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Behavioral repertoire of giant anteater (*Myrmecophaga tridactyla*, Linnaeus 1758) in nature at Serra da Canastra National Park, MG and in captivity at Curitiba Zoo, PR, Brazil

ALESSANDRA BERTASSONI[1] E LENY C. MILLÉO COSTA[2]
[1]*Universidade Federal de Mato Grosso do Sul*
[2]*Instituto de Pesquisas Cananeia*

Repertório Comportamental de tamanduás-bandeiras (*Myrmecophaga tridactyla*, Linnaeus 1758) em vida livre no Parque Nacional da Serra da Canastra, MG e em cativeiro no Zoológico de Curitiba, PR, Brasil. O repertório comportamental do tamanduá-bandeira (*Myrmecophaga tridactyla*), mamífero da Ordem Pilosa, foi estudado no Parque Nacional da Serra da Canastra, MG e no Zoológico de Curitiba, PR. Foram determinadas as categorias comportamentais de manutenção, deslocamento, alerta, inter e intraespecífica, totalizando 24 padrões motores na natureza e 27 no cativeiro. A compreensão e a análise do comportamento da espécie são relevantes, uma vez que são poucas as descrições das categorias comportamentais tanto em campo quanto em cativeiro. Ainda, estudos etológicos auxiliam no manejo da vida silvestre e no bem-estar das populações cativas. O comportamento mais frequente, tanto para os animais silvestres como para os cativos, foi o de forrageamento. Os tamanduás-bandeiras cativos demonstraram plasticidade comportamental através de padrões motores intraespecíficos, denotando adaptação para uma espécie considerada como solitária no ambiente natural.
Palavras-chave: Tamanduá-bandeira. Comportamento. Cativeiro. Parque Nacional da Serra da Canastra. Forrageamento.

Behavioral repertoire of giant anteater (Myrmecophaga tridactyla, Linnaeus 1758) in nature at Serra da Canastra National Park, MG and in captivity at Curitiba Zoo, PR, Brazil. The behavioral repertoire of the giant anteater (*Myrmecophaga tridactyla*), a mammal from Pilosa Order, was studied at Serra da Canastra National Park, MG and at Curitiba Zoo. The behavioral categories of maintenance, movement, alert, inter and intra specific were determined, totalizing 24 patterns in nature and 27 in captivity. The comprehension and analysis of this species behavior is relevant once the description of behavioral categories for this species in wild and captivity are insufficient. Also ethological studies assist in wildlife improvement and welfare of captive populations. The most frequent behavior was foraging to wild as captivity animals. The captivity giant anteater's shown behavioral flexibility through intraspecific patterns demonstrated adaptive process to a species known as solitary in wild.
Key-words: Giant Anteater. Behavior. Captivity. Serra da Canastra National Park. Foraging.

The giant anteater (*Myrmecophaga tridactyla* Linnaeus, 1758), a mammal from Pilosa Order, is a predator specialized in ants and termites. It is listed as vulnerable (UICN 2010 - www.uicnredlist.org) and in Brazil it is listed in the same status (MMA 2006), this fact is a result of decreasing population of this species, due to large-scale agriculture and antropic development (Braga, 2003), hunting (Leeuwenberg, 1997), fire (Silveira et al., 1999) and trampling. The major information about the giant anteaters' behavior was provided by studies made in zoos (Shaw, Machado-Neto & Carter, 1987). Also, some behaviors have been reported singly to wild giant anteaters (e.g. Shaw & Carter

Alessandra Bertassoni, Programa de Pós-Graduação em Ecologia e Conservação, Universidade Federal de Mato Grosso do Sul, 79070-900, Campo Grande MS, Brasil. Laboratório de Fauna, Embrapa Pantanal, Caixa Postal 109, 79320-900 Corumbá MS, Brasil. E-mail: alebertassoni@gmail.com. Leny C. Milléo Costa, Instituto de Pesquisas Cananéia – IPeC, 13098-106, Campinas SP, 13098-106, Brasil. E-mail: leny.cristina@terra.com.br.

