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Fossil cold-water corals (Scleractinia and Gorgonacea) from the Burdwood Reef, Argentina Republic

Corales de aguas frías fósiles (Scleractinia y Gorgonacea) del Arrecife Burdwood, República Argentina

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ABSTRACT

The Burdwood Bank is a rocky platform emerging from the abyssal plain to depths of 50-100 m between the South Atlantic Ocean and the Drake Passage. Regarding its geological affinity, it has a composition similar to the Staten Island (Isla de los Estados), therefore aligned to the Andes-Darwin Cordillera. This bank is crossed from south to north by the Antarctic Bottom Water; very cold and rich in nutrients. Rocks dredged from the shallower portions at its western portion are composed of carbonatic blocks. The analyses indicated fossil specimens of *Desmophyllum* sp. (Order Scleractinia) and *Gorgonacea palmatum* (Order Gorgonacea), genera living today in the region. In this sense, sectors of this western portion should be considered as an ancient reef composed mostly of cold-water corals. The major implications are assigned to oceanographic and climatic issues. During the Upper-Pleistocene lowstand, the sunlight was more available at shallower depths and therefore corals were very frequent at wave-dominated areas. Sea-level variations have therefore strong influence on some cold-water coral growths in the sense that nutrient availability by currents can significantly changed between glacial and interglacial periods.

Keywords — Cold-water corals; Scleractinia; Gorgonacea; Burdwood Bank, Argentina.

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RESUMEN

El Banco Burdwood es una plataforma rocosa que emerge de las planicies abisales a profundidades de 50-100 m entre el Océano Atlántico Sur y el Pasaje de Drake. Considerando su afinidad geológica, posee una composición similar a la Isla de los Estados, alineada entonces a la Cordillera de los Andes-Cordillera Darwin. Este banco está cruzado de sur a norte por la Corriente Antártica de Fondo, muy fría y rica en nutrientes. Las rocas extraídas de las porciones menos profundas de la porción occidental están compuestas de bloques carbonáticos. El análisis indicó especímenes fósiles de *Desmophyllum* sp. (Orden Scleractinia) y *Gorgonacea palmatum* (Orden Gorgonacea), géneros viviendo actualmente en la región. En este sentido, sectores de la porción occidental deberían ser considerados como un arrecife antiguo compuesto mayormente de corales de agua fría. Las mayores implicancias se asignan a temas oceanográficos y climáticos. Durante los niveles bajos del durante el Pleistoceno Superior, la luz solar era más disponible a profundidades menores y por lo tanto los corales eran muy frecuentes en las áreas dominadas por olas. Las variaciones del nivel del mar tienen entonces significativa influencia en el crecimiento de algunos corales de agua fría en el sentido de que la disponibilidad de nutrientes por las corrientes puede cambiar significativamente entre períodos glaciales e interglaciales.

Palabras clave — Corales de aguas frías, Scleractinia; Gorgonacea; Banco Burdwood, Argentina.

INTRODUCTION

The Burdwood Bank is a rocky platform emerging from abyssal depths between the South Atlantic Ocean and the Drake Passage, within the Argentina submerged territories (Aceñolaza *et al.*, 2010). Regarding its Geology, it can be assigned to the composition of the neighbor Isla de los Estados: Jurassic tuffs (Lemaire Formation) and Cretaceous fine-grained sedimentary rocks (Beauvoir Formation; Caminos and Nullo, 1979; Ponce and Rabassa, 2012). Regarding its surface composition, it could be conceived as a reef in the sense that most of the western part is composed of carbonate sediments of biological origin (corals, bryozoans, brachiopods, pelecypods). The area was assigned as a marine reserve by the Argentine authorities (Law 26875/13).

The first reference to this feature is reported at the second volume of the book of Sir James Clark Ross (1847). On November 22, 1842, the HMS *Philomel*, under the orders of Capt. Bartholomew James Sulivan, entered Port Louis (Malvinas Islands) to precise the exact position of the Burdwood Bank; *"...a great danger ...owing to the irregular breaking sea which must occur there during stormy weather".* The region was surveyed in detail during several cruises of the *USNS Eltanin* vessel (Goodell, 1964).

Although reefs are assumed to be shallow-water structures, it is also applied to deep-water framework-forming corals (Roberts *et al.,* 2009). In this sense, cold-water corals concentrate on ridges or rocky outcrops. They are more sensitive to temperature, oxygen content and nutrient supply avoiding sediments or wastes (Roberts *et al.,* 2009).

