Journal of South American Earth Sciences 56 (2014) 242–250

Contents lists available at ScienceDirect

Journal of South American Earth Sciences

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

Paleoenvironmental setting and description of an estuarine oyster reef in the Eocene of Patagonia, southern Argentina

Martín Rodríguez Raising [a], Silvio Casadío [b,*], Nadine Pearson [c], Gabriela Mángano [c], Luis Buatois [c], Miguel Griffin [d]

[a] XR-GEOMAP, R. Durand Av. N 397, Grand Bourg, Salta, Argentina
[b] Universidad Nacional de Río Negro, Av. Roca 1242, 8332 General Roca, Río Negro, Argentina
[c] University of Saskatchewan, Department of Geological Sciences, 114 Science Place, Saskatoon, Saskatchewan S7N 5E2, Canada
[d] Universidad Nacional de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina

A R T I C L E I N F O

Article history:
Received 12 May 2014
Accepted 7 September 2014
Available online 18 September 2014

Keywords:
Crassostrea
Oyster reef
Middle Eocene
Río Turbio Formation
Patagonia
Argentina

A B S T R A C T

A middle Eocene *Crassostrea* sp. reef near Río Turbio, southwestern Patagonia (Argentina), represents the earliest record of an oyster reef associated with estuarine facies in the southern hemisphere, and also one of the few known worldwide occurring in Paleogene rocks. The reef grew in an outer estuary environment subject to periodic changes in salinity and may have reached a maturing phase. The Río Turbio reef – by its dimensions, geometry, and substrate lithology– would have been located in a tidal channel convergence area. This reef provides new evidence suggesting that estuaries served as refuges for *Crassostrea* populations allowing them to disperse into fully marine environments many times throughout the Cenozoic.

1. Introduction

Oysters are among the most abundant bivalves to be found in shallow-marine and estuarine environments. They are filter-feeding organisms and they can deposit or self-silt eight times the volume of sediment that would have been deposited in the same time due to gravity alone. Lund (1957) calculated that a single layer of oysters could biodeposit sediment at a rate of about 6×104 g/m^2/yr. The results presented by Mitchell (2006) indicate that biodeposition loadings from intertidal oyster reefs can be significant. However tidal flow can disperse this material resulting in minimal enrichment of the sediments around the reefs. The outcome of this material deposited elsewhere in the lagoon and their impact on the benthic community remains unknown.

Oyster reefs affect the geomorphology and hydrologic regime of estuaries in three ways: (1) modifying current velocity, (2) passively changing sedimentation patterns, and (3) increasing sedimentation through biodeposition (Bahr and Lanier, 1981). Ample evidence supports interactive connections between oysters and hydrology (Kennedy, 1996a,b; Lenihan, 1999; McCormick-Ray, 2005), and also their impact on estuaries; thus, Newell (1988) stated that the extensive *Crassostrea* populations of Chesapeake Bay before 1870 had the potential –during the summer months– to filter the bay's entire water column in less than a week.

The incubatory oysters show no promyal passage in the exhalant chamber of their mantle cavity, a trait that renders them less efficient in selecting food particles. For this reason they do not tolerate high turbidity levels (Hopkins, 1979) and are restricted to nearshore oceanic waters; or to the outermost zones of estuaries, where salinity, temperature, and turbidity are not significantly different from those in the ocean. Conversely, non-incubatory species –belonging according to Stenzel (1971) in the genera *Crassostrea*, *Saccostrea*, and *Striostrea* – can live in the ocean but are more abundant in estuaries, as they are better adapted to frequent changes in salinity, temperature, and high levels of turbidity.

Most species of *Crassostrea* are able to withstand freshets in tidal rivers or estuaries by keeping their valves closed for long periods of time.

In the southeastern United States, the living *Crassostrea virginica* forms large reef systems in estuaries and lagoons with the associated marsh, mudflat and tidal drainage networks.

In the modern analogues of the southeastern United States the reefs observed are found restricted to the middle portion of the intertidal zone. In this area competition and predation are reduced due to longer periods of subaerial exposure allowing the oyster

* Corresponding author. Tel./fax: +54 298 4427399.
E-mail addresses: scasadio@unrn.edu.ar, silvio63ar@yahoo.com.ar (S. Casadío).

