	Averías, Gral. Taboada	SdE	28°44'S, 62°27'W	entrevista	Gorosito, G. Pobladora encuestada 2006
4	2000/01	Algarrobal viejo, Pellegrini	SdE	25°43'S, 64°02'W	atropellado	Juliá, J. P., REHM, Tucumán
5	2005	Tacañitas, Gral. Taboada	SdE	28°37'S, 62°36'W	entrevista	Salto, J. Poblador encuestado 2006
6	1998	Los Juries, Gral. Taboada	SdE	28°28'S, 62°06'W	entrevista	Aranda, D. Poblador encuestado 2006
7	2005	RP 21, Km 454, Gral. Taboada	SdE	28°38'S, 62°36'W	entrevista	Aranda, D. Poblador encuestado 2006
8	2005	Departamento Copo	SdE	25°50'S, 61°54'W	captura	Santillán Ger, S. Zoo San F. de Asís, Sgo. del Estero
9	2004	Departamento Copo	SdE	25°50'S, 61°54'W	captura	Santillán Ger, S. Zoo San F. de Asís, Sgo. del Estero
10	2005	Nueva Esperanza, Pellegrini	SdE	26°12'S, 64°16'W	avistaje	Abdala, C., REHM, Tucumán
11	2003	Herrera, Avellaneda	SdE	28°28'S, 63°03'W	entrevista	Gómez, C. Maestro rural encuestado 2006
12	2006	Copo, Copo	SdE	25°50'S, 61°54'W	captura	Alzogaray, A. Guardaparque, PN Copo
13	2006	Huachana, Jiménez	SdE	26°25'S, 63°29'W	captura	Quagliata, C., Zoológico de F. Varela
14	2003	PP Urugua-í, M. Belgrano	MS	25°53'S, 54°12'W	trampas fotográficas	Paviolo, A. (Becario CONICET-LIEY U.N.T. Datos sin pub.)
15	2004	PN Iguazú, Iguazú	MS	25°43'S, 54°25'W	trampas fotográficas	Paviolo, A. (Becario CONICET-LIEY U.N.T. Datos sin pub.)
16	2002	PN Iguazú, Iguazú	MS	25°43'S, 54°25'W	avistaje	Fabri, S. DRNEA - APN base de datos, CIES
17	2004	J. V. Gonzalez, Anta	SL	25°05'S, 64°11'W	captura	Juliá, J. P., REHM, Tucumán
18	2002	Orán, Orán	SL	23°08'S, 64°20'W	captura	Herrera, C., S. M. A. Subprograma Recursos Faunísticos
19	2003	Tartagal, Gral. San Martín	SL	22°32'S, 63°49'W	captura	Herrera, C., S. M. A. Subprograma Recursos Faunísticos
20	2004	J. V. Gonzalez, Anta	SL	25°05'S, 64°11'W	captura	Herrera, C., S. M. A. Subprograma Recursos Faunísticos
21	2004	Tartagal, Gral. San Martín	SL	22°33'S, 63°48'W	captura	Herrera, C., S. M. A. Subprograma Recursos Faunísticos
22	2006	J. V. Gonzalez, Anta	SL	25°05'S, 64°11'W	captura	Herrera, C., S. M. A. Subprograma Recursos Faunísticos
23	2005	Tartagal, Gral. San Martín	SL	22°33'S, 63°48'W	captura	Galliari, C., Zoológico y Botánico de La Plata
24	2004	Ruta J. Azurduy, Km 80, Alte. Brown	CH	25°34'S, 61°30'W	avistaje	Nigro, N., Red Yaguareté
25	2005	Fuerte Esperanza, Gral. Güemes	CH	25°09'S, 61°50'W	atropellado	Lamas, V., Fund. Azara
26	2004	Cnel. Du Graty, Fontana	CH	27°40'S, 60°56'W	entrevista	Coria. Poblador encuestado 2006
27	2002	Castelli, Gral. Güemes	CH	25°57'S, 60°37'W	avistaje	Diario Norte. Resistencia Chaco
28	2000	PN Chaco, Sgto. Cabral-De la Plaza	CH	26°50'S, 59°40'W	avistaje	Soria, DRNEA - APN base de datos
29	2000	Reserva Natural Formosa, Bermejo	FM	24°12'S, 62°06'W	avistaje	Soria, DRNEA - APN base de datos
30	2000	PN Pilcomayo, Pilcomayo	FM	25°02'S, 58°12'W	avistaje	Soria, DRNEA - APN base de datos
31	2000	PN Pilcomayo, Pilcomayo	FM	25°02'S, 58°12'W	avistaje	Lanfiutti, DRNEA - APN base de datos
32	2000/01	Reserva Natural Formosa, Bermejo	FM	24°19'S, 61°43'W	avistaje	Blanco, J. Guardaparque
33	2005	PN Pilcomayo, Pilcomayo	FM	25°02'S, 58°12'W	avistaje	Waisman, P.; Blanco, J. Guardaparque
34	2005	RPr. Guaycolec, Formosa	FM	25°60'S, 58°10'W	atropellado	Maciel, S. Guardaparque
35	2005	El Talar, Ledesma	JJ	23°33'S, 64°21'W	captura	Rivera, A.; Rivera, R. Fund. Crecer Juntos
36	2005	Área de Ituzaingó, Ituzaingó	CR	27°30'S, 56°14'W	entrevista	Solis, G. Asociación Rescate Silvestre
37	2004	Paraje Noguez, Gral. Obligado	SF	28°00'S, 59°00'W	avistaje	Giarduz, C.; Morales, R.
38	2006	Calchaquí, Vera	SF	29°47'S, 60°28'W	avistaje	Giarduz, C.; Morales, R.
39	2005	RP 95, Pozo Borrado, 9 de Julio	SF	29°00'S, 61°40'W	captura	Quagliata, C. Zoológico de F. Varela
40	2005	Cañada de las Víboras, 9 de Julio	SF	28°05'S, 61°12'W	entrevista	Penna. Poblador encuestado 2006
41	2006	7 de Abril, Burruyacu	TU	26°17'S, 64°30'W	entrevista	Sierra, J. F. Poblador encuestado 2006

En todas las entrevistas realizadas, los lugareños coincidieron en recalcar que no cazan la especie, ya que no tiene utilidad alguna ni su carne ni su cuero, sólo lo matan si el animal ataca a sus perros.

Discusión

La provincia de Santa Fe no es incluida por ninguno de los autores consultados en la distribución actual del oso hormiguero. Parera (2002) publica que históricamente alcanzaba los 31°S, lo que sin dudas incluiría a ésta. Sin embargo, según los datos obtenidos, se ha determinado la presencia en el norte de la citada provincia en la actualidad reciente. En la provincia de Misiones sólo se han obtenido datos recientes para el norte.

Se constató la presencia en las provincias de Formosa (Departamentos Pilcomayo, Formosa, Bermejo), Chaco (Departamentos Gral. Güemes, Alte. Brown, M. L. J. Fontana, Sgto. Cabral, Presidente de la Plaza), norte de Santa Fe (Departamentos 9 de Julio, Vera y Gral. Obligado), centro este, noroeste y norte de Santiago del Estero (Departamentos Alberdi, Copo, Gral. Belgrano, Gral. Taboada, Avellaneda, Pellegrini), este de Salta (Departamentos Anta, Gral. San Martín y Orán), noreste de Tucumán (Departamento Burruyacú), noreste de Jujuy (Departamento Ledesma), norte de Misiones (Departamentos Iguazú y Gral. Manuel Belgrano) y centro norte de Corrientes (Departamento Ituzaingó).

Según los datos recabados se puede concluir que la distribución del oso hormiguero gigante (*Myrmecophaga tridactyla*) en Argentina, alcanzaría aproximadamente los 29° de latitud Sur como punto más austral, unos 2° más al sur que lo publicado por Fonseca y Aguiar (2004). Si bien es cierto que la especie se podría encontrar más al sur, en áreas no relevadas por los autores, esto se considera poco probable dada la gran modificación antrópica sufrida por dichas zonas.

En la actualidad la información de distribución de los vermilinguas en la República Argentina es insuficiente. Por lo dicho es que se considera fundamental que se inicien nuevos y más profundos trabajos en este tópico. Así mismo se debería hacer hincapié en confirmar fehacientemente la presencia de *Myrmecophaga tridactyla* en el norte de la provincia de Corrientes.

Guillermo Pérez Jimeno, Asesor Científico y **Lucía Llarín Amaya**, Voluntaria, Proyecto de Conservación Oso Hormiguero Gigante (*Myrmecophaga tridactyla*), Artis Royal Zoo, Holanda - Zoo F. Varela, Argentina. *Dirección para correspondencia:* Zoológico de Florencio Varela, Avenida Pte. Perón 800, Florencio Varela (1888), Buenos Aires, Argentina.

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Apéndice I: Investigadores Consultados

- Juan Pablo Peretti (Red Yaguareté) y Lara Denapole (Instituto en Conservación y Manejo de Vida Silvestre, Universidad Nacional de Costa Rica), inmediaciones Parque Nacional Copo, Santiago del Estero, 3 avistajes, Picada Olmos, Picada Balcanera, Picada Interprovincial, respectivamente. 2004.
- Cristian Abdala (Reserva Experimental de Horco Molle, REHM), avistaje, Nueva Esperanza, Santiago del Estero. 2005.
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- Norberto Nigro (Red Yaguareté), avistaje, Ruta Provincial Juana Azurduy km 80, Chaco. 2004.
- Virginia Lamas (Fundación AZARA), atropellamiento, inmediaciones de Fuerte Esperanza, Chaco. 2005.
- Agustín Paviolo (Becario CONICET-LIEY, U.N.T., datos sin publicar), imágenes de cámaras trampas, Parque Provincial Urugua-í y Parque Nacional Iguazú, Misiones. 2003 y 2004.
- Cesar Giarduz y Raquel Morales, avistaje, Paraje Noguez, 2004 y avistajes por un poblador, Oscar Diez (Administrador de la Estancia Las Aves), Calchaquí, Santa Fe. 2006.
- Gustavo Solís (Asociación Rescate Silvestre), referencia diversas observaciones por lugareños en área Ituzaingó, Corrientes. 2005.

Entre los funcionarios de Áreas Protegidas se obtuvo la información que se detalla:

- Silvina Fabri (Delegación Regional Noreste Argentino–Administración de Parques Nacionales, DRNEA–APN), avistajes, Parque Nacional Iguazú, Misiones. 2002.
- Soria (DRNEA–APN), avistajes, Parques Nacionales Chaco, Chaco; Reserva Natural Formosa y Parque Nacional Pilcomayo, Formosa. 2000. Lanfiutti (DRNEA–APN), avistajes, Parque Nacional Pilcomayo, Formosa. 2000.
- Silvio Maciel (Guardafauna, Reserva Guaycolec), atropellamiento, cercanías del lugar, Formosa. 2005.
- Pablo Waisman y Jorge Blanco (Guardaparques, Parque Nacional Pilcomayo), avistajes, área de la Seccional Estero Poí, Parque Nacional Pilcomayo, Formosa. 2005.
- Jorge Blanco, avistajes, Reserva Natural Formosa, Formosa. 2000 y 2001.
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Scat-Detection Dogs Seek Out New Locations of *Priodontes maximus* and *Myrmecophaga tridactyla* in Central Brazil

Carly Vynne
Ricardo B. Machado
Jader Marinho-Filho
Samuel K. Wasser

The use of scat-detection dogs is increasingly recognized as a valuable wildlife assessment and monitoring tool (Long *et al.,* 2007a). Chosen for their drive for play-reward with a tennis ball, these dogs enable researchers to seek out scat samples of rare and otherwise difficult-to-study species. The dogs are able to cover large areas, are unbiased in their sampling of gender, and have demonstrated accuracy in their ability to home in on their targets while ignoring non-target species (Smith *et al.,* 2003). Studies comparing detection dogs with camera-traps and hairsnag surveys have demonstrated that detection dogs are superior both at locating the presence of target species as well as number of individuals (Wasser *et al.,* 2004; Harrison, 2006; Long *et al.,* 2007b). Once located, the scat samples may be used to understand wildlife movements, for diet and disease studies, and for DNA and hormone analyses (Wasser *et al.,* 2004).

In 2004 we employed three teams of scat-detection dogs in a successful pilot study to survey carnivores (maned wolf *Chrysocyon brachyurus*, jaguar *Panthera onca*, and puma *Puma concolor*) in the Cerrado of central Brazil (Vynne *et al*., 2005). Given this success, we decided to try training these seasoned dogs to also find two species of xenarthrans, *Priodontes maximus* and *Myrmecophaga tridactyla*. Subsequent field seasons, beginning in May 2006, have yielded valuable information on the occurrence and habitat use of these two species (Vynne *et al*., in prep.; Silveira *et al.,* 2009) in and around Emas National Park, a 133,000-hectare reserve on the common border of the states of Goiás and Mato Grosso do Sul. To our knowledge, this is the first study using scat-detection dogs outside of North America, and the first to survey for species in the Xenarthra.

Results thus far include 67 point localities of giant armadillo and 560 of giant anteater in and around Emas National Park. These locations have been the first to show extensive use of non-Park areas by the two species and to demonstrate how the two species are using the system of legal reserves and agricultural lands. Giant anteater samples are being used to monitor changes in the density of the population, which has been susceptible to large-scale fires in the Park, and giant armadillo samples will be analyzed to learn how these localities correspond to movement and home range.

Of particular importance has been that both species are still found to occur outside of Emas National Park. While Emas is a grassland island, almost entirely surrounded by intensive agriculture, current Federal legislation requires landowners to set aside 20–30% of their farm as protected land. Our initial assessment is that this mosaic of habitat fragments is extremely important for these two species, providing corridors for movement and critical protection to individuals and their food sources. Of concern, however, is the small amount of natural grasslands, the habitat preferred by the two species inside the Park, under protection beyond Park borders. As these grasslands support the highest density of ant and termite mounds, priority should be given to protecting and restoring natural, open habitats that support these critical food sources in the landscape surrounding Emas National Park.

Our field surveys concluded in May of 2008 and spatial analyses are underway. In the meantime, we are looking for collaborators who may be interested in using the physical samples that we have been collecting. Samples have been divided for DNA and diet/hormone/disease analyses and are stored in a 20% DMSO (dimethylsulfoxide) salt solution (a preservative for DNA) and frozen. Each sample has associated information on habitat, spatial location and sample quality that we would make available. The samples are currently in Brazil at the Universidade de Brasilia and within-country requests will receive first priority, although it is possible to arrange for export permits if necessary. For more information, please contact Carly Vynne at <cvynne@u.washington.edu>.

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Carly Vynne and **Samuel K. Wasser**, Center for Conservation Biology, Department of Biology, University of Washington, Seattle, WA 98115-1800, USA, e-mail <cvynne@u.washington.edu> and <wassers@u.washington.edu>, **Ricardo B. Machado**, Department of Zoology, Institute, of Biological Science, University

of Brasilia, Campus Darcy Ribeiro, 70910-900, Brasilia DF, Brazil, e-mail:<rbmac@uol.com.br> and **Jader Soares Marinho-Filho**, Universidade de Brasília, Instituto de Ciências Biológicas, Departamento de Zoologia, Campus UnB, Asa Norte, 70910900 - Brasilia, DF – Brazil, e-mail: <jmarinho@unb.br>.

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Evidence for Three-Toed Sloth (*Bradypus variegatus*) Predation by Spectacled Owl (*Pulsatrix perspicillata*)

James Bryson Voirin
Roland Kays
Margaret D. Lowman
Martin Wikelski

Abstract

We detected the nighttime death of a radio-collared three-toed sloth (*Bradypus variegatus*) with an automated radio telemetry system in a Panamanian moist forest. Forensic evidence collected at the fresh carcass, including five pairs of zygodactyl puncture wounds, and the consumption of only soft tissue, suggests that the predator was a large owl, probably *Pulsatrix perspicillata*. Telemetry data, feces in the sloths' rectum, and old sloth feces at the base of the tree near the carcass suggest that the sloth was descending to the ground to defecate when it was killed. If correct, this is the first record of *P. perspicillata* killing such a large prey, highlighting the importance of crypsis, and not self-defense, as sloths' anti-predator strategy. This event also suggests there are high risks for sloths climbing to the ground to defecate, a puzzling behavior with no clear evolutionary advantage discovered yet.

Key Words: BCI; Panama; predation; radio-telemetry; risk behavior; sloth

Predation risk has driven a diverse array of adaptations to allow animals to hide from, escape from, or fight against predators (Endler, 1991). Amidst these, body size has been identified as the most important effect on predator-prey interactions. Larger animals have fewer potential predators, with the very largest species, such as adult elephants, facing virtually no predation risk (Sinclair *et al.*, 2003). Predators are less likely to attack larger prey because they are harder to kill and are more likely to injure the attacking predators when defending themselves.

The relationship between the body size of predator and prey is well established across mammalian carnivores (prey mass = 1.19 predator mass; Carbone *et al.*, 1999) and predatory birds (Newton, 1979). The exceptions to this rule have come primarily from large predators eating small, superabundant prey, such as the sloth bear (*Ursus ursinus*, Shaw 1791) feeding on colonies of invertebrates (Carbone *et al.*, 1999). Here we report the possibility of an exception in the opposite direction, with predation of a large prey by a relatively small predator.

We conducted this work on Barro Colorado Island (BCI), Panama (1,500 ha; 9°10'N, 79°50'W), part of the Barro Colorado Nature Monument (5,500 ha total; Leigh, 1999). BCI is a hilltop that was isolated from the mainland in 1914 when the Chagres River was dammed to create Lake Gatun as part of the Panama Canal. The minimum distance between the island and the mainland is 200 m, although small islands break up this gap in some places. The habitat is moist tropical forest (Tosi, 1971; Leigh, 1999), and annual precipitation is approximately 2,600 mm, with a pronounced dry season (Windsor, 1990). The forest type is mixed, with both extensive second-growth regions as well as old-growth primary forests.

We caught a three-toed sloth on 13 March 2006 by climbing a tree using the single rope technique (Moffett and Lowman, 1995) and securing the sloth with a snare pole (Montgomery and Sunquist, 1975; Rattenborg *et al.*, 2008). The sloth was an adult female with a young of about four months. We did not separate the baby from the mother, but obtained a weight of the two together (6 kg) and estimated the weight of the mother to be 3.5–4.5 kg. We fixed a radio collar to the adult and immediately released both individuals together back into the forest canopy. The sloth's radio-collar was monitored by the Automated Radio Telemetry System (ARTS, <http://www.princeton.edu/~wikelski/research/index.htm>; Crofoot *et al.*, 2008; Lambert *et al.*, 2009).

The ARTS uses automated telemetry receivers mounted on seven above-canopy towers to monitor the location and activity of radio-collared animals through data relayed to the laboratory in real time (Crofoot *et al.*, 2008). It records the strength of signals from six fixed antennae on each tower and the changes in these signals can be used to estimate the activity of an animal (Cochran *et al.*, 1965; Kjos and Cochran, 1970; Lambert *et al.*, 2009). Data are transmitted back to the lab in real-time, so that the death of an animal can be quickly noted by the lack of an individual's activity (Aliaga-Rossel *et al.*, 2006). For the purpose of this paper, clear differences can be seen between three levels of activity: the highly dynamic signals of moving animals, the nearly static signals of resting animals, and the completely static signals from collars on dead individuals.

The strength of a signal from a radio-collar is dependent on the distance between the transmitter and receiver and the interference caused by terrain and

vegetation between the two. Signals will greatly decrease if an animal moves into a hole, for example, or behind a large rock or tree. The height of a transmitter in the forest canopy also has a large effect on signal strength, with canopy transmitters typically being detected >10db stronger than those on the ground at the same location (Crofoot *et al.*, 2008).

At 21:20 h (± 2 min) on 13 March 2006 the signal from the radio-collared sloth began to slowly decrease in strength as received from three ARTS towers, consistent with a slow descent to the ground (Fig. 1). Because the three towers were all at different angles to the sloth, alternative explanations for this decrease in signal strength, such as climbing into a tree hole or on the backside of a very large tree, are excluded. At 23:00 h, the signal was completely static and did not change again. On the morning of 14 March 2006 we noticed the unchanging signals from the sloth collar and immediately went out to the field to check the condition of the sloth. We followed the radio-signal to find the dead sloth at the base of a large *Enterolobium cyclocarpum* (Jacq., Griseb) tree with several lianas. In addition to the sloth carcass, around the base of the tree we found a pile of fresh sloth hair and two piles of previously defecated sloth feces. Thus, based on the pattern of telemetry signals, presence of feces in the dead animal's rectum (*see below*), and the site of death apparently representing a preexisting sloth latrine, we conclude that the animal was likely climbing down to defecate when it was killed.

