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ANNUAL DIET OF THE LITTLE HAIRY ARMADILLO, *CHAETOPHRACTUS VELLEROSUS* (MAMMALIA, DASYPODIDAE), IN BUENOS AIRES PROVINCE, ARGENTINA

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Analysis of the stomach contents of 28 little hairy armadillos (*Chaetophractus vellerosus*), collected during a 14-month period at Pipinas, Argentina, showed that about 63.6% of the weight of prey items was composed of animal remains, 18% was plant material, and the remaining 18.4% was undetermined organic remains. Insects were the most frequent diet item, followed by plant material, amphibians, reptiles, and lastly birds and mammals in similar proportion. During autumn, plant material was the most abundant item, followed by vertebrates and invertebrates. During winter invertebrates prevailed, followed by a lower percentage of vertebrates and scarce plant remains. Invertebrates also were predominant during spring, whereas plant material and vertebrates composed very low percentages.

Key words: annual diet, *Chaetophractus vellerosus*, Dasypodidae, Pipinas, prey item

The family Dasypodidae is currently represented by 9 living genera and 21 species of armadillos, distributed from the southern United States to the Strait of Magellan (Wilson and Reeder 2005). The 9 living genera have different food preferences, ranging from carnivores–omnivores to generalized and specialized insectivores (Redford 1985).

The species studied here, *Chaetophractus vellerosus* Gray, 1865 (commonly known as the little hairy armadillo), occurs from the Gran Chaco and central Argentina to Mendoza Province and the middle latitudes in Buenos Aires Province, Argentina. However, its distribution has been recently expanded by the finding of new populations in the coastal area of Samborombón Bay, which are not continuous with the main area occupied by the species. This disjunct distribution has been explained as a relict of a more extensive paleodistribution that comprised the current territory of Buenos Aires Province during the late Pleistocene and part of the Holocene (Carlini and Vizcaíno 1987). Recent discoveries in Ensenadan sediments (lower to middle Pleistocene) of southeastern Buenos Aires Province also has extended the temporal distribution of this species (Soibelzon et al. 2006).

Our study provides the 1st description of the annual diet of *C. vellerosus* in Buenos Aires Province, as well as a comparison with previous information from Catamarca Province (Greegor 1980). Knowledge of the diet of these armadillos is essential for the interpretation of their ecological role in ecosystems. In addition, comparison of the diets of specimens from such different environments (vide infra) is a fundamental contribution to assessment of the influence of certain ecological aspects on the geographic distribution of *C. vellerosus*.

Our study complements the contribution of Glaz and Carlini (1999) on the home range of *C. vellerosus*, because both studies are focused on the assessment of the behavior of this species in 2 areas with very dissimilar climatic characteristics.

The role of *C. vellerosus* in the dynamics of local soils also is a subject that has received little study. Such studies are scarce for armadillos (Kalmbach 1944; Machera et al. 2004), but have been conducted for some fossorial rodents in the family Octodontidae. For example, Contreras (1966) and Contreras and Maceiras (1970) described alteration of soils by *Ctenomys* (commonly known as tuco-tucos) in southeastern Buenos Aires Province. Finally, we highlight the possible role of *C. vellerosus* as an agent for pest control in agricultural lands. In this sense, its predation on insect larvae (such as some Scarabeidae,

