

Management and care of a *dasyopus novemcinctus* (nine-banded) pup received in a wildlife triage center in Brazil's southern most area

Manejo e cuidados de um filhote de *dasyopus novemcinctus* (tatu-de-nove-bandas) recebido em um centro de triagem de animais selvagens no extremo sul do Brasil

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ABSTRACT

The *Dasybus novemcinctus* is popularly called the nine-banded armadillo, which is a terrestrial mammal with crepuscular/nocturnal habits. This animal is widely distributed in the Americas, however, there is still little information about pup raising and behavior in captivity. This report aims to describe the raising management, with emphasis on feeding and behavioral adaptation, of a *Dasybus novemcinctus* pup received at the Wildlife Rehabilitation Center. The adaptation process to the diet offered in captivity was long, but the weight gain and behavioral development occurred according to what was expected in the environmental conditions for this species outside captivity. The armadillo described in this report was released in nature weighing 925 g and measuring a little more than half the size of an adult animal.

Keywords: xenarthra, nutrition, rehabilitation.

RESUMO

Dasybus novemcinctus popularmente chamado de tatu-galinha é um mamífero terrestre, solitário de hábito crepuscular/ noturno. Esse animal é amplamente distribuído nas Américas, no entanto ainda são escassas as informações sobre o manejo de criação e comportamento de filhotes em cativeiro. Este estudo tem como objetivo descrever o manejo de criação, com ênfase na adaptação alimentar e comportamental, de um filhote de *Dasybus novemcinctus* recebido em um centro de reabilitação. O processo de adaptação a dieta ofertada em cativeiro foi longo, no entanto o ganho de peso e desenvolvimento comportamental ocorreram de acordo com o esperado para a espécie em vida livre. Procedeu-se a soltura do exemplar na natureza, pesando 925 g e medindo pouco mais que a metade de um indivíduo adulto.

Palavras-chave: xenarthra, nutrição, reabilitação.

1 INTRODUCTION

Although long neglected by the scientific community, the Xenarthra have over the last few decades gained relevance as research subjects. Xenarthrans are experiencing a period of significant taxonomic change, with important implications for conservation. Concomitantly, the nature and severity of threats are changing, all of which suggests that conservation is more important than ever. The Xenarthra, which are endemic to the

Americas, consist of two distinct clades, the Pilosa (anteaters and sloths) and the Cingulata (armadillo) (SUPERINA; ABBA, 2020).

The *Dasypus novemcinctus* (nine-banded armadillo) is a terrestrial, solitary mammal with crepuscular/nocturnal habits, widely distributed in the Americas. It is an opportunistic insectivore, eating mainly invertebrates, but complementing its diet with other items such as fruits, small amphibians, eggs, fungi, and plant matter (SIKES; HEIDT; ELROD, 1990; TESTA et al., 2019). Among the Xenarthras, the genus *Dasypus* is the only diphyodont, with brachydont deciduous teeth, and hypsodont permanent teeth. They have a discrete homogeneous and molariform dentition (OLIVEIRA, 2017).

In general, diets for armadillos raised in captivity are empirical, consisting of animal protein, fruits, vegetables, and supplementation of vitamins, minerals, and amino acids. Regarding diets for raising pups, mixtures with milk substitutes and eggs are common (SUPERINA et al., 2014). When pups reach 30 days old, few different food items should be introduced, such as fruits, vegetables, eggs, beef, insects (termites and ants), soil, and vegetable substrate. This is mainly important when the animals will be released into nature (LOUGHRY; McDONOUGH, 1998; SUPERINA; LOUGHRY, 2012).

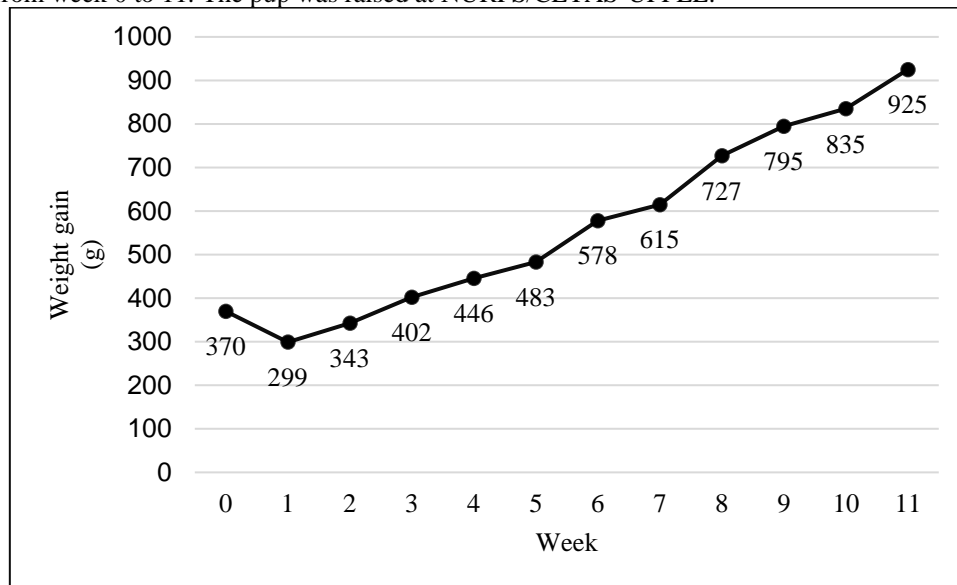
Armadillos are constantly threatened due to predatory hunting, habitat fragmentation, and environmental destruction by humans, so it is common to receive injured specimens and orphaned pups in wildlife triage and rehabilitation centers (LOUGHRY; McDONOUGH, 1998; MIRANDA, 2014; CORRÊA; OLIVEIRA; VILELLA, 2014; LOUGHRY; McDONOUGH; ABBA et al., 2014). In general, the maintenance of armadillos in captivity is a challenge due to the scarcity of scientific data, mainly on nutritional demands for both young and adults (MIRANDA, 2014). Therefore, the objective of this report is to describe the raising management of a *Dasypus novemcinctus* pup with an emphasis on its feeding and behavioral adaptation considering its return to nature.

