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Ecological conditions and isotopic diet (^{13}C and ^{15}N) of Holocene caviomorph rodents in Northern Patagonia

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ABSTRACT

This work improves our knowledge about the relationship between diet and environment among Northern Patagonian caviomorph rodents. In order to characterize long-term individual diets, we present $\delta^{13}C$ and $\delta^{15}N$ data from osteological remains of the caviomorph rodents *Dolichotis patagonum*, *Myocastor coypus*, *Lagostomus maximus*, *Lagidium viscacia*, *Microcavia australis*, *Galea leucoblephara* and *Ctenomys* sp., recovered from archaeological and recent contexts. These data are analyzed by temporal and geographic context and compared with the previous dietary studies based on macrorremains and microhistological analysis. Significative differences were found between rodents from Monte and Patagonian phytogeographic provinces, as well as between archaeological and modern members of the genus *Ctenomys*, indicating diet changes between Late Holocene and recent times individuals, that could confirm the climatic variations and/or the recent overgrazing effect. The results indicate trends in rodent diets of 20th and 21st centuries were different to those of the Late Holocene, suggesting a decrease in precipitation and/or an increase of the summer pattern of the same, and/or an increase of mean annual temperature. In addition, this work confirms the generalist strategy of several taxa, although mainly in *Ctenomys*, which its diet co-varies with these environments.

1. Introduction

The relationship between diet and resource structure is central for understanding evolutionary, ecological and paleoecological processes, particularly at the community level. Most organisms depend on other living creatures for food, whether directly or indirectly. Even where they do not, as with primary producers, they still serve as a source of food for others. These consumer–resource interactions play a critical role in determining both the development of community structure and the evolutionary trajectories of community members. Rodents form a key link in this chain owing to their small size, high numbers, high reproductive rates, and low trophic position. They play important roles in plant dispersal (Van der Waal, 2003), alter vegetation and landscape characteristics via herbivory and burrowing (e.g. Zhang et al., 2003), serve as hosts for parasites and as vectors for pathogens (Meerburg et al., 2009), and constitute the primary dietary components of many small to large sized reptilian, avian, and mammalian predators. While less well studied than in other parts of the world, a growing number of investigations from arid western Argentina have focused on many of these key issues in rodent ecology, including their diets (e.g. Albanese et al., 2010; Borruel et al., 1998; Campos, 1997; Galende and Grijera, 1998; Galende and Raffaele, 2012; Galende et al., 1998, 2013; Kufner and Pelliza De Sbriller, 1987; Puig et al., 1998, 2010), habitat use and conservation (Gonnet and Ojeda, 1998; Rodriguez, 2009; Tabeni et al., 2012, 2013), and role as prey (Bisceglia et al., 2008, 2011; Nabte et al., 2008).

Here we are concerned with the diets of seven taxa belonging to four representative families of caviomorph rodents from northern Patagonia and Monte Desert of western Argentina. Our particular interest is in identifying spatial and temporal variation in the diet using stable isotope signatures. Ultimately we want to identify the extent to which a given taxon can be used as an indicator of particular habitats or climatic regimes. In the process we hope to contribute data useful to the broader ecological debates just cited.

In order to do this, we employ stable carbon and nitrogen isotopes to infer or confirm the diets of the caviomorph rodents *Dolichotis patagonum*, *Myocastor coypus*, *Lagostomus maximus*,

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Lagidium viscacia, *Microcavia australis*, *Galea leucoblephara* and *Ctenomys* sp. recovered from archaeological and recent contexts in arid and semi-arid regions of North Patagonia. These include specimens from both Monte Desert and northern Patagonian environments of southern Mendoza and the extreme north of Neuquén. Our results 1) demonstrate broad agreement between the observed isotope values of many, but not all, rodents and the values expected given existing histological studies for those same species, 2) highlight geographic differences in diets of rodents inhabiting Monte and Patagonian phytogeographic regions, and 3) identify temporal changes in isotope values and inferred diet among the genus *Ctenomys*, the best represented taxon. The latter appear related to vegetation changes, recent warming trends, and overgrazing by cattle during the last century.

2. Materials and methods

2.1. Study area

The study area is located in western Argentina between 34°30′–37°30′S and 70°30′–67°W (Fig. 1). The region is environmentally heterogeneous, owing in large part to the presence of the Andean cordillera, which reaches heights of up to 5000 m asl. The high mountains impede the Westerlies generated by the Pacific anticyclone, casting a substantial rain shadow and producing arid to semi-arid climatic conditions (Polanski, 1954). A piedmont fringe composed of numerous alluvial fans with heights between 1800 and 1000 m asl extends along the mountains, while a large, lowland plain averaging 200 m asl extends eastward from the piedmont to the Desaguadero river. These plains are formed by alluvial sediments deposited by the Atuel and Diamante rivers, and in certain sectors form extensive aeolian dune fields (Polanski, 1954). Finally, there is the volcanic region of La Payunia, a large area of volcanic badlands and ephemeral fluvial systems covering much of the south portion of the province of Mendoza east of the Andes and south of Cerro Nevado (Polanski, 1954).

