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Observations on the feeding behavior of the Sierra de Aroa shrew (*Cryptotis aroensis,* Eulipotyphla: Soricidae), in Venezuela

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The shrew *Cryptotis aroensis* from Sierra de Aroa, Venezuela, was recently described. Little is known on the natural history of the species. This note reports the first records on the foraging behavior of *C. aroensis* in captivity feeding on invertebrates and small vertebrates. We placed one individual previously captured in a pitfall trap inside a plastic box for ten days. We also added litter, log remains, bromeliads and mosses inside the box. Potential invertebrate and vertebrate preys were captured and placed simultaneously with the shrew to make observations on locomotion, posture, feeding preferences and prey manipulation. We supplied 17 invertebrate and two small vertebrate preys belonging to three phyla and seven classes during the period of captivity (Table 1). The foraging behavior consisted of sniffing the substrate and air (Figure 1A, B). The stalking behavior on prey consisted of rapid movements above or under the litter, and catches were made directly with the snout (Figure 1C, D). Handling prey for consumption involved tearing, cutting and chewing a small portion; the same pattern was repeated until the prey was consumed completely. *Cryptotis aroensis* consumed a variety of prey, but it showed no apparent preference for any prey, contrary to what was reported for *C. meridensis* in Merida, Venezuela (Woodman and Diaz de Pascual 2004). *C. aroensis* differed from *C. meridensis* in the search and capture strategies, but coincided with *C. parvus* (Whitaker 1974). Although the information reported in this note should not be taken as conclusive because it derived from a single individual under inadequate study conditions; nonetheless, it represents the first record on the behavior of the species in captivity.

La musaraña, *Cryptotis aroensis* fue descrita recientemente de la Sierra de Aroa, Venezuela. Poco se sabe de la historia natural de la especie. Esta nota presenta los primeros registros obtenidos de comportamiento de depredación y alimentación de *C. aroensis* sobre animales invertebrados y pequeños vertebrados en cautiverio. Se colocó un ejemplar previamente capturado en un sistema de trampas de fosa adentro de una caja de plástico por diez días. La caja fue ambientada con hojarasca, restos de troncos, bromelias y musgos. Se colectaron potenciales presas de invertebrados y vertebrados que fueron colocadas simultáneamente con la musaraña para hacer observaciones de locomoción, postura, preferencias alimentarias y manipulación de las presas. En el periodo de cautiverio se le suministró al ejemplar de *C. aroensis* 17 presas de invertebrados y dos pequeños vertebrados pertenecientes a tres Phyla y siete Clases (Tabla 1). El comportamiento de exploración consistió en "olfatear" sobre el sustrato y aire (Figura 1A, B). El comportamiento de acecho de las presas fueron rápidos movimientos por encima o por debajo de la hojarasca y las capturas fueron realizadas directamente con su hocico (Figura 1C, D). La manipulación de las presas para el consumo fue desgarrar, cortar y masticar una pequeña porción y luego volver a repetir el mismo patrón hasta consumirlos completamente. *Cryptotis aroensis* consumió a varias de las presas suministradas, sin aparentemente mostrar un comportamiento de preferencia por alguna, contrario a lo reportado para *C. meridensis* en Mérida, Venezuela (Woodman and Díaz de Pascual 2004). El comportamiento de búsqueda y captura, igualmente fue distinto al reportado para *C. meridensis*, pero coincidió con *C. parvus* (Whitaker 1974). Aunque los datos presentados en esta nota no deben de tomarse como conclusivos debido a que los ensayos fueron realizados con un solo individuo y las condiciones para el estudio no fueron las adecuadas, representan los primeros registros sobre el comportamiento en cautiverio de la especie.

Key words: foraging behavior; shrew; Sierra de Aroa; Yaracuy, Venezuela.

