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A methodology for the determination of pollen sources in studies of Patagonian camelid coprolites

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ABSTRACT

Pollen studies on Patagonian camelid coprolites (Argentina) focus on palaeodiet analyses and palaeoenvironmental reconstructions. The elucidation of the source of pollen in coprolites is a main issue to interpret what and how past facts happened. The aim of this work is to evaluate the source of the pollen contained in both modern *Lama guanicoe* feces and camelid coprolites to evaluating the post-depositing contamination. Pellets were separated into outer and inner parts, and pollen extraction was made of each for analysis. As to pollen concentration, differences probably linked to the pollination season were found between both parts of the feces. The presence of certain taxa only in the outer part could be due to postdepositional contamination. Coprolites evidenced more *Nothofagus* anemophilous pollen concentration in the outer surface of feces and certain taxa were only registered in a single part. A separate pollen analysis of the outer and inner parts of modern feces and coprolites yields information referred to contamination by environmental pollen; thus, the items conforming part of the diet of the vegetation area not consumed by the organisms can be discriminated.

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1. Introduction

The finding of Holocenic coprolites ascribed to camelids in caves from the Argentine Patagonia (sites CCP5 and CCP7, Perito Moreno National Park) gave rise to questions about the seasonality in the site use of camelids and men (Martínez Tosto and Yagueddú, 2012; Martínez Tosto et al., 2012, 2013; Velázquez et al., 2014), of palaeodiets and of the contribution of the analysis of coprolites to environmental studies.

Since *Lama guanicoe* (camelid) was the main subsistence resource of hunter-gatherers (Borrero, 2001; Miotti and Salemme, 1999), the knowledge of palaeodiets, action range and seasonality in the use of caves/eaves could yield information on the mobility dynamics of these groups.

Pollen studies on coprolites focus on palaeodiet analyses and environmental reconstructions (Reinhard and Bryant, 1992; Carrión et al., 2001, 2004; Horrocks et al., 2003; Burry et al., 2008; Martínez Tosto et al., 2012; Velázquez et al., 2015, 2010; Wood et al., 2012). Various authors point out that a main issue is the elucidation of the source of the pollen content. For instance, pollen grains in coprolites of herbivores are related to their diet and the plant availability in the environment. In this way, the presence of pollen in herbivore, can be the result of:

1) diet of anthers, leaves, stems, flowers and fruits, ingested with pollen grains adhered to the organs surface (Bryant and Holloway, 1983)
2) water drinking with suspended pollen grains coming either from pollen rain or aquatic plants,
3) air inhalation,
4) pollen depositing over the feces surface after deposition, mainly pollen grains with anemophilous dispersion (Carrión et al., 2001, 2005). This happens because once the deposition has occurred, *mucus* surrounding feces acts as a pollen trap from the pollen rain (Chaves, 2000) (Fig. 1): it is the post-depositional pollen contamination.

The concentration and preservation of pollen within coprolites are influenced by many factors: a) type of plant pollination (zoophilous, anemophilous, hydrophilous or autopollination); b) physiology of the organisms digestive system; c) organisms' feeding habits or behavior and d) preservation environment, like temperature, humidity and acidity.

On the other hand, studies of modern feces together with coprolite analyses and experimental studies allow for comparisons and contribute to the necessary information to interpret what and how past facts happened (Fernández-Jalvo et al., 2010; Gil-Romera et al., 2014). In studies of modern diets and palaeodiets, and the analysis of fresh feces and coprolites it is important to ascertain the origin of pollen and spores to contribute information to other ecological matters of organisms (Fig. 1).

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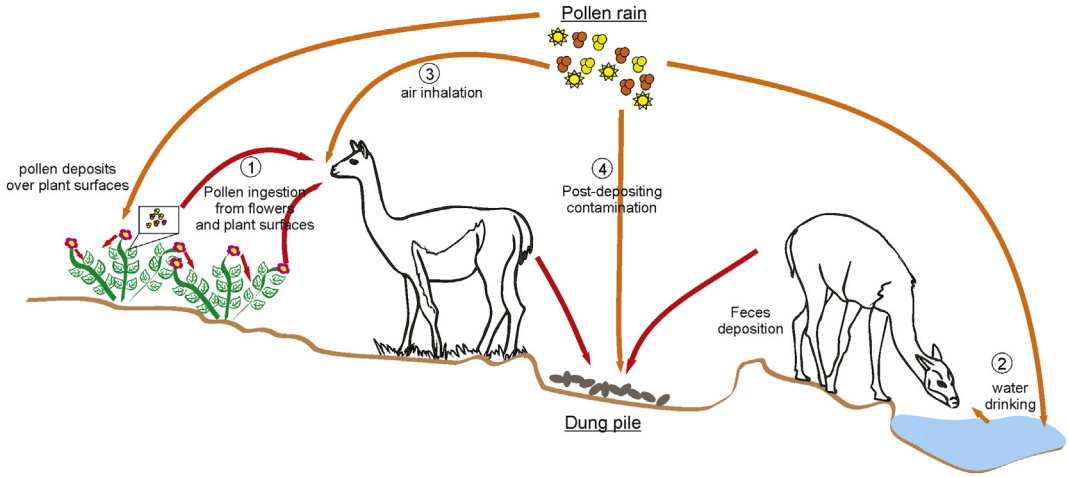

Fig. 1. Different input pollen routes to *Lama guanicoe* feces.

