Quaternary International xxx (2016) 1–8

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Reconstructing drowned terrestrial landscapes. Isotopic paleoecology of a late Pleistocene extinct faunal assemblage: Site GNL Quintero 1 (GNLQ1) (32° S, Central Chile)

Patricio López Mendoza [a, *], Isabel Cartajena [a], Diego Carabias [b], Francisco J. Prevosti [c], Antonio Maldonado [d], Valentina Flores-Aqueveque [e]

[a] ARQMAR, Centre for Maritime Archaeology Research of the South Eastern Pacific, Departamento de Antropología, Facultad de Ciencias Sociales, Universidad de Chile, Ignacio Carrera Pinto 1045, Santiago, Chile
[b] ARQMAR, Centre for Maritime Archaeology Research of the South Eastern Pacific, ÀRKA – Maritime Archaeology, Cochrane 401, Of. 1, Casilla 21, Correo Central Valparaíso, Chile
[c] Centro Regional de Investigaciones Científicas y Transferencia Tecnológica de La Rioja (CRILAR), UNLaR, SEGEMAR, UNCa, CONICET, Entre Ríos y Mendoza s/n (5301) Anillaco, La Rioja, Argentina
[d] Centro de Estudios Avanzados en Zonas Áridas, CEAZA, Universidad de La Serena, Raúl Bitrán 1305, La Serena, Chile
[e] ARQMAR, Centre for Maritime Archaeology Research of the South Eastern Pacific, Escuela de Ingeniería, Universidad Santo Tomás, Av. Ejército 146, Piso 5, Edificio A, Santiago, Chile

ARTICLE INFO

Article history:
Available online xxx

Keywords:
Late Pleistocene
Mammals
Paleoecology
Stable isotopes
Continental shelf
Central Chile

ABSTRACT

Site GNL Quintero 1 (GNLQ1), located nearshore at Quintero bay in the central coast of Chile (32° S), is the only documented Late Pleistocene drowned terrestrial site along the Pacific coast of South America. During the last decade, through underwater archaeological operations conducted at GNLQ1, several clusters of shallowly buried bone deposits were documented and excavated, revealing a well preserved high-resolution *in situ* context. Taxonomic analysis of the faunal assemblage recovered yielded at least 26 individuals comprising extinct Camelidae, Cervidae, Equidae, Mylodontidae, and Xenarthra as well as Canidae, Myocastoridae, Octodontidae, Cricetidae, among others. By conducting stable isotope analyses ($\delta^{13}C_{ap}$ and $\delta^{18}O_{ap}$) on mammalian bioapatite, we aim to perform a first characterization of the GNLQ1 taxa paleoecology and carry out paleoenvironmental inferences. Regional records for the Last Glacial Maximum (LGM) suggest lower sea surface temperatures and more humid climatic conditions for Central Chile. Isotopic data obtained suggests a landscape of mixed vegetation areas, in good agreement with the sedimentary context of the fossil remains and a preliminary Quintero paleolandscape model: a wetland environment developed under semiarid conditions prior to post-glacial sea level rise, with GNLQ1 located >6 km inland as the paleoshoreline was further out on the continental shelf.

1. Introduction

Site GNL Quintero 1 (GNLQ1), located in nearshore waters of Quintero Bay (32°46′ S–71°30′ W), in the central coast of Chile, is a drowned terrestrial site containing fossil remains of a Late Pleistocene continental faunal assemblage (Fig. 1a–c). Through submerged prehistoric archaeology research strategies largely undisturbed deposits on the seabed containing a stratigraphic context comprising micro, meso and megafauna remains were systematically studied (Cartajena et al., 2011, 2013; Carabias et al., 2014; López et al., 2012, 2016). Site formation was attributed to natural mortality events of a high diversity of taxa as cf. *Palaeolama*, Cervidae, cf. *Lama gracilis*, Mylodontidae, *Lycalopex culpaeus*, Octodontidae, Cricetidae, *Myocastor coypus*, *Abrocoma* sp., *Equus* (*Amerhippus*), among others (López et al., 2016).

Despite the identification of two possible cut marks in a proximal Xenarthra femur (López et al., 2016), human association at GNLQ1 cannot be conclusively ascertained at this stage of the research and will require further investigation. This issue is

* Corresponding author.
E-mail addresses: patriciolopezmend@gmail.com (P. López Mendoza), isabel.cartajen@gmail.com (I. Cartajena), dcarabias@arqmar.org (D. Carabias), protocyon@hotmail.com (F.J. Prevosti), amaldonado@ceaza.cl (A. Maldonado), yokanti@gmail.com (V. Flores-Aqueveque).

http://dx.doi.org/10.1016/j.quaint.2016.08.017
1040-6182/

particularly relevant in the context of new debates on early peopling of South America that focus on the ambiguity of the archaeological evidence and stress the importance of formational studies for constructing adequate interpretive frameworks (Suárez et al., 2014; Borrero, 2015, 2016 among others).

Skeletal elements and molars of various taxa sampled from the GNLQ1 assemblage were directly dated by the AMS-radiocarbon method, using the bioapatite fraction, reporting ^{14}C ages between 19,280 ± 40 and 24,890 ± 70 uncal BP (Table 1). Although this technique has been successfully applied for dating bone and tooth enamel samples, bioapatite diagenesis may affect radiocarbon ages (Cherkinsky, 2009). Recently, an initial paleolandscape model for Quintero Bay was created by combining a computer derived Relative Sea Level (RSL) curve with a mean estimated uplift rate of 0.5 m/ka (Carabias et al., 2014). This simulation proved consistent with eustatic sea-level curves (Lambeck et al., 2002). According to this model, by the Late Glacial Period 29,000–24,000 cal BP site GNLQ1 could have been located at an estimated distance of >6 km from the coastline.

winter months (281 mm/yr) that supports sclerophyllous shrubland vegetation. In the coastal area, scattered swamp forests are found, associated with small hydrographic basins where the water table rises close to the land surface, influenced by local rainfall. The recent onset of the wet climatic conditions originated the swamp forest near Quintero Bay at 2,000 uncal BP (Villa and Villagrán, 1997; Maldonado and Villagrán, 2002). Unfortunately, palynological records for GNLQ1 are still lacking, since attempts to obtain fossil pollen for the Late Pleistocene-Early Holocene from the continental shelf and nearby coastal lagoons has been unsuccessful so far. This fact can be attributable to prolonged periods of desiccation or differences in pollen preservation due to exposure or oxidation (Minckley et al., 2011).

Site GNLQ1 was highlighted as a primary source of data on now submerged paleolandscapes providing critical context to late glacial and early postglacial environment and habitats common to both extinct fauna and the initial populations of the Andean Pacific coast (Carabias et al., 2014). Considering the significant lack of paleoecological proxies for Late Pleistocene

Table 1
^{14}C AMS dates on bioapatite fraction of bones and molars. *Calibrated ages with OxCal 4.2, SH Cal 13 (Bronk et al., 2013). SI: Same individual.

Taxa/Sample	ID sample	Sample provenance	^{14}C age years BP	Calibrated years BP*	$\delta^{13}C_{ap}$ (‰)	$\delta^{18}O_{ap}$ (‰)
Sedimentary matrix	UGAMS 9194	Unit 2	13,640 ± 40	16,716–16,878	−25,4	–
Equus (*Amerhippus*) sp.	UGAMS 15535	Tooth enamel	24,890 ± 70	27,159–26,679	−12,3	−3,0
Equus (*Amerhippus*) sp.	UGAMS 20838	Tooth enamel (SI)	24,010 ± 60	26,270–25,816	−12,2	−3,4
Equus (*Amerhippus*) sp.	UGAMS 20839	Bone (SI)	23,110 ± 50	25,605–25,250	−11,4	−3,0
Equus (*Amerhippus*) sp.	UGAMS 20847	Tooth enamel	–	–	−12,3	−3,5
Cervidae	UGAMS 15536	Tooth enamel	23,720 ± 70	25,974–25,659	−12,6	−2,5
Cervidae	UGAMS 20840	Tooth enamel	–	–	−14,1	−4,9
Cervidae	UGAMS 20842	Tooth enamel	–	–	−11,4	−3,1
Cervidae	UGAMS 20850	Tooth enamel	–	–	−14,2	−1,7
Cervidae	UGAMS 20852	Tooth enamel	–	–	−13,5	−2,5
cf. *Palaeolama*	UGAMS 15537	Tooth enamel	21,580 ± 60	24,037–23,735	−13,5	−2,7
cf. *Palaeolama*	UGAMS 15539	Bone	21,690 ± 50	24,103–23,834	−11,6	−2,6
cf. *Palaeolama*	UGAMS 20843	Tooth enamel	–	–	−12,2	−2,9
Mylodontidae	UGAMS 15538	Bone	23,060 ± 60	25,574–25,202	−12,0	−3,2
Mylodontidae	UGAMS 20846	Bone	–	–	−13,3	−3,3
Mylodontidae	UGAMS 20848	Bone	–	–	−14,3	−3,8
Octodontidae	UGAMS 20844	Tooth enamel	19,280 ± 40	21,481–21,002	−12,7	−2,3
Octodontidae	UGAMS 20849	Tooth enamel	–	–	−12,6	−2,5
Lycalopex culpaeus	UGAMS 20845	Tooth enamel	–	–	−13,6	−3,4
Myocastor coypus	UGAMS 20841	Tooth enamel	20,040 ± 45	22,312–21,911	−14,7	−5,6

