

Edentata

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

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

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Letter from the Editors

Welcome to another issue of our Newsletter! In Edentata 13 you will find five articles and seven short communications on a wide range of topics related to Xenarthra conservation. Among many other relevant topics, this issue includes a very interesting review of the distribution and conservation status of xenarthrans in French Guiana, suggestions for the next national Red List assessment of xenarthrans in Paraguay, and an analysis of the existing literature on *Myrmecophaga tridactyla*. The latter article highlights the low number of existing publications on this charismatic species and, especially, on its conservation. We are proud to see that one-fourth of all articles on giant anteaters that were analyzed for this study have been published in our Newsletter Edentata and hope there will be many more!

This issue also includes a summary of the workshop on Xenarthra conservation that took place during the II Latin American Mammalogy Congress in Buenos Aires, Argentina. We aim at organizing additional workshops and symposia at other congresses to continue promoting Xenarthra research and conservation and will keep you informed about upcoming events through our website and facebook page. Please also remember to regularly check our website and our facebook page so that you don't miss any future Articles in Press!

We are very happy that Nadia Moraes-Barros joined our editorial team and has brought in her expertise on sloths to further improve the quality of our Newsletter. Nadia has replaced our former co-editor Flávia Miranda, who is now focusing her energy on other projects of our Specialist Group, such as coordinating the research and conservation projects about *Tolypeutes tricinctus*, the Mascot of the 2014 FIFA World Cup (see News section). Many thanks to Flávia for her excellent job as co-editor over the past few years!

We would also like to extend warm thanks to all anonymous reviewers who have helped improving the quality of our Newsletter, as well as the San Antonio Zoological Society for the generous financial support!

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Registros de hormigas y termitas presentes en la dieta de osos hormigueros (Mammalia: Myrmecophagidae) en tres localidades de Colombia

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Resumen Los osos hormigueros (Mammalia: Myrmecophagidae) se alimentan principalmente de hormigas y termitas. En Colombia habitan las tres especies de la familia Myrmecophagidae reconocidas: el oso hormiguero palmero *Myrmecophaga tridactyla* y dos especies de osos hormigueros de menor talla, *Tamandua mexicana* y *Tamandua tetradactyla*, pero la información relacionada con aspectos de la ecología trófica de dichas especies en el territorio nacional es inexistente. Presentamos información sobre las presas consumidas a partir de la revisión de contenidos estomacales y heces y comparamos las diferencias entre las especies. La información de *M. tridactyla* proviene de cuatro deposiciones de la región de la Orinoquía, mientras que las de *Tamandua* fueron obtenidas a partir de contenidos estomacales de dos especímenes de la región Andina y de la Orinoquía. Fueron encontradas un total de 27 especies de hormigas, agrupadas en 14 géneros, 10 tribus y cinco subfamilias, mientras que se hallaron sólo dos especies de termitas. La mayor cantidad de especies de hormigas se encontró en las muestras de *T. mexicana*. Los géneros de hormigas en mayor proporción en las muestras fueron *Camponotus*, *Solenopsis* y *Ectatomma* y las obreras constituyeron la casta más abundante en la dieta. Las especies de *Tamandua* presentan en su dieta una mayor proporción de hormigas arborícolas mientras que *M. tridactyla* de hormigas del suelo. Las diferencias en la dieta de los osos hormigueros parecen estar relacionadas con la oferta de alimento y la disponibilidad de las especies de hormigas más comunes presentes en los hábitats de cada especie.

Palabras clave: Colombia, dieta, Formicidae, hormigas, *Myrmecophaga*, *Tamandua*, termitas.

Records of ants and termites present in the diet of anteaters (Mammalia: Myrmecophagidae) in three localities of Colombia

Abstract Anteaters (Mammalia: Myrmecophagidae) feed mainly on ants and termites. Three anteater species are present in Colombia: the giant anteater *Myrmecophaga tridactyla*, the Northern lesser anteater *Tamandua mexicana*, and the Southern lesser anteater *Tamandua tetradactyla*. Nothing is known about their trophic ecology in the country. This study presents records of prey consumed by these species based on the analysis of stomach contents and feces, and compares the interspecific differences in consumed prey types. Data for *M. tridactyla* were obtained from four fecal samples from the Orinoco region, and the *Tamandua* samples were obtained from stomach contents of two specimens, one from the Andes region and the second one from the Orinoco region. Twenty-seven ant species were identified, belonging to 14 genera, ten tribes, and five subfamilies. Only two species of termites were found. *Tamandua mexicana* was the anteater that ate the greatest amount of ant species. *Camponotus*, *Solenopsis* and *Ectatomma* were the most frequent ant genera, and workers were more common than other castes. *Tamandua* species fed mainly on arboreal ants, while *M. tridactyla* had only ingested terrestrial ants. The differences between diets of anteaters seem to be related with resource availability and the abundance of ants in the habitat of each species.

Keywords: Ants, Colombia, diet, Formicidae, *Myrmecophaga*, *Tamandua*, termites.

INTRODUCCIÓN

Las hormigas y termitas son elementos faunísticos conspicuos y dominantes alrededor del globo, con una mayor diversidad en las regiones tropicales que gradualmente disminuye hacia las regiones templadas (Kusnezov, 1957; Redford, 1986). En la región tropical han sido descritas cerca de 3.200 especies de hormigas, lo cual representa el 30% de la riqueza total mundial de este grupo. Para Colombia se cuenta con 14 subfamilias, 94 géneros y alrededor de 1.000 especies (Fernández & Sendoya, 2004), lo que las convierte en un grupo altamente diverso en el país. Las termitas son menos diversas que las hormigas en el Neotrópico, con más de 500 especies registradas (Constantino, 1998). La riqueza de termitas en Colombia no ha sido aún estimada y existe una carencia de estudios básicos sobre su taxonomía y dinámicas poblacionales, entre otros (Abadía & Arcila, 2009).

Múltiples estudios muestran que las hormigas y termitas son un componente importante de la biomasa de los bosques. Las investigaciones en los bosques amazónicos indican que estos dos grupos componen un 30% del total de la biomasa de invertebrados terrestres y cerca del 75% del total de la biomasa de insectos (Fittkau & Klinge, 1973). En muchos lugares del mundo las hormigas y termitas son una presa potencial básica para mamíferos depredadores (Redford, 1986; Taylor *et al.*, 2002; Cooper & Withers, 2004). En comparación con otros artrópodos, las hormigas y termitas son un recurso concentrado y fácilmente asequible. Asimismo, cumplen un rol importante en la dieta de varias especies de mamíferos debido a su abundancia en los ambientes neotropicales, los altos contenidos nutricionales que proveen y sus hábitos coloniales (Redford & Dorea, 1984; Redford, 1986).

En el Neotrópico, los osos hormigueros (Mammalia: Myrmecophagidae) se alimentan principalmente de hormigas y termitas; esto se ve reflejado en sus características morfológicas como la forma de la mandíbula, lengua y musculatura palatal, lo que limita severamente las presas que pueden ingerir (Redford, 1985; Reiss, 1997). En Colombia habitan las tres especies de la familia Myrmecophagidae reconocidas actualmente (Cuervo Díaz *et al.*, 1986; Alberico *et al.*, 2000; Gardner, 2008): el oso hormiguero palmero (*Myrmecophaga tridactyla* Linnaeus, 1758) y dos especies de osos hormigueros de menor talla: *Tamandua mexicana* (Saussure, 1860) y *Tamandua tetradactyla* (Linnaeus, 1758). Sólo en Colombia, Ecuador y Perú se pueden encontrar estas tres especies, lo que convierte a estos países en sitios importantes para analizar diferentes aspectos biológicos de este grupo, particularmente en el ámbito ecológico, pieza clave en programas de conservación.

La dieta de *M. tridactyla* en países como Panamá y Venezuela consiste principalmente de hormigas terrestres (Montgomery, 1985b; Shaw *et al.*, 1985). En

el Cerrado Brasileiro se alimenta frecuentemente de hormigas del género *Camponotus*, pero también consume termitas de los géneros *Cornitermes*, *Syntermes* y *Velocitermes* (Redford, 1994), variando los porcentajes de cada una según la época del año. La cantidad de hormigas o termitas que puede llegar a ingerir en un solo día se acerca a las 35.000 (Moeller, 1990). Los casos anecdóticos de la dieta de esta especie registran larvas de escarabajo en Bolivia y milípedos en Brasil, así como algunos vertebrados pequeños en condiciones de cautiverio (Redford, 1985, 1986). Para el género *Tamandua* muchas especies de hormigas y termitas arbóreas son importantes en su dieta aunque observaciones recientes han mostrado que *T. mexicana* puede suplementar su dieta con frutos (Brown, 2011). *Tamandua mexicana* en Costa Rica se alimenta regularmente de las termitas de los géneros *Nasutitermes* y *Microtermes*, y en menor medida de las hormigas del género *Azteca*, ya que éstas poseen eficientes métodos de defensa de los nidos (Lubin *et al.*, 1977). En Panamá, *T. mexicana* consume tanto termitas como hormigas pero con aparente preferencia por las castas reproductivas y trabajadoras sobre los soldados. Además, prefiere los nidos que evidencien alados y pre-alados (Lubin & Montgomery, 1981) debido a que los alados tienen un alto valor calórico por gramo, más que las termitas trabajadoras y los soldados (Weigert, 1970). En Venezuela, las termitas del género *Nasutitermes* hacen parte importante de la dieta de *T. tetradactyla* las cuales son una fuente importante de proteínas, grasa y vitaminas y un bajo recurso de minerales (Oyarzun *et al.*, 1996).

En Colombia la información relacionada con la ecología trófica de los osos hormigueros es nula. Por eso, el presente estudio pretendió elaborar un acercamiento preliminar a la dieta de los hormigueros a partir de la revisión de contenidos estomacales y heces procedentes de tres localidades del país.

MATERIALES Y MÉTODOS

Obtención de muestras

La información de *M. tridactyla* procede del análisis de cuatro deposiciones fecales (**FIG. 1B**) encontradas en el mes de febrero de 2010 en la región de la Orinoquía, departamento de Casanare, municipio de San Luis de Palenque, Vereda el Tigre, cerca de la Finca El Jordán (05°11'37"N, 71°19'53"W; 142 msnm; **FIG. 2**). Este sitio se caracteriza por la presencia de áreas abiertas (pastos, esteros y sabanas inundables) y bosques (vegetación secundaria y bosques de galería; **FIG. 1A**). En los espacios abiertos la vegetación predominante está compuesta por *Leersia hexandra* Sw., *Axonopus purpusii* (Mez) Chace, *Selaginella* sp. y *Paepalanthus* aff. *fasciculatum*, entre otras, y varias especies de la familia Poaceae, mientras que en los bosques la vegetación está dominada por *Adiantum* sp., *Piper laevigatum* Kunth. y *Monstera adansonii* Schott, entre otras. En la región, el régimen pluviométrico es

monomodal, con un período lluvioso entre los meses de agosto y diciembre y una época seca de enero hasta junio (León-Sicard, 2011).

Las heces fueron determinadas como pertenecientes a *M. tridactyla* por: (1) la presencia de una cubierta mucosa o queratinosa (ver Montgomery, 1979); (2) la digestión de las presas incompleta y en algunos casos se podían observar ejemplares de hormigas casi intactos; (3) tamaño, lo que descarta que correspondan al armadillo *Dasypus kappleri* Krauss, 1862 que es una especie generalista, sin ninguna preferencia por las hormigas y termitas (Barreto *et al.*, 1985; Redford, 1986); y (4) por comparación con imágenes de heces de la especie de otras regiones de América del Sur ilustradas en trabajos previos (Möcklinghoff, 2008). Igualmente, se descarta que las heces pertenezcan al armadillo ocarro *Priodontes maximus* (Kerr, 1792) debido a que no hay evidencias directas ni indirectas de su existencia en el sitio de estudio.

Para *T. mexicana* se obtuvieron muestras del contenido estomacal de un individuo encontrado muerto en la región Andina, departamento de Antioquia, municipio de Maceo, cerca de la Hacienda Santa Bárbara (06°32'50"N, 74°37'34"W; 437 msnm). Se ubica en la vertiente oriental de la cordillera Central,

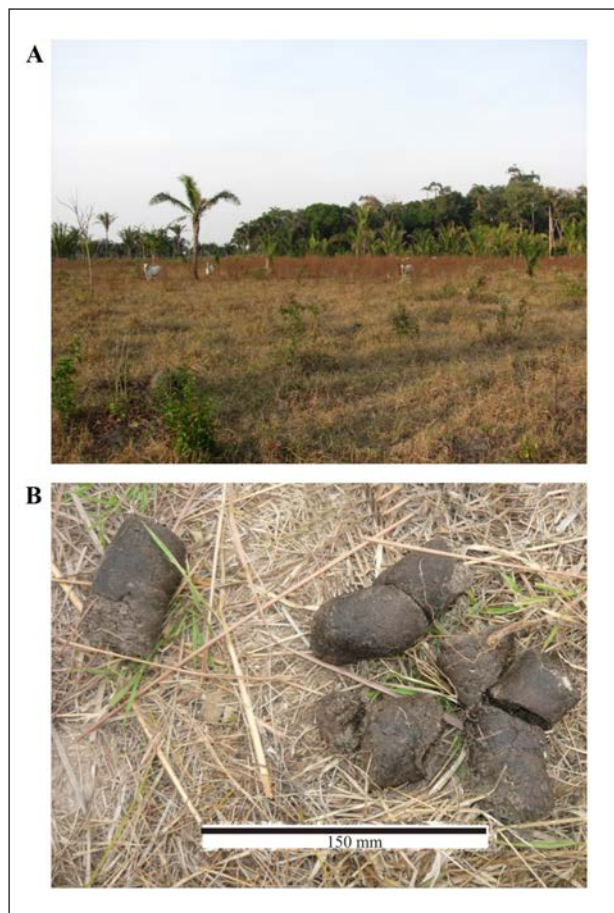


FIGURA 1. Localidad de registro de las excretas de *Myrmecophaga tridactyla* en la vereda El Tigre, San Luis de Palenque, Casanare: (A) Fisionomía del paisaje, (B) excretas.

en la región del Magdalena Medio (**FIG. 2**). La zona se encuentra dentro del área de reserva “Distrito de manejo integrado de los recursos naturales Cañón del Río Alicante” y está conformada por cañones con pendientes fuertes y cortas, colinas y valles aluviales estrechos. La configuración vegetal está representada por bosques secundarios, rastrojos altos y bosques secundarios maduros, en los que dominan las familias Mimosaceae, Rubiaceae, Malvaceae, Melastomataceae, Araceae, Marantaceae, Costaceae y Ciclanthaceae, entre otras (Pulgarín-R., 2005). Esta zona se ubica como bosque húmedo tropical (bh-T) con una temperatura promedio anual de 23 °C y una precipitación entre 2.000 y 4.000 mm anuales. El régimen de lluvias para la zona es bimodal con lluvias de abril a junio y de agosto a noviembre y una época seca de diciembre a marzo y de julio a agosto (Holos Ltda., 1997).

Para *T. tetradactyla* sólo fue posible revisar una muestra perteneciente a las hormigas del género *Cephalotes* obtenidas del contenido estomacal de un individuo encontrado muerto en el departamento de Meta (**FIG. 2**), sin datos de localidad y depositado en la Universidad del Valle.

Separación y análisis de las muestras

Las muestras de contenido estomacal y heces fueron limpiadas y separadas en el Laboratorio de la Colección Teriológica de la Universidad de Antioquia, donde se discriminó el tipo de alimento por tipo de material y calidad. Posteriormente el material fue almacenado en viales con alcohol etílico al 70% e identificado utilizando las claves taxonómicas para géneros

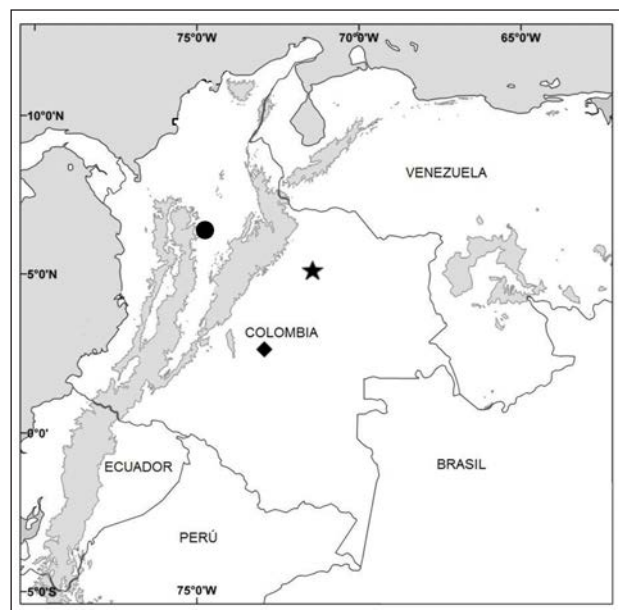


FIGURA 2. Localidades de procedencia de las muestras analizadas. Círculo: Maceo, departamento de Antioquia (*Tamandua mexicana*). Estrella: San Luis de Palenque, Casanare (*Myrmecophaga tridactyla*). Rombo: departamento del Meta (*T. tetradactyla*).

de hormigas neotropicales de Palacio & Fernández (2003), las claves para géneros de hormigas del mundo de Bolton (1994) y las claves para familias de termitas del Brasil de Constantino (1999). La identificación de las termitas fue corroborada en el Laboratorio de Termitología del Departamento de Biología de la Universidade Federal de Viçosa, Brasil.

RESULTADOS

Un total de 27 especies de hormigas fueron encontradas en la dieta de los osos hormigueros, agrupadas en 14 géneros, 10 tribus y cinco subfamilias (TABLA 1). El número de especies de termitas fue mucho menor, con tan sólo dos especies y en menor proporción que las hormigas registradas (TABLA 1). Los géneros de hormigas más consumidos por los osos hormigueros fueron *Camponotus*, *Solenopsis* y *Ectatomma* y la casta más abundante fue la de obreras. Las especies de

Tamandua se habían alimentado en mayor proporción de hormigas arborícolas pertenecientes a los géneros *Camponotus*, *Cephalotes* y *Crematogaster* mientras que *M. tridactyla* había consumido hormigas de suelo de los géneros *Atta*, *Ectatomma*, *Pheidole* y *Solenopsis*.

La mayor cantidad de especies de hormigas (23 especies) fue encontrada en el contenido estomacal de *T. mexicana*, pero las termitas tuvieron una baja proporción con sólo una especie del género *Cornitermes* (Termitidae: Syntermitinae). Los géneros más consumidos por *M. tridactyla* fueron *Solenopsis*, *Camponotus* y *Atta*; las especies más comunes en su dieta fueron *Solenopsis* sp.1, *Atta* sp.1 y *Camponotus* sp.1, mientras que las especies exclusivas consumidas por este hormiguero fueron *Atta* sp.1 y *Anochetus* sp.1.

Myrmecophaga tridactyla se alimenta casi exclusivamente de hormigas habitantes del suelo y su

TABLA 1. Hormigas encontradas en las tres especies de osos hormigueros de Colombia. Mt: *Myrmecophaga tridactyla*. Tm: *Tamandua mexicana*. Tt: *Tamandua tetradactyla*.

Subfamilia	Tribus	Especies	Mt	Tm	Tt	
Ecitoninae	Ecitonini	<i>Eciton</i> sp.1		X		
		<i>Neivamyrmex</i> sp.1		X		
Ectatomminae	Ectatommini	<i>Ectatomma ruidum</i> (Roger, 1860)	X	X		
		<i>Ectatomma tuberculatum</i> (Olivier, 1792)		X		
Formicinae	Brachymyrmecini	<i>Brachymyrmex</i> sp.1		X		
		<i>Brachymyrmex</i> sp.2		X		
	Camponotini	<i>Camponotus</i> sp.1	X	X		
		<i>Camponotus</i> sp.2	X	X		
		<i>Camponotus</i> sp.3	X	X		
		<i>Camponotus</i> sp.4		X		
		<i>Camponotus</i> sp.5		X		
	Myrmicinae	Attini	<i>Acromyrmex</i> sp.1	X	X	
			<i>Atta</i> sp.1	X		
		Cephalotini	<i>Cephalotes pusillus</i> (Klug, 1824)			
<i>Cephalotes umbraculatus</i> (Fabricius, 1804)						X
Crematogastrini		<i>Crematogaster</i> sp.1		X		
		<i>Crematogaster</i> sp.2		X		
Pheidolini		<i>Pheidole</i> sp.1	X	X		
		<i>Pheidole</i> sp.2		X		
Solenopsidini			<i>Monomorium</i> sp.1		X	
			<i>Solenopsis geminata</i> (Fabricius, 1804)	X	X	
	<i>Solenopsis</i> sp.1		X	X		
	<i>Solenopsis</i> sp.2		X	X		
	<i>Solenopsis</i> sp.3			X		
	<i>Solenopsis</i> sp.4			X		
Ponerinae	Ponerini	<i>Anochetus</i> sp.1	X			
		<i>Odontomachus</i> sp.1	X	X		
TOTAL			12	23	2	

dieta incluyó 12 especies de hormigas (**TABLA 2**). Tuvo predilección por el género *Atta*, el cual es muy abundante en zonas intervenidas y presenta nidos amplios con mayores proporciones de obreras de gran tamaño que forrajean buscando hojas, flores y frutos. Otro género frecuente en las muestras fue *Solenopsis*, el cual presentó la más alta abundancia en la dieta por presentar hormigas diminutas que pueden ser consumidas rápidamente y sin oponer mucha resistencia, además son muy comunes en la hojarasca y construyen nidos de fácil acceso. Las termitas encontradas en la dieta de *M. tridactyla* corresponden a una especie del género *Cornitermes* y una de la subfamilia Nasutitermitinae.

Los géneros de hormigas encontrados en mayor proporción en la muestra de *T. mexicana* fueron *Ectatomma*, *Solenopsis*, *Brachymyrmex* y *Camponotus*; las especies más comunes en la dieta fueron *Ectatomma tuberculatum* (Olivier, 1792), *Solenopsis* sp.1 y *Brachymyrmex* sp.2. Las especies de hormigas exclusivas consumidas por *T. mexicana* fueron *Eciton* sp.1, *Neivamyrmex* sp.1, *Ectatomma tuberculatum*, el género *Brachymyrmex*, *Camponotus* sp.4, *Camponotus* sp.5, el género *Crematogaster*, *Pheidole* sp.2, *Monomorium* y dos especies de *Solenopsis*. Según lo que muestran los resultados, *T. mexicana* se alimenta tanto de hormigas presentes en los árboles como de hormigas del suelo. Un total de 23 especies diferentes de hormigas fueron encontradas en la muestra incluyendo epigeas, hipogeas y arbóreas (**TABLA 3**).

Las especies exclusivas consumidas por *T. tridactyla* fueron *Cephalotes pusillus* (Klug, 1824) y *Cephalotes umbraculatus* (Fabricius, 1804), las cuales son arbóreas. Desafortunadamente, no fue posible revisar especímenes de otros géneros de hormigas y termitas presentes en la muestra de esta especie.

La especies de hormigas compartidas entre *M. tridactyla* y *T. mexicana* son *Ectatomma ruidum* (Roger, 1860), tres morfoespecies de *Camponotus*, *Acromyrmex* sp.1, *Pheidole* sp.1, *Solenopsis geminata* (Fabricius, 1804), *Solenopsis* sp.1 y *Solenopsis* sp.2.

DISCUSIÓN

Si bien hay pocos estudios de campo donde se exprese predominancia en la dieta de hormigas o termitas de los osos hormigueros, la disponibilidad de estas presas puede variar geográfica y estacionalmente (Medri *et al.*, 2003). En este caso, aparentemente las diferencias en la dieta de los osos hormigueros están relacionadas con la oferta de alimento y las especies de hormigas más comunes presentes en los hábitats de cada especie. Por ejemplo, las hormigas cortadoras del género *Atta* y *Acromyrmex* son más abundantes en áreas abiertas, con predominancia de gramíneas; algunas especies de los géneros *Solenopsis* y *Pheidole* son dominantes omnívoras del suelo, con colonias grandes que pueden estar siendo favorecidas en ambientes perturbados, mientras que la diversidad de especies del género *Camponotus* y *Cephalotes* puede estar relacionada con la cantidad de troncos en descomposición dentro del bosque, el tipo de vegetación y biomasa vegetal (Silvestre *et al.*, 2004). A pesar de esto, el número de especies de hormigas encontradas en este trabajo es alto y por lo general corresponden a representantes de los géneros *Camponotus* y *Solenopsis*, los cuales son muy diversos, teniendo *Camponotus* cerca de 1.000 especies descritas y *Solenopsis* 90 especies (Fernández, 2003). El género *Camponotus* representa hormigas de gran porte con bastante valor alimenticio para los osos hormigueros, comunes en estos ambientes donde se encuentran forrajeando en el suelo o en los árboles y además carecen de aguijón, por lo que son fácilmente consumidas. Cabe

TABLA 2. Composición de hormigas en la dieta de *Myrmecophaga tridactyla* de la Orinoquía de Colombia.

Subfamilia	Tribus	Especies	Porcentaje especie	Porcentaje género
Ectatomminae	Ectatommini	<i>Ectatomma ruidum</i> (Roger, 1860)	6,4	6,4
	Camponotini	<i>Camponotus</i> sp.1	16,3	
		<i>Camponotus</i> sp.2	5,4	25,3
		<i>Camponotus</i> sp.3	3,6	
Myrmicinae	Attini	<i>Acromyrmex</i> sp.1	3,6	3,6
		<i>Atta</i> sp.1	18,2	18,2
	Pheidolini	<i>Pheidole</i> sp.1	7,3	7,3
	Solenopsidini	<i>Solenopsis geminata</i> (Fabricius, 1804)	6,4	
		<i>Solenopsis</i> sp.1	21	30,1
		<i>Solenopsis</i> sp.2	2,7	
Ponerinae	Ponerini	<i>Anochetus</i> sp.1	4,5	4,5
		<i>Odontomachus</i> sp.1	4,6	4,6
		TOTAL	100	100

TABLA 3. Composición de hormigas en la dieta de *Tamandua mexicana* de los Andes de Colombia.

Subfamilia	Tribus	Especies	Porcentaje especie	Porcentaje género
Ecitoninae	Ecitonini	<i>Eciton</i> sp.1	0,9	0,9
		<i>Neivamyrmex</i> sp.1	0,9	0,9
Ectatomminae	Ectatommini	<i>Ectatomma ruidum</i> (Roger, 1860)	3,7	22,2
		<i>Ectatomma tuberculatum</i> (Olivier, 1792)	18,5	
Formicinae	Brachymyrmecini	<i>Brachymyrmex</i> sp.1	10,2	21,2
		<i>Brachymyrmex</i> sp.2	11	
	Camponotini	<i>Camponotus</i> sp.1	4,6	13,9
		<i>Camponotus</i> sp.2	3,7	
		<i>Camponotus</i> sp.3	2,8	
		<i>Camponotus</i> sp.4	1,9	
		<i>Camponotus</i> sp.5	0,9	
Myrmicinae	Attini	<i>Acromyrmex</i> sp.1	1,9	1,9
		Crematogastrini	<i>Crematogaster</i> sp.1	2,8
	<i>Crematogaster</i> sp.2		1,9	
	Pheidolini	<i>Pheidole</i> sp.1	2,8	4,6
		<i>Pheidole</i> sp.2	1,8	
	Solenopsidini	<i>Monomorium</i> sp.1	3,7	3,7
		<i>Solenopsis geminata</i> (Fabricius, 1804)	2,8	21,4
		<i>Solenopsis</i> sp.1	13	
		<i>Solenopsis</i> sp.2	0,9	
		<i>Solenopsis</i> sp.3	1,9	
		<i>Solenopsis</i> sp.4	2,8	
	Ponerini	<i>Odontomachus</i> sp.1	4,6	
	TOTAL			100

resaltar que estos dos géneros de hormigas son también consumidos en considerables proporciones por el osito trueno *Cyclopes didactylus* (Linnaeus, 1758) (Cyclopedidae), el cual es un mirmecófago estricto que consume ampliamente hormigas arbóreas, además de representantes del género *Solenopsis* que son predominantemente terrestres (Miranda *et al.*, 2009).

La mayor abundancia de hormigas del género *Solenopsis* (30,1%) y *Camponotus* (25,3%) en la dieta de *M. tridactyla* concuerdan con los resultados encontrados en el Pantanal da Nhecolândia (Mato Grosso do Sul) de Brasil, donde las hormigas presentaron la siguiente distribución porcentual de hallazgo: *Solenopsis interrupta* (36%), *S. saevissima* (36%), *S. pusillignis* (5%), *Camponotus crassus* (7%), *C. renggeri* (5%), *S. invicta* (5%), *Ectatomma planidens* (2%), *Labidus spininodis* (2%) y *Odontomachus minutus* (2%); en cambio la mayoría de las termitas pertenecieron a *Asutitermes coxipoensis* y un registro del género *Armitermes* (Medri *et al.*, 2003). Redford (1994) hace referencia que en el Cerrado Brasileiro *M. tridactyla* consume termitas del género *Cornitermes*, *Syntermes* y *Velocitermes*, de los cuales el primero fue encontrado

también en nuestras muestras. Para Venezuela se ha mencionado que en un excremento de oso palmero pueden encontrarse hasta 14.253 cabezas de hormigas (30% de *Camponotus*) (Montgomery, 1985a). Caso similar ocurre en los llanos venezolanos inundables, los cuales no son habitables para las termitas terrestres y en donde se presentan altos porcentajes de hormigas en las dietas (Redford, 1986). En los sitios no inundables de Venezuela las termitas se convierten en el ítem más importante en la estación lluviosa, ya que *M. tridactyla* responde a la variación de la disponibilidad de presas: en las áreas secas las hormigas componen el 100% de la dieta, mientras que las termitas son escasas en esas áreas (Montgomery, 1985b). Drumond & Rylands (1994) obtuvieron datos cuantitativos de ítems alimenticios de *M. tridactyla* en Brasil y encontraron que la dieta de esta especie muestra una variación estacional en la selección de las presas, y esto fue también evidentemente determinado por los diferentes mecanismos de defensas de las hormigas (notablemente *Solenopsis*, *Camponotus* y *Crematogaster*) y termitas (principalmente Apicotermatinae, Nasutitermitinae y Termitinae). Shaw *et al.* (1985) registraron una dieta compuesta

por un 88% de hormigas y 12% de termitas durante dos meses al finalizar la estación húmeda, pero este porcentaje de termitas suele ser más alto e incluso componer la mayor parte de la dieta en otras épocas del año. Según Lubin *et al.* (1977) diferentes niveles de depredación sobre los nidos de termitas de los géneros *Nasutitermes* y *Microcerotermes* ocurren en las épocas más lluviosas donde hay mayor abundancia de castas reproductivas, las cuales tienen un alto valor calórico comparado con obreros y soldados (Weigert, 1970). Este tipo de comportamiento podría explicar la baja proporción de termitas encontradas en el presente trabajo, ya que las muestras provienen de la estación seca. Se requiere de la obtención y análisis de nuevas muestras procedentes de la estación lluviosa para corroborar este hecho.

Para *T. mexicana* que presenta una amplia variedad de hormigas consumidas, los resultados son acordes con los registrados por Lubin (1983) y Montgomery (1985a, b) quienes encontraron que esta especie se alimenta de hormigas y termitas que se encuentran en el suelo y sobre árboles. Montgomery (1985a) encontró en la isla de Barro Colorado, Panamá, que *T. mexicana* enfocaba su dieta en una especie de hormiga durante cada período de alimentación, sin ser la misma especie día a día o de un individuo a otro. Las hormigas preferidas fueron *Procryptocerus belti* y *Crematogaster* sp., que junto a una especie que no se pudo identificar sumaron el 45% de las hormigas de la dieta (Montgomery, 1985a). El género *Ectatomma* fue una presa remarcable en la dieta de *T. mexicana*. Las especies de este grupo se encuentran en bosques y sabanas donde pueden ser muy conspicuas y abundantes. Los nidos son terrestres con una abertura de entrada y son depredadoras generalizadas de diversos artrópodos y anélidos. Además, recolectan líquidos azucarados como las secreciones de hemípteros y nectarios, o líquidos de frutas. El género *Brachymyrmex* cuenta con especies pequeñas que habitan el suelo y hojarasca y al carecer de aguijón no oponen mucha resistencia al consumo por parte de los hormigueros. *Pheidole* y *Monomorium* son géneros comunes de la región Neotropical, habitan principalmente el estrato epigeo del suelo, a diferencia de *Neivamyrmex* que es hipogeo, y en el caso del segundo género, podrían ser plagas caseras distribuidas por actividades humanas. Por otro lado el género *Crematogaster* habita principalmente en los árboles de los trópicos. Se han descrito más de 200 especies, subespecies y variedades para la región Neotropical, lo que las hace un recurso muy abundante y diverso en el estrato arbóreo (Fernández, 2003).

Para *T. tetradactyla* debido al pequeño tamaño de la muestra los resultados requieren de una nueva valoración. Para esta especie se ha mencionado que se alimenta de hormigas y termitas que extrae de nidos arbóreos, aunque también suele forrajear en el suelo; prefiere las termitas en su dieta (Wetzel, 1982;

Montgomery, 1985a) y suele visitar entre 50 y 80 colonias de hormigas y termitas durante cada ciclo diario de actividad (Montgomery, 1985a).

El presente trabajo constituye un aporte al conocimiento de la dieta de las especies de la familia Myrmecophagidae en Colombia. Sin embargo es clara la necesidad de realizar análisis más completos, como la inclusión y estandarización de las muestras, evaluar las posibles diferencias en épocas climáticas a lo largo del año e incluir más localidades en el amplio mosaico ecológico donde los miembros de esta familia pueden estar presentes. De esta manera se podrá acceder de forma más completa a los aspectos de la ecología trófica de estas especies en el país.

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Perception and popular reports about giant anteaters (*Myrmecophaga tridactyla* Linnaeus, 1758) by two Brazilian traditional communities

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Abstract In Brazil, the giant anteater (*Myrmecophaga tridactyla* Linnaeus, 1758) is a mammal mentioned in some popular folklore stories, most often negatively. As a threatened mammal, listed in Brazil and world-wide as Vulnerable, such reports can negatively affect its conservation in some regions. The main purpose of this study is to describe perceptions about the physical and behavioral characteristics of giant anteaters and to verify the existence of popular reports involving these animals, in two Brazilian traditional communities where the species is relatively abundant in the wild. Through semi-direct interviews I registered 24 popular reports involving giant anteaters, three of which had been cited previously in the scientific literature.

Keywords: Conservation, giant anteater, *Myrmecophaga tridactyla*, semi-direct interviews, traditional communities, traditional ecological knowledge

Percepção e relatos populares sobre tamanduá-bandeira (*Myrmecophaga tridactyla* Linnaeus, 1758) por duas comunidades tradicionais brasileiras

Resumo No Brasil, o tamanduá-bandeira (*Myrmecophaga tridactyla* Linnaeus, 1758) é um mamífero alvo de histórias de cunho folclórico, sendo que em sua maioria o relacionam à aspectos negativos. Para um mamífero ameaçado de extinção, no status Vulnerável em nível nacional e internacional, a sua associação a relatos populares pode contribuir negativamente para a sua conservação em algumas áreas. Este estudo tem como finalidade reconhecer a percepção sobre características físicas e comportamentais dos tamanduás-bandeiras; e verificar a existência de relatos populares envolvendo o animal, já previamente citados ou não na literatura, em duas comunidades tradicionais onde a espécie ocorre relativamente em abundância na natureza. Através de entrevista semi-diretiva foram registrados 24 relatos diferentes em relação ao tamanduá-bandeira, apenas três deles relatados anteriormente pela literatura.