2 CASE REPORT

A *Dasypus novemcinctus* pup (nine-banded armadillo) from Pedro Osório town, Rio Grande do Sul state, was received at the Wildlife Rehabilitation Center. At the arrival, the pup weighed 370 g. On clinical examination, it was hydrated, active, and had a good body score. Other significant findings were not shown. It was estimated the pup was two months old, based on its body weight. Initially, the pup remained at rest over the shavings

during the day, and increased the activity level during the night, drinking water and ingesting small amounts of food. At the end of the first week, a loss of 71 g was recorded. In the subsequent weeks, there was gradual weight gain. The weights obtained at the end of each week are shown in (Fig. 1).

Figure 1. Weight gain of a *Dasybus novemcinctus* (nine-banded armadillo) pup registered at the end of each week, from week 0 to 11. The pup was raised at NURFS/CETAS-UFPEL.



The food initially offered consisted of a hand-made mixture of (400 ml of warm water; 2 tablespoons of commercial wet food for cats; 6 tablespoons of commercial cracked dry food for cats; 4 tablespoons of powdered milk Ninho[®]; 6 tablespoons of milk substitute Petmilk[®]; 1 scoop of vitamin supplement Aminomix[®]; 0.5 peeled papaya and no seeds; 4 peeled bananas; 10 kale stems; 4 peeled boiled eggs; 100 g of beet; 200 ml of natural yogurt and 20 ml of whipped cream). The mixture was heated to 30-33°C and administered orally using a 5 ml syringe coupled to a 4 urethral tube. During the process of feeding, the pup was wrapped in a towel and approximately half a centimeter of the probe was inserted laterally into its oral cavity. The food was given slowly and in small amounts to avoid a pulmonary aspiration. It was administered daily 10-20% of the puppy's live weight, initially divided into five different meals throughout the day (Table 1).

Table 1. Handling feeding adaptation of a *Dasypus novemcinctus* (nine-banded armadillo) pup raised at NURFS/CETAS-UFPEL.

Time (days)	Observations	Frequency	Daily amount of mixture (10% - 20% BW)
1	Forced feed	5x/day	20 mls
2-6	Forced feed	4x/day	30 - 50 mls
7-17	On the 12 th day, starts to use the tongue to capture food in the glove	4x/day	50 - 70 mls
18-23		3x/day	45 mls
24-37	On the 26 th day, food was administered straight to the container	2x/day	30 mls
38-39		1x/day	15 mls
40-66	Spontaneously eating in the enclosure		60-90 mls

Other kinds of food were offered with the formulation simultaneously, such as wet commercial cat food, mashed bananas, ground beef, and broken quail eggs with and without the shell. It was always offered animal protein, mixture, and water on the premises for stimulating the searching of food. All items were routinely weighed on a digital scale (model) and offered in shallow containers to facilitate access. The waste was analyzed visually in percentile by the same person who previously offered the food to the pup. Due to the digging behavior, the waste weighing was difficult due to presenting other elements in the container, such as soil and wood shavings, making it impossible for measuring only the residual food.

During the process of adaptation to captivity, a spreadsheet was used to monitor the weight gain, food intake, and the animal's behavior. In total four behavioral categories were recorded, classified in eating, digging, exploring, and resting. There were also measurements classified in four levels of activity (no activity, mild, moderate, and intense), and four levels of mentation (lethargic, alert, active, hyperactive) presented by the individual at the time of observation. The weight gain was evaluated daily before providing the first meal in the morning.

Two biometrics were performed, one upon arrival (week 0) and another before release (week 11), using a caliper and a common measuring tape. The data obtained included thorax circumference, total length, tail length, body length, head length, right ear length and width, right thoracic limb length, and right pelvic limb length (Table 2).

