Journal of South American Earth Sciences 45 (2013) 147–159

Contents lists available at SciVerse ScienceDirect

Journal of South American Earth Sciences

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

Micropaleontological record of Holocene estuarine stages in the Bahía Blanca estuary, Argentina

Lydia Calvo-Marcilese[a,*], Juan Pablo Pérez Panera[b], Gabriela Cusminsky[a], Eduardo A. Gómez[c]

[a] Centro Regional Universitario Bariloche, Universidad Nacional del Comahue, INIBIOMA-CONICET, Quintral 1250, Bariloche CP 8400, Río Negro, Argentina
[b] CONICET-División Paleozoología Invertebrados, Museo de La Plata, Paseo del Bosque s/n, B1900FWA La Plata, Argentina
[c] Instituto Argentino de Oceanografía (CONICET/UNS), CC 804, 8000 Bahía Blanca, Argentina/UTN, Facultad Regional Bahía Blanca, 11 de Abril 461, B8000LMI Bahía Blanca, Argentina

ARTICLE INFO

Article history:
Received 14 November 2012
Accepted 14 March 2013

Keywords:
Benthic foraminifera
Calcareous nannofossils
Estuarine paleoenvironments
Holocene
Argentina

ABSTRACT

Holocene paleoenvironmental changes have been interpreted on the basis of benthic foraminifera and calcareous nannofossils recovered in samples from Napostá Grande Stream, Bahía Blanca estuary, southern Buenos Aires Province. Samples are fine sands and clay sediments from a Holocene outcrop and were studied with quantitative techniques. The benthic foraminiferal assemblage is dominated by *Ammonia parkinsoniana*, *Ammonia tepida*, *Bolivina pseudoplicata*, *Bolivina striatula*, *Bolivina* sp., *Buccella peruviana*, and *Elphidium* spp. The calcareous nannofossil assemblage recovered is a typical cold-water association, dominated by *Calcidiscus leptoporus*, *Coccolithus pelagicus*, *Emiliana huxleyi* and *Gephyrocapsa oceanica*. A dendrogram classification by cluster analysis was made for each microfossil group. The results of these analyses were coincident, showing a liaison between changes in the assemblages of benthic foraminifera and calcareous nannofossils. Those results, jointly with the sedimentological information, lead to the identification of three different paleoenvironments along the Napostá N1 site. The lower part of the succession represents an estuarine environment with larger marine connection. The middle part represents a gradual passage to a more restricted estuarine environment, and the upper part represents the establishment of the modern continental fresh-water environment.

1. Introduction

Foraminifers are well known for their remarkable fossil record and for their variety and abundance in almost all modern marine environments. These minute organisms constitute the most diverse group of testate protists in modern oceans, and are one of the fossil groups capable of provide reliable analogs for the understanding of marine environmental changes in the past (Scott, 2006). The advantage of using benthic foraminifers in paleoecology lies in their substantial abundance in marine sediments and in the exceptional preservation of their tests. Because their distributions and ecological preferences are fairly well known from the studies conducted in modern habitats, these assemblages can be used as proxies, and as reliable tools for paleoenvironmental reconstructions and environmental characterization (Sen Gupta, 1999).

Calcareous nannofossils on their part, have proved to be very useful on paleoceanographic and paleoenvironmental reconstructions during the Quaternary (Houghton, 1993; Winter et al., 1994; Roth, 1994; Jordan, 2002). They show sensibility to different environmental parameters as water temperature, availability of macro and micronutrients, salinity, light penetration, turbulence, and water depth (Jordan, 2002). While some species show low-adaptation capability, others exhibit differential toleration or preference for diverse environmental conditions and are key-species for paleoenvironmental interpretation. A series of studies and experiments were carried out with selected cultured species (mainly *Emiliania huxleyi* and *Gephyrocapsa oceanica*) to test their response to different environmental factors (Watabe and Wilbur, 1966; Wilbur and Watabe, 1967; Okada and Honjo, 1975; Kleijne, 1990, 1991; Fisher and Honjo, 1991; Hagino et al., 2000; Takahashi and Okada, 2000, among others).

Since Quaternary species are almost the same as modern living species, recent biogeographic distribution and composition of the assemblages could be extrapolated for paleoenvironmental and paleoceanographic reconstruction (McIntyre, 1967; McIntyre and Bé, 1967; McIntyre et al., 1970; Bukry, 1974; Dudley et al., 1980; Giunta et al., 2003; Alday et al., 2006).

* Corresponding author. Tel: +54 0294 4423374x278/9.
E-mail addresses: lydiacalvomarcilese@yahoo.com.ar, lydiacalvom@gmail.com (L. Calvo-Marcilese), perezpanera@gmail.com (J.P. Pérez Panera), gcusminsky@gmail.com (G. Cusminsky), gmgomez@criba.edu.ar (E.A. Gómez).

0895-9811/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jsames.2013.03.005

A paleoenvironmental reconstruction is presented after combining benthic foraminifera and calcareous nannofossil data. This contribution provides alternative evidence using multiple proxy analysis (sedimentology, benthic foraminifera and calcareous nannofossils) of the paleoenvironmental conditions during the beginning of the last Holocene transgression within the Bahía Blanca estuary. The objective of this contribution is to increase the knowledge about the Holocene transgression and environmental responses of the coastal area of the Bahía Blanca estuary; in order to reconstruct regional Holocene sea-level changes and to adjust the chronology of these events.

2. Study area

The Bahía Blanca estuary is a mesotidal environment located in the south of Buenos Aires Province and occupies a wide coastal stripe (Fig. 1). Its regional setting is determined by the presence of a complex web of meandering channels of different dimensions. Lots of low islands, extensive tidal flats and salt marshes described the physiography of the area. While the estuary has no significant watershed, is home of one of the major deep-water port systems of Argentina (Cuadrado et al., 2007).

From the point of view of their morphology, the estuary has a funnel configuration, with the main channels, Bermejo, Bahía Falsa, Bahía Verde and Caleta Brightman oriented NW-SE. It also has two tributary channels located on the north coast, which are the main freshwater inputs to the system (Fig. 1). Towards the head of the estuary is located the Sauce Chico River and a 1.6 km southeast of Ingeniero White lays the Napostá Grande Stream. Both small tributaries are also incorporating water in local rainfall runoff (Cuadrado et al., 2007).

The total area is 2300 km^2, 410 km^2 correspond to regions permanently emerged as islands; 1150 km^2 are occupied by intertidal zones and 740 km^2 correspond to subtidal areas (Montesarchio and Lizasoain, 1981). The largest intertidal areas are located in the northern portion; while in the southern sector the proportion is much lower (Piccolo and Perillo, 1999). Mean depth is 10 m, although values of 22 m were registered at the mouth of the estuary (Aliotta and Perillo, 1990). Mean annual surface temperature is of 13 °C varying from 21.6 °C in summer to 8.5 °C in winter (Piccolo et al., 1988). The distribution of mean surface salinity shows an exponential growth from the head up to the middle reach of the estuary. In the middle portion, the average salinity has a local minimum influence by the Napostá Grande stream and the Bahía Blanca city sewage discharge.

As for the balance of sediment in the Bahía Blanca estuary, it can be said that it is negative, since the amount of sediment leaving the estuary is higher than the input. However, it is necessary to note that this does not mean that the entire estuary is under erosion, as there are intertidal areas where eroded mud is retained mainly caused by stabilization due intertidal vegetation (*Spartina alterniflora* Loiseleur-Deslongchamps, 1807); while the sand eroded from channel banks and exiting the estuary usually forms internal, sub and intertidal, sand banks (Codignotto et al., 1993). The size distribution of sediments in the estuary is a direct consequence of environmental dynamics (Borel and Gómez, 2006).

3. Previous work on the Bahía Blanca estuary

Holocene sea level fluctuations for Buenos Aires Province have been analyzed by numerous authors, suggesting several environmental schemes based on studies of regional geology, paleontology and radiocarbon dates (Fray and Ewing, 1963; Parker and Violante, 1982; Codignotto et al., 1992; Codignotto and Aguirre, 1993; Cavallotto, 1995; Violante et al., 2001; Gómez et al., 2005; Schnack et al., 2005). In general terms the Holocene environmental setting for this area would have developed as follows:

At about 17000 yr BP, the peak of the last glaciation occurred. Sea level would have been located at about 170 km east of the existing shoreline, with a depth of −115 m. During the Late Pleistocene-Early Holocene transition (11000 yr BP); there was a progressive rise in sea level (Aguirre, 1995). Towards 9500 and about 7500 yr BP sea-level continued to rise to altitudes between −12 and −18 m (Aliotta and Perillo, 1990).

At 7000 years BP the increasing sea level, would reached similar values to the current ones and then surpassed them as proposed by Cavallotto et al. (2004) for the La Plata River. At *ca.* 6000 yr BP the

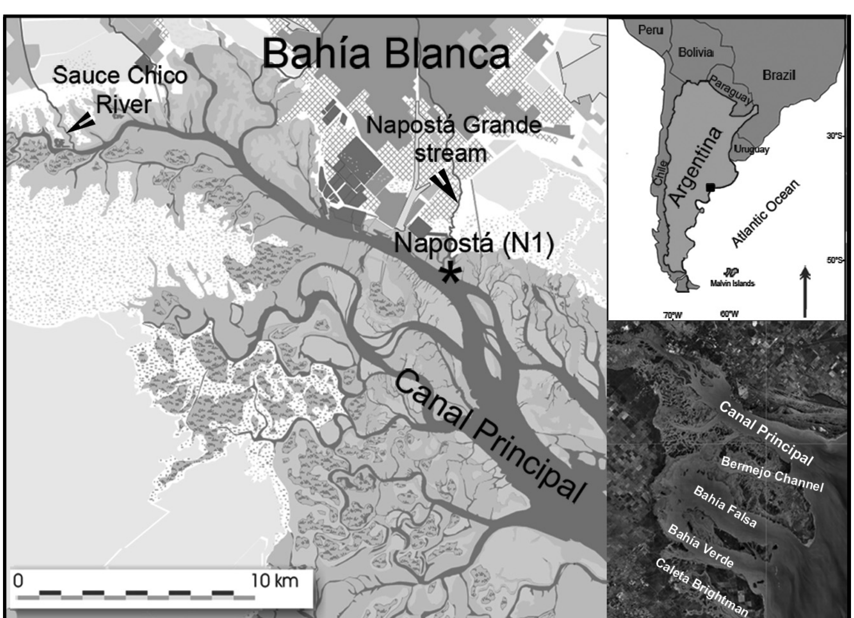

Fig. 1. Location map of Bahía Blanca estuary and Napostá N1 analyzed section.