http://dx.doi.org/10.1016/j.jsames.2014.09.009
0895-9811/

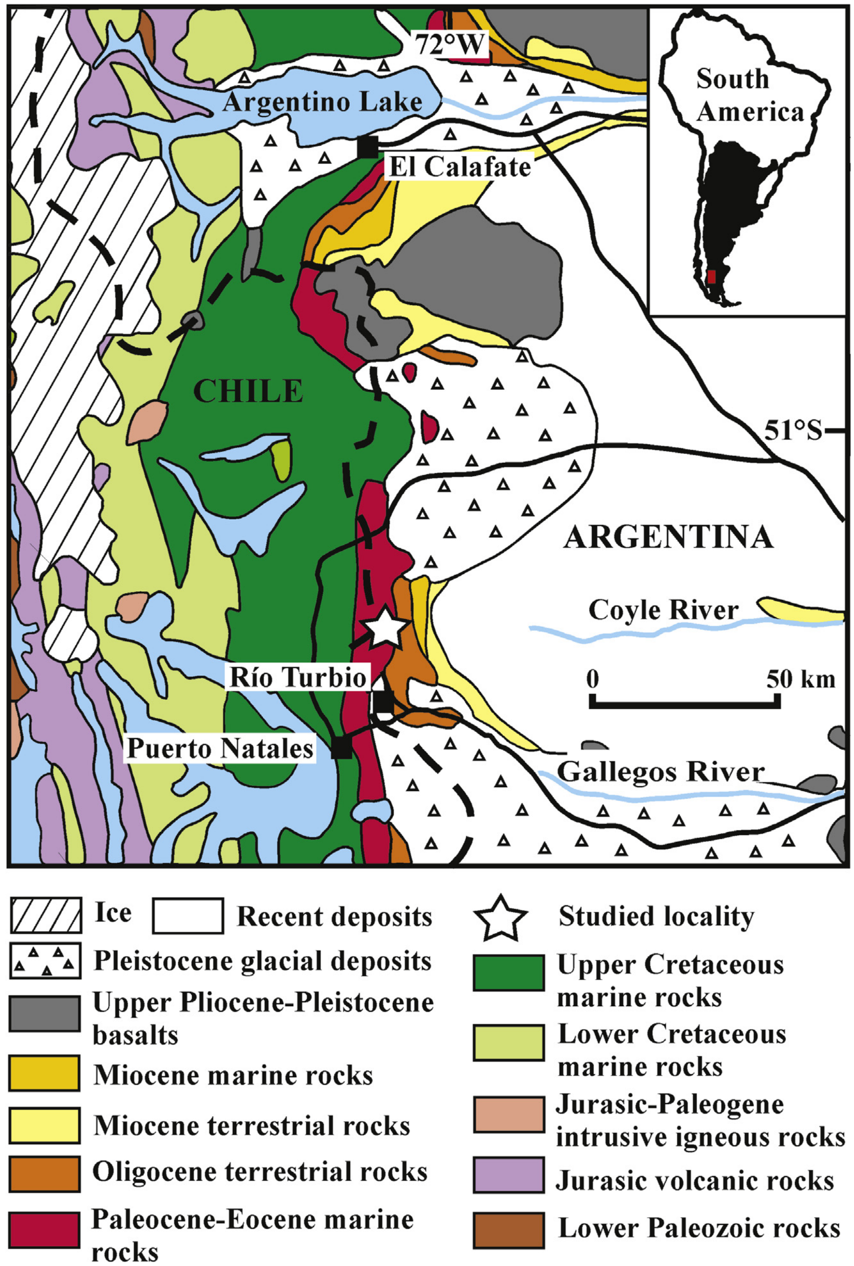

Fig. 1. Simplified geological map of the studied area and location of the *Crassostrea* reef.

populations to flourish (Bahr and Lanier, 1981). The lower intertidal and subtidal areas have an increase in both pelitic sedimentation and predation, which restricts the populations of oysters to only a few scattered individuals (Bahr and Lanier, 1981; Hopkins, 1979). Bahr and Lanier (1981) proposed that the aptitude of most species of *Crassostrea* to tolerate wider ranges of salinity, turbidity, temperature, and oxygenation was the main feature that favored its worldwide distribution and early colonization of brackish-marine environments.

Seilacher (1984) separated soft-botton oysters into heavyweight and lightweight types. The second type appeared later and was related to the acquisition of shell chambers and chalky deposits that were main innovations in the evolution of *Crassostrea.*

The earliest records of euryhaline oysters associated with marginal marine facies are from the Middle Jurassic of the British Isles (Hudson and Palmer, 1976). The earliest records specifically of *Crassostrea* reefs associated with estuarine facies are from the Ushimaro Formation (Middle Jurassic) of Japan (Komatsu et al., 2002) and from the upper Coniacian of New Mexico (Brown, 1988). Late Cretaceous to Neogene references including descriptions of oyster reefs in estuarine environments are few (Toshimitsu et al., 1990; Jiménez et al., 1991, Pufahl and James, 2006) and most of them doubtful (e.g., Martinius, 1991), as they are usually associated with marine facies and stenohaline organisms (e.g., corals and echinoids) characteristic of fully marine conditions.

In this paper we describe a *Crassostrea* sp. reef from the middle Eocene of southern Argentina (Fig. 1), located at approximately 50°S paleolatitude. This is the earliest record of an oyster reef associated with estuarine facies in the southern hemisphere, and also one of the few known worldwide occurring in Paleogene rocks. This reef provides us with information that not only increases our knowledge of the evolution of *Crassostrea* reefs and their