1980; Shaw et al. 1985; Shaw et al 1987; Medri & Mourão 2005; Rocha & Mourão 2006; Mourão & Medri, 2007). Behavior and ecology data about this mammal found exclusively in South and Central America are necessary once it is rare in literature.

Ethological studies assist in wildlife improvement and welfare of captive populations, contributing to refine management techniques and to report natural history in situ. It is believed that there is similarity concerning the behavior of animals in the wild and in the Zoo, but some differences of execution and frequency are expected, respecting phylogenetics limits and adaptive plasticity recurrent from the each environment. The main objective was to describe, register and analyze the behavioral repertoire of giant anteaters from wild and captivity contexts.

This study is relevant once the behavioral description for this species in wild are insufficient and also this kind of research allows comparison of the behavioral repertoire of giant anteater in both contexts wild and captivity.

Methods

Study site

The study was carried out in Serra da Canastra National Park (SCNP), located in the Southwest of Minas Gerais State - Brazil, under the geographical coordinates 20°18'16" S and 46°35'56" W at an average elevation of 1400m. The climate is classified as "tropical of altitude", with a dry season from April to September and a rainy season from October to March (MMA, 2006) and vegetation is "cerrado" (Brazilian savanna).

The individuals' observations in nature occurred in an opportunistic way in 24 km straight in regions near the main road of PNSC. The field research happened during the months of July 2005, January, February and July 2006, totalizing 86 hours and 30 minutes in 65 giant anteater direct observations. These observations took place five to ten meters from the animal, avoiding human interference. Once giant anteater's eyesight and hearing are poor and if the wind is in favor of the observer is possible to have a big approach of the individual to made observations from small distances without intervention (Shaw & Carter, 1980). This possibility is directly related with the sense of smell very acute, once the smell of the observer will be sending in the opposite direction of the snout.

At Curitiba Zoo two specimens of giant anteater were observed (a juvenile male that was born in the zoo and an adult female coming from nature) from May to December 2005 and from March to June 2006 reaching September the same year, totalizing 101 hours and 30 minutes in 38 observations. The observations were performed from the management corridor, in the feeding house and in the exposition area. The Zoo offered termite nests taken from the nature, as a complementary food of the main food made of milk, yogurt and meat. The observations were started in the zoo to observe and understand the behaviors and to be familiar and recognize them *in situ*. Just one observer made the SCNP and Curitiba Zoo observations.

The research was apoproved by the Ethical Committee of Pontifícia Universidade Católica do Paraná and the IBAMA – Parna Canastra license number 03/2005.

Method applied

In the initial phase of the study the *ad libitum* sampling (Altmann, 1974) was applied in order to identify and describe the motor patterns of the giant anteater and detecting the occurrences afterward. These motor patterns were classified by the positions of the legs, neck, head, snout and tail. The focal-animal sampling (Altmann, 1974) was used to analyze how frequent these motor patterns occurred. Each giant anteater's observation was individualized and lasted ten minute, this period was divided minute by minute. There was a 20 minutes pause between samplings. If a new behavior appeared, the focal-sampling was interrupted and this new behavior was described. Data recording was done with a photographic camera and binoculars. The data of frequency from the focal sampling were analyzed, to both studies site, using the relative frequency to each motor pattern inside of it behavioral category, and to each category inside of the total. The chi-square frequency test was calculated to test the signifi-

cance from each category and motor pattern in the level of significance 0,01, obeying the hypothesis of equal probability.

Results

The behaviors observed were included in the categories of maintenance, alert, locomotion, intra and inter specific to both study sites adding up 24 motor patterns for animals in wild and 27 in captivity (Table 1). Some behaviors were registered and described by *ad libitum* sampling, but they did not appear when the frequency analysis was performed. The maintenance behavior was the most frequent in both study sites from all the categories (75%, n=9.301).