Palavras-chave: Conhecimento popular, conservação, entrevistas semi-diretivas, *Myrmecophaga tridactyla*, povos tradicionais, tamanduá-bandeira

INTRODUCTION

The giant anteater (*Myrmecophaga tridactyla* Linnaeus, 1758) is a mammal in the order Pilosa that specializes in feeding on ants and termites (Montgomery & Lubin, 1977; Redford, 1985). It occurs exclusively in South America, and in Brazil the original geographic range comprised all the country and biomes (Eisenberg & Redford, 1999; Medri *et al.*, 2006). Although considered a flagship species in South America, it is currently listed as Vulnerable by the IUCN Red List of Threatened Species (Superina *et al.*, 2010), as well as in Brazil (Medri & Mourão, 2008).

In Brazil, some popular folklore surrounds this animal, the majority of which describes giant anteaters negatively. Shaw & Carter (1980) listed three of these reports: (1) Giant anteaters can suffocate a person by placing the snout over the victim's mouth and nose; (2) According to some South American Indians and traditional community stories, giant anteaters are capable of killing jaguars (*Panthera onca*); (3) All giant anteaters are females and procreate by mating with lesser anteaters (*Tamandua tetradactyla*), which are all males. According to a fourth report, a giant anteater symbolizes bad luck, especially if it crosses someone's path. These reports can negatively impact

the conservation of giant anteaters in some localities where the animals are considered dangerous to humans (Shaw & Carter, 1980).

Understanding the connection between popular and scientific knowledge about an animal may enhance public awareness of it, as well as improve its conservation. In this study, popular knowledge about giant anteaters was gathered in two Brazilian traditional communities where the species is relatively abundant in the wild. Traditional people were defined, following Wavey (1993) and Diegues & Arruda (2001), as human groups that are culturally different, somewhat isolated, adapted to specific ecological niches, and maintain their way of life over generations. Using semi-direct interviews, I hoped to identify perceptions about the physical and behavioral characteristics of giant anteaters and to verify the existence of popular reports involving this species.

MATERIALS AND METHODS

Brazilian traditional communities

The first community is located at a rural zone of São Roque de Minas (20°13'57"S, 46°22'10"W), Minas Gerais State, and is mainly comprised of small land owners in the area surrounding Serra da Canastra National Park. This community is known as land workers. Interviews were conducted there in September 2009. The second community is located at Fazenda Nhumirim (18°59'16"S, 56°36'52"W), in the Pantanal wetland of Mato Grosso do Sul State. The people there are cattle ranchers and their workers. These people are known as *pantaneiros*. For this community, interviews were conducted in June 2009 and February 2010.

Both traditional communities are situated in geographic regions where giant anteaters are relatively abundant in the wild, so it was expected that the respondents knew the animal.

Interviews

Popular folklore and stories about giant anteaters were gathered using semi-direct interviews (10 people in each community), through oral and writing communication. Semi-direct interviews involve a series of guideline questions, exposed to the respondents (Huntington, 1998; Kapila & Lyon, 2006).

Respondents were officially informed about the purpose of the study with a Statement of Consent form that was evaluated and approved by the Ethics Committee of Universidade Federal de Mato Grosso do Sul.

The first step was talking to each respondent briefly to describe the purpose of the study and its aims and to provide a succinct description of a giant

anteater. Because both the giant anteater and the lesser anteater (*Tamandua tetradactyla*) were present in each community, it was made clear that the focus of the study was the giant anteater. The questions contained in the interview were clear and easy to comprehend in terms of vocabulary (Appendix 1).

When an answer invoked information from other people, the information was classified as coming either: (1) from a relative, or (2) popular imagination. I defined as popular imagination reports that used phrases such as "is told by people", "everyone here knows that" and "this is what people say".

Data were analyzed quantitatively and qualitatively, and the answers of each respondent were compared with those of the others. First, an analysis of objectivity was performed to eliminate information not consistent with the study goals. The same answer from the same respondent to two different questions was considered as one. Open answers were categorized according to the origin: morphologic, behavioral, or subjective.

RESULTS

I interviewed 20 people. The average age of the respondents was 50.79±11.10 years (range 33–66 years). All the respondents knew the giant anteater and had seen at least one animal in its natural habitat. Only two people from the *pantaneiros* group knew other names for the animal, such as *Jurumi*, *Bandeira*, and *Bandurra*.

Perceptions about physical and behavioral characteristics of giant anteaters

Characteristics of giant anteaters cited by respondents were: hairy and long tailed (24.6%), long snout (24.6%), slow gait (8.2%), good looking (8.2%), strong claws (6.56%), stripes on the body (6.56%), long tongue (6.56%), carries the offspring on the back (4.9%), sleeps with the tail folded over the body (3.3%), big animal (3.3%), footprint is similar to a child's footprint (1.64%), and good sniffer (1.64%). The answers were divided into Morphologic, Behavioral, and Subjective categories (TABLE 1).

Only one respondent did not know what giant anteaters eat. For the remainder "ants" was the most cited (37.3%), followed by "termites" (35.3%). Other answers showed low percentage and were complementary to these two (TABLE 2).

Popular reports involving giant anteaters

I registered 24 types of popular reports involving giant anteaters. The most cited by respondents were: giant anteaters attack humans (18.8%), attack dogs (15.9%), symbolize bad luck, especially if one crosses a person's path (5.8%), are good swimmers (4.3%), have a fast gait in woody environments (4.3%), their meat is consumed by humans (4.3%),

TABLE 1. Characteristics of giant anteaters (*Myrmecophaga tridactyla*) cited by respondents from two Brazilian traditional communities, by category and number of answers.

Characteristics	Category	Number of answers	%
Hairy and long tailed	Morphologic	15	24.60
Long snout	Morphologic	15	24.60
Slow gait	Behavioral	5	8.20
Good looking	Subjective	5	8.20
Strong claws	Morphologic	4	6.56
Stripes on the body	Morphologic	4	6.56
Long tongue	Morphologic	4	6.56
Carries the offspring on the back	Behavioral	3	4.90
Sleeps with the tail folded over the body	Behavioral	2	3.30
Big animal	Subjective	2	3.30
Footprint is similar to a child's footprint	Morphologic	1	1.64
Good sniffer	Behavioral	1	1.64

found the dead bodies of giant anteaters and jaguars clinging to each other (4.3%), their claw marks can be seen on trees and termite mounds (4.3%), remains of burned animals have been found (4.3%), and they sleep with the tail folded over the body (4.3%). Other information was mentioned only once or twice. Sixteen of these 24 reports were witnessed by respondents (TABLE 3).

When the respondents were questioned about how dangerous giant anteaters are, all of them answered that the animal is not dangerous at all. However, 17 respondents had reservations: "if it is touched" (35%), "if it is threatened (persecuted or cornered)" (19.3%), "if it is in a woody patch" (19.3%), "if needed, it knows how to defend itself" (11%), "only if molested" (7.7%) and "if the mother carries her pup" (7.7%).

When asked about gender, 17 respondents said that there are male and female giant anteaters, two respondents said that there are only females, and one respondent answered that giant anteaters are hermaphrodites.

Regarding the giant anteater's predators there were four answers: jaguars and pumas, snakes, humans, and it has no predators. When questioned about the giant anteater's ability to kill, and if it uses its claws to do so, all respondents answered yes. Finally, when questioned about which animals the giant anteater is able to kill, there were different answers such as: dogs, crab eating foxes (*Cerdocyon thous*), anything except jaguars and pumas, deer, hares, jaguars, humans, and any small animal.

DISCUSSION

Traditional and local ecological knowledge helps to guide a community in such a way that people feel connected to the environment around

TABLE 2. Food items in the diet of giant anteaters (*Myrmecophaga tridactyla*), as cited by respondents from two Brazilian traditional communities, and number of answers.

Food items	Number of answers	%
Ants	19	37.25
Termites	18	35.3
Bugs	4	7.84
Baby birds	1	1.96
Eggs	1	1.96
Human food	1	1.96
Honey	1	1.96
Spiders	1	1.96
Larvae	1	1.96
Wood	1	1.96
Fruits	1	1.96
Leaves	1	1.96
Do not know	1	1.96

them, including the local fauna. This study shows that people in two Brazilian traditional communities knew many morphological and behavioral details about giant anteaters, and had many subjective impressions of the animals.

The giant anteater is highly specialized for feeding on ants and termites, although honey cannot be ignored as a rare and uncommon feeding resource, as its ingestion was evidenced once at Emas National Park (Miranda *et al.*, 2003). Consistent with the scientific view that giant anteaters are obligately myrmecophagous (Redford, 1985), 80.39% of the respondents in this study stated that anteaters consume "ants", "termites", and "bugs" (excluding the one respondent who did not know what giant anteaters eat). This demonstrates that the respondents had good knowledge about the diet of giant anteaters.

TABLE 3. Popular reports involving the giant anteater (*Myrmecophaga tridactyla*), as cited by respondents from two Brazilian traditional communities, by origin and observations.

	Popular report	Number of reports	Origin of report			Observations
			Observed by respondent	Told by relative	Popular imagination	
1	Attacks dogs	11	6	1	4	
2	Attacks humans	13	4	1	8	
3	Enters a market	2	2	0	0	In Campo Grande city, Mato Grosso do Sul State
4	Symbolizes bad luck, especially if it crosses a person's path	4	0	0	4	
5	Good swimmer	3	2	0	1	
6	Fast gait in woody environments	3	1	0	2	
7	Meat is consumed by humans	3	2	0	1	One respondent said that it tastes bad
8	Anteaters may emit roars	2	1	0	1	One respondent said that only the males roar
9	Found dead giant anteaters clinging to dead jaguars	3	0	1	2	
10	Agonistic encounter between a maned wolf (<i>Chrysocyon brachyurus</i>) and an anteater	2	1	1	0	
11	Claw marks on trees and termite mounds	3	3	0	0	
12	Found burned giant anteater	3	2	1	0	All reports were associated with wildfires
13	Sleeps with the tail folded over the body	3	3	0	0	
14	Tame giant anteater	2	2	0	0	When grown up around humans
15	Can suffocate a dog by placing its snout over the dog's mouth and nose	1	0	0	1	
16	To save a person that is being attacked by an anteater, one has to bite the animal's snout	2	0	0	2	
17	A snake bite can be deadly for the giant anteater	1	1	0	0	
18	Defecates in the water	1	1	0	0	
19	In order to approach a giant anteater the wind must be in your favor	2	2	0	0	
20	Displays of docile behaviors depending on lunar phases	1	0	0	1	
21	It eats more termites depending on lunar phases	1	0	0	1	
22	Dogs fear giant anteaters	1	0	0	1	
23	It protects itself from fire hiding in water	1	0	0	1	
24	Offspring sleeps on the mother's back	1	1	0	0	

The three types of folklore reported previously by Shaw & Carter (1980) were found during this study. One respondent said that a giant anteater caused asphyxia with its snout/tongue; however, the attack was on dogs. Three respondents stated that the giant anteater is capable of killing jaguars, and that dead bodies of giant anteaters and jaguars clinging to each other were also found. Details

provided by the respondents attempted to show how this could be possible. For example, it was claimed that the giant anteater kills a jaguar by perforating the skin with its claws, and the jaguar kills an anteater by biting on the neck. This information seems to come from an indigenous Brazilian source (Shaw & Carter, 1980), and probably is a fable relating to the balance of forces in nature. Even so, giant

anteaters do occur in the diet of jaguars (Cavalcanti & Gese, 2010). However, there are no data suggesting that giant anteaters kill jaguars.

Folklore that there are no male giant anteaters appeared on three answers, two of which affirmed that the species is composed only of females, and one that stated giant anteaters are hermaphrodites. When questioned why they believed such a theory, the answer was that it was impossible to see any genitalia, so anteaters must not have testicles. The lack of sexual dimorphism and the fact that males have internal testicles no doubt helped to foster this interpretation.

The idea that the giant anteater symbolizes bad luck was mentioned in four answers. Specific maladies included: "if an animal crosses someone's path, while going fishing, that person will not catch any fish" and "if you are going somewhere and a giant anteater crosses your path, it's better to go back or something bad will happen". One respondent said that when a giant anteater crosses in front of a truck it brings bad luck to the truck driver, and the only way to break this curse is to kill the anteater and remove the claws as an amulet. The respondent also said that this could be the cause of many accidents on the roads that provide access to the Pantanal. Another xenarthran, the fairy armadillo *Calyptophractus retusus*, also symbolizes bad luck among the Izoceño people of the Bolivian Gran Chaco. *Calyptophractus retusus* is not required for food but is killed whenever found; this hunting comes from a belief that the animal is a bad luck omen, foretelling an impending death in the family (Cuéllar, 2001).

Many of the reports in this study indicated knowledge of the giant anteater's behavior, and are consistent with scientific findings. For instance, some giant anteaters are injured or even killed during forest fires (Silveira *et al.*, 1999) which would lead to the discovery of burned remains. Scientific literature that confirms other reports shows that giant anteaters: leave claw marks in natural structures such as trees and termite mounds (Braga *et al.*, 2010); take baths and defecate in various bodies of water (Emmons *et al.*, 2004); are eaten by humans (Lizot & Ross, 1979; Leeuwenberg, 1997); and fold the tail over the body to conserve body heat while sleeping (Shaw & Carter, 1980; Wetzel, 1985; Medri & Mourão, 2005). Likewise, in semi-captive conditions it has been shown that the mother carries the offspring for about three months, until they are self-sufficient, and as time goes by the pups spend less time on the mother's back (Jerez & Halloy, 2003). Evidence regarding sensory abilities includes that, when the wind is in the observer's favor, it is easier to approach a giant anteater without being detected (Shaw & Carter, 1980). Other studies further indicate the olfactory sense is very acute (McAdam & Way, 1967), but vision is poor (Redford, 1994). In

Nicaragua, dogs often accompany hunters in order to hound giant anteaters and force the animal into a defensive posture (Koster, 2008). In such a situation giant anteaters might attack dogs or even humans (Shaw & Carter, 1980). It is also possible that dogs with a negative previous experience with anteaters might develop fear of the animal.

Despite the assertion of Shaw & Carter (1980) that in South America giant anteaters are considered dangerous to humans, all respondents in this study did not view the animals as a hazard, stating they pose no real danger if unmolested or not threatened. Of course, the same could be said for almost all mammalian species.

Popular imagination, or folklore, brings the benefit of people recognizing an animal, but whether the animal is viewed negatively or positively depends on the nature of the myth. For example, in some Chinese communities, animals are associated with a spiritual realm and are worshiped and respected (Xu *et al.*, 2005). For any species, it is essential to know what an animal actually represents and what it symbolizes. Conservation programs must incorporate ethnobiological studies in order to understand the social and cultural attributes that communities give to species. Positive attributes can be used to facilitate conservation goals, while negative views may require a program of demystification.

There is a wide variety of studies in the scientific literature about local and traditional ecological knowledge (*e.g.*, De Bôer & Baquete, 1998; Gilchrist *et al.*, 2005; Cocks & Dold, 2006; Forth, 2007; Daw *et al.*, 2011). These often have implications for conservation plans. For example, a study using a semi-direct questionnaire about belugas (*Delphinapterus leucas*) found that people from traditional communities described in details aspects of interactions with humans and anthropogenic influences (Huntington, 1998). Such information was rare in the published literature on belugas. Research on the crab *Ucides cordatus* demonstrated that knowledge from people that gathered the crabs provided a useful basis for understanding local crab stocks and their population dynamics (Alves *et al.*, 2005). A study aiming at perceptions of human-carnivore conflicts found that hunting is probably a conservation problem for the Andean cat (*Leopardus jacobitus*), a little known carnivore and one of the world's most threatened felids (Lucherini & Merino, 2008). Another study with *Aquilaria*, an Asian resin producer plant, showed that traditional knowledge can assist in identifying areas of research for vegetal domestication (Donovan & Puri, 2004).

Most of the popular reports told by these two Brazilian traditional communities seemed to have an origin in morphologic and behavioral aspects of giant anteaters. For most of the respondents, there

was not much concern with the human-animal relationship. However, more studies with an ethnobiology focus need to be done in both localities, as well as elsewhere. Specifically, it would be useful to increase the number of interviewers, to interview in other places, and with other traditional people, such as some native indigenous tribes. The reports about anteaters killed on the road having their claws removed for an amulet need to be investigated. Is this a common practice? Does it really happen? Another important question concerns what happens to folklore in regions where giant anteaters are critically threatened. Do traditional reports disappear, or do they go on, even after local extinction?

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APPENDIX

Personal Identification

Name / Birth date / Place of birth / Phone number / Religion / Scholary level

Questions

1. Do you know the animal called giant anteater?
2. Do you know it by any other names? If so, which ones?
3. Could you point out some of the giant anteater's characteristics?
4. What does this animal feed on?
5. Do you know any myth, story or report that involves this animal? If yes, which ones?
6. Did you witness any myth, story or event? If not, who told you about it?
7. Do you think the giant anteater is a dangerous animal? Why?
8. Did you see any attack from this animal to a human being or another animal? If so, are you able to describe what you saw?
9. Have you ever seen a giant anteater hit by a car? If so, on which road?
10. Do you believe that giant anteaters have only one gender (for example, only males)? If so, do you have an explanation for it?
11. Do you know any giant anteater predator? Which one?
12. Do you think that a giant anteater is capable of killing another animal using only the claws? If yes, which animal?

Assessing the assessment, the relevance of the 2006 Paraguayan mammal Red List to the reality of Xenarthra conservation in 2012

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Abstract The last assessment of the conservation status of mammals in Paraguay took place in 2006 and found just two species of Xenarthra, *Myrmecophaga tridactyla* and *Priodontes maximus*, to be threatened at the national level. Though seriously outdated in a rapidly-changing landscape, this assessment continues to be used today as a tool for national wildlife management decisions. This paper highlights difficulties in the current national assessment process, and suggests solutions with the aim of producing a more accurate reflection of the conservation status of Paraguayan xenarthrans during the next review. The provision to reviewers of regularly updated “crash-courses” in the current issues affecting the conservation of xenarthrans in Paraguay is suggested as a useful tool in reaching this aim, and a revision of the main factors that reviewers should be considering at the time of writing is provided here for each of the Paraguayan species.

Keywords: anteater, armadillo, conservation assessment, Dasypodidae, IUCN, Myrmecophagidae

Evaluando la evaluación. La relevancia de la evaluación de conservación de los mamíferos de 2006 del Paraguay para la realidad de la conservación de Xenarthra en 2012

Resumen La última revisión del estado de conservación de los mamíferos de Paraguay se realizó en 2006 y tan sólo dos especies de Xenarthra, *Myrmecophaga tridactyla* y *Priodontes maximus*, fueron consideradas amenazadas a nivel nacional. Esta última revisión sigue siendo la base para decisiones sobre el manejo de vida silvestre en el país, aunque actualmente esté desactualizada ya que Paraguay es un país donde el ambiente está cambiando de forma rápida. El siguiente trabajo identifica las dificultades asociadas con el proceso actual de revisión y ofrece soluciones a algunos de los problemas enfrentados con fines de facilitar el proceso y asegurar una lista más precisa del estado actual de la conservación de los Xenarthra de Paraguay durante la próxima revisión. La presentación a los revisores de una guía actualizada regularmente sobre las amenazas que afectan la conservación de los Xenarthra en Paraguay es sugerida como una herramienta útil para alcanzar este objetivo. Asimismo, se presenta aquí una exposición de los factores principales que los revisores deberían tener en cuenta en el momento de la revisión para cada una de las especies de Paraguay.

Palabras clave: Dasypodidae, Myrmecophagidae, oso hormiguero, revisión del estado de conservación, tatú, UICN

INTRODUCTION

The last assessment of the conservation status of mammals in Paraguay was held in 2005 (SEAM, 2006) yet it is still being used as a baseline for management decisions on wildlife in Paraguay. Since this resolution however, Paraguay has seen considerable agricultural development in the previously largely pristine Chaco region, continuing environmental conflict in the Oriental region and a change in government policy towards greater exploitation

of the national resources of the country, including the lifting of a voluntary moratorium on exports of all species protected under the CITES agreement.

Under the SEAM (*Secretaría del Ambiente / Ministry of the Environment*) project *Proyecto de Conservación y Utilización de la Vida Silvestre* (Project for the Conservation and Utilization of Wildlife - henceforth PCUVS) permits are now being granted to companies that wish to exploit wildlife for profit based on a supposedly sustainable scheme

TABLE 1. Approved harvesting quotas for xenarthrans on a single permit issued to the wildlife export company “Animal Business” in 2010. Reproduced from Vinke & Vinke (2012).

Collecting site	<i>Ch.vellerosus</i>	<i>Ch.villosus</i>	<i>Eu.sexinctus</i>	<i>To.matacus</i>	<i>Ta.tetradactyla</i>
Carmelo Peralta 20,000 ha			45	45	45
Campo Loro 10,475 ha	12		6	12	
10 de Febrero 5,000 ha	10		5	10	
Ebetogue 2,875 ha	52	52	26	51	
Ingapui 5,000 ha	3		2	3	
Chovoreca 20,002 ha	30		15	30	
Totals	107	52	99	151	45

of harvesting quotas (**TABLE 1**), with an established amount payable to the landowners on whose land the individual animals are captured. After passing through the system of governmental controls, animals can then be sold on the international markets for considerably higher sums. The mammal quotas were calculated, at least in part, on the extremely limited and frequently outdated distribution data that are readily available, in tandem with the conclusions of SEAM (2006).

The IUCN Red List Categories and Criteria (2001) recommend that “re-evaluation of taxa against the criteria should be carried out at appropriate intervals” and that “This is especially important for taxa listed under Near Threatened, Data Deficient, and for threatened taxa whose status is known or suspected to be deteriorating.” The regional IUCN guidelines (2003) state that “For the purposes of regional conservation assessments there are important reasons to assess species’ extinction risk and publish Red Lists within specific geographically defined areas.” Whilst an attempt was made to hold a mammal workshop during 2011 logistical factors meant that the meeting did not happen, and the seriously outdated results of the 2006 resolution remain active, despite the criteria for review having been fulfilled many years ago.

Given the chronic lack of reliable and up-to-date scientific data on populations and distribution of xenarthrans in Paraguay, it may be assumed that many of the designations made in the 2006 resolution were the result of inferences or in reference to older field data that were already out of date even at the time of the meeting. In fact only two species of xenarthrans were considered to be threatened at the national level (SEAM, 2006) and at least one xenarthran species (*Bradypus variegatus*) for which no evidence of its presence in Paraguay exists was considered and declared to be under no threat in the country (Morales, 2007).

The SEAM published two further lists of Paraguayan species on 25 May 2010 (though the bicentenary logo suggests that this document was

in fact released in 2011) on a “threatened species” page on their website (<http://www.seam.gov.py/especies-amenazadas.html>). The two lists are entitled “species threatened with extinction” and “species in danger of extinction”. Though they are clearly based in large part on SEAM (2006), neither list has an accompanying definition of the criteria for inclusion, nor makes any reference to IUCN categories. Under these lists *Myrmecophaga tridactyla* is classified as a “species threatened with extinction” and *Priodontes maximus* and *Cabassous chacoensis* are classified as “species in danger of extinction”. The preferential use of these arbitrary categories over the well-defined and established IUCN categories does little to clarify the extent or nature of the threats faced by the species included. Consequently the data upon which management decisions for fauna are being made may be considered to be at best unreliable or confusing and at worst leading to potentially grave consequences for the species affected. In other words, inaccurate threat categories may be exacerbating the problem of the conservation of xenarthrans in Paraguay by failing to reflect the true gravity of the situation at the national level.

This paper does not pretend to substitute for a new IUCN workshop to update conservation statuses in the country, but hopes to provide a succinct summary of available information and relevant issues currently affecting the conservation of xenarthrans in Paraguay that should be considered by workshop participants when the next meeting is finally held, as well as offering some recommendations on the application of IUCN criteria at the national level.

DASYPODIDAE (ARMADILLOS)

General considerations: Armadillos are often amongst the most conspicuous members of the mammal fauna in Paraguay and their size, approachability, and comical appearances make them objects of curiosity. Because of the ease of capture, frequent diurnal activity and palatability, many species are seen as attractive targets for hunters. At night armadillos do not show reflective eyeshine, and the

habit of some species of foraging on or near roads means that they are frequent victims of roadkill. Reproductive strategies vary considerably between species, with the reproductive capacity of some genera being great, while that of others is extremely low (Smith, 2012).

Tribe Euphractini

General considerations: The two genera of Euphractine armadillos (*Euphractus* and *Chaetophractus*) contain adaptable and successful species with wide geographical ranges (Wetzel *et al.*, 2008). They are omnivorous and their diet enables them to exploit food resources that most other armadillos are unable to utilize, such as carrion (Dalponte & Tavares-Filho, 2004). Reproduction is seasonal and though two young are typically produced, a short gestation period (*ca.* 2 months) means that a second breeding may be attempted if conditions allow (Neris *et al.*, 2002). Sexual maturity is reached by the end of the first year, meaning that the reproductive potential of these species is higher than that of most other xenarthrans.

Euphractus sexcinctus - Six-banded armadillo

A common, adaptable and widespread species, this is one of the most frequently-encountered armadillo species in Paraguay. It is found in a variety of habitats, but because of its size it is hunted for food in areas where its range comes into contact with human habitation. It is a frequent roadkill victim as a result of its diurnal activity, and the zigzagging flight behavior makes it difficult to avoid. However, due to its tolerance for habitat disturbance, high reproductive potential, presence in a number of protected areas, and unspecialized ecological requirements it is not under any obvious threats (Morales, 2007; Smith, 2007b).

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Least Concern (LC)

Chaetophractus vellerosus - Lesser or screaming hairy armadillo

A decline in the number of field observations of this species over the last few years has been noted by naturalists working within the species range in the Paraguayan Chaco. This is a small armadillo that is easily captured by hand and which makes a potentially attractive pet. Though the species may be hunted for food, its small size makes it less attractive to hunters than larger species. Recently permissions have been granted establishing quotas for the harvesting of lesser hairy armadillos by for-profit companies for export abroad under the PCUVS (example **TABLE 1**), and a value of 25,000 Gs (4.31 Euros) has been established per individual. Confirming whether the perceived recent decline in field observations

represents a real population down turn and investigating the potential causal factors should be considered a priority. The effects of harvesting quotas on populations, especially those in the most accessible areas of the species range, need to be closely monitored.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Near Threatened (NT)

Justification: The decline in the number of field observations of this species is probably indicative of a population reduction, and though the causes may not be clear, the inclusion of this species in the PCUVS program does not facilitate a recovery.

Chaetophractus villosus - Large or greater hairy armadillo

Though the Paraguayan range of this species is geographically restricted, this is a common species and the most frequently-encountered armadillo in the most arid areas of the Dry Chaco. Throughout most of its Paraguayan range human population pressure is low, and the small size of this armadillo compared to the abundant game animals in these areas means that it is likely to be under limited hunting pressure. It is able to tolerate considerable habitat modification, and though animals may be killed by dogs or on roads where they come into contact with humans, this is unlikely to have a major effect on the population. Abba & Superina (2010) note that the population of this species may be increasing in Argentina, and while population data for Paraguay are unavailable, they would seem to be stable for the moment. Recently permissions have been granted establishing quotas for the harvesting of large hairy armadillos by for-profit companies for export abroad (example **TABLE 1**). The effects of harvesting quotas on Paraguayan populations need, however, to be closely monitored.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Least Concern (LC)

Tribe Chlamyphorini

Calyptophractus retusus - Chacoan fairy armadillo

Virtually nothing is known of the biology or ecological requirements of this species, though it is assumed it gives birth to a single young (Cuéllar, 2001; Cuéllar & Noss, 2004) and may be considered endemic to the Chaco (Abba & Superina, 2010). The species is restricted to areas with loose, sandy soils in the Dry Chaco region and hence the distribution in Paraguay is probably limited to the extreme northwestern Chaco in the Parque Nacional Teniente Agripino Enciso and Parque Nacional Médanos del

Chaco area. All known Paraguayan specimens come from that area and though this species is rarely observed it would seem that the collected specimens do reflect to some degree the limited Paraguayan range. Much of its presumed range is encompassed within the aforementioned national parks, though the protection provided by these parks is due more to their remoteness than the effectiveness of the protected areas system. However, in recent years the areas immediately adjacent to these parks have begun to see more development, and during 2011 several new *estancias* were being cleared directly opposite the northern Médanos del Chaco national park boundary (P. Smith, pers. obs.). Whilst this species may be able to tolerate some degree of habitat modification, the land clearing processes in use in the Chaco, involving bulldozing and burning of large areas, has the potential to cause considerable impact on unprotected populations of this relatively immobile, slow-moving species and will likely lead to a further constriction of the already limited range.

Global: Data Deficient (DD)

National: Previous Designation Least Concern (LC); Recommended Designation Vulnerable (VU) B1ab(iii)

Justification: *Calyptophractus retusus* qualifies as Vulnerable because the known geographic range in the form of area of occupancy is < 2,000 km², severely fragmented and continuing to decline in area, extent, and quality of habitat.

Tribe Dasypodini

General considerations: *Dasypus* armadillos are favored by local hunters in much of their Paraguayan range (Esquivel, 2001), and though *D. novemcinctus* is preferred for its size, the other species are probably not commonly distinguished by most hunters. The superficial similarity of the species of *Dasypus* means that field observations of smaller species are unreliable. The differences between species are subtle and morphological, and considerable confusion has existed over the identity of Paraguayan specimens and resulted in an incomplete knowledge of the distribution of the species. *Dasypus novemcinctus* may be considered a habitat generalist with a preference for forested areas (Meritt, 2008), but this is not the case for the other two species which much more heavily rely on natural grassland habitats (Abba *et al.*, 2007, 2011).

Dasypus hybridus - Southern long-nosed armadillo

We have been able to trace only two specimens of this species from Paraguay, one 19th Century specimen in the Royal Ontario Museum that lacks specific locality data and another misidentified as *D. septemcinctus* from Estancia Rama, Departamento Canindeyú in the Museo Nacional de Historia Natural del Paraguay. The Canindeyú specimen

is the only recent record (7 December 2006) of the species in Paraguay and no other information is currently available about its distribution or habitat preference in Paraguay. Azara's (1923) description of *Tatuejo-mulita* has been historically attributed to this species and includes the vague statement that it does not "pass north of 26 and a half, but is found to the south". Though the Canindeyú record suggests a wider distribution than Azara was aware of, in modern day Paraguay the area he describes coincides with the region of greatest habitat modification in the country due to large-scale agricultural practices. Abba *et al.* (2007) state that this species is typical of native, undisturbed grasslands in Argentina, though Abba *et al.* (2011) confirm that it is able to persist in highly-modified habitats. Given the lack of records and the large-scale habitat modification of much of its assumed range in Paraguay, the species may be assumed to have declined considerably and is likely threatened.

Global: Near Threatened (NT)

National: Previous Designation Least Concern (LC); Recommended Designation Data Deficient (DD)

Justification: The lack of clear information about the distribution of this species in Paraguay and the paucity of records mean that *D. hybridus* is best considered Data Deficient. A decline in populations in neighboring countries suggests that it may be eligible for uplisting in future. Additional population data are urgently required and a reassessment is recommended as soon as sufficient data become available.

Dasypus novemcinctus - Nine-banded armadillo

A widespread and adaptable species that is found in a variety of forested areas throughout the country, except the most arid areas of the extreme northwestern Chaco (Frutos & Van den Bussche, 2002; Meritt, 2008). With the reduction in large mammal populations in eastern Paraguay as a result of habitat loss and human pressure, *D. novemcinctus* has become the principal mammalian game species for hunters in the Oriental region. The nine-banded armadillo became more prominent in the diet of the Aché indigenous group between 1980 (when it represented 13.5% of the wild game in the diet) and 1994 (when it represented 43.1% of the diet), and a similar and increasing trend has likely occurred in other areas of eastern Paraguay as habitat loss has continued (Cartes, 2007). The species has very likely experienced a considerable decline in the Oriental region as a result of habitat destruction and hunting pressure, but it is still fairly common in some of the protected areas in eastern Paraguay. Frutos & Van den Bussche (2002) present genetic evidence that the species is in continuous range expansion in Paraguay. In the Central Chaco it is considered a delicacy, even

amongst people who do not depend on wild game for their meat, and is frequently sought by hunters (T. & S. Vinke, pers. comm.).

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Least Concern (LC)

Dasypus septemcinctus - Seven-banded armadillo

The seven-banded armadillo is extremely poorly represented in Paraguayan collections and the extent of its Paraguayan range is unclear. *Dasypus septemcinctus* was for a long time confused with *D. hybridus* until Hamlett (1939) clarified its diagnostic characters, rendering older bibliographical references to the species in Paraguay of questionable value unless they provide specific morphological information that facilitates a correct identification. In Paraguay sight records must be considered unreliable because of the danger of confusion with juvenile *D. novemcinctus*. Though notably smaller than adult nine-banded armadillos, the species can only be reliably distinguished from juveniles of that species using morphometric characteristics that require the close examination of the specimen (Hamlett, 1939). This species is associated principally with arid grassland habitats in most of its range and is able to tolerate moderate habitat modification (Aguiar & Fonseca, 2008). Silva & Barros-Henrique (2009) estimated an area of between 6,700 and 27,800 ha as necessary to maintain a viable population of seven-banded armadillos. The paucity of records and the preference for natural grasslands mean that the species is probably locally distributed in Paraguay, but perhaps overlooked because of confusion with *D. novemcinctus*.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Data Deficient (DD)

Justification: The lack of clear information about the distribution of this species in Paraguay and the paucity of records suggest that it is best considered Data Deficient.

Tribe Priodontini

Genus *Cabassous*

General considerations: *Cabassous* armadillos are myrmecophagous and fossorial in habits, meaning that they are rarely observed and poorly represented in specimen collections. The wide use of pesticides in agricultural areas restricts food availability. No data are available on their population density in Paraguay, but they may be assumed to be naturally uncommon and probably locally distributed. *Cabassous* are slow moving and easily captured by hand, their main defense consisting of rapid

burrowing into the substrate. Little is known about their reproductive ecology, but typically a single young is born and consequently their capacity for population growth is limited (Wetzel, 1980).

Cabassous chacoensis - Chacoan naked-tailed armadillo

This species is surprisingly well-represented in Paraguayan specimen collections, but the specimen records are clumped and the area of occupancy documented by them is small, concentrated in the highly-sampled Central Chaco area. Though the distribution may be larger than currently assumed, there have been very few recent field records of the species. However, like all *Cabassous* armadillos it is difficult to observe and hence likely under-recorded, most often being seen prior to thunderstorms when it leaves its burrow (T. & S. Vinke, pers. comm.). Meritt (2008) reports just two sight records in the Paraguayan Chaco despite 20 years of field work and associates the species with open thorn forest or thorn scrub with porous, non-clay soil. Such soils are rare in the Paraguayan Chaco and are the most suitable for certain types of agriculture (especially peanuts, sesame, and sorghum), but *C. chacoensis* may even be found in pasture lands provided the correct soil type is available. The species is commonly mistaken for an abandoned juvenile *Priodontes maximus* and is sometimes taken into captivity with the intention to raise it and force fed with milk until it eventually dies (T. & S. Vinke, pers. comm.). Abba & Superina (2010) note that the global population may have declined by as much as 25% over the last 10 years as a result of increased human activity in the species range and that it is on the verge of being considered globally Vulnerable. The alarming increase in change of land usage in the Paraguayan Chaco may be inferred to be having a deleterious effect on populations of this poorly known species. Increased contact with humans, roads, and dogs also undoubtedly represent a major threat to this small and relatively defenseless armadillo.