We brought the sloth carcass back to the laboratory for analysis and photographing, finding five paired sets of bloody puncture wounds (Fig. 2a–c). The ventral side of the sloth was facing up, with the belly skin cleanly removed (Fig. 2d). All of the sloth's internal organs were gone (Fig. 2e), although there were some fresh feces in the rectal area (Fig. 2f). Besides the bloody, zygodactyl (two-up, two-down) puncture wounds and empty body cavity, the rest of the carcass was undamaged. These paired puncture wounds are a very unique pattern, unlike the anisodactyl (one-up, three-down) talons of eagles, hawks, and falcons, and of the teeth bite marks of any mammalian predator. The paired, 2-2 zygodactyl talon pattern is rare in birds, and locally known only in trogons (Trogonidae, diurnal fruit eaters), woodpeckers (diurnal insectivores), osprey (Pandionidae, diurnal fish eaters), and owls (nocturnal predators). Of these, owls are the

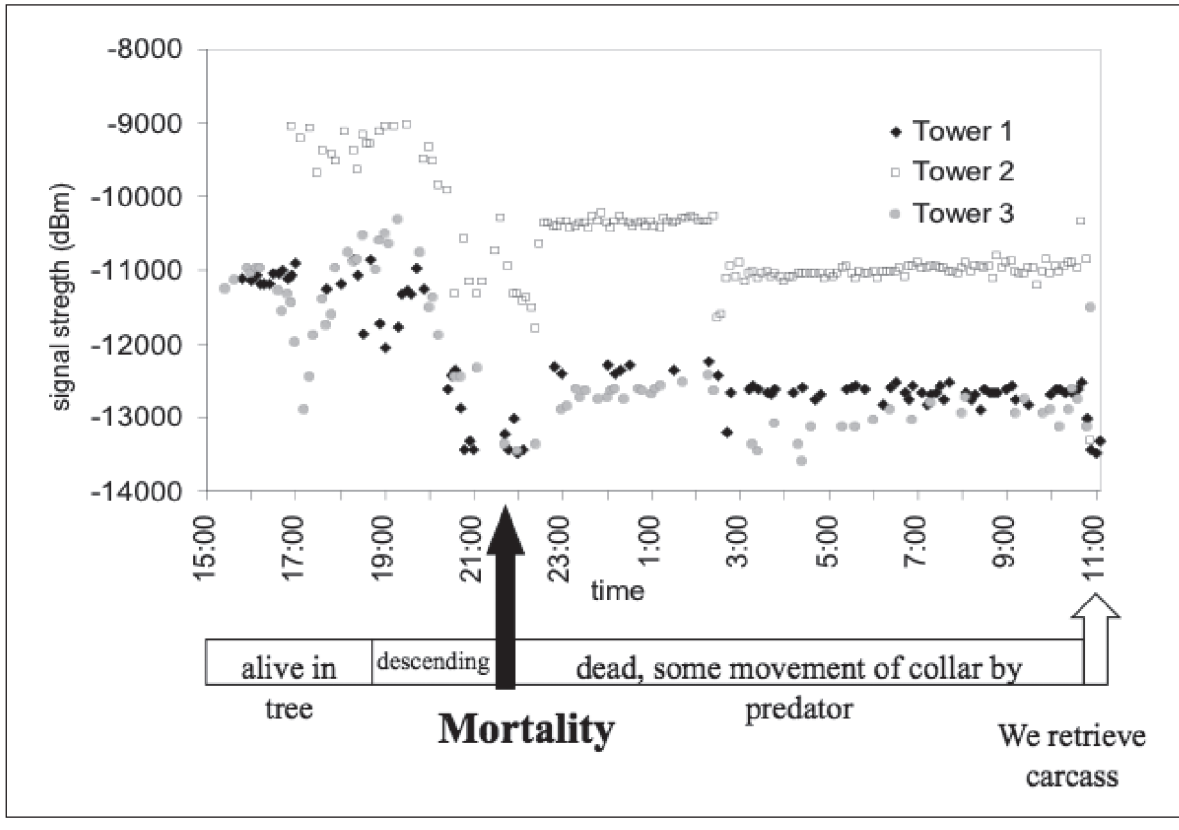

Figure 1. Time series of the signal strength of a sloth's radio-collar on the night of its predation as received by three automated telemetry receivers. Dynamic signal strength reflects animal activity while static signals indicate a resting or dead animal. Just before death all three towers registered a slow decline in signal strength, which we interpret as resulting from the animal descending a tree.

most likely to kill a sloth at night. In particular, the spectacled owl (*Pulsatrix perspicillata*, Latham 1790, up to 1250 g) is the largest owl in our study site and the most likely predator of this sloth.

The treatment of the sloth carcass is also suggestive of a smaller predator, consistent with our suggestion of being an owl. The carcass was not thrown around or carried away to a nest, and only the softest tissue was eaten. Ocelots (*Leopardus pardalis*, Linnaeus 1758) are common on BCI, but are much more destructive eaters. Not only do they typically decapitate and remove limbs from their prey, but they also drag the carcass away from the site of death and then cover it with leaves at dawn (Aliaga-Rossel *et al.*, 2006). This three-toed sloth carcass was treated more delicately, as the lack of internal organs and paired puncture wounds were the only signs of trauma and the carcass was not moved from the kill site.

Sloths have not been reported in the diet of owls, but are commonly eaten by medium-sized and large felids (Sunquist and Sunquist, 2002; Moreno *et al.*, 2006) and eagles (Fowler and Cope, 1964; Galetti and Carvalho, 2000; Touchton *et al.*, 2002). We are fairly confident that the predator was not a harpy eagle (*Harpia harpyja*), as they were not known from BCI at the time, do not hunt in the

Figure 2. Diagram and photographs of freshly killed sloth. (a) Locations of five paired puncture wounds. (b) Close up views of punctures to side of the head and (c) the trapezius region of the back. (d) Ventral view of the cleanly disemboweled sloth carcass. (e) Close up view of the pericardial cavity and cleanly cut trachea, and (f) posterior view showing sloth feces in the rectum.

middle of the night, and furnish talons with a large, easily identifiable anisodactyl spread. Spectacled owls are the largest owls found in the Neotropics, and are common on BCI. Gómez de Silva *et al.* (1997) found that, in Mexico, the majority of their diet is comprised of rats weighing approximately half their body weight. However, spectacled owls have been reported preying on a variety of larger species, including agoutis (*Dasyprocta* spp., Illiger 1811, up to 4 kg), opossums (*Didelphis marsupialis*, Linnaeus 1758, up to 2 kg), and skunks (*Mephitidae* spp., Bonaparte 1845, up to 4 kg) (Gómez de Silva *et al.*, 1997; Johnsgard, 2002).

Some owls are known to be well adapted to pin prey to the ground and feast on them at the kill site, instead of engaging in hawk-like swooping kills (Marti, 1974). Owls are also known to spread their toes just before an attack, increasing the cover area of the claw (Payne, 1962). Although pellet studies have yet to report sloths in their diets, little if any of the soft viscera eaten in this case would be identifiable in a regurgitated pellet. Previous studies on the diet of spectacled owls admit the obvious yet unavoidable bias towards only finding food that leaves remains in pellets (Gómez de Silva *et al.*, 1997).

Nearly every aspect of a sloth's lifestyle is adapted to avoid detection by predators. This includes its famously slow movement (Beebe, 1926), camouflaged pelage (Aiello, 1985), and uncanny ability to hide in the tree canopy. Its muscles and nerves are even developed to be slower in moment and response, further concealing its normal movements in the canopy (Goffart, 1971). Indeed, Montgomery *et al.* (1973) could only visually locate the sloths in their study five percent of the time, despite the fact that they wore radio-collars. Such extreme adaptation inevitably results in trade-offs. The three-toed sloth's elongated, mobility-reduced forearms and smaller, twisted hind legs aid its arboreal lifestyle, allowing efficient suspension from tree branches. However, these adapted appendages are all but useless on the ground, not supporting its body weight, thus forcing the sloth to awkwardly crawl about when not in the trees (Beebe, 1926). Sloths have a basal metabolism less than half of what is seen in other mammals their size (McNab, 1978) and often sleep for a long time, but not as much as previously suggested (Rattenborg *et al.*, 2008).

Here, we suggest another tradeoff associated with sloth metabolism — poor defense against predators leading to potentially being susceptible to a wider range of predators.

Koalas (*Phascolarctos cinereus*, Goldfuss 1817, 4–14 kg) have adapted a similar, although less extreme, sedentary and arboreal lifestyle to the sloth. They are presumably inactive up to 16 hours a day and also have converged with sloths in having modified arms and legs, and a similarly low metabolism (Martin *et al.*, 1999; Grand and Barboza, 2001). Thus, for their body size, koalas are probably also relatively defenseless to predators, and they have also been found in the diet of raptors smaller than them (*e.g.* powerful owls, *Ninox strenua*, Latham 1802, up to 1700 g, and wedge-tailed eagles, *Aquila audax*, Latham 1802, up to 5300 g) (Melzer *et al.*, 2000).

This sloth mortality also potentially highlights one aspect of sloth behavior that is not obviously adapted to hide from predators: defecation. The sloth in our study was presumably climbing down a tree to defecate when it was killed. The sloth's ground-based defecation and urination remains one of the most enigmatic elements of its behavior, for which a convincing evolutionary explanation is still lacking. Sloths climb to the ground every three to eight days, dig a small hole with their stubby tail, defecate, and climb back into the trees (Britton, 1941; Goffart, 1971). The specific benefit to the sloth remains unknown, but theories include proposed benefits from fertilizing their favorite trees, communicating with other sloths through social latrines, or trying to hide their scent from predators (Beebe, 1926; Krieg, 1939; Goffart, 1971). A predation event as the one observed here highlights the risky nature of this ground-based defecation behavior, as does the high proportion of sloth in the diet of BCI ocelots, a felid not known to be a strong climber (Moreno *et al.*, 2006). We suggest that ground-based defecation behavior — existent in both genera of sloths despite obvious predation risks — will likely have a strong adaptive value that is yet to be discovered.

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James Bryson Voirin, Department of Migration and Immunoecology, Max Planck Institute for Ornithology, Schlossallee 2, Radolfzell 78315, Germany, e-mail: <voirin@orn.mpg.de>, **Roland Kays,** New

York State Museum, 222 Madison Avenue, Albany, NY 12230, USA, **Margaret D. Lowman,** New College of Florida, 5800 Bayshore Road, Sarasota, FL 34243, USA, and **Martin Wikelski,** Department of Migration and Immunoecology, Max Planck Institute for Ornithology, Radolfzell 78315, Germany.

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New Records of *Bradypus torquatus* (Pilosa: Bradypodidae) from Southern Sergipe, Brazil

Renata Rocha Déda Chagas
João Pedro Souza-Alves
Leandro Jerusalinsky
Stephen F. Ferrari

One of the main threats to the survival of the endangered maned sloth (*Bradypus torquatus*) is its relatively restricted geographic range, especially in comparison with the other mainland species of the genus (Aguiar and Fonseca, 2008; Chiarello, 2008). This range is basically restricted to the coastal Atlantic Forest between eastern Rio de Janeiro and southern Sergipe (Fonseca and Aguiar, 2004; Lara-Ruiz and Chiarello, 2005), and thus also coincides with the region of Brazil with the longest history of European colonization and deforestation (Dean, 1995). Furthermore, there is some evidence of the existence of three geographically and genetically distinct populations in Bahia, Espírito Santo, and Rio de Janeiro (Lara-Ruiz *et al.*, 2008) which may even represent separate taxa (Fonseca and Aguiar, 2004).

There are recent records of the species from southern Bahia (Prado, 2001), where a few large tracts of Atlantic Forest still remain. On the other hand, Fonseca and Aguiar (2004: p. 7) affirm that the species is absent from Sergipe, where "the forest is gone". Deforestation has reached critical levels in this state (Siqueira and Ribeiro, 2001), but many relatively small fragments, of up to 900 hectares, still persist. Some of these forests harbor a surprisingly diverse fauna of mammals, including the endangered primates *Callicebus coimbrai* and *Cebus xanthosternos*, and even pumas, *Puma concolor* (Jerusalinsky *et al.*, 2006; Santos Júnior, 2007). Recent surveys have confirmed that *Callicebus coimbrai* occurs in dozens of fragments statewide, including in some of less than ten hectares.

Unexpectedly, ongoing fieldwork — which is directed primarily at the local primate populations — has also resulted in the observation of maned sloths at two sites in the south of the state. These observations not only confirm that the species still occurs as far north as Sergipe, but also suggest that *B. torquatus* may be relatively abundant in this region. It is clear, however, that additional research is needed to confirm the size and status of these populations.

The first record of *B. torquatus* was collected on August 1st, 2004, at the Fazenda Riacho Seco (11°18'S, 37°33'W), in the municipality of Arauá (Figure 1), during a survey of local *Callicebus* populations (Jerusalinsky *et al.*, 2006). The adult sloth was seen at 14–14:30 h moving and feeding approximately 10 m above the ground in the crown of a jitaí tree (*Apuleia leiocarpa*) in a relatively small, disturbed fragment of less than 25 hectares. While local residents indicated that *Callicebus* was also present in the fragment, this was not confirmed during the survey.

Bradypus torquatus was also observed during mammal surveys at the Fazenda Trapsa (11°12'S, 37°14'W), an abandoned farm in the municipality of Itaporanga d'Ajuda, just south of the state capital Aracaju (Figure 1). This site encompasses a mosaic of Atlantic Forest fragments that vary in size from a few dozen to more than a hundred hectares, with a total cover of more than 500 ha. Maned sloths were observed in three of these fragments, denominated Alagado (118 ha.), Viveiro (62 ha.) and Camboinha (15 ha.), in June and July of 2008, and in April and August of 2009.

Alagado is characterized by relatively well-preserved hilltop forest with an open understorey, and canopy height of five to 15 m. By contrast, much of the smaller Viveiro fragment caught fire approximately ten years ago, and the forest is now characterized by dense undergrowth and a mostly discontinuous canopy. The much smaller Camboinha fragment was also extensively damaged by fire in early 2009. Nevertheless, much of the vegetation is still well-preserved, with trees of up to 15 m in height and a relatively open understorey.

One adult *B. torquatus* (Figure 2) was observed at Alagado on June 1st, 2008, at 13:50 h, moving up a vertical trunk at approximately 10 m height. As soon

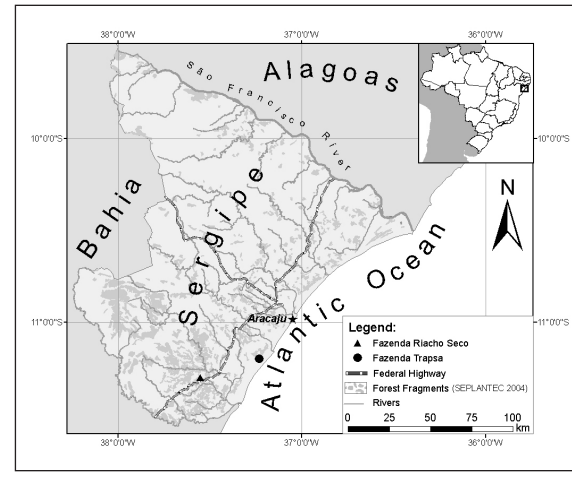

Figure 1. Location of *Bradypus torquatus* sightings in Sergipe, Brazil.

as it perceived the presence of human observers, the animal remained motionless for a few moments, but then continued its upward movement. At 06:44 h on April 17, 2009, an adult was observed at a height of 9 m in a *Dalbergia* sp. tree.

At the Viveiro forest, sloths were observed on the mornings of July 16 and 21, 2008, at 11:30 h and 09:30 h, respectively. On the first occasion, an adult individual was observed at a height of approximately 7 m in an "açoita-cavalo" (*Luehea divaricata*) tree, close to the area regenerating from the fire. This individual had a head-body length of 570 mm, but its sex was not recorded given the difficulties of identifying the gender in this species (Pinder, 1993; Chiarello, 1998a).

On the second occasion, a female carrying an infant dorsally was observed moving, apparently seeking shelter, in a lapachillo tree (*Poecilanthe parviflora*) in a part of the forest that is still in the initial stages of regeneration. The adult female had a head-body length of 609 mm (length of: head = 100 mm, right arm = 390 mm, right leg = 209 mm, hand = 75 mm, and foot = 79 mm). The infant was about a third the size of the adult, with a head-body length of 209 mm. The body length of the female is typical of the species, considering the values recorded by Pinder (1993: 520–672 mm; see also Lara-Ruiz and Chiarello, 2005).

Finally, one individual was observed at Camboinha on August 22, 2009, at 07:43 h. The animal was apparently a subadult, but its sex was not determined. It was at rest at a height of approximately 10 m.

Additionally, at least two sloths are known to have been captured by local residents during the past year (pers. obs.; E. M. Santos Junior, pers. comm.). Overall, the observations from the Fazenda Trapsa appear to indicate that *B. torquatus* is relatively abundant at this site. These records, together with the one from Riacho Seco, seem to support the assumption that the species is present in at least some of the region's other fragments. In fact, A. Cunha and R. Beltrão-Mendes (pers. comm.) have recently observed the species at two other sites in southern Sergipe, in the municipalities of Santa Luzia do Itanhi and Indiaroba.

Figure 2. Adult *Bradypus torquatus* from Fazenda Trapsa, Sergipe, Brazil.

The few ecological data available for the species (Chiarello, 1998a; 1998b) indicate that its diet consists almost exclusively of leaves, and that individuals occupy home ranges of a few hectares. *A priori*, then, it seems likely that the species would be able to survive in most fragments. A series of factors ranging from historical processes and ecological constraints, to habitat quality and hunting pressure may, however, determine its presence or absence from a given site.

The answer to the question of why the species had not been recorded in Sergipe in recent decades is probably a simple one — a combination of the lack of specific surveys and the cryptic habits of the animal. With the exception of general observations of terrestrial mammals in the Serra de Itabaiana National Park (Oliveira *et al.*, 2006), most recent fieldwork in the state has been directed specifically at the primate fauna (Sousa, 2003; Jerusalinsky *et al.*, 2006; Santos Júnior, 2007; Chagas, 2008). The fact that the observations recorded here were an indirect result of the latter fieldwork might be indicative of the possible relative abundance of *B. torquatus* in this region.

Good knowledge of a species' geographic distribution is key to the reliable assessment of its conservation status (IUCN, 2008) and the planning of conservation strategies (Primack and Rodrigues, 2001). The records presented here not only extend the known range of *B. torquatus* northwards by a number of hundred kilometers, but also suggest that it may still be present in at least some of the Atlantic Forest fragments that remain in the intervening area in Bahia and Sergipe. It is also possible that the species may still range as far north as the São Francisco River, although there is less forest cover and fewer fragments in Sergipe further north and east of Fazenda Trapsa (Jerusalinsky *et al.*, 2006).

Overall, the main hindrance to the identification of *B. torquatus* populations, such as those reported here, may simply have been the lack of expectations based on the available literature (e.g. Eisenberg and Redford, 2000; Prado, 2001; Fonseca and Aguiar,

2004; Chiarello, 2008). In the light of the evidence presented here, it is clear that such expectations need to be revised, and it would seem recommendable to include the identification of sites at which *B. torquatus* may occur in the aims of any survey conducted within the Northern Atlantic Forest. The species could easily be included in the standardized interviews used to survey primate populations (Jerusalinsky *et al.*, 2006) or even in the objectives of ecological studies.

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Renata Rocha Déda Chagas, Programa de Pós-Graduação em Desenvolvimento e Meio Ambiente, Universidade Federal de Sergipe, Av. Marechal Rondon s/n, Jardim Rosa Elze, 49.100-000, São Cristóvão – SE, Brazil, e-mail: <renata_deda118@hotmail.com>, **João Pedro Souza-Alves,** Programa de Pós-Graduação em Desenvolvimento e Meio Ambiente, Universidade Federal de Sergipe, Av. Marechal Rondon s/n, Jardim Rosa Elze, 49.100-000, São Cristóvão – SE, Brazil, e-mail: <allocosa@hotmail.com>, **Leandro Jerusalinsky,** Centro de Proteção de Primatas Brasileiros, Instituto Chico Mendes de Conservação da Biodiversidade, Praça Antenor Navarro, nº5, Varadouro, 58.010-480, João Pessoa - PB, Brazil, e-mail: <leandro.jerusalinsky@icmbio.gov.br>, **Stephen F. Ferrari,** Departamento de Biologia, Universidade Federal de Sergipe, Av. Marechal Rondon s/n, Jardim Rosa Elze, 49.100-000, São Cristóvão – SE, Brazil, e-mail: <ferrari@pq.cnpq.br>.

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Ecology of the Giant Armadillo (*Priodontes maximus*) in the Grasslands of Central Brazil

Leandro Silveira
Anah Tereza de Almeida Jácomo
Mariana Malzoni Furtado
Natália Mundim Torres
Rahel Sollmann
Carly Vynne

Abstract

The giant armadillo (*Priodontes maximus*) is the largest armadillo and is considered at risk of extinction by IUCN. Due to its fossorial and highly cryptic nature, it is also one of the least-studied mammals. The Cerrado grassland-savannahs of central South America comprises approximately 25 percent of the species' range, and the 1320 km² Emas National Park (ENP) is considered to be a stronghold area for the species in this biome. In this study, we employed a combination of radio-tagging, burrow surveys, camera-trapping, and scat detection dogs, to gain insights into the ecology of the giant armadillo in the Central Brazilian grasslands. Biometrics of five males and four females captured showed sexual dimorphism. Mean home range of five radio-tracked individuals was 10 km², and minimum density was estimated at 3.36 animals/100 km². The species showed a nocturnal activity pattern. Overall, it preferred open habitat. For burrows, soil or termite mounds were the preferred over ant mounds. No prior information exists regarding how many giant armadillos inhabit the park, or how they are using the surrounding area.

Introduction

The giant armadillo (*Priodontes maximus*) is the largest extant species of the Magnaorder Xenarthra, family Dasypodidae. Classified as Vulnerable by the IUCN (IUCN, 2007; but see Fonseca and Aguiar, 2004 for detailed discussion of listing), listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2007) and listed as endangered on the official list of the Brazilian fauna (IBAMA, 2003) the giant armadillo is at risk of extinction due to habitat loss, hunting for food, and capture for the black market (Fonseca and Aguiar, 2004). While rare everywhere it occurs, the giant armadillo tolerates a wide range of habitat types, from tropical evergreen forests to savannas, and it feeds almost exclusively on ants and termites (Redford, 1985; Eisenberg and Redford, 1999). The geographic distribution covers 12 countries of South America, from Colombia and Venezuela in the north, to Paraguay and northern Argentina and Brazil in the south (Wetzel, 1982).

Knowledge about giant armadillo ecology has traditionally been obtained mainly from indirect signs, sporadic sightings, or dead animals. Abundance and ranging behavior are largely unknown (Noss *et al.*, 2004). Activity patterns are highly nocturnal and the species is known to sometimes remain inside a burrow for more than three days (Anacleto, 1997). During our three year ecological study of *Priodontes maximus* in Emas National Park and its surroundings (Figure 1), data about biometry, home range, density, activity patterns, and habitat use of the species were obtained. Novel methods were tested and are evaluated in this article. This work represents the most comprehensive study of giant armadillo ecology to date.

