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Using growth and geochemical composition of *Clathromorphum compactum* to track multiscale North Atlantic hydro-climate variability

Valentin Siebert [a,*], Pierre Poitevin [a,1], Laurent Chauvaud [a], Bernd R. Schöne [b], Pascal Lazure [c], Julien Thébault [a]

[a] Univ Brest, CNRS, IRD, Ifremer, LEMAR, F-29280 Plouzané, France
[b] Institute of Geosciences, University of Mainz, Johann-Joachim-Becher-Weg 21, 55128 Mainz, Germany
[c] Ifremer, Laboratoire d'Océanographie Physique et Spatiale (UMR6523 CNRS/Ifremer/IRD/UBO), 29280 Plouzané, France

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ABSTRACT

Records of ocean/atmosphere dynamics over the past centuries are essential to understand processes driving climate variability. This is particularly true for the Northwest Atlantic which is a key region with an essential role in global climate regulation. Over the past two decades, coralline red algae have been increasingly used as environmental and climatic archives for the marine realm and hold the potential to extend long-term instrumental measurements. Here, we investigate the possibility to extract climate and environmental information from annual growth patterns and geochemical composition of the coralline red algae, *Clathromorphum compactum*, from Saint-Pierre & Miquelon (SPM), a French archipelago southwest of Newfoundland. However, measurements of *C. compactum* growth trends is challenging due to difficulties in identifying annual growth lines directly. So far, growth pattern investigations were commonly performed based on geochemical data of coralline calcite matrix. Nonetheless, this method is expensive and therefore prevents from analyzing a large number of specimens that would be representative of the population. For this reason, we enhanced the growth line readability by staining polished sections with Mutvei's solution and performed growth analysis based on direct increment width measurements. Geochemical analyses were also carried out in order to validate the assumption that growth lines observed after staining were formed on an annual basis. Moreover, growth pattern and trace element composition were measured on multiple axes of several individuals in order to assess the intra- and inter-specimen variability and validate their use for paleoenvironmental reconstructions. Finally, relationships between the *C. compactum* sclerochronological records from SPM and environmental datasets covering different geographical areas allow a better knowledge of flow dynamics in the Northwest Atlantic and confirm the findings related to *Arctica islandica* from the same location.

1. Introduction

The Northwest Atlantic Ocean is a key region with respect to climate variability as it represents the starting point of the Atlantic Meridional Overturning Circulation (AMOC) which is an important and active component of the climate system (e.g. Rahmstorf, 2003). Southern Newfoundland's coast and the Saint-Pierre & Miquelon (SPM) region lie at the confluence of the main oceanographic currents ruling the North Atlantic Basin (Poitevin et al., 2019) (Fig. 1). However, despite its importance, the physical flow dynamics of this region is poorly understood (Wu et al., 2012). This gap mainly exists because of the lack of long-term environmental records in this area before the mid-20th century (Halfar et al., 2011).

Proxy data allow us to generate such records retrospectively and are of crucial importance to extend our knowledge of past environmental conditions. In the oceanic realm, carbonate hard structures of long-lived marine species hold the potential to generate such proxy data to extend instrumental observations by several decades to centuries. While multi-centennial reconstructions of tropical marine hydro-climates have been generated since the 1990's using corals (e.g. Dunbar et al., 1994;

* Corresponding author.
E-mail addresses: valentin.siebert@univ-brest.fr (V. Siebert), pierre.poitevin@univ-brest.fr (P. Poitevin), laurent.chauvaud@univ-brest.fr (L. Chauvaud), schoeneb@uni-mainz.de (B.R. Schöne), pascal.lazure@ifremer.fr (P. Lazure), julien.thebault@univ-brest.fr (J. Thébault).
[1] Present address: Fisheries and Oceans Canada, Maurice Lamontagne Institute, Mont-Joli, QC, Canada.

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