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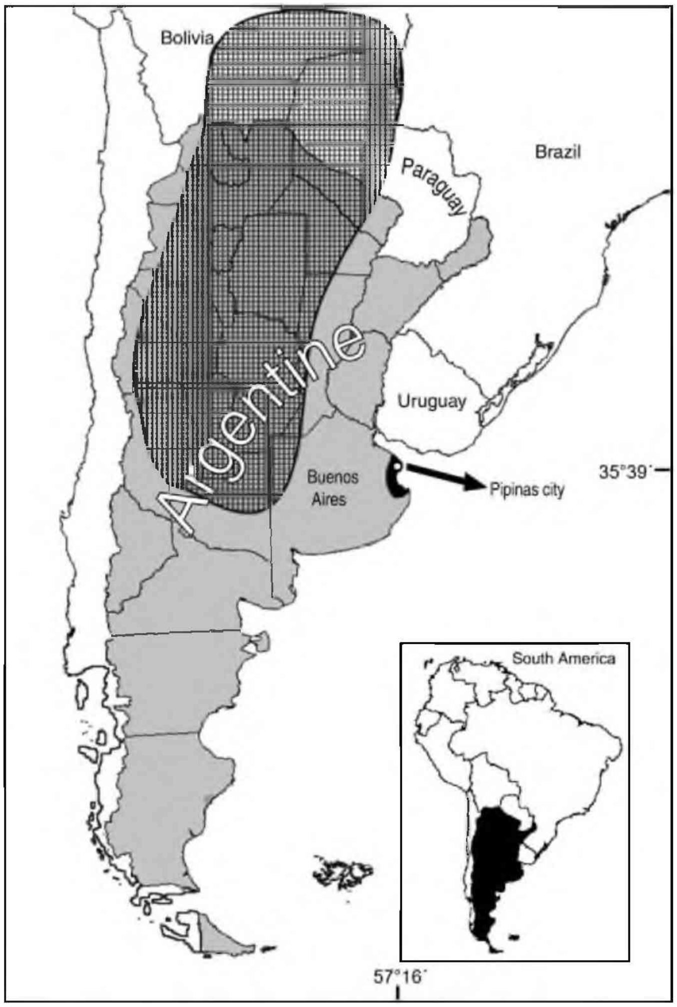

FIG. 1.—Map showing the geographic distribution of *Chaetophractus vellerosus*. Cross-hatched area: main distribution; black area: relictual area in Buenos Aires Province, Argentina.

Curculionidae, and Noctuidae) is particularly important because some of these insects are common crop-damaging species (see Castelo and Corley 2004; Fava and Imwinkelried 2004; Frana and Imwinkelried 1996; Lanteri 1994; Rizzo 1977).

MATERIALS AND METHODS

Study area.—The study was carried out from September 2001 to November 2002 in Pipinas (35°39′S, 57°16′W), a locality situated approximately 20 km southeast of Magdalena City (Fig. 1) in the coastal region of the Buenos Aires Province (Bahía Samborombón), Argentina. From a biogeographical perspective, the area is part of the Chacoan Domain of the Neotropical Region (Cabrera and Willink 1980). The climate in the area is temperate humid, with 1,200 mm mean annual precipitation and 16°C mean annual temperature (Fig. 2).

The local edaphic characteristics in the area result in more xeric conditions than the regional soils (Murriello et al. 1993). These conditions favor the development of xerophytic woodlands dominated by tala (*Celtis tala*) and coronillo (*Scutia buxifolia*) that are collectively known as Talares (*C. tala* forests). These Talares develop on elevated shell-beds (albardones), which are covered by markedly sandy soils; the ensemble forms a system that is extremely permeable to water. These deposits, originated during Quaternary marine ingressions, represent elevations of 1–2 m above the level of adjacent areas (Goya et al. 1992). The distribution of *C. vellerosus* is restricted specifically to these sectors (Glaz and Carlini 1999).

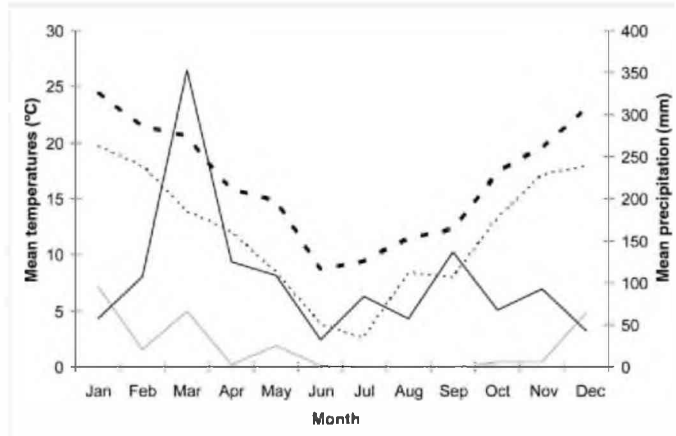

FIG. 2.—Mean temperatures and precipitations for 2 localities where *Chaetophractus vellerosus* has been studied. Thin lines: Andalgalá, Catamarca Province; thick lines: Pipinas, Buenos Aires Province; dotted lines: monthly mean temperature; continuous lines: monthly mean precipitation. Source: Argentine National Meteorological Service, Buenos Aires, Argentina.

Sample collection.—The stomachs were obtained primarily from specimens that were hunted by landowners, who consider the species as damaging to their agricultural activities. Secondarily, we obtained stomachs from specimens that had recently died and that had whole and undamaged stomachs, and that were found along nearby routes. A total of 28 stomachs were collected (9 in autumn, 9 in winter, and 10 in spring) and fixed immediately in 10% formaldehyde for subsequent analysis of their contents. No specimens were collected during summer, when the armadillos were nocturnal or crepuscular in their activity (see also Breece and Dusi [1985] for *Dasypus novemcinctus*). Date of capture was complemented whenever possible with other data including hour of capture, sex, weather conditions, and exact site of collection. Each stomach was weighed using digital scales with ±0.1-g accuracy. Once open, the stomach contents were sifted using a sieve with 0.1-cm^2 mesh size, regarding all particles less than 0.1 cm^2 in diameter as sediment (Greegor 1980). For identification of prey items, the remainder of the stomach contents was analyzed under a 10× stereoscopic microscope. As observed by Breece and Dusi (1985), most food items were practically unbroken, and thus identifications were unequivocal. Many items found were almost undamaged (e.g., insect larvae, *Hypsiboas pulchellus*, and *Amphisbaena*), but only fragmentary remains were found for others (e.g., adults insects, feathers, and hair). We consulted specific literature for all determinations (Alvarado 1980; Brewer and de Argüello 1980; Cei 1980, 1993; Morrone and Coscarón 1998; Richards and Davies 1983). Because some

Table 1.—Percent of the overall weight (%W) of stomach contents composed of prey items found in stomachs of 28 individual *Chaetophractus vellerosus*. Numbers in parentheses indicate the number of stomachs examined. Subscripts s and t indicate season and total, respectively.

	Seasons			
Prey items	$\%W_s$ autumn (9)	$\%W_s$ winter (9)	$\%W_s$ spring (10)	$\%W_t$ (28)
Plant material	37.2	0.5	5	17.9
Invertebrates				
Insects				
Orthoptera	0	3.4	0	0.5
Coleoptera				
Beetle adults	0	11.1	0	1.7
Beetle larvae	1.6	37.8	0.7	6.9
Lepidoptera				
Caterpillars	1.1	7.5	36.8	17.1
Diptera				
Diptera larvae	0	0	3	1.2
Hymenoptera				
Ants	13	22.5	4.4	10.9
Others	0	0	0	0
Arachnida	0	0	0.4	0.2
Unidentified ivertebrates	6.2	0	7.1	5.6
Total invertebrate	21.9	82.3	52.4	44.2
Vertebrates				
Amphibia				
Hypsiboas pulchellus	1.8	0	0	0.8
Odontophrynus americanus	1.2	14.5	0	2.7
Reptilia				
Amphisbaena sp.	0.4	0	3.8	1.7
Birds	0	0	2.1	0.9
Mammalia				
Rodentia	31.3	0		13.2
Unidentified vertebrates	0.3	0	0	0.1
Total vertebrate	34.8	14.5	5.9	19.5
Undetermined remains	6.1	2.7	36.7	18.4

Table 2.—Frequency of occurrence (%FO) of prey items found in stomachs of 28 individual *Chaetophractus vellerosus*. Numbers in parentheses indicate the number of stomachs examined. Subscripts s and t indicate season and total, respectively.

	Seasons			
Prey items	$\%FO_s$ autumn (9)	$\%FO_s$ winter (9)	$\%FO_s$ spring (10)	$\%FO_t$ (28)
Plant material	88.8	11.1	20	39.2
Invertebrates				
Insects				
Orthoptera	0	11.1	0	3.5
Coleoptera				
Beetle adults	0	22.2	10	10.7
Beetle larvae	55.5	44.4	50	50
Lepidoptera				
Caterpillars	44.4	55.5	90	64.3
Diptera				
Diptera larvae	0	0	20	7.1
Hymenoptera				
Ants	22.2	22.2	10	17.8
Others	0	11.1	20	10.7
Arachnida	11.1	0	30	14.2
Unidentified invertebrates	88.8	0	30	39.2
Vertebrates				
Amphibia				
Hypsiboas pulchellus	22.2	0	0	7.1
Odontophrynus americanus	11.1	11.1	0	7.1
Reptilia				
Amphisbaena sp.	11.1	0	10	7.1
Birds	0	0	10	3.5
Mammalia				
Rodentia	11.1	0	0	3.5
Unidentified vertebrates	11.1	0	0	3.5
Undetermined remains	11	33	70	39.2

insect larvae (such as Carabidae) could not be unambiguously identified to genus or family (Cicchino 2006), our identifications were performed to the level of order. Prey items were classified into 4 main categories: invertebrates, vertebrates, plant material, and undetermined remains. The latter category included all unidentifiable filtrate. The results are presented as percent of the overall weight (wet weight) of all items in the diet and frequency of occurrence (Tables 1 and 2):

$$\%W_s = Pi_w \times 100/Ti_w$$
$$\%W_t = \sum Pi_w \times 100/\sum Ti_w$$
$$\%FO_s = Pi_p \times 100/N$$
$$\%FO_t = \sum Pi_p \times 100/\sum N$$

where %W is the weight percent, %FO is frequency of occurrence (measured as percent), Pi_W is totaled weight for an individual prey item (in grams) over the season, Ti_W is totaled weight of all prey items (total weight [g]) over the season, Pi_p is number of stomachs containing the prey item, N is number of stomachs per season, and subscripts s and t indicate seasonal and total (i.e., all 3 seasons pooled), respectively.

To examine the relationships within invertebrates and vertebrates, the weight percent ($\%W_s$ and $\%W_t$) of all invertebrates (TI) and all vertebrates (TV) were calculated:

$$TI = i_w \times 100/\sum Ti_w$$
$$TV = v_w \times 100/\sum Ti_w$$

where i_w is the weight of all invertebrates (in grams) over the season and v_w is the weight of all vertebrates (in grams) over the season. A new weight percent for each prey item was calculated using the TI or TV value as 100%W.

Results

General diet analysis.—Over the 14-month period, approximately 44.2% of the weight of the total stomach contents ($\%W_t$) was composed of invertebrates, 17.9% was plant

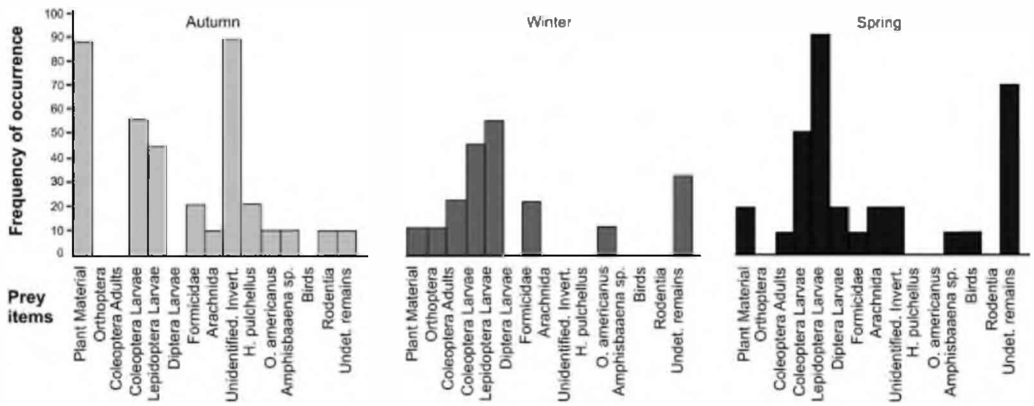

Fig. 3.—Seasonal frequency of occurrence (%FO_s) of the most common prey items found in the diet of 28 *Chaetophractus vellerosus* collected in Pipinas (Buenos Aires Province, Argentina), during 3 seasons of the year.

material, 19.5% was vertebrates, and the remaining 18.4% was undetermined remains (Table 1). Among invertebrates, insects were the most abundant items, with 85.5%W_t and a frequency of occurrence close to 100%. The most important invertebrate prey items were Lepidopteran larvae (38.8%W_t), Hymenopterans (24.6%W_t), and Coleopterans (19.5%W_t). Other prey items, with less than 25%FO_t, included Orthopterans, Dipterans, and Arachnids, and represented less than 2%W_t. It is noteworthy that insect larvae were much more common diet items than adult insects (100%FO_t and 14.2%FO_t, respectively). Within the vertebrates, the highest weight percent corresponded to mammals (67.8%), followed by amphibians (18%), reptiles (9.5%), and lastly birds (4.7%). However, the most frequent prey items were amphibians (14.2%), followed by reptiles (7.1%), and lastly birds and mammals in equal proportions (3.5%; Table 2; Fig. 3).

Seasonal analysis.—A partial seasonal replacement of certain prey items by others was apparent: plant material and vertebrates were replaced by invertebrates during winter and spring (Fig. 4). Although mammals composed a high weight percent during autumn, this was due to finding the remains of 1 rodent that represented about 90% of the weight of all vertebrate prey. Without this item, the vertebrates would have presented the lowest weight percent in all the seasons studied. The frequency of occurrence of amphibians and reptiles as prey items was higher than that of birds and mammals, and coincided with the former being recorded during the coldest seasons of the year (autumn and winter).

Among the groups of invertebrates, seasonal replacement was observed between Coleopterans, Lepidopterans, and Hymenopterans (Fig. 5). We would predict a decrease in occurrence of larvae during summer, along with their replacement by adult forms, because larval stages of most species predominate during spring and metamorphose into adults during summer (Alvarado 1980; Richards and Davies 1983).

Discussion

We do not know whether the dietary items recorded in our study were ingested as carrion or captured and consumed alive, because food items analyzed were in diverse conditions when recorded, from perfectly preserved individuals (e.g., insect larvae and some vertebrates) to minimal remains (hairs, feathers, legs, etc.). Specifically in the case of amphibians and reptiles, it is highly probable that the armadillos were able to find these prey items buried and immobile, in conditions that would promote their capture (Breece and Dusi 1985; Wirtz et al. 1985). In this respect, Zug et al. (2001:180) state "in frogs, the ability to jump is critical for escape from terrestrial predators . . . the distance moved, however, is temperature dependent," and Huey (1982:58) asserts that "the seasonal activity of reptiles is strongly influenced by thermal biology." Consequently, their activities decrease with lower temperatures to the point that some of them undergo hibernation (Greegory 1982; Zug et al. 2001). With respect to strategies for prey procurement, *C. vellerosus* would likely make use of the prey items that are most abundant and easiest to capture according to the season. This hypothesis could not be tested because indices of relative abundance were not available for the prey items in the study area.

Greegor (1980) showed that in northwestern Argentina the most abundant prey items during winter (May–July) were plant materials, followed by invertebrates and vertebrates. During summer, invertebrates represented the highest percentage of prey items, followed by vertebrates, and lastly, plant material. Our analysis showed that in winter, invertebrates were the most important dietary item, whereas plant material was the least abundant item in the diet. We suggest that this difference was determined by climatic factors that influenced the availability of different prey items. In this respect, precipitation could be more important than temperature as a limiting factor (Fig. 2). Precipitation was practically absent in Catamarca during the winter months, a condition that favors the development of xerophytic plant species (e.g., *Prosopis*) and is detrimental to animal species with higher humidity requirements (e.g., amphibians). For this reason, we may conclude that, during winter, the populations of *C. vellerosus* at Pipinas are more insectivorous than those at Catamarca.

Given the environmental disparity between the main distributional area for *C. vellerosus* and our study area (temperatures

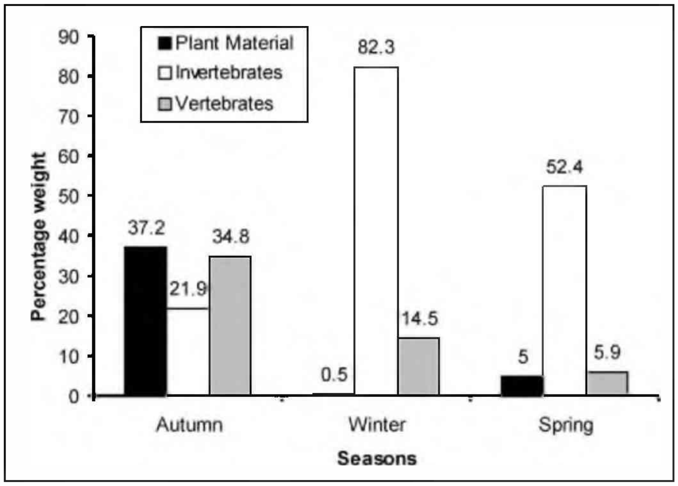

FIG. 4.—Weight percent for each season (%W_s) of the main categories of prey item consumed by *Chaetophractus vellerosus*, showing seasonal replacement of plant material and vertebrates by invertebrates during winter and spring.

about 5°C higher throughout the year, and more than double the mean annual precipitation) and following Carlini and Vizcaíno (1987), we suggest that the occurrence and permanence of *C. vellerosus* at these higher latitudes is due to the edaphic characteristics of the Talares (*C. tala* forests).

Finally, we emphasize the necessity for research on other possible ecological aspects of *C. vellerosus* (e.g., food availability, population status, role as pest control species, and possible agents of soil alteration). Some larvae of Scarabeidae and Curculionidae (Coleoptera) are considered important crop-damaging species (e.g., *Diloboderus abderus*, *Rachiplusia nu*, *Aramigus tessellatus*, and *Pantomorus auripes*). Most of the life cycle of these insects takes place in agricultural fields and they feed on the roots of some agricultural plants (Castelo and Corley 2004; Gopar and Ves Losada 2004). Some of these species probably occur among the insects consumed by *C. vellerosus*. Consequently, the supposed damage caused by these dasypodids to agricultural lands could be less than the beneficial effects of their predation upon some of these damaging insect species. Such studies are even more necessary when we consider that *C. vellerosus* has a relictual distribution in Buenos Aires Province and that hunting by humans, coupled with habitat fragmentation (Haene 2006), could reduce the number of individuals to ecologically nonsustainable levels, leading to the disappearance of the small populations of *C. vellerosus* at these latitudes.

RESUMEN

Se describe y analiza el contenido estomacal de 28 armadillos (*Chaetophractus vellerosus*) colectados en la localidad de Pipinas. De esta forma se puso de manifiesto que aproximadamente el 63.6% del peso de los ítems presa hallados corresponde a restos animales, el 18% a vegetales y el 18,4% restante a restos orgánicos indeterminados. En este sentido, los insectos fueron los más numerosos (frecuencia de ocurrencia cercana al 100%), seguidos por restos vegetales (39.2%), anfibios (17.8%,), reptiles (7.1%) y por último aves y mamíferos en igual proporción (3.5%). Durante el otoño, los restos vegetales fueron el ítem más abundante, seguido por vertebrados e invertebrados. En invierno, el ítem ampliamente predominante fueron los invertebrados, seguido en menor porcentaje por los vertebrados y por escasos restos vegetales. En primavera los invertebrados fueron nuevamente el ítem más importante, los restos vegetales y los vertebrados representaron un porcentaje muy bajo.

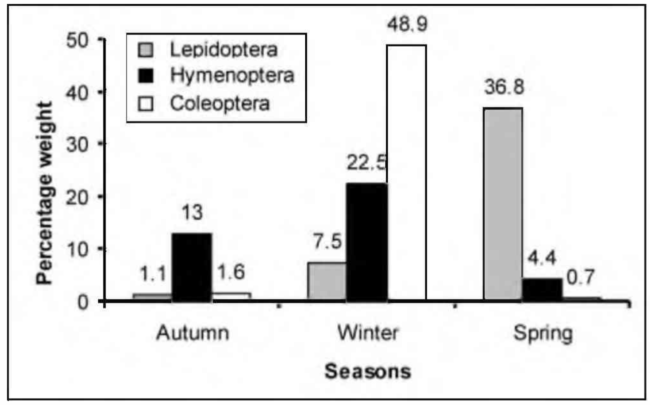

FIG. 5.—Weight percent (%W_s) of insects consumed by *Chaetophractus vellerosus* in each season, showing seasonal replacement of beetle larvae by caterpillars.

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