Maintenance:

The behaviors registered for both study sites were: foraging, feeding, resting, excretion, scratching, snout cleaning and grooming. The most significant behavior in relation to the others was foraging ($X^2_{(7)}$=4939; P<0,01)

Foraging

Sniffing. The sniff in captivity was made in the tree trunks, in the bars, in the soil and in the termite nests when offered. Therefore in SCNP, the animal sniffs bushes, stones, termite and ant nests and some specific areas. In this motor pattern the giant anteater head stays at the level of

Table 1- Number of occurrence of giant anteater's behavior categories in SCNP and Curitiba Zoo. The zero is the lack of behavior and *only refers to ad libitum sampling.

Category	Behavior	Motor Pattern	SCNP	Zoo
Maintenance (n=9301)	Foraging	Sniffing	514	460
		Rummaging branches	*	*
		Snout near the soil	3552	785
		Digging	573	49
		Changing dir. forag.	226	*
	Feeding	Feeding zoo mixture	0	194
		Feeding termite/ant	552	08
		Drinking water	*	15
		Stop Specific point	1551	17
	Resting	Sleeping	06	424
		Stretching	*	15
		Lying down	05	68
		Static position	15	111
	Excretion	Urinate	*	03
		Defecate	01	09
	Snout cleaning	Snout cleaning	36	16
	Grooming	Grooming	*	20
	Scratching	Scratching	08	68
Alert (n=1042)	Alert	Alert	460	582
Locomotion (n=1897)	Walking	Walking	419	1457
	Running	Running	20	01
Intra specific. (n=144)		Foraging same area	*	0
		Following	*	17
		Meeting	*	0
	Intra specific	Female with cub	*	0
		Touching	0	31
		Licking tongue	0	02
		Sniffing other	0	94
Inter specific. (n=5)	Inter specific	Feeders	0	4
		Vultures	0	1
Total (n= 12389)			7938	4451

the "object" which it wants to sniff and so the neck is stretched taking the snout near the object. The captivity juvenile male demonstrated some difficulties in getting termites from nests, despite coming closer and obtain the insects, waiting for the female to do so, and then the male looked for insects in an opportunistic way.

Rummaging branches. The forelimbs moves against the branches and the claws involved it seems to raise it. The fore hinds are kept parallels and the head is inclined down. The tail is a little bit raised from the soil.

Snout near the soil. This is characterized by the continuous movement of the animal with the snout directed to the soil. The animal seems to scent for termites and ants.

Digging. The forelimb is against the object that the animal wants to dig, which can be the soil or social insect's nests. The claws are used against the object in repeatedly movement. It was common to observe the wild animal handling rocks and this pattern is similar to digging. The animal sniffs a set of rocks and stopped to manipulate one (figure 1) or two rocks using the claws. Probably the animal is looking for preys.

Figure 1. Giant anteater (*Myrmecophaga tridactyla*) manipulating a rock to forage.

Changing direction of foraging. This motor pattern was considered like foraging because the animal was looking for preys doing it. When it was foraging with the snout near to the soil it rapidly change it direction to the other side, but the snout was always near to the soil. This action seems to be made when giant anteater scented preys nearby but in the other direction, because the movement was short and delicate.

Feeding

Feeding the zoo mixture. The body is driven in front of the recipient with the mixture. The forelimbs are kept in parallel or one stays in front of the other. The hind limbs are parallel too. The head is inclined to the mixture and sounds were produced. The tail is kept near of the soil or touches it. The head and the neck could show some movements during this action and the giant anteater could be sitting or not. There are some resting intervals during the eating process when the tongue is taken from the feeding source. The average duration of feeding zoo's food was 15.1 ± 7 minutes. The female and male could eat in the same moment (figure 2).

Figure 2. Female and male giant anteaters (*Myrmecophaga tridactyla*) eating the zoo mixture together.

Feeding termites and ants. After digs the animal is able to take termites/ants that are exposed on the surface. The body is inclined to the termite/ant nest. Forelimbs could be parallels or one in front of other. Giant anteaters could eat the social insects sit or not and also it could be back up in the nest, with the forelimbs (or just one) stand for on the nest and the hind limbs

parallels on the soil. This motor pattern was equal for SCNP and Curitiba Zoo.