Cold-water corals were sampled either at the Burdwood Bank (López González *et al.*, 2003; Zamponi, 2008; Schejter, 2008; Margolin *et al.*, 2014), Cabo de Hornos region (Waller and Robinson, 2012) and at the Drake Passage (Waller *et al.*, 2011). They were also collected from the steep slopes of the reef, exceeding 200 m (Schejter *et al.*, 2016). Fossil corals were also collected at the Burdwood Bank and its flanks from depths between 120 and 1879 m; specimens collected at depths shallower than 500 m were all younger than 15 kyrs (Margolin *et al.*, 2014). This paper reports fossil cold-water corals extracted from the Western portion of the Burdwood Bank. Special reference is assigned to the ecological implications of the distribution of different cold-water corals.

SETTING

The Geologic evolution of this region is subject to the different interactions of several plates during the Neogene (Barker, 2001). However, the Burdwood Bank is clearly related to the interactions of the South America and Scotia plates according the horizontal movement of the North Scotia Ridge (Fig. 1).

Water temperatures of 4 to 9 degrees Celsius were reported from Modis-Aqua satellite measurements (2003-2014 interval) for the top of the reef; maxima temperatures estimated in February and minima in August (Allega *et al.*, 2014). Jets deviations towards the East and North of the Circumpolar Current were reported from the OSCAR data base with important processes of mesoscale or eddies (Guerrero and Fenco, 2014).

Nautical charts recently performed by the National Hydrographic Survey of Argentina indicate that the dominant depth of this horst structure is 100 m (SHN, chart H-5014). However, depths of only 22 m have been measured at 54° 36.474´ S,

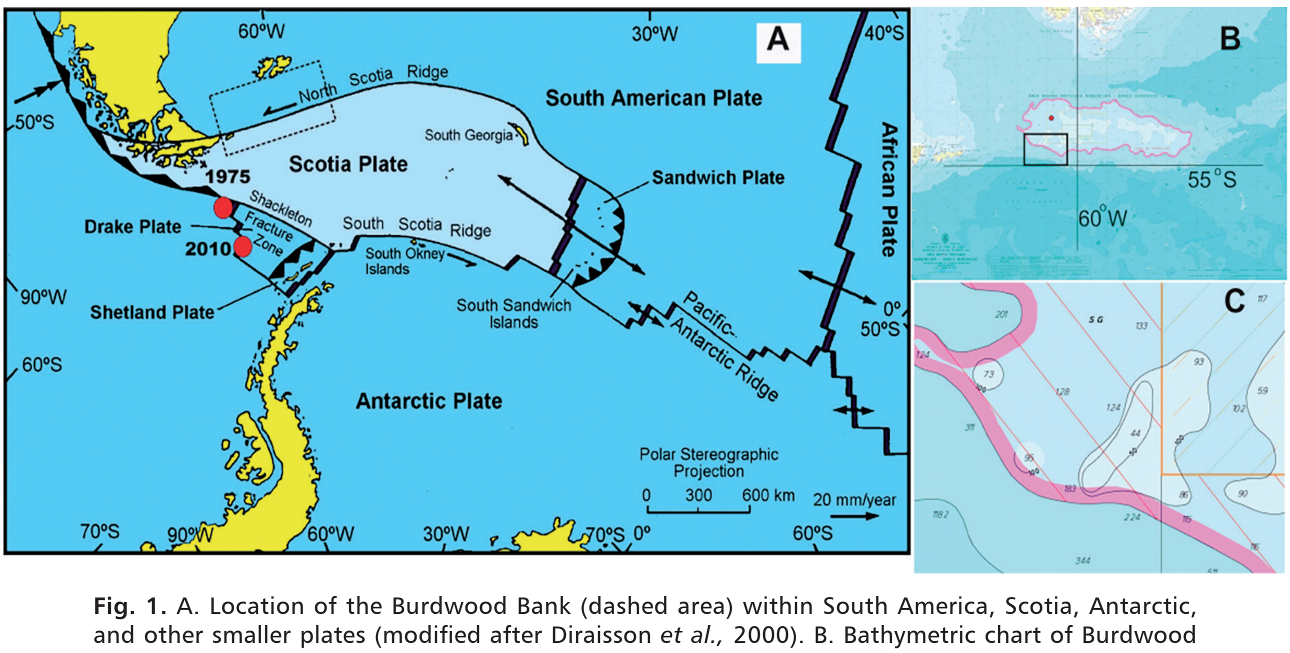

Fig. 1. A. Location of the Burdwood Bank (dashed area) within South America, Scotia, Antarctic, and other smaller plates (modified after Diraisson *et al.,* 2000). B. Bathymetric chart of Burdwood Bank. C. Detailed area of the bathymetry at the SW of the reef.

and 61° 17.869´ W, a minimum depth of 44 m is indicated in the chart (Fig. 1). In this sense, during the Late Pleistocene lowstand of approximately 100-120 m (Guilderson *et al.*, 2000) high-relief positive features were emerging from the extended abrasion platforms. In Tierra del Fuego, the sea level rose to approximately +5 m about 6000 years BP (Gordillo *et al.*, 1992; Vilas *et al.*, 1999). These rocks emerging from the top of this horst structure are assumed to constitute nunatacks similar to those characterizing the peaks of the Isla de los Estados (Ponce and Rabassa, 2012).

RESULTS

Carbonatic blocks were collected by means of a dredge at 101 m depth at the location 54° 36,474' S, and 61° 17,869' W during a survey aboard GC *Prefecto García* (Prefectura Naval Argentina). The analyses indicate specimens of *Desmophyllum dianthus* (Order Scleractinia) and *Gorgonacea palmatum* (Order Gorgonacea), genera living today in the region. *D. dianthus* is assumed to tolerate temperature variations between 4 and 17.5 °C (Försterra *et al.*, 2014). Separate polyps can be discerned with its own corallite walls (Fig. 2).

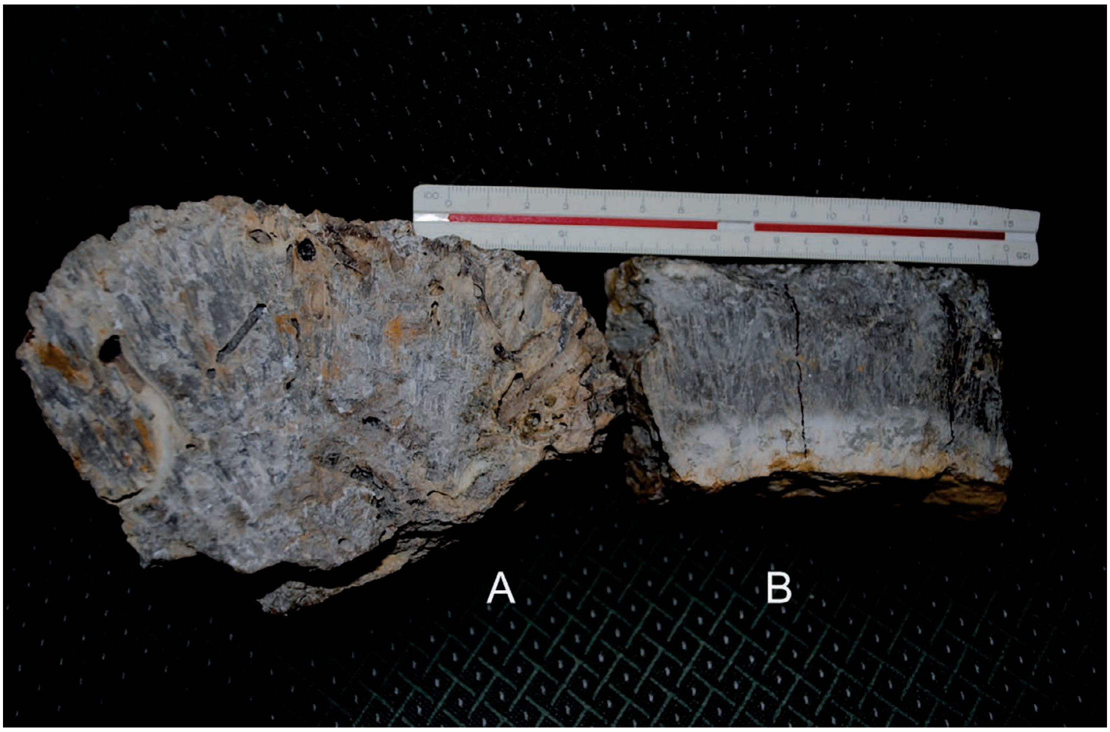

Fig. 2. Photograph of the sampled specimens. A) Polips of *Desmophyllum dianthus* separated by corallite walls. B) Adult specimen and juvenile of *Gorgonacea palmatum*.

DISCUSSION

The present growth of cold-water coral mounds at depths below 700 m at Galway Mound (Ireland) has been related to different circumstances: hydrography, nutrient supply, suitable substrates, sedimentation rates (Eisele *et al.*, 2008). Significant variations or hiatuses have been reported in the growth of these deep cold-water coral reefs during the Holocene (Van der Land *et al.*, 2014) flourishing during glacial times (Flögel *et al.*, 2014). The availability of nutrients and dissolved oxygen of the Malvinas Current were considered as key factors for the dispersion of cold-water corals towards the north at the Continental Slope of Argentina (Zamponi, 2008).

In the case of the aragonitic corals sampled at shallow depths of the Burdwood Bank, the major consequences are assigned to their oceanographic and climatic implications. During the Upper-Pleistocene lowstand of approximately -100 m (Guilderson *et al.*, 2000), sunlight was more available and therefore corals dominate at the shallow reef dominated by wave action (Fig. 3). Lowstands occur during the last glaciation about 18,000 years BP (oxygen isotopic stage 2) or during the sea level variations that characterize the OIS 3.In this sense, the reef can be composed by colonies of different ages.

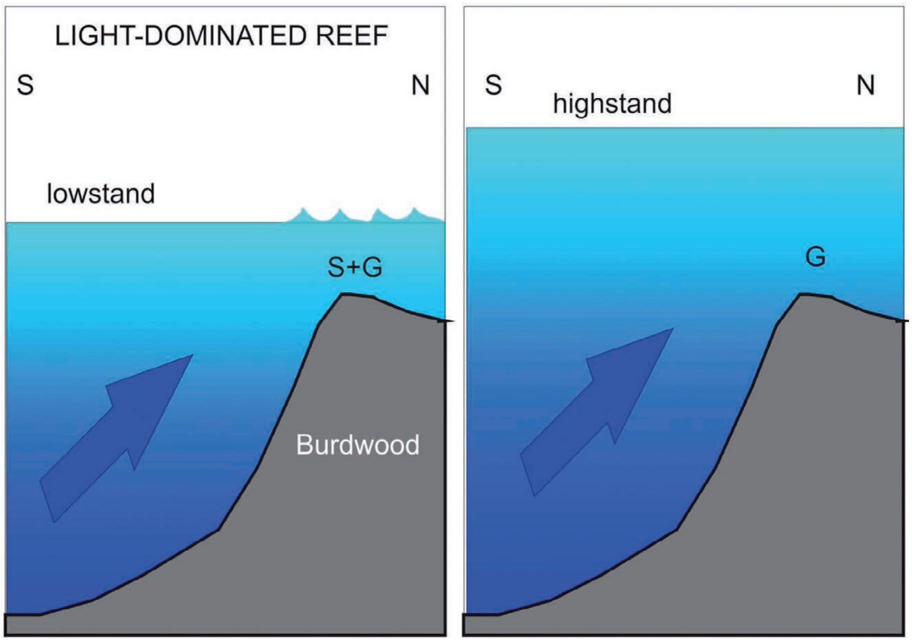

Fig. 3. A. During lowstands light availability permit the growth of cold-water corals, either gorgonians and scleractinians. Wave and tidal effects were more significant. B. During highstands light availability is much less and scleractinians corals are absent (modified from Roberts *et al.*, 2009).

Sea level variations would have strong influence on cold-water coral growths in the sense that nutrient supply by currents can significantly change between glacial and interglacial periods (Øvrebø *et al.*, 2006; Roberts *et al.*, 2009; Raddatz *et al.*, 2014). The seepage of hydrocarbons related to geological faults has been also suggested for the abundance of cold-water corals (Hovland *et al.*, 1994). It was suggested that the 'hydraulic activity' in the vicinity of a seep could supply inorganic phosphorus, nitrate and sulfur compounds with organic compounds such as light hydrocarbons (methane) that induces bacterial productivity and stimulates a food chain with cold-water corals at the higher trophic levels (Hovland and Thomsen, 1997).

CONCLUSIONS

Fossil cold-water corals covered the western portion of the Burdwood Reef, without a significant cover of sediment.

The ages of these corals are Pleistocene although several colonies can be superimposed.

As the nutrients are assured at those latitudes supplied by the Antarctic Bottom Current, the growth of these corals was dependent on light availability and wave energy.

Light availability therefore conditioned the distribution of cold-water coral specimens with different tolerances.

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