Science of the Total Environment 888 (2023) 164011

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

High-resolution history of oxygen depletion in the SW Baltic Sea since the mid-19th century as revealed by bivalve shells

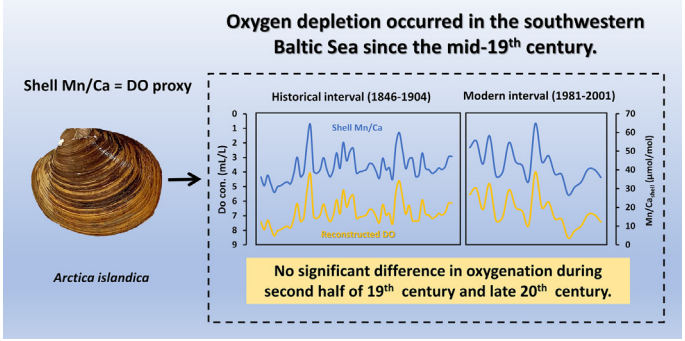
Xizhi Huang [a,*], Liqiang Zhao [b], Michael L. Zettler [c], Regina Mