Available online at www.sciencedirect.com
ScienceDirect
Palaeogeography, Palaeoclimatology, Palaeoecology 246 (2007) 163–187
PALAEO
www.elsevier.com/locate/palaeo

Palaeoenvironmental change in the Gulf of Carpentaria (Australia) since the last interglacial based on Ostracoda

Jessica M. Reeves [a,*], Allan R. Chivas [a], Adriana Garcia [a], Patrick De Deckker [b]

[a] *GeoQuEST Research Centre, School of Earth and Environmental Sciences, University of Wollongong, NSW 2522, Australia*
[b] *Department of Earth and Marine Sciences, The Australian National University, Canberra, ACT 0200, Australia*

Received 29 December 2005; received in revised form 6 September 2006; accepted 14 September 2006

Abstract

Throughout the last glacial cycle, the region between Australia and New Guinea, which is today known as the Gulf of Carpentaria, has oscillated from open shallow marine conditions to a large, land-locked freshwater lake, including periods of subaerial exposure. Ostracod faunal assemblages and variations in the valve morphology, preserved in the sediments of the gulf, record these changes. A 14.8 m long core (MD972132) extracted from near the centre of the modern Gulf of Carpentaria, spanning the last 130 ka BP provides the basis of this study.

Environmental facies were determined by R- and Q-mode cluster analysis of the ostracod assemblage data, including 72 species, and comparison with modern analogues from both the Gulf of Carpentaria and Southeast Asian region. Using these methods, six clearly distinct biofacies were identified:

(i) open shallow marine facies, including bairdiids, pectocytherinids and cytherettids;
(ii) shallow marine facies, dominated by *Cytherella* and *Hemikrithe*;
(iii) marginal marine facies, including *Xestoleberis* and *Praemunita*;
(iv) tidal channel facies, dominated by *Loxoconcha*;
(v) estuarine assemblage, comprising *Venericythere* and *Leptocythere*;
(vi) non-marine facies
  a. brackish lagoon/lake facies dominated by *Cyprideis* and *Leptocythere*;
  b. freshwater facies, including *Ilyocypris*, with *Cyprinotus* and *Cypretta*.

In addition, morphological variation of valves of the more “plastic” species, in particular *Cyprideis australiensis* and *Leptocythere hartmanni*, was observed and related to environmental variables, including salinity and solute composition. These two species occur through more than half of the length of the core and show significant variability. *C. australiensis* with irregular-shaped sieve pores is associated with heavily reticulated valves of *L. hartmanni*, around 90–70 ka BP, indicating increased salinity and carbonate-limited environments. Conversely, *C. australiensis* with round sieve pores occurs with finely reticulated valves of *L. hartmanni* from around 50 ka BP, in fresher, carbonate-rich environments. The preservation of valves was also noted so as to infer post-depositional effects, revealing shoreline features, channel activity and subaerial exposure.

Combined ostracod biofacies and morphological analysis reveals a fluctuating marine environment through Marine Isotope Stage (MIS) 5, terminating in a restricted lagoon around 90 ka BP, followed by an extensive period of subaerial exposure in this

* Corresponding author. Present address: Department of Earth and Marine Sciences, The Australian National University, Canberra, ACT 0200, Australia. Tel.: +61 2 6125 4303; fax: +61 2 6125 5544.
E-mail address: jessica@ems.anu.edu.au (J.M. Reeves).

doi:10.1016/j.palaeo.2006.09.012

region of the gulf. MIS 3 marks a return of marine conditions and an increase in fluvial activity. Lake Carpentaria then appears as a permanent feature, at least to the current 60 m depth contour, from around 40 ka BP, with the freshest water occurring around 16 cal. ka BP, prior to the most recent marine transgression, at 10.8 cal. ka BP. Although the presence of Lake Carpentaria had previously been identified, this study extends the knowledge of the region through the last glacial cycle and provides greater detail of the sequential biofacies.

Keywords: Ostracoda; Gulf of Carpentaria; Last interglacial; Sea-level change; Lacustrine; Marginal marine

1. Introduction

1.1. The Gulf of Carpentaria

The Gulf of Carpentaria is an epicontinental sea located between Australia and New Guinea (Fig. 1). The gulf is bordered to the north by the south coast of West Papua (Indonesia) and Papua New Guinea and to the south by the north coast of Australia from Arnhem Land, Northern Territory in the west to Cape York Peninsula, Queensland in the east. This broad, shallow embayment reaches a maximum water depth of 70 m near the eastern margin. Below 50 m water depth, the sea floor is essentially flat with a gradient of about 1:13,000 (Edgar et al., 2003).

The Arafura Sill is a sedimentary feature that separates the gulf from the Indian Ocean to the west, 53 m below present sea level (bpsl). Seismic profiles taken across the sill reveal numerous previously incised channels. The most recent of these are cut to depths of 62 m and 75 m (Jones and Torgersen, 1988).

Torres Strait is a shallow platform extending from Papua New Guinea to the tip of Cape York Peninsula and separating the Gulf of Carpentaria from the Pacific Ocean. The Strait is generally between 15 m and 60 m deep and is bounded on the eastern side by a sill only 12 m deep.

Throughout the Quaternary, during times of low sea level, the gulf was isolated from either the Pacific Ocean alone, forming an embayment, or the Indian Ocean as well. At these times, a large, shallow lake, known as Lake Carpentaria, existed in the basin. The presence of Lake Carpentaria has been identified from previous studies (Nix and Kalma, 1972; Smart, 1977). Episodes of basin-wide subaerial exposure have also been noted (Chivas et al., 2001).

During the 1980s the sedimentological units (Table 1) and hydrological history of the gulf region over the last 40 ka were established (Torgersen et al., 1983, 1985, 1988; Jones and Torgersen, 1988). These studies included identification of major ostracod groups and chemical analysis (Mg/Ca, Sr/Ca and $^{87}Sr/^{86}Sr$) of ostracod valves for facies determination and climatological information (De Deckker et al., 1988; McCulloch et al., 1989).

1.2. Ostracod ecology

Ostracods are small bivalved crustaceans, present in both marine and non-marine environments, ranging from the deep ocean to freshwater lakes and including temporary pools, springs, groundwater, rivers, estuaries, swamps and even some semi-terrestrial habitats. They provide an eminently suitable proxy for the study of past environments as they are generally abundant and well preserved in the fossil record and are sensitive to a broad range of ecological variables, with most taxa living along environmental gradients. Palaeoenvironmental reconstruction may be ascertained by: a) extrapolating modern ecological constraints to fossil assemblages and b) morphological analysis of the carapaces with respect to physical and chemical parameters both during the organisms' life time and post-deposition.

For recent reviews of ostracod ecology and their use in palaeoenvironmental studies, the reader may refer to the volumes by Holmes and Chivas (2002) and Park and Smith (2003).

1.3. Morphological variation

Morphological features of some ostracod species, such as surface reticulation, carapace size and thickness and sieve pore shape, may vary extensively in response to fluctuating environmental conditions (Fig. 2). Numerous studies of taxa in waters transitional between fresh and saline have revealed an intraspecific gradational change in ornamentation (Hartmann, 1982; Carbonel, 1988; Carbonel and Hoibian, 1988; Peypouquet et al., 1988). The variation refers to the degree of ornamentation, the locus of which is genetically predetermined (Carbonel, 1988). This, in turn, corresponds to the carbonate equilibrium at the sediment–water interface, controlled by the biological consumption/modification of organic matter; a relationship termed the