Global: Near Threatened (NT)

National: Previous Designation Least Concern (LC); Recommended Designation Vulnerable (VU) A2c

Justification: *Cabassous chacoensis* qualifies as Vulnerable because of an inferred and continuing population size reduction of at least 30% over the last 10 years resulting in a decline in the area of occupancy, extent of occurrence, and quality of habitat.

Cabassous unicinctus - Southern naked-tailed armadillo

The presence of this species in Paraguay was documented by Smith *et al.* (2012), though a specimen in the Museo Nacional de Historia Natural del Paraguay (MNHN) dating from 1989 was also

located. The identification of the MNHNP specimen as *Cabassous tatouay* suggests that they have been confused in the past, and that all *Cabassous* armadillos captured in the Oriental region may habitually have been assumed to be *C. tatouay*. Currently known only from three localities in Departamentos San Pedro and Amambay, the known distribution of the species is associated with the *cerrado* eco-region of northern Paraguay. Ecological factors (e.g., fossorial habits) contribute to *Cabassous* armadillos being difficult to observe (Tomas *et al.*, 2009), but they are likely to be present throughout the Paraguayan *cerrado* at low density. Local people in San Pedro know the species but avoid eating it on account of its “strong smell” and one person interviewed claimed that people in the area do not eat it because of the belief that its consumption causes severe stomach pains (Smith, 2011). The principal threat to *C. unicinctus* at the global level is the conversion of its habitat to agriculture (Abba & Superina, 2010), and some degree of threat can perhaps be inferred at the national level given the restricted known range. Bonato *et al.* (2008) suggested that reproduction is seasonal and estimated that juveniles made up 9% of the population of *C. unicinctus* in their study area. The species is present in Parque Nacional Cerro Corá and the private Reserva Natural Laguna Blanca, though the latter is currently protected for a period of just five years since its declaration in 2010 (Decreto 3893 under Artículo 26 of Protected Areas Law 352/94).

Global: Least Concern (LC)

National: Previous Designation NOT LISTED; Recommended Designation Near Threatened (NT)

Justification: *Cabassous unicinctus* qualifies as Near Threatened because of an apparent association with the threatened *cerrado* habitat, presumed low density of occurrence, and increasing habitat degradation within the Paraguayan range. If the species proves to be more widespread than is currently known, then it may be eligible for downlisting given its occurrence in at least two protected areas.

Cabassous tatouay - Greater naked-tailed armadillo

The largest of the *Cabassous* is known from few Paraguayan specimens, and sight records are rare. As a large, slow-moving species it presumably represents an attractive target for hunters, though because of its low density it is likely hunted opportunistically rather than specifically targeted. In the period 1980 to 1996 only 24 individuals were taken by the indigenous Aché of the well-protected Mbaracayú Biosphere Reserve, representing just 0.8% of the wild game biomass that they consumed (Cartes, 2007). The recent discovery of *C. unicinctus* in eastern Paraguay (Smith *et al.*, 2012) raises the possibility that at least some of the previous sight records attributed to *C. tatouay* in fact refer to *C. unicinctus* and whilst the range of the species in the country

is apparently wide, populations are probably localized and small. The species is known to be present in several at least nominally protected areas within the Atlantic Forest and *cerrado* eco-regions, but no details on its population status are available and habitat fragmentation throughout the Oriental region has been severe.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Vulnerable (VU) A2c

Justification: *Cabassous tatouay* qualifies as Vulnerable because of an inferred and continuing population size reduction of at least 30% over the last 10 years resulting in a decline in the area of occupancy, extent of occurrence, and quality of habitat.

Genus *Priodontes*

General considerations: The same ecological considerations as for *Cabassous* are valid for *Priodontes*, though the exceptional size of this species makes it more conspicuous and more attractive to hunters, and, hence, under more intense pressure. Carter & Encarnação (1983) estimated home range sizes of 450 ha in Brazil. It is somewhat nomadic in behavior and though home ranges may overlap, the size of these ranges results in extremely low densities even in favorable habitats (Silveira *et al.*, 2009).

Priodontes maximus - Giant armadillo

Though specimen collections suggest a much wider geographic range for this species in Paraguay, it has in fact disappeared relatively recently from much of its former range in direct relation to the expansion of human habitation. *Priodontes maximus* is naturally rare and patchily distributed throughout its global range (Abba & Superina, 2010) and is now extinct in most of eastern Paraguay, though it may still occur locally in remote areas removed from human interference (Neris *et al.*, 2002). If such pockets of populations do persist they must be considered unsustainable given the current rates of human population growth and expansion of development in the Oriental region. All recent records are from the Chaco but there are no data available on the sustainability of these populations. With 286,000 ha of forest suffering a change of land use to agriculture in the Chaco during 2011 (Guyra Paraguay, unpublished data) and deforestation rates showing no sign of decreasing, the remaining giant armadillo populations must now be coming into increasingly frequent contact with humans, and the resultant habitat fragmentation will seriously restrict the availability of suitable habitat for this species. Though it is officially protected in Paraguay (SEAM, 2006), the enforcement of such protection measures are ineffective in the remote areas in which this species persists and where there is little knowledge of, or respect for,

environmental legislation. In fact, most recent records of giant armadillos in Paraguay are the result of hunters breaking this legislation and their infractions being reported in the national press. This was highlighted most recently during August 2010 when one hunter became the subject of investigation only after he had posted images of a hunted *Priodontes* on his Facebook account and these images reached the newspapers. The giant armadillo may thus be assumed to be on the verge of a serious population decline in Paraguay.

Global: Vulnerable (VU) A2cd

National: Previous Designation Endangered (EN); Recommended Designation Critically Endangered (CR) A4c

Justification: *Priodontes maximus* qualifies as Critically Endangered because of an inferred, projected, and continuing population reduction of at least 80% based on a decline in area of occupancy, extent of occurrence, and habitat quality.

Genus *Tolypeutes*

Tolypeutes matacus - Southern three-banded armadillo

Ecological factors mean that this species is active both by day and night, and as a result of its non-fossorial behavior is more commonly encountered than other armadillos in the Paraguayan Chaco (Abba & Superina, 2010). As with all Tolypeutine armadillos the reproductive capacity is low, with a single young typical (Abba *et al.*, 2007).

This armadillo is confiding and easily captured by hand, making it a popular pet and the “preferred armadillo for the table” in the Chaco (H. del Castillo, pers. comm.). It is said to have the best flavor amongst the armadillos, and it is usually “cooked in the shell”, with hollowed out carapaces often found around hunters camp fires (Meritt, 2008).

The demand for three-banded armadillos in the pet trade means that since 2010 permissions have been granted establishing quotas for their harvesting by for-profit companies for export abroad under the PCUVS (example **TABLE 1**), and a value of 45,000 Gs (7.41 Euros) has been established per individual. On 10 February 2011 ABC newspaper reported that a permission granted by the SEAM to animal traders Johanna Aquino and Patricia Karina Varela for the export of 151 wild individuals of *T. matacus* (in addition to other species), represented an estimated market value of US\$ 52,850 in this species alone, and at least one other permission of this kind was granted to Wildlife Services S.A. (Bryce Owen) during the same year (T. & S. Vinke, pers. comm.). However, ineffective control measures once permits are granted have resulted in substandard transportation methods and alleged abuses of the system (Vinke & Vinke, 2012),

though judicial cases brought against permit holders have been unsuccessful.

Perhaps as a direct result of this trade, local naturalists based in the Chaco report an alarming decline in three-banded armadillos and other species habitually included on these permits in areas around the Mennonite Colonies (T. & S. Vinke, pers. comm.), compared with just a few years ago. In the most recent global conservation assessment for xenarthrans Abba & Superina (2010) cite Redford & Eisenberg (1992) that the species is “abundant in most xeric parts of the Paraguayan Chaco”, but whilst this may have been the case until relatively recently, it is no longer an abundant species in Paraguay and in fact appears to be in a steep and rapid decline. The availability of more recent published information may even have been sufficient for three-banded armadillos to have qualified for listing in a globally threatened category during the last global review.

Global: Near Threatened (NT)

National: Previous Designation Least Concern (LC); Recommended Designation Vulnerable (VU) A3cd

Justification: *Tolypeutes matacus* qualifies as Vulnerable because of a projected population size reduction of at least 30% over the next 10 years resulting from a decline in the area of occupancy, extent of occurrence, and quality of habitat and related to actual and potential levels of exploitation.

Myrmecophagidae (Anteaters)

General considerations: Like all xenarthrans, anteaters do not show reflective eyeshine at night yet are even more susceptible to roadkill deaths than armadillos because of their poor eyesight, slow movements, and a tendency to stand on their hind legs in defensive position in the middle of the road when approached by a vehicle. Though in most of the country they do not figure in the diet of local people, they are treated as objects of curiosity and may be attacked by dogs in areas close to human habitation (Lacerda *et al.*, 2009). The wide use of pesticides in agricultural areas restricts food availability. Reproductive strategies are slow and costly in anteaters, with high investment in a single offspring and as a result the capacity for the recovery of diminishing populations is limited (Jerez & Halloy, 2003). In areas where populations are diminishing this can rapidly result in inbreeding and high genetic homogeneity (Collevatti *et al.*, 2007).

Myrmecophaga tridactyla - Giant anteater

Threats to this species are well understood, but have not ceased and it is not known whether they are reversible (Abba & Superina, 2010). Though casual observations seem to suggest that giant anteater populations remain healthy in the Chaco region, the species has all but disappeared from most of the

Oriental region where the density of human populations is much greater and the conversion of natural habitats to agriculture is most severe (Neris *et al.*, 2002). The rapid expansion of the agricultural frontier in the Chaco and the massive deforestation that has accompanied this over the last few years has the potential to rapidly alter the situation in western Paraguay; and *M. tridactyla* is probably undergoing a considerable associated decline. In eastern Paraguay it apparently persists only in the more remote areas of the northern Orient, an area that continues to undergo major land use changes.

The species is uniquely susceptible to death from wildfires, its long pelage being extremely flammable (Silveira *et al.*, 1999), and fire is commonly used in Paraguay for clearing of grassy habitats. Though the giant anteater is not generally hunted for food in most of the country, its slow movements, large size, and approachability mean that it is an attractive victim for sport hunters. A notable exception, however, is the Ayoreo indigenous group who considers it one of the most highly prized food species. It is commonly hunted out of areas surrounding their communities, and they may even travel in pursuit of the species (T. & S. Vinke, pers. comm.). It does not fare well near to busy roads, and a total of 12 roadkill victims were counted along the length of the Ruta Trans-Chaco (approximately 630 km) on 12 October 2007 (Smith, 2007a).

An additional and perhaps rarely considered threat to *M. tridactyla* in the Humid Chaco and Pantanal areas is associated with the natural and periodic flooding that affects this region. Though this is a natural process, flooding drives the species to islands of higher ground where it can still get access to food. This may act to concentrate populations, making them more vulnerable to predators, whilst accelerating habitat fragmentation has the potential to drive them into increasingly close contact with humans who also seek to settle high ground in this region. Flooding may be an as yet unconfirmed factor in sudden increases in the species presence on and around the raised areas of the Ruta Trans-Chaco. If this is the case, it would be extremely dangerous for inferences on population densities to be based on sight records or roadkill individuals associated with this major thoroughfare (one of the few roads that is permanently accessible in this region), and extrapolations to the Chaco as a whole may result in over-estimation of real populations. Given its low fecundity and the potentially irreversible consequences of habitat change in the core areas of the species Paraguayan range, a future population decline seems inevitable.

Global: Vulnerable (VU) A2c

National: Previous Designation Vulnerable (VU); Recommended Designation Vulnerable (VU) A4c

Justification: *Myrmecophaga tridactyla* qualifies as Vulnerable because of an inferred, projected, and continuing population reduction of at least 30% over a continuing ten year period based on a decline in area of occupancy, extent of occurrence, and habitat quality. Additional population data are urgently required and a reassessment is recommended as soon as sufficient data become available.

Tamandua tetradactyla - Southern tamandua

This adaptable species is able to tolerate a high degree of habitat degradation, and occurs throughout the country in all the major eco-regions. Though habitat fragmentation, coupled with the extensive use of pesticides in agricultural areas, is undoubtedly having a negative effect on populations, the species is unlikely to be declining fast enough to warrant threatened status yet. It remains common in the Humid Chaco and northern Oriental region, but it is a frequent roadkill victim. The reproductive capacity of this species is low, with sexual maturity reached at two years of age and a single young born annually after a gestation period of around 160 days (Redford & Eisenberg, 1992).

The tamandua is not seen as an attractive target for hunters in Paraguay and is more likely to be treated with curiosity by local people unfamiliar with the species. Such curiosity can, however, have negative consequences, with the animal either being captured and kept as a pet, handed over to zoos (in a misguided attempt to do the right thing), or unintentionally mistreated or killed. Since 2010 permissions have been granted establishing quotas for the harvesting of tamanduas by for-profit companies for export abroad under the PCUVS (example **TABLE 1**), and a value of 160,000 Gs (27.59 Euros) has been established per individual. Thomas and Sabine Vinke (pers. comm.) report a decrease in the number of roadkill tamanduas in the Chaco over the last few years, and this may represent a population decrease. Populations in areas where permits are active must be closely monitored.

Global: Least Concern (LC)

National: Previous Designation Least Concern (LC); Recommended Designation Least Concern (LC)

DISCUSSION

The designation of Red List categories is a serious process that depends to no small degree on the availability of reliable and up-to-date information for its success. The accuracy of such assessments thus depends in no small part on a thorough and taxon-specific understanding of the relevant threats

by each of the decision makers. Whilst decisions can be reached based on general concerns on habitat loss or extrapolation of issues applicable to a broad range of taxa (IUCN, 2001), the consideration of species-specific threats undoubtedly leads to much more reliable and effective results. The recognition that decision makers cannot be experts on all taxa, implies that some groups of species may be receiving more attention than others and that conservation threats may unconsciously be over-estimated or under-estimated as a byproduct of the knowledge base or interests of the group of assessors.

Such species-specific information is not always readily available, yet it is a duty of all participants in conservation assessment workshops to reach a conclusion that is as reflective of the current situation as possible. The reliance on outdated information, a handful of generalized publications or guesstimation of perceived trends based on personal and perhaps limited field experience is prone to serious errors influenced by the differing ecologies and behaviors exhibited by different species. With national conclusions also contributing to the decision making process on a global level, such errors of judgment could be having additional knock-on consequences for global conservation. At least two species that occur in Paraguay - *Cabassous chacoensis* and *Tolypeutes matacus* - may even have qualified for higher global threat statuses if more accurate national assessments had been available to the global evaluators. In order to combat this uncomfortable reality, the provision of country-specific summaries of important factors for consideration, such as this attempted here for xenarthrans, may be a valuable preparative tool for decision makers.

In Paraguay conservation planning meetings organized by the national IUCN committee aim to be inclusive, with numerous attendees and representatives of different organizations and agencies invited to contribute. Whilst this inclusive attitude is to be commended, it creates logistical difficulties that may have played a role in the infrequency of such meetings, with the availability of invitees complicating the fixture of suitable meeting dates. Additionally, time pressures associated with attempting to review multiple groups in a short space of time undoubtedly lead to insufficient consideration of some issues and rush the decision-making process to comply with the time constraints. One solution to this could be the holding of meetings for different taxonomic groups at different times (rather than attempting to assess all the mammals in one sitting), whilst summaries of this nature (that can and should be updated prior to each meeting) may also facilitate the process by providing decision makers with a crash course in taxon-specific issues in advance of the meeting as well as offering the opportunity for those unable to attend the meeting to offer their own comments for

consideration. Similar techniques aimed at streamlining the process are already being employed in neighboring countries such as Brazil.

A failure to address these factors in Paraguay has probably played a significant role in the infrequency of these meetings, the greatly inaccurate categories that are currently in place for mammals, and the unconscious role of these categorizations in potentially damaging decisions on wildlife management in Paraguay. The 2006 national threat categories proposed for Paraguayan xenarthrans fail to reflect the current level of threat faced by the species they are charged with protecting and are in urgent need of radical review lest they become complicit in the steep population declines that they aim to prevent. The regular and accurate updating of Red List categories for mammals is a basic requirement in their effective conservation, and the current infrequent and cumbersome review process employed for mammals in Paraguay is failing to achieve these aims. The preparation of frequently updated species summaries of this nature will assist in the streamlining of this process and may contribute towards a more effective conservation protocol for Paraguayan mammals in future.

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Xenarthrans in French Guiana: a brief overview of their distribution and conservation status

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Abstract Nine species of *Xenarthra* are found in French Guiana, a French overseas region that lies between Suriname and Amapá (Brazil) in the Guianan Shield. Most species seem to occur throughout this ca. 83,000 km² region, as deduced from distribution data extracted from a database of 470 visual or vouchered observations. *Cabassous unicinctus* and *Cyclopes didactylus* have been mostly observed in the northern part of the country, but additional field surveys are necessary before concluding that they have a restricted distribution. Five species (*Cabassous unicinctus*, *Cyclopes didactylus*, *Myrmecophaga tridactyla*, *Priodontes maximus*, and *Tamandua tetradactyla*) are fully protected by national or regional laws. Subsistence hunting is allowed for the two species of sloths, and there is no restriction on hunting *Dasypus novemcinctus* and *D. kappleri*. Documented threats include roadkills, which are rather common along the few concrete roads (*Tamandua tetradactyla* is the most common victim), and deforestation, which is fortunately still very limited at the regional scale. Few studies have been devoted to xenarthrans in French Guiana, except at the Petit-Saut hydroelectric dam, where scientists had the opportunity to handle several hundred sloths that were translocated to a non-flooded nearby area.

Keywords: *Bradypus tridactylus*, *Choloepus didactylus*, distribution, French Guiana, *Xenarthra*

Los xenartros en Guayana Francesa: una breve actualización de su distribución y estado de conservación

Resumen Nueve especies de xenartros se encuentran en la Guayana Francesa, una región de ultramar francesa que se ubica entre Surinam y Amapá (Brasil) en el Escudo Guayanés. La mayoría de las especies parecen encontrarse a lo largo de toda esta región (ca. 83.000 km²), según se deduce de los registros de distribución extraídos de una base de datos de 470 observaciones visuales o con colecta de ejemplares. *Cabassous unicinctus* y *Cyclopes didactylus* han sido en su mayoría observados en la parte norte del país, pero estudios de campo adicionales son necesarios antes de concluir que tienen esta distribución restringida. Cinco especies (*Cabassous unicinctus*, *Cyclopes didactylus*, *Myrmecophaga tridactyla*, *Priodontes maximus* y *Tamandua tetradactyla*) están plenamente protegidos por las leyes nacionales o regionales. La caza de subsistencia está permitida para las dos especies de perezosos, y no hay ninguna restricción para la caza de *Dasypus novemcinctus* y *D. kappleri*. Las amenazas documentadas incluyen muertes por atropellamiento, que son bastante comunes a lo largo de los pocos caminos asfaltados (*Tamandua tetradactyla* es la víctima más común), y la deforestación, que afortunadamente está aún muy limitada a una escala regional. Pocos estudios se han dedicado a los xenartros en la Guayana Francesa, excepto en la represa hidroeléctrica de Petit-Saut, donde los científicos tuvieron la oportunidad de manipular varios cientos de perezosos que fueron trasladados a una zona no inundada cercana.

Palabras clave: *Bradypus tridactylus*, *Choloepus didactylus*, distribución, Guayana Francesa, *Xenarthra*

BASIC INFORMATION ON FRENCH GUIANA

French Guiana (officially “Département de la Guyane”) is an overseas region of France, consisting of a single department located on the northern Atlantic coast of South America. French Guiana has borders with two nations: Brazil (state of Amapá) to the east and south, and Suriname to the west. Its 83,534 km² have a very low human population density of less than three inhabitants per square kilometre, with almost half of its *ca.* 230,000 people (census in January 2010: see <http://www.insee.fr/fr/themes/tableau.asp?reg_id=25&ref_id=poptc02104>) living in the urban area of Cayenne, its capital, and in the northern small cities of Saint-Laurent du Maroni, Kourou, and Saint-Georges de l’Oyapock. French Guiana is also populated by 10,000 Amerindian people, of several ethnic groups (Palikur, Wayãpi, Wayana, Kaliña, etc.), and by 22,000 Maroons, also organised in various ethnic groups (Aluku, Ndjuka, Saramaccans, etc.) (Barret, 2002).

French Guiana lies between latitudes 2° and 6° N, and longitudes 51° and 53° W. It consists of two main geographical regions: a coastal strip where the majority of the people live, and dense, near-inaccessible rainforest which gradually rises to the modest peaks of the Tumac-Humac mountains along the

Brazilian frontier. French Guiana’s highest peak is Bellevue de l’Inini near Maripasoula (851 m asl). Other mountains include Mont Machalou (782 m asl), Pic Coudreau (711 m asl), and Mont St Marcel (635 m asl).

French Guiana is home to many important ecosystems: tropical rainforests, coastal mangroves, savannahs, inselbergs, and several types of wetlands (Gond *et al.*, 2011). French Guiana has one of the highest levels of biodiversity in the world, in terms of both flora and fauna. This is due to the presence of old-growth forests (*i.e.*, ancient/primary forests) of various kinds from well-drained to swampy forests, which are biodiversity hotspots. The rainforests of French Guiana and neighboring regions are hypothesized to have provided shelter for many species during dry periods related to terrestrial glaciations (Anhuf *et al.*, 2006). These forests are partially protected by the Guiana Amazonian Park (“Parc Amazonien de la Guyane”), which was established in 2007 and covers some 33,900 km² in the municipalities of Camopi, Maripasoula, Papaïchton, Saint-Élie, and Saül. Additionally, six nature reserves in various parts of north and central French Guiana were established from 1992 to 2006 and cover almost 3,000 km² (FIG. 1).

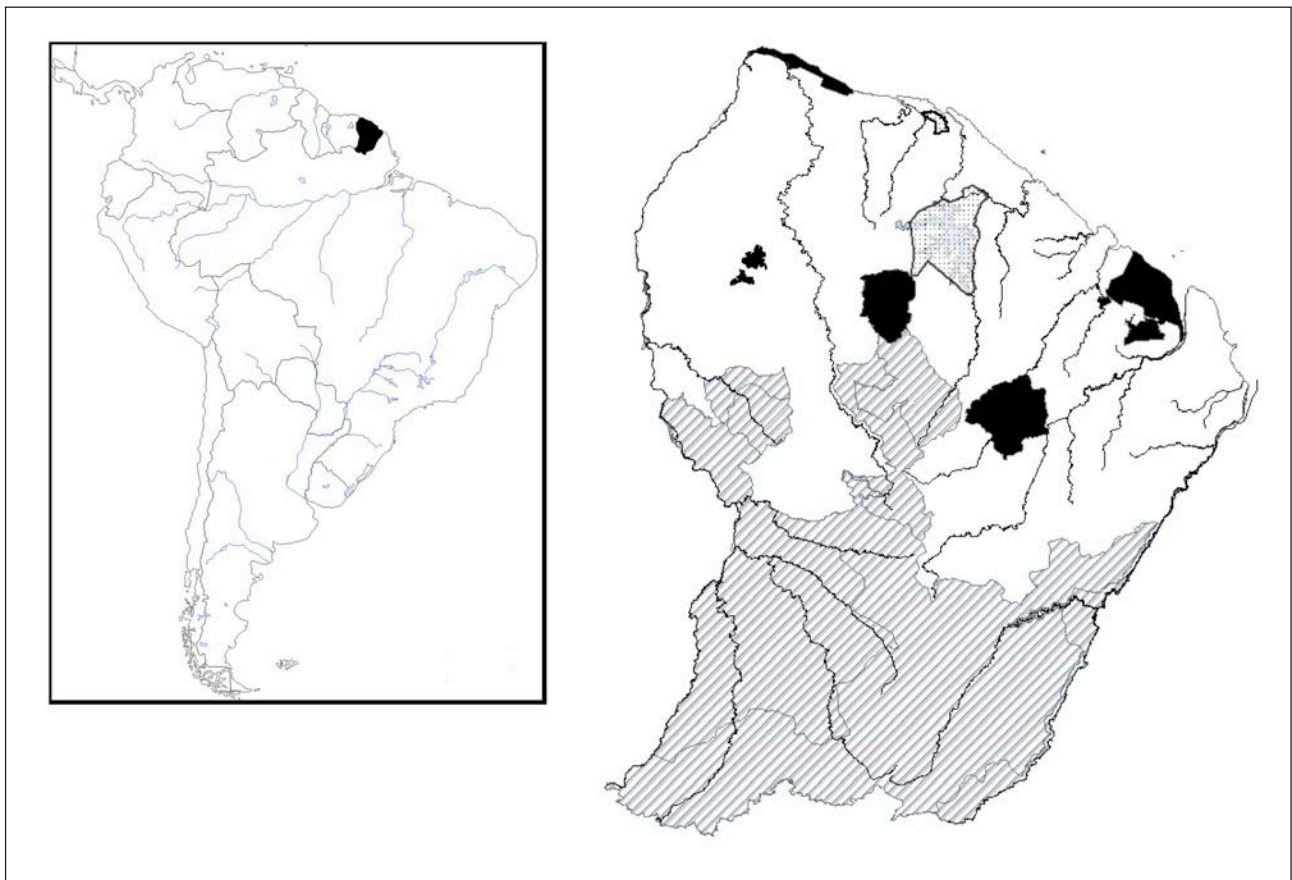


FIGURE 1. *Left:* map of South America with the location of French Guiana in black. *Right:* map of French Guiana with the large protected areas. In black the major natural reserves (“Reserve Naturelle”); in dashed lines the Guiana Amazonian Park (“Parc Amazonien de la Guyane”), small dots for the no-hunting area of Petit-Saut hydroelectric dam.

SPECIES OF XENARTHRA PRESENT IN FRENCH GUIANA

French Guiana harbours nine species of xenarthrans: four armadillos, two sloths, and three anteaters (Voss *et al.*, 2001; Catzeflis, 2010), which are listed in **TABLE 1**. These represent 75% of the xenarthran fauna of the whole Guianan Shield, with only three additional species not found in French Guiana: *Bradypus variegatus* (in the Venezuelan states of Amazonas and Bolivar), *Dasyopus sabanicola* (in Bolivar, Venezuela), and *Euphractus sexcinctus* (in southern Suriname and in Brazilian Amapá; Lim *et al.*, 2005).

PROTECTION AND LEGAL STATUS

Four species (*Cyclopes didactylus*, *Myrmecophaga tridactyla*, *Tamandua tetradactyla*, *Priodontes maximus*) are fully protected by national law (Ministerial Decree of 15 May 1986, updated on 24 July 2006). Similarly, *Cabassous unicinctus* is fully protected by a regional law ("Arrêté Prefectoral") since 31 January 1975. The Ministerial Decree allows hunting for subsistence but forbids any kind of trade for the two sloths (*Bradypus tridactylus*, *Choloepus didactylus*).

Hunting or any destructive action is forbidden for all xenarthran species in all nature reserves (*ca.* 3,000 km²) and in two other designed areas covering *ca.* 400 km² (**FIG. 1**); hunting activities in the Guiana Amazonian Park have not yet been defined by the administration, and it is expected that hunting by non-permanent inhabitants will not be allowed in the central core (*ca.* 20,300 km²) of the Park.

ABUNDANCE

No comprehensive population assessment has yet been done for any xenarthran in French Guiana, but there are indirect estimates of relative abundance, such as those derived from the rescue operation organized by Electricité de France, the company that built the hydroelectric dam at Petit-Saut.

Between January 1994 and July 1995, 365 km² of primary forest were inundated by the filling of the Petit-Saut hydroelectric dam on the Sinnamary River, during which time veterinarians and technical staff captured 3,202 non-volant mammals on dozens of islands spread over the inundated area (Vié, 1999). Mammals were caught manually by climbing trees and with various kinds of traps as well as snares, ground-nets, and noose-poles, with an emphasis on animals larger than *ca.* 0.3 kg. Captures were done opportunistically, covering *ca.* 125 km² in an environment of old-growth primary forests, including both well-drained and swampy forests.

Xenarthrans caught (and released in a non-flooded nearby area) during that inventory amounted to 1,251 individuals belonging to five species: 638 *Bradypus tridactylus*, 317 *Choloepus didactylus*, 188 *Dasyopus novemcinctus*, 63 *Dasyopus kappleri*, and 45 *Tamandua tetradactyla* (Taube *et al.*, 1999; Vié, 1999). Clearly, the three-toed sloths were the commonest species (51% of all xenarthrans), as was the case in a similar environment in Suriname during the filling of Brokopondo Lake (Walsh & Gannon, 1967). At both sites (Petit-Saut in French Guiana, Afobakka in Suriname), it appears that three-toed sloths were about twice as abundant as two-toed sloths (638 three-toed and 317 two-toed individuals in French Guiana; 2,104 and 840 in Suriname, respectively). Nine-banded armadillos seemed to be much more abundant (75% from a total of 251 *Dasyopus* spp.)

TABLE 1. The nine species of xenarthrans found in French Guiana: scientific, French, and English names.

Bradypodidae & Megalonychidae	Paresseux	Sloths
<i>Bradypus tridactylus</i> Linné, 1758	aï, paresseux à trois doigts	pale-throated three-toed sloth
<i>Choloepus didactylus</i> (Linné, 1758)	unau, paresseux à deux doigts	southern two-toed sloth
Dasypodidae	Tatous	Armadillos
<i>Cabassous unicinctus</i> (Linné, 1758)	petit cabassou	southern naked-tailed armadillo
<i>Dasyopus kappleri</i> Krauss, 1862	tatou de Kappler	great long-nosed armadillo
<i>Dasyopus novemcinctus</i> Linné, 1758	tatou à neuf bandes	nine-banded long-nosed armadillo
<i>Priodontes maximus</i> (Kerr, 1792)	tatou géant	giant armadillo
Myrmecophagidae	Fourmiliers	Anteaters
<i>Cyclopes didactylus</i> (Linné, 1758)	fourmilier myrmidon, myrmidon	silky or pygmy anteater
<i>Myrmecophaga tridactyla</i> Linné, 1758	grand tamanoir, grand fourmilier	giant anteater
<i>Tamandua tetradactyla</i> (Linné, 1758)	fourmilier tamanoir, tamandua tetradactyle	collared or southern tamandua

than great long-nosed armadillos at Petit-Saut, but no comparison is possible with Brokopondo Lake because the two species were not distinguished among the 1,051 *Dasyopus* spp. reported by Walsh & Gannon (1967).

Four xenarthran species were not caught at Petit-Saut dam during the 1994–1995 rescue operation: *Myrmecophaga tridactyla*, *Cyclopes didactylus*, *Priodontes maximus*, and *Cabassous unicinctus*. Three of these (*M. tridactyla*, *C. didactylus*, *C. unicinctus*) had nevertheless been recorded in the soon-to-be-flooded Sinnamary River catchment by bona-fide naturalists, but there is no record of *Priodontes* in the Petit-Saut region. Possibly, these four xenarthrans are less abundant than the remaining five species caught in the primary old-growth forests of north-central French Guiana; alternatively, they are more mobile (*Myrmecophaga*) or more cryptic (*Cabassous*, *Cyclopes*) than the others. Whereas *Cabassous* (3 individuals) and *Priodontes* (7 individuals) were rarely caught during the flooding of Brokopondo Lake in Suriname, it appears that the pigmy anteater was rather common there, as Walsh & Gannon (1967) indicate that 161 individuals were rescued.

For both sloths, a more precise study by Taube *et al.* (1999) estimated densities at 1.7 *B. tridactylus*/km² and 0.9 *Ch. didactylus*/km² for the whole flooded area (365 km²), but those densities might be much higher in some parts of the forest, in particular the marshy areas. Taube *et al.* (1999) wrote that estimated densities “can be corrected upward to 9 *B. tridactylus* and 4.5 *Ch. didactylus*/km² if we consider only the area having indeed yielded captures instead of the total flooded area.”

Another indirect estimate of relative abundances can be inferred for the two sloths based on the census of mammals hunted by Wayãpi Amerindians (Ouhoud-Renoux, 1998). Two cohorts of Wayãpi hunters were studied in 1976 (29 hunters) and 1994 (14 hunters) at Trois-Sauts, an isolated locality in the south of French Guiana. During both surveys, *Bradypus* were collected and brought back to camp much more often than *Choloepus*: 34 and 18 individuals, respectively, in 1976; 17 and 3 individuals in 1994. The areas where Wayãpi hunting took place consisted mostly of old-growth terra-firme primary forests, and their surface areas were estimated by Ouhoud-Renoux (1998) as *ca.* 160 and 270 km², respectively.

Finally, in a large fragment of mature secondary forests near Cayenne, Charles-Dominique *et al.* (1981) estimated the density of *Bradypus* at 3 to 6 individuals per hectare.

THREATS: HUNTING

Few xenarthrans are hunted in French Guiana, notwithstanding the fact that five species are strictly protected (see above). A recent survey of six localities

where bush meat is regularly sold at markets suggests that even unprotected xenarthrans (*Bradypus*, *Choloepus*, *Dasyopus novemcinctus*, and *D. kappleri*) are a very minor component of hunted mammals. Out of a total of 1,626 specimens of hunted mammals, xenarthrans make up less than 1% (or 15 individuals) with 12 *Dasyopus* spp., 1 *Choloepus*, and 2 *Bradypus* (Grenand, 2003).

THREATS: ROADKILLS

In the northern part of the country, where all of the major roads are located, automobile traffic is certainly a major threat for various xenarthrans (FIG. 2). These highways cross large tracks of open vegetation (savannahs, wet shrublands, agricultural landscapes) alternating with small or large patches of forests (mainly primary forests to the East, mainly secondary forests to the West). The main concrete road connects Saint-Laurent du Maroni (border with Suriname) to Saint-Georges de l’Oyapock (border with Brazil), passing by cities of Sinnamary, Kourou, Cayenne, and Regina.