Methods

Study area

Emas National Park (ENP), located in central western Brazil (18°19'S, 52°45'W), is 1320 km² in size and is one of the largest protected areas representing the Cerrado biome. ENP is primarily comprised of open grassland, with patches of shrubland (Cerrado *sensu stricto*), marshes and gallery forest (Jácomo *et al.*, 2004). The Park is located in one of Brazil's most productive agricultural areas; soy bean and corn plantations dominate the surrounding landscape. While comprising approximately 25% of the giant armadillo's range of distribution, the Cerrado has suffered from extensive conversion, and consequently fragmentation, of its natural habitat. Eighty percent of the biome is considered degraded to some extent (Cavalcanti and Joly, 2002). Emas National Park is, therefore, very likely one of the last refuges available for protecting the giant armadillo in this biodiversity hotspot (Mittermeier *et al.*, 2004). Our study area was concentrated on the open areas within Emas National Park. Scat detection dog surveys occurred in all Park habitat types, as well as on an additional 3300 km² of private lands outside the Park (Figure 1).

Live capture and biological data collection

The capture efforts were concentrated in Emas National Park during March 2004 through September 2005, and from December 2006 to February 2007. We monitored the internal roads of the park during the night and the early morning, with the objective of locating active animals and capturing them with a net. Additionally, we set a *jiqui* trap

at the entrance of burrows that were thought to be active. The *jiqui* trap is a funnel-shaped cage closed at the narrow end and with a trap door at the wider end, which is placed at the borrow entrance and closes upon an animal entering the cage.

Once captured, armadillos were immobilized with a tiletamine/zolazepam combination (Zoletil®, 50 mg of tiletamine and 50 mg of zolazepam per ml), given intramuscularly by a handheld syringe. The dose chosen for each animal was based on a visual assessment of the individual's size and weight and a dose of 4 mg/kg was estimated. After anesthetic induction, armadillos were weighed and measured. Blood, feces and ectoparasites were sampled. We compared body measurements for males and females using a factorial ANOVA to detect sexual dimorphism. In five out of nine cases, the animals were fitted with a radio transmitter. During the seasons of 2004 and 2005, the radio transmitters were attached by drilling through the posterior carapace at the height of the hind limbs. Placement was such that the transmitter did not interfere with the animal's ability to excavate and could not be removed with its claws. In 2006, we implanted a transmitter into the peritoneal cavity of one individual.

Radio Tracking and Home Range Estimates

Radio-tracking provides a useful technique for studying the movement of wildlife populations, permitting the determination of home ranges, activity patterns, habitat preference, social behavior, and migration patterns (White and Garrot, 1990; Millspaugh and Marzluff, 2001). To determine locations of our study animals outfitted with transmitters, two directional bearings of the transmitter's position were obtained from known locations. The radio-transmitter had a frequency of 151.000 MHZ.

We conducted radio-tracking surveys both at night and during the day, in equal proportions, using a 4×4 vehicle or an all terrain vehicle (ATV). We tracked individual armadillos at least once per week. From the two directional bearings taken in the field, we obtained the location of the individual using the computer program "Locate II" (Nams, 2000). We used locations of the same individual obtained on two consecutive days to calculate the minimum distance moved per night.

Home range analysis considered locations of the same animal taken 12 hours apart to minimize spatial autocorrelation. We used the computer program RANGES VI.211 (Kenward *et al.*, 2003) to estimate home range size for animals with more than 10 independent locations using the Minimum Convex Polygons (MCP) with 95 % of the locations. We further analyzed home range overlap using the MCP with 100% of the locations. While Kernel estimators are known to give better home range estimates, they suffer from small sample bias (Millspaugh and Marzluff, 2001). Due to our small sample size, we restricted our home range analysis to the MCP.

Density estimate

Camera trapping as a tool to determine a species' abundance and density has been developed for population studies of tigers (Karanth, 1995; Karanth and Nichols, 1998) and constitutes a methodology applicable to any species that can be individually identified by photographs. To survey giant armadillo density in Emas National Park, in 2002 we set 78 cameras in four Park areas, and in 2005, 45 camera traps in two areas. Camtrakker® cameras were set at every 1.5 km along animal trails and automatically recorded the day and hour on each photograph. Cameras were active continuously, and were checked every 15 days and reloaded with film or batteries when necessary.

Individual giant armadillos were identified according to the distinct scale patterns, particularly the dividing line between dark and light scales on the carapace and hind legs (Noss *et al.*, 2004). Lack of recaptures prohibited the use of mark-recapture models. We therefore calculated a minimum density, dividing the identified individuals by the sampled area. To account for the area covered by the outer camera traps beyond the outer trap polygon limit (Karanth and Nichols, 1998), we calculated the radius of mean giant armadillo home range, assuming home range to be circular, based on the findings from our telemetry study (see results below). We used the resulting value as radius of a circular buffer placed over every camera-trap, with the resulting area constituting the effective sampled area. This procedure was performed in ArcGIS 9.0© (ESRI, Redlands, CA, USA).

Activity pattern

Activity pattern was interpreted using time of registers of the species by camera-traps. All camera-trapping data accumulated between 2001 and 2006 in ENP and its surroundings were considered, including data from the two giant armadillo density surveys described above, but also from additional camera trapping events that targeted other species, but yielded giant armadillo records. By dividing the day into 12 time intervals, we grouped all activity registers into two-hour time intervals to identify hours of increased activity.

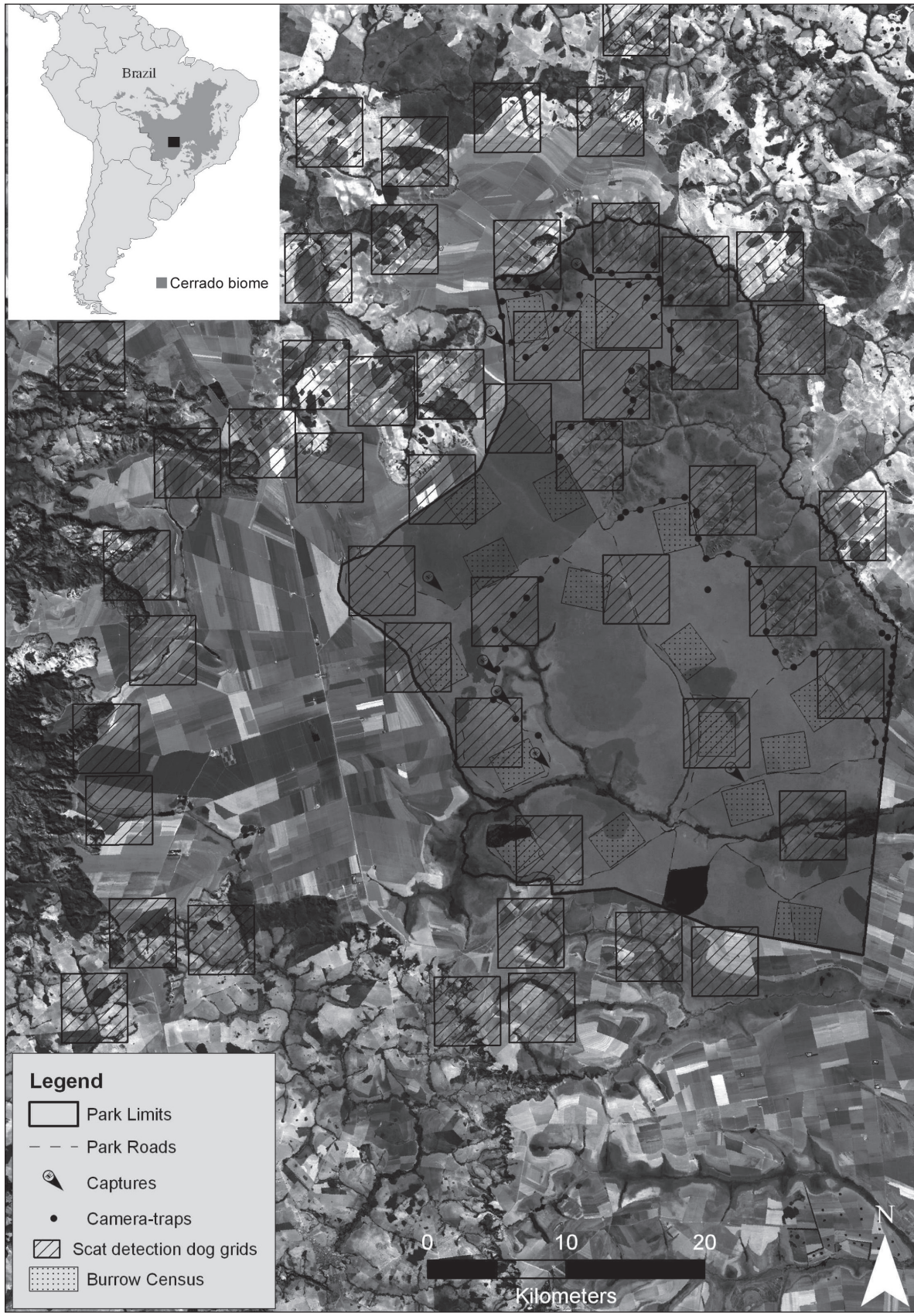

Figure 1. Location of Emas National Park within the Cerrado of Brazil, and locations within the park and its surroundings where each method was employed.

Scat Detection Dogs

Three scat detection dog teams were employed to locate scat of giant armadillos during May–July of 2006 (3 teams), April–June 2007 (2 teams), and November 2007–February 2008 (1 team). Detector dogs have been demonstrated to be highly efficient at surveying for presence of rare animals (Wasser *et al.*, 2004; Harrison, 2006; Long *et al.*, 2007) and they have demonstrated high accuracy at homing in on target animals even in the presence of sympatric species of the same family (Vynne *et al.*, submitted). To our knowledge, this study represents the first detection dog project outside of North America, as well as the first to employ the method for the giant armadillo (in addition to giant armadillo, dogs were trained to find scat of giant anteater *Myrmecophaga tridactyla*, maned wolf *Chrysocyon brachyurus*, puma *Puma concolor*, and jaguar *Panthera onca*). Surveys were conducted on foot and principally during the morning hours (6:30 – 12:30 hs).

While giant armadillo scat samples have yet to be DNA-confirmed, the same three dogs employed on this study have a combined accuracy of 95% based on DNA-confirmed sampling of 300 putative maned wolf scat samples from the same study, as well as a 91% DNA-proven accuracy for more than 1,000 caribou and wolf samples they identified on a study conducted in Canada in 2006 and 2007 (Vynne *et al.*, submitted; Wasser *et al.*, submitted). To ensure the highest accuracy of species ID possible without DNA proof, we are only including for the purpose of this study samples that received a "high" confidence ranking in at least two of the five categories: handler gestalt, dog response, presence of tracks, size/shape, and smell. We collected and preserved scats for future DNA, diet, and hormone analyses.

Burrow census

Due to their large size in comparison with those of other sympatric Dasypodidae, the burrows of the giant armadillo are readily identifiable in the field. We employed two burrow survey methods to better understand habitat selection by this species and the preferred substrate for digging burrows. We used the burrow census walked by scat detection dog teams to investigate habitat selection by giant armadillos. These teams walked daily ~10 km loops within pre-designated survey grids both inside and outside of ENP (Figure 1). We conducted our surveys on foot and GPS-recorded locations of all encountered burrows. For the habitat use results, we include only burrows that were at least 10 m in distance from one another as an independent burrow.

To better understand substrate selection for digging burrows, we conducted systematic transect searches inside ENP. Throughout the park, we walked transect groups consisting of four parallel lines, each 2 km in length and 1 km in distance from each other, starting at interior Park roads. These transects were realized on foot, by car, and by ATV by two or more observers. Burrows within 5–25 m of each side of the transect line, depending on visibility due to different vegetation, were marked with a GPS location, and it was noted whether the burrow occurred in the soil, or at the base of an anthill or termite mound. We estimated sampled area as transect length multiplied with twice the maximum distance of burrow visibility. We calculated mean burrow density for all transects and compared number of burrows found in the soil, at the base of termite mounds, and in anthills.

Results

Biometry

Between March 2004 and September 2005, and between December 2006 and February 2007, five male and two female giant armadillos were captured in Emas National Park, and an additional two females in the Park's surroundings. Four males were fitted with a radio transmitter on their carapace. The fifth male was the only individual captured with the *jiqui* trap and also the only one in which we implanted a radio transmitter. In one instance, the *jiqui* was armed at an active burrow, but the animal escaped digging a second exit, a behaviour not previously observed.

All animals were adults, with mean body weight of 44.40 kg (SD = 4.1) for males and 28.00 kg (SD = 2.71) for females, and a mean total body length of 155.90 cm (SD = 4.46) for males and 137.74 cm (SD = 4.01) for females (Table 1). Both parameters' means differed significantly between sexes ($F = 46.904$, $df = 8$, $p \leq 0.001$; $F = 40.050$, $df = 8$, $p \leq 0.001$). We found significant gender differences in mean body measurements in seven out of the 14 parameters recorded.

All animals appeared to be in good health and physical condition. The mean of the anesthetic (tiletamine/zolazepam combination) dose was 3.8 ± 0.58 mg/kg.

Home range

A total of 115 independent localizations of the five individuals fitted with radio transmitters were obtained through radio-telemetry in a mean period of 27.25 days of monitoring. Three of the four external transmitters fell off after a mean period of 45 days and were found after that period.

We obtained 18 pairs of locations for the same individual on consecutive days. Mean minimum distance moved per night was 1800 m (SD = 1356). This value does not include consecutive registers of an animal at the same location, as we cannot distinguish whether the animal remained in its burrow or returned to the same burrow.

For four of the five monitored individuals, we obtained more than 10 independent locations. When analyzed using the 95% MCP, the estimated home range was 10.05 km² (SD = 4.64). Home range overlap for two individuals using 100% of the localizations was 1.56%.

The armadillos were observed spending up to three consecutive days inside their burrows.

Density

Throughout 2002 we sampled four areas of the park, with an average of 19.5 cameras per area for a total of 4447 trap days. We obtained 40 photo records of giant armadillos. From February to June 2005, we re-sampled two of the areas with a mean of 22.5 cameras per area, accumulating 439 trap days and obtaining four records of giant armadillos. We estimated a mean home range of 10 km², which, if assumed to be circular, has a radius of 1.8 km. Placing circular buffer areas with this radius over the camera traps resulted in a total sampled area of

TABLE 1. Mean body measurements for five male and four female adult giant armadillos captured in Emas National Park between 2004 and 2006, with standard deviation (SD) and p-values for comparison of means between sexes using an ANOVA (p ANOVA); measurements that presented significantly different means between sexes are indicated with an asterisk (*).

Measure	Sex	Mean	SD	p (ANOVA)
Weight* (kg)	Males	44 .40	4 .10	0 .000
	Females	28 .00	2 .71	
Head circumference* (cm)	Males	31 .70	0 .45	0 .000
	Females	28 .75	0 .87	
Neck circumference* (cm)	Males	35 .10	1 .02	0 .001
	Females	31 .75	0 .50	
Thorax circumference* (cm)	Males	86 .60	5 .94	0 .006
	Females	73 .13	3 .92	
Head length (cm)	Males	20 .90	0 .74	0 .625
	Females	20 .70	0 .24	
Body length w/o tail* (cm)	Males	100 .20	3 .85	0 .004
	Females	89 .88	3 .33	
Tail length* (cm)	Males	55 .30	1 .75	0 .001
	Females	47 .88	2 .25	
Total length head to tail* (cm)	Males	155 .90	4 .46	0 .000
	Females	137 .75	4 .01	
Ear length (cm)	Males	5 .60	0 .42	0 .101
	Females	6 .00	0 .00	
Ear width (cm)	Males	2 .64	0 .59	0 .745
	Females	2 .75	0 .29	
Shoulder height (cm)	Males	49 .00	5 .67	0 .490
	Females	46 .50	0 .87	
Hindleg length (cm)	Males	18 .50	1 .32	0 .083
	Females	17 .13	0 .25	
Carapace length (cm)	Males	80 .40	3 .45	0 .216
	Females	76 .00	6 .20	
Carapace width (cm)	Males	63 .75	2 .63	0 .376
	Females	69 .83	12 .55	

359 km² in 2002 and 204 km² in 2005. In each area, we identified two to five giant armadillos. Resulting local minimum densities ranged from 1.27 to 5.55 individuals/100 km², with a mean minimum density of 3.36 individuals/100 km² (SD = 1.63). As this is a minimum value, we estimate 50 adult individuals to inhabit the 1320 km² of ENP.

Activity Pattern

From 2001 to 2006, we accumulated 9051 camera-trap days and obtained a total of 65 temporally independent photographic registers of giant armadillos. Due to technical problems, time of day was recorded only in 50 of them. These records suggested a highly nocturnal activity pattern for the giant armadillos. The peak of activity was observed from 2:01 to 4:00 hs (24% of the photos), and there were no registers during the daytime, from 10:01 to 18:00 hs (Figure 2). Direct observations by CV, who conducted scat detection dog surveys on foot between 7:00 and 13:00 hs in 2006–2008, yielded two registers of giant armadillos that were day active. One was found walking on a Park road at 10:15 hs (April 2007) and another digging a burrow at the base of an anthill at 12:30 hs (June 2007).

Habitat use

Habitat use for the giant armadillo was determined based on our scat detection dog teams' identification of burrows and giant armadillo scats. Scat detection dog teams (canine, dog handler, and, when available, field assistant) logged 281 field days, 2343 km of trails (human distance covered), and 794 hours of direct search (excludes time collecting samples or resting in field) between May 2006 and February 2008. Forty percent of our effort was dedicated to inside the Park and sixty percent to a 3300 km² area of private land surrounding the Park.

Of 67 putative scats encountered, 54 received a "high" confidence score in at least two of five categories and thus are included in these results and related analyses. Scats were encountered an average of one in five search days, requiring an average of 13 direct search hours per scat encounter. Burrows were found on average during every two hours of search effort.

The habitat breakdown of where scats and burrows were found relative to amount of search time is shown in Figure 3. In this region, the giant armadillo shows a clear preference for open habitats, with open cerrado, grasslands, and marsh edges being the most commonly used areas. While there is some evidence of individuals using altered landscapes (pastures and agricultural edges), we found no evidence of burrow digging or scat samples of armadillos in croplands or pasture further than 100 m from a natural habitat edge.

While only 40% of our dog teams' effort was dedicated to searching within the Park, 57% of the giant armadillo localities were within Park borders. Twenty-two of the 54 scats (41%), and 169 of 394 burrows (43%), were located within Park boundaries. The number of locations outside of ENP decreased with distance. There was only one location of an armadillo found outside ENP in an area not connected by habitat corridors. This location, also the sole location further than 18 km from the Park boundary (it was 30 km from ENP), occurred at the border of a state protected area. Finally, whereas the majority of locations inside the Park were in predominantly open habitat types, most beyond-Park occurrences were in closed cerrado.

Of the 54 scat samples found, a minimum of 22 are expected to be from a different individual. These 22 samples are exclusive to a radius of 1.8 km around each sample, which comprises the giant armadillo's presumed home range (this study). 59% of burrow locations had a scat encountered within the presumed home range area of 10 km². Since giant armadillo scats are unlikely to persist in the landscape beyond a matter of days, these areas can thus be considered as active home ranges.

Burrow census

A total of 943 ha were sampled, walking 183 km of transects. We identified 723 giant armadillo burrows. Mean burrow density for all transects was 1.47/ha (SD = 1.07). Forty-five percent of the burrows were dug in the soil, 40% at the base of termite mounds, and 15% in ant hills. This distribution differed significantly from an equal distribution ($\chi = 15.50$, $df = 2$, $p < 0.001$). Pairwise comparison showed significant preference of both soil and termite mounds over anthills ($\chi \geq 11.364$, $df = 1$, $p \leq 0.001$), but no significant difference between soil and ant hills.

Discussion

The giant armadillo has not been extensively studied in the wild and little is known about its ecology. With nine animals captured, and five of them monitored for a mean period of 27 days each, the present study comprises the highest number of captures of giant armadillos until today. To our knowledge, the studies

at Serra da Canastra (MG), where two individuals were captured (Carter and Encarnação, 1983) and at Fazenda São Miguel (MG), where one individual was captured (Anacleto, 1997), serve as the only previously published references about attempts to capture the species. Besides the nine captures and subsequent radio-telemetry locations, we collected more than 700 additional observations through camera-trap photos, scats, and burrows, all of which provided further insight in this species' ecology in the Brazilian grasslands (Table 2).

Average weight of the females captured at Emas National Park was lower than that observed by Encarnação (1986), while the average weight of the males was higher than that found by Anacleto (1997). The body weights observed in this study corroborate the literature in that adult individuals weigh more than 30 kg (Emmons and Feer, 1990) but no more than 60 kg (Nowak, 1991). Body and tail measurements from this study are within the range of measures given by Emmons and Feer (1990), but higher than the average described by Nowak (1991) and Anacleto (1997). The significant gender differences in 7 out of 14 body measurements indicates some degree of sexual dimorphism exists in this species; however, a larger number of individuals would need to be measured to confirm this conclusion.

Giant armadillos are difficult to equip with radio transmitters due to their morphology and digging behavior. We tested the acrylic resin used by Carter and Encarnação (1983) and Anacleto (1997) without success. The method we used of drilling into the edge of the carapace improved the time the device stayed on the animal, but was still limited to an average of 45 days. Recapture of the animal showed no complications caused by the way the transmitter was attached to the carapace. In contrast to external transmitters, implants hold potential for monitoring giant armadillos over longer time periods. In the present study, we did not observe any

TABLE 2. Sampling effort and observations of giant armadillos in Emas National Park and surroundings, listed by method.

Study Method	Number of Observations	Effort*
Capture	9	Not recorded
Telemetry	115	Not recorded
Camera-traps	65	9051 trap days
Scats: high confidence	54	794 hrs / 2343 km
All putative scats	67	794 hrs / 2343 km
Burrows – scat survey	394	794 hrs / 2343 km
Burrows – line census	723	183 km

*Includes only time spent doing direct survey using the respective method; not preparation, travel, or set-up time.

