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Colonization of soft sediments by benthic communities: An experimental approach in Admiralty Bay, King George Island

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ABSTRACT

In order to understand nearshore biological community colonization following impact events that affect the distribution and occurrence of species and subsequent recovery a manipulative experiment was set up in King George Island. This work aimed to study colonization patterns of benthic macrofauna in defaunated soft sediment, comparing them with occurrence patterns of macrofaunal benthic organisms found in the natural soft sediment of adjacent areas, in shallow waters of Admiralty Bay, King George Island, Antarctic Peninsula. For this, a manipulative field experiment was installed through SCUBA diving at 22 m depth in front of the Antarctic Brazilian Station. Samples of defaunated and natural soft-sediments were analyzed. Defaunated soft sediment in plastic boxes ($a = 0.02\ m^2$) were deployed in the seabed and examined after 6, 12 or 18 months. Natural soft-sediment collected with cylindrical corers of 10 cm in diameter ($a = 0.08\ m^2$), in adjacent areas at the experiment installation and during the changing and removal of the experimental boxes, were also analyzed. Altogether, 20,680 organisms belonging to 6 phyla among 42 species were identified. Thirty three taxa out of the 42 recorded were common in both natural and defaunated sediment types, 6 taxa occurred only in natural sediment and 3 taxa only in defaunated sediment. The most abundant groups throughout the experiment were: Oligochaeta, Polychaeta, Bivalvia, Gastropoda and Crustacea. In the natural sediment a total of 10 species were considered *Constant*, 8 species *Accessory*, 21 species *Accidental*. In the defaunated sediment 14 species were *Constant*, 4 species *Accessory*, 18 species *Accidental*. Analysis of variance indicated significant differences in total abundance and in *Torodrilus* sp. abundance in the periods of 6 and 18 months, and MDS analysis showed a clear separation between natural and defaunated treatments. *Torodilus* sp. was the taxon with the highest relative contribution (26%) in natural sediment. In the defaunated sediment treatments, the most common taxa were cumacean Leuconidae morphotype 1 (19%) and the bivalve *Yoldia eightsi* (Couthouy, 1839) (18%). The statistical results indicated significant differences between the natural and defaunated treatments with respect to benthic macrofaunal associations. Species richness and abundance in defaunated treatment were less than in natural treatment. The results suggest that recovery levels in Antarctic waters after events of defaunation are very low and in order to be of value experiments may need to be for longer periods.

1. Introduction

Recruitment to the substratum is a crucial event in the life cycle of benthic marine invertebrates when organisms are changing in habitat and life style by settlement and early development (Stanwell-Smith and Barnes, 1997). Studies of benthic species generally consider that new settlers can arrive at a place by two main ways: 1) recruitment of pelagic larvae; 2) migration of juvenile and adults from nearby areas (Smith and Brumsickle, 1989).

The life cycle of benthic species can include the indirect development with planktonic larvae (planktotrophic or lecithotrophic), the direct development with incubation of embryos and hatching of juveniles' forms, or mixed development, of various incubation degrees and hatching stage of larvae (Absher et al., 2003; Barnes et al., 1993; Giese and Pearse, 1977; Hoffman et al., 2013; Peck, et al., 2006).

Larval-stage duration depends on many related factors, for instance, egg type and food availability and physical-chemical conditions of seawater. Metamorphosis may happen before, during or after settlement, and in all cases the larvae becomes negatively phototactic and/or positively geotactic and goes to the sea bottom. The larva tests the physical, chemical and biological conditions of the substratum and when finding a suitable situation, completes its metamorphosis (Brusca and Brusca, 1990).

Larvae are present in the water column all year round in Antarctica (Bowden et al., 2009) and settlement of some groups occurs over different periods (Pearse et al., 1991, Bowden et al., 2006). In Admiralty bay, with the beginning of the austral summer (November to March),