According to reported observations in our database, all nine species of xenarthrans have been found as roadkills in French Guiana, but there has been no regular survey for quantifying road mortality. Certainly the most commonly found is *Tamandua tetradactyla*, which accounts for 14 out of

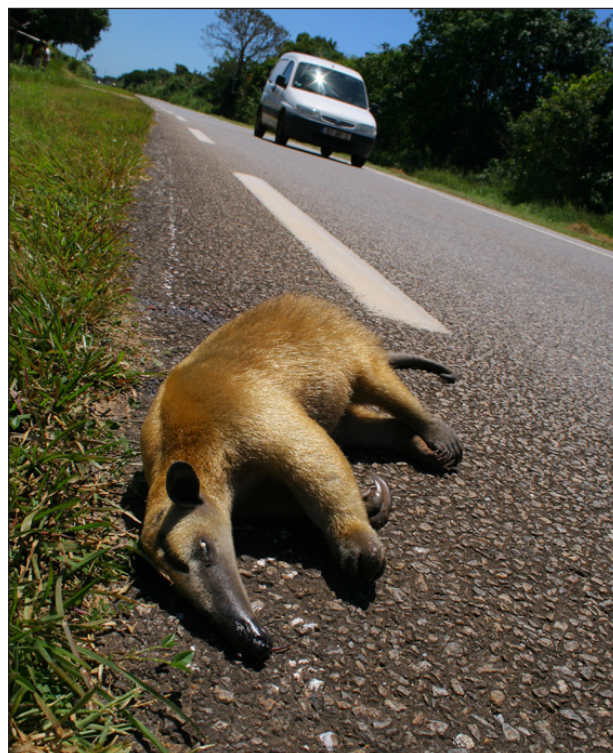


FIGURE 2. Roadkills are rather common along the paved roads in the northern part of French Guiana. Photograph by Sebastien Barrioz of a *Tamandua tetradactyla* along national road RN1 between Cayenne and Kourou.

30 reported xenarthran roadkills; surprisingly, the arboreal species *B. tridactylus* is second in roadkill abundance.

THREATS: DEFORESTATION

As elsewhere in the Guianan Shield and in Amazonia, deforestation is a major threat to xenarthrans, especially to sloths.

Due to low human population density, habitat loss remains rather limited and mainly occurs in the north of French Guiana. Of the 5,600 km² of natural habitats in the littoral zone, 220 km² have been converted to anthropized landscapes during the last decade (ONF, 2010), which add to an area of 300 km² currently used for agriculture and cattle ranching in the littoral zone (INSEE, 2010). Further to the south is the area dedicated to logging (9,800 km²), which is managed by the National Forest Agency (ONF). The ONF is the agency responsible for assigning logging concessions, carrying out surveillance activities, managing tract openings, controlling wood extraction, implementing low impact practices, and (recently) initiating global double ecocertification (PEFC and FSC). Consequently, illegal deforestation and habitat loss due to extensive logging is very limited in French Guiana. Further, records of xenarthrans are common in logged forests, suggesting that current practises allow the various species to persist.

Lastly, gold mining activities (Hammond *et al.*, 2007) are responsible for an annual loss of 2,000 hectares of forest habitats.

Habitat destruction and fragmentation occurred during the flooding of *ca.* 360 km² of forests for the Petit-Saut hydroelectric impoundment of the Sinnamary River. Dalecky *et al.* (2002) studied the short-term effects of forest fragmentation on the large mammal fauna, by performing censuses on five medium-sized (11–67 ha) and 33 small-sized (1–10 ha) islands during 1996 to 1999; that is, just after the flooding that occurred from January 1994 until August 1995. During 1993 and 1994 (*i.e.*, before flooding), five xenarthrans were regularly observed on three large blocks of continuous forest through various censuses: *Tamandua tetradactyla*, *Myrmecophaga tridactyla*, *Dasypus* spp. (*D. novemcinctus* and *D. kappleri* were not distinguished), *Bradypus tridactylus*, and *Choloepus didactylus*.

Dalecky *et al.* (2002) found that *Dasypus* was the most resilient taxon, as its presence after flooding was documented on 63% of the 38 surveyed islands. *Tamandua*, *Bradypus*, and *Choloepus* apparently suffered from fragmentation, as they were only found on 6, 7, and 6 islands, respectively. *Myrmecophaga* could not be observed on any island, large or small, among the 38 islands surveyed, indicating that

habitat fragmentation is a major threat for the giant anteater.

GEOGRAPHIC DISTRIBUTION OF XENARTHANS IN FRENCH GUIANA

With the help of numerous naturalists and scientists living permanently or engaged in temporary fieldwork in French Guiana, we compiled a database of *ca.* 470 observations on nine xenarthran species. The database was built by collecting all bona-fide observations of non-volant mammals during the years 1993–2012, amounting to *ca.* 3,700 items (as of June 2012). One should keep in mind that such a database built on a voluntary basis includes some biases, the most important being that the data just reflect the localities visited by the *ca.* 50 contributors. This probably explains two facts: i) that the number of different localities is relatively low even for the most common species; ii) that most observations are located in the northern half of the country, where access (presence of roads, tracks, large rivers) is easiest, and where most of fauna surveys have been implemented. For the purpose of quantifying localities per species in the paragraphs that follow, two adjacent sites were considered to represent distinct localities if they were at least 3 km distant from one another. For clarity, however, only those localities separated by about 10–15 km are mapped in **FIG. 3**.

Sample sizes for observations and localities vary among the nine xenarthrans, from a maximum of 98 observations for *Tamandua tetradactyla* (74 localities) to a minimum of 24 observations for *Priodontes maximus* (21 localities). Apparently, all species can be found almost everywhere in French Guiana, from the northern coastal strip to the deep south, but the following comments are hypotheses that warrant testing by additional surveys:

- *Cyclopes didactylus* (44 observations in 32 localities) is mostly found in the northern part of French Guiana, and seems particularly common along the western part of the coastal strip;
- *Myrmecophaga tridactyla* appears evenly distributed throughout French Guiana (64 observations in 56 localities), with many observations along the national roads passing through savannahs and open lands between Saint-Laurent and Cayenne;
- *Tamandua tetradactyla* has not been reported from the center-west or from the south-west, and we do not know if this result is not simply due to the lack of observers in those regions; this species is nevertheless very common elsewhere in French Guiana, with 98 observations in 74 localities;
- *Cabassous unicinctus* seems globally uncommon or extremely cryptic; the species may be



FIGURE 3. Maps of French Guiana with localities of observations for nine species of Xenarthra. The capture data from Petit-Saut have been allocated to a single locality, but they derive from a ca. 125 km² area along the Sinnamary catchment (as explained in Vié, 1999: pp. 120–122). The scale bar on the bottom right of each map represents 80 km. See text for further details.

semifossorial, seldom emerging from its shallow burrows (26 observations in 23 localities, most in the northern part of the country);

- *Dasyopus kappleri* is probably distributed all over French Guiana (27 observations for 23 localities), and its apparent absence from the southern-most parts might simply reflect the rarity of surveys in those remote areas, and/or the difficulty at distinguishing the species from its congener *D. novemcinctus*;
- *Dasyopus novemcinctus* is distributed all over the country, and is rather common in many places (52 observations in 47 localities);
- *Priodontes maximus* seems uncommon overall (24 observations in 21 localities) but has a wide repartition throughout the country; again, the species might be cryptic, feeding and travelling at night, with its burrows almost always located in treefalls (R.S. Voss, pers. comm.);
- *Bradypus tridactylus* is distributed all over French Guiana, with slightly more localities (73 observations for 52 localities) than the two-toed sloth;
- *Choloepus didactylus* has been observed throughout the country, and seems less common (59 observations for 45 localities) than the three-toed sloth.

Clearly, at the regional scale, all nine xenarthrans are broadly sympatric, at least in the northern half of French Guiana.

PRESENCE IN PROTECTED AREAS

All nine xenarthrans have been observed in the “Parc Amazonien de la Guyane” (Guiana Amazonian Park). In other protected areas, up to seven species have been observed, for example: Reserve Naturelle de la Trinité (not recorded species are *Cabassous* and *Cyclopes*), Reserve de l’Amana (both species of *Dasyopus* not yet recorded). Based on the distribution maps (FIG. 3), we suspect that all nine xenarthrans live in most large protected areas of French Guiana.

USE (MEDICINE, PETS, TRADE) AND LOCAL PERCEPTION

Thanks to the courtesy of Pierre Grenand (pers. comm., January 2012), an ethnobiologist who has 40 years of expertise with the Wayãpi people living at Trois-Sauts (in the headwaters of the River Oyapok), the following can be reported for the relations of native Amerindians with xenarthrans:

Armadillos of the genera *Dasyopus* and *Cabassous* are rarely hunted by Wayãpi, probably due to the fact that only elderly people are allowed to eat them. The giant armadillo *Priodontes* benefits from a strict

culinary interdict, and consequently is never hunted. The reason invoked by Wayãpi for not consuming Dasypodidae is that armadillos eat earthworms, and that those invertebrates on their turn might have eaten cadavers. Moreover, the blood of armadillos is considered a health-risk for women of childbearing age. On the other hand, armadillos (of all species) are culturally valued for their extraordinary strength: one design of body painting alludes to armadillos, and several names of people (first name, family name) have included the wayãpi word “tatu” (tatu e’e, tatu u, and tatu tawa are the local names for *Dasyopus* spp., *Priodontes*, and *Cabassous*, respectively).

The two smaller species of anteaters (*Cyclopes*, *Tamandua*) have no particular role in the Wayãpi culture; neither taxon is hunted, nor do they benefit from any particular belief. To the contrary, the giant anteater (*Myrmecophaga*) is hated by the whole Wayãpi community, who believe that giant anteaters have no magical strength and are intrinsically wicked and malevolent. As a consequence, their belief is that one should kill giant anteaters when encountered.

Sloths, in their turn, benefit from a very positive value assigned to them in Wayãpi culture. If *Bradypus tridactylus* is the commonest game sloth in numbers, the two-toed sloths are even more appreciated. Both taxa are regularly kept as pets (FIG. 4),



FIGURE 4. A young *Bradypus tridactylus* kept as a tamed pet by a Wayãpi Amerindian at Trois-Sauts. Photograph by François Catzefflis (November 2010).

which are patiently tamed after being adopted at a young age. Some kinds of boyhood games allude to sloths, with children clinging (entangling) to each other.

Several names of people include the Wayãpi word "ai" (aikay and aie'e are the local names for *Bradypus* and *Choloepus*, respectively). There is also a kind of traditional basket named aisoã in Wayãpi, which literally translates to « buttock of sloth », which serves to store cotton fluff and/or cotton fancy-work in progress (with its spindle and cotton ball).

The Wayãpi believe that, in the telluric world (or chthonian world), the regular inhabitants are giant sloths [spelled wo'ó] who live and behave like humans.

Armadillos, sloths, and anteaters evoke empathy, if not fondness, from most people living in cities, and there are several children books with xenarthran stories. The main parade of Carnival, an important social gathering at Cayenne and elsewhere, had a giant armadillo prepared by a local band in February 2010 (FIG. 5).

STUDIES ON XENARTHTRANS CARRIED OUT IN FRENCH GUIANA

During and after the flooding of the Petit-Saut hydroelectric dam, abundance, biometry, reproduction, translocation, and post-release ecology of the two sloths have been studied (Richard-Hansen & Taube, 1997; Taube *et al.*, 1999, 2001). Many innovative results were achieved, of which the most salient are:

- For the *ca.* 840 sloths caught in the inundated area, the proportion of young individuals was higher in *Choloepus* than in *Bradypus*;
- Both species are essentially solitary in their natural forest habitat, as more than 95% of sloths



FIGURE 5. A representation of an armadillo at the main Carnival parade in Cayenne, February 2010. Photograph by Association Natural Tribal (Cayenne).

were caught alone with no other conspecific in the immediate vicinity;

- In the surrounding area of primary terra-firme forest where sloths were released after translocation, radiotracking estimated the home range for *Bradypus* at between 1.4 and 3.6 ha, and for *Choloepus* at between 1.2 and 6.5 ha.
- Breeding appears to be continuous, or at least non-seasonal, in *Choloepus* whereas breeding appears to be seasonal in *Bradypus* (births occurring during the long rainy season from April to July), confirming an earlier study (Henry & Dubost, 1994).

Other studies based upon the large biological materials collected at Petit-Saut have addressed veterinary aspects, including biochemistry, hematology, and chemical immobilization (Fournier-Chambrillon *et al.*, 1997; Vogel *et al.*, 1998) and biometry aspects (Richard-Hansen *et al.*, 1999).

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Ethogram of the giant anteater (*Myrmecophaga tridactyla*) in captivity: an experience in the Temaikèn Foundation

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Abstract The giant anteater (*Myrmecophaga tridactyla*) is one of the most distinctive animals of South America. In northern Argentina it is found in forests, savannahs, and grasslands. It is listed as Vulnerable in the IUCN Red List of Threatened Species. The present study was conceived as a husbandry tool for individuals of this species in zoos. The research was developed at CRET (Temaikèn Center of Species Reproduction) and consisted in elaborating the behavioral repertoire of a group of three adult females from April 2009 to April 2010. A total of 122 h of behavioral observations were made by the naked eye at a distance of 1–5 m through a metallic mesh, five times a week, with focal animal *ad libitum* sampling from 9:00 to 18:00 hr. A diagram of the exhibit was confected to ease the data collecting process. To facilitate the description of the behavioral acts, an identification of the different physical characteristics of each individual was conducted along with the segmentation of the body. During the 12 months of observations, 38 behavioral acts were defined, which were then grouped into eleven categories. Finalization of data collection was based on the saturation curve; the first asymptote was reached at 35 h, while the final one, which remained constant, was reached at 52 h and contained the 38 behavioral acts registered in the ethogram.

Keywords: behavior, captivity, ethogram, giant anteater, husbandry, *Myrmecophaga tridactyla*, Xenarthra

Etograma de oso hormiguero (*Myrmecophaga tridactyla*) en cautiverio: una experiencia en la Fundación Temaikèn

Resumen El oso hormiguero (*Myrmecophaga tridactyla*) es uno de los mamíferos más distintivos de América del Sur. Se encuentra en las selvas, sabanas y pastizales del Norte Argentino. Está listado como Vulnerable por la Lista Roja de Especies Amenazadas de la IUCN. El presente estudio fue concebido como una herramienta para el manejo de individuos de esta especie en zoológicos. El trabajo se desarrolló en el CRET (Centro de Reproducción de Especies Temaikèn) y consistió en elaborar el repertorio comportamental de un grupo de tres hembras adultas de oso hormiguero desde abril 2009 hasta abril 2010. Un total de 122 hs de observación se realizaron con registro animal focal *ad libitum*, cinco veces por semana, en los horarios de 9:00 a 18:00 hs, a una distancia de 1–5 m a través de una malla metálica. Se confeccionó un esquema del recinto para simplificar la recolección de datos. Para facilitar la descripción de los actos de conducta, se realizó una identificación de las características físicas de cada individuo junto con la segmentación de los cuerpos. Durante los 12 meses de observación, se definieron 38 actos de conducta, los cuales luego fueron agrupados en 11 categorías. La finalización de la recolección de datos se basó en la curva de saturación; la primera asíntota se alcanzó a las 35 hs, mientras que la última, que permaneció constante, se alcanzó a las 52 hs conteniendo los 38 actos de conducta registrados en el etograma.

Palabras clave: cautiverio, comportamiento, etograma, manejo, *Myrmecophaga tridactyla*, oso hormiguero gigante, Xenarthra

INTRODUCTION

Ethology is traditionally known as the study of natural animal behavior. Martin & Bateson (1986) specifically define the purpose of ethology as the study of the biological function of behavior, in the attempt to understand the purpose of behavior in its natural context. Lorenz (1993) discusses the significance of field and captive studies arguing that the comparison between the two is one of the basic tools of ethology, as stimuli are reduced and, therefore, some behaviors will be missing in captive conditions. Furthermore, an elevated threshold exists in captivity, meaning that more stimuli will be needed to trigger a specific behavior. Thus in captivity behaviors may be missing, but no behaviors will appear that do not already occur in nature.

Ethology can also provide key information for designing appropriate enclosures, since to study an animal, is actually to study a portion of nature that was separated from its environment. Lorenz (1993) recommends to never undertake a study without knowing the ethogram of the species and basic information on its ecology. Any project that involves the captive maintenance of animal groups should assign part of its resources to structuring an ethogram.

About the ethogram

Fagen (1978) defines a behavioral repertoire as a group of mutually exclusive and collectively exhaustive acts of an animal or species. Laffitte de Mosera & Caprio (1980) define ethogram as a precise description of animal activity, meaning a thorough description of the observable behaviors in the animal that constitutes the initial phase (observation) of the ethological method.

For Lehner (2003) an ethogram is a group of wide descriptions of the behavioral patterns characteristic of a species. This author clarifies that it is the result of many hours of observations, in some cases of sound recordings, and descriptions, and that it must be the starting point of any ethological research. According to Lehner (2003) the questions that an ethologist tries to answer about the behavior are: what happens (description), when does it happen (temporal component), how (motor patterns), and why (motivational and ecological adaptation of behavior). Martin & Bateson (1986) define it as a catalog of descriptions of discrete behavioral patterns, typical of the species-object, that form the basic behavioral repertoire of the species.

In all cases, the following characteristics should be highlighted:

- temporality: an ethogram can never be considered finished
- thoroughness: the behaviors must be described accurately, to ensure that they are recognizable without a doubt

The elaboration sequence

An ethogram is a list of acts of behavior, it is what the observer considers implied in what he is observing (Lahitte *et al.*, 1993). Since an act of behavior comes from a specimen-environment relationship, the inventory of behavioral acts is consequently a list of the different ways that the observed specimens relate to one another and with their environment. The procedure is to observe and record, after the reading and analysis of those records, a description of the behavioral acts is elaborated, they are then grouped by affinities, differences, functionality, structure, etc. For each category of records, a group of acts can be defined that covers and summarizes them. When the observations that originated the records are presumed complete, meaning such an outlook that more observation time will not add records that do not fall into any of the already defined acts, then it is considered that the list of definitions is an ethogram, a complete list of behaviors of that species. Once this list of behaviors is completed, it remains incorporated into the conceptual framework and it starts being employed as a tool.

Having concluded this introduction, and with the ethological framework established, an ethogram is presented of the giant anteater (*Myrmecophaga tridactyla*) in captivity, conceived as a tool for the management of individuals of this species in zoos. The giant anteater is one of the most distinctive animals of South America. It has been recorded from Honduras in Central America, south through South America to the Gran Chaco region of Bolivia, Paraguay, and Argentina (Superina *et al.*, 2010). In Argentina its geographical range has been diminishing within the last century, being found presently in the forests of the province of Misiones, savannahs, grasslands, and forests of Formosa and Chaco, and in the woods of the drier Chacoan region including the east of Salta, Jujuy, and north of Santiago del Estero (Pérez Jimeno & Llarín Amaya, 2007; Pautasso *et al.*, 2009). In Argentina the species is categorized as In Danger (EN, in Spanish EP) (Díaz & Ojeda, 2000), and globally it is considered as Vulnerable (Miranda & Medri, 2010).

Myrmecophaga tridactyla is locally uncommon to rare. Habitat loss, roadkills, and wildfires are substantially affecting the wild populations and have led to a continuing decline in mature individuals (Superina *et al.*, 2010).

MATERIALS AND METHODS

The present study was conceived as a husbandry tool for individuals of this species in zoos. The research was developed at CRET (Temaikèn Center of Species Reproduction), and consisted in elaborating the behavioral repertoire of a group of three adult females from April 2009 to April 2010, including a

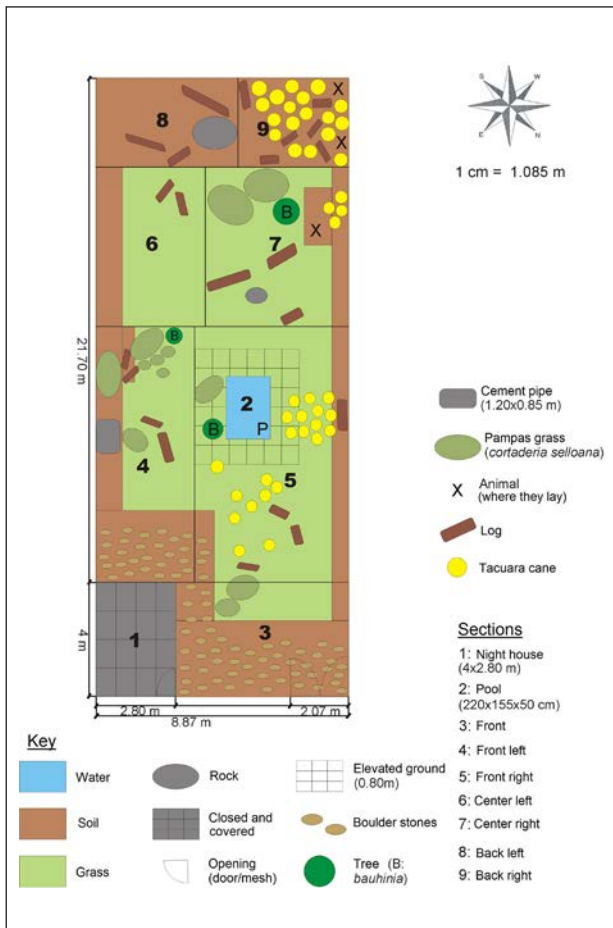


FIGURE 1. Diagram of the exhibit where the giant anteaters (*Myrmecophaga tridactyla*) were housed during the study. A reference scale, keys, dimensions, and sections are provided.

full year cycle of climatic seasons. A total of 122 h of behavioral observations were made by the naked eye at a distance of 1–5 m through a metallic mesh, five times a week (Monday–Friday), four times a day with focal animal *ad libitum* sampling (Altmann, 1974), during 12 months from 9:00 to 18:00 hs. A diagram of the exhibit (FIG. 1) was constructed and divided into sections to ease the data collecting process during the observations. To facilitate the description of the behavioral acts, a description of the different physical characteristics of each individual was conducted along with the segmentation of the body to identify them (FIG. 2). A climatic description was used as a reference applied in the observations.

The three females were differentiated by fur color, size, and the difference in the anteaters' characteristic diagonal shoulder stripe in their fur, which is on both lateral sides of the torso. One of the females had lighter brown colored fur and the diagonal stripes were less defined. The second female had darker black fur and the diagonal stripes were more defined. The third female was larger in size, with brown fur, and presented defined diagonal stripes; also, her tail was longer than average.

Finalization of data collection was based on the saturation curve (Lehner, 2003) which consists of creating a graph showing the number of observed behaviors *versus* the number of observations until an asymptote is reached. When a constant asymptote is reached, more observations will not show new behavioral acts; this implies that even if the data collection is expanded, the observed behaviors will still be

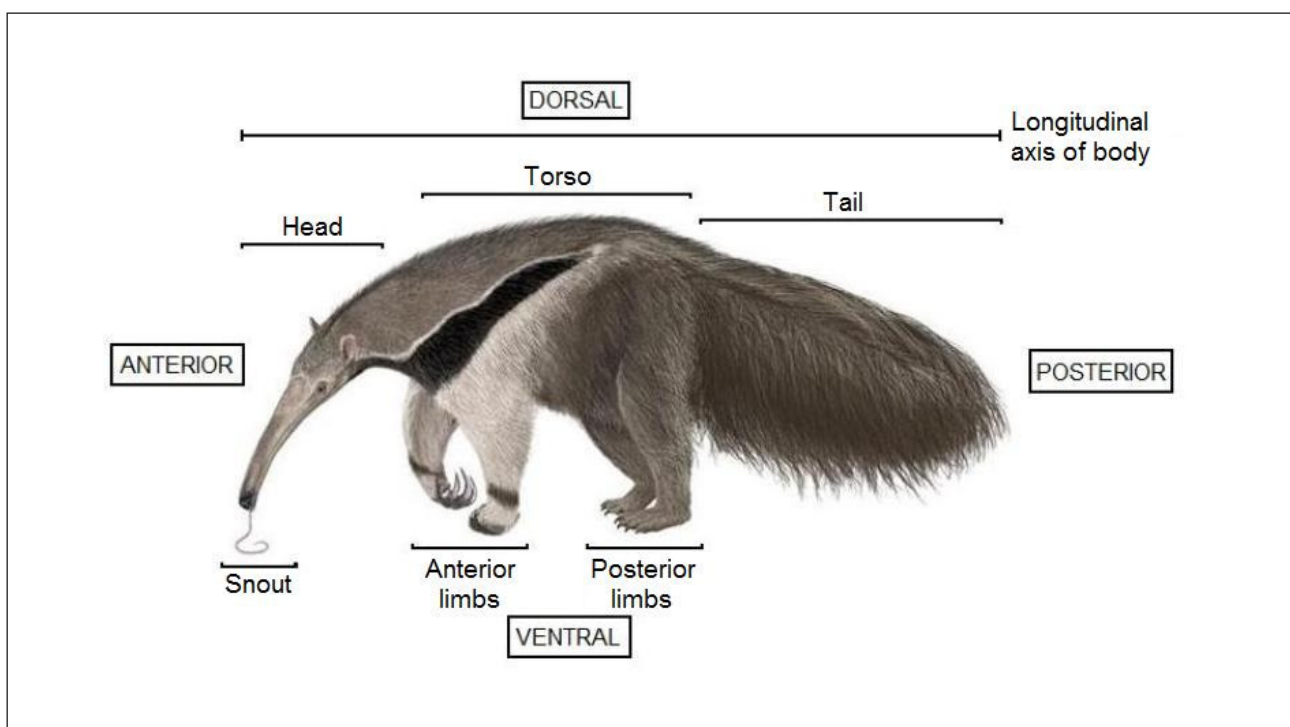


FIGURE 2. Segmentation of the giant anteaters' (*Myrmecophaga tridactyla*) body showing the anterior, posterior, dorsal, and ventral regions.

applicable to the same group of behavioral descriptions already found.

RESULTS

Displacement of the body segments

As shown in **TABLE 1**, the body segments were divided into head, torso, tail, and anterior and posterior limbs, and their displacement was described vertically and horizontally.

Behavior

During the 12 months of observations, 38 behavioral acts were defined, which were then grouped into 11 behavioral categories described in **TABLE 2**. A description of all specific behaviors recorded during the behavioral observation sessions are shown in the behavioral ethogram in **TABLE 3**. All behaviors were coded for frequency (total number of occurrences).

TABLE 1. Description of the displacement of the giant anteaters' (*Myrmecophaga tridactyla*) body. The body is segmented into head, torso, tail, and anterior and posterior limbs. The displacements are described both vertically and horizontally.

Body Segment	Vertical Displacement	Horizontal Displacement
Head	Below, above or in the same longitudinal axis of the body	To the right, left or in the same longitudinal axis of the body
Torso	Parallel to the ground standing on anterior and posterior limbs	Perpendicular to the ground standing on posterior limbs only
Tail	Below, above or in the same longitudinal axis of the body	To the right, left or in the same longitudinal axis of the body
Limbs	Extended	Semi flexed or flexed

TABLE 2. Description of the 11 behavioral categories that include the 38 specific behaviors observed in giant anteaters (*Myrmecophaga tridactyla*).

Behavior category	Description	Specific behavior
Alert	Brief state in which the animal is motionless, interrupting any activity it was engaging in, head points in the direction of a noise source if there was any; usually occurs in the presence of people.	Stand (SD)
Locomotor	Sequence of events in which the animal uses full body locomotion, moving from one point to another of the exhibit, horizontally or vertically.	Walk (WK), Run (RN), Turn (TU), Climb (CB)
Rest	Prolonged motionless state in which the animal is in a specific spot in the exhibit, distinguished by minimal or null head and limb movement, eyes commonly closed.	Sit (ST), Lay (LY), Sunbathe (SB)
Foraging	Sequence of events in which the animal explores the exhibit in search of food, distinguished by use of anterior limbs and snout and the presence of a substrate or object. It is observed more frequently during or after rainfall or after the grass in the exhibit is cut.	Investigate (IV), Smell (SM), Swipe (SW), Puncture (PT), Move (MV), Dig (DG)
Feeding	Any action that culminates with the ingestion of food or water, marked by the repetitive introduction and retraction of the tongue into the nutritional source, often accompanied with salivation, anterior limbs are not involved.	Drink (DR), Eat (EA)
Grooming	Any action that involves handling of its own body; the snout, anterior or posterior limbs contact any body part.	Self Smell (SS), Scratch (SR), Rub (RB), Snout Clean (SC), Bathe (BT)
Excretion	Event characterized by the elimination of feces or urine, executed in the back of the exhibit where there is dirt or in small superficial excavations on the ground.	Defecate (DE), Urinate (UR)
Social Interactions	Sequence of events that occur between specimens; the action of one individual evokes a behavioral response in the other.	Touch (TC), Sniff (SF), Follow (FL), Tongue Lick (TL)
Agonistic Interactions	Sequence of events that occur between specimens involving aggression.	Aggression 1 (A1), Aggression 2 (A2), Aggression 3 (A3), Defense (DF), Territorial (TR)
Stereotypic	Sequence of events, generally long, repeated always in the same manner, that does not show obvious functional achievements.	Pacing Figure 8 (P8), Pacing Figure 0 (P0)
Other	Other behaviors that do not fit the descriptions of the previous categories.	Tongue Out (TO), Play (PL), Vocalization (VO), Not Visible (NV)

TABLE 3. Description of each specific behavior recorded during the behavioral observation sessions in giant anteaters (*Myrmecophaga tridactyla*). Each behavioral act is listed within its behavioral category and has been coded.

Behavior category and specific behavior	Description
Alert	
Stand (SD)	In a specific area, the animal has all four limbs on the ground or only one anterior limb is raised and semi flexed inwards towards its ventral region, the head is horizontally above, below or commonly in the same longitudinal axis of the torso, the tail is also in the same longitudinal body axis, and the animal's eyes are open (FIG. 3).
Locomotor	
Walk (WK)	Standing with its head below or on the same longitudinal body axis, the tail does not touch the ground and remains also in the same longitudinal body axis, the animal stands on two opposite limbs at the same time. The sequence begins with the right anterior limb and the left posterior limb in contact with the ground, then the animal raises its left anterior limb and the right posterior one, moves both of them forward and places them on the ground. The animal then raises its right anterior limb and left posterior limb, moving both of them forward then placing them on the ground again and so on. The claws from both its anterior limbs are kept retracted towards its ventral region.
Run (RN)	Standing, the animal's head and tail are in the same longitudinal body axis, the tail does not touch the ground and may swing from side to side, the animal stands with two limbs in contact with the ground. The sequence starts with both anterior and posterior limbs against the ground, then both anterior limbs slightly raise and the posterior limbs stretch from the ground driving the animal forward rapidly while lifting both posterior limbs from the ground, the anterior limbs immediately touch the ground followed by the posterior ones that impulse the animal again and so on.
Turn (TU)	Walking, the animal then stops and rests its body weight on both its posterior limbs, it arches its column inwards towards the ventral region, puts its tail on the ground and turns its body horizontally towards the right or left, then the anterior limbs come in contact with the ground and the animal walks in the opposite direction it came from.
Climb (CB)	Standing, the animal raises, extends, and leans one or both of its anterior limbs against the mesh or the cement posts on the sides of the exhibit, the animal raises its head above the longitudinal axis of the body directing the snout towards any object, the tail and both posterior limbs are against the ground.
Rest	
Sit (ST)	The animal's anterior limbs are extended and in contact with the ground, its posterior limbs are fully flexed against the ground, its posterior body region and tail are also touching the ground, with or without horizontal or vertical head movement, the animal's eyes are open or closed (FIG. 4).
Lay (LY)	With either lateral side of its torso or part of the abdomen leaning against the ground, the head is also against the ground vertically tilted towards its ventral region or lifted from the ground, the animal's eyes are open or closed, its anterior and posterior limbs are flexed inwards or extended, the tail lays motionless on the ground or is bent towards the side covering its whole body including the head. According to Astwood Romero <i>et al.</i> (2010) this makes it difficult to differentiate the anterior and posterior regions of the animal (FIG. 5).
Sunbathe (SB)	Laying with its body on the ground while the animal's back or abdomen is exposed upwards towards the sun, its anterior limbs may shield the face. Or sitting with its chest facing the sun, the head is lifted above the longitudinal body axis with its snout extended vertically upwards.
Foraging	
Investigate (IV)	Standing, walking or sitting, the animal touches the substrate or object with its snout or one or both anterior limbs (FIG. 6).
Smell (SM)	Standing, sitting or walking (most common), the animal's head and snout are pointing to a substrate or object, the animal makes a nasal sound, without the use of its anterior limbs. If the object is elevated, such as vegetation or in the air, the animal raises its head vertically and stretches the snout towards it. If the object is on the ground, such as substrate or vegetation, the animal tilts its head below the longitudinal body axis and reaches it with its snout (FIG. 7).
Swipe (SW)	Standing, the animal extends one or both anterior limbs exposing its claws and repeatedly touches the substrate or object, the movement of its limbs is from front to back, the animal usually sniffs the substrate or object simultaneously.
Puncture (PT)	Standing, the animal extends one anterior limb against the substrate or object, it exposes its claws and with the largest one punctures the object once or various times creating a hole through which the animal then introduces its tongue.
Move (MV)	Standing, the animal raises and extends one anterior limb on an object, grabs the object from underneath with its claws and raises the limb toward its ventral region and outwards achieving the movement of the object. The animal may lean its head and sniff under the object simultaneously.
Dig (DG)	Standing, the animal extends one or both anterior limbs and touches the ground with its claws. It is a repetitive front to back limb movement that causes displacement of soil behind the animal leaving a hole through which it introduces its tongue (FIG. 8).

TABLE 3, CONTINUED ON NEXT PAGE

TABLE 3, CONTINUED

Behavior category and specific behavior	Description
Feeding	
Drink (DR)	Standing, the animal draws its head in direction to a water source, tilting its head vertically below the body axis, then sticks its tongue out until it reaches the water and retracts it, or submerges the snout and sticks its tongue in and out while blowing out the nose.
Eat (EA)	Standing, the animal's head is tilted vertically above or below the body axis, the snout is in direction or in contact with a nutritional source found in different substrates (ground, log, rock, vegetation). The animal sticks its tongue out of the oral cavity repeatedly, often accompanied with salivation, it may emit nasal sounds, and while swallowing the food external movements of the throat are seen. When eating from substrates or vegetation, the animal introduces its snout in the ground or at the base of a plant, it usually uses one anterior limb to separate the leaves in order to stick its head further in between the leaves and eat (FIG. 9, FIG. 10).
Grooming	
Self Smell (SS)	Standing, laying or sitting, the animal extends the snout towards a body part of its own and sniffs it, the snout can be in contact or kept at a close distance to that body part.
Scratch (SR)	Standing, laying or sitting, the animal raises and extends one anterior or posterior limb towards its own body part, once they come into contact the animal exposes its claws and performs short and repetitive movements against it (FIG. 11)
Rub (RB)	Standing or laying, the animal makes contact with its whole body or back against the cement posts of the exhibit, against the edge of the pool by laying down or against slanted tree logs by walking under them. It is usually a repetitive movement from side to side or front to back maintaining the contact of the body with different substrates.
Snout Clean (SC)	Standing or laying, the animal's claws from one anterior limb come into contact with the base of its own snout, wrapping around it and the animal moves the limb sliding its claws to the snout's tip, it may be repetitive and usually occurs after eating to remove dirt or ants.
Bathe (BT)	The animal enters a pool with both the head and tail raised above the water, then sits and scratches its back or abdomen with one anterior limb, the animal usually turns its head in the direction it is scratching, it does not submerge its head into the water. When coming out of the pool, the animal continues scratching with its anterior or posterior limbs, then usually sits and rearranges its tail fur with anterior limbs, the animal may also rub its back against the edge of the pool.
Excretion	
Defecate (DE)	Standing on all four limbs, the animal raises its tail slightly above the longitudinal body axis, excretes feces and then moves away.
Urinate (UR)	Standing on all four limbs, the animal separates horizontally one posterior limb from the other and excretes urine, it may slightly crouch its posterior region, then moves away.
Social interactions	
Touch (TC)	Standing or laying, one animal touches with its anterior limb the back, snout or head of another animal that responds by either ignoring it, touching it back or eluding it by moving aside.
Sniff (SF)	Standing, sitting, laying or walking, the snout of one animal approaches any body part of another and smells it, the other animal responds by either ignoring it, sniffing it back or eluding it by moving aside.
Follow (FL)	Walking, one animal follows another behind it or next to it, both directing themselves in the same direction for a short distance, the other animal continues walking, there is no physical contact between them.
Tongue Lick (TL)	Standing, one animal is facing or next to another, one of them tilts its head vertically downwards below its body axis and turns it upwards to the right or left touching with its snout the snout of the other that also tilts its snout downwards. If both animals stick their tongue out they come into contact and lick each other, if only one of them does it then it licks the other's snout. This usually occurs after feeding.
Agonistic interactions	
Aggression 1 (A1)	Standing or walking, one animal leans its snout against another's back or snout pushing it downwards, the animal that receives the aggression responds by either standing still or eluding it by moving aside. This usually occurs when both animals try to access or walk in the same place at the same time.
Aggression 2 (A2)	Standing or walking, one animal raises, extends and leans one or both of its anterior limbs against the head, snout or back of another animal, when it occurs against the other's back, the animal pushes it downwards forcing the other animal to sit, if it uses both anterior limbs it holds the other's posterior region and prevents it from walking. The animal that receives the aggression responds by either standing still or trying to walk to get away, if he achieves it the aggressor may follow him a short distance (FIG. 12).
Aggression 3 (A3)	Standing, one animal raises one or both of its anterior limbs, exposes its claws and swipes the other animal's back, head or snout. The animal that receives the aggression takes a defense posture.

