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HUSBANDRY REPORT

Husbandry of a Pink Fairy Armadillo (*Chlamyphorus truncatus*): Case Study of a Cryptic and Little Known Species in Captivity

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Pink fairy armadillos, *Chlamyphorus truncatus*, are poorly known fossorial mammals that are endemic to central Argentina. These smallest of all extant armadillos are rarely observed in the field and extremely difficult to maintain under captive conditions. This case study describes the husbandry of a male pink fairy armadillo that was maintained in an artificial environment for 8 months. A stable, undisturbed environment consisting of abundant compact sand and hiding places on the surface was the key to its successful maintenance. The artificial diet consisted of a semiliquid mixture of ground cat food, insectivore diet, mashed banana, vitamins, and minerals. Any slight modification to its environment or diet triggered a stress response. Zoo Biol 30:225–231, 2011.

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INTRODUCTION

Ex situ research can provide a wealth of information on endangered animals [Hardy, 1996; Kleiman, 1992]. Studies of animals in captivity may be suitable, and sometimes are the only way, to investigate the natural history of species that are difficult to observe in the wild, such as nocturnal or fossorial mammals.

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Fig. 1. Juvenile pink fairy armadillo *Chlamyphorus truncatus*. Photograph by Paul Vogt.

The pink fairy armadillo (*Chlamyphorus truncatus*; Fig. 1) is a nocturnal fossorial mammal inhabiting sandy plains and sand dunes in xeric environments of central Argentina [Meritt, 1985; Minoprio, 1945]. This smallest extant armadillo species [body length 13 cm, body mass 120 g; Meritt, 1985] is currently classified as Data Deficient by the IUCN Red List of Threatened Species [Superina et al., 2009a], owing to the lack of scientific information on its natural history and population dynamics. Field sightings are rare, incidental, and less common than a few decades ago [Roig, 1995; Superina, 2006]. Many wild-caught individuals have died during or a few days after transport from their natural habitat to captive facilities, suggesting that this species is extremely susceptible to stress and sudden changes in environmental conditions [Superina, 2006]. Successful reports of captive maintenance of *C. truncatus* are limited to Rood [1970] who kept one individual for at least 2.5 years in a terrarium, and Meritt [1985] who reports about a male living at Chicago Zoological Park from February 1970 to December 1971. Meritt [1976] briefly mentions that the longevity record for a captive pink fairy armadillo is more than 4 years, but gives no additional information on that specimen.

The goal of this brief communication is to describe the husbandry of a male *C. truncatus* that was maintained in an artificial environment for 8 months, with special emphasis on the enclosure type, soil conditions, and food items that were accepted or rejected by the animal. The detailed description of the challenges faced while maintaining this individual will be useful to reduce failures during future attempts to keep pink fairy armadillos in captivity.

MATERIALS AND METHODS

A juvenile male pink fairy armadillo (body mass: 77 g) was found by locals in an empty urban lot in a small town of eastern Mendoza Province, Argentina (approximately 33.5°S, 67.5°W) on January 31, 2009. It was immediately handed over to the authorities and kept in a bucket with sand and a warm water bottle. As the animal could not be released at the capture site owing to its high risk of being

killed by stray dogs, the animal was transferred 12 hr after its capture to a captive care facility in Luján de Cuyo, Mendoza Province (33.0°S, 68.9°W) where other armadillo species are kept for scientific research [Superina and Jahn, 2009; Superina et al., 2009b]. Permission to study this individual was granted by the Department of Natural Renewable Resources of Mendoza Province through Resolution 339/08.

For the first 2 weeks, the animal was kept in a semitransparent plastic box ($35 \times 45 \times 25\,cm^3$) filled with sand. A plastic bottle with warm water was placed on the surface to offer a temperature gradient. The armadillo remained underground for most of the time. When disturbed, it sometimes emitted a high-pitched screaming, and then ran along the perimeter of its enclosure for several minutes. Later on, it was maintained in a terrarium ($100 \times 60 \times 60\,cm^3$, 40 cm loose sand) in a room with central underfloor heating, at a minimum ambient temperature of 21°C. The same was placed adjacent to a window facing north to ensure exposure to sunlight and natural heating of the sand. Logs and fragments of terracotta flowerpots were provided as hiding places. Aboveground activity and movements along the terrarium's lateral glass panes were monitored for 116 days by means of two digital infrared cameras with motion sensors (Guangzhou JSP Electronics Co. Ltd., Guangzhou, China) connected to a personal computer.