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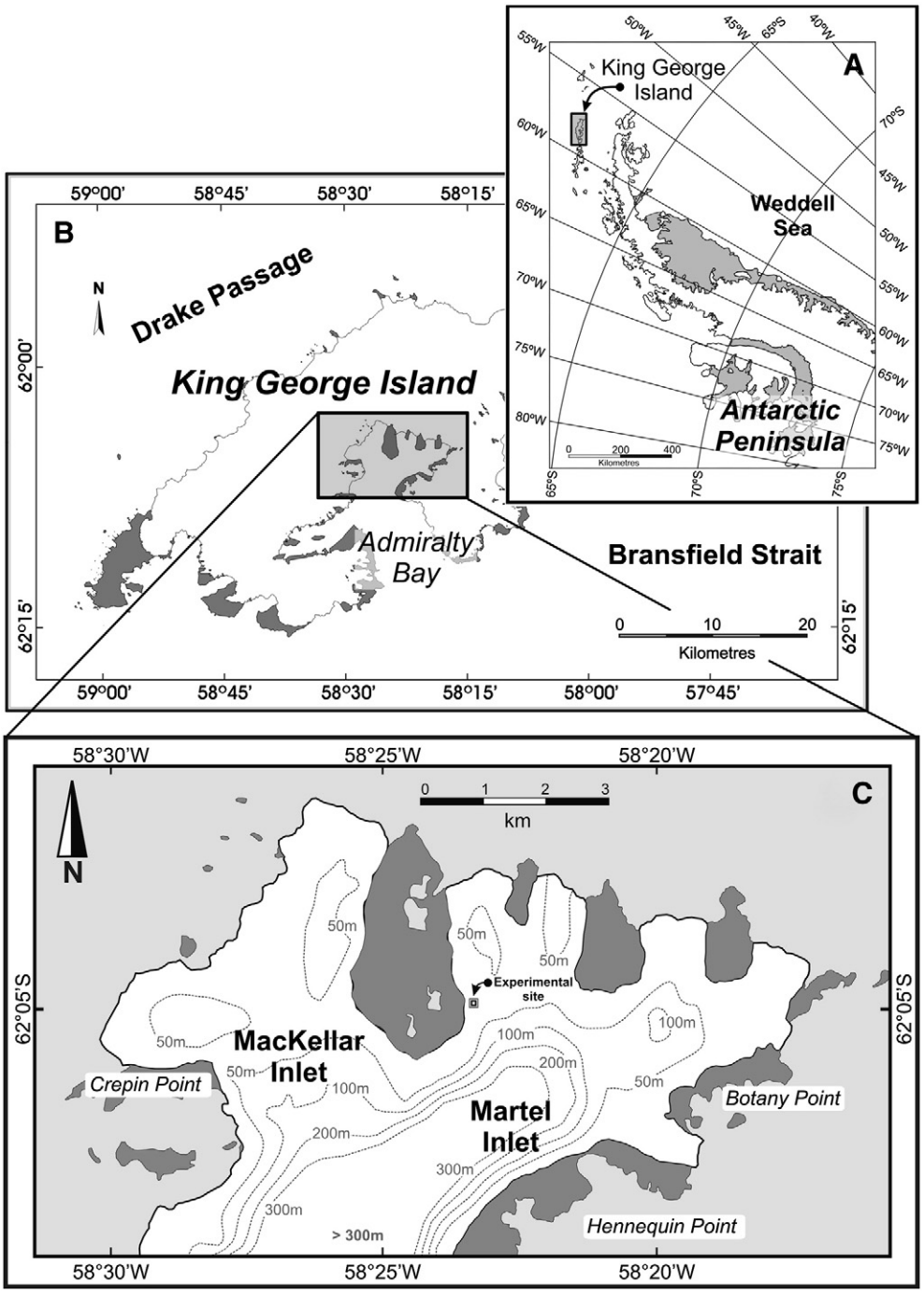

Fig. 1. EACF location in Martel Inlet (modified from Simões et al., 2004).

begins the supply of larvae or juveniles from the water column or sediment from adjacent areas (Freire et al., 2006). The success of larval recruitment may be affected by several factors, including the presence of adults, the hydrodynamic properties of the area, the existence of chemical traces, or some combination of these factors. While larval supply may be limiting or not, the success in the species colonization depends on the nature of the existing community together with the attributes of the local substratum, as, for instance, its stability (Constable, 1999).

Processes that govern the survival and dispersion of planktonic larvae in the water column are very different from the mechanisms of substratum selection, metamorphosis and settlement of larvae, with transitional behavior occurring between planktonic and benthic stages. Substratum colonization during this period is complex, with dominance patterns and composition of the benthic community changing through time (Bromberg et al., 2000; Nonato et al., 1992). The importance of studies coupling the distribution of established taxa and substratum colonization in ecology of benthic invertebrates has been recognized since the adults' populations are linked by the dispersion of the larval stages (Bostford et al., 1994).

Table 1
Dates of installation, retrieval, time of permanency and boxes numbers of the colonization experiment in defaunated sediment.

Installation	Retrieval	Permanency	Area	Box no.
December 2002	December 2003	12 months	I–III	1 to 4–9 to 12
December 2003	June 2004	6 months	Ib–IIIb	1b/4b–9b/12b
December 2002	June 2004	18 months	II–IV	5 to 8–13 to 16