TABLE 3, CONTINUED ON NEXT PAGE

TABLE 3, CONTINUED

Behavior category and specific behavior	Description
Defense (DF)	An animal after receiving aggression 3 stands, raises one or both of its anterior limbs and exposes its claws until the aggression ceases, there is no physical contact with the aggressor since this one usually retracts.
Territorial (TR)	Standing or sitting, one animal raises, extends and touches with one anterior limb the other's snout pushing it away, this usually occurs when both animals eat from the same nutritional source. The animals do not always touch, sometimes the animal only raises an anterior limb towards the other's snout exposing its claws (FIG. 13).
Stereotypic	
Pacing Figure 8 (P8)	An animal walks from one edge of the exhibit border to another through a lateral wall making an 8 figure, turning in each corner to the left to continue walking in the opposite direction, the animal may momentarily stop to smell the ground, vegetation or air. This is usually executed in the back of the exhibit (sections 8 and 9), in the front along the night house door (section 3), or on the left lateral border (section 6). It is highly repetitive, and it can be carried out by all animals in the same section at the same time.
Pacing Figure 0 (P0)	An animal walks along all the borders of the exhibit making a 0 shape, this generally begins from the back towards the front through one of the lateral sides, the animal walks through the front side and returns to the back by the opposite lateral side, then walks through the back side back to the starting point. When walking in the left border, the animal usually passes through a cement pipe that is located there, and when passing by the night house it smells the door. It is slightly repetitive.
Other	
Tongue Out (TO)	Standing, sitting, laying or walking, the animal's head is in the same longitudinal axis of the body or above it, the animal draws out its whole tongue from the mouth and immediately retracts it without it touching anything, this is usually seen after the animal smells something or when it wakes up.
Play (PL)	Standing or sitting, with its snout, anterior or posterior limbs in contact with objects or logs, the animal manipulates the object by first swiping at it with one or both anterior limbs, then abruptly lays on the ground against its back without letting go of the object, picks it up and situates it against its chest or abdomen holding it in place with one or both posterior limbs and continues swiping at it with its anterior limbs, the animal may pounce over the object with its abdomen against it (FIG. 14).
Vocalization (VO)	The animal makes a short low-frequency whistle, it is highly unusual and cannot be widely described nor could it be audio recorded.
Not Visible (NV)	The animal is partially or fully outside the observer's viewing range, it is most likely in the back right corner of the exhibit covered by the vegetation (section 9) or inside the night house.



FIGURE 3. Giant anteater (*Myrmecophaga tridactyla*) standing with all four limbs on the ground, with both head and tail in the same longitudinal axis as the torso.



FIGURE 4. Giant anteater (*Myrmecophaga tridactyla*) sitting and interacting with enrichment object, with both anterior limbs extended and posterior limbs flexed.



FIGURE 5. Giant anteater (*Myrmecophaga tridactyla*) laying, the tail covers the body, the head is lifted from the ground, and the eyes are open.



FIGURE 8. Giant anteater (*Myrmecophaga tridactyla*) digging the ground with its claws. One anterior limb digs while the animal introduces its tongue in the hole it created.



FIGURE 6. Giant anteater (*Myrmecophaga tridactyla*) investigating in the vegetation, the snout is touching the substrate.



FIGURE 9. Giant anteater (*Myrmecophaga tridactyla*) eating from an enrichment nutrient source, the snout is in contact with the nutritional source and the tongue is seen.



FIGURE 7. Giant anteater (*Myrmecophaga tridactyla*) sniffing tree logs, the head is tilted below the longitudinal body axis and reaches the logs with its snout.



FIGURE 10. Giant anteater (*Myrmecophaga tridactyla*) eating from an enrichment termite mound. The head is above the longitudinal body axis and the snout is in contact with the nutritional source.



FIGURE 11. Giant anteater (*Myrmecophaga tridactyla*) scratching its back. The animal is in a sitting position using one anterior limb to scratch itself and the other anterior limb to support its body weight.



FIGURE 12. Giant anteater (*Myrmecophaga tridactyla*) displaying aggression against the back of another anteater. The aggressor is leaning one anterior limb against the other animal forcing it to sit.



FIGURE 13. Giant anteater (*Myrmecophaga tridactyla*) displaying territoriality against another anteater. Both animals are eating from the same nutritional source and one animal is pushing the others' snout away with one of its anterior limbs.

Data collected

FIGURE 15 shows the number of new and accumulated behaviors versus the number of observation sessions. The first asymptote was reached at 35 h, there was a second one at 46 h, and the final asymptote, which remained constant, was reached at 52 h and contained the 38 behavioral acts registered in the ethogram.

There were many changes in the behavior of the females throughout the seasonal changes. The investigative and feeding behavior increased during the rainy season and on average, the anteaters were most active during the afternoons *versus* in the mornings. The heat of the summer with 30–35 °C was when the anteaters were most active. The captive facility where this research was conducted is outside the giant anteater's natural distribution, which possibly affected the behaviors the animals displayed.

DISCUSSION

Little background information was available on the specimens used in this research. They were born in the wild and then donated to the Temaikèn Foundation. This lack of background information brings forth a discussion regarding the variations between behaviors in the wild and in captivity. For example, in this study the only laying behavior observed was with the tail folded over the body when sleeping, which helps the anteater conserve the body heat generated by its metabolism and also serves to camouflage the sleeping animal (Shaw & Carter, 1980).

However, observations in natural habitats indicate variations of this behavior depending on

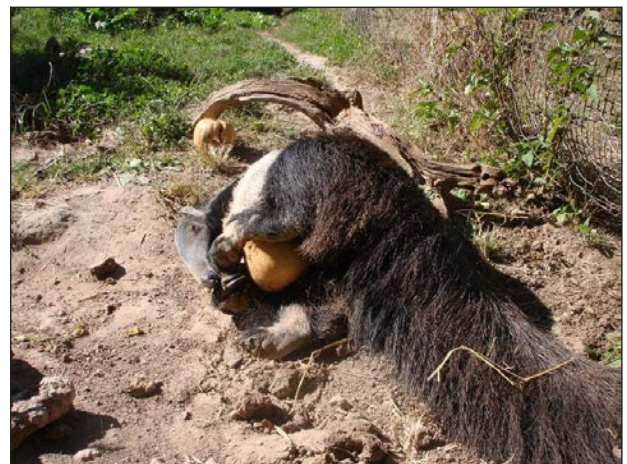


FIGURE 14. Giant anteater (*Myrmecophaga tridactyla*) playing with an enrichment object. The animal is laying on the ground while manipulating the object with its anterior limbs and holding it in place with its posterior limb.

ambient temperature (Medri & Mourão, 2005). In a large number of sightings (n=107), giant anteaters were found sleeping with their bushy tails covering their bodies even on days when the temperature exceeded 30 °C, while on a cool sunny morning, when ambient temperature was about 17 °C, the giant anteater was sleeping stretched out flat on the ground exposing the full length of its body to sunlight, a behavior that suggests it was using solar radiation as a source of heat to raise its body temperature (Medri & Mourão, 2005).

Another finding that shows the variations of giant anteater behavior is the bathing habit. In this research, the animals used the pool to bathe and also enjoyed being hosed down by their keepers as a part of their enrichment. In the wild, bathing in water is rare in mammals that are not semi-aquatic and giant anteaters do not share the physical characteristics of other bathing mammals. However, Emmons *et al.* (2004) acquired over 70 photos with a camera trap of giant anteaters coming to a watering hole in Parque Nacional Noel Kempff Mercado in Santa Cruz, Bolivia. The photos showed many anteaters arriving dry, then leaving the hole soaking wet (Emmons *et al.*, 2004).

There has been much dispute regarding the climbing behavior of giant anteaters. In this study

this specific behavior was only recorded when the animal was motivated to climb with the use of food type enrichment. This behavior was described by the observations of Young *et al.* (2003), where the ability of both captive and wild giant anteaters to climb termite mounds, trees, and man-made objects was fully described. In both studies, the conclusion reached is that a sufficiently hungry or motivated giant anteater will display the climbing abilities needed to obtain certain goals, such as food.

Agonistic behaviors recorded in this research and others in captivity seem to be less violent and do not end with serious injuries, as opposed to the fighting behavior that occurs in the wild and which has been described in the scientific literature (Shaw *et al.* 1987; Rocha & Mourão, 2006; Kreutz *et al.*, 2009). However, some of the aggressive behaviors seen in this study could be associated with reproductive periods when comparing these behaviors with those found in the work of Astwood Romero *et al.* (2010). Although the study performed by Astwood Romero *et al.* (2010) is about courtship and mating behaviors of giant anteaters in *ex situ* conditions, it also includes a basic ethogram with some of the same behaviors recorded in this study, such as climbing, sleeping, smelling, rubbing, running, following, turning, eating, and grooming. The agonistic behaviors displayed by these three females seem to fit some of the courting descriptions of Astwood Romero *et al.* (2010), and may in fact be a part of a misdirected courtship attempt.

CONCLUSIONS

The results described here are useful for the husbandry of giant anteaters in captivity in order to achieve their welfare. The zookeepers of these animals now have a better understanding of them, accomplishing the goal of this study.

Accomplishing a good management of animal behavior is of utmost importance because it results in sanitary treatments, veterinarian interventions, and handling with higher probabilities of success. This study has helped improve the training techniques used by the keepers of these giant anteaters.

Good management also helps in the conditioning of exhibits and in the possible reintroduction of the animals into their environment, as it allows recognizing when an animal is ready to be released. Based on the results of this study, the three females will be separated from each other and placed in better conditioned exhibits.

Environmental enrichment allows the animals to express species-appropriate behaviors and thus increases the chance of successful reproduction of endangered species, such as the giant anteater. Following the completion of this ethogram a more suitable environmental enrichment program will be

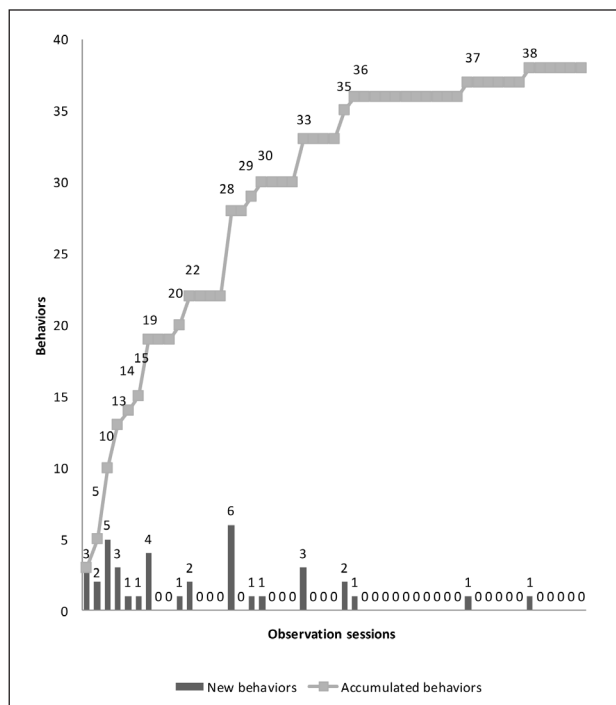


FIGURE 15. Chart showing the number of new behaviors / accumulated behaviors observed in giant anteaters (*Myrmecophaga tridactyla*) versus the number of observation sessions. The first asymptote was reached at 35 h, there was a second one at 46 h, and the final asymptote, which remained constant, was reached at 52 h and contained the 38 behavioral acts registered in the ethogram.

put into practice at Temaikèn Zoo to diminish the high frequency of aggression and stereotypies recorded in this study.

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Cinco años de radiomarcaje de osos hormigueros (*Myrmecophaga tridactyla*): mejoras implementadas y lecciones aprendidas

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Resumen Diferentes autores han propuesto el uso de arneses para fijar radiotransmisores a osos hormigueros gigantes. En este estudio evaluamos la duración y aplicabilidad de estos arneses en osos hormigueros de distintas edades, pusimos a prueba mejoras en su diseño, reportamos si tienen algún efecto negativo en la reproducción y evaluamos el desempeño de un implante intraperitoneal en una hembra. En la Reserva Natural del Iberá, Corrientes, Argentina, radiomarcamos 29 animales (26 reintroducidos y tres nacidos *in situ*) con 37 transmisores VHF colocados sobre arneses, acumulando un total de 370 meses de seguimiento. Cada animal fue recapturado periódicamente (82 recapturas en total), encontrándose en sólo cuatro casos heridas causadas por los arneses, las cuales fueron tratadas adecuadamente. En ningún caso se dio una muerte causada por los arneses. A partir de los diseños originales incorporamos una modificación en la forma de la caja transmisora, que redujo su resistencia a la vegetación, además de incluir una banda elástica a la correa que rodea el tórax que previene la remoción del arnés y las heridas causadas por cambios de peso en el animal. El implante interno implicó una pérdida notable de la señal del transmisor en relación al arnés. Recomendamos el uso de arneses mejorados como un método de sujeción de radiotransmisores para osos hormigueros, ya que ofrecen la mejor calidad de señal y no parecen afectar la reproducción. Sin embargo, este sistema debe incorporar recapturas periódicas para evitar la aparición de posibles heridas graves en animales que experimentan cambios significativos de peso.

Palabras clave: arnés, fijación de radiotransmisor, *Myrmecophaga tridactyla*, oso hormiguero gigante, radiotelemetría

Five years of radio tagging giant anteaters (*Myrmecophaga tridactyla*): implemented improvements and learned lessons

Abstract Several authors have proposed using harnesses to attach radio transmitters to giant anteaters. We assessed harness endurance and applicability on giant anteaters of different ages, tested improvements on its design, and evaluated potential negative impacts on reproduction. We also assessed the performance of an internal transmitter in a female anteater. We radiotagged 29 animals (26 reintroduced and three *in-situ*-born cubs) with 37 VHF harness-mounted transmitters, accumulating 370 months of radiotracking giant anteaters in Iberá Natural Reserve, Corrientes, Argentina. Each animal was periodically recaptured finding harness-related wounds in four cases for a total of 82 recaptures. All these wounds were properly treated and healed, and there were no cases of deaths related to harnesses. We designed and field-tested modifications on the transmitter canister shape that reduced resistance to vegetation, and also included an expandable section added to the strap around the thorax that prevented animals from removing their harnesses, while avoiding injuries related to changes in the anteater's weight. The internal implant resulted in a significant loss in signal strength. As result of our experience, we recommend the use of harnesses as the best way to attach radio-transmitters to giant anteaters because they offer the best quality of signal while having no apparent effect on reproduction. However, we highly recommend periodical recaptures of radio-harness tagged animals to avoid potentially fatal wounds coming from ill-adjusted harnesses in animals that are experiencing sharp changes in weight.

Keywords: fitting radiotransmitter, giant anteater, harness, *Myrmecophaga tridactyla*, radiotelemetry

INTRODUCCIÓN

La radiotelemetría es una de las técnicas más utilizadas para el estudio de vertebrados silvestres, ya que permite conocer aspectos de la ecología, demografía y comportamiento de especies elusivas o difíciles de observar (Kenward, 1987; White & Garrot, 1990). A lo largo de las últimas décadas se han desarrollado y mejorado diferentes tecnologías que permiten localizar, observar, e incluso obtener información de la actividad y parámetros fisiológicos de los animales de estudio. Para que esta herramienta sea efectiva, debe estar fijada al animal de forma tal que perdure en el tiempo, no afecte su comportamiento y favorezca la óptima transmisión de la señal utilizada.

Si bien existe una gran diversidad de formas de fijar radiotransmisores u otros sistemas similares a distintas especies, algunos grupos poseen particular dificultad para ello. Entre los mamíferos terrestres, los collares son una forma de fijación generalizada, pero hay grupos, como los mustélidos y algunos xenartros, que normalmente requieren sistemas más especializados debido a su morfología y comportamiento (*e.g.*, Herbst, 1991; Silveira *et al.*, 2011). El oso hormiguero gigante, *Myrmecophaga tridactyla* Linnaeus, 1758, posee un cráneo pequeño en relación al cuello, y los collares no son una opción viable.

Rodrigues *et al.* (2003) revisaron diferentes métodos de sujeción de radiotransmisores sobre osos hormigueros gigantes, concluyendo que “la combinación de un arnés con una antena interna parece ser el mejor método para fijar radiotransmisores en osos hormigueros gigantes”. Este modelo consta de cinco piezas: una correa alrededor del cuello, una alrededor del tórax, una correa principal uniendo las dos anteriores, donde va adosado el transmisor y baterías, y dos correas laterales, paralelas a la principal y por encima de las extremidades anteriores para dar estabilidad al arnés y permitir que la correa principal y el transmisor queden posicionados sobre la cruz del animal o levemente hacia un lado (**FIG. 1**).



FIGURA 1. Imagen de radioarnés colocado en un oso hormiguero gigante, *Myrmecophaga tridactyla*.

En esta especie la hembra carga a su cachorro en su espalda hasta aproximadamente un año de edad (Shaw *et al.*, 1987), y cuando son radiomarcadas con estos arneses, la correa del tórax queda posicionada por detrás de las extremidades anteriores, cercana y delante de los pezones. En los estudios realizados no se evaluó si los arneses tuvieron algún efecto en las fases reproductivas, como la cópula, el amantamiento y el transporte de la cría; o se pusieron a prueba otras alternativas, como los implantes intraperitoneales.

Otro punto relevante es que los osos hormigueros llegan a la edad adulta alrededor de los tres años de edad, con un marcado pico de crecimiento entre la segunda mitad del segundo año y el tercer año de edad (Shaw *et al.*, 1987). Este crecimiento rápido hace especialmente difícil el tener animales marcados durante este período, ya que hay que observarlos y/o recapturarlos con mayor frecuencia, para asegurar que el arnés no produzca heridas o estrangulamiento.

En este trabajo continuamos la línea de trabajo propuesta por Rodrigues *et al.* (2003), planteándonos los siguientes objetivos: 1. evaluar la duración y aplicabilidad del modelo de arnés propuesto por Rodrigues *et al.* (2003) para osos hormigueros gigantes de distintas edades; 2. poner a prueba diferentes mejoras en su diseño que permitan trabajar con animales en crecimiento y durante períodos de varios años; 3. reportar si estos arneses tienen algún efecto negativo en la reproducción de la especie; y 4. evaluar el desempeño de un implante intraperitoneal en una hembra de oso hormiguero en comparación con los arneses externos.

MATERIALES Y MÉTODOS

Realizamos este estudio en la Reserva Privada Rincón del Socorro (12.400 ha; 28°32'S, 57°10'W), ubicada sobre el margen suroriental de la Reserva Natural del Iberá, Corrientes, Argentina. El clima en los Esteros del Iberá es subtropical. La temperatura media del mes más frío (julio) varía entre 15 y 16 °C y en verano (enero y febrero) varía entre 27 y 28 °C. Las precipitaciones pluviales medias anuales varían entre 1.500 y 1.800 mm (Neiff & Poi de Neiff, 2006). La vegetación es una combinación de malezales (*e.g.*, pastizales abiertos temporalmente inundados), sabanas arboladas, bosques hidrófilos y pantanos (Tressens *et al.*, 2002). La Reserva Rincón del Socorro fue utilizada como estancia ganadera hasta el año 2000, cuando fue adquirida por *The Conservation Land Trust* con fines de restauración y conservación, por lo que el ganado fue excluido de la propiedad. Los osos hormigueros radiomarcados fueron parte del proyecto de reintroducción de la especie en la Reserva Natural Iberá (Jiménez Pérez, 2006).

En este estudio seguimos las directrices de la Guía para el uso de mamíferos silvestres en investigación,

aprobado por la *American Society of Mammalogists* (Sikes *et al.*, 2011). Desde octubre 2007 a agosto 2012 radiomarcamos un total de 29 animales (15 machos y 14 hembras) de diferentes edades (de cinco meses a más de ocho años de edad), en distintos momentos y durante períodos de tiempo variables (de uno a 43 meses por individuo), con una media \pm DE de $12,8 \pm 12,0$ meses, dependiendo de su llegada al proyecto, liberación o nacimiento, acumulando un total de 370 meses de seguimiento de osos hormigueros marcados. De éstos, 26 fueron ejemplares reintroducidos provenientes de distintas localidades de la ecoregión del Gran Chaco argentino, y tres individuos fueron crías nacidas en el sitio de estudio a partir de hembras reintroducidas. De los individuos reintroducidos, 22 fueron animales criados en cautiverio o semicautiverio. Éstos provienen de rescates y decomisos de animales capturados a temprana edad luego de que sus madres fueran muertas por cazadores, casi siempre asociado a conflictos con los perros de caza (17 individuos) y donaciones de zoológicos u otras instituciones (cinco individuos). Los cuatro ejemplares silvestres corresponden a adultos recuperados y traslocados que fueron previamente removidos de su hábitat natural por encontrarse heridos por atropellamientos u otras causas. Previo a su liberación, los animales fueron mantenidos en instalaciones de cría y/o cuarentena, donde se evaluó su estado general y sanitario. En caso de heridas o enfermedades, los animales fueron tratados por el personal veterinario, y aquellos de temprana edad fueron criados en cautividad hasta que alcanzaron el tamaño adecuado para ser radiomarcados y liberados. En el sitio de liberación, los animales permanecieron de cinco a 25 días en corrales de presuelta (7 ha) previo a su liberación, donde fueron alimentados artificialmente durante el cautiverio y un mes posterior a su liberación, reduciendo la cantidad y periodicidad gradualmente hasta suspender totalmente el suplemento alimenticio.

Para manipular a los animales para radiomarcaje, tratamientos, intervenciones quirúrgicas o recapturas utilizamos dos procedimientos anestésicos de inmovilización: Tiletamina/Zolazepam (3 mg/kg; Zelazol, Fort Dodge Animal Health, Colonia Portales, México, D.F.) y una combinación de Ketamina (5 mg/kg) y Midazolam (0,1 mg/kg, Richmond, Vet Pharma, Buenos Aires, Argentina). Para suplementar o prolongar el efecto de los anestésicos, utilizamos sólo Ketamina en la mitad de la concentración inicial y en ambiente controlado (cuarentena y centro de cría) utilizamos Isoflurano inhalatorio.

Todos los animales fueron radiomarcados con transmisores VHF (*Very High Frequency*) con sensor de actividad y mortalidad (Telonics, Mesa, Arizona. <<http://www.telonics.com/products/vhfStandard/anteater.php>>) fijados a través del modelo de arnés propuesto por Rodrigues *et al.* (2003), pero cuya forma, tamaño y diseño fueron ajustados y mejorados a

lo largo de los cinco años de trabajo con estos dispositivos. El material usado en los arneses fue caucho de butilo impregnado con dacrón.

El peso total de los arneses para adultos fue de 750 g, con batería suficiente para una duración de al menos 24 meses (MOD 400). Para los animales de peso inferior a 23 kg diseñamos arneses de menor tamaño provistos de un transmisor MOD 335, con un peso de 550 g y con un batería con duración aproximada de 12 meses para el tipo de emisión programada. El peso de los radioarneses nunca superó el 6 % del peso del animal (ver Brander & Cochran, 1971). En cuanto a la antena de los modelos utilizados, seguimos la recomendación de Rodrigues *et al.* (2003) y utilizamos antenas internas modelo "TA-7 helical" embutidas dentro de la correa dorsal.

Una hembra adulta fue equipada con un implante interno IMP/400/L de la misma compañía. El implante fue colocado en posición intraabdominal mediante una operación quirúrgica realizada en condiciones controladas y de máxima asepsia en un quirófano cubierto. La cirugía para la colocación del transmisor fue realizada en la última semana de julio del 2010 y el animal se recuperó adecuadamente después de algunas semanas sin mostrar molestias de importancia, más allá de que en los días posteriores a la operación mostró una tendencia a rascarse en el área intervenida. Esta hembra fue liberada en octubre del mismo año.

Cada animal radiomarcado fue recapturado periódicamente, lo que sirvió para evaluar su peso, estado general, identificar posibles daños causados por el arnés y realizar los ajustes apropiados o colocar un nuevo arnés provisto de radiotransmisor. En el caso de los animales recién liberados, realizamos las recapturas entre el primer y segundo mes de su liberación para ir espaciando gradualmente éstas hasta llegar a realizar una o dos recapturas por año en el caso de animales adultos (*i.e.*, más de tres años de edad) que ya llevaban más de un año en vida libre. En total realizamos 82 recapturas de animales radiomarcados utilizando anestésicos, sin registrar mortalidad o impacto negativo importante sobre los animales en el proceso. En el año 2012 decidimos comenzar a retirar de manera definitiva los arneses a los machos adultos de la población que habían sido seguidos por más de dos años (dos casos en este estudio).

RESULTADOS Y DISCUSIÓN

Utilizamos un total de 37 radioarneses, además del implante interno. El 100% de los transmisores empleados en los arneses funcionaron adecuadamente hasta que fueron recuperados.

En los primeros momentos del estudio, diez de los arneses siguieron las especificaciones elaboradas por investigadores previos en Brasil, las cuales coincidían con las experiencias y aprendizajes descritos

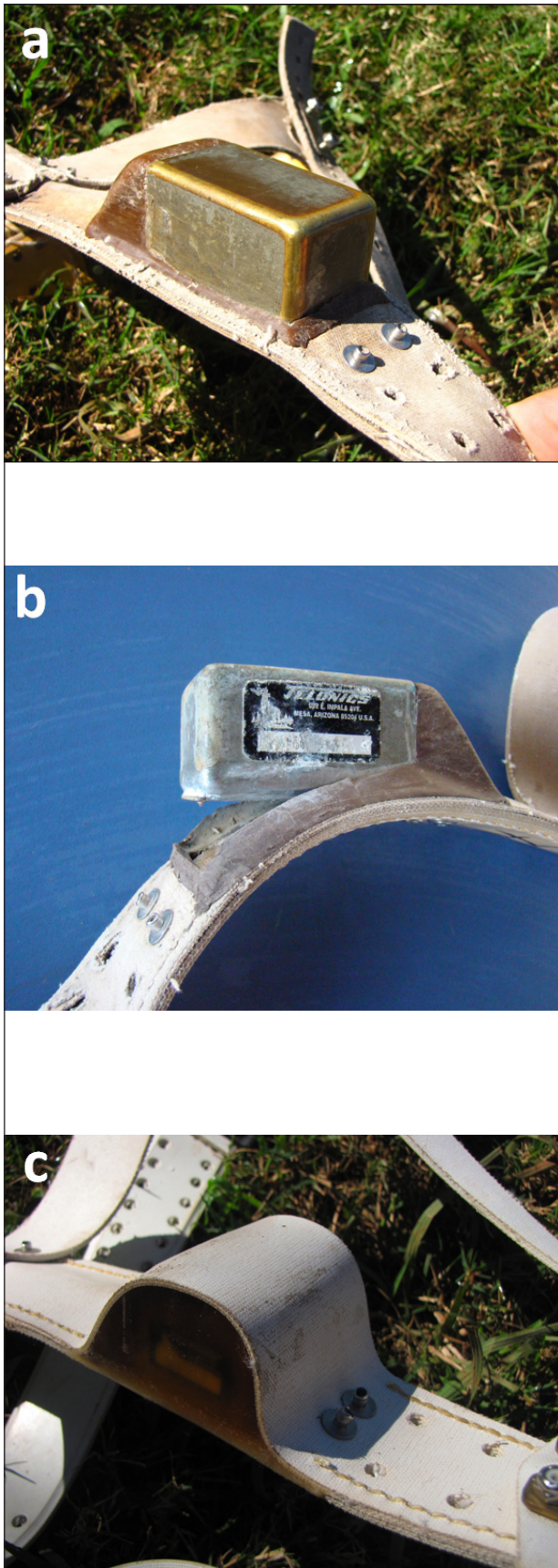


FIGURA 2. Ejemplos de cajas de protección del radiotransmisor ubicadas sobre la correa dorsal del arnés: a) modelo original de caja de forma rectangular, b) ejemplo de cómo este modelo puede acabar separándose del arnés con el uso, y c) modelo mejorado de caja transmisora cubierto con epoxi y con una banda extra de butilo.

por Rodrigues *et al.* (2003). En estos modelos pudimos comprobar que las antenas internas funcionaron adecuadamente, no presentando ninguna avería o pérdida. Sin embargo, encontramos problemas con el diseño de la forma de la caja protectora del transmisor y su sistema de sujeción al arnés. En lo que se refiere a la forma de la caja, ésta contenía ángulos de 90° muy marcados que daban al equipo una forma que favorecía los impactos fuertes cuando un animal entraba en un área de vegetación cerrada (**FIG. 2A**). Además de esto, el transmisor estaba adosado a la correa dorsal del arnés únicamente por una placa metálica soldada a su base. El resultado de la forma de la caja transmisora y sistema de sujeción, fue una alta resistencia a la vegetación, produciendo ciertas dificultades en el desplazamiento de los animales y el eventual desprendimiento de la caja de la placa metálica (**FIG. 2B**). Este desprendimiento ocurrió en seis de los 10 radioarneses a una media \pm DE de $15 \pm 4,17$ meses de uso. Esto, a su vez, incrementó aún más la resistencia, y probablemente de no haber sido detectado a tiempo, hubiese implicado el desprendimiento total del transmisor del arnés (**FIG. 2B**).

Estos hallazgos motivaron que buscáramos un nuevo sistema de sujeción de la caja transmisora y que mejorásemos su forma. Como resultado de nuestras conversaciones con el fabricante (Telonics), realizamos modificaciones que consistieron en cubrir la caja del transmisor en Epoxi, creando ángulos suaves para los extremos anterior y posterior. Además, reforzamos el sistema de sujeción del transmisor al cubrir totalmente la caja con una banda de butilo. Todo esto resultó en una mayor durabilidad del radioarnés. Este sistema fue probado extensivamente en los 27 radioarneses subsiguientes, sin encontrar más casos en que la caja transmisora estuviera a punto de desprenderse del arnés o detectar daños en ella (**FIG. 2C**).

Otro problema que encontramos con el modelo original, es que los primeros dos animales liberados lograron quitarse el arnés, perdiendo así la posibilidad de monitorearlos. Los arneses removidos por ambos animales fueron encontrados totalmente armados, sin el desprendimiento o avería de ninguna de las piezas. Esto y la forma del animal sugieren que para quitárselo, lograron pasar las extremidades anteriores por detrás de la correa que rodea el tórax, para luego continuar desplazando el arnés hacia adelante, superando el cuello y finalmente la cabeza. Esto sólo es posible si la correa del tórax no está lo suficientemente ajustada al cuerpo para permitir que el animal pase la extremidad anterior por detrás de ella. En este sentido, la edad de los individuos es relevante, ya que en animales en desarrollo, éstos deben ser ajustados de manera tal que tengan suficiente espacio para poder crecer, al menos por un tiempo prudencial o hasta la eventual recaptura. También hemos detectado una tendencia a que los animales pierdan peso en la época

invernal (datos no publicados). Todo eso hace que se necesite diseñar arneses con una correa que se pueda ajustar adecuadamente al tórax del animal, pero que a su vez este ajuste no limite su crecimiento y no se pierda cuando un ejemplar pierde peso.

Para cumplir con estos propósitos agregamos una banda elástica de unos 20 cm de largo y 4 cm de ancho en el interior de la correa del tórax fija del arnés. En principio esta banda fue hecha con una cámara de neumático de bicicleta (**FIG. 3A**) y luego nos pasamos al uso de material elástico específicamente diseñado para collares expandibles que pensamos ofrecía mejores prestaciones en lo que se refiere a la humedad interna asociada al contacto entre la banda elástica y el pelo de los animales (**FIG. 3B**). Esta banda elástica se adhiere al cuerpo del animal impidiendo que pase las extremidades anteriores para desprenderse del arnés, a la vez que permite el ajuste de éste tanto si el animal gana como pierde peso.

Luego de aplicar esta mejora de diseño, en sólo dos ocasiones los animales removieron su arnés. Una de esas ocasiones se dio con la primera cría nacida en vida libre que radiomarcamos. Esto era esperable, ya que era la primera vez que se ensayaba el radiomarcaje con un animal de ese tamaño (10 kg) y utilizamos un modelo experimental de arnés con dimensiones

menores que los otros probados anteriormente. En el otro caso, una hembra juvenil, probablemente hubo un error en el ajuste del arnés, ya que luego fue recapturada y remarcada sin mostrar inconvenientes posteriores. Nuestra experiencia muestra que la inclusión de una banda elástica de ajuste en el interior de la correa del tórax rígida del arnés disminuye la pérdida de estos dispositivos y se adecua a los cambios de peso en los animales.

Más allá del uso de bandas elásticas, a lo largo de las 82 recapturas realizadas en el estudio detectamos la necesidad periódica de modificar los puntos de sujeción del arnés para permitir el adecuado crecimiento de los animales. En cuatro ocasiones encontramos heridas causadas por el contacto del arnés con los osos hormigueros, producidas por el rozamiento de la correa del tórax ante los cambios de tamaño del animal. Gracias a las recapturas pudimos limpiar y desinfectar las heridas (agua oxigenada, H_2O_2 ; Iodo Povidona o Pervinox, laboratorios Phoenix, Buenos Aires, Argentina) y aplicar cicatrizantes (Bactrovet plata, laboratorios König, Buenos Aires, Argentina; Cicaderma enzimática, laboratorios Planeta SRL, Buenos Aires, Argentina) y los animales pudieron recuperarse adecuadamente en todos los casos. A lo largo del estudio encontramos nueve cadáveres de osos hormigueros dotados de radioarnés, sin que en ninguno de los casos se encontraran señales o heridas que apuntaran al arnés como causante de la muerte. A pesar de esto, consideramos que sin un sistema periódico de recapturas que permitan estos reajustes, los arneses pueden causar heridas y la eventual muerte de los osos hormigueros gigantes, especialmente en animales en crecimiento. Por nuestra experiencia, estos ajustes deben realizarse al menos dos veces por año en animales de edades comprendidas entre uno y cuatro años de edad, y una vez por año en animales de edades superiores. Esto implica que cualquier proyecto de radiomarcaje de estos animales a largo plazo, basado en el uso de arneses como los aquí descritos, debe incluir un protocolo adecuado de recaptura de los ejemplares marcados. En algunos casos evaluamos el estado de ajuste del arnés y el posible impacto de éste acercándonos a los animales a pocos metros, sin tener que recurrir a una inmovilización anestésica. Sin embargo, esto puede ser el resultado de que muchos de los animales reintroducidos mostraban un comportamiento especialmente dócil con las personas al haber sido criados en cautividad. Es dudoso que esto pueda hacerse con animales nacidos en vida libre.

