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Seasonal changes in body composition of *Ctenomys talarum* (Rodentia: Octodontidae): An herbivore subterranean rodent

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Abstract

Ctenomys talarum is a subterranean herbivorous rodent whose burrow systems exhibit particular characteristics, distinct from other subterranean environments. We studied seasonal variation in body composition of *C. talarum* in relation to energetic requirements. Body lipid content seasonally changed in *C. talarum*, related to reproductive cycle and thermorregulatory mechanisms. A decrease in protein body content was found only in spring. Ash content of females was lowest when most of them are in post partum estro. Observed variations in water body content could be associated with plant water content and/or metabolic regulation. Our results show the occurrence of seasonal variations in body composition in *C. talarum*, which could be related to the high cost of reproduction and the subterranean life style of this species.

Keywords: Body composition; Burrow; *Ctenomys talarum*; Energy requirements; Energy reserves; Octodontidae; Subterranean rodent; Tuco-tuco

1. Introduction

Burrow systems are characterized by the absence of light, low primary productivity and poor ventilation. Subterranean habitats appear to be more stable than surface habitats. However, the subterranean niche imposes to the organism environmental conditions more stressful than those encountered above ground (Buffenstein, 2000).

The genus *Ctenomys* (tuco-tuco) comprises about fifty to sixty species of subterranean herbivorous rodents. This genus is widely distributed, extending from the high bunchgrass of the Andean Altiplano in southern Peru and Bolivia to sea level in Chile, and throughout most of Argentina into southeastern Brazil (Lacey, 2000). Previous works of our group regarding the biology of *Ctenomys talarum* have shown that tuco-tucos are typically solitary, living in a tunnel system excavated parallel to the soil surface (Busch et al., 2000). *C. talarum* individuals show arrhytmic patterns of locomotor activity under seminatural conditions (Luna et al., 2000; Luna and Antinuchi, 2003). This apparent arrhytmicity has been related to a constant need for territorial defense against conspecifics and predators (Luna et al., 2000; Luna and Antinuchi, 2003). The acquisition of food by subterranean rodents is energetically expensive due to the high energetic cost of digging (Vleck, 1979). This has been also shown to be the case for *C. talarum* (Luna et al., 2002). Moreover, the diet of *C. talarum* consists mostly of low quality monocotiledons and its composition changes in relation to food availability (del Valle et al., 2001).

Previous work in our laboratory has shown that *C. talarum* appeared to regulate their reproductive activities in relation to environmental cues such as temperature, photoperiod and seasonal changes in food biomass (Fanjul et al., 2002). Pregnancy and lactation are energetically costly periods for *C. talarum* females exhibiting a high increase in metabolic rate during these periods (about 150%) (Zenuto et al., 2002).

C. talarum burrow system in Mar de Cobo (Buenos Aires province, Argentina) exhibits particular characteristics. The

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temperature inside *C. talarum* burrow shows seasonal variations (Cutrera and Antinuchi, 2004). Furthermore, due to the fact that *C. talarum* also forages above ground venturing away from their tunnels (Comparatore et al., 1995; del Valle et al., 2001), these rodents have to face not only the thermal variation inside the burrow but also the changes in surface temperature for brief periods (Cutrera and Antinuchi, 2004). Thus, besides the energetically costly subterranean life *C. talarum*, unlike other subterranean rodents, has also to buffer both the surface and burrow environmental variations. Therefore, it is expected that to maintain a positive energy budget this species would exhibit different physiological strategies.

In several surface rodent species fat constitutes an energy reserve that could be metabolized when energy uptake decreases or when energy demands increase by physiological or environmental stress (Sawicka-Kapusta, 1974; Millar and Schieck, 1986; Mutze, 1990; Wirminghaus and Perrin, 1993; Voltura and Wunder, 1998; del Valle and Busch, 2003). In addition to fat reserves, variations in other body components (i.e.: water, protein, ash) appeared to occur in response to changes in environmental conditions (Sawicka-Kapusta, 1974; Wirminghaus and Perrin, 1993; Unangst and Wunder, 2003; Król et al., 2005). In this context, we have shown such variation in body composition in the surface rodent *Akodon azarae* inhabiting Mar de Cobo grassland (Buenos Aires province, Argentina) (del Valle and Busch, 2003). To our knowledge it is still unknown whether these physiological strategies occur in subterranean rodents.