Drinking water. The forelimbs are kept in parallel as the hind limbs, but these ones stayed a little bit away. The head stays inclined to the water source and the mouth is drive to the water. The tongue is put out and touches the other a lot of times. The tail could be near to the soil or touches it. In SCNP the animal exhibited this motor pattern sit and the neck had to moves until the water source. The movements from the hyoid apparatus are very similar in feeding and drinking.

Stopping at a specific point. In the SCNP the vegetation commonly hide body structures and is not possible to see if the animal is feeding, sniffing or digging actually. But we standardized that when the hyoid apparatus is moving the animal was feeding. In this motor pattern the animal is foraging when just stopped with the head inclined to the soil. The forelimbs could be parallels, semi-inflected or one in front of other. The necked is kept curved. The tail could be near to the soil or touches it.

Resting

The resting behavior is the second most evidenced behavioral activity registered in the Curitiba Zoo ($X^2_{(1)}=544$; $P<0,01$). The female showed to be motionless than the male ($X^2_{(1)}=4$; $P<0,05$).

Sleeping. The animal is lying down with closed eyes totally relaxed evidenced by the slow breath. The forelimbs and the hind limbs are covered by the tail as the lateral of the body that has not contact with the soil. The body is curved seems to be convoluted. The snout stayed between the forelimbs. The neck is totally curved. Sometimes one of the forelimbs is stretched. In the zoo the animal before sleeps it digs a small burrow to lye down there.

Stretching. After waking the head is raising up slowly until not been between the forelimbs. The head continuous to rise until the animal is sit. When sit the head continuous to raise until be at a vertical position. The neck is raised maximum. The forelimbs could be stretched on vertical pointed up to sky.

Lying down. It happens when the animal puts one of the laterals of the body horizontally on the soil; the head can be close to the forelimbs or can stay on the soil surface. The forelimbs are stretched in parallel and the tail is touching the soil.

Static position. The animal stops any kind of movement and freezing in a static position, that could be sit or not. The eyes could gentle close and open several times.

Excretion

Urinate. The urinating act could not be seen in SCNP since the vegetation hid the parts of the body. In the zoo the urinating act happened in the standing position when the two forelimbs were spread and the head lightly inclined to the soil. The hind limbs were a little bit spread and parallels. The tail is much raised up from the soil. Some gentle movements could be seen by the head.

Defecate. The defecating act has the same procedure of the urinating, but in captivity this activity was registered in the pool. Where the four legs stayed inside of the pool, the head could express some small movements. The eyes could be close slowly. The tail stayed much raised almost in the vertical. This motor pattern could be exhibit with just two legs inside of the pool.

Other maintenance behavior

Snout Cleaning. The snout cleaning happens after eating in order to clean it or to relieve the irritation caused by the insect's defense, such as bites and chemical liberation of termites and ants.

Grooming. Giant anteater takes the elongated head between the forelimbs and sniffs it abdomen and other parts of the body (figure 3). This behavior was observed in captivity and in wild.

Scratching behavior. Giant anteaters reach the area to be scratched with one of the legs, twisting often it body. It may also rub the area to be scratched against hard objects such as bushes or zoo's walls.

Figure 3. Giant anteater (*Myrmecophaga tridactyl*a) in the motor pattern of grooming.

Alert:

This activity happens when the animal interrupts its actions, the head is at the level of the body and the animal tries to catch any alteration through the sense of smell. This is evidenced by the movements of the snout and by sounds produced. One of the forelimbs could be raised from the soil. This act was registered in the presence of co-specific and human beings (tourists in SCNP, zoo's feeders and visitors) also in the presence of tourist cars on the SCNP. The alert behavior was more significant in the zoo ($X^2_{(1)}=14$; $P<0,01$) than in SCNP.

Locomotion:

Walking. The coordination standard of the paws is a lateral march. The head stays in the body level or gently inclined. The tail is above of the soil level, but near of it. Sometimes the tongue comes out from the mouth during the walk. The difference between "Snout near the soil" and walking is the head's level regarding the soil also the execution speed is different. Here it is associated to slow movements and short steps, where animal protects the claws putting them in the inner side of the anterior members. The captive female shows a vicious walking behavior, walking without function from a side of the exposition area to another several times in a short period. There was not a significant difference of frequency between the walking behavior in SCNP and in captivity.