Nuestra experiencia con un transmisor implantado intraabdominalmente no fue satisfactoria como sistema de radiomarcaje de osos hormigueros. La cirugía no tuvo complicaciones, pero fue realizada en un ambiente controlado, en las instalaciones de cuarentena y se trató de una hembra proveniente de cautiverio. Esto último adquiere relevancia porque el

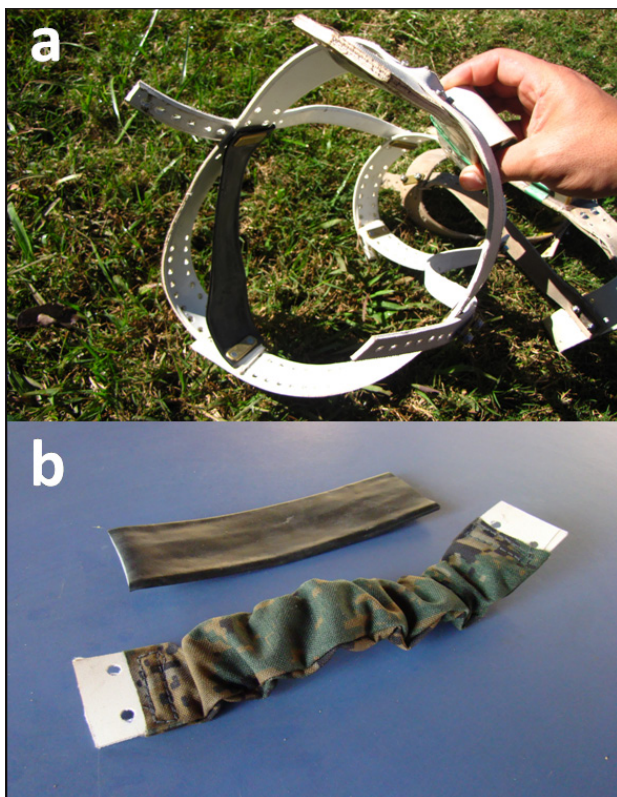


FIGURA 3. Ejemplos de bandas elásticas colocadas dentro del arnés para maximizar el ajuste y a la vez otorgar capacidad de expansión o retracción en caso de cambios de peso: a) prototipo original con una cámara de bicicleta, y b) Material expresamente diseñado para collares expandibles fabricada por Telonics Inc.

tiempo de recuperación total de la cirugía fue prolongado (alrededor de 30 días), y no sería factible de hacer en un ambiente silvestre. Sin embargo, el animal se recuperó adecuadamente del proceso y actualmente está en vida libre desde hace dos años, mostrando un comportamiento y estado físico satisfactorios, y habiendo dado a luz a una cría.

Aparte de estas importantes limitaciones, los implantes implicaron una significativa pérdida de la calidad de la señal obtenida, ya que el rango e intensidad de ésta se vieron claramente reducidos en comparación con los transmisores colocados sobre arneses. Hubo repetidos casos en que la señal sólo pudo ser detectada por el receptor a una distancia inferior a 200 m, en general cuando el animal se encontraba en reposo en un sitio de vegetación cerrada. Esto nunca ocurrió con los transmisores colocados en los arneses, que siempre tuvieron una distancia mínima estimada de alrededor de los 1.000 m, y pudiendo superar los 3.000 m utilizando antenas manuales de dos elementos a la altura de una persona en el terreno. Todo esto hizo que el seguimiento de la hembra dotada de un transmisor interno fuera mucho más difícil y aleatorio que el de los animales equipados con radioarneses. De hecho, esta hembra está siendo seguida actualmente a través de uno de estos últimos dispositivos, lo que ha mejorado significativamente la frecuencia con la que podemos conocer sus movimientos y comportamiento.

En cuanto al posible impacto de los arneses en la reproducción de los animales marcados, en nuestro estudio observamos la reproducción de tres de las cuatro hembras con estos dispositivos en el año 2011, las cuales pudieron copular, amamantar y transportar a sus crías hasta la edad de independencia sin problemas aparentes debido a los arneses. Dos de las hembras radiomarcadas se reprodujeron dos veces ese año. Una de ellas abandonó su primera cría aparentemente el mismo día de su nacimiento por un encuentro fortuito con uno de los investigadores, resultando en la pérdida de la cría y su inmediata preñez y alumbramiento ese mismo año. La otra hembra pudo sacar a sus dos crías adelante. En este estudio, la edad en que las crías se independizaron fue algo menor a lo reportado en otros estudios (Shaw *et al.*, 1987; Redford, 1994), siendo de una media de 5.8 ± 0.84 meses para las cuatro crías que llegaron a independizarse de las madres radiomarcadas.

Estos datos coinciden con los de la primera hembra que fue liberada en la zona, la cual se quitó su arnés a los pocos meses de su liberación, y que continuó siendo monitoreada sólo a través de cámaras-trampa. Esta hembra tuvo cuatro crías en el sitio de estudio entre 2009 y 2012, y de acuerdo a la evidencia fotográfica, pudimos concluir que las tres primeras de ellas (la cuarta no se había independizado aún para la fecha de preparación de este artículo) mostraron una edad de independización ($5,66 \pm 1,53$ meses) similar a

las de las crías de hembras de osos hormigueros marcadas con arnés. Si bien éste es sólo el caso de una hembra, esto sugiere que no existiría una relación entre el arnés y la edad de independencia de las crías.

CONCLUSIONES

Consideramos que los arneses sugeridos por Rodrigues *et al.* (2003) son altamente efectivos. Coincidimos con los autores citados en el uso de antenas internas para este tipo de dispositivos de radiomarcaje. El agregado de la banda elástica permite radiomarcarse animales en crecimiento y reducir las posibilidades de que los animales se quiten el arnés. A su vez, para animales en crecimiento hay que considerar las probabilidades de recapturar con éxito al animal en los tiempos planificados, ya que sin esta certeza, puede resultar en serias heridas y la probable muerte del individuo marcado. Los arneses no parecen afectar la reproducción de los individuos radiomarcados, y no recomendamos otras opciones, como los implantes intraperitoneales, ya que estos muestran una transmisión reducida de la señal dependiendo de las características del ambiente y el comportamiento del animal. La caja cubierta con epoxi y la correa de butilo redujo la resistencia a la vegetación, generando menor dificultad en el desplazamiento de los animales en lugares cerrados, y aumentando así la durabilidad de los arneses.

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SHORT COMMUNICATION

Use of boat surveys to provide complementary data on the ecology of *Bradypus tridactylus* (Pilosa: Bradypodidae) from northern Amazonia

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Abstract Here we present new data on relative abundance and diet of *Bradypus tridactylus* Linnaeus, 1758 resulting from 2,505 km of river based surveys conducted in northern Amazonia. Our sampling effort using a motorized boat provided a low number of *B. tridactylus* detections ($n = 4$, relative abundance of 0.02 individuals/10 km surveyed). Our observations provide the first record of *Parkia velutina* Benoist (Leguminosae – Mimosoideae) consumption for *B. tridactylus*. We contribute with recommendations of standardized complementary survey techniques that can be used to provide data on relative abundance of arboreal mammals such as sloths in tropical forests.

Keywords: Amazonia, *Bradypus tridactylus*, diet, relative abundance, sloths

Uso de levantamentos em barcos motorizados para fornecer dados complementares sobre a ecologia de *Bradypus tridactylus* (Pilosa: Bradypodidae) na Amazônia Oriental

Resumo Neste estudo apresentamos novos dados sobre a abundância relativa de *Bradypus tridactylus* Linnaeus, 1758 e de sua dieta, obtidos a partir de observações realizadas em 2505 km ao longo de rios no norte da Amazônia. O esforço amostral utilizando um barco motorizado resultou em um baixo número de detecções de *B. tridactylus* ($n = 4$, abundância relativa de 0,02 indivíduos/10 km percorridos). As observações forneceram o primeiro registro do consumo de *Parkia velutina* Benoist (Leguminosae – Mimosoideae) para *B. tridactylus*. Nós apresentamos informações de técnicas de amostragem padronizadas e complementares que podem fornecer dados sobre abundância de mamíferos arbóreos em florestas tropicais, como as preguiças.

Palavras-chave: abundância relativa, Amazônia, *Bradypus tridactylus*, dieta, preguiças

Sloths are folivorous, arboreal mammals that are currently classified in the order Pilosa and suborder Folivora (Wilson & Reeder, 2005). Despite their wide distribution across Neotropical forests, few studies describe the ecology and behavior of sloths (but see Carvalho, 1960; Montgomery & Sunquist, 1975; Queiroz, 1995; Chiarello, 1998; Taube *et al.*,

1999; Taube *et al.*, 2001; Bezerra *et al.*, 2008; Cassano *et al.*, 2011). One reason for this relative scarcity of information is the difficulty human observers experience in detecting sloths that often remain stationary and obscured from vision in the forest canopy (Brattstrom, 1966).

Bradypus tridactylus, the pale-throated three-toed sloth, occurs in the northern Neotropics in Venezuela, Guyana, Suriname, French Guiana, and northeastern Brazil from the delta of the Orinoco River to north of the Amazon River and east of Negro River (Hayssen, 2009; Moraes-Barros *et al.*, 2010; Chiarello & Moraes-Barros, 2011). Due to the camouflage provided by the pelage color of *B. tridactylus* (Hayssen, 2009) and the general behavior of moving very slowly in trees, thus avoiding predation largely by preventing detection (Brattstrom, 1966) it is difficult to discern *B. tridactylus* during terrestrial field surveys (e.g., line-transect census). Thus, the majority of studies available for *B. tridactylus* come from captivity and museum specimens and have focused on physiology, metabolism, morphology, and molecular phylogeny (Foley *et al.*, 1995; Gilmore *et al.*, 2000; Green, 2009; Moraes-Barros *et al.*, 2011).

Studies reporting abundance and density estimates of *B. tridactylus* are scarce. For example, in a total line transect census effort of 1,739.6 km in the southern Amazonia, sloths were not detected (Michalski & Peres, 2007) and only three observations of *B. tridactylus* were made during 2,192 km of census in Varzea and *Terra Firme* forests in central-western Amazonia (Haugaasen & Peres, 2005). Density estimates were reported from Guyana (31 individuals/km²) (Beebe, 1926) and from a rescue operation in French Guiana (Taube *et al.*, 1999). From this rescue operation Taube *et al.* (1999) provide a density estimate considering the entire study area (1.7 individuals/km²) and a corrected estimate considering only the area surveyed (9.0 individuals/km²).

Additionally, behavioral data are also lacking for this species. For example, there is only one study with observations on the diet of this species that was conducted in an urban park in Pará, Brazil (Carvalho, 1960). Currently, most of the knowledge on the behavior of *B. tridactylus* is inferred from its Amazonian congener *B. variegatus* (Emmons & Feer, 1997), which is considered to have similar biology and behavior (Eisenberg & Redford, 1999).

In this study, we present new information on the relative abundance and diet of *B. tridactylus* observed along waterways in a continuous forest area in northern Amazonia. We also contribute with discussion of standardized survey techniques that can be used to complement ecological studies of sloths.

The study was conducted around the Floresta Nacional do Amapá (FLONA), a protected area of 412,000 ha designated for sustainable use, located in northern Amazonia (0°55'29"N, 51°35'45"W; **FIG. 1**). FLONA is adjacent to continuous undisturbed forests and maintains the complete community of medium and large bodied vertebrates. This protected area experiences low levels of anthropogenic perturbations (e.g. subsistence hunting), in part because

only thirteen families live on the reserve border, and the nearest city is located 46 km away by river (Brandão & Silva, 2008).

From March 2011 to February 2012 we conducted surveys of mid to large bodied vertebrates along waterways (Araguari and Falsino Rivers) in a motorized boat using a standardized boat census protocol (Pitman *et al.*, 2011). To optimize detections the boat was piloted along the center of the rivers at a low speed (mean velocity \pm SD = 11.9 \pm 3.3 km/h, range = 3–20). At least three observers (range = 3–5) searched for vertebrates in the river (aquatic species), on the border of the river (terrestrial species), and along the tree line / canopy (arboreal species), with the help of binoculars. To avoid detection bias due to differences in observer experience, all field surveys were conducted with a local field assistant who had lived for more than 30 years in the study area and was trained to identify vertebrates, and one researcher with a minimum of 6 years experience with Neotropical vertebrate censuses. All censuses took place in rainless weather during the morning (08:00–11:59 hr) or afternoon (13:00–18:00 hr).

Here we present a subset of the data that provides information on the abundance and behavior of *B. tridactylus*. We analyzed boat census data in terms of individuals detected per 10 km travelled, which enables our data to be compared with other surveys in the Amazon (Haugaasen & Peres, 2005; Michalski & Peres, 2007; Pitman *et al.*, 2011).

In total, our census effort covered 2,505 km, including 1,677 km along the Araguari and 828 km along the Falsino rivers. Our sampling effort resulted in a low number of detections of *B. tridactylus* (n=4), and a relative abundance of 0.02 individuals/10 km surveyed. Two *B. tridactylus* individuals were observed on 10 July 2011, at the end of the rainy season, when the river water levels in the study area were still high. The other two *B. tridactylus* were observed during the dry season (02 and 15 November 2011), when the river water levels were lower.

The first observation of a solitary *B. tridactylus* occurred at 10:13 hr on 10 July 2011 along the Araguari River. The individual was observed eating leaves (**FIG. 2**) in the upper stratum of a low canopy tree at a height of 24 m (estimated visually from the boat at a perpendicular distance of 20 m). During the 12 min of observation the sloth was first seen at the upper stratum of the tree canopy, eating leaves, but after 3 min it descended and disappeared into the dense under canopy vegetation at a height of ca. 15 m. This individual was identified as a male by the characteristic dorsal orange-yellow patch with a broad, tapering, black central streak and a black spot (Hayssen, 2009) (**FIG. 2**). The tree was identified as *Parkia velutina* (Leguminosae - Mimosoideae) (voucher deposited at the Instituto de Pesquisas

Científicas e Tecnológicas do Amapá – IEPA, Herbarium number: HAMAB-18234).

The second observation occurred at 14:56 hr on 10 July 2011. We observed another *B. tridactylus* individual at the edge of the Araguari River supported between vines at a height of 0.5 m above the water line. We remained in the boat at a distance of approximately 15 m from the individual, which did not alter its behavior as a result of our presence. We observed this individual for a total of 7 min during which the animal climbed slowly through the vines until it disappeared into the forest.

The third observation occurred at 14:11 hr on 02 November 2011, when we observed a male *B. tridactylus* swimming across the Araguari River in the direction of the protected area. We observed this individual for a total of 13 min during which the animal reached the river bank and climbed a canopy tree.

The fourth observation occurred at 12:23 hr on 15 November 2011 along the Falsino River. We observed another *B. tridactylus* male along the border of FLONA at a height of 20 m above the water line (estimated visually from the boat at a perpendicular distance of 12 m). This individual was climbing a canopy tree and after 8 min of observation disappeared into the dense canopy vegetation.

As far as we are aware this study is the first to provide information on the relative abundance and diet of *B. tridactylus* in a continuous forest area in the northern Amazonia. In general, density estimates for sloths vary greatly between studies, depending on forest type and census method, and it appears to be difficult to obtain reliable estimates of sloth densities (Taube *et al.*, 1999).

The relative abundance of *B. tridactylus* detected in our study area was similar to those reported in unflooded (*Terra Firme* – 0.02 individuals/10 km transect), and slightly higher than the abundance in flooded forests (*Varzea* – 0.01 individuals/10 km transect) in central-western Amazonia (Haugaasen & Peres, 2005). However, these figures are likely underestimates due to limited visibility along transects. Our abundance estimate for the study area is also probably an underestimate.

Wildlife rescue operations such as the one conducted by Taube *et al.* (1999) will always provide a better estimate of sloth densities as the majority of animals are seen and rescued. Thus, animal records obtained from rescue operations will tend to be higher (Taube *et al.*, 1999) than those observed on census surveys with no capture (Haugaasen & Peres, 2005; Michalski & Peres, 2007; Pitman *et al.*, 2011). However, due to their sporadic nature estimates from rescue operations are unlikely to provide sufficient data for comparative analysis across Neotropical forests.

Obtaining reliable abundance estimates for sloths is challenging and there is currently no single technique that can provide cost effective data for comparative studies. Line transect census is widely used to study arboreal species such as primates in the Neotropics (Peres, 1999). However, issues of detectability mean that this technique is less effective for sloths. The majority of Amazon forests are accessible by boat (Peres & Terborgh, 1995), and we suggest that boat surveys should be used to complement more focused line transect and behavioral studies. Yet caution needs to be taken as results obtained by

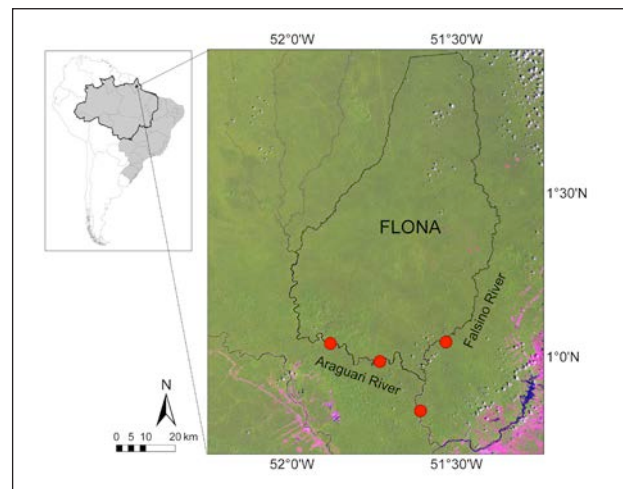


FIGURE 1. Location of the study region around the Floresta Nacional do Amapá (FLONA), state of Amapá, eastern Brazilian Amazon. Inset shows Legal Amazon (bold black line), and the polygon within the main figure shows the limits of FLONA. A Landsat TM image (226 / 59, 25 October 2009) shows locations of *Bradypus tridactylus* (red circles) detected via motorized boat surveys. Green, pink, and blue areas represent forest, non-forest, and open-water cover, respectively.



FIGURE 2. Male *Bradypus tridactylus* eating leaves of a *Parkia velutina* tree (Leguminosae: Mimosoideae) observed during boat surveys along the Araguari River on the border of the Floresta Nacional do Amapá (FLONA), state of Amapá, eastern Brazilian Amazon.

boat surveys may tend to underestimate sloth abundances and should therefore be used to complement other techniques.

Although boat surveys can cause potential biases by failing to detect species that avoid rivers, are difficult to observe due to cryptic behavior, and that are spooked by the noise of boats, the method has a high data-to-cost ratio and a high potential for long-term monitoring. Additionally, this technique is capable of detecting a broad range of species, ranging from small cryptic (*e.g.*, *Saimiri boliviensis*) to large bodied vertebrates (*e.g.*, *Panthera onca*) (Pitman *et al.*, 2011). A particular advantage of boat surveys compared with terrestrial forest survey techniques such as line transect census is that the canopy is visible. Such advantages combined with the fact that researchers often use boats to access Amazonian study areas means that standardized boat surveys have the potential to provide a cost effective source of complementary data on sloth ecology.

As well as abundance estimates, our results show that boat surveys can also contribute with data on species natural history and behavior. We provided data on displacement (swimming) across rivers, which is a rarely documented behavior. We also provided the first observation on the consumption of leaves of the genus *Parkia* and the species *P. velutina* (Leguminosae – Mimosoideae) for *B. tridactylus*. The only previous description of the diet of wild *B. tridactylus* comes from an urban park in Belém (Pará State, Brazil) where this species was recorded eating leaves of *Hevea viridis* Huber. (Euphorbiaceae), *Elizabetha paraense* Ducke. (Leguminosae – Mimosoideae), and *Ceiba summa* Schum. (Bombacaceae) (Carvalho, 1960). In our study area, Leguminosae is the dominant family accounting for 23.9% of the species surveyed in a 1.9 ha forest plot (Pereira *et al.*, 2007). Yet there are no studies available to enable insights into the relative generality or selectivity of *B. tridactylus* feeding patterns.

Considering the lack of knowledge of this species and other sloths there is clearly a need to implement complementary field techniques that can be incorporated into current studies with a minimal increase in time and costs to improve the quantity and quality of existing data. This is especially true in remote Amazonian areas where access for researchers is provided by boat travel and terrestrial census and trap studies are more expensive (Pitman *et al.*, 2011).

We suggest that by integrating boat surveys with existing survey techniques it may be possible to cost-effectively generate broad scale comparative data on the distribution and abundance of sloths across Amazonia. Boat surveys can be conducted by people from the local community trained to identify sloths and other vertebrate species (Danielsen *et al.*, 2009). These people could combine the census

technique with other activities (*e.g.*, displacement to fish), thereby ameliorating the logistical constraints of time and money. This strategy could increase the number of sloths observed, sampling effort, and the data-to-cost ratio in long-term projects (Pitman *et al.*, 2011) as well as provide data on natural history of poorly studied sloth species.

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SHORT COMMUNICATION

Field metabolic rate, water flux and food consumption by free-living silky anteaters (*Cyclopes didactylus*) in Panama

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Abstract Wild silky anteaters (*Cyclopes didactylus*) were studied in Panama during the dry season using doubly-labeled water (DLW) to measure field metabolic rates (FMR) and water intake rates (WIR), and to estimate feeding rates. Their daily requirements for energy, food and water were low: only one- to two-thirds of those of typical eutherian mammals with the same body size. Anteaters' body-size-adjusted requirements were similar to, but higher than, those of sympatric three-toed sloths, another xenarthran species. Xenarthrans in general may have unusually low metabolic intensities and nutritional needs. Silky anteaters were strictly nocturnal, arboreal and myrmecophilous, and had relatively low body temperatures (31.5 °C).

Keywords: *Cyclopes didactylus*, daily energy expenditure, drinking behavior, feeding rate, field metabolic rate, silky anteater

Tasa metabólica de campo, flujo de agua y consumo de alimentos de Serafines del platanar (*Cyclopes didactylus*) silvestres en Panamá

Resumen Se estudiaron serafines del platanar (*Cyclopes didactylus*) en Panamá durante la estación seca con agua doblemente marcada (DLW) para medir las tasas metabólicas de campo (FMR), la tasa de ingesta de agua (WIR) y para estimar las tasas de alimentación. Sus requerimientos diarios de energía, alimento y agua fueron bajos: correspondían a uno a dos tercios de los valores típicos para mamíferos euterios de tamaño corporal similar. Los requerimientos de los serafines, ajustados por el tamaño corporal, fueron similares pero más altos que los registrados en otra especie de Xenarthra simpátrica, el perezoso de tres dedos. Los xenartros en general pueden tener intensidades metabólicas y necesidades nutricionales inusualmente bajas. Los serafines del platanar fueron estrictamente nocturnos, arbóreos y mirmecófagos, y tenían una temperatura corporal relativamente baja (31,5 °C).

Palabras clave: *Cyclopes didactylus*, comportamiento de consumo de agua, gasto diario de energía, serafín del platanar, tasa de alimentación, tasa metabólica de campo

The silky, or pygmy, anteater (*Cyclopes didactylus*) is sympatric with the three-toed sloth (*Bradypus variegatus*) on Barro Colorado Island in Lake Gatun, Panama. Both are in the Magnorder Xenarthra which, as a group, may have unusually low resting energy requirements (Irving *et al.*, 1942; McNab, 1978, 2002). In free-living three-toed sloths, we found that field metabolic rates (FMRs), which include costs of activity, thermoregulation, digestion, and other costs

of living above resting metabolic rates, were also unusually low (Nagy & Montgomery, 1980). We hypothesized that silky anteaters may also have comparatively low field metabolic rates. In addition, diet may influence resting or basal metabolic rates as well as field metabolic rates in mammals in general (see reviews by Speakman, 1997; Cruz-Neto & Bozinovic, 2004). Accordingly, we hypothesized that silky anteaters (insectivores) would have higher

body-mass-adjusted FMRs than the folivorous sloths living in the same habitat. The study described here included measurements of field metabolic rates, and water influx and efflux rates, along with estimates of feeding rates. We also determined body temperatures and recorded daily time budgets, which allowed us to estimate the energetic costs of sleeping and activity.

Free-ranging silky anteaters living in the rain forest around the Smithsonian Tropical Research Institute's field station on Barro Colorado Island, Panama were studied near the end of the dry season (April) in 1977. Animals were captured by noosing them while they slept in trees during the daylight hours. After an anteater was captured, a small radio-transmitter with whip antenna was taped to its tail temporarily to facilitate relocation and recapture (Montgomery *et al.*, 1973). Five individuals were recaptured on one to four occasions during different times of the day for measurement of body temperature (rectal, 1 cm deep) using a calibrated Tele-thermometer® (YSI) equipped with a blunt flexible probe. Ambient (shaded air) temperatures were measured adjacent to the anteaters immediately after measuring rectal temperatures.

Two radio-tagged anteaters were given doubly labeled water (DLW) (Nagy, 1980) in order to measure FMRs and water flux rates over time intervals lasting 3–4 days. The decline in hydrogen isotope concentration in a doubly labeled animal over time is a measure of the rate of water movement (gain and loss) through its body. The oxygen isotope traces both water and CO₂ loss, so the difference in the washout rates of the two isotopes is a measure of CO₂ production, or metabolic rate (Lifson & McClintock, 1966). An anteater was weighed (to ±1 g), a small (0.5 ml) blood sample was taken for measurement of background isotope levels, and the animal was given an intra-peritoneal injection of sterile water containing 0.9% NaCl, 90 atom % oxygen-18 and 0.10 milliCurie tritium per ml. After waiting at least 6 h for the labeled water to mix thoroughly in the body water space, another small blood sample was taken, and the animal was released where captured. The animal was recaptured three or four days later, weighed, and a blood sample taken before it was released again the next day. One of the animals was recaptured after 3.5 more days of free-living to obtain a third DLW measurement. Blood samples were analyzed at the University of California, Los Angeles, and rates of CO₂ production and water flux were calculated from isotope washout rates (Nagy, 1980; Nagy & Costa, 1980; and see details in Nagy & Montgomery, 1980). Body water volumes, required in the DLW calculations, were estimated as 0.754 l/kg body mass, which is the mean water content (determined as isotope dilution space; Nagy, 1980) of two injected anteaters. Labeled

anteaters were radio-located frequently while they were free-ranging, and times spent active and resting, and distances moved, were estimated.

Diet was determined by sampling stomach contents (via intubation) of five marked silky anteaters on Barro Colorado Island. Feeding rates were estimated three ways. First, recaptured anteaters were placed in cloth bags to collect all feces voided over the next 24 hours. They remained relaxed and quiet while in these bags. The feces were dried and examined microscopically, and were found to consist nearly entirely of ants of over two dozen morpho-species. The numbers of ant heads in each morpho-species seen were recorded. Then, samples of each morpho-species were collected in the field, and the fresh and dried mass of the individual ants were measured to obtain average dry and live body masses per ant head for each ant morpho-species seen in *Cyclopes* feces. Daily food intake by a given anteater was estimated by multiplying the numbers of heads of each morpho-species of ant in its 24-h feces collection by the average fresh and dry mass per head of that ant type, and adding these together. Secondly, feeding rates were estimated from field metabolic rates (in units of kJ/d) by calculating the mass of ants required to provide that amount of metabolizable energy. We calculated that the overall ant diet was 76% water (from fresh and dry masses of our ant morpho-species samples), that the ant dry matter was 90% digestible (from our data on dry matter per ant head in food samples and in feces samples), that 90% of the digested dry matter was available for energy metabolism (metabolizable energy ≈ 90% of assimilable energy; Nagy, 2004a), and that the metabolizable dry matter was mainly protein, having 23 metabolizable kJ/ metabolizable g dry matter (Nagy, 1980). These values yielded the conversion factors of 0.22 g fresh food consumed per kJ metabolized, and 0.054 g dry matter of food consumed per kJ metabolized. Third, we estimated feeding rates from water intake rates, by assuming that all water taken in by silky anteaters was part of the food, either the preformed water already in the food (its succulence) or water formed later during oxidation of the nutrients in the food (metabolic water). For these calculations, we assumed that the metabolizable dry matter in ants yielded 0.098 ml metabolic water per g fresh ant food, and 0.41 ml metabolic water per g dry matter of ant food (conversion factors from Nagy, 1983). Thus, total water in the anteater's food (preformed plus metabolic) was 0.858 ml/g fresh matter, and 3.58 ml/g dry matter, which yield the conversion factors of 1.17 g fresh food consumed/ml water intake and 0.28 g dry food consumed/ml water intake.

The body temperatures of four adult and one juvenile silky anteater in the field averaged only 31.5 °C (SD=0.7 °C; 14 measurements on five anteaters). This

was about 5.1 °C (SD=0.5 °C) above ambient (shaded air) temperatures measured at the same time, but about 6 °C below the body temperature of 37 °C that is typical of eutherian mammals (McNab, 2002). However, silky anteaters had body temperatures that were similar to those in the three-toed sloths living in the same habitat (Montgomery & Sunquist, 1978). Our data were too sparse to detect possible daily variation in body temperatures of silky anteaters.

Body masses remained rather constant over the approximately four-day DLW measurement periods, and averaged 269 g per animal (TABLE 1). Rates of water gain and water loss were nearly equal, and averaged about 21 ml/d, while field metabolic rates averaged 120 kJ/d. The small sample sizes and large confidence intervals (near 20%) for these average rate values suggest some caution in interpreting the following calculations that are based on these rates. The three different estimates of feeding rate were surprisingly similar: 19.3 g fresh food eaten/d (based on 24-h fecal collections), 24.1 g eaten/d (from FMR

measurements), and 26.3 g eaten/d (from water intake rates; TABLE 1).

The generally good agreement between feeding rates based on FMR (which we believe are the most reliable) and those based on water influx rates indicates that nearly all water intake can be accounted for by water in the food alone (preformed water plus metabolically produced water). This suggests that silky anteaters did not drink much free water during our measurements, even though there were rain showers nearly every day of the study. The water economy index (WEI) for free-living anteaters was calculated as the water intake rate, 21 ml/d, divided by the FMR, 120 kJ/d, to yield a value of 0.17 ml water intake per kJ of energy expenditure. This value is at the upper end of the range expected for an animal eating a carnivorous diet and not drinking any free water – 0.08 to 0.17 ml/kJ (Nagy, 2004b). This comparison further supports the suggestion that silky anteaters did not drink much water during our study period.

TABLE 1. Body masses and rates of mass change, water influx, water efflux, field metabolism, and estimated food consumption in free-living silky anteaters during the dry season on Barro Colorado Island, Panama. FMR=Field metabolic rate.

Animal number	5	9	9	Mean (SD)
Age, sex	Adult female	Adult male	Adult male	
Days elapsed	3.4	4.1	3.5	3.7 (0.38)
Body mass, g	241	279	286	269 (24)
Mass change rate, %/d	-0.12	+0.65	-1.65	-0.37 (1.17)
Water in, ml/d	18.7	20.1	22.9	20.6 (2.1)
Water out, ml/d	18.9	18.7	26.6	21.4 (4.5)
FMR, kJ/d	97.2	112.6	148.7	120 (26)
Food intake, g fresh/d (from feces)	12.3	22.9	22.7	19.3 (6.1)
Food intake, g fresh/d (from H ₂ O in)	21.9	23.5	26.8	24.1 (2.5)
Food intake, g fresh/d (from FMR)	21.4	24.8	32.7	26.3 (5.4)
Food intake, g dry/d (from FMR)	5.25	6.08	8.03	6.45 (1.43)

TABLE 2. Time-activity budgets, and estimated energy budgets of silky anteaters during the dry season on Barro Colorado Island, Panama. BMR=Basal metabolic rate. FMR=Field metabolic rate.

Animal number	5	9	9	Mean (SD)
Age, sex	Adult female	Adult male	Adult male	
Time sleeping, h/d	11.3	13.4	13.1	12.6 (1.1)
Time active/foraging, h/d	12.7	10.6	10.9	11.4 (1.1)
Distance traveled, m/d	56	73	99	76 (22)
Cost while sleeping, kJ/d	25.1	35.3	35.4	31.9 (5.9)
Cost while active, kJ/d	71.5	77.3	113.3	87.4 (22.7)
Cost of basal metabolism during activity period, kJ/d	28.9	27.9	29.4	28.7 (0.8)
Added cost of being active (above resting), kJ/d	42.6	49.4	83.9	58.6 (22.1)
Activity MR/BMR ratio	2.47	2.77	3.85	3.03 (0.73)
FMR/BMR ratio	1.80	1.78	2.29	1.96 (0.29)

Time budget and activity budget observations on telemetered, free-ranging silky anteaters showed that they were strictly arboreal and strictly nocturnal. They spent 12.6 hours per day (the daylight hours; **TABLE 2**) sleeping, curled up in the shade, hanging on lianas or small branches well below the canopy. They were active all night (11.4 hours per day), moving nearly constantly but slowly, and stopping briefly to feed at many ant colonies along their routes. They moved an average of 76 m each night. We used McNab's (1984) value for basal/resting metabolic rate (BMR) of silky anteaters to calculate the energy expenditures for sleeping anteaters and for the basal expenses during the activity period. Added costs of being active were determined by subtraction (**TABLE 2**). While active at night, anteaters were spending energy about three times as fast as when they were sleeping and were presumed to be at BMR. Over a 24-h period their FMR averaged 1.96 times BMR (**TABLE 2**).

Comparison with sloths and other mammals: The average field metabolic rate of free-living silky anteaters was only 38% [(120/316) kJ/d times 100] of the FMR expected for a eutherian mammal weighing 269 g (Nagy *et al.*, 1999). Their water flux rates averaged only 66% [(21/31.7) ml/d times 100] of that expected for a typical eutherian mammal (Nagy & Peterson, 1988), and their feeding rates averaged only 42% [(26.3/62.3) g fresh food/d times 100], on average, of that predicted for a 269 g eutherian mammal (Nagy, 2001). Sympatric three-toed sloths (data from Nagy & Montgomery, 1980) had FMRs that were 28% [(600/2154) kJ/d times 100] of that expected for a 4080 g eutherian mammal, their water flux rates averaged only 53% [(155/293) ml/d times 100] of the predicted rate, and their feeding rates averaged 35% [(61/176) g dry food/d times 100] of that expected (predictions derived from references cited above). Thus, both of these xenarthrans had unusually low energy, water, and food requirements. This supports our first hypothesis, that silky anteaters also had quite low energy, water and food needs for a mammal of their size. We suspect that xenarthrans in general may have unusually low FMRs and food requirements.