To facilitate the armadillo's acclimatation to the large terrarium, the plastic box was initially placed in the center of the terrarium, thus allowing the animal to explore the new habitat and return to its usual environment. As the pink fairy armadillo incessantly ran along the terrarium glass, it was returned to its original location after 20 min. There, it calmed down and disappeared underground within a few minutes. The procedure was repeated on the following day with the same result. A heating stone ($20 \times 10\,cm^2$; New Pet, Buenos Aires, Argentina) was installed in a corner of the enclosure and the sand heated with hot water bottles before the third attempt to release the animal in the terrarium. The pink fairy armadillo explored the enclosure aboveground and dug under the logs for approximately 1 hr, then hid under a piece of terracotta where it slept for several hours. As the animal continued to run along the glass panes and never remained underground for more than a few minutes, one-fourth of the substrate was replaced by clayey sand on March 20. The armadillo immediately dug a burrow and did not emerge for two days. After this modification, the animal never again rested aboveground and visibly calmed down, as the episodes of running along the perimeter became less frequent. Rotten logs, branches, and small shrubs (*Larrea* sp.) were placed or relocated in the terrarium at irregular intervals.

Food offered—and rejected—on the first day consisted of items readily accepted by other armadillo species, such as pichis (*Zaedyus pichiy*), screaming hairy armadillos (*Chaetophractus vellerosus*), and hairy armadillos [*C. villosus*; Superina, unpublished data]. It included ground-soaked cat food (Whiskas® Beef, Masterfoods Argentina Ltd., Mercedes, Argentina), mashed banana, hard-boiled egg, melon, grapes, and fruit of *Condalia microphylla* (''piquillín''), a shrub native to the pink fairy armadillo's habitat. Owing to the animal's increasing weakness, 1 ml of a mixture used to hand-rear a hairy armadillo (*C. villosus*) was administered by introducing the tip of a type K-35 gastric tube of 1.4 mm diameter (Koler S-14, Deplamed S.R.L., San Martín, BsAs, Argentina) into the animal's mouth in the evening of Day 1. This semiliquid diet consisted of 250 ml lowfat milk, one tablespoon cream, 80 g ground-soaked cat food (Whiskas Beef), half mashed

TABLE 1. Acceptance of Food Items by a Captive Pink Fairy Armadillo *Chlamyphorus truncatus*

Never	Ground meat, hard-boiled egg,[a] boiled rice, apple,[a] melon,[a] grape,[a] pineapple,[a] banana,[a,b,c] *Condalia microphylla* fruit, *Prosopis flexuosa* pods, pumpkin flesh[a] and seeds, sweet potato,[a] avocado flesh,[a] avocado shell with flesh, Whiskas Beef,[c,d,e] Whiskas® Chicken and Vegetables,[d,e] Whiskas® Chicken and Milk,[d,e] earthworms, beetles, pill bugs, insect larvae
Once	Plum,[a] peach,[a] vanilla yoghurt, strawberry yoghurt
Repeatedly	Water melon, avocado shell with rests of flesh, Mazuri Insectivore Diet[c,e]

[a]Finely chopped.
[b]Mashed.
[c]Accepted if mixed with other ingredients.
[d]Ground, soaked.
[e]Soaked.

banana, and 3 g vitamin/mineral supplement (Vionate S, Novartis S.A. Sanidad Animal, Buenos Aires, Argentina). From the second day on, three-fourth teaspoon breadcrumbs mixed with 30 g of the soupy mixture were offered in two round plastic plates (4 cm) and readily accepted by the animal. Milk was gradually replaced by water and the cat food substituted by Mazuri Insectivore Diet® (PMI Nutrition International, Saint Louis, MO) until reaching a mixture of 250 ml water, 55 g Mazuri Insectivore Diet, 25 g ground Whiskas Beef, half mashed banana, and 3 g Vionate S. Kept refrigerated, one preparation of this mixture lasted for 2 weeks.

Food offered in the morning always remained untouched. Feeding time was, therefore, set at 20:30 hr, before the first emergence of the armadillo. Additional food items were offered opportunistically, at least three times each, during the study period (Table 1). The pink fairy armadillo was never observed drinking, although water was offered ad libitum.

RESULTS AND DISCUSSION

A stable, undisturbed environment was the key to the successful maintenance of *C. truncatus*. When undisturbed, the armadillo emerged to eat two to five times per night and returned to its burrow within 3–5 min. Aboveground activity was sometimes initiated at 20:30 hr, but other times after 01:00 hr, and ended before 08:00 hr. Underground activity could be intermittently observed through the glass panes or owing to movements of the terrarium surface (indicating the animal was digging below ground) between 08:00 and 12:00 hr, but not in the afternoon. Although underground movement was more common in the upper half of the sand layer, the pink fairy armadillo sometimes dug along the bottom of the terrarium.

The different textures of fine and clayey sand allowed visual differentiation of substrates. For the first 5 months, the animal only seemed to utilize the part of the terrarium containing clayey sand, as no surface soil or underground movement along the glass panes was detected in the remainder of the terrarium. From August to October, surface soil movement suggested that the pink fairy armadillo was sometimes digging below the surface in the sandy ground. It is possible that this behavior was related to the sand initially being too loose for the animal to construct a stable burrow. This hypothesis is reinforced by the observation that before the addition of clayey sand, the animal remained aboveground all the time and hid under

pieces of ceramics instead of resting underground. Later on, natural compaction of the substrate may have allowed the armadillo to dig in the entire terrarium.