Running. The running resembles a gallop and it consists of a lateral march with quick speed and a long distance between the steps. The head stays in the body's level and the tail is above of the soil surface. All the body seems to twist. This motor pattern happened more frequent in the wild ($X^2_{(1)}=67$; $P<0,01$).

Intra specific relations

At SCNP - These patterns were just observed during the description phase and there was not any occurrence in the focal sampling.

Foraging in the same area. It occurs when giant anteaters at a distance of five to 20 meters are foraging in the same area. There is a tolerance from both in the presence of the other and the forage is not interrupted.

Following. It is executed on walking when both animals go to the same direction, being one in front and the other behind, but close to the first animal tail. The tails of both animals are in the level of the soil. In Curitiba zoo the animals touch the other tail with the snout, but in SCNP it never been touched.

Meeting. It occurs when one individual is foraging in a specific area and another one comes to the same area, the possible answers to the meeting are alert or moving to another area. An agonistic behavior was not verified after the meeting.

Female with cub. It was observed in July 2005 one female with a cub that was being carried on the mother's back and holding firmly to the mother's fur. The young stays with it legs open and the head is reclined on the mother's back and the baby snout is undercover by the mother's fur. The tail is in the opposite side from the head. When the female moves the cub twisted in her back and moves to fix better. The female executed the other motor patterns regularly and when she stops to sit and eat, she looked several times back to the baby.

At Curitiba Zoo:

Touching. It happens when both animals are one in front of the other and one of them puts the forelimb in front of the other animal with the intention of contact. The answer to the touch can be ignored, touched or avoided. Sometimes the snouts touch each other. The tails are above to the soil level. This motor pattern was also registered when both animals are stand up and lying down (figura 4).

Figure 4. Giant anteaters (*Myrmecophaga tridactyla*) in the motor pattern of touching in lying down position.

Licking the other's tongue. The touching behavior can cause the linking of the other's tongue, then the animals' tongue is put out of the mouth and they mutually get in touch. Sniffing other giant anteater. It happens when the animal snout is taken to the part of the second individual body to be smelled. This could occur when animals are parallel, in front of the other and when one is sleeping. When animals are parallels they intend to sniff the ear's region, when one in front other the neck is preferred to sniff and while sleeping the body lateral is the sniff focus.

Following. This behavior is executed the same way as in wild.

Inter specific relations

At Curitiba Zoo:

Interaction between giant anteaters and feeders. The feeders entered the place daily to give the mixture, as well as to keep the place. The presence of the feeders can cause running behavior in the direction of the feeding house when the food is brought or the following behavior after alert, in the occasions when the feeder has to accomplish the maintenance. In the last case, the giant anteater is behind the feeder and trying to frequently sniff.

Interaction between giant anteaters and vultures. The place is visited by vultures that stay on the bars and occasionally enter the feeding house to get the leftovers. In any moment an agonistic action was observed among these animals, the answers registered in the presence of the vultures were to ignore the bird, the attempt to sniff or to approach. The birds appeared as opportunistic since they interact to get food. No motor pattern was registered in relation to the presence of the visitors of the zoo since the animals were doing their daily activities and seemed to ignore visitor's presence.

Discussion

The results show that most of behaviors are found in both in situ and captivity populations, fact inferred by the lack of variation in the execution of the motor patterns even in so different environment in relation to the resources, such as food, shelter and space. The differences between the behavioral attitudes are expected regarding adaptive plasticity and flexibility recurrent from the each environment and the available resources for each situation. This fact is evidenced by the captive animals when they drink water in a cement recipient and look for social insects on the bars. In comparison, the wild animals look for natural spring of water and search out in stones, in the vegetation, in the dense vegetation and in several termite and ant nests available in SCNP.

The Zoo presented the greatest behavioral attitudes, probably due to the facility and accessibility to visualize all individuals' body. The observations in the field showed the most difficulties concerning to these two factors.