Introduction

The shrew *Cryptotis aroensis* from Venezuela was recently described, and to date is known only from three locations in Sierra de Aroa, municipality of Bolívar, Yaracuy State: Capilla de Milla (type locality; Quiroga-Carmona and Molinari 2012), El Silencio and La Trampa del Tigre (Yurubí National Park; García *et al.* 2013). Nothing is known about the diet and foraging behavior of *C. aroensis.*

In an inventory on mammals inhabiting humid forests at Yurubí National Park, Sierra de Aroa, Venezuela (García *et al.* 2013), an adult female of *C. aroensis* was captured in a pitfall trap fitted with a drift fence placed in the area known as "La Trampa del Tigre" (10° 24′ 11″ N, 68° 48′ 01″ W, 1,700 m). The finding of this animal offered the opportunity to document the first observations related to its activity and foraging behavior over a short period of time in captivity.

Materials and Methods

Since the capture of a living *C. aroensis* in the pitfall trap was unexpected (most of the time, these animals do not remain alive after being caught up in these traps), an improvised site had to be conditioned for the handling and mainte-

nance of the shrew in the base camp at Yurubí National Park; in addition, a method was designed for the observations and collection of prey items used as food. For further details on the habitat, population and ecological aspects of *C. aroensis,* refer to (García *et al*. 2013; Quiroga-Carmona and Molinari 2012).

The specimen of *C. aroensis* (adult; weight = 11.0 g) was placed in a plastic box (50 cm long x 35 cm wide x 35 cm high) for ten days (May 16 to 25, 2012). The box was conditioned with a thin layer of litter, log remains, bromeliads (*Guzmania* spp.) and mosses. Ambient temperature in the locality over the course of the experiment ranged from 10 °C at night to 25 °C in daytime. When the experiments were completed, the animal was sacrificed, processed as biological material (skin, skull and skeleton), and deposited in the Museo de la Estación Biológica de Rancho, Aragua State, Venezuela, under catalog number EBRG-29398. The scientific collection license granted by the Ministerio del Poder Popular para el Ambiente was registered under number 3411.