The aim of this work is to evaluate the source of the pollen contained in modern *Lama guanicoe* feces and camelid coprolites. The hypothesis posed is that the feces surface is contaminated with pollen coming from the pollen rain.

2. Regional setting

The Perito Moreno National Park (PMNP) is located in central-west Santa Cruz, in the Andes Mountain Range, Río Chico Department (Fig. 2).

The climate, influenced by the South Pacific Anti-cyclone, is temperate-cold to cold in summer and glacial the rest of the year, with predominant western winds. Mean annual temperatures are less than 4 °C, with a sharp seasonality (in winter, temperatures can reach −30 °C, and in summer 15 °C). Annual precipitations in the park range from near 600 mm in the west to 400 mm in the east (Aschero, 1981–1982; Paruelo et al., 1998).

Phytogeographically, the park is located in the Deciduous Forest District of the Subantarctic Province and in the Central District of the Patagonic Province (Cabrera, 1976). The area of study consists of caves located in Cerro Casa de Piedra (CCP) (47°57′S; 72°05′O, 900 m asl), east of the Andes Mountain Range, in a transitional belt between the mountain range forest and the Patagonic steppe, in the Roble River basin and Lake Burmeister. The hill has a series of eaves and caves, among which are the sites Cerro Casa de Piedra cave 5 (CCP5) and 7 (CCP7), 600 m from the Roble River southern margin (Fig. 3a).

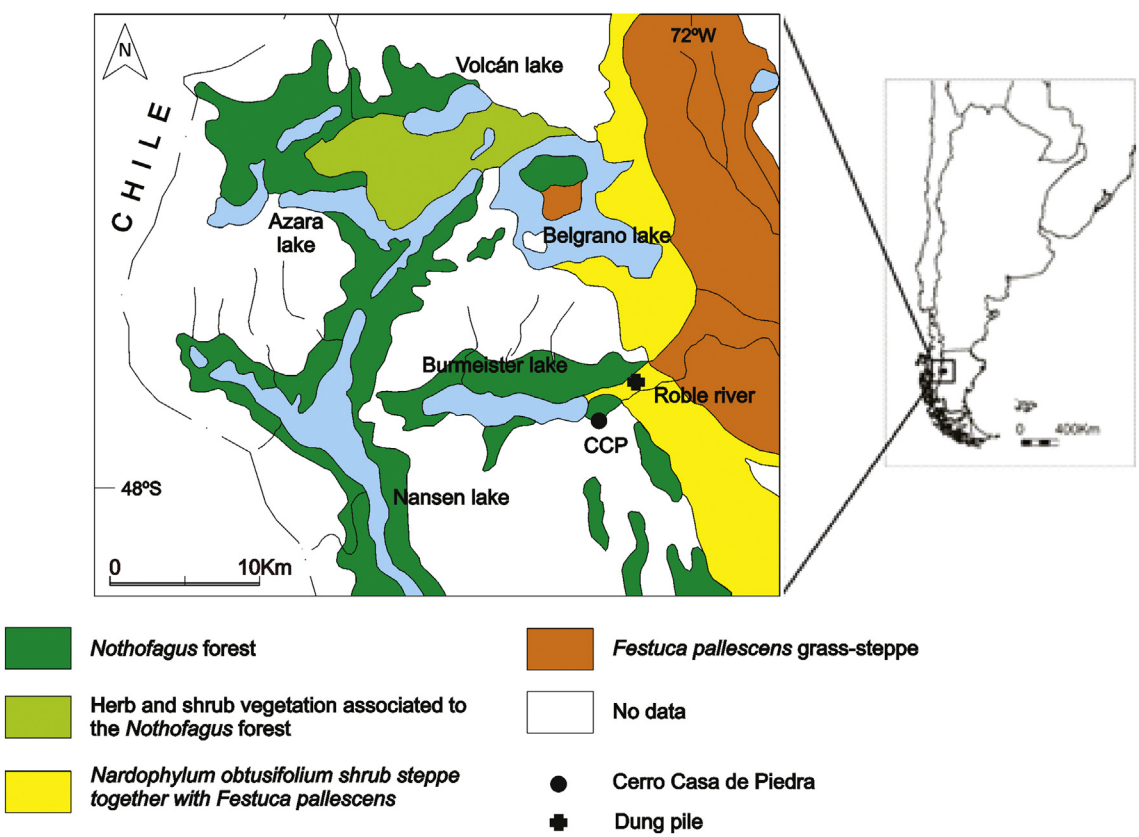

Fig. 2. Map of the Perito Moreno National Park vegetation units, province of Santa Cruz (modified from Movia et al., 1987), and Cerro Casa de Piedra location.

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