The observations that silky anteaters had apparently higher size-adjusted relative FMRs than sloths (38% vs. 28% of predicted for a eutherian), higher size-adjusted relative water fluxes (66% vs. 53%), and higher size-adjusted relative feeding rates (42% vs. 35%) supports the dietary effect hypothesis of McNab (1986) that, as insectivores, silky anteaters should have relatively higher resource requirements than do the folivorous three-toed sloths (but see Cruz-Neto & Bozinovic, 2004). Unfortunately, the small sample sizes available for silky anteaters preclude adequate statistical comparisons at this time, so these differences remain suggestive only.

The FMR/BMR ratio of 1.96 for silky anteaters is similar to that of 1.80 for three-toed sloths (Nagy & Montgomery, 1980). This indicates that both of these xenarthrans were not working very hard to maintain themselves in the rain forest. Similarly, howler monkeys (*Alouatta palliata*) living in the same forest, which have a much higher size-adjusted BMR and FMR, close to those of typical eutherians, had an FMR/BMR ratio of 1.98 (Nagy & Milton, 1979). These large monkeys were using energy much faster than the xenarthrans for both resting and being active, but their relative intensity of work (above BMR) to maintain themselves was about the same. All three of these arboreal mammals living on Barro Colorado Island have energetically conservative life styles. Many species of eutherian mammals, marsupial mammals, and birds have FMR/BMR ratios that are well above 2.0, and some species in all three taxa have FMR/BMR ratios between 5 and 7, all while maintaining constant body mass in their natural habitats (Peterson *et al.*, 1990).

In summary, silky anteaters (mean body mass 269 g), studied in the field in Panama during the dry season, had energy, food and water requirements that were only one-third to two-thirds of those expected for a typical free-living eutherian mammal of their body size. Their reduced resource requirements resulted mainly from a reduced basal metabolic rate and low body temperature (31.5 °C), and a sedentary, nocturnal, arboreal life style, moving only about 76 m per night while foraging. They ate only ants, mainly from arboreal ant colonies. The very low energy, food and water needs of these anteaters were similar to those of another xenarthran living in the same forest: the three-toed sloth. There are indications that the apparently higher body-size-adjusted resource needs of silky anteaters (myrmecophagous) compared with those of three-toed sloths (folivorous) may be related to diet differences.

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SHORT COMMUNICATION

Size and orientation of giant armadillo burrow entrances (*Priodontes maximus*) in western Formosa province, Argentina

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Abstract Giant armadillos (*Priodontes maximus*) are one of the most endangered mammals in the Gran Chaco. They are largely nocturnal, highly fossorial and solitary, characteristics that have limited the understanding of their behavior and ecology. We report on the results of a study of the structure of 32 giant armadillo burrows in 25,000 ha of semi-arid forest owned by Toba aborigines of Formosa, Argentina. Burrow entrances were on average 43 cm wide and 36 cm high and more likely to be facing west (24) than east (8).

Keywords: Argentinean Chaco, giant armadillo burrows, *Priodontes maximus*

Tamaño y orientación de cuevas de tatú carreta (*Priodontes maximus*) en el oeste de la provincia de Formosa, Argentina

Resumen Los tatú carreta (*Priodontes maximus*) son uno de los mamíferos en mayor peligro de extinción del Gran Chaco. Son animales principalmente nocturnos, fosoriales y solitarios, características que han limitado el conocimiento sobre su comportamiento y ecología. Presentamos en este trabajo los resultados de un estudio para caracterizar la estructura de 32 cuevas de tatú carreta en 25,000 ha de bosques semi-áridos propiedad de comunidades Toba de Formosa, Argentina. Las entradas de las cuevas eran, en promedio, de 43 cm de ancho y 36 cm de alto, y estaban más frecuentemente orientadas hacia el oeste (24) que hacia el este (8).

Palabras clave: Chaco argentino, cuevas del armadillo gigante, *Priodontes maximus*, tatú carreta

Giant armadillos are the largest of the armadillos, with a head-to-body length of approximately 89 cm and an average adult body mass of 30–40 kg (Redford & Eisenberg, 1992; Meritt, 2008). They range over most of South America, from Colombia and northern Venezuela to Paraguay and northern Argentina (Silveira *et al.*, 2009; Srbe-Araujo *et al.*, 2009; Abba & Superina, 2010; Torres & Jayat, 2010). They are found in the tropical forests of Amazonia, as well as in the open savannas of the Cerrado and Gran Chaco. The species has been classified as Vulnerable at the global level by the IUCN Red List of Threatened Species (Superina & Abba, 2010) and in Argentina its populations are threatened with extinction due to hunting and habitat destruction (Porini, 2001).

Giant armadillos are rarely seen because they are largely nocturnal, highly fossorial and solitary animals (Carter, 1983; Carter & Encarnaçao, 1983; Redford & Eisenberg, 1992; Vizcaíno & Milne, 2002; Cuéllar & Noss, 2003; Noss *et al.*, 2004). They are extremely powerful diggers that dig for food (mainly ants and termites) and refuge (Carter & Encarnaçao, 1983; Redford & Eisenberg, 1992).

We report here information on the size and orientation of giant armadillo burrow entrances found in 25,000 ha of semi-arid forest owned by 12 Toba communities in Formosa Province, Argentina. The area is part of the semiarid Argentinean Chaco (61°–62°W, 23.5°–23.7°S), which is characterized by low xeric vegetation, patches of thorny

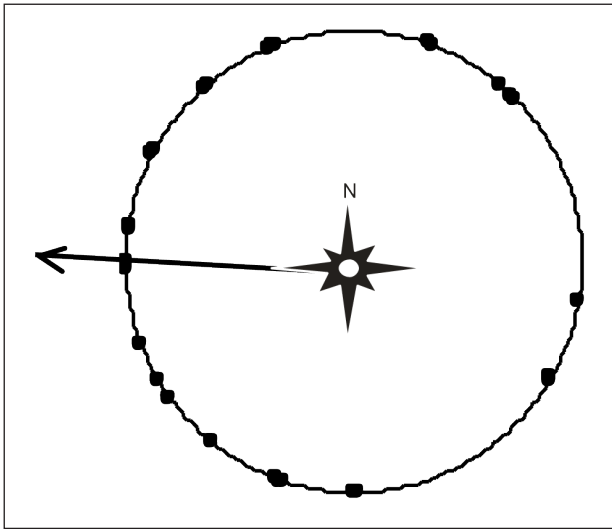


FIGURE 1. Compass orientation of 32 giant armadillo burrows. The average orientation is indicated with a black solid arrow.

bushes, bromeliads, and cacti (Morello & Horts, 1987; Adámoli *et al.*, 1990).

After signing an agreement between the Toba civil association and Fundación ECO of Formosa, a group of 12 Toba men volunteered to report to us the burrows they found while actively searching for them or during their daily activities. One of us (NC) traveled to the field site monthly to visit the burrows that had been found. For each burrow, we measured the length and the width at the entrance of the burrows using a measuring tape, and the slope of the entrance with a clinometer. We recorded the compass orientation of the burrow's entrance from inside the burrow. The statistical significance of the variation in the compass orientation of the burrow's entrance was tested with the Rayleigh's test for circular uniformity (Zar, 1999). The sample sizes for the different results varied because not all measurements were possible in all burrows.

The Toba volunteers found 32 burrows between January and December 2003. The majority of burrows (94%) were located on ant mounds and the remaining ones ($n=2$) on the ground. Although these data may suggest a strong preference for digging the burrows in ant mounds, it is possible that the results were influenced by biases in the searches conducted by the Toba. The Toba, given the conspicuousness of ant mounds in the landscape, and aware of the association between ant mounds and burrows, may have been visually searching for ant mounds instead of giant armadillo burrows.

Burrows were more frequently facing west ($n=24$) than east ($n=8$, **FIG. 1**). The difference between the number of burrows facing west or east was statistically significant as indicated by the Rayleigh's

test for circular uniformity ($R_{0.05, 32}$: 9.87, $z=3.04$, mean angle: 273.3°).

Given that a western orientation maximizes the amount of heat reaching the entrance to the burrow, this orientation may be an adaptive response to handle the relatively cold days of the Chaco, as it seems to be the case with other armadillo taxa (Carter, 1983; González *et al.*, 2001; Abba *et al.*, 2005).

The average length of the burrows was 36 ± 7 cm, whereas the average width of the entrance was 43 ± 9 cm ($n=27$). The average entrance slope was $26\pm 7^\circ$ ($n=23$). These results are in general good agreement with the existing data on the structure of giant armadillo burrows. The average length and the average width were a little larger than the burrows measured by Carter (1983) in Serra da Canastra National Park, Brazil (30.8 cm and 41.3 cm, respectively), but the slope of the entrance was similar.

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COMUNICACIÓN BREVE

Nuevo registro del cabasú chaqueño, *Cabassous chacoensis* Wetzel, 1980 para la Provincia de Córdoba, Argentina

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Resumen Se reporta un nuevo registro del cabasú chico o quirquincho blanco, *Cabassous chacoensis* Wetzel, 1980 para la provincia de Córdoba, Argentina. Un individuo macho fue hallado en las proximidades de El Quemado (Dpto. Pocho, pedanía Chancaní), mientras atravesaba un camino rural. El sitio pertenece al Chaco Árido y presenta una fisonomía de arbustal abierto con escasos árboles y signos de disturbios relacionados con ganadería extensiva, tala e incendios. Este registro permite ampliar su distribución para Córdoba, representando la observación más austral para la provincia.

Palabras clave: Armadillos, *Cabassous chacoensis*, cabasú chico, Chaco Árido, distribución, Xenarthra

New record of the Chacoan naked-tailed armadillo, *Cabassous chacoensis* Wetzel, 1980 in Cordoba Province, Argentina

Abstract A new record of the Chacoan naked-tailed armadillo, *Cabassous chacoensis* Wetzel, 1980 is reported for Córdoba province, Argentina. A male was found while it was crossing a rural road near El Quemado (Dept. Pocho, *pedanía* Chancaní). The location belongs to the Arid Chaco and presents an open shrubland with few trees and signs of disturbance related to intense cattle grazing, logging, and fires. This record allows to extend the range of this species, as it represents the southernmost observation in the province.

Keywords: Arid Chaco, armadillo, *Cabassous chacoensis*, Chacoan naked-tailed armadillo, distribution, Xenarthra

El cabasú chico, quirquincho blanco o tatú de rabo molle, *Cabassous chacoensis* Wetzel, 1980 es una especie principalmente chaqueña que habita bosques xerófilos poco densos y sabanas abiertas (Wetzel, 1985a, b).

Su alimentación se basa principalmente en hormigas y termitas, a las que logra acceder luego de romper las colonias con sus fuertes garras (Chebez, 1994; Canevari & Vaccaro, 2007). Este armadillo es considerado un excelente cavador. Sus hábitos fosoriales, nocturnos y solitarios probablemente influyan en que los avistajes de esta especie sean poco frecuentes (Chebez, 1994; Smith, 2008), ya que se entierra en grandes hormigueros y solo es posible observarlo cuando se muda de un lugar de alimentación a

otro (Chebez, 1994). Esto a su vez dificulta la determinación de su abundancia y distribución, como así también contar con información exhaustiva sobre su biología.

La distribución de *C. chacoensis* se extiende al oeste de Paraguay y centro-norte de Argentina (Abba & Superina, 2010; IUCN, 2010). En Argentina, esta especie ha sido registrada en varias provincias: Chaco, Formosa, Santa Fe, Santiago del Estero y Tucumán (Vizcaíno *et al.*, 2006; Abba *et al.*, 2012); Agüero *et al.* (2005) la mencionan para las proximidades de Chamental, La Rioja; mientras que Nellar *et al.* (2008) la citan para el norte de San Luis. Más recientemente, Monguillot & Miatello (2009) hallaron un ejemplar

de *C. chacoensis* en el Parque Nacional Talampaya, La Rioja.

En cuanto a la provincia de Córdoba, la presencia de *C. chacoensis* ha sido largamente discutida, puesto que por mucho tiempo faltaron capturas que la confirmaran. Hasta la fecha hay dos registros publicados (Morando & Polop, 1997; Luaces *et al.*, 2010). El primero pertenece a un ejemplar de la colección del Museo Regional Morteros en base al cual se infiere la presencia de la especie en la provincia, aunque Morando & Polop (1997) no mencionan la localidad del registro. Consultas realizadas al personal del nombrado museo, a fin de conocer dicha localidad, fueron infructuosas. El segundo registro (Luaces *et al.*, 2010) corresponde a la localidad de Santo Domingo, al noroeste de la provincia.

Al ser una especie poco muestreada, no se conocen los límites de su distribución en la provincia de Córdoba; el presente trabajo realiza un aporte en tal sentido.

El día 15 de marzo de 2012, mientras se seleccionaban sitios de muestreo para un proyecto de investigación sobre los armadillos de la zona, se efectuó una captura viva de un ejemplar macho de *C. chacoensis* (FIG. 1). El mismo se encontraba atravesando un camino rural, aproximadamente a las 14:00 hs, en las cercanías de El Quemado (Departamento Pocho, pedanía Chancaní, 31°26'37,9"S, 65°35'29,7"W, FIG. 2).

El sitio pertenece al Distrito Chaqueño Occidental (Cabrera, 1976) de la provincia fitogeográfica del Chaco Árido (Morello *et al.*, 1985). Se trata de un área de arbustal abierto con escasos árboles y signos de disturbios relacionados con ganadería extensiva, tala e incendios. Las especies arbustivas principales son: lata (*Mimozyanthus carinatus*), jarilla (*Larrea divaricata*), espinillos (*Acacia caven*, *A. aroma*),

garabato macho (*Acacia atramentaria*), entre otras. En el estrato arbóreo se cuentan ejemplares aislados de algarrobos (*Prosopis* spp.) y quebrachos blancos (*Aspidosperma quebracho-blanco*).

En cuanto a las características externas del ejemplar capturado, su caparazón presentó 13 bandas móviles y midió 30 cm desde el extremo del hocico hasta el punto de inflexión de la cola, mientras que el largo total de la cola fue de 9 cm. Luego de ser medido y

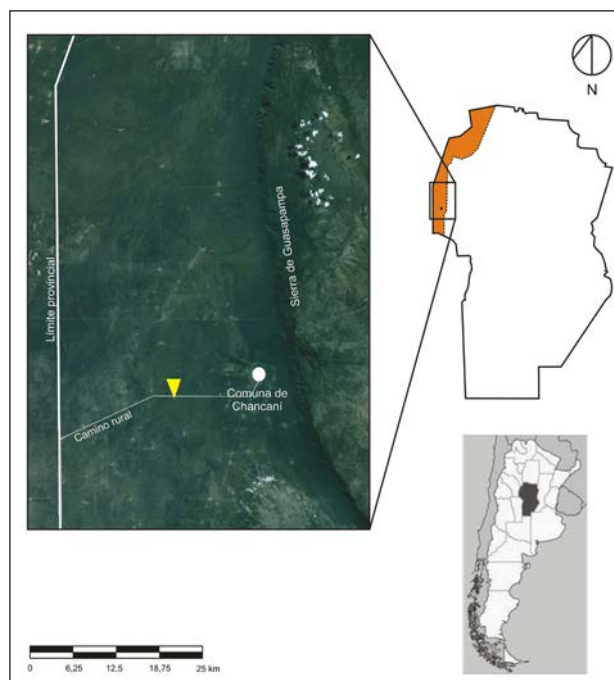


FIGURA 2. Localización del nuevo registro de *Cabassous chacoensis* en Córdoba, Argentina. En el área ampliada se muestra el sitio del hallazgo (triángulo amarillo) y las referencias geográficas más cercanas al mismo. A la derecha, se presenta el mapa de la provincia de Córdoba con la localización del área ampliada y, en naranja, el área de distribución provincial para la especie según IUCN (2010).



FIGURA 1. Ejemplar macho de *Cabassous chacoensis* capturado en proximidades de El Quemado, provincia de Córdoba.



FIGURA 3. *Cabassous chacoensis* cavando activamente tras ser liberado en proximidades de El Quemado, provincia de Córdoba, Argentina.

fotografiado, el individuo fue liberado, tras lo cual se introdujo rápidamente en una cueva (Fig. 3).

Este nuevo registro permite ampliar la distribución de la especie en el oeste de Córdoba, siendo hasta el momento la observación más austral para esta provincia. A partir del trabajo que se está llevando a cabo en el área se espera realizar nuevos aportes de esta especie y de los demás armadillos.

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SHORT COMMUNICATION

New records of giant armadillo *Priodontes maximus* (Cingulata: Dasypodidae) at Serra do Amolar, Pantanal of Brazil

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Abstract The giant armadillo is one of the least studied South American mammals. It is classified as Vulnerable due to habitat loss and subsistence hunting. This species has been recorded at several sites within the Pantanal biome of Brazil. We aimed to confirm the species presence in Serra do Amolar, in the western border of the Pantanal. Using camera traps and burrow censuses we confirmed its presence in an area with no previous information. Nevertheless, it is necessary to assess the population status and to gather more information about its ecology in order to contribute to its regional conservation.

Keywords: camera trap, conservation, giant armadillo, *Priodontes maximus*, Serra do Amolar

Novos registros do tatu-canastra *Priodontes maximus* (Cingulata: Dasypodidae) na Serra do Amolar, Pantanal do Brasil

Resumo O tatu-canastra é um dos mamíferos sul-americanos menos estudados, e, atualmente, classificado como Vulnerável devido à perda de habitat e à caça de subsistência. A espécie foi registrada em vários locais dentro do bioma Pantanal, Brasil. Nosso objetivo foi confirmar a presença do tatu-canastra na Serra do Amolar, na fronteira oeste do Pantanal. Através de armadilhas fotográficas e censo de tocas pudemos confirmar a presença da espécie em uma área onde não havia informação. No entanto, é necessário avaliar o estado da população e obter mais informações sobre sua ecologia, a fim de contribuir para sua conservação a nível regional.

Palavras-chave: armadilhas fotográficas, conservação, Pantanal, *Priodontes maximus*, Serra do Amolar, tatu-canastra

The giant armadillo, *Priodontes maximus* (Kerr, 1792), is the largest armadillo among the 21 extant species (Abba & Superina, 2010), and is classified by the IUCN Red List of Threatened Species as Vulnerable with a decreasing population trend (IUCN, 2012). Major threats include habitat loss,

subsistence hunting, and illegal capture for animal collectors (Fonseca & Aguiar, 2004; Abba & Superina, 2010).

Although widely distributed in South America, the giant armadillo seems to occur at low population densities, with a patchy distribution (Aguiar &

Fonseca, 2008). It is solitary, nocturnal or crepuscular, highly fossorial, and rarely observed (Eisenberg & Redford, 1999). Due to its cryptic nature, it is also one of the least studied mammals (Silveira *et al.*, 2009).

According to Silveira *et al.* (2009) the information on giant armadillo ecology has mainly been obtained from indirect signs, sporadic sightings, or dead animals, including in some areas of Pantanal (Schaller, 1983; Alho *et al.*, 1987; Coutinho *et al.*, 1997; Schneider, 2000). In the past few years, the increasing use of camera-trapping provided new evidence of its presence, for example in Chiquitano and Chaco forests of Bolivia (Noss *et al.*, 2004), the grassland-savannahs of central Brazil (Silveira *et al.*, 2009), the Atlantic forest (Srbek-Araujo *et al.*, 2009), and again in Pantanal (Trolle, 2003; Trolle & Kéry, 2005). Despite the increasing data on its distribution some aspects of its ecology remain poorly understood.

In this study we report the first record from camera trapping of the giant armadillo in the region of Serra do Amolar in the western Pantanal, a biome known for its unique abundance of wildlife (Trolle, 2003) that preserves more than 80% of its original vegetation coverage (Sollmann *et al.*, 2008). Although its presence in the area was already confirmed since the 1970s (Schaller, 1983), we obtained the first record from camera traps for Serra do Amolar.

The study was carried out in the 200 km² Engenheiro Eliezer Batista Private Natural Heritage Reserve (RPPN EEB), located on the western border of Pantanal, between the Paraguay river and lake Mandioré on the Bolivian border, 180 km north of Corumbá (18°05'26"S, 57°18'29"W). The area consists of several rocky peaks (highest altitude of 870 m asl) and flooded plains, and contains a mixture of plant communities, such as moist tropical rainforest plants, semi-arid woodlands, Brazilian Cerrado, and grasslands. Here the ecosystem suffers drastic alterations during the year with an inundation and a desiccation phase, which can alter the spatial ecology of most animal species. Average yearly rainfall is 1,000–1,400 mm, with most precipitation occurring between November and March. Mean temperature is 25 °C but temperatures can fluctuate from 0 to 40 °C. During the rainy season the water level can rise between two and five meters, which isolates most of the peaks. Human presence is low with sparse fishermen settlements along the Paraguay river. The predominant soil in the area is sandy.

The PNHR EEB was created in 2008 by private initiative in order to enhance the conservation efforts of Pantanal Matogrossense National Park. In partnership with other private institutions the PNHR EEB also takes part of Rede de Proteção e Conservação da Serra do Amolar (RPCSA), a multi-organizational conservation framework for Serra do Amolar that legally protects 209,000 ha of Pantanal

biome (Bertassoni *et al.*, 2012), since the Brazilian Environment Ministry classifies Serra do Amolar as an area of extremely high importance and priority for biodiversity conservation (MMA, 2007).

We undertook transects along the main roads from March until September 2011 in order to identify potential signs of presence, such as tracks, scats, and burrows. We conducted daily surveys once a month over a period that ranged from two to four days. To complement data collection, we also conducted a camera trapping survey between August and September 2011 in order to assess mammal biodiversity. The rapid expansion of camera trap surveys for detecting elusive species has led to the extensive application of this technique as camera technology has improved and equipment costs decreased (Kelly & Holub, 2008). Twenty-three camera traps (12 Bushnell Trophycam[®] digital cameras and 11 Tigrinus 6.0 C[®] analog cameras) were installed along the main dirt roads and in the hills in a trapping grid arrangement with an average of 400 m between cameras. All cameras were programmed to operate continuously (24 h / day) and to take pictures with a minimum interval of 30 s for the digital models, and 5 min for the analog models. The geographic coordinates of camera traps, photographic captures, and presence signs were recorded in a GPS navigator and exported to ArcGis 10 (ESRI[®]). Sampling effort and sampling success were calculated following Srbek-Araujo & Chiarello (2005).

With an effort of 550 trap-days we obtained two captures of giant armadillo (0.36 captures per 100 camera-days) from camera traps installed on one of the roads and in the valley (**FIG. 1**). The animals were registered at night, and because of their position we were not able to determine their sex. The giant armadillo was the only *Xenarthra* species recorded on this camera trapping effort but other species have been detected by camera traps previously installed in the protected area, such as the nine-banded armadillo (*Dasybus novemcinctus*), six-banded armadillo (*Euphractus sexcinctus*), and giant anteater (*Myrmecophaga tridactyla*) (Instituto Homem Pantaneiro, unpublished data). Although further studies are planned to gather information about the ecology and conservation status of these *Xenarthra* species, they seem to occur at low densities at the PNHR EEB, since the area has large flooded fields in proportion to the dry lands.

Our census effort comprised approximately 40 hours, and we identified three distinct burrows along two main roads of the RPPN EEB. The first burrow was located under an anthill, and there were three entrances around the mound. The second burrow was found on the road, under a fallen trunk, and the third burrow was found beside the dirt road, in a sand bank formed due to the accumulation of soil taken to open the road (**FIG. 1**). The point where this

hole was dug was covered by vegetation, and there were no signs of ant or termite mounds.

Although in recent years new information has been obtained about giant armadillos, this species is still poorly known. Most of this knowledge has been obtained by the use of camera trapping methodology. In this context, camera traps have been shown to be an efficient and non-invasive tool to study important ecological aspects of the species such as activity patterns, density estimates, habitat use, home range, and interaction with other species (Noss *et al.*, 2004; Silveira *et al.*, 2009; Srbek-Araujo *et al.*, 2009).

In a study conducted in the upper Rio Negro Basin, Trolle (2003) concluded that camera trapping allows analyzing the field biology of many species to a degree of precision that had not been published before in the region of the study area. Yet, he found only one old burrow of a giant armadillo in Acuri (*Attalea phalerata*) forest, and the species was never recorded by camera trapping, seeming to be rare.

In a review, Rodrigues *et al.* (2002) detailed other areas within the Pantanal where giant armadillo presence was confirmed such as the upper Paraguai river basin, in the region of Manso river hydroelectric power plant (Schneider, 2000), Serra do Amolar, in Acurizal ranch (Schaller, 1983), Chapada

dos Guimarães (Cope, 1889), and Nhumirim ranch (Alho *et al.*, 1987). Also, a giant armadillo was photographed with a conventional camera at Fazenda 4 Cantos, in the Pantanal of Nhecolândia (18°36'54"S, 56°16'59"W), in 2011. The picture was taken by Mr. Pablo Lima, one of the farm owners, and shown to one of the authors (GEOP). The species was also registered by Trolle (2003) in the upper Rio Negro basin, and in the northern Pantanal by Trolle & Kéry (2005) (FIG. 2).

The most recent previous sign of giant armadillos in Serra do Amolar dates back to the late 1970s, at the Acurizal ranch, 30 km north of our study area. At that time, Schaller (1983) concluded that this species was very rare or recently extinct on the ranch, and only a few abandoned burrows were found in Cerrado and gallery forest.

Our research confirms the species' presence in Serra do Amolar both by signs and by photos. Nevertheless, it is necessary to gather information on habitat use, population density, interactions, and feeding ecology, as well as to assess its population status at Serra do Amolar in order to fill gaps in scientific knowledge and to strategically contribute to conservation planning.

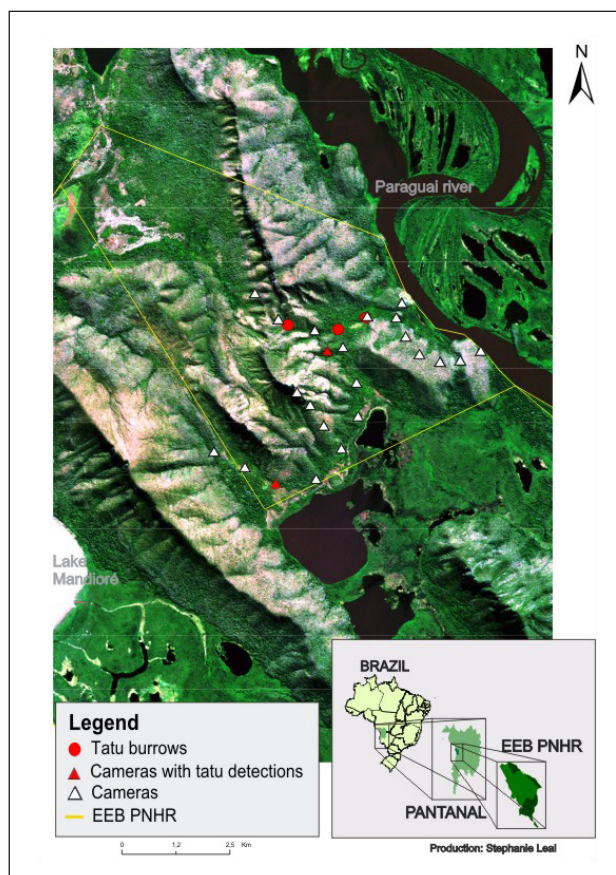


FIGURE 1. Location of Engenheiro Eliezer Batista Protected Area (EEB PNHR), and locations of giant armadillo captures and signs.



FIGURE 2. Giant armadillo detections in the Brazilian Pantanal. 1: Schneider (2000); 2: Cope (1889); 3: Trolle & Kéry (2005); 4: Schaller (1983); 5: this study; 6: P. Lima, pers. comm.; 7: Alho *et al.* (1987); 8: Trolle (2003).

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SHORT COMMUNICATION

The charismatic giant anteater (*Myrmecophaga tridactyla*): a famous John Doe?

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Abstract Species conservation depends on biological knowledge. This study evaluates the current level of scientific knowledge of the giant anteater (*Myrmecophaga tridactyla*). We conducted a bibliographic search in Web of Science and in Edentata and recovered 81 articles related to the species, scattered throughout 47 journals. Ecology represents the most studied research theme (25 articles) and only 12 articles focus on conservation. There are more *in situ* (48 articles) than *ex situ* (32 articles) studies. The small number of conservation articles is cause of concern. Unfortunately the lack of basic knowledge may be one of the reasons hampering the implementation of conservation studies.

Keywords: giant anteater, *Myrmecophaga tridactyla*, scientometrics

O carismático tamanduá-bandeira (*Myrmecophaga tridactyla*): um famoso João Ninguém?

Resumo Conservar espécies depende do conhecimento sobre as mesmas e suas relações com o ambiente. Avaliamos o nível do conhecimento científico sobre o tamanduá-bandeira (*Myrmecophaga tridactyla*). Realizamos uma pesquisa bibliográfica no Web of Science e na Edentata e obtivemos 81 artigos, distribuídos em 47 periódicos. Ecologia é o tema mais estudado (25 artigos) e apenas 12 artigos abordaram a conservação da espécie. Existem mais estudos *in situ* (48 artigos) do que *ex situ* (32 artigos). O pequeno número de artigos sobre conservação da espécie é motivo de preocupação. Infelizmente, a falta de conhecimentos biológicos básicos pode ser um limitante na conservação desta espécie.

Palavras-chave: cienciometria, *Myrmecophaga tridactyla*, tamanduá-bandeira

The current biodiversity crisis is one of the front issues in conservation biology (Singh, 2002). A global review of the conservation status of mammals shows that 25% of all known species are listed as threatened by extinction (Schipper *et al.*, 2008). Besides that, mammal population losses predict that more mammal species are likely to decline (Ceballos & Ehrlich, 2002; Yackulic *et al.*, 2011). Biological knowledge on organisms is of utmost importance in attempts to halt population declines (Greene, 2005). Unfortunately, it seems that academic interest in mammal natural history and basic biology is dwindling (Schmidly, 2005; Hafner, 2007; Weigl, 2009; Cotterill & Foissner, 2010). Since current conservation spotlight is skewed towards charismatic species (*e.g.*, Walpole & Leader-Williams, 2002; Home *et al.*,

2009), one might expect that such species are better known by scientists than non-charismatic species (Amori & Gippoliti, 2000). However, this general trend might not hold true for particular species and/or regions (*e.g.*, Brito *et al.*, 2009).

In order to tackle with this issue, we use the giant anteater (*Myrmecophaga tridactyla*) as a case study to evaluate the current level of scientific biological knowledge of a charismatic Neotropical species. The giant anteater is a good model for our analysis, since it is charismatic and listed as threatened (under the category Vulnerable), and its population declines are particularly worrisome (IUCN, 2012).

We conducted a bibliographic search in Thomson's ISI Web of Science (<[76](http://portal.</p></div><div data-bbox=)

isiknowledge.com>) and in the journal Edentata, using as keywords the scientific (*Myrmecophaga tridactyla*) or the common name (giant anteater) of our focus species. We included in our analyses all articles published between 1957 and 2011. For each article, we collected the following data: (a) year of

publication; (b) journal where the article was published; (c) country where the study was conducted (for articles that were based on fieldwork); (d) country of author affiliation; (e) research theme (anatomy, biochemistry, conservation, ecology, ethology, evolution, genetics, histology, microbiology, parasitology, veterinary, zoology); and (f) if the research had an *in situ* (fieldwork) or an *ex situ* (e.g., zoos, captive populations) approach.

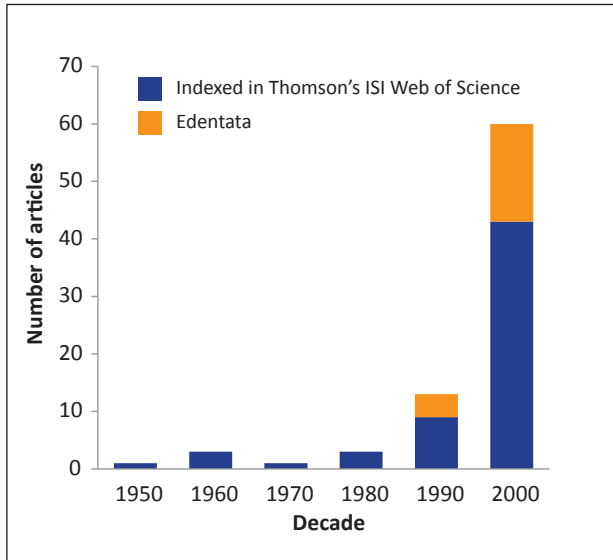


FIGURE 1. Total number of articles on giant anteater (*Myrmecophaga tridactyla*) biology published in journals indexed in Thomson's ISI Web of Science (<<http://portal.isiknowledge.com>>) and in Edentata per decade.

Our search recovered 81 articles on the giant anteater published between 1957 and 2011 (a mean value of 1.5 articles per year throughout the period) (see **APPENDIX 1** for a list of articles retrieved in our bibliographic search). It is noticeable that there is an increase of articles across time with the majority of publications targeting the species originating in the last decade (**FIG. 1**). The giant anteater was the focus of research in 54 articles (single-species articles), while it was a secondary objective present in broader-approach articles (e.g., multi-species articles on mammals) in 27 articles. The articles on giant anteater biology are scattered throughout 46 different journals indexed in Thomson's ISI Web of Science plus Edentata (**FIG. 2**). Only eight journals published more than one article focusing on the species, concentrating 52% of all published articles in these few periodicals (**FIG. 2**). The majority of studies on giant anteaters were conducted in Brazil (both *in situ* and *ex situ* studies) and the USA (*ex situ* studies) (**FIG. 3**).