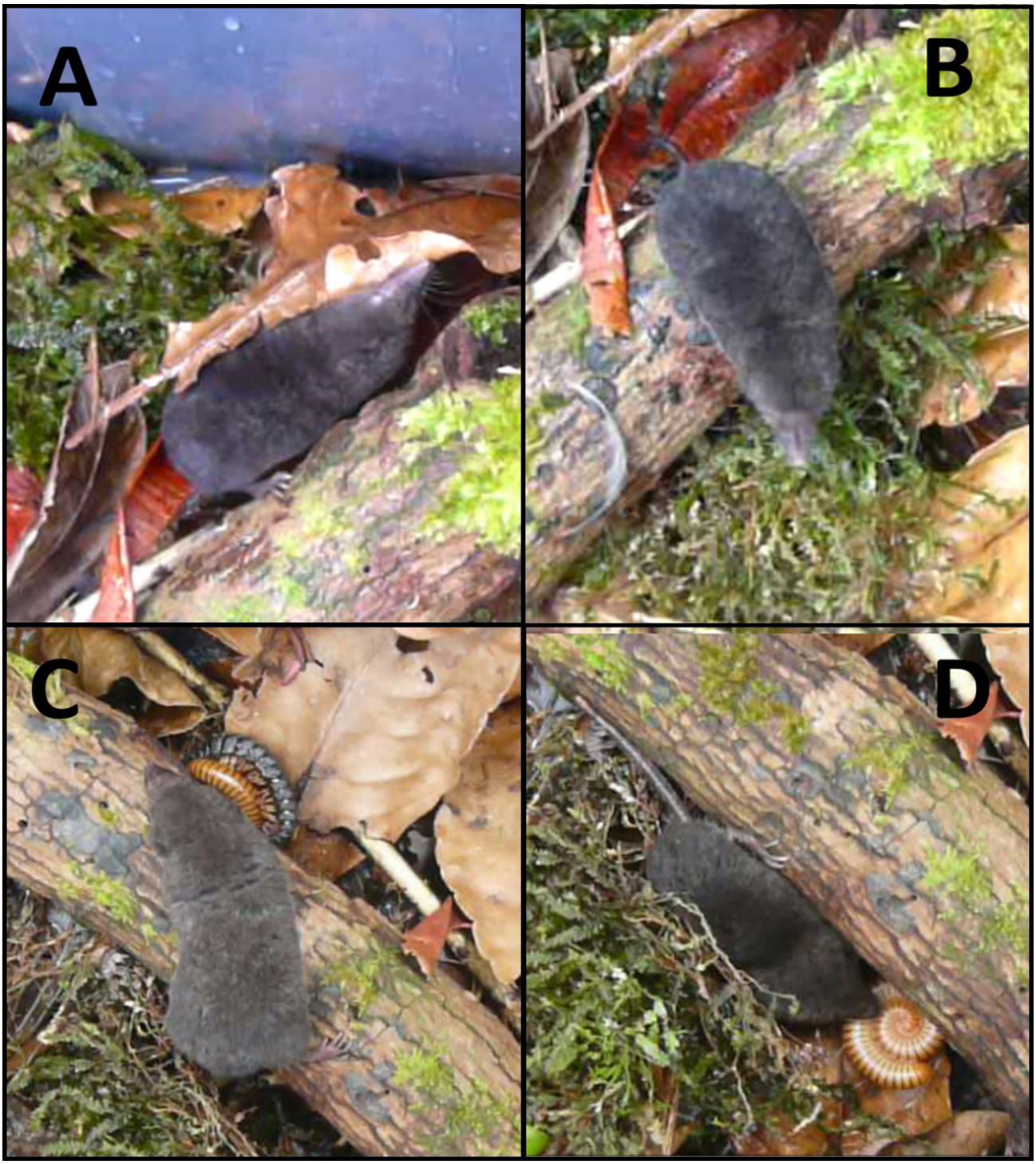

Figure 1. Transformed images of visual records that show a female of *Cryptotis aroensis* in the search phases and interacting with invertebrate preys (Chilopoda and Diplopoda). In images A and B, the shrew searches the area by sniffing above and below the substrate; in C, the shrew conducts searching activities and once a prey is localized, *C. aroensis* captures with its snout and takes it to a shelter to consume it (D).

Potential preys were divided into three categories: soft body and size < 50 mm; hard body and size < 50 mm; and soft or hard body and size >50 mm. Prey items were placed inside the box simultaneously (every two hours from 18:00 until 06:00 hours). Most of them were offered in equal amounts, every day, and visual records were made simultaneously with a digital camera to document locomotion, posture, food preferences and prey manipulation.

Results

A total of 17 invertebrate and two small vertebrate preys belonging to three phyla and seven classes were supplied to *C. aroensis* (Table 1). With regard to behavior, observations were the following: at the beginning of the activity (approximately 18:00 hours), the shrew moved quickly using its four legs; no jumps were observed. Very often, it stopped to sniff out the air as well as above and under the substrate (Figure 1A, B). Then, it resumed rapid movements in a straight line over the edge and the central portion of the box; these movements were a combination of displacement above and under the litter layer. In the few moments of inactivity observed (from 20:00 hours and approximately every three hours), the shrew rested above the substrate or hidden under the litter or among small logs.

When a prey was detected, the shrew approached it quickly above or below the litter and captured it with the snout (Figure 1D). All capture attempts at the first encounter involved a quick bite to the anterior or posterior region of the prey's body, immediately followed by another quick bite to attract the prey toward itself. These catches were 100 % effective in the first encounter with annelids (Annelida), sawbugs (Oniscidea), beetle larvae (Coleoptera) and geckos (*Gonatodes rapicauda* and *Thecadactylus falconensis*).

When the first bite was unsuccessful, the prey escaped (mostly Blattide, Acrididae, Gryllidae and *Grillotalpa* sp.), forcing the shrew to chase it; when it reached the prey, the shrew bit it repeatedly at the back portion of the body (rear end of the abdomen and legs). In other cases, *C. aroensis* completely ignored the prey (Opiliones, Hymenoptera, Chilopoda, Diplopoda and Lepidoptera larvae).

Table 1. Potential prey types supplied to *Cryptotis aroensis* during the experimental phase.