Table 2. Biometrics performed in a *Dasypus novemcinctus* (nine-banded armadillo) pup raised at NURFS/CETAS-UFPEL.

	Week 0	Week 11
Thorax circumference	18.0 cm	25.7 cm
Total length	35.1 cm	51.5 cm
Body length	14.4 cm	21.0 cm
Tail length	14.3 cm	20.5 cm
Head length	6.3 cm	10.0 cm
Right ear length	2.9 cm	2.9 cm
Right ear width	1.4 cm	1.6 cm
Total RTL* length	8.8 cm	9.1 cm
Total RPL* length	9.6 cm	10.8 cm

*RTL, right thoracic limb; RPL, right pelvic limb.

The individual was accommodated in a square steel fenced area measuring 1.5 m x 1.0 m x 1.5 m. The concrete floor was covered by a thick layer of wood shavings, allowing the animal to make burrows or dig, which is a daily common behavior for this species. Termite mound fragments were placed into the area to stimulate the digging and foraging behavior. The room was air-conditioned at a temperature of 26 - 27 °C. Additionally, a bottle with hot water was positioned in a corner of the room as an extra source of heat, where the pup usually preferred to settle. Environmental enrichment was performed with foliage on the floor, in the squared fence, and mainly in the resting and feeding place, to allow a greater level of activity to the pup in the enclosure.

After the eighth week, the animal spent the day in a different enclosure with measurements 3.0 m x 3.0 m x 1.5 m, in an external area with soil, fragments of a termite mound, abundant foliage, and a water container measuring 50 cm x 20 cm x 10 cm. Every evening the animal was moved to the initial enclosure for spending the night.

3 DISCUSSION

According to Superina et al. (2014), young and juvenile armadillos adapt more easily to the captive diet than adults. In the National Zoological Park, in Washington (Block, 1974), two pups of *Dasypus septemcinctus* quickly accepted the offered diet using the tongue to capture the food, and consequently were eating by themselves at four weeks of age. Even though the pup in our study was more developed, it only started to apprehend the mixture with his tongue on the 13th day and started to feed himself from the 38th day (sixth week). There were no episodes of diarrhea during adaptation. The longer adaptation period can be explained by the lack of other individuals stimulating the natural competitive behavior and search for food (SUPERINA et al., 2014).

At the end of the first week, a loss of 71 g was recorded, probably associated with the stress of adaptation to handling. However, there was a gradual weight gain in the subsequent weeks, reaching an average of 62 g per week. Another study showed that when well-adapted, pups tend to show linear growth rates with gains of 10 g per day (LOUGHRY; McDONOUGH, 1998). McDonough et al. (1998) were able to point out a similar weight gain rate among young captive and wild individuals.

At weaning, the pups usually show a preference for food with a higher percentage of protein, justified by the high nutritional demand for this macronutrient, which corresponds to 22.4% in the species (TESTA et al., 2018). Therefore, termites, raw shelled eggs, and wet commercial cat food were the most appreciated protein items throughout the study, with increased demand during weaning. According to Cortez Duarte et al. (2016), the offering of termite mound fragments in the enclosure is a good environmental enrichment, with good acceptance for different armadillo species.

The spreadsheet used for monitoring the animal was very helpful, given the difficulty in finding literature that could accurately give information about the ethology of *Dasypus novemcinctus* pups, especially of an orphaned specimen separated from the litter. The behaviors observed in this study were similar to the ones showed by Cortez Duarte et al. (2015), mainly the individual behavior of digging, burying, and foraging. There was no presentation of stereotypic behaviors. Overall, the specimen in this study remained at rest for most of the day and showed a greater level of activity during the night. From the sixth week onwards, there was a significant increase in activity at the beginning of the twilight period (5:00 pm), corroborating the crepuscular/nocturnal habit registered for the species in the wild (McBee and Baker 1982; Green et al. 2016).

In the enclosure with dirt, there was a greater level of activity and many different behaviors were expressed, even though short periods of intense activity were observed during the day. The bathing behavior listed by Cortes; Mariella; Trujillo (2015) was also observed in this study. The specimen used to position himself below the water placed for cooling the enclosure's soil on warmer days (29 - 30 °C). This behavior is expressed to obtain thermoregulation, a strategy used by animals belonging to the superorder Xenarthra, which are characterized as imperfect homeotherms (ATTIAS et al., 2018).

According to Superina et al. (2014), armadillos kept in captivity for a long time without the possibility of digging, need to spend a few weeks in an enclosure with special treatment. During this time they need to have contact with natural substrate and vegetation to strengthen their muscles until they are considered fit for release into the wild. In our

study, there was an adaptation period of three weeks in an external enclosure with abundant dirt and vegetation. During the same time, the weaning of the mixture and the increase in the supply of termite mound fragments and raw eggs were carried out. The specimen studied was considered fit for release after demonstrated similar behavior to what is registered for the species in the wild, besides continued weight gain after weaning the mixture.

4 CONFLICTS OF INTEREST

The authors declare no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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