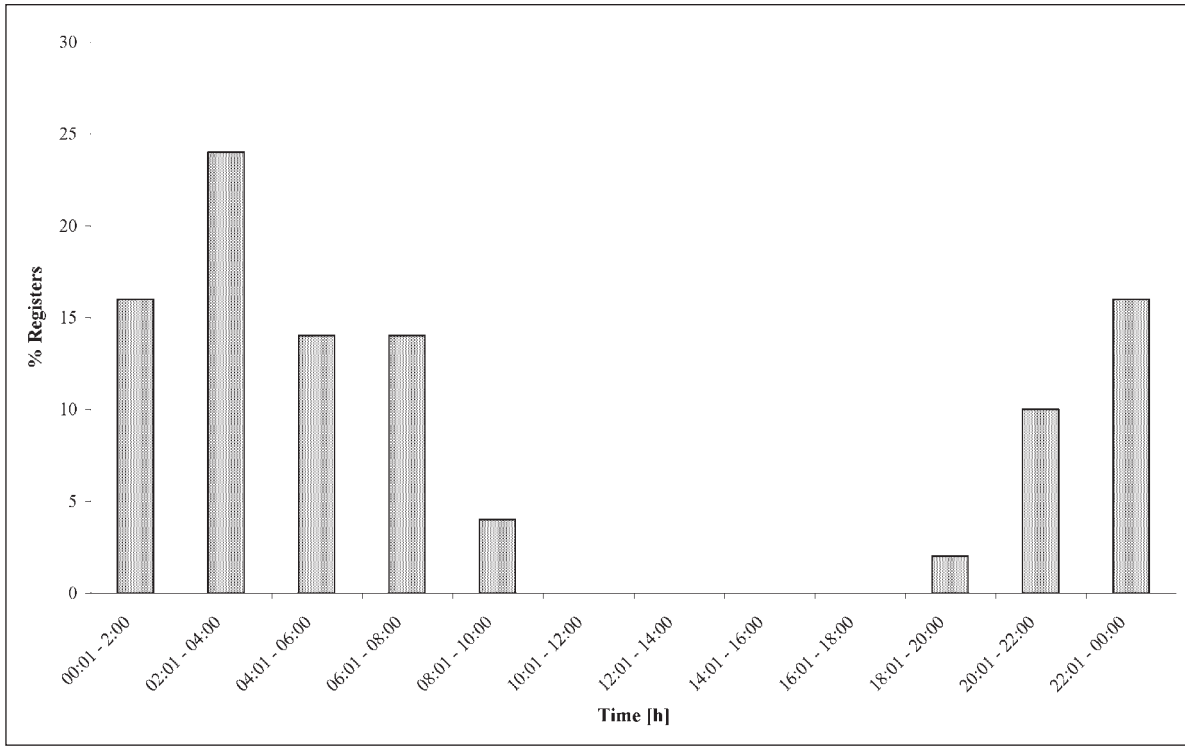

Figure 2. Activity pattern of the giant armadillo in Emas National Park, expressed as percentage of photographic records (N = 50) per two-hour time interval.

complications caused by the surgery or the implant itself. This method merits further testing, perhaps on other more common members of the family, to determine its effectiveness and safety. Radio telemetry is an important technique to acquire detailed data about a species of interest, and we recommend further study into how to safely monitor giant armadillos via telemetry in the wild.

Although relatively few locations could be accumulated using radio telemetry, home range estimates reached a reasonable stability and are thus reliable. Our estimate of 10.05 km² falls within the 3 to 15 km² estimated from three camera-trap locations in Bolivia by Noss *et al.* (2004). Medium home range size was larger than that found by Carter (1985, cited in Nowak, 1991) of 4.52 km².

We confirmed the nocturnal activity of the giant armadillo cited in literature (Nowak, 1991; Anacleto, 1997; Emmons and Feer, 1999; Noss *et al.,* 2004). Most of the time, the animals were inactive during the day and presumably remained inside their burrows. The distance of 1800 m we observed giant armadillos to cover per night was larger than that found by Encarnação (1986, cited in Nowak, 1991) of 300 m daily and smaller than the 2765 m per night found by Carter (1985, as cited in Nowak, 1991).

The preference for open habitats determined in this study differs from the results found by Anacleto (1997), who states cerrado and forest as the habitats most used by giant armadillos. For the first time, we report the occurrence of this species in the Park's surroundings and clearly show that it persists in this fragmented landscape by using remaining patches of native habitat set aside on private lands. The fact that the armadillos use more closed habitats outside of ENP than inside probably indicates a lack of open habitat types conserved outside of the Park.

The low number of scats found per unit effort is due in part to our study design, which was based on a multi-species approach and emphasized landscape matrix use by each of the species. A large part of the search therefore occurred outside of preferred habitat of the giant armadillo and outside of the protected area. This heavy search effort outside of areas typically considered by the armadillo, however, did allow us to locate occurrences not previously known for the species. Because use of scat detection dogs allows relatively rapid sampling over a large area, this method allowed us to cover a much larger area than with any

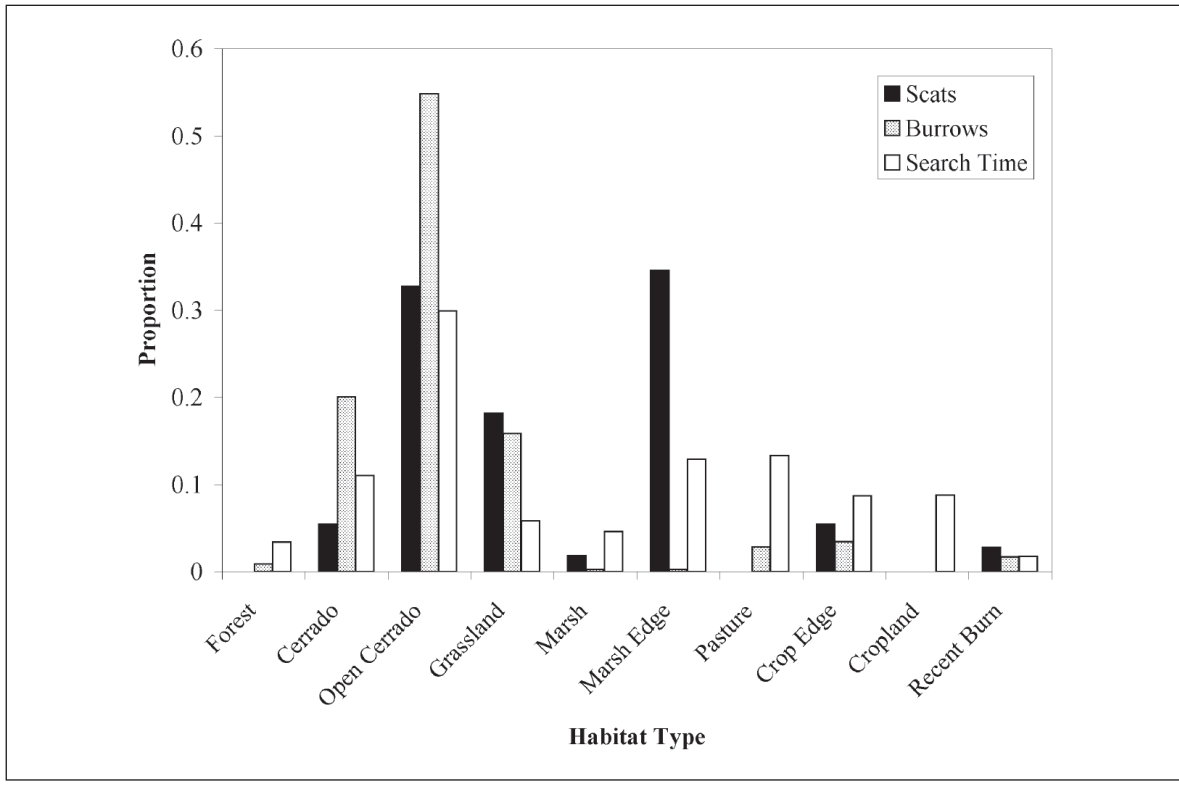

Figure 3. Habitat use of the giant armadillo in Emas National Park and surroundings, expressed as proportion of total scats and burrows found per habitat type, and proportion of search time spent in each habitat type.

of the other methods thus far tested for studying giant armadillos. In spite of the low scat encounter rates for giant armadillos, we likely found scats from a minimum of 22 individuals.

Forty-one percent of burrows did not have a scat associated within the presumed home range of the giant armadillo. Possibly, our dogs failed to detect the presence of an individual within the range of these burrows. Because we marked all burrows, however, and some of them were many months, if not years, old, it is possible that these areas represent locations where the animals are not currently present. Since our home range estimates were derived from a relatively short period of time, it is possible that the armadillos move into different parts of a larger home range while searching for food throughout the year. The areas where burrows were found but not scats, thus, could represent areas where giant armadillos are currently absent.

The preferred substrate for digging burrows in our study area was soil. This differs from the results obtained by Anacleto (1997), who found that ant mounds were the substrate most preferred by the armadillos, while Carter and Encarnação (1986) found termite mounds to be preferred. Choice of the substrate for burrows appears to vary with food availability and the effort necessary to acquire it (Anacleto, 1997). In our study, the repeated use of a burrow was observed only once, while Carter and Encarnação (1983) observed repeated use of burrows in three cases. Anacleto (1997) states that mainly burrows dug in termite mounds are used repeatedly, while recently used burrows are never reused by the animal. Every individual seems to dig various burrows within its home range (Eisenberg, 1989). It would be worthwhile to study if substrate preference varies in human-altered landscapes.

Due to the cryptic nature of the giant armadillo, few studies have yielded even basic ecological information on this enigmatic species. By applying a combination of standard and novel techniques in this first study of the giant armadillo in the grasslands of Central Brazil, we have acquired a base of knowledge on the animal's ecology, as well as laid the groundwork for refining the most useful methods for further investigation of this species.

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Leandro Silveira, Anah Tereza de Almeida Jácomo, Mariana Malzoni Furtado, Natália Mundim Torres, and Rahel Sollmann, Jaguar Conservation Fund, Caixa Postal 193, GO-341, Km 82 Mineiros – GO 75.830-000, Brazil, e-mail: <jaguar@jaguar.org.br>; **Rahel Sollmann,** Leibniz Institute for Zoo and Wildlife Research, Research Group for Evolutionary Ecology, Alfred-Kowalke-Strasse 17, 10315 Berlin, Germany; **Carly Vynne,** Department of Biology, University of Washington, Seattle, WA 98115-1800, USA, e-mail: <cvynne@u.washington.edu>.

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Morfometria de Tatu-Peba, *Euphractus sexcinctus* (Linnaeus, 1758), no Pantanal da Nhecolândia, MS

Ísis Meri Medri
Guilherme Mourão
Jader Marinho-Filho

Abstract

A total of 31 yellow armadillos, *Euphractus sexcinctus*, were captured in the Pantanal of Nhecolândia, Brazil, between October 2006 and October 2007. The individuals were anesthetized and measured. This study presents data about body mass, number of moveable bands, head length and width, head and body length, tail length and circumference, chest circumference, ear length and width, forefoot and hindfoot length, and penis length. Morphometric averages of yellow armadillos were compared with other values available in the scientific literature. The data provided in this study will be useful for further comparative studies.

Introdução

A morfometria é o estudo da forma e tamanho dos organismos, bem como de suas estruturas. Através da morfometria é possível relacionar estas características com variáveis, como por exemplo, sexo, idade, ou estabelecer relações históricas entre os organismos estudados (Moraes, 2003). As medidas morfométricas também podem ter um papel importante nas análises sistemática e filogenética de algumas espécies (Santos *et al*., 2003). Além disso, as variáveis métricas de animais provenientes de uma determinada região podem ser comparadas com as de populações de outras regiões geográficas (Richard-Hansen *et al*., 1999), e variáveis bióticas e abióticas podem ser relacionadas às variações morfométricas de uma mesma espécie em ambientes diferentes.

O tatu-peba, *Euphractus sexcinctus* (Linnaeus, 1758), na idade adulta pode medir mais de 40 cm de comprimento cabeça-corpo, sua cauda pode atingir de 11,9 a 24,1 cm, e a massa corporal varia de 3,2 a 6,5 kg (Redford e Wetzel, 1985). Esta espécie possui cinco dedos em cada membro, todos com garras, sendo que o segundo dedo é o mais desenvolvido (Pocock, 1924). A carapaça apresenta coloração pardo-amarelada a marrom-clara, alguns pêlos esbranquiçados e longos, e 6 a 8 cintas móveis na região mediana. Na região dorsal da cintura pélvica, ocorrem 2 a 4 glândulas odoríferas na carapaça de machos e fêmeas desta espécie (Redford e Wetzel, 1985). A secreção destas glândulas é provavelmente utilizada para a demarcação de tocas, e também pode ser importante na identificação e na informação da receptividade sexual dos indivíduos (McDonough e Loughry, 2003). Não há dimorfismo sexual evidente em *E. sexcinctus*, mas o sexo pode ser facilmente determinado pela observação das genitálias. Os tatus machos apresentam um dos pênis mais longos dentre os mamíferos, estendendo-se até cerca de 2/3 do comprimento do corpo em algumas espécies (McDonough e Loughry, 2001).

Medidas morfométricas dos animais geralmente são feitas baseadas em espécimes preservados em museus e coleções biológicas de instituições científicas, como por exemplo, as medidas morfométricas de tatus-peba obtidas por Wetzel (1985). Entretanto, nos casos em que as medidas morfométricas são obtidas de animais provenientes de museus, geralmente falta informação, como por exemplo, a massa corporal destes animais (Richard-Hansen *et al*., 1999).

Há poucos trabalhos relacionados à morfometria de tatus, principalmente feitos a partir de animais vivos. Entre estes estão os seguintes: morfometria de sete espécies de tatus, incluindo *E. sexcinctus*, na Serra da Canastra, Goiás (Encarnação, 1987); uma população de *Dasypus sabanicola* Mondolfi, 1968, nos lhanos da Venezuela (Laguna 1984); uma população de *Tolypeutes tricinctus* (Linnaeus, 1758) no Cerrado, área localizada na divisa da Bahia com Goiás (Guimarães, 1997); medidas de um exemplar de *Priodontes maximus* (Kerr, 1792) no Cerrado de Minas Gerais (Anacleto, 1997); medidas de sete espécies de tatus, incluindo *E. sexcinctus*, abrigadas no cativeiro do Complejo Ecológico Municipal de Sáenz Peña, na Argentina (Ceresoli *et al*., 2003); morfometria de três espécies de tatus, incluindo *E. sexcinctus*, no município de Cocalinho, Mato Grosso (Anacleto, 2006) e medidas de *Zaedyus pichiy* (Desmarest, 1804) no oeste da Argentina (Superina, 2008). Com relação aos demais registros de medidas morfométricas de tatus-peba obtidos por Redford e Wetzel (1985) e Redford e Eisenberg (1992) não foi possível determinar se os animais estudados foram provenientes de capturas no campo ou de coleções científicas. Os trabalhos que sabidamente apresentaram medidas morfométricas provenientes de tatus-peba vivos foram os de Encarnação (1987) com medidas morfométricas de 14 indivíduos, Anacleto (2006) com medidas de seis indivíduos e Ceresoli *et al*. (2003) que analisaram quatro indivíduos.

O presente estudo teve como objetivo obter um conjunto de medidas morfométricas externas de *E. sexcinctus*, no Pantanal da Nhecolândia – Mato Grosso

do Sul, comparando esta população com outros registros disponíveis na literatura científica e ampliando a base de conhecimento sobre esta temática para a espécie.

Material e Métodos

Área de estudo

O estudo foi realizado entre o período de outubro de 2006 a outubro de 2007, na Fazenda Nhumirim (18°59'S, 56°39'W), uma estação experimental da Embrapa Pantanal. A fazenda possui área aproximada de 43 km^2, sua sede está a 98 m de altitude, e dista 160 km do município de Corumbá, Estado de Mato Grosso do Sul. A área de estudo está inserida no bioma Pantanal, e na sub-região conhecida como Pantanal da Nhecolândia (Hamilton *et al*., 1996).

O clima do Pantanal é tropical semi-úmido, ou *Aw* segundo a classificação de Köppen, com uma estação chuvosa de outubro a março e uma estação relativamente seca de abril a setembro, com massas esporádicas de ar frio vindas do sul do país (Cadavid Garcia, 1984; Cadavid Garcia, 1986).

O Pantanal da Nhecolândia abriga uma fauna diversa e numerosa de mamíferos, e a topografia plana e aberta da região facilita a observação destes animais. O tatu-peba é abundante nesta região do Pantanal, pois foi uma das espécies, de hábito solitário, mais observadas em censos realizados na Fazenda Nhumirim (Alho *et al*., 1987). Apesar disso os autores descreveram que a abundância desta espécie foi subestimada devido ao seu tamanho pequeno e hábito silencioso.

Coleta de dados

Esta pesquisa obteve licença do Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) através do Processo 02038.000114/06-90. O trabalho de campo foi desenvolvido no período de outubro de 2006 a outubro de 2007, porém os meses de janeiro, fevereiro, junho e julho não foram amostrados. A área de estudo foi extensamente percorrida com o uso de quadriciclo *Honda® FourTrax TRX-350*. Os tatus-peba observados na área foram capturados manualmente e colocados em caixa de transporte de plástico com ventilação adequada, fixada no quadriciclo, e posteriormente foram levados ao laboratório da Fazenda Nhumirim para a execução dos procedimentos necessários. Os animais capturados foram codificados com as iniciais do gênero e epíteto específico, seguido por um número sequencial de captura (por exemplo: primeiro *E. sexcinctus* capturado = ES1). Os procedimentos realizados, tanto na captura dos tatus-peba quanto no laboratório, seguiram as recomendações do Guia para o Uso de Mamíferos Silvestres em Pesquisa, aprovado pela *American Society of Mammalogists* (Gannon *et al*., 2007).

No laboratório, cada tatu-peba teve seu sexo identificado e a massa corporal foi determinada com um dinamômetro *Pesola®*, com capacidade para 10 kg. A classe etária dos tatus-peba foi determinada conforme a massa corporal dos indivíduos: adultos (> de 3 kg), subadultos (entre 2 e 3 kg) ou filhotes (< de 2 kg). Os animais foram anestesiados para permitir a manipulação e a aferição de medidas morfométricas com o mínimo estresse para o animal. O anestésico administrado foi *Zoletil® 50* (Virbac do Brasil, Jurubatuba, SP), que consiste numa associação de tiletamina e zolazepam, na dosagem de 4 mg/kg, por injeção intramuscular, com agulha *BD®* tamanho 0,60 × 25 mm. Após a anestesia, as medidas morfométricas dos indivíduos foram feitas com fita métrica.

Foram obtidas as seguintes medidas morfométricas dos tatus-peba: comprimento da cabeça = desde a ponta do focinho até a junção na borda anterior da carapaça; largura da cabeça = parte mais alargada da cabeça; comprimento rostro-anal = desde a ponta do focinho até a base de inserção da cauda; comprimento da cauda = desde a base de inserção da cauda até a extremidade distal; circunferência da cauda = medida feita na base da cauda próximo da junção com o corpo; circunferência do tórax = medida feita na porção torácica, logo abaixo dos membros dianteiros do animal; comprimento da orelha = desde a base de inserção na cabeça até a extremidade; largura da orelha = parte mais alargada da orelha; comprimento da pata traseira = desde o calcanhar até a extremidade distal do dedo mais longo, sem incluir a unha; comprimento da pata dianteira = desde o punho até a extremidade do dedo mais longo, sem incluir a unha; pênis = desde a base até a extremidade do órgão.

Durante o período de duração da anestesia de cada animal, de 22 minutos à 1 hora e 43 minutos (média = 47 minutos; desvio padrão = 25; $n = 14$), primeiramente foram feitas coletas de sangue (para estudos genéticos futuros) e ectoparasitas, e posteriormente a estes procedimentos foram aferidas as medidas morfométricas, quando alguns dos indivíduos já estavam se restabelecendo da anestesia, dificultando ou impossibilitando o registro de algumas medidas morfométricas. Desta forma, não foi possível obter todas as medidas morfométricas de alguns dos indivíduos capturados. Após o completo restabelecimento

da anestesia, os animais foram soltos no exato local de captura, ainda no mesmo dia.

Análise dos dados

A normalidade de cada uma das variáveis morfométricas foi avaliada com o teste *Shapiro Wilk*. As medidas morfométricas foram comparadas entre tatus-peba machos e fêmeas adultos através do teste *t*. Ambos os testes foram feitos no programa *BioEstat 3.0* (Ayres *et al*., 2003).

As médias de massa corporal e de algumas medidas morfométricas obtidas no presente estudo (comprimento rostro-anal, comprimento da cauda e comprimento da orelha) foram comparadas com as de outros trabalhos disponíveis na literatura científica (Wetzel, 1985; Encarnação, 1987; Ceresoli *et al*., 2003) com o uso de *ANOVAs*. As médias morfométricas do estudo de Anacleto (2006) não foram comparadas através do teste *ANOVA*, pois a maioria dos animais analisados neste estudo não foi da idade adulta. Dos seis indivíduos analisados por Anacleto (2006), quatro tiveram massa corporal menor que 3 kg, sendo considerados como subadultos, e um indivíduo teve massa corporal menor que 2 kg, ou seja, um filhote. As médias das demais medidas morfométricas e os dados provenientes dos trabalhos de Redford e Wetzel (1985) e Redford e Eisenberg (1992) também não puderam ser analisados, pois para o cálculo das *ANOVAs* são necessárias informações sobre média, desvio padrão e número amostral (Zar, 1999). Antes de comparar as médias morfométricas, a normalidade das variáveis coletadas no presente estudo foi avaliada através do teste *Shapiro Wilk*. A normalidade foi avaliada também para os estudos de Encarnação (1987), Ceresoli *et al*. (2003) e Anacleto (2006), que apresentaram os dados brutos de cada medida analisada. Todas as medidas testadas apresentaram distribuição normal dos dados, com exceção da medida de comprimento da pata traseira do estudo de Encarnação (1987) ($W = 0,81$; $p = 0,03$), por isso, esta variável não foi comparada estatisticamente. Como as demais medidas analisadas de três estudos apresentaram normalidade, foi assumido que as medidas do trabalho de Wetzel (1985) também tiveram distribuição normal. Comparações posteriores das médias morfométricas dos tatus-peba entre os estudos disponíveis na literatura foram feitas com o teste *Tukey* para tamanhos de amostras diferentes (Zar, 1999).

