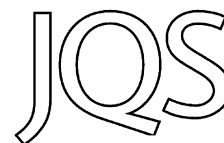


# Potential seasonal calibration for palaeoenvironmental reconstruction using skeletal microstructures and strontium measurements from the cold-water coral *Lophelia pertusa*



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**ABSTRACT:** *Lophelia pertusa* is a colonial cold-water coral species with a wide spatial distribution in recent marine waters. Analysing the chemistry of its skeleton allows reconstruction of environmental parameter variations. While numerous studies have attempted to interpret such analyses, little information is available on the microstructures of *Lophelia pertusa* and their temporal constraints. This study introduces newly recognized microstructures in the coral wall following growth along the radial axis. The thicknesses of these 'micro-layers' are correlated with strontium concentrations and can be used to estimate seasonal growth rates of single polyps from the colony. We propose that each of these micro-layers represents a period of 1 month of mineralization and can locate two decreasing periods in growth rate during a year: one caused by limited food availability during winter months and one in autumn linked to gametogenesis. High-frequency study of strontium concentrations using this interpretation shows a lunar cycle. We demonstrate that while the micro-layers are present in all *L. pertusa* specimens from four locations in the Atlantic Ocean and the Mediterranean Sea, growth patterns reveal a complex organization that limits their visibility. Strontium fluctuations, however, appear to be a promising mechanism by which to establish a temporal calibration. Copyright © 2014 John Wiley & Sons, Ltd.

**KEYWORDS:** cold-water corals; growth rate; *Lophelia pertusa*; microstructure; strontium.

## Introduction

Azooxanthellate cold-water corals such as *Lophelia pertusa*, *Madrepora oculata* and *Desmophyllum dianthus* are widely distributed in the marine environment, with the only known exceptions being the Bering Sea and the high Arctic regions (Roberts *et al.*, 2009). The depth range of occurrence of these scleractinians is also wide, ranging from 40 m in Norwegian waters (Trondheimsfjord) to 6300 m in the Aleutian Trench. This observation implies that water characteristics (e.g. temperature and salinity) rather than depth are a major factor in their distribution (Keller, 1976). The establishment and development of living colonies in specific areas are favoured by strong currents that generally promote oxygenation, food supply, and removal of accumulated sediment particles and waste products (White, 2007; Foubert *et al.*, 2008; Davies *et al.*, 2009; Mienis *et al.*, 2012).

*Lophelia pertusa* (Linnaeus, 1758) is a colonial species that generally occurs in deep-sea areas around the world (Davies *et al.*, 2008; Roberts *et al.*, 2009). As a reef-building species, this scleractinian constructs a three-dimensional aragonitic structure that serves as a habitat for a large number of

invertebrate and fish species that use it as a sheltered location for feeding, spawning and nursing. Habitats formed by *L. pertusa* colonies generally display an overall increase in biodiversity and productivity compared with adjacent areas where these cold-water corals are absent (Costello *et al.*, 2005; Henry and Roberts, 2007; Söffker *et al.*, 2011; Biber *et al.*, 2014).

In terms of modes of growth, scleractinian corals build their skeletons with aragonitic needles from centres of calcification along the theca (Gladfeiter, 1982). Unlike tropical corals that display differential density layers that facilitate tomographic imaging (Saenger *et al.*, 2009; Cantin *et al.*, 2010) cold-water corals do not appear to build such layers. Nevertheless, growth structures defined by opaque and translucent bands in the coral wall as revealed by transmitted light have been described in the skeletons of cold-water corals, including *L. pertusa* (Wainwright, 1964). These bands were originally interpreted as annual patterns (Lazier *et al.*, 1999) but it has recently been demonstrated that this is not necessarily the case for either *D. dianthus* (Adkins *et al.*, 2004) or *L. pertusa* (Gass and Roberts, 2011). As a result, their use in establishing temporal calibrations is in doubt.

Biogenic carbonates produced by *L. pertusa* can be used as archives for environmental reconstruction through the use of

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