TAXA	Body consistency	Size class (mm)	Consumed	Consumption time (min)	Individuals per day
ANNELIDA					
Olygochaeta					
Lumbricus sp.	soft	< y >50	YES	< 3	6
ARTHROPODA					
Arachnida					
Aranae	soft	< 50	YES	< 3	4
Scorpionida					
Tityus falconensis	hard	50	YES	> 5	1
Opiliones	soft	< 50	NO		6
Malacostraca					
Decapoda					
Pseudothelphusa sp.	hard	< 50	YES	> 5	1
Oniscidea	soft	< 50	YES	< 3	6
Chilopoda					
Scolopendridae	soft	< 50	YES	> 5	
Morfo 1	hard	> 50	NO		2
Diplopoda	hard	> 50	NO		2
Insecta					
Orthoptera					
Acrididae	hard	< 50	YES	< 3	6
Gryllidae	hard	< 50	YES	< 3	6
Gryllotalpidae					
Grillotalpa sp.	hard	< 50	YES	< 3	6
Blattaria					
Blaberidae	soft	< 50	YES	< 3	6
Coleoptera					
Carabidae	hard	< 50	YES	< 3	4
Scarabaeidae (Larva)	soft	< 50	YES	< 3	6
Lepidoptera (Larva)	soft	> 50	NO		2
Hymenoptera					
Formicidae	hard	< 50	NO		6
CHORDATA					
Reptilia					
Gonatodes falconensis	soft	< 50	YES	> 5	1
Thecadactylus rapicauda	soft	< 50	YES	> 5	1

Prey handling for consumption consisted in tearing, cutting and chewing a small portion, and then repeating this same pattern until the prey was eaten up completely. The time taken to consume a prey ranged from two to three minutes for crickets and grasshoppers (Gryllidae), mole crickets (*Gryllotalpa* sp.) and cockroaches (Blattaria), up to over five minutes for the rest (Table 1).

Discussion

Under laboratory conditions, Woodman and Díaz de Pascual (2004) reported the consumption of a variety of invertebrates by a female Merida shrew (*Cryptotis meridensis*) observed over one month. The experiments conducted with *C. meridensis* documented its preference for earthworms (*Lumbricus* sp.); the feeding pattern involved search runs followed by patterns of circular movements and audible sounds in each of the search phases. Unlike those observations, *C. aroensis* showed no apparent preference for *Lumbricus*; during the experiments, all animals preyed upon were consumed in equal amounts, with neither patterns of circular movement nor audible sounds produced at the time of stalking and search.

Another study on *Cryptotis parvus* (Whitaker 1974) recorded the consumption of a large amount of invertebrates, amphibians, reptiles and small mammals by the shrew. The author mentions previous studies with *C. parvus* specimens in captivity evidencing a behavior similar to the one observed here for *C. aroensis*. In most encounters of *C. parvus* with its prey, the latter were captured by the head; some tried to escape and were chased and bitten on the head. Others were ignored and those with a soft body were consumed completely. In all observations of *C. aroensis*, the shrew never used the front legs or adopted a bipedal posture for prey handling and consumption, as recorded for other small mammals with similar prey preferences (Martin and González-Chávez 2015).

Some studies suggest that the external morphology of the legs among the different groups of species in the genus *Cryptotis* (particularly the development of the front legs with claws and humerus), provides information on their evolutionary history and food preferences (*e. g.*, Woodman *et al.* 2003; Woodman and Morgan 2005). In the case of *C. aroensis*, Quiroga-Carmona and Molinari (2012) propose an apparent association with a more specialized diet including underground prey, due to the ease of digging provided by its developed front legs. In the trials conducted with the *C. aroensis* female, no direct evidence of digging or making tunnels and shelters was observed, as previously noted for the shrew *C. meridensis* under natural conditions (Díaz de Pascual and Woodman 2004, Linares 1998), but its ability to penetrate beneath the moss layer and litter when displacing was observed.

The lack of evidence of a more underground behavior of *C. aroensis* is likely due to the fact that the litter-moss layer was not too thick and contained no mineral sandy or clayey soil that could restrain the movements when the shrew attempted to move under the surface. Another potential explanation is that underground preys (*e. g.*, *Lumbricus* sp., Scolopendridae), did not have the opportunity to escape and hid under the substrate, so that the shrew was not forced to dig for them; or maybe the duration of the experiment was insufficient to document all possible behaviors of the species.

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