Morphological and sedimentological analysis performed on a marine core (T1), provides a complete stratigraphic sequence for the site, with three stratigraphic units exhibiting clearly different sedimentological features. From top to bottom, according the Unified Soil Classification System (USCS), Unit 1 contains well-sorted fine sand (SW) related to the current coastal dynamics. Sediments belonging to Unit 2 were classified as clast-supported clayey gravel (GC), characterized by gravel-sized highly resistant rounded masses (hereinafter referred to as 'agglomerates') composed of fine sand and clay in a sandy to clayey matrix (Fig. 2a). Agglomerates exhibit evidence of oxidation and carbon residue (Fig. 2b). The colour, the presence of charcoal lenses, and the very fine size of the grains observed in both the matrix as well as in the agglomerated fragments suggests that sedimentation of Unit 2 occurred within a very low-energy environment, possibly a floodplain. The faunal remains were registered in the upper portions of Unit 2 and exhibit a similar staining pattern to that present on sediments (Fig. 2c). On the other hand, the orange hues observed at Unit 3 and at the base of Unit 2 were interpreted as a transition from a subaerial deposition environment (Unit 3) to an underwater environment (Unit 2) (Cartajena et al., 2013; Carabias et al., 2014).

Today, the study area has a Mediterranean semi-arid climate, with maritime influence and rainfall concentrated during the

extinct mammals in Central Chile, the high taxonomic diversity of GNLQ1 is particularly relevant for reconstructing isotopic paleoecology. In the present study, carbon and oxygen isotopes analyses from the bioapatite fraction of the GNLQ1 herbivore assemblage were conducted with the purpose of characterizing its paleoecology (Feranec et al., 2010; Iacumin et al., 2010; Domingo et al., 2012; Kovács et al., 2012; Gąsiorowski et al., 2013; Prevosti and Martin, 2013; Bocherens et al., 2016), and carrying out paleoenvironmental inferences about this now-submerged landscape preserved on the nearshore continental shelf. Isotope data of the taxa is presented and discussed considering previous stable isotope data for the Southern Cone of South America (28°–38°S). Finally a new set of direct radiocarbon dates on the bioapatite fraction of different taxa of the GNLQ1 mammalian assemblage is presented and chronological issues are discussed.

2. Material and methods

We analysed a total of 19 bone and teeth samples from *Equus* (*Amerhippus*) sp. (N = 4), Cervidae (N = 5), cf. *Palaeolama* sp. (N = 3), Mylodontidae (N = 3), Octodontidae (N = 2), *L. culpaeus* (N = 1) and *M. coypus* (N = 1) (Table 1). The collected samples did

Please cite this article in press as: López Mendoza, P., et al., Reconstructing drowned terrestrial landscapes. Isotopic paleoecology of a late Pleistocene extinct faunal assemblage: Site GNL Quintero 1 (GNLQ1) (32° S, Central Chile), Quaternary International (2016), http://dx.doi.org/10.1016/j.quaint.2016.08.017