The maintenance behavioral category was the most frequent in both study sites, as expected. In this category, the foraging behavior was the most frequent, emphasizing the importance of searching for food to an animal with low metabolic rate (McNab, 1984).

The zoo mixture offered to captive specimens is rich in proteins distinguishing from the nutritional components found in insects of Isoptera e Hymenoptera Order (Redford & Dorea, 1984). The zoo mixture usually put together milk, eggs and ground meat and this is the alternative food that the zoos found for giant anteaters being reported many years ago (Carvalho, 1966). The mean period for the captive animals eat that mixture was 15.1 ± 7 minutes. Shaw, Carter and Machado Neto (1985) registered *in situ* 30.8 ± 0.6 seconds for each visited nest. So the difference in feeding time could be noticed, which can be attributed to the lack of food options in the Zoo compared to wild as well as the lack of ant and termite's defense. Even the feeding behavior is functional similar for both environments, the results demonstrate that the availability and the quality of resources affect drastically the development of the behavioral activities of the species.

The captive giant anteaters are obliged to adapt themselves to a place with bars, missing the opportunity of learning in the natural environment. This matter can be seen in the juvenile male of the Zoo, which was born in captivity, presenting limitations to get termites from nests offered as a complementary source. Jerez and Halloy (2003) say that the young depends on the mother to be nurtured, to get protection, to have the hygiene and transport, probably this is the phase that the juvenile learns to recognize, to find and to eat preys. The lack of contact with individuals from the same species can cause this behavioral problem, considering the absence of learning once the innate components, sniffing and approaching the nest are present.

In the wild the second most frequent behavior was feeding behavior. This can be justified by the distribution and quantity of preys available in Serra da Canastra. Being so, the animal spends great time looking for food and; consequently, eating and keeping the metabolic needs. On the other hand, in the zoo, it was evidenced that resting behavior was frequent and pointed out high level of rest time in the captive individuals.

When the giant anteater sleeps, it covers the body with the tail to keep the temperature. Medri and Mourão (2005) described the posture "to lie horizontally", which was observed in captivity and not seen in SCNP. This motor pattern is related to the solar energy as a source of heat to increase the body temperature. At Curitiba Zoo when there was the occurrence of solar rays the animals sometimes executed "to lie horizontally".

The defecate act happened in captivity in the pool lots of times, when the animal had the body underwater, except the head. In Bolivia some cameras traps registered the presence of the giant anteater at night in the water in a behavior called the bath (Emmons et al., 2004). Therefore the authors could not explain this kind of behavior in a mammal which apparently does not present this hygienic activity, not taking into account the possibility of refreshing the body for the low local temperature. The present observations made possible the hypothesis of making use of the water for the excretions.

In relation to the alert activity, it can be seen that in ex situ situation the animals were obligated to a great contact with human being and with distinctive stimuli from the nature, so in captivity is expected more frequent alert.

The snout cleaning was also verified by Lubin (1983) in lesser anteater (*Tamandua tetradactyla*) and for giant anteater, "...it uses the claws repeatedly to take them of from the snout" (Carvalho, 1966, p. 343) referring to the ants. The first author still observed that the lesser anteater executes the alert behavior the same way as the giant anteater consisting of sniffing the air (denomination given by Lubin, 1983) when foraging.

In the parental behavior the diagonal strip with a white delimitation of the female and of the young overlap each other, characterizing a criptical behavior, so both individuals seem to be just one (Shaw & Carter, 1980). The same pattern between the female and the young was observed in semi captivity (Jerez & Halloy, 2003), in the same way as this study.

The captivity generates a big relation between the individuals, fact detected by the high frequency of an exchange of social attitudes among the co-specific. The adaptive process of giant anteater in captivity evidenced a wide behavioral repertoire where in an unusual situation the animal increased its abilities making use of the intra-specific behaviors. The unusual fact is because the giant anteater is a species considered solitary in wild.

The behavioral act of meeting registered in SCNP has not resulted in an agonistic behavior; different from the one observed by Rocha and Mourão (2006) who saw a behavioral sequence between two individuals that finished with an injury of one of them.

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