In this work, we studied the body composition of *C. talarum* from Mar de Cobo in their natural habitat to investigate the possible existence of seasonal variations in relation to energetic requirements. To our knowledge this work constitutes the first attempt to establish the body composition dynamics in a subterranean rodent.

2. Material and methods

2.1. Animal collection and classification

Individuals of *C. talarum* were live trapped in Mar de Cobo, Buenos Aires Province, Argentina (37°45′ S, 57°56′ W). The study area was located on a grassland of the Pampeana Region characterized by a temperate seasonal climate with oceanic influence. Temperature is maximal in January reaching an average of 20.1 °C and lowest in July with an average of 7.4 °C. Night time frosts are common during the winter. Annual rainfall ranges between 178 mm and 1800 mm with most falling during March, December and January. The cold semester (April–September) is less rainy, with a minimum in June and July (Reta et al., 2001). The area belongs to the eastern portion of the phytogeographical province of the Pampas grassland dominated by species of Compositae (*Tessaria*), grasses (*Cortaderia, Paspalum, Stipa, Panicum*) and Cyperaceae (*Androtrichium*). Cabrera (1941) provided a more detailed description of the vegetation.

Animals were seasonally trapped. Plastic live traps were placed in active burrow system, distinguished by the conspicuous mounds of fresh earth brought to the surface during burrowing activities, and were checked every hour throughout the day. Animals were carried to the laboratory where they were individually housed in cages. The day after capture, animals were anesthetized with sodium pentobarbital (50 mg/kg body mass) before being sacrificed by cervical dislocation.

Before necropsy, body mass (0.1 g) and length (1 cm) were recorded. Individuals were classified in relation to sex and reproductive status in: mature and immature males and reproductive and non-reproductive females. Males were classified as mature if spermatozoa were present in slides of seminal fluid. Females were classified as reproductive if they were pregnant or lactating.

The age of the animals was estimated by using the growth curve for *C. talarum* based on von Bertalanffy' s model (Malizia and Busch, 1991). According to age tuco-tucos were divided into adults and subadults. Males and females were classified as adults when they were older than 8 months and 5 months, respectively.

2.2. Body composition

During necropsy, the carcasses (excluding gut, reproductive tract and embryos) were weighed and dried at 70 °C to constant mass. The mean water content was determined as the difference between wet and dry mass. Then, the carcasses were ground in a grinder. Three sub-samples (to the nearest g) were dried for 24 h, weighed (to the nearest mg), and placed in pre-weighed cellulose extraction thimbles. Fat from these samples was extracted in petroleum ether for 8–10 h by using a Soxhlet extraction apparatus, dried and reweighed. Petroleum ether was used because it extracts lipids completely, but does not extract significant amounts of non-lipid material (Dobusch et al., 1985). After drying and reweighing, the carcasses (without fat) were placed in crucibles and put into a muffle furnace for 12 h at 550 °C. Protein content was then determined as the difference between total mass and water, fat, and ash. Total fat, protein and ash content were calculated as the mean of the three sub-samples. The data are presented as the mean (g) ± SE of fat, protein and ash.

The body condition was estimated using the physical condition index (PCI) = wet mass body/(total length − tail length)^2 (Willett, 1998; Olsson et al., 2002).

2.3. Statistical analysis

Statistical analysis were performed using the STATISTICA (2001) statistical package for the Windows operating system. A parametric (ANOVA) or a non-parametric (Kruskal-Wallis) analysis of variance were used to test the null hypothesis of no differences among season or age for each variable, a posteriori ANOVA test (Student-Newman-Keuls Method) was used to identify differences among season or age. Due to the fact that only one immature male was captured in fall, analysis in body composition was only performed for spring and summer by using a parametric analysis of mean. Differences due to sex, reproductive status and age were analyzed by a parametric analysis of mean. The fact that reproductive females, non-reproductive females and immature males could not be captured