Spring-time dynamics of diatom communities in landfast and underlying platelet ice in Terra Nova Bay, Ross Sea, Antarctica

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1. Introduction

Annually formed sea ice is the main feature of the polar regions and plays a fundamental role in structuring marine ecosystems at high latitudes, thus affecting the interactions between the ocean and the atmosphere as well as influencing global climate (Eicken, 1992; Thomas and Dieckmann, 2002; Smetacek and Nicol, 2005). Sea ice is a complex matrix containing channels, capillaries and pores, intimately connected with the underlying water column, and represents a harsh physico-chemical environment characterized by steep gradients in temperature, salinity, light and nutrient concentrations (Eicken, 1992; McMinn et al., 1999; Thomas and Dieckmann, 2002). Nevertheless, diverse microbial communities, known as the sympagic biota, are able to survive in the brine inclusions and interstices of the sea ice habitat (e.g. Arrigo, 2014).

The most conspicuous members of the sea ice microbial communities are the microalgae that are adapted to live in extreme conditions and flourish within the distinct micro-habitats that are created when the sea ice forms and develops (Lizotte, 2003; Arrigo and Thomas, 2004; Lavoie et al., 2005; Mock and Thomas, 2005; Matsuoka et al., 2009). The microalgae living in the annual pack ice may contribute ca. 10–30% of the annual primary production in the Antarctic regions (Arrigo et al., 1998) and up to 57% in the central Arctic Ocean (Gosselin et al., 1997). Although landfast ice occupies only 1 to 5% of the total ice cover around Antarctica, standing crops of microalgae are three orders of magnitude greater than those reported for the multi-year pack ice autotrophic communities (Ackley and Sullivan, 1994; Archer et al., 1996; Guglielmo et al., 2000; Kózajńska et al., 2008).

In landfast ice, microalgae form distinct surface, interior and bottom communities that originate and develop over time under the influence of different environmental variables (e.g. Horner, 1985; Horner et al., 1992; Arrigo, 2014). Surface communities occurring at the snow–ice interface mainly result from seawater infiltration (Meguro, 1962). The internal horizons are probably the most inhospitable habitats for microalgal life, because they are constituted by columnar ice (Arrigo, 2014). Although these horizons can receive sufficient light for photosynthesis, they are characterized by brine salinities that are too high to allow microalgal growth (Arrigo and Sullivan, 1992), while the low brine volumes in the interior ice layers restrict nutrient exchange.

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