Vegetation within these various regions is grouped into three basic phytogeographic units (Cabrera, 1976). From west to east these are the High Andean, Patagonian and Monte vegetation zones (Fig. 1). The High Andean unit comprises the Andean cordillera above 3000 m. It is characterized by cold, windy climatic conditions and winter dominant precipitation (300–800 mm). The shrubby and herbaceous steppes of this unit are composed mostly of C_3 photosynthetic bunch grasses and shrubs such as *Adesmia* spp., *Oxalis muscoides* and *Mulinum spinosum* (Cabrera, 1976; Cavagnaro, 1988; Llano, 2009). The Patagonian unit is located from the piedmont fringe to sectors of the eastern plain and western La Payunia region. It is defined by a cold and semi-arid climate with winter precipitations (200–500 mm). The steppe community is mainly dominated by C_3 plants such as *M. spinosum*, *Ephedra ochreata*,

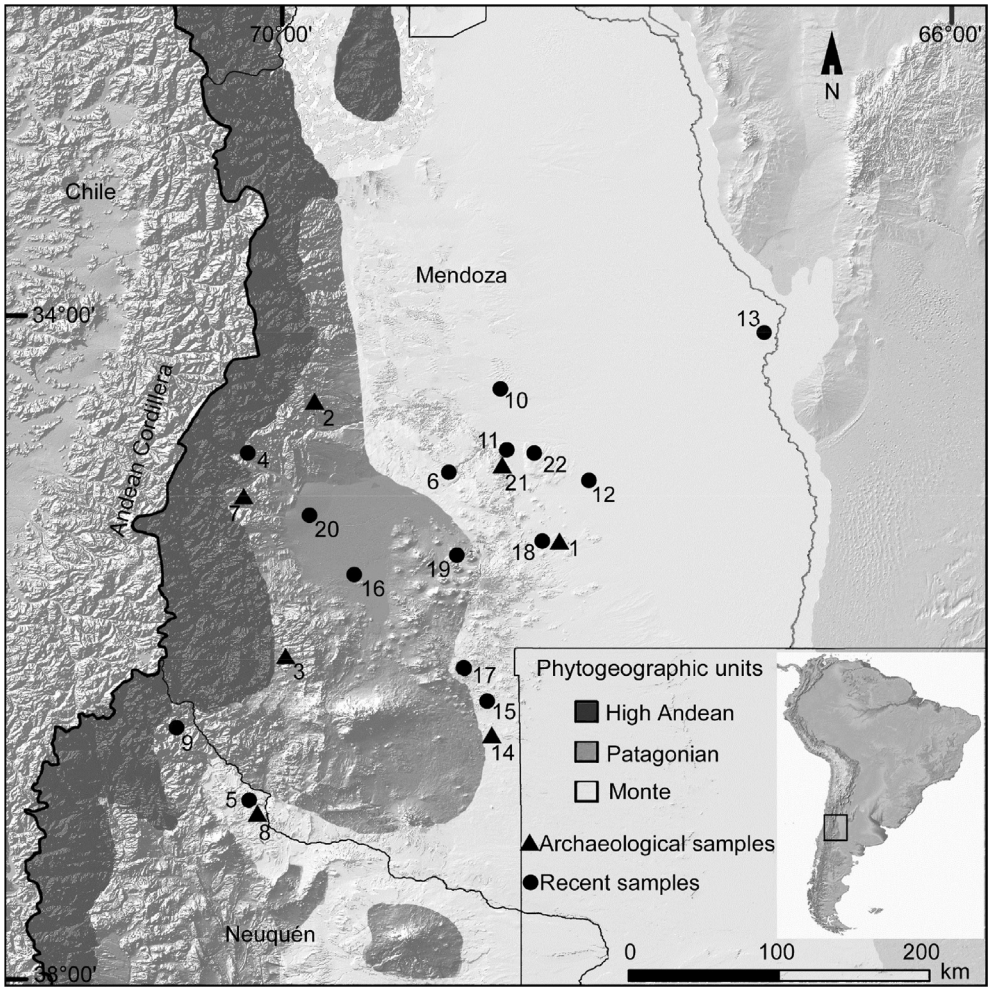

Fig. 1. Map of the study area, including Mendoza and northern Neuquén Provinces, Argentina. The map shows the locations of archaeological and recent samples superimposed on the main phytogeographic units (according to Cabrera, 1976). Numbers are those used in Supplementary material.