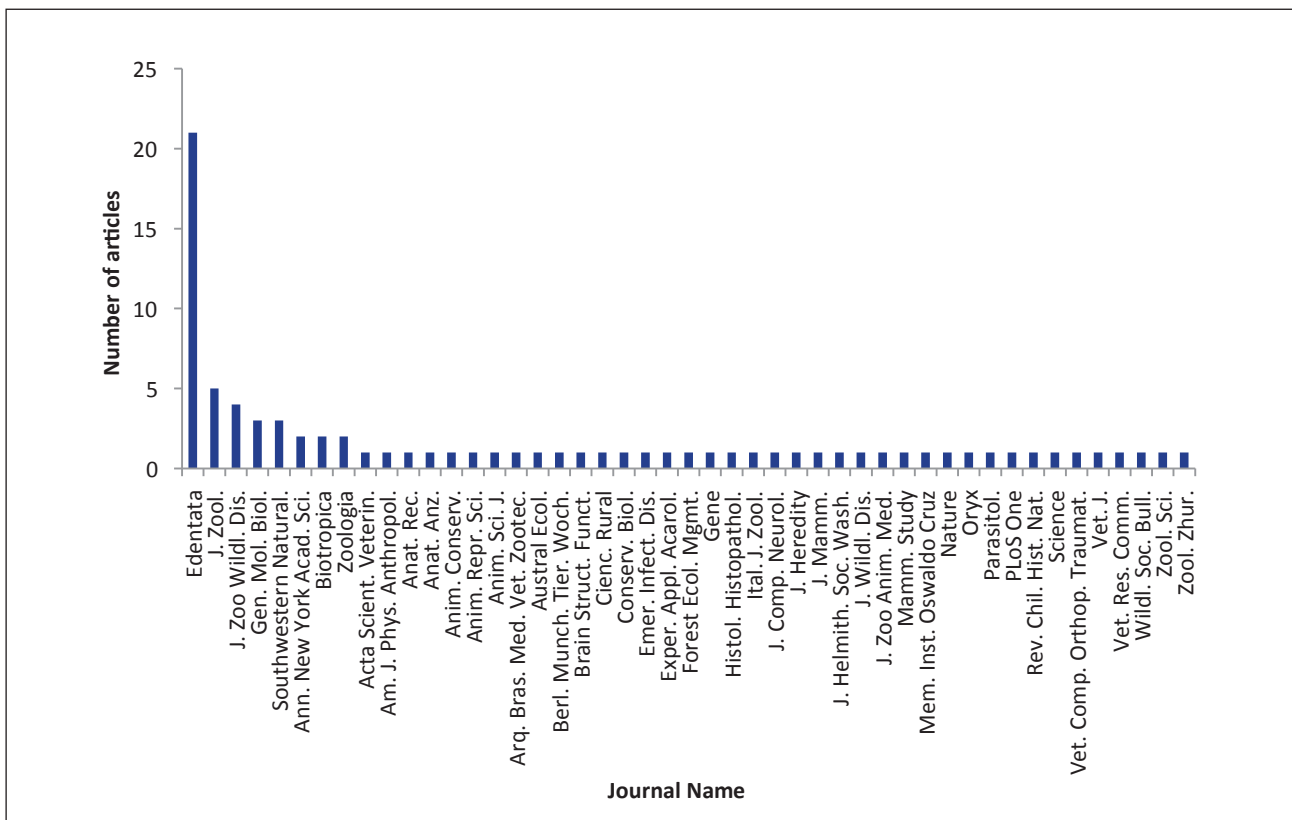


FIGURE 2. Number of journals indexed in Thomson's ISI Web of Science plus Edentata that have published articles on giant anteater (*Myrmecophaga tridactyla*) biology.

The majority of researchers working with the species are also affiliated to institutions located in Brazil and the USA (FIG. 4). Ecology and anatomy are the research themes that accumulate more articles (FIG. 5). A total of ten articles deal with conservation of the giant anteater (FIG. 5). There are 44 articles focusing on giant anteaters in the wild (*in situ*), 28 articles on *ex situ* research (captive breeding, zoos, museums), and three articles both with *in situ* and *ex situ* issues.

It is surprising that the overall knowledge for such a charismatic species is not that comprehensive. Even though our results show a wide array of themes, there are relatively few articles for each area of knowledge (FIG. 5). Besides that, even though the giant anteater is a widespread species in the Neotropics (IUCN, 2012), *in situ* studies cover only a small number of sites/populations (TABLE 1) and suggest that current knowledge is not necessarily

TABLE 1. A list of sites that have been the target of *in situ* studies on giant anteater (*Myrmecophaga tridactyla*) biology. See Appendix 1 for complete citations.

<i>In situ</i> research site	Coordinates	References
Embrapa Pantanal, Nhumirim, Brazil	18°59'S; 56°39'W	Mourão & Medri (2002)
	18°59'S; 56°39'W	Medri (2003a;b)
	18°59'S; 56°39'W	Rodrigues <i>et al.</i> (2003)
	18°59'S; 56°39'W	Medri & Mourão (2005)
	18°59'S; 56°37'W	Camilo-Alves & Mourão (2006)
	18°59'S; 56°39'W	Rocha & Mourão (2006)
	18°59'S; 56°39'W	Mourão & Medri (2007)
	18°59'S; 56°39'W	Desbiez & Medri (2010)
Emas National Park, Brazil	18°19'S; 52°45'W	Redford (1985)
	18°19'S; 52°45'W	Silveira <i>et al.</i> (1999)
	Not informed	Bechara <i>et al.</i> (2002)
	18°19'S; 52°45'W	Sanderson & Silveira (2003)
	Not informed	Lima <i>et al.</i> (2004)
	18°18'S; 52°54'W	Garcia <i>et al.</i> (2005)
	18°15'S; 52°53'W	Collevatti <i>et al.</i> (2007)
Not informed	Vynne <i>et al.</i> (2009)	
Roraima, Brazil	02°49'N; 60°39'W	Kreutz <i>et al.</i> (2009)
Rio das Mortes Xavante Reserve, Brazil	Not informed	Leeuwenberg (1987)
	Not informed	Prada & Marinho-Filho (2004)
Bragança, Brazil	Not informed	Barros <i>et al.</i> (2003)
Brasília National Park, Brazil	15°35'S; 48°05'W	Lacerda <i>et al.</i> (2009)
Serra da Canastra National Park, Brazil	20°20'S; 46°38'W	Shaw <i>et al.</i> (1987)
Jaguariaíva, Brazil	24°15'S; 49°42'W	Braga <i>et al.</i> (2010)
Noël Kempff Mercado National Park, Bolivia	14°33'S; 60°55'W	Emmons <i>et al.</i> (2004)
Bosawas Biosphere Reserve, Nicaragua	18°30'S; 84°59'W	Koster (2008)
Rio Plátano Biosphere Reserve, Honduras	14°44'S; 84°40'W	McCain (2002)
Honduras	<i>a</i>	Portillo <i>et al.</i> (2010)

a: Portillo *et al.* (2010) reviewed the occurrence of giant anteater in Honduras and provided several point localities with coordinates where the species was recorded within the country.

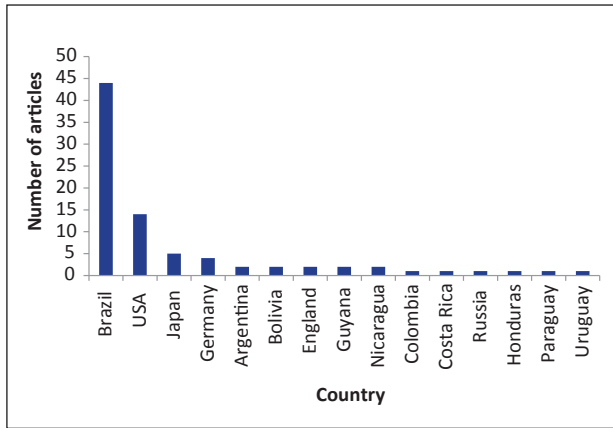


FIGURE 3. Countries where research on giant anteater (*Myrmecophaga tridactyla*) biology was conducted.

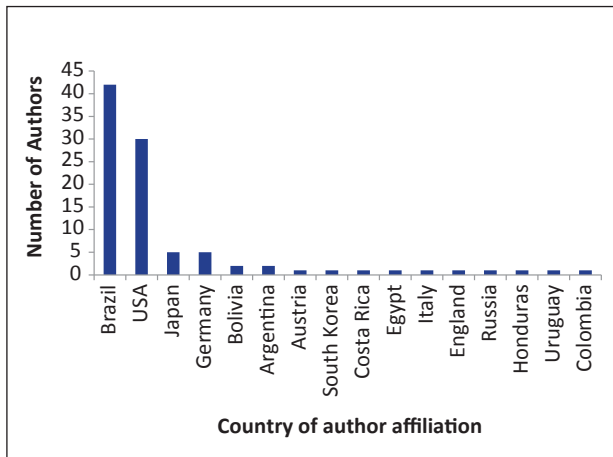


FIGURE 4. Number of authors working on giant anteater (*Myrmecophaga tridactyla*) biology per country of affiliation.

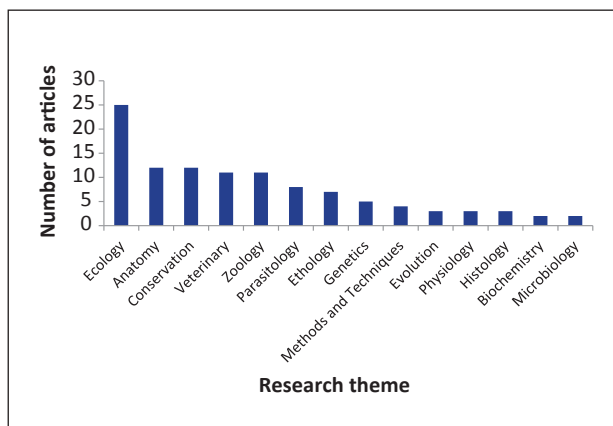


FIGURE 5. Number of articles on giant anteater (*Myrmecophaga tridactyla*) biology per research theme.

representative of the species as a whole. This might be a problem as giant anteater populations are declining throughout the species range (IUCN, 2012). The absolute number of articles focusing on the conservation of the giant anteater is still low in the face of the conservation status of this charismatic species. It seems that the idea that charismatic species are well-known by science does not hold true for the giant anteater, making it a famous John Doe of wildlife conservation.

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SHORT COMMUNICATION

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

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

Keywords: Caatinga, diet, feeding behavior, xenarthrans.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Taller “Conservación de xenartros: nuevos proyectos, perspectivas y prioridades en América Latina”

II Congreso Latinoamericano de Mastozoología y XXV Jornadas Argentinas de Mastozoología, Ciudad Autónoma de Buenos Aires, Buenos Aires, Argentina, 9 de Noviembre de 2012.

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- 1- Lic. Magalí Gabrielli. Centro Regional de Estudios Genómicos (CREG), Universidad Nacional de La Plata - CONICET, Argentina.
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OBJETIVOS

El principal objetivo del taller fue presentar las nuevas líneas de investigación en temáticas relacionadas con la conservación de los xenartros, buscar soluciones a problemas comunes, generar colaboraciones, planificar temáticas a abordar de manera multidisciplinaria y plantear prioridades en América Latina.

BREVE DESCRIPCIÓN DE LAS ACTIVIDADES

El Taller se llevó a cabo en el marco del II Congreso Latinoamericano de Mastozoología y las XXV Jornadas Argentinas de Mastozoología. Se realizó una presentación del Grupo de Especialistas de la IUCN y las distintas actividades que se hicieron en los últimos dos años. A continuación se pasó a las sesiones orales que estuvieron a cargo de cinco investigadores jóvenes exponiendo sus trabajos con armadillos, osos hormigueros y perezosos

(ver Expositores). El cierre del taller consistió en una primera parte de discusión y planteo de ventajas y desventajas de trabajar con xenartros. Luego se expuso una presentación de prioridades a cargo de los organizadores/coordinadores del Taller y para terminar se discutieron las prioridades planteadas.

VENTAJAS DE ESTUDIAR XENARTROS:

- Se pueden obtener muchos datos novedosos y todo es publicable en buenas revistas científicas.
- Las becas en instituciones nacionales (argentinas) son relativamente accesibles en comparación con otros taxones porque hay menos competencia (algunos participantes no estaban convencidos de que sea cierto). A nivel internacional, los pedidos de subsidios para trabajar con xenartros son bien recibidos por las instituciones financiadoras extranjeras dado que los xenartros son un orden endémico de América poco estudiado.
- Son animales muy llamativos y particulares.
- Hay mucho por estudiar, existen pocos datos. Sin embargo, esto también puede ser una desventaja, ya que muchas veces hay que empezar de cero por falta de antecedentes. Pero en este caso, la ventaja es que se pueden publicar papers sobre metodologías novedosas.

DESVENTAJAS:

- El trabajo con poblaciones es muy difícil – son cazados muy frecuentemente y muchas veces la gente no quiere colaborar por pensar que uno los va a denunciar por estar comiéndoselos o matándolos por otras razones.
- El modo de vida semifosorial de los armadillos complica su estudio.
- Se sabe poco de los xenartros – por ejemplo, si no se sabe que el piche (*Zaedyus pichiy*) hiberna y entra en sopor porque nunca se ha estudiado su termorregulación, uno podría ir al campo en la época equivocada y hacer conclusiones erróneas (p.ej. que no hay piches, pero en realidad simplemente están dentro de sus cuevas).
- La cacería también complica el estudio de los armadillos. No se pueden hacer estudios a largo plazo porque los cazadores furtivos matan a los animales de estudio. Esto incluso pasa en las áreas protegidas.
- Las rutas también son un problema, hay muchos atropellamientos de xenartros. Aunque otros participantes dicen que a esto se puede aprovechar para obtener muestras, lo cual sería una “ventaja” entre comillas.
- De varios países de los cuales no tenemos información, no se pueden exportar muestras (p.ej. para hacer estudios genéticos) por cuestiones legales. O sea, cada país quiere que se hagan los análisis genéticos de sus animales nativos en su territorio pero si no hay nadie que trabaje en genética de xenartros se complica, y además no hay forma de hacer estudios comparativos ya que no se pueden concentrar todas las muestras en el mismo laboratorio porque no se pueden conseguir las autorizaciones de exportación.

PRIORIDADES

Para esta sección se tuvieron en cuenta las propuestas realizadas por los participantes (expositores y público en general) y los siguientes trabajos:

Superina M., Pagnutti N. & A. M. Abba. In prep. What do we know about armadillos? An analysis of four centuries of knowledge about a group of strange South American mammals.

Diniz, M. F. & D. Brito. 2012. The charismatic giant anteater (*Myrmecophaga tridactyla*): a famous John Doe? *Edentata* 13: 76–83.

Superina M., F. R. Miranda & A. M. Abba. 2010. The 2010 anteater Red List assessment. *Edentata* 11: 96–114.

Superina M., T. Plese, N. Moraes-Barros & A. M. Abba. 2010. The 2010 sloth Red List assessment. *Edentata* 11: 115–134.

Armadillos

- Realizar más investigaciones a campo.
- Especies prioritarias: *Dasyopus pilosus*, *Dasyopus yepesi*, *Calyptophractus retusus*, *Chlamyphorus truncatus*, *Tolypeutes tricinctus*, *Dasyopus septemcinctus*, *Dasyopus sabanicola*, *Dasyopus kappleri*, *Cabassous tatouay*, *Cabassous chacoensis*, *Cabassous centralis*, *Cabassous unicinctus* y *Chaetophractus nationi*.
- Temáticas a tratar: Ecología, Conservación, Genética, Taxonomía, Metabolismo, Comportamiento, Reproducción.
- Regiones a trabajar: Escudo de las Guayanas, Perú, Ecuador, Paraguay, Colombia, Venezuela, Bolivia.

Osos hormigueros

Myrmecophaga tridactyla

- Realizar estudios en más zonas de su amplia área de distribución ya que la mayor parte de los trabajos se concentran en principalmente en dos regiones de Brasil. Hacer estudios fuera de las áreas de conservación (áreas protegidas), p.ej. en zonas con presión antrópica (rutas, silvicultura, etc.).
- Temáticas a tratar: Conservación, Genética, Fisiología, Reproducción.
- Regiones a trabajar: centro de Brasil, Escudo de las Guayanas, Perú, Ecuador, Paraguay, Colombia, Venezuela, Bolivia, Argentina.

Para el resto de los osos hormigueros (incluyendo la población separada de *Cyclopes didactylus* del noreste de Brasil) se necesitan realizar estudios de taxonomía, tamaño de las poblaciones y distribución, historia natural, niveles y tendencias de caza, tendencias poblacionales, tendencias de su hábitat, reproducción.

Perezosos

Se necesita seguir trabajando con las especies amenazadas (*Bradypus pygmaeus* y *B. torquatus*) y para todas las especies se necesitan realizar trabajos de taxonomía, tamaño de las poblaciones y tendencias de las mismas e historia natural. En menor medida se postula que hay que realizar estudios de niveles y tendencias de caza y tráfico, amenazas, tendencias de su hábitat y reproducción.

Resúmenes de los trabajos presentados

AVALIAÇÃO DA RELAÇÃO ENTRE ÁREA DE VIDA, DISTÂNCIA MÉDIA DIÁRIA PERCORRIDA E DISPONIBILIDADE DE ENERGIA PARA TAMANDUÁS-BANDEIRA (*MYRMECOPHAGA TRIDACTYLA*) EM SAVANAS BRASILEIRAS

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O tamanduá-bandeira (*Myrmecophaga tridactyla*), ordem Pilosa, é um especialista alimentar em formigas e cupins. A mirmecofagia da espécie influencia sua biologia e ecologia. Informações sobre área de vida de um animal ampliam as investigações ecológicas e vários estudos já relacionaram área de vida com energia de mamíferos, principalmente carnívoros terrestres. Contudo, poucos são os dados sobre movimento diário, e até o presente não há estudos enfocando a relação entre distância média diária e energia para um mamífero especialista. A distância diária aponta o uso do espaço e associa-se às necessidades energéticas do animal. O objetivo do estudo foi avaliar a relação entre distância média diária, área de vida e disponibilidade energética; e mensurar a densidade de colônias de formigas e cupins dentro das áreas de vida de tamanduás-bandeira em três savanas brasileiras (Campos Lavrados de Roraima, Pantanal da Nhecolândia e Parque Nacional da Serra da Canastra – PNSC). O sistema de telemetria com GPS foi utilizado para avaliar padrões de deslocamento e tamanhos de áreas de vida; a energia, mensurada por calorimetria, foi analisada dentro das áreas de vida de 10 tamanduás-bandeira; e a densidade de formigas e cupins foi estimada em plotes de 5x5 metros, dentro das áreas de vida. Para os tamanduás-bandeira as áreas de vida foram correlacionadas com a distância média diária. O PNSC apresentou maior disponibilidade energética de formigas e cupins, e não houve diferença significativa entre Pantanal e Roraima. Colônias de formigas foram as mais comuns e as espécies *Camponotus crassus* e *Solenopsis* sp. estiveram representadas em todos os sítios. O tamanho das áreas de vida não foi correlacionado com as densidades de colônias. As distâncias médias diárias e as áreas de vida não foram inversamente proporcionais à disponibilidade de energia do sistema, ao contrário do que, geralmente, se espera ocorrer com carnívoros.

ESTUDIOS PARASITOLÓGICOS EN DASYPODIDAE (MAMMALIA, XENARTHRA) DE ARGENTINA: HELMINTOS Y ARTRÓPODOS PARÁSITOS EN LA INTERPRETACIÓN DE LAS ASOCIACIONES PARÁSITO- HOSPEDADOR-AMBIENTE

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Los parásitos son utilizados como indicadores del comportamiento de sus hospedadores (cambios de dieta, uso diferencial de microhábitats) y la diversidad de las comunidades parasitarias puede estar influenciada por el rango geográfico, la longevidad y densidad poblacional del hospedador). Con el fin de determinar si las especies parásitas son indicadoras de la relación hospedador/ambiente, se realizó un estudio en *Chaetophractus villosus* (N=42), *Chaetophractus vellerosus* (N=41), *Zaedyus pichiy* (N=22) y *Dasypus hybridus* (N=10), procedentes de las regiones Pampeana, Chaqueña, Patagónica y Monte. Los parásitos se estudiaron según las técnicas convencionales, se calcularon riqueza (R) y diversidad parasitaria (H) (índice de Shannon-Weaver). Se hallaron en total 15 especies de helmintos, 6 de pulgas, 1 de ácaro y 1 de garrapata. *Chaetophractus villosus*, eurifágico y de mayor distribución geográfica, presentó mayor diversidad (R=18; H=1,11) que *D. hybridus*, estenofágica y distribución más acotada (R=5; H=0,8), observándose la influencia del espectro trófico y la distribución geográfica en la composición y estructura de la comunidad parasitaria. La comparación entre una población aislada de *C. vellerosus* (Este Buenos Aires) (R=9; H=1,05) y la población núcleo del corredor La Rioja/Oeste Buenos Aires (R=19; H=1,19), reveló diferencias de hábitats y uso de los mismos. Los eufractinos (*C. villosus*, *C. vellerosus*, *Z. pichiy*) compartieron el 95% de las especies parásitas, y las poblaciones más occidentales de *Z. pichiy* y *C. vellerosus* tuvieron similar riqueza, aún un nematode (*Cyclobulura*) que hasta el momento sólo había sido hallado en serafines de Brasil. Sólo *Aspidodera fasciata* y *Pterygodermatites chaetophracti* (Nematoda) estuvieron presentes en todas las especies hospedadoras. Ello muestra que su distribución no depende del ambiente y que cambios hospedatorios fueron exitosos (especificidad a nivel familia). Las pulgas Malacopsyllidae estuvieron siempre asociadas a los Euphractini, pero nunca a *D. hybridus*; *Tunga* spp. (Tungidae), *Amblyomma pseudoconcolor* (Ixodidae) y *Dasyponyssus neivai* (Dasyponyssidae) tuvieron una distribución hospedatoria heterogénea y con influencia del ambiente. La profundidad de estos resultados permitirá avanzar en la interpretación parásito/ hospedador/ ambiente.

AVANCES EN LA FILOGEOGRAFÍA DE ZAEDYUS PICHY (MAMMALIA, XENARTHRA); HERRAMIENTAS MOLECULARES APLICADAS PARA LA PRESERVACIÓN DE ESPECIES

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La filogeografía es un instrumento importante en la biología de la conservación desde que se reconoció a la diversidad genética como el nivel basal de la biodiversidad. El objetivo de nuestro estudio es analizar el patrón filogeográfico del armadillo *Zaedyus pichiy* en todo su rango de distribución en Argentina, mediante el análisis de marcadores moleculares mitocondriales. Se obtuvieron 130 muestras de tejido, provenientes de colecciones de museos, cedidas por investigadores y colectadas en viajes de campaña. La calidad y antigüedad variables de las muestras permitió poner a prueba diferentes protocolos y testear técnicas modificadas de extracción de ADN, así como también, diversos protocolos para la amplificación por PCR de los marcadores moleculares seleccionados. En particular, se amplificó la primera porción de la Región Control (D Loop) utilizando los primers universales Thr-L15926 y DL-H16340, mientras que el gen Citocromo Oxidasa subunidad I (COI) fue amplificado usando un coctel diseñado para la obtención del código de barras genético del Consorcio iBOL. Las primeras secuencias obtenidas de ambos marcadores resultaron de aprox. 600pb y los análisis preliminares muestran una alta diversidad de haplotipos en relación a la cantidad de secuencias, indicando que los marcadores moleculares elegidos resultan informativos para el estudio filogeográfico de esta especie.

REPRODUCCIÓN Y CITOGÉNICA EN LA CONSERVACIÓN DE LOS ARMADILLOS EUFRACTINOS (*XENARTHRA, DASYPODIDAE*) DE ARGENTINA

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Los armadillos eufractinos son exclusivos de Sudamérica y todas sus especies ocurren en la Argentina. Su manejo poblacional presenta actualmente una dicotomía, ya que casi todas sus especies, dada la caza indiscriminada y la progresiva pérdida de hábitat, han disminuido sus poblaciones; mientras que el peludo, *Chaetophractus villosus*, se ha vuelto localmente abundante siendo considerado en muchas regiones como plaga. Comprender su biología reproductiva satisface un doble objetivo: la posibilidad de conservar aquellas especies en peligro y la de controlar otras cuyo actual crecimiento genera conflictos con el hombre. Caracterizar su citogenética poblacional es fundamental para garantizar tanto la reproducción como la fertilidad de la descendencia en planes de reintroducción de especies localmente extintas.

Mediante mediciones de hormonas sexuales esteroideas en materia fecal fue estudiado el ciclo reproductivo femenino de *C.villosus* y del piche llorón, *Chaetophractus vellerosus*; mientras que mediante estudios anatómicos, histológicos y hormonales del testículo fue abordado el ciclo reproductivo masculino en *C. villosus*. A partir de cultivo de sangre obtenida de individuos capturados en puntos representativos de su distribución natural, fueron estudiadas citogenéticamente las especies *C.villosus*, *C.vellerosus*, el gualacate *Euphractus sexcinctus* y el piche *Zaedyus pichiy*.

Se observó un ciclo reproductivo estacional en hembras de *C.villosus* y *C.vellerosus* (con actividad en invierno y verano) y en machos de *C.villosus* (con una interrupción de la espermatogénesis a mediados del otoño). Fueron demostradas variaciones en el cariotipo (inversiones y deleciones) en todas las especies estudiadas para ciertas localidades de su distribución.

Determinar el período reproductivo es crucial en el desarrollo de campañas destinadas concientizar poblaciones rurales e indígenas en disminuir la presión de caza en los meses de cópula y gestación. La posible existencia de razas cariotípicas en estas especies requiere un intensivo estudio citogenético-poblacional a fin de garantizar su reproducción *in-situ* y *ex-situ*.

CONSTRUINDO O CAMINHO DA PREGUIÇA-COMUM (*BRADYPUS VARIEGATUS*) – LIGAÇÃO ENTRE AS FLORESTAS ATLÂNTICA E AMAZÔNICA PELO NORDESTE BRASILEIRO

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A preguiça-comum possui uma ampla distribuição, ocorrendo na floresta Amazônica (AMZ) e Mata Atlântica (MA), entre outras. Várias pontes de ligação entre ambas as florestas têm sido propostas para diversos vertebrados. Porém, para a preguiça-comum, a rota mais provável de ligação entre AMZ e MA parece ter origem no leste amazônico, ou seguindo diretamente para o sudeste da MA ou percorrendo o nordeste brasileiro. De modo a testar estas rotas de ligação, foram amostradas três populações da MA (MU1 – sudoeste, MU2 – centro, e MU3 – nordeste) e duas potenciais populações de origem na AMZ (MU5 – nordeste, e AC – sudoeste). Também se desenvolveu uma bateria de 42 microssatélites não-ligados. Os índices de diversidade e diferenciação genética foram calculados usando-se os softwares GenAlEx6 e Arlequin31. O potencial isolamento pela distância (IBD) foi testado através de teste de Mantel, implementado no GenAlEx6, e através de testes de correlação em R. O número mais provável de clusters foi inferido com o auxílio dos softwares Structure e Structure Harvester. O teste de Mantel suporta a existência de IBD entre todas as populações amostradas ($R^2=0.70$, $p=0.001$). Este é um resultado esperado, dada a amostragem esparsa e a baixa mobilidade da espécie. Porém, análises mais detalhadas, revelaram uma correlação negativa entre as distâncias geográfica e genética entre MU5 e as populações da MA ($R^2=0.771$; $p=0.0127$), mas não entre as populações do AC e da MA ($R^2=0.1464$; $p=0.0726$). Ainda, inferências Bayesianas suportam a existência de dois clusters (MU1+MU2 e MU3+MU5+AC), evidenciando a ligação AMZ/MA pelo nordeste do Brasil. As estimativas temporais relativas demonstram que as populações da AMZ são sequencialmente mais antigas do que MU5, MU2 e MU1, o que está de acordo com trabalhos anteriores. Assim, concluímos que a preguiça-comum terá colonizado a MA partindo do nordeste da AMZ e atravessando o nordeste Brasileiro em direção ao sul.

NEWS

GOAL SCORED FOR ARMADILLO CONSERVATION!

The Brazilian three-banded armadillo (*Tolypeutes tricinctus*) will be the 2014 FIFA World Cup Mascot! We are absolutely thrilled that an armadillo listed as Vulnerable by the IUCN Red List of Threatened Species will be featured in such an important event. Let's hope this will not only trigger conservation initiatives to save this charismatic little creature from extinction, but also help increase awareness for biodiversity conservation in general.



THE 2012 EDITION OF THE RED LIST OF THREATENED MAMMALS OF ARGENTINA HAS BEEN PUBLISHED!

Two out of ten mammals of Argentina are threatened by extinction. This means that in the 2012 issue of the national Red List, 81 of the 385 known mammals inhabiting Argentina are listed in a threatened category. The main threats affecting mammals in Argentina include habitat loss, fragmentation and degradation, hunting, land use conflicts, illegal animal traffic, and diseases.



The Xenarthra have been assessed by members of the IUCN SSC Anteater, Sloth and Armadillo Specialist Group. Out of 18 species, one has been listed as Endangered (EN), two as Vulnerable (VU), five as Near Threatened (NT), six as Data Deficient (DD), and only four as Least Concern (LC).

Pilosa (Superina *et al.*, 2012a):

<i>Bradypus variegatus</i> :	DD
<i>Myrmecophaga tridactyla</i> :	VU A2c+3c
<i>Tamandua tetradactyla</i> :	NT

Cingulata (Superina *et al.*, 2012b):

<i>Cabassous chacoensis</i> :	NT
<i>Cabassous tatouay</i> :	VU B1ab(iii)
<i>Calyptophractus retusus</i> :	DD
<i>Chaetophractus nationi</i> :	DD
<i>Chaetophractus vellerosus</i> :	LC
<i>Chaetophractus villosus</i> :	LC
<i>Chlamyphorus truncatus</i> :	DD
<i>Dasyopus hybridus</i> :	NT
<i>Dasyopus novemcinctus</i> :	LC
<i>Dasyopus septemcinctus</i> :	DD
<i>Dasyopus yepesi</i> :	DD
<i>Euphractus sexcinctus</i> :	LC
<i>Prionodontes maximus</i> :	En A2cd+3cd
<i>Tolypeutes matacus</i> :	NT
<i>Zaedyus pichiy</i> :	NT

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If you are interested in acquiring the Red List of Threatened Mammals of Argentina, please contact Agustín M. Abba at abbaam@yahoo.com.ar.

RESEARCH PROJECT: USE OF HABITAT FOR ARMADILLOS (MAMMALIA: CINGULATA) IN A HIGH-MONTANE FOREST OF ATLANTIC RAINFOREST IN SOUTHERN BAHIA, BRAZIL.

Fragmentation of habitat has been identified as one of the main factors of biodiversity loss at the global scale because of the negative impact on

species richness, abundance, distribution, and genetic diversity. Fragmentation and hunting cause negative consequences for mammal conservation. Armadillos (Order Cingulata) are animals that contribute to the maintenance of ecosystem integrity by intervening in nutrient recycling and soil structure. One of the most threatened tropical forests is the Atlantic Rainforest. In southern Bahia (Brazil), the complex Private Natural Heritage Reserve (RPPN) Sierra Bonita protects a large area of high montane forest. It presents an altitudinal gradient between 200 and 950 m asl. The Reserve protects approximately 1,800 ha, with forest fragments embedded in production systems of coffee, cocoa and pastures, and is home to a great diversity of flora and fauna. The objectives of this project are to identify the species present in the area, evaluate the effect of altitude, vegetation type, topography and soil properties on armadillo distribution and building burrows, and study the temporal pattern of use of forest fragments in RPPN Sierra Bonita. Transect methods will be used to record tracks and burrows, and also camera traps, standard techniques for analysis of soils, and GIS. Given the importance of the Cingulata order in the conservation and ecosystem integrity, the effect of fragmentation on species loss and the high conservation value of the RPPN Sierra Bonita for the Atlantic Rainforest, this study earned funds from the Universidade Estadual de Santa Cruz (UESC), Programa de Pós-Graduação em Zoologia (UESC), Instituto Uiraçu and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES). The team is led by Professor Dr. Martín R. Alvarez and composed of the researchers Prof. Dr. Alexandre Schiavetti, Prof. Dr. Agna Almeida Menezes, Paulo Henrique Ribeiro Pinheiro, Catalina Sánchez Lalinde, and José Felipe Velez García.

For further information, please contact **Prof. Dr. Martín R. Alvarez**, Departamento de Ciências Biológicas, Universidade Estadual de Santa Cruz, Rodovia Jorge Amado, Km 16, Salobrinho, Ilhéus (BA, Brasil), CEP 45662-900, Tel. (55 73) 3680-5445, <<http://www.uesc.br/zoologia>>, E-mail: malva@uesc.br.

SLOTH RESCUE IN SURINAME

A plot of land having a size of 6.8 hectare in the urban area of Greater Paramaribo, Suriname, and characterized as a forest island, was cleared for the purpose of cattle-raising in October and November 2012. The Green Heritage Fund Suriname (GHFS) was made aware of this by the Animal Protection Society Suriname, who had positively counted 14 sloths (*Bradypus tridactylus*) to be inhabiting this forest island. The GHFS then contacted the Nature Conservation Division and the owner of the land, and started a sloth rescue action. This action



started ironically on the International Day of the Sloth, 22 October 2012, and lasted through 22 November 2012, when the last trees were cleared from the land. Although the Green Heritage Fund Suriname expected to find maybe double the amount of sloths, the total amount of animals collected, of which 90% belonged to the species *Bradypus tridactylus*, ran into the amazing number of 200 animals. Among the species found or seen, as some could not be captured such as the lesser anteater (*Tamandua tetradactyla*), were the pale-throated three-toed sloth (*Bradypus tridactylus*), the two-toed sloth (*Choloepus didactylus*), the silky anteater (*Cyclopes didactylus*), the porcupine (*Coendou prehensilis*), the capuchin monkey (*Sapajus apella*), and the squirrel monkey (*Saimiri sciureus*).

The animals were collected by a field team, which worked closely with the operator of the excavator, then transported to a temporary holding place at the home of the Chairman of the Board of the GHFS in Paramaribo. The sloths were then transported to a location in the North of the District of Saramacca, in a multiple-use management area, where they were released on the edge of a patch that still has many hectares of a similar type of swamp forest as where the animals came from. Almost half of the animals were weighed and measured, and some samples were collected for future genetic studies. Animals that needed special care were kept until they were healthy enough to be released and babies under the weight of 1.2 kg were also kept and fed. Most of these babies, with the exception of around 4 animals, were separated from their mothers. A number of females was kept to function as surrogate mothers. These animals will stay at the rehabilitation location until they are big enough to survive on their own and can be released with the surrogate mothers.

If you wish to receive further information or a copy of the technical report when it is published, please contact Monique Pool at info@greenfundsuriname.org.



NOTES TO CONTRIBUTORS

Edentata is the official, peer-reviewed, annual publication of the IUCN/SSC Anteater, Sloth and Armadillo Specialist Group. It aims to publish information that contributes to the conservation of xenarthrans.

A broad range of topics is welcomed and encouraged, including taxonomy, systematics, genetics, biogeography, ecology, conservation, behavior, and health. Manuscripts must describe original research findings that have not been published or submitted simultaneously to other journals. Any overlap of contents with already published papers should be minimal.

Edentata accepts manuscripts of original research findings related to any aspect of xenarthran conservation. It also encourages submission of short communications, field notes, thesis abstracts, news items, recent events, book reviews, congress announcements, and the like.

Manuscripts may be written in English, Portuguese or Spanish. Authors whose first language is not English should please have their texts *carefully reviewed* by a native English speaker.

Once the manuscript has been received, the editors will perform a first evaluation. Manuscripts not satisfying the editorial instructions will be returned to the author without review.

Detailed instructions to authors are available on the Specialist Group's website <<http://www.xenarthrans.org/bibliography/edentata>>.

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Todos los manuscritos son sometidos a revisión por pares. Se aceptan manuscritos que se encuentren dentro de una amplia variedad de temáticas, incluyendo: taxonomía, sistemática, genética, biogeografía, ecología, conservación, comportamiento y salud. Los manuscritos deben ser trabajos originales y no haber sido publicados ni enviados simultáneamente a otros medios de publicación. La superposición de contenidos con artículos relacionados ya publicados debe ser mínima.

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Todos os manuscritos são submetidos a revisão por pares. Serão aceitos manuscritos que se encontrem dentro da ampla variedade temática, incluindo-se taxonomia, sistemática, genética, biogeografia, ecologia, conservação, comportamento e saúde. Os trabalhos devem ser originais, não publicados ou enviados simultaneamente a outros meios de publicação. A superposição dos conteúdos com artigos relacionados e já publicados, deve ser mínima.

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