Resultados

Foram obtidas medidas morfométricas de 31 tatus-peba. Desse total, 16 indivíduos foram machos e 15 fêmeas. A maioria dos animais capturados foi composta por indivíduos adultos, com exceção de dois machos filhotes e uma fêmea subadulta. O número de bandas móveis na carapaça dos 29 tatus-peba examinados foi seis bandas móveis em 23 indivíduos (79%), e sete bandas móveis em seis indivíduos (21%).

A massa corporal dos machos adultos variou de 3,30 a 5,40 kg (média = 4,38 kg; desvio padrão = 0,60; $n = 14$), ao passo que as fêmeas adultas tiveram massa corporal entre 3,15 e 5,50 kg (média = 4,45 kg; desvio padrão = 0,64; $n = 14$; Tabela 1), sendo que não houve diferença significativa entre a massa corporal de tatus-peba machos e fêmeas adultos ($t = 0,11$; $p = 0,90$). Também não houve diferença significativa entre as medidas morfométricas de tatus-peba machos e fêmeas adultos ($t = -1,43$ a $1,38$; $p = 0,16$ a $0,90$; Tabela 1).

Houve diferença significativa entre a medida do comprimento rostro-anal dos tatus-peba entre os estudos analisados ($F = 6,33$; $p < 0,001$; Tabela 2), sendo que os tatus-peba do presente estudo tiveram comprimento rostro-anal maior do que os estudados por Wetzel (1985) (*Tukey*; $p < 0,05$). Também houve diferença significativa no parâmetro massa corporal dos animais entre os estudos comparados ($F = 7,93$; $p < 0,005$), sendo que os tatus-peba do presente estudo tiveram massa corporal menor do que os estudados por Wetzel (1985) (*Tukey*; $p < 0,05$). Não houve diferença significativa entre as médias morfométricas de comprimento da cauda ($F = 2,99$; $p > 0,05$) e comprimento da orelha ($F = 3,10$; $p > 0,05$) entre os estudos analisados. As médias das demais medidas morfométricas não puderam ser analisadas, por não estarem disponíveis nos trabalhos consultados ou porque os autores não forneceram os dados do desvio padrão e/ou do número amostral para o cálculo das *ANOVAs* (Tabela 2).

Discussão

A massa corporal e as medidas morfométricas dos tatus-peba adultos não diferiram entre machos e fêmeas. Embora haja alguns registros de diferenças modestas entre o tamanho de machos e fêmeas de várias espécies de tatus, sendo os machos geralmente maiores do que as fêmeas, os tatus não apresentam dimorfismo sexual óbvio (McDonough e Loughry, 2001), fato que também foi observado para os tatus-peba do Pantanal da Nhecolândia.

As médias morfométricas de comprimento rostro-anal, comprimento da cauda, comprimento da orelha e comprimento da pata traseira dos tatus-peba

TABELA 1. Médias das medidas morfométricas (cm) de tatus-peba, *Euphractus sexcinctus* (Linnaeus, 1758), capturados entre outubro de 2006 e outubro de 2007, na Fazenda Nhumirim, Pantanal da Nhecolândia – MS. As medidas morfométricas foram provenientes de membros esquerdos.

Medidas morfométricas	*Euphractus sexcinctus* Machos		*Euphractus sexcinctus* Fêmeas	
	adultos	filhotes	adultas	subadulta
Massa corporal (kg)	4,38 ± 0,60 (3,30–5,40; *n*=14)	1,10 ± 0,07 (1,05–1,15; *n*=2)	4,45 ± 0,64 (3,15–5,50; *n*=14)	2,55 (*n*=1)
Número de bandas móveis	6 (*n*=9) 7 (*n*=3)	6 (*n*=2)	6 (*n*=11) 7 (*n*=3)	6 (*n*=1)
Comprimento da cabeça	13,45 ± 0,46 (12,50–14; *n*=14)	9,80 ± 0,28 (9,60–10; *n*=2)	13,34 ± 0,58 (12,40–14; *n*=14)	12 (*n*=1)
Largura da cabeça	9,26 ± 0,84 (8–10,50; *n*=13)	7,25 ± 0,35 (7–7,50; *n*=2)	9,29 ± 0,77 (8–10,50; *n*=13)	7,50 (*n*=1)
Comprimento rostro-anal	47,72 ± 1,59 (44,40–50; *n*=14)	30 ± 0 (*n*=2)	47,90 ± 1,62 (44,50–51,50; *n*=14)	40 (*n*=1)
Comprimento da cauda	23,51 ± 1,21 (21,80–25,90; *n*=14)	17 ± 0 (*n*=2)	23,01 ± 1,18 (21–25; *n*=14)	20 (*n*=1)
Circunferência da cauda	12,85 ± 0,56 (12–13,70; *n*=12)	7,75 ± 0,35 (7,50–8; *n*=2)	13,14 ± 0,52 (12,50–14; *n*=14)	10 (*n*=1)
Circunferência do tórax	46,23 ± 3,18 (41–51,50; *n*=13)	26,50 ± 2,12 (25–28; *n*=2)	45,86 ± 2,66 (41–49; *n*=14)	–
Comprimento da orelha	4,13 ± 0,39 (3,50–5; *n*=12)	3,20 ± 0 (*n*=2)	3,99 ± 0,43 (3–4,50; *n*=13)	4 (*n*=1)
Largura da orelha	2,97 ± 0,34 (2,50–3,70; *n*=12)	2,25 ± 0,35 (2–2,50; *n*=2)	2,74 ± 0,47 (2–3,50; *n*=13)	2,50 (*n*=1)
Comprimento da pata dianteira	7,24 ± 1,09 (4–8; *n*=12)	6,15 ± 0,21 (6–6,30; *n*=2)	7,32 ± 0,78 (5,50–8; *n*=13)	7 (*n*=1)
Comprimento da pata traseira	8,57 ± 0,72 (7–9,50; *n*=12)	7 ± 0 (*n*=2)	8,75 ± 0,62 (8–10; *n*=13)	7,80 (*n*=1)

TABELA 2. Média ± desvio padrão (cm), e número amostral (*n*) das medidas morfométricas de tatus-peba adultos, *Euphractus sexcinctus* (Linnaeus, 1758), capturados entre outubro de 2006 e outubro de 2007, na Fazenda Nhumirim, Pantanal da Nhecolândia – MS, em comparação com valores encontrados para a mesma espécie em outros estudos. Compr. = comprimento; Circunf. = circunferência.

Estudos	Compr. cabeça	Compr. rostro-anal	Compr. cauda	Compr. orelha	Compr. pata dianteira	Compr. pata traseira	Massa corporal (kg)
Presente estudo	13,39 ± 0,51 (*n*=28)	47,81 ± 1,57 (*n*=28)	23,26 ± 1,20 (*n*=28)	4,06 ± 0,41 (*n*=25)	7,28 ± 0,92 (*n*=25)	8,66 ± 0,66 (*n*=25)	4,43 ± 0,59 (*n*=28)
Redford & Wetzel (1985)*	–	45,3 – (*n*=14)	22,05 – (*n*=13)	3,9 – (*n*=14)	–	8,61 – (*n*=14)	4,68 – (*n*=14)
Wetzel (1985)	–	44,66 ± 3,42 (*n*=23)	23,13 ± 1,4 (*n*=23)	3,89 ± 0,35 (*n*=14)	–	8,42 ± 0,62 (*n*=13)	5,39 ± 0,94 (*n*=9)
Encarnação (1987)	–	46,28 ± 2,94 (*n*=9)	21,99 ± 2,11 (*n*=9)	3,63 ± 0,27 (*n*=9)	–	8 ± 0,75 (*n*=9)	4,92 ± 0,48 (*n*=9)
Redford e Eisenberg (1992)*	–	39,57 – (*n*=12)	22,02 – –	3,52 – (*n*=12)	–	8,35 – (*n*=13)	3,95 (*n*=6) 4,68 (*n*=14)
Ceresoli *et al.* (2003)	–	45,1 ± 2,33 (*n*=3)	21,5 ± 2,38 (*n*=4)	4 ± 0,35 (*n*=4)	–	8,25 ± 0,64 (*n*=4)	–
Anacleto (2006)	12,83 ± 1,16 (*n*=6)	41 ± 5,05 (*n*=6)	21,16 ± 1,86 (*n*=6)	3,21 ± 0,26 (*n*=6)	4,91 ± 1,11 (*n*=6)	6,83 ± 0,40 (*n*=6)	2,89 ± 0,90 (*n*=6)

*estes trabalhos não citaram o desvio padrão e não forneceram os dados brutos das medidas morfométricas para que o desvio padrão pudesse ser calculado.

provenientes do Pantanal da Nhecolândia excederam um pouco os valores previamente relatados para os indivíduos provenientes do oeste de Goiás (Redford e Wetzel, 1985) e também para os indivíduos provenientes de várias coleções científicas (Wetzel, 1985). Entretanto, a massa corporal média dos indivíduos deste estudo foi um pouco menor do que a registrada para os indivíduos de Goiás e do que os valores registrados para indivíduos citados no trabalho de Wetzel (1985). O mesmo padrão aconteceu em relação aos valores obtidos para tatus-peba no Parque Nacional da Serra da Canastra – MG, por Encarnação (1987), ou seja, as médias morfométricas encontradas para os indivíduos adultos do Pantanal da Nhecolândia excederam um pouco os valores dos indivíduos adultos da Serra da Canastra, entretanto a massa corporal média dos indivíduos do Pantanal da Nhecolândia foi um pouco mais baixa que a média encontrada para os indivíduos da Serra da Canastra. As médias das medidas morfométricas obtidas no presente estudo também superaram as médias registradas nos tatus-peba do Complejo Ecológico Municipal de Sáenz Pena, na Provincia del Chaco, Argentina, por Ceresoli *et al*. (2003), mas no trabalho não há menção da massa corporal dos indivíduos.

Embora tenha ocorrido diferença significativa apenas entre o comprimento rostro-anal e a massa corporal dos tatus-peba do presente estudo em relação aos dados de Wetzel (1985), foi constatado um padrão de variação sutil entre todas as médias morfométricas e a massa corporal dos tatus-peba do presente estudo em comparação com os registros disponíveis na literatura científica. Os tatus-peba do Pantanal da Nhecolândia apresentaram-se maiores, porém com massa corporal menor que os demais indivíduos analisados nos outros trabalhos, com exceção dos tatus-peba analisados no estudo de Anacleto (2006), provenientes do município de Cocalinho – MT, que apresentaram a menor massa corporal entre todos os trabalhos comparados, pelo fato de que a maioria dos indivíduos analisados não foi da idade adulta.

Nem sempre o tamanho do corpo do animal está diretamente relacionado à massa corporal, ou seja, indivíduos maiores podem ser mais leves do que alguns indivíduos menores e mais pesados, como por exemplo, o que acontece para a preguiça *Bradypus torquatus* Illiger, 1811, na mata Atlântica (Lara-Ruiz e Chiarello, 2005). Isto pode estar relacionado às variações na condição nutricional e reprodutiva dos indivíduos, bem como na retenção de fezes e urina que ocorre nas preguiças (Goffart, 1971). Além das características fisiológicas dos indivíduos, as condições ambientais também podem influenciar a morfometria de espécimes de *B. torquatus* situados em diferentes regiões geográficas (Lara-Ruiz e Chiarello, 2005), e esta influência ambiental deve ser considerada também na variação morfométrica de outras espécies da superordem Xenarthra. A variação morfométrica registrada para tatus-peba entre o presente estudo e os demais existentes na literatura científica pode ser apenas um atributo da população local estudada, associado às características genéticas e ambientais das áreas de estudo, que determinam a variabilidade fenotípica das populações comparadas.

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Ísis Meri Medri, Universidade de Brasília, Instituto de Ciências Biológicas, Programa de Pós-Graduação em Ecologia, Brasília 70910-900, Distrito Federal, Brasil, e-mail: <isismedri@gmail.com>, **Guilherme Mourão,** Embrapa Pantanal, Laboratório de Fauna Silvestre, Corumbá 79320-900, Mato Grosso do Sul, Brasil, e-mail: <gui@cpap.embrapa.br>, **Jader Marinho-Filho,** Universidade de Brasília, Instituto de Ciências Biológicas, Departamento de Zoologia, Brasília 70910-900, Distrito Federal, Brasil, e-mail: <jmarinho@unb.br>.

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Eto-Ecología y Conservación de Tres Especies de Armadillos (*Dasypus hybridus*, *Chaetophractus villosus* y *C. vellerosus*) en el Noreste de la Provincia de Buenos Aires, Argentina

Agustín M. Abba
Sergio F. Vizcaíno
Marcelo H. Cassini

Abstract

A capture-recapture study was performed to obtain data on abundance of three armadillo species inhabiting a highly modified habitat—the Argentinean pampas—and the intrinsic factors affecting this parameter. A total of 144 live armadillos (42 *Dasypus hybridus*, 15 *Chaetophractus villosus* and 87 *C. vellerosus*) were caught and 49 dead animals (30 *D. hybridus*, 15 *C. villosus* and 4 *C. vellerosus*) were collected on four farms subjected to different degrees of land use. Armadillos were negatively affected by habitat use and hunting pressure. Densities varied between 0.07 and 0.6 armadillos per hectare, with higher densities occurring on farms farther away from urban settlements, with few domestic dogs, low hunting pressure, conservative land use, and well-preserved natural grasslands. The results suggest the existence of source-sink metapopulations.

Introducción

Los armadillos, con sus 21 especies, representan la familia más importante del Magnorden Xenarthra. Gran número de investigaciones a lo largo de más de 100 años los tuvieron como objeto de estudio en variados temas (ver Superina, 2007). Sin embargo, el avance en aspectos ligados a la ecología, comportamiento y conservación fue bastante limitado (ver Abba y Cassini, 2008; McDonough y Loughry, 2008).

Los pastizales pampeanos ocupan 760.000 km^2 en tres países sudamericanos (Argentina, Brasil y Uruguay). En ellos conviven nueve especies de armadillos con unas 30 millones de personas, 50 millones de cabezas de ganado y 320.000 km^2 de agricultura (ver Bilenca y Miñarro, 2004). En este contexto, es prácticamente imposible encontrar pastizales naturales o prístinos en Argentina (Cabrera y Willink, 1973; León *et al.*, 1984; Ghersa *et al.*, 1998; Bilenca y Miñarro, 2004).

En el marco de un proyecto de tesis doctoral de la Facultad de Ciencias Naturales y Museo de la Universidad Nacional de La Plata (Abba, 2008) desde el año 2003 se vienen realizando distintas investigaciones sobre ecología, comportamiento y conservación de las tres especies de armadillos (la mulita *Dasypus hybridus*, el peludo *Chaetophractus villosus* y el piche llorón *C. vellerosus*) que conviven en el noreste de la provincia de Buenos Aires, Argentina (Figura 1). La primera

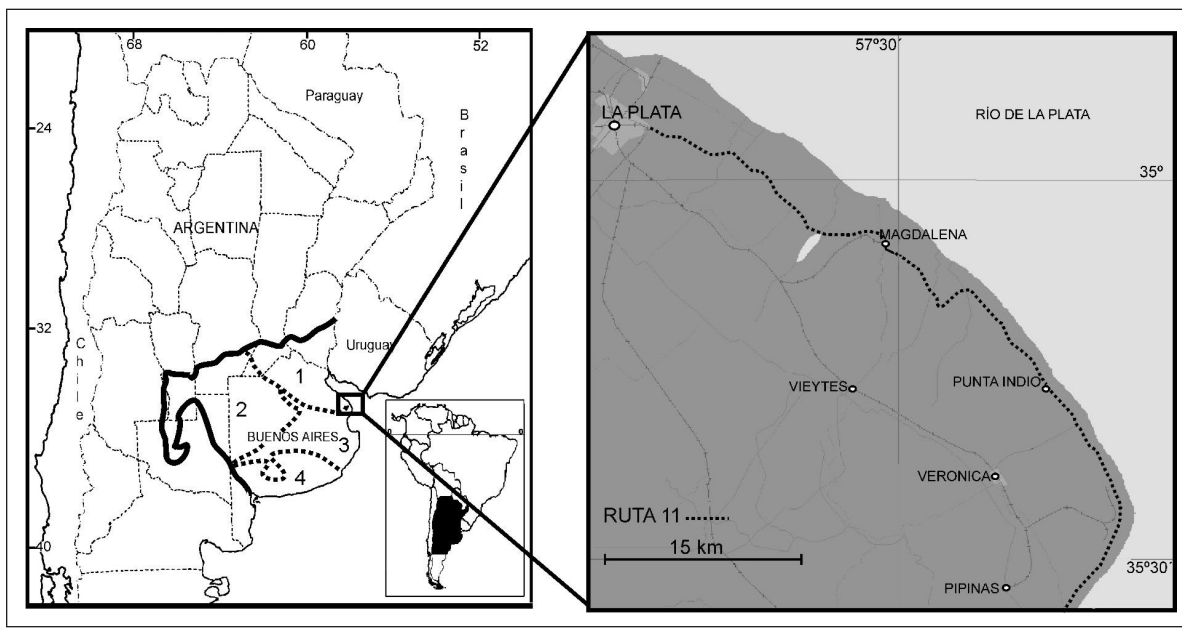

Figura 1. Ubicación del área de estudio. En el mapa de Argentina se exponen las subdivisiones en la región pampeana: 1. Pampa ondulada, 2. Interior, 3. Deprimida y 4. Austral.

etapa consistió en el relevamiento de evidencias indirectas y entrevistas a los propietarios y/o trabajadores de 34 campos (ver Abba *et al.*, 2007; Abba, 2008; Abba y Cassini, 2008). Para ello, se correlacionaron distintas variables locales o ambientales, variables históricas, fisiográficas y de uso de la tierra con las abundancias relativas de las tres especies de armadillos. Los resultados más destacados fueron los siguientes:

- *D. hybridus* depende de los pastizales naturales y evita las pasturas cultivadas. Asimismo, es más abundante en sitios alejados de la ciudad principal de la zona (La Plata) y se ve afectada por la cantidad de perros que se encuentran en los campos.

- *C. villosus*, la especie de armadillo más abundante de la región, ve comprometida su abundancia y distribución al aumentar la intensidad de caza.

- *C. vellerosus* fue el más especialista de los tres en el uso del hábitat y tiene una fuerte dependencia de los suelos calcáreo-arenosos.

A partir de esta información se diseñó un muestreo para confirmar y ajustar estas conclusiones con datos de abundancia absoluta, y obtener información sobre los factores intrínsecos que afectan la abundancia poblacional de los armadillos. Esto significa estudiar, fundamentalmente, el comportamiento social (formación de grupos o territorialidad), la competencia (por interferencia o por consumo) y la dispersión; para luego analizar el efecto de estos factores sobre la estructura espacial de las poblaciones. En el caso de los armadillos, se plantea la hipótesis de encontrar una estructura meta-poblacional de tipo fuente-sumidero, en la que los lugares con alta presión de caza y/o intensa actividad agropecuaria tengan una población de individuos que provienen de poblaciones protegidas, a través de procesos de dispersión. Dentro de los sitios protegidos, se espera encontrar que la distribución sea 'uniforme', como resultado de cierto grado de territorialidad, ya que los armadillos son animales típicamente solitarios, por lo cual se espera cierto grado de defensa del territorio.

En este informe se presentan los resultados preliminares de los muestreos de abundancia absoluta y los factores intrínsecos que afectan la abundancia poblacional de los armadillos en cuatro campos de la zona centro-oriental de la región pampeana.

Materiales y Métodos

Para cumplir con este objetivo, poner a prueba la hipótesis planteada y obtener información básica de estas tres especies de armadillos, se seleccionaron cuatro de los 34 establecimientos agropecuarios previamente visitados. La elección se basó en tener representados

Figura 2. Piche llorón (*Chaetophractus vellerosus*) con tres marcas para individualizarlo. 1. Corte de oreja (permanente). 2. Arito (Semi - permanente). 3. Calcomanía (Temporaria).

los dos ambientes principales de la zona (montes de talas — *Celtis tala* — y pastizales) y distintos niveles de caza y actividad agropecuaria. Se realizaron censos diurnos, en las cuatro estaciones del año, cubriendo un total de 150 ha por campo. En cada uno de los campos, el esfuerzo de muestreo fue de nueve horas por persona por día durante cuatro días en cada estación. El relevamiento fue efectuado por dos personas, las cuales realizaban transectas de observación de unos 30 m de ancho. El censo consistió en recorrer una vez por día, desde la mañana hasta la tarde, las 150 ha de campo, capturando, marcando, y liberando a todos los armadillos que se observaban. En algunos casos se continuó con el muestreo en forma asistemática durante las primeras horas de la noche. Agregado a esta búsqueda de armadillos activos en la superficie, se realizó una exploración minuciosa de las cuevas para poder capturar los individuos que estaban dentro. Además se colectaron todos los restos de armadillos muertos que se encontraron en los campos.

La técnica de captura utilizada fue a mano o con la ayuda de una red. Esta metodología se seleccionó ya que los armadillos son relativamente lentos y fáciles de perseguir y capturar, no suelen caer en las trampas estándar y porque permite obtener la información necesaria de forma rápida y sin dañar a los individuos. Las marcas utilizadas para individualizar a los armadillos fueron de tres tipos (Figura 2): permanentes, semi-permanentes y temporarias.

De cada uno de los individuos se registraron los siguientes datos: especie, sexo, edad relativa, fecha, hora y lugar de captura, medidas corporales, marcas o lastimaduras, si estaba sólo, comportamiento al momento de la captura y al liberarlo y si tenía ectoparásitos. Se colectaron las heces que producían los armadillos al atraparlos para realizar estudios coproparasitológicos y de dieta. Asimismo se registraron datos ambientales, de suelo, ubicación con respecto a las variaciones micro-topográficas del terreno y tipo, cobertura y altura de la vegetación.

A continuación se exponen las principales características de los cuatro establecimientos donde se llevó a cabo el estudio:

El Destino (35°08'S, 57°23'W): se encuentra en el partido de Magdalena a 15 km de la ciudad cabecera y a unos 50 km de la ciudad de La Plata. Es un establecimiento ganadero de 1000 ha donde se realiza tareas de invernada y cría. Realizan rotación del ganado entre los diferentes potreros y no usan agroquímicos. Al momento de efectuar el censo había cinco perros que eran criados en el campo. La intensidad de caza fue determinada como media o nivel 2 (ver Abba *et al.*, 2007). En las 150 ha de campo donde se realizó el censo los suelos predominantes son húmicos, existen 12 hectáreas de montes de tala y el resto de pastizales naturales. La cantidad de ganado es de 165 cabezas.