Diurnal underground movement was mainly observed in the part of the terrarium opposite the window, near the heating stone, whereas nocturnal aboveground activity occurred in all the terrarium. Considering that the pink fairy armadillo's eyes show adaptations to a nocturnal and fossorial lifestyle [Minoprio, 1945], it is possible that the animal did not dig along the glass pane facing the window to avoid being blinded by the sunlight. Alternatively, the animal's apparent preference for the opposite side of the window may have been related to its poor thermoregulatory ability. Other armadillo species are known to be poorly equipped to cope with cold ambient temperatures owing to their low rates of heat production and high thermal conductance [McNab, 1980, 1985]. Although no data are available on the physiology of pink fairy armadillos, they have been described as extremely susceptible to sudden ambient temperature changes [Roig, 1971]. Sand temperature near the window varied between 18 and 30 or even 40°C, with an average daily amplitude of 11.2°C in May/June, whereas it usually ranged between 20 and 24°C (average daily amplitude: 2.4°C) on the opposite side of the terrarium. Remaining on the latter side may thus have helped avoiding temperature extremes.

Behavioral enrichment was limited to a minimum because any modification in its environment resulted in the animal acting excited and moving about for a prolonged time (up to 3 hr). Changes triggering such a stress response included transferring it to a larger enclosure; changing the location of logs and branches inside the terrarium; moving food plates to the other side of the enclosure; installing infrared cameras and a personal computer near the enclosure; or offering a slightly different diet, such as increasing the proportion of mashed banana or using another variety of dry cat food in the mixture. Excited behavior was also observed whenever the animal emerged in the evening, before food was placed in its enclosure. Rotten logs did not stimulate the armadillo's exploratory behavior and remained untouched. Items buried in the enclosure were sometimes explored by the animal. For instance, the pink fairy armadillo was repeatedly observed inspecting a disk-shaped temperature datalogger of 17 mm, initially placed at 10 cm depth.

According to Redford [1985], *C. truncatus* mainly feeds on invertebrates and possibly some plant material, and can be classified as a fossorial generalist insectivore. Finding an appropriate artificial diet for the animal was not easy. Rood [1970] kept a pink fairy armadillo on a diet consisting of bread soaked in milk, whole oats, beetles, and beetle larvae. Meritt [1976] mentions that a different dietary approach is necessary for pink fairy armadillos than for other armadillos, and suggests the same diet reported by Rood [1970]. Meritt [1985] reports that a captive male ate crickets, mealworms, white bread soaked in milk, and grains of barley and oats. Considering that earlier studies reported that both wild and captive pink fairy armadillos ingest invertebrates, it was reasonable to assume that the animal studied here would thrive on insects and earthworms. It showed, however, no interest for them. It also refused to ingest the large majority of other food items offered, although it did accept some of them when mixed together (Table 1).

It is clear that the food quantity offered daily (30 g) was too high for such a small animal. Measurement of food intake was not possible, as the soupy mixture dried out between serving and food intake. Also, the armadillo often stepped into the round food plates while eating, thus mixing the remaining food with sand.

Nevertheless, the relatively stable body mass after the animal reached its adult weight (from March to September: 107.5 ± 7.6 g) suggests it was ingesting only what it needed. The moist diet often stuck to its claws and sand adhered to it, which led to formation of clumps that had to be manually removed. This problem was resolved by using smaller food plates, such as a plastic recipient of $10 \times 1 \times 1\,cm^3$.

The pink fairy armadillo was found dead on October 11, 2009, approximately 25 cm below the surface. The reasons for its death remain unknown. No macroscopic lesions were observed during necropsy and preliminary histopathology has been unrevealing. Considering that the animal's diet was based on its taste preference rather than its (unknown) nutritional requirements, a nutritional imbalance cannot be ruled out as contributory in its death. If true, the latter may explain why this captive pink fairy armadillo survived for a shorter time than the individual kept by Rood [1970], which received a more natural diet that included invertebrates.

CONCLUSIONS AND RECOMMENDATIONS

1. Pink fairy armadillos seem to be extremely susceptible to stress. A stable, undisturbed environment consisting of abundant compact (clayey) sand and hiding places on the surface are key to a successful maintenance.
2. A strict hands-off management should be used to avoid stress. For the same reason, cage cleaning, feeding, and any modifications in the enclosure should always be performed at the same time of the day and by the same person.
3. Because food preferences seem to vary individually, offering a variety of food items and mixtures will help determining the appropriate diet. A soupy consistency will ensure the animal ingests enough water. The diet should include live invertebrates.
4. Food should be offered in receptacles that prevent the animal from stepping into the diet.

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