El 12 (35°10'S, 57°20'W): se localiza en Magdalena a 22 km de la ciudad cabecera del partido y a unos 57 km de la ciudad de La Plata. La superficie del establecimiento es de 350 ha y se llevan a cabo principalmente tareas de cría de ganado vacuno. Realizan rotación y no usan agroquímicos. Sólo hay un perro en el campo. La intensidad de caza es de nivel 2 (ver Abba *et al.*, 2007). En las 150 ha de campo donde se realizó el censo los suelos predominantes son calcáreo-arenosos, existen dos hectáreas de talares y el resto de pastizales. La cantidad de ganado es de unos 100 vacunos y 90 ovinos.

Talar Chico (35°16'S, 57°14'W): se encuentra en Punta Indio, adyacente a la ciudad cabecera del partido, y a unos 75 km de La Plata. El sector donde se realizó el censo posee unas 80 ha de pastura realizada con siembra directa, unas 15 ha de talares, 10 ha de montes exóticos y lo que resta de pastizales naturales muy modificados. La actividad realizada es ganadería y tienen unas 200 cabezas. Realizan rotación y usan agroquímicos. Se crían dos perros en el campo, no obstante, se observaron con frecuencia más perros de las casas vecinas. La intensidad de caza es alta (nivel 3, ver Abba *et al.*, 2007). Los suelos predominantes son calcáreo-arenosos.

Juan Gerónimo (35°30'S, 57°11'W): se encuentra en el partido de Punta Indio cercano a la localidad de Punta Piedras y a unos 95 km de La Plata. Este campo pertenece a la Estancia Juan Gerónimo, de unas 3000 ha. En el sector donde se realizó el censo no existen pasturas ni montes exóticos sino que todos los pastizales son naturales y existen unas 10 ha de montes de tala. La actividad agropecuaria es ganadería de cría y poseen unas 200 cabezas de ganado adulto, además de unos 30 caballos. Realizan rotación y no usan agroquímicos. No hay perros en el campo. La intensidad de caza es baja (nivel 1, ver Abba *et al.*, 2007). Los suelos predominantes son húmicos.

Resultados

En total se capturaron 144 armadillos (42 *D. hybridus*, 15 *C. villosus* y 87 *C. vellerosus*) y se colectaron 49 individuos muertos (30 *D. hybridus*, 15 *C. villosus* y 4 *C. vellerosus*). A continuación se detallan los resultados por campo:

El Destino: se capturaron tres *C. villosus*, ocho *D. hybridus* (ver Tabla 1) y se encontraron 14 armadillos muertos, siete peludos y siete mulitas, todos adultos excepto un *C. villosus*. El 80% de las capturas se realizó en verano y se obtuvieron dos recapturas dentro del mismo muestreo. Una recaptura fue de un ejemplar de mulita macho juvenil que la primera vez se lo había capturado solo y en la recaptura se lo observó a unos 120 m de la primera captura, interactuando con una hembra juvenil; cabe destacar que en este campo fue la única vez que se observó dos o más armadillos juntos. La otra recaptura fue de un peludo hembra a unos 200 m de la captura previa.

Los peludos fueron capturados principalmente al atardecer y las mulitas entre la mañana y la tarde (Tabla 2). Todos los armadillos fueron capturados en terrenos altos con suelos húmicos. Excepto una mulita que fue capturada en un monte de tala, a todos los demás se los atrapó en áreas de pastizales con alta cobertura vegetal (más del 75%) y una altura de la vegetación entre 10 y 50 cm. De las 13 capturas, dos se realizaron cuando los armadillos estaban quietos, tres cuando se estaban alimentando (hozando) y el resto cuando los armadillos estaban caminando. Al liberarlos todos corrieron hacia los montes de tala y se refugiaron en cuevas o huecos asociados a los mismos. La densidad fue de 0,07 individuos por hectárea. En un solo peludo se encontraron ectoparásitos (Ezquiaga *et al.*, 2008).

El 12: se capturaron 91 armadillos: un peludo, tres mulitas y 87 piches llorones (ver detalles en Tabla 1). Además, se colectaron 10 armadillos muertos. En otoño, primer censo en este campo, se obtuvieron 10 recapturas; en invierno 16 recapturas (13 de otoño y tres de la misma estación); en primavera ocho recapturas (cuatro de invierno, una de otoño y tres de la misma estación) y en verano 10 recapturas (dos de primavera, dos de otoño, una de invierno, una de otoño e invierno, una de invierno y primavera, y dos de la misma estación). Los horarios de capturas de los piches llorones variaron entre las 9:54 y 21:40 hs, el peludo fue capturado a la mañana y las tres mulitas por la tarde (Tabla 2). Todos los armadillos fueron capturados en terrenos altos de pastizales; el 95% en suelos calcáreo-arenosos y el 5% en suelos húmicos. La cobertura vegetal de los sitios de captura fue alta (entre 50 y 100%) y la altura muy variable (entre 2 y 100 cm). 72 individuos se capturaron mientras se desplazaban de un lugar a otro, 17 estaban quietos, 34 hozando, 14 cavaban y cuatro estaban dentro de cuevas. Nunca se registró en este campo agrupaciones ni interacciones entre armadillos. El comportamiento de escape fue en el 90% de los casos correr o caminar entre 1 a 150 m y refugiarse en una cueva o hueco y luego cavar; sólo en 15 oportunidades (11%) corrieron hacia montes de tala. La densidad fue de 0,6 individuos por hectárea. Se registraron ectoparásitos en 18 piches llorones (Ezquiaga *et al.*, 2008).

Talar Chico: sólo se capturaron dos *C. villosus* en verano, uno adulto y otro juvenil, ambos asociados a las pocas hectáreas de pastizales naturales. Además se colectaron tres peludos y una mulita muertos, todos adultos.

Juan Gerónimo: se capturaron 40 armadillos: 9 peludos y 31 mulitas (ver Tabla 1), además se colectaron 21 mulitas muertas. En invierno se recapturó una mulita de otoño; en primavera se recapturaron cuatro mulitas (una de invierno, una de otoño y dos de la misma estación) y en verano se recapturó una mulita de primavera.

TABLA 1. Capturas de armadillos por campo, especie, edad y estado reproductivo. A. = adulto no reproductor, J. = juvenil, C. = cría, A.L. = hembra adulta lactante, A.R. = macho adulto reproductor.

Especie	Campo	♀ A	♂ A	♀ A.L.	♂ A.R.	♀ J	♂ J.	♀ C.	♂ C.	Total
D. hybridus	El Destino	4	1	1	0	0	3	0	0	9
	El 12	0	3	0	0	0	0	0	0	3
	Talar Chico	0	0	0	0	0	0	0	0	0
	Juan Gerónimo	4	5	5	1	2	0	14	0	31
C. vellerosus	El Destino	0	0	0	0	0	0	0	0	0
	El 12	28	31	13	5	7	3	0	0	87
	Talar Chico	0	0	0	0	0	0	0	0	0
	Juan Gerónimo	0	0	0	0	0	0	0	0	0
C. villosus	El Destino	1	2	0	0	0	0	0	0	3
	El 12	0	1	0	0	0	0	0	0	1
	Talar Chico	0	2	0	0	0	0	0	0	2
	Juan Gerónimo	2	1	3	1	0	0	0	1	8
Totales		**39**	**46**	**22**	**7**	**9**	**6**	**14**	**1**	**144**

La mayoría de las capturas fueron fruto de la revisión de las cuevas, sólo 10 (22%) se realizaron con individuos activos en la superficie. Un solo peludo se capturó en superficie a las 14:05 hs, y los horarios de capturas de las mulitas variaron entre las 9:20 y las 19:15 hs (ver Tabla 2). Todas las capturas se realizaron en terrenos altos de suelos húmicos. Excepto dos mulitas que se capturaron en montes de talas, a todos los demás armadillos se los capturó en pastizales. La cobertura vegetal de los sitios de captura fue alta (entre 50 y 100%) y la altura variable (entre 10 y 90 cm). Una mulita fue capturada quieta al lado de la cueva, tres corriendo, dos caminando y una caminando y olfateando. El comportamiento de escape de los armadillos activos fue correr entre 15 y 100 m y refugiarse en cuevas; en 5 de los 10 casos fueron hacia lugares de montes de tala. Los que fueron extraídos de las cuevas mostraron una mayor variación en el comportamiento, registrando animales que se quedaban quietos durante segundos y luego corrían, otros que se refugiaban en la misma cueva de dónde provenían y la gran mayoría tomaba el comportamiento descripto para los animales capturados en la superficie. En tres ocasiones se capturaron peludos de a pares, de ellas dos veces fueron un macho y una hembra adultos, una en otoño y otra en invierno, y en verano se capturó a una hembra adulta con una cría del mismo sexo, todos en cuevas con pasto. Sólo una vez se registró a un macho y una hembra de mulita juntos, los cuales estaban caminando; las otras capturas de más de una mulita se realizaron en las cuevas con pasto y fueron dos camadas de crías sin la madre, una de 8 y otra de 6 hembras. La densidad fue de 0,26 individuos por hectárea. Un solo armadillo presentó ectoparásitos (ver Ezquiaga *et al.*, 2008).

Analizando a los cuatro campos juntos observamos lo siguiente: todos los armadillos fueron capturados en terrenos altos, con una alta cobertura vegetal y una altura de la vegetación que varió entre 5 y 100 cm. Si se tienen en cuenta las capturas de las tres especies de armadillos activos por estación no se observan diferencias significativas entre las mismas (χ^2: 3,49, gl = 3, p<0,05). Sin embargo, cuando se analizan las especies por separado (*C. villosus* no se analizó por las escasas capturas) observamos que *D. hybridus* y *C. vellerosus* tienen diferencias entre las estaciones (mulita χ^2: 15,78 y piche llorón χ^2: 14,57, gl = 3, p<0,05), obteniendo mayor cantidad de capturas en verano y primavera para *D. hybridus* y en otoño e invierno para *C. vellerosus* (ver Tabla 2). En cuanto a los períodos de actividad (ver Tabla 2) se observa que la mulita no posee diferencias significativas entre la cantidad de capturas realizadas durante la mañana o la tarde (χ^2: 1,54, gl = 1, p<0,05) y sí obtenemos un amplia diferencia para el piche llorón, capturando muchos más individuos durante la tarde (χ^2: 59,6, gl = 1, p<0,05). Los muestreos asistemáticos realizados durante la noche dieron por resultado la captura de 10 piches llorones.

Discusión

La primera consideración a tener en cuenta es que, según trabajos previos (Abba *et al.*, 2008) y observaciones actuales, *C. villosus* es más nocturno que diurno. Por lo tanto, es probable que esta especie haya sido sub-muestreada ya que los censos fueron básicamente diurnos. Sin embargo, creemos que este efecto

TABLA 2. Cantidad de capturas de armadillos activos en superficie y dentro de las cuevas (entre paréntesis) por estación y por especie. M = mañana (8–12 hs), T = tarde (12–20 hs) y *N = noche (20 hs en adelante)*. Tener en cuenta que el censo fue diurno y las recorridas nocturnas fueron asistemáticas.

Especie	Hora	Verano	Otoño	Invierno	Primavera	Total
D. hybridus	M	7 (1)	1 (1)	0 (1)	1 (1)	9 (4)
	T	4	0 (2)	1 (3)	9 (16)	14 (21)
	N	*0*	*0*	*0*	*0*	*0*
	Total	11 (1)	1 (3)	1 (4)	10 (17)	23 (25)
C. villosus	M	0	1	0 (1)	0 (1)	1 (2)
	T	4 (2)	1 (2)	0 (1)	0 (1)	5 (6)
	N	*0*	*0*	*0*	*0*	*0*
	Total	4 (2)	2 (2)	0 (1)	0 (1)	6 (6)
C. vellerosus	M	0	8 (2)	8 (1)	4	20 (3)
	T	18 (2)	31 (2)	37 (8)	21 (3)	107 (15)
	N	*5*	*0*	*5*	*0*	*10*
	Total	23 (2)	39 (4)	50 (9)	25 (3)	137 (18)
Totales		38 (5)	42 (9)	51 (15)	35 (22)	**166 (51)**

fue notablemente reducido al realizar una búsqueda intensa en las cuevas.

La simple observación de los datos hace destacar la gran diferencia encontrada en cuanto a la densidad de armadillos. Teniendo en cuenta las características de los establecimientos se pueden plantear dos pares de comparaciones para analizar los resultados: 1- El Destino vs. Juan Gerónimo y 2- Talar Chico vs. El 12.

1 - Creemos que las poblaciones en El Destino están muy influenciadas por los perros criados en el campo, otros de áreas vecinas y por la caza. Más de la mitad de los armadillos muertos (8 de 14) poseían signos de haber sido muertos por perros y cotidianamente se observaron personas cazando en el establecimiento. En Juan Gerónimo la densidad casi cuatro veces mayor a la registrada en El Destino (0,26 vs. 0,07 armadillos/ha) puede explicarse por la escasa presión de caza, la baja densidad de perros en la zona, la virtual ausencia de centros urbanos cercanos y la buena conservación de los pastizales naturales.

2 - En El 12 se registró una alta densidad de armadillos, que puede explicarse por una combinación de factores como la escasa influencia de la caza y de centros urbanos, poca cantidad de perros y una actividad conservativa del campo. En Talar Chico sólo se capturaron dos peludos, esto posiblemente se deba a una influencia negativa de la ciudad de Punta Indio y de las actividades intensas realizadas en el campo. El efecto negativo de la ciudad puede explicarse por la frecuente visita de perros y cazadores que pueden perturbar en forma directa a las poblaciones de armadillos. El uso intensivo del campo puede verse reflejado en que sólo el 40% de la superficie es de pastizales naturales, los cuales están muy modificados por la gran carga ganadera que soportan. Además, la actividad de siembra directa de pasturas realizada en este campo produce anualmente al menos cuatro períodos de laboreo intenso con maquinaria agrícola. Hay que tener en cuenta que potencialmente más del 50% de este campo podría sostener poblaciones de *C. vellerosus*, ya que las características de los suelos son idénticas a las observadas en El 12. Sin embargo, los trabajadores del campo sólo han observado a esta especie en contadas ocasiones.

El uso de hábitat y los comportamientos observados, a grandes rasgos, coinciden con los citados por la bibliografía (Cabrera y Yepes, 1940; Carter y Encarnação, 1983; Abba *et al.*, 2005; McDonough y Loughry, 2008). En cuanto a las pautas registradas durante la liberación, cabe destacar que en los campos que poseen mayor superficie de montes (El Destino y Juan Gerónimo) los armadillos se dirigían hacia ellos.

A modo de conclusión se puede señalar que los datos obtenidos apuntan a la hipótesis metapoblacional planteada, ya que en los sitios protegidos, como El 12 y Juan Gerónimo, se registran mayores densidades de animales que en los no protegidos como El Destino y Talar Chico. En la actualidad se están realizando nuevos muestreos y se están iniciando estudios genéticos para corroborar esta hipótesis.

Por lo expuesto, sería interesante detectar más establecimientos como El 12 y Juan Gerónimo ya que podrían funcionar como refugios para las especies de armadillos. Asimismo, se destaca la necesidad de alertar a los entes reguladores sobre la cantidad de perros y su influencia sobre la fauna silvestre y, por supuesto, sobre la caza furtiva realizada en la zona.

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Agustín M. Abba, División Zoología Vertebrados, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina, y Grupo de Estudios en Ecología y Etología de Mamíferos, Departamento de Ciencias Básicas, Universidad Nacional de Luján, Rutas 5 y 7, 6700 Luján, Argentina, e-mail: <abbaam@yahoo.com.ar>, **Sergio F. Vizcaíno,** División Paleontología Vertebrados, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina, y **Marcelo H. Cassini,** Grupo de Estudios en Ecología y Etología de Mamíferos, Departamento de Ciencias Básicas, Universidad Nacional de Luján, Rutas 5 y 7, 6700 Luján, Argentina.

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Ecologia de População e Área de Vida do Tatu-Mirim (*Dasypus septemcinctus*) em um Cerrado no Brasil Central

Kena F. M. da Silva
Raimundo Paulo Barros Henriques

Introdução

São poucas as informações sobre a ecologia e história natural de tatus dos Cerrados brasileiros (Wetzel, 1985a). Para a maioria das espécies faltam dados sobre a sua distribuição geográfica, densidade, dieta e uso do hábitat. Para o bioma Cerrado é indicada a presença de 9 espécies de tatus (Fonseca e Aguiar, 2004). O número de espécies em diferentes áreas de Cerrado normalmente varia de 4 a 5 espécies (Talamoni *et al.,* 2000; Bonato, 2002; Rodrigues *et al.*, 2002).

Estudos sobre as populações de tatus foram realizados por Bonato (2002), que determinou a abundância e distribuição de habitats de 4 espécies de tatus no Cerrado de Itirapina em São Paulo, onde as espécies mais abundantes foram *Cabassous unicinctus* e *Euphractus sexcinctus*. Guimarães (1997) estudou a área de vida e dieta de *Tolypeutes tricinctus* em região de Cerrado em Jaborandi na Bahia, sugerindo que estes animais podem ser territoriais. Embora, a ecologia populacional de *Dasypus novemcinctus* seja muito conhecida nos Estados Unidos, existem poucas informações sobre essa espécie no Brasil (McBee e Baker, 1982; Loughry e McDonough, 1998a).

O tatu–mirim (*Dasypus septemcinctus*) é a menor espécie do gênero *Dasypus*, estando restrito à América do Sul. Se distribui a partir da porção sudeste da Bacia Amazônica até o extremo norte da Argentina. Limita-se a oeste pelo Mato Grosso e Chaco no Paraguai, englobando as áreas centrais do Brasil até o Rio Grande do Sul, leste do Brasil, leste da Bolívia e Paraguai (Wetzel, 1985a, 1985b; Emmons e Feer, 1997; Eisenberg e Redford, 1999). Foi registrado para vários tipos de habitats como florestas, matas de galeria, cerrados e campos (McDonough *et al.*, 2000; Margarido e Braga, 2004). Na Floresta Atlântica essa espécie foi registrada para áreas alteradas de campos e de mata (Loughry e McDonough, 1997, McDonough *et al.*, 2000, Araújo *et al.*, 2008). No Cerrado Bonato (2002) registrou a presença dessa espécie para campo sujo e cerrado *sensu stricto*.

No Edentate Species Assessment Workshop, realizado em 2004, nenhuma informação sobre a ecologia populacional de *D. septemcinctus* foi apresentada (Fonseca e Aguiar, 2004), de modo que sua situação em termos de conservação ainda é desconhecida.

Este trabalho teve como objetivo estudar a ecologia de uma população de tatu-mirim (*D. septemcinctus*) em uma área de Cerrado *sensu stricto*, no Distrito Federal. Especificamente foram determinados a densidade, a razão sexual, a biomassa e o uso do espaço.

Métodos

Área de estudo

As áreas de estudo estão situadas na Fazenda Água Limpas (FAL), área experimental da Universidade de Brasília e na Reserva Ecológica do Instituto Brasileiro de Geografia e Estatística (IBGE - RECOR), ambas localizadas na área central do bioma Cerrado a 15°57'S e 47°53'W, a cerca de 30 km de Brasília. As duas unidades somam 5.340 ha de área. O clima da região é tropical chuvoso (AW segundo a classificação de Köppen), com duas estações bem definidas, uma seca que vai de maio a setembro e uma chuvosa que vai de outubro a abril. A média pluviométrica anual registrada ao longo de 24 anos foi de 1.534 mm, com temperatura média de 21,9°C (Dados da estação meteorológica da RECOR/IBGE). A área da RECOR e da FAL é ocupada por vários tipos diferentes de vegetação do Cerrado, mas a maior parte da área é ocupada pela fisionomia de campo sujo e cerrado *sensu stricto.*

Captura dos animais

Para o estabelecimento do gradeado foi escolhida uma área de aproximadamente 100 ha de cerrado *sensu estricto* na FAL. Essa área foi escolhida por estar protegida de atividades humanas sendo representativa do tipo predominante de vegetação da região de estudo. O gradeado apresentava dimensão de 90 m × 300 m (2,7 ha), onde foram instaladas 40 estações de capturas, distantes 30 m entre si. A partir de setembro de 2005, o gradeado foi aumentado para 120 m × 420 m (5,04 ha). Em cada estação de captura foi colocada uma armadilha Havahart® (81 × 32 × 26 cm). As armadilhas foram iscadas com uma mistura de mandioca, abóbora, cará, inhame e gengibre na mesma proporção. As capturas foram realizadas ao longo de 13 meses, de julho de 2005 a julho de 2006, com armadilhas em operação por 4 até 15 dias por mês. Nos dias de operação as armadilhas eram verificadas pela manhã (8 às 10 horas), para cada animal capturado foi registrado a espécie, idade, reprodução, peso, depois marcados com brincos metálicos numerados (modelo 1005-1, *National Band and Tags Co*.,

Newport, KY, USA) e soltos no mesmo local de captura. Para verificação das condições reprodutivas usamos a presença de mamilos desenvolvidos com exsudação de leite por pressão dos dedos.

Além dos animais capturados no gradeado, foram incluídas observações de capturas de animais em mais duas áreas: uma área de cerrado *sensu stricto* na Reserva Ecológica do IBGE (RECOR) e outra área na FAL. Nestes locais os animais foram capturados em alçapão, usando baldes de 60 litros enterradas até a borda na superfície do solo (Bonato, 2002), que ficaram abertos ao longo de todo o período de estudo.

Análise dos dados

A densidade populacional de *D. septemcinctus* na área do gradeado foi calculada pelo método de Krebs (1966), do Número Mínimo de Animais Marcados e Vivos (NMAM). A lista de todos os indivíduos conhecidos vivos (NMAM) a cada mês incluía: (i) todos os indivíduos que foram capturados durante o mês e (ii) todos os indivíduos marcados que foram capturados antes e depois do mês de capturas. A densidade foi calculada dividindo NMAM pela área efetiva do gradeado. A área efetiva do gradeado usado para o cálculo de densidade da população foi calculada adicionando à área do gradeado, uma faixa com a metade do espaçamento entre as estações de captura (15 m). A área de vida foi calculada usando o método do Mínimo Polígono Convexo (MPC) (Mohr, 1947), o qual é considerado um método simples e acurado (Harris *et al*., 1990).

Para a análise da distância em que os indivíduos se deslocaram entre as capturas sucessivas, foram usados dados de todos os indivíduos capturados no gradeado mais de uma vez (5 indivíduos). As distâncias entre capturas sucessivas foram calculadas usando os eixos principais do gradeado como as coordenadas (x, y). A distância era calculada entre o primeiro (x_o, y_o) e o segundo ponto de captura (x_1, y_1) usando na equação de Distância Euclidiana: $DE = [(x_1 - x_0)^2 + (y_1 - y_0)^2]^{1/2}$.

A separação entre os indivíduos de idade adulta e jovem (incluindo sub-adultos) foi determinada usando o peso da menor fêmea que foi encontrada em estado reprodutivo (0,7 kg). Acima desse valor os indivíduos foram considerados adultos e abaixo desse valor jovens. Como não foi encontrada diferença significativa no peso entre os sexos ($p > 0,05$), o mesmo critério foi usado para machos e fêmeas.

Resultados e discussão

Espécies de tatus capturadas e sucesso de captura

Foram capturados no total 26 indivíduos de duas espécies de tatus ao longo dos 13 meses de estudo, sendo 22 indivíduos de *D. septemcinctus*, dos quais 11 foram capturados no gradeado do cerrado e 11 indivíduos nas armadilhas de alçapão, sendo 9 na RECOR e 2 na FAL. Dois indivíduos de *C. unicinctus* foram capturados manualmente em área de cerrado *sensu stricto*, na FAL e dois foram capturados em alçapão, na RECOR. O uso de armadilhas de alçapão

TABELA 1. Número de indivíduos machos, fêmeas e total mensal de *Dasypus septemcinctus* em um cerrado na Fazenda Água Limpas, Distrito Federal, calculados pelo método NMAM (Krebs, 1966).

Meses	Machos	Fêmeas	Total
2005			
Julho	1	0	1
Agosto	1	0	1
Setembro	1	0	1
Outubro	0	1	1
Novembro	0	1[a]	1
Dezembro	2	2	4
2006			
Janeiro	2	1[b]	3
Fevereiro	1	0	1
Março	0	1	1
Abril	1	1	2
Maio	1	1	2
Junho	0	2[a]	2
Julho	0	0	0

[a] Fêmeas reprodutivas (mamilos evidentes).

[b] Fêmea pós - lactante

possibilitou tanto a captura de *D. septemcinctus* como de *C. unicinctus*.

O método de captura manual, apesar de ser utilizado com sucesso em outros estudos com tatus (Carter e Encarnação, 1983; Breece e Dusi, 1985; Encarnação, 1987; McDonough, 1997; Bonato, 2002), não foi eficiente para *D. septemcinctus* neste estudo, pois esta espécie possui uma grande habilidade em se esquivar através de saltos na vegetação, refugiando-se com grande velocidade na primeira toca ou buraco que encontra (Silva, obs. pess.).

Essa foi a primeira vez que foram utilizadas armadilhas Havahart® para capturar *D. septemcinctus*. Existe somente um registro na literatura de capturas de tatus com armadilhas. Na Guiana Francesa Fournier-Chambrillon *et al*. (2000) usaram armadilhas Tomahawk® de dimensão semelhante às usadas nesse estudo para capturar *Dasypus kappleri* e *D. novemcinctus*.

Apenas a espécie *D. septemcinctus* foi registrada no gradeado ao longo do período de estudo, portanto as análises posteriores referem-se apenas a ela. O esforço amostral no gradeado foi de 9.205 armadilhas/noite, com um sucesso de captura total de 0,23%. O sucesso de captura foi muito baixo com uma média de 0,3%/mês (0%/mês – 0,9%/mês).

Densidade, área de vida e tempo de permanência

A densidade média de *D. septemcinctus* para a área de cerrado *sensu stricto* foi de 0,30 indivíduos/ha. Indivíduos machos e fêmeas apresentaram a mesma densidade (0,17 indivíduos/ha). O número de indivíduos variou ao longo do ano, atingindo o máximo de 4 indivíduos em dezembro de 2005 (estação chuvosa) e declinando após este período, não sendo registrado nenhum indivíduo no último mês de captura (julho de 2006) (Tabela 1). Essa variação no tamanho da população pode refletir diferença no esforço amostral, mas consideramos que esse efeito não foi alto em virtude do baixo número de recapturas (Tabela 2), onde >50% dos indivíduos foram capturados apenas uma vez.

A densidade encontrada neste estudo para *D. septemcinctus* (0.30 indivíduos/ha) foi maior que o encontrado para outro estudo em uma área de Floresta Atlântica perturbada no Rio de Janeiro (0,001–0,003 indivíduos/ha; Araújo *et al*., 2008). Mas foi semelhante ao registrado para *D. novemcinctus* no Pantanal (0,21 indivíduos/ha; Schaller, 1983), *D. novemcinctus* na floresta tropical da Costa Rica (0,10 indivíduos/ha; Timock e Vaughan, 2002) e outras espécies de tatus do Cerrado como *C. unicinctus* (0,27 indivíduos/ha) e *E. sexcinctus* (0,14 indivíduos/ha) (Bonato, 2002; Bonato *et al.*, 2008). O outro relato sobre a abundância de *D. septemcinctus* para o cerrado é o registro de 3 indivíduos capturados ao longo de um ano de estudo no cerrado de Itirapina em São Paulo (Bonato, 2002).

A área de vida foi determinada para 3 indivíduos (2 machos e uma fêmea) que tiveram mais de 3 capturas no período de estudo e que estiveram em momentos diferentes no gradeado, ou seja, não houve sobreposição nos meses de captura para estes indivíduos. O maior tamanho de área de vida foi de 1,6 ha para um macho (1,2 kg). Outro macho menor que o anterior (0,8 kg) obteve uma área de vida de 1,1 ha. A única fêmea (0,7 kg) capturada 3 vezes apresentou uma área de vida de 0,8 ha. A média da área de vida para estes três indivíduos foi de 1,2 ha. O tempo de permanência dos indivíduos na população foi baixo, com 54,5% (N = 6) dos indivíduos permanecendo por apenas um mês no gradeado. O tempo máximo de permanência no gradeado em 13 meses de estudo foi de 4 meses alcançado por uma fêmea adulta (Tabela 2).

O único dado anterior de área de vida de *D. septemcinctus* é de um estudo com apenas uma fêmea adulta acompanhada durante 13 dias por radiotelemetria na Serra da Canastra - MG (Encarnação, 1987). Este indivíduo teve uma área de vida de 0,44 ha, valor abaixo da média encontrada neste estudo (1,2 ha). Os valores de área de vida encontrados para *D. septemcinctus* para o Cerrado estão abaixo do limite inferior dos valores registrados para *D. novemcintus* nos Estados Unidos, onde foi relatada área de vida variando entre 1,6 ha até 13,8 ha (McBee e Baker, 1982). Uma menor área de vida de *D. septemcinctus*, provavelmente reflete o tamanho menor (1,5 ± 0,4 kg) dessa espécie quando comparada com *D. novemcinctus* (3,3 ± 0,56 kg) (Wetzel, 1985b), pois para mamíferos em geral, o tamanho da área de vida está relacionado com a massa corporal (Buskirk e Lindstedt, 1989).

Foram obtidos dados de deslocamento médio de 5 indivíduos que foram recapturados pelo menos duas vezes no gradeado. O deslocamento médio de

TABELA 2. Tempo de permanência em meses de *Dasypus septemcinctus* em um cerrado na Fazenda Água Limpas, Distrito Federal.

Tempo de permanência				
Número de meses	1	2	3	4
Número de indivíduos	6	2	2	1
%	54,5	18,1	18,1	9,3

D. septemcinctus foi de 153 ± 21 m, variando de um mínimo de 30 m até o máximo de 280 m, sendo que a maioria dos indivíduos (N = 4) se deslocou entre 130 e 180 m (Figura 1). Esses dados são inferiores aos valores médios (200 m) encontrados para *D. novemcinctus* na Flórida, Estados Unidos (Loughry e McDonough, 1998b).

Razão sexual, reprodução e biomassa

A razão sexual de todos os indivíduos capturados no gradeado foi de 6 machos : 5 fêmeas, o que não diferiu de uma proporção de 1:1 ($\chi^2 = 0.091$; GL = 1; p > 0,05). Para o cerrado de Itirapina, Bonato (2002) encontrou valores semelhantes para *C. unicinctus* (1 : 0,9), no entanto, para *E. sexcinctus* a proporção de machos foi significativamente maior do que a proporção de fêmeas (1 : 0,18).

A proporção de adultos e de jovens de *D. septemcinctus* foi respectivamente de 45,4% (N = 5) e 54,6% (N = 6). Indivíduos em reprodução foram registrados em novembro de 2006 e junho de 2005. Os indivíduos jovens só foram capturados a partir do mês de dezembro de 2005. Fora do gradeado, em fisionomia de cerrado *sensu stricto* foi registrada uma fêmea pós-lactante no mês de janeiro. Esses resultados sugerem que o período reprodutivo dessa espécie ocorre do meio do período seco e início do período chuvoso (junho – setembro) e que os jovens sejam recrutados na estação chuvosa (Tabela 1).

Estudos de reprodução em tatus são baseados principalmente em *D. novemcinctus* nos Estados Unidos. Esta espécie possui implantação tardia do óvulo (3 a 4 meses) e, após a implantação, a fêmea tem os filhotes depois de 4 a 5 meses (McBee e Baker, 1982; McDonough, 1997). Se *D. septemcinctus* segue um padrão semelhante de implantação tardia e essas fêmeas forem fecundadas no início da estação seca (junho), a implantação dos óvulos será no fim desta estação e o nascimento da ninhada no meio da estação chuvosa (dezembro e janeiro), o que coincidiria com o período de recrutamento dos jovens observado neste mesmo estudo. Um maior tempo de acompanhamento de populações desta espécie pode comprovar essa hipótese.

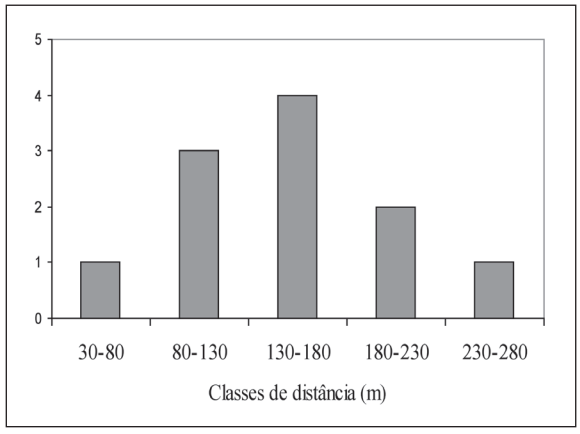

Figura 1. Distribuição de classes de distância entre capturas sucessivas dos mesmos indivíduos de *Dasypus septemcinctus* (N = 5) em um cerrado na Fazenda Água Limpas, Distrito Federal.

Incluindo as capturas realizadas na RECOR e FAL, o peso médio de fêmeas adultas foi maior (1,0 ± 0,3 kg; N = 5) do que dos machos adultos (0,9 ± 0,2 kg; N = 8), mas essa diferença não foi significativa (p > 0,05). A biomassa total da população de *D. septemcicntus,* estimada a partir do peso médio dos indivíduos da área (0,6 ± 0,4 kg) e multiplicada pela densidade (0,3 indivíduos/ha) foi de 0,2 kg/ha.

Implicações para a conservação

Dasypus septemcinctus é classificada pela IUCN como uma espécie sem ameaças para a sua sobrevivência a longo prazo ("Least Concern", LC) (IUCN, 2009), no entanto, existe muito pouca informação mesmo para esse estatus. Parte da carência de informações sobre a ecologia dessa espécie se deve a sua semelhança com *D. novemcinctus*, que dificulta a separação acurada dessas duas espécies no campo. Os indivíduos jovens de *D. novemcinctus* são facilmente confundidos com indivíduos adultos de *D. septemcinctus*. Desse modo muitos estudos baseados em observações de campo podem estar registrando indivíduos jovens de *D. novemcinctus* como adultos de *D. septemcinctus* ou de modo inverso, classificando como jovens de *D. novemcinctus*, indivíduos adultos de *D. septemcinctus*.

Os registros recentes indicam diferenças na abundância dessa espécie entre áreas no Cerrado e da Floresta Atlântica. Em uma área de Cerrado em São Paulo apenas 3 indivíduos dessa espécie foram registrados por Bonato (2002). Usando o número de capturas com o mesmo método e o cálculo de densidade das outras espécies de tatus na mesma área, é possível estimar para *D. septemcinctus*, valores de densidade inferiores a 0,1 indivíduo/ha. A baixa abundância dessa espécie nesse estudo não pode ser atribuída à diferença no método de captura, pois o uso do método de alçapão em nossa área embora não quantificado, se mostrou aparentemente eficiente com a captura de 11 indivíduos no período de estudo.

Em uma área de Floresta Atlântica secundária no Rio de Janeiro, Araújo *et al*. (2008) estimou para essa espécie valores de densidade entre 0,001–0,003 indivíduos/ha. Deve ser ressaltado que apesar das áreas desse estudo ser de conservação nelas ocorria caça, o que pode explicar esses baixos valores de densidade. Usando os dados de densidade de adultos (0,30 indivíduos/ha), razão sexual (1:1) e da proporção de jovens e adultos (50:50) para *D. septemcinctus* de nosso estudo, estimamos que seja necessária uma área de aproximadamente 6.700 ha para manter essa espécie, supondo um tamanho populacional viável mínimo (TPVM) de 1.000 indivíduos adultos (Thomas, 1990). Usando um valor de TPVM igual a 4.169 indivíduos como sugerido por Traill *et al.* (2007), a área mínima estimada aumenta para 27.800 hectares. Apenas unidades de conservação maiores que esse valor poderiam manter populações viáveis dessa espécie. Nas áreas menores e onde a densidade dessa espécie for baixa, a chance de populações viáveis vai ser reduzida.

A caça, apesar de proibida no Brasil é outro fator que pode diminuir a densidade dessa espécie. A caça de tatu é uma prática comum no meio rural no Cerrado (Becker, 1981), mesmo próximo dos centros urbanos e áreas de conservação (Henriques, obs. pess.). Outro fator de ameaça para essa espécie, ainda pouco conhecido é a predação por cães ferais (*Canis familiaris*) em áreas de conservação, como registrado no Parque Nacional de Brasília por Lacerda *et al.* (2009). O aumento do desmatamento, a fragmentação do Cerrado em áreas menores que 7.000–28.000 ha, a caça e o crescimento de populações de cães no entorno de unidades de conservação tendem a crescer nos próximos anos no bioma Cerrado, tornando a sobrevivência dessa espécie nas próximas décadas incerta.

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Kena F. M. da Silva e **Raimundo Paulo Barros Henriques,** Departamento de Ecologia, Universidade de Brasília, CP 04457, CEP 79.919-970, Brasília, DF, Brasil, e-mail: <henriq@unb.br>.

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Nine-Banded Armadillo (*Dasypus novemcinctus*) Records in New Mexico, USA

Jennifer K. Frey
James N. Stuart

New Mexico represents the western range limit of the nine-banded armadillo (*Dasypus novemcinctus*) in the United States, although the nearest known established populations are in adjacent western Texas (Layne, 2003). Early records of armadillos in New Mexico were based on incidental observations (Findley *et al.*, 1975). Stuart and Knight (1998) provided a comprehensive synopsis of scattered literature records and additional new observations of the armadillo in New Mexico, although that publication is difficult to access. Most recently, Stuart *et al.* (2007) provided records of the first armadillo specimens collected and preserved in the state and a map of all known locality records of armadillos in New Mexico, but did not give details about previous records. They concluded that while many records were likely the result of human intervention, at least some from southeastern New Mexico were possibly of natural origin and that suitable habitat exists in this part of the state (Stuart *et al.*, 2007).

Herein we provide a complete synopsis of all records of *Dasypus novemcinctus* in New Mexico known to us, including localities, dates, and sources of information. A map of these locations (Figure 1) shows that records are from the eastern third of New Mexico, which delineates the northwestern range limits of the species as currently understood. Each record is provided as a direct quote of the locality data taken from the cited source. Additional data on a record are in brackets and the reference is in parentheses. Bold numbers in parentheses correspond to localities mapped in Figure 1 and in several cases refer to two or more records from the same locality or geographically similar locations. Abbreviations include: DOR = dead on road; MSB = Museum of Southwestern Biology, University of New Mexico.

Chaves County: (**1**) "On 2 December 2001, the skeleton of an adult armadillo (sex indeterminate) was collected along U.S. Highway 82, circa 9.5 km NNE of Dunken, Chaves County (Sec. 26, T16S, R18E; circa 32.86° N, 105.17° W" [catalog number is MSB 140060] (Stuart *et al.*, 2007); (**2**) "On 11 December 2006, a mostly disarticulated skeleton (adult, sex indeterminate) was collected from a dry concrete watering trough in a cattle pen at Hagerman, Chaves County, 1.2 km N and 2.4 km E of the junction of New Mexico Highway 2 and New Mexico Highway 249 (33.1221°N, 104.3099°W" [catalog number is MSB 146777] (Stuart *et al.*, 2007).

Curry County: (**3**) "During 1994–1995, a live animal was captured [on a soccer field] in Hillcrest Park in Clovis, Curry County and was released by a U.S. Fish and Wildlife Service agent in Texas (Wes Robertson, New Mexico Department of Game and Fish, pers. comm.)" (Stuart *et al.*, 2007).

Eddy County: (**4**) "near Carlsbad" [1 found in February 1924; fate unknown] (Bailey, 1928:60); "in Carlsbad" [1 acquired by wildlife rehabilitator on 28 December 1988; fate unknown] (Stuart and Knight, 1998:40); "On 22 June 2006, C. Gehrt and T. Nelson collected a road-killed adult (sex indeterminate) at the north end of Carlsbad, Eddy County, near an abandoned concrete flume over the Pecos River (32.4471°N, 104.2564°W)" [catalog number is MSB 146776] (Stuart *et al.*, 2007).

Guadalupe County: (**5**) "on highway 66, 9 and 9 and three-quarters miles respectively west of Santa Rosa" [2 DOR observed on 21 August 1962] (Hendricks, 1963:581).

Harding or San Miguel County: (**6**) "Mosquero area" ["several" or more observed ca. 1970; Stuart *et al.*

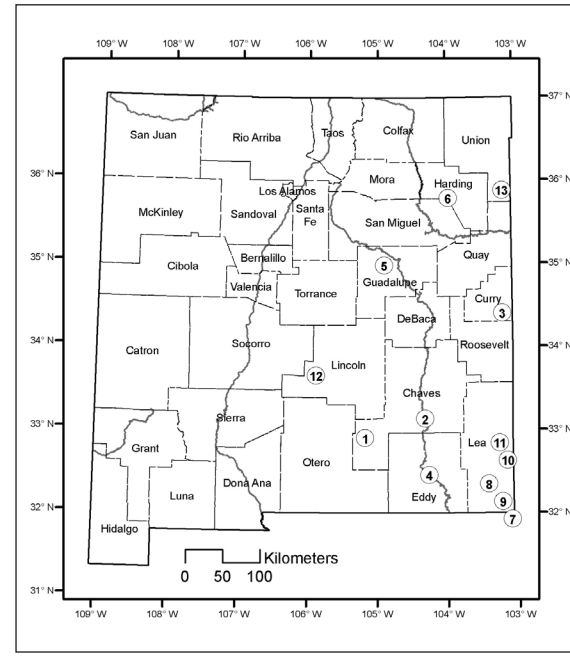

Figure 1. Map of New Mexico, showing localities of *Dasypus novemcinctus* records. Numbers in circles correspond to localities referenced in the text. Some numbered localities represent two or three records from the same general area.

(2007) thought these observations might have been the result of an unconfirmed release near Mosquero during this period] (Schaefer, 1975:134).

Lea County: (**7**) "for a distance of 70 miles or more north of [Monahans, Ward County, Texas]" [record based on a 1909 letter from J. Holman, a rancher from Monahans, Texas] (Bailey, 1931:8); "both sides of the New Mexico line" [reported as very scarce; record based on a 1909 letter from H. Campbell, a rancher from Monahans, Texas] (Bailey, 1931:8); (**8**) "around San Simon Sink" [reports of "shells," possibly not recent, and observations of live animals in general area as recently as 1930s] (Buchanan and Talmage, 1954:143); (**9**) "along State Highway 128 near County Road 6A just west of Jal" [1 DOR observed on 20 July 1978] (Stuart and Knight, 1998:40); (**10**) "Hobbs" [1 acquired by wildlife rehabilitator on 17 January 1988; released in San Angelo, Texas] (Stuart and Knight, 1998:40); "vicinity of Hobbs, near the Texas border" [2 DOR observed ca. 1993–1994] (D. Sutcliff, pers. comm. *in* Taulman and Robbins, 1996:642–643); (**11**) "On 15 July 2007, a road-killed armadillo was photographed by Calvin B. Smith along New Mexico Highway 18 between mile markers 61 and 62, approximately 11.2 km S and 8 km E of Lovington, Lea County (circa 32.83°N, 103.25°W" [photograph catalog number is MSB 140242] (Stuart *et al*., 2007).

Lincoln County: (**12**) "Carrizozo (?)" [skull in New Mexico State University Vertebrate Museum (NMSU 1364), no other collection data; specimen examined in 1987] (Stuart and Knight, 1998:40).

Union County: (**13**) "dump site along Monia Creek, 5 kilometers south of Amistad via State Highway 402" [1 carcass photographed 30 May 1988; probably transported to location with household refuse] (Stuart and Knight, 1998:39).

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Jennifer K. Frey, Department of Fish, Wildlife, and Conservation Ecology and The Vertebrate Museum, Department of Biology, P.O. Box 30003, Campus Box 4901, New Mexico State University, Las Cruces, New Mexico, 88003-8003, USA, e-mail: <jfrey@nmsu.edu> and **James N. Stuart,** New Mexico Department of Game and Fish, Conservation Services Division, P.O. Box 25112, Santa Fe, New Mexico 87504, USA, e-mail: <James.Stuart@state.nm.us>.

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Presencia de *Cabassous chacoensis* en el Parque Nacional Talampaya, La Rioja, Argentina

Julio C. Monguillot
Rodolfo Miatello

Cabassous chacoensis es descrito como un armadillo endémico de la región chaqueña de Paraguay, Bolivia y norte de Argentina (Wetzel, 1982). Chebez (1994) comenta que es una "especie de amplia dispersión en la región chaqueña pero rara en todas partes». Cuenta con registros documentados en Formosa, Santiago del Estero, Santa Fe y Tucumán y menciones a confirmar para Chaco y Salta. Vizcaíno *et al.* (2006) la citan para las provincias de Chaco, Formosa, Santa Fe, Santiago del Estero y Tucumán.

Morando y Polop (1997) lo citan para el norte y noroeste de la provincia de Córdoba. Agüero *et al.* (2005) reportan avistajes en las proximidades de Chamical, en La Rioja, y recientemente Nellar *et al.* (2008) lo observaron en Pampa de las Salinas y alrededores, en el norte de San Luis. En todos los casos, las citas mencionadas se corresponden con ambientes chaqueños.

La observación de un ejemplar en el Parque Nacional Talampaya el 25 y 26 de mayo de 2007, ocupando ambientes de la ecorregión del Monte de Sierras y Bolsones (Burkart *et al.*, 1999) constituye un hecho relevante para el conocimiento de su bioecología, ya que se trata de una especie tradicionalmente asociada a ambientes chaqueños.

El individuo observado fue detectado desplazándose en horario diurno (10–12 hs) en el sector conocido como Puerta de Talampaya (29°47'46,64"S – 67°51'04,73"W, 1.391 msnm), al ingreso del cañón homónimo. En este sitio fue registrado y fotografiado por personal del parque en tres oportunidades. En una de estas ocasiones llevaba adheridas al cuerpo numerosas hormigas (Figura 2), lo que hace suponer que previamente habría estado alimentándose en un hormiguero. Esta nueva cita extiende su rango de distribución conocido a unos 300 km al oeste, en ambientes del Monte de Sierras y Bolsones, y confirma su presencia a una altitud de casi 1.400 msnm.

En el Parque Nacional Talampaya, además de *Cabassous chacoensis*, están presentes *Chlamyphorus truncatus*, *Zaedyus pichiy* y *Chaetophractus vellerosus* (Monguillot, 2006). En sitios próximos al sector sur de la unidad, en ambientes del ecotono Chaco – Monte, han sido registrados además, *Tolypeutes matacus* y *Chaetophractus villosus*.

Este registro pone aún más en evidencia la necesidad de profundizar los relevamientos faunísticos en esta extensa unidad de conservación, ubicada en la provincia de La Rioja.

Julio C. Monguillot, Delegación Regional Centro – Administración de Parques Nacionales, Av. Richieri 2298, (5000) Córdoba – Argentina, e-mail: <jmonguillot@apn.gov.ar>, **Rodolfo Miatello,** Agencia Córdoba Ambiente – Areas Naturales Protegidas, Av. Richieri 2265, (5000) Córdoba – Argentina.

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Figura 1. Detalle de la cabeza y miembros delanteros de *Cabassous chacoensis.*

Figura 2. *Cabassous chacoensis* con hormigas adheridas al cuerpo.

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Ocorrência de *Euphractus sexcinctus* (Xenarthra: Dasypodidae) na Região do Médio Rio Amazonas

Eldianne Moreira de Lima
Izaura da Conceição Magalhães Muniz
José Abílio Barros Ohana
José de Sousa e Silva Júnior

De acordo com Redford e Wetzel (1985) e Wetzel (1985), o tatu-peba (*Euphractus sexcinctus*) é uma espécie de ampla distribuição geográfica, ocorrendo nas porções nordeste, centro-oeste, sudeste e sul do Brasil, além das áreas adjacentes da Bolívia, Paraguai, Uruguai e Argentina. Existe também uma população disjunta na região de fronteira entre o Brasil e o Suriname (Wetzel, 1985). As questões relacionadas à presença da espécie na Amazônia vêm sendo investigadas nos últimos anos através de levantamentos de mamíferos realizados no Brasil. Silva Júnior *et al*. (2001) estenderam a distribuição de *E. sexcinctus* à parte amazônica do Maranhão. Concomitantemente, Silva Júnior e Nunes (2001) ampliaram a área disjunta para sudeste, registrando a espécie em cinco localidades do Amapá.

Mais recentemente, Silva Júnior *et al*. (2005a, b) relataram ocorrências de *E. sexcinctus* em três localidades situadas na ilha de Marajó, e Andrade *et al*. (2006) estabeleceram um novo registro no leste do Pará, próximo à costa do Atlântico. Estes dados indicam que a disjunção na distribuição geográfica da espécie era um artifício ocasionado por deficiência de amostragem. Entretanto, existem indícios de que a distribuição da espécie não se restringe à periferia oriental da Amazônia. Oliveira *et al*. (2006) consideraram a possibilidade de *E. sexcinctus* ser encontrada no noroeste do Pará, com base em relatos obtidos na Floresta Nacional Saracá-Taqüera. Entretanto, tal informação não pode ser confirmada através de dados empíricos. O objetivo do presente estudo é relatar a ocorrência de *E. sexcinctus* na região do médio rio Amazonas, promovendo uma nova ampliação de sua área de distribuição geográfica.

Os dados foram obtidos durante a realização de um inventário de mamíferos no Parque Estadual Monte Alegre (PEMA: 02°02'38"S, 54°09'10"W). O PEMA foi criado em 2001, mas a região de Monte Alegre é mundialmente conhecida desde 1848, graças às pinturas rupestres existentes no conjunto de serras localizadas na atual unidade de conservação (Wallace, 1979). A área do Parque é de 3.678 ha, onde foram identificadas duas tipologias vegetais: cerrado e floresta equatorial ombrófila. O cerrado, ou campo de Monte Alegre, é a fitofissionomia dominante (Oliveira *et al*., 2001). Esta vegetação pode ter algumas variações, de acordo com as condições do relevo e solo. Em alguns locais, o estrato arbustivo é dominante, e em outros, as gramíneas dominam no estrato herbáceo, podendo ainda ser encontrados arbustos isolados ou manchas de vegetação, com algumas árvores de médio porte. As serras estão localizadas, em sua maioria, na periferia do PEMA. Existem dois fragmentos de floresta equatorial ombrófila, um maior (Mata da Ilha Grande), localizado na porção central, com aproximadamente 320 ha, e um menor (Mata do Paytuna), na porção sul, com aproximadamente 250 ha. Observa-se uma conexão entre estes dois fragmentos, e também com uma área de mata localizada na comunidade Paytuna.

Foram realizadas duas expedições ao PEMA, cada uma com duração de 15 dias, durante o ano de 2006, sendo uma no mês de maio (final do período chuvoso) e outra no mês de setembro (início do período seco). O procedimento para o levantamento de mamíferos seguiu as recomendações para uma Avaliação Ecológica Rápida (Fonseca *et al*., 2001; Young *et al*., 2003).

Os resultados indicaram a ocorrência local de oito espécies pertencentes à ordem Xenarthra: *Cyclopes didactylus* (tamanduaí), *Tamandua tetradactyla* (tamanduá-de-colete), *Bradypus variegatus* (preguiça-de-bentinho), *Choloepus didactylus* (preguiça-real), *Cabassous unicinctus* (tatu-rabo-de-couro), *Dasypus kappleri* (tatu-quinze-quilos), *D. novemcinctus* (tatu-galinha) e *Euphractus sexcinctus* (tatu-peba). Durante as entrevistas, os moradores das proximidades do parque, ao relatarem a presença de *E. sexcinctus* na região, chamaram a atenção para o deslocamento solitário e em grupos, tal como observado por Desbiez *et al*. (2006) na região do Pantanal. Os registros efetivos de *E. sexcinctus* no Parque (Fig. 1) foram realizados durante a segunda excursão, através de observações diretas. Um indivíduo juvenil, do sexo masculino (Fig. 2a), foi encontrado deslocando-se no cerrado aberto, nas proximidades da Mata da Ilha Grande. Durante o inventário florístico (M. Andrade, com. pessoal), um segundo indivíduo (Fig. 2b) foi avistado no cerrado, nas proximidades da Serra do Ererê (250 m de altitude).

Os dados obtidos no PEMA implicam em uma nova ampliação, de grande extensão, da área de distribuição geográfica de *E. sexcinctus*, confirmando a sua presença em uma região mais central da Amazônia. Os registros realizados no PEMA constituem um indício de que a distribuição da espécie pode se estender

ainda mais para o interior desta região, reforçando a hipótese de Oliveira *et al*. (2006) sobre a ocorrência da mesma na Floresta Nacional Saracá-Taqüera.

A região de Monte Alegre foi indicada pelo MMA (2004) como prioritária para a conservação dos biomas Amazônia e Cerrado, devido ser uma área de alta diversidade ambiental e biológica, com ocorrência de espécies endêmicas, raras ou ameaçadas de extinção, além de possuir grande importância para estudos arqueológicos, devido às pinturas rupestres alí existentes. Os registros de *E. sexcinctus* no parque

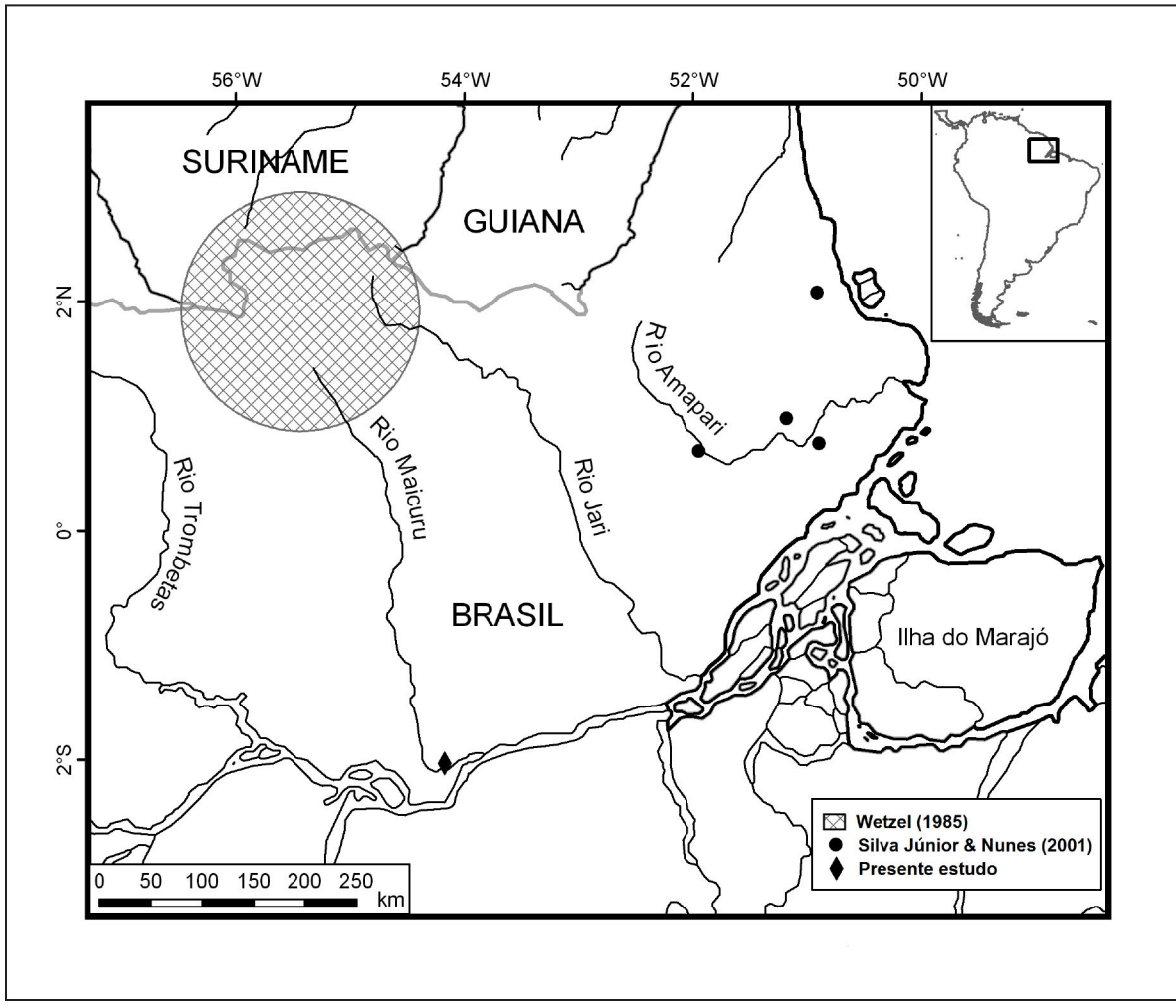

Figura 1. Distribuição geográfica de *E. sexcinctus* na Região Norte do Brasil, com a localização da área indicada por Wetzel (1985) na fronteira entre o Suriname e o Brasil, dos registros de Silva Junior & Nunes (2001) no Amapá, e do Parque Estadual Monte Alegre, Pará.

Figura 2. Exemplares de *E. sexcinctus* observados no PEMA: **A.** indivíduo observado nas proximidades da Mata da Ilha Grande (Foto: I.C.M. Muniz); **B.** indivíduo observado nas proximidades da Serra do Ererê (Foto: M. Andrade).

constituem uma indicação de que a diversidade real de mamíferos na região é maior do que o esperado com base no conhecimento atual.

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Eldianne Moreira de Lima, Izaura da Conceição Magalhães Muniz, Bolsistas DTI, Departamento de Zoologia, Museu Paraense Emílio Goeldi, Caixa Postal 399, 66040-170 Belém, Pará, Brasil, e-mail: <eldiannelima@yahoo.com.br>, **José Abílio Barros Ohana,** Bolsista PIBIC, Departamento de Zoologia, Museu Paraense Emílio Goeldi, Caixa Postal 399, 66040-170 Belém, Pará, Brasil, e-mail: <abilio_ohana@yahoo.com.br>, e **José de Sousa e Silva Júnior,** Coordenação de Zoologia, Departamento de Zoologia, Museu Paraense Emílio Goeldi, Caixa Postal 399, 66040-170 Belém, Pará, Brasil, e-mail: <cazuza.junior@gmail.com>.

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NEWS

New Specialist Group Website!

The IUCN/SSC Anteater, Sloth and Armadillo Specialist group is pleased to announce the launch of its new, dynamic website <www.xenarthrans.org> (also available at <www.asasg.org>). The site will feature, among other changes, information on the biology and conservation status of all xenarthran species, including range maps and pictures. You will also find profiles of our Specialist Group Members, manuals, an updated version of the armadillo bibliography, and, of course, all issues of our newsletter Edentata. The site is still under construction, so please check back regularly to keep yourself informed about everything related to armadillo, sloth, and anteater conservation.

We are especially pleased to provide a News section, which will be updated regularly. We welcome your contributions! Please send us field updates, congress announcements, pictures, or any other information you would like to see on the new website to <webmaster@xenarthrans.org>. We are looking forward to receiving your comments and suggestions, and hope this new forum will be an intensely used resource for researchers, students, and the general public. We hope it will eventually help promote the conservation of these fascinating mammals.

A Must-Have: The Biology of the Xenarthra

The Biology of the Xenarthra, edited by Sergio Vizcaíno and Jim Loughry, is now available! The volume features an impressive group of international scholars who explore the current biology and ecological status of these mammals in each of the geographic regions they inhabit. Many of these populations reside in developing countries, and before now, information on these species has been scarce. Topics cover a wide array of issues including genetics, physiology, behavior, ecology, and conservation. Discussions range from paleontological perspectives on xenarthran evolution to both lab and field-based studies of living species. Contemporary research in areas such as genome sequencing and leprosy in armadillos is also included.

"Destined to become a classic in the field of xenarthran biology and is a must for anyone interested in living armadillos, anteaters, and sloths, as well as their extinct relatives."

Michael A. Mares
Sam Noble Oklahoma Museum of Natural History

"From their very early beginnings in mammalian history to their utility in modern human medicine, xenarthrans represent an ancient basal lineage of mammals deserving of interest from a wider audience."

Don E. Wilson
Smithsonian Institution's
National Museum of Natural History

The book can be purchased through Amazon <http://www.amazon.com> or the University of Florida Press website <http://www.upf.com>.

Call for help: developmental series of xenarthrans and afrotherians

I am starting a long term post-doctoral project at the University Museum of Zoology of Cambridge under the supervision of Dr. Robert Asher within the "Mammal Evolution and Morphology" group. We seek to determine if high-level clades of placental mammals differ in terms of their skeletodental development, as described here:

<http://www3.interscience.wiley.com/journal/122498520/abstract> and <http://www.leverhulme.ac.uk/news/Awards_in_Focus/Asher/>

Towards this end, we are interested in obtaining embryonic, foetal, and post-natal developmental series of xenarthrans and afrotherians (e.g., armadillos, hyraxes, tenrecs, among other species). We would be delighted to hear from anyone who could provide access to such series; and we are happy to compensate interested parties for any expenses incurred.

We look forward to hearing from you!

Lionel Hautier
Robert Asher
Museum of Zoology
University of Cambridge
Downing St. CB2 3EJ
United Kingdom
E-mail: <ljh75@cam.ac.uk and <rja58@hermes.cam.ac.uk>

Morphological and Genetic Variability in Silky Anteaters (*Cyclopes didactylus*) (Pilosa: Cyclopedidae).

A research project on the morphological traits and genetic diversity of Silky anteaters (*Cyclopes didactylus*) is being conducted as a collaborative study between the Projeto Tamanduá, Wildlife Conservation Society, Laboratory of Bio-diversity and Molecular Evolution (LBEM) at the Federal University of Minas Gerais, and the Program of Ecology at the University of Luiz de Queiroz/ ESALQ – USP.

This project focuses on the morphological, ecological and genetic aspects of the Silky anteater. It was initiated in 2006 with a comparison of Amazonian and Atlantic Forest (REBIO Trombetas and Pernambuco) populations. The next step is to extend the research to all of its range. If you have information on the species and wish to collaborate with the project, please contact Flávia Miranda at <flaviamiranda@yahoo.com> or <fmiranda@wcs.org>.

MEETINGS

59th Annual Meeting of the Wildlife Disease Association

For the first time, a WDA International Meeting will take place in South America. The 59th annual meeting of the Wildlife Disease Association (WDA) will be held 30 May – 4 June 2010 in Misiones, Argentina, in the heart of Iguazú Falls. A perfect mixture of wild nature and cultural heritage awaits you, so mark your calendars now and we will ensure that you experience all the wonders Iguazú has to offer.

This year's theme is **Ecosystem health in the Neotropics: a growing challenge**. For additional information, please visit the official congress website <http://sites.google.com/site/wda2010argentina/conference-home-2> or the Wildlife Disease Association's website <http://www.wildlifedisease.org>.

Symposium Announcement: *Form and Function in Xenarthra*

9th International Congress of Vertebrate Morphology
26–31 July 2010
Conrad Hotel & Spa
Punta del Este, Uruguay

Timothy Gaudin and François Pujos are convening a Symposium called "Form and Function in the Xenarthra" at the **Ninth International Congress on Vertebrate Morphology (ICVM9)** in Punta del Este, Uruguay. We would like to inform the community of xenarthrologists about this symposium with the hope of encouraging participation.

The proposal of this Symposium is a logical continuation of the two previous symposia on xenarthran biology presented during *ICVM6* and *ICVM8,* but also an excellent opportunity for the contributors of the "X Book" (*The Biology of the Xenarthra,* 2008, University of Florida Press, Gainesville, FL, USA) to present their latest results to the community of vertebrate morphologists.

The goal of this Symposium, "*Form and Function in Xenarthra,*" is to present the results of the most recent research on modern and/or fossil forms. The proposed presentations suggested for the Symposium will be given by a mixture of young and established researchers from Europe and America.

The Congress will be held from 26–31 July 2010. More information about the meeting can be found at the following website: <http://icvm-9.edu.uy>.

NOTES TO CONTRIBUTORS

Scope
Edentata, the newsletter of the IUCN/SSC Anteater, Sloth and Armadillo Group, aims to provide a basis for conservation information relating to xenarthrans. We welcome texts on any aspect of xenarthran conservation, including articles, thesis abstracts, news items, recent events, recent publications, and the like.

Submission
Mariella Superina, IMBECU - CCT CONICET Mendoza, Casilla de Correos 855, Mendoza (5500), Argentina. Tel. +54-261-5244160, Fax +54-261-5244001, e-mail: <mariella@superina.ch>.

Contributions
Manuscripts may be in English, Portuguese or Spanish, and should be double-spaced and accompanied by the text and any tables and/or figures on diskette for PC compatible text-editors (MS-Word, WordPerfect, Excel, and Access), and/or emailed to <mariella@superina.ch>. Hard copies should be supplied for all figures (illustrations and maps) and tables. The full name and address of each contributing author should be included. Please avoid abbreviations and acronyms without the name in full. Authors whose first language is not English should please have their texts *carefully reviewed* by a native English speaker.

Conservation research ethics
Authors must confirm in written that their research protocols have been approved by an authorized animal care or ethics committee and/or the authors had the necessary permits to carry out their research.

Articles
A broad range of topics is welcomed and encouraged, including but not limited to: Taxonomy, Systematics, Genetics (when relevant to systematics), Biogeography, Ecology, Conservation, and Behavior. Texts should not exceed 20 pages in length (double-spaced and including the references). For longer articles please include an abstract in English and an optional one in Portuguese or Spanish. Please limit the number of tables and figures to six, excepting cases where fundamental to the text.

Figures and Maps
Articles may include small high-quality photographs, figures, maps, and tables. Image resolution should be 300 dpi or higher in any of the following electronic file formats: .jpg, .tif, .eps, .pdf, .psd, or .ai. We also accept original artwork, photos, or slides to scan and return to the owner.

News Items
Please send any information on projects, field sites, courses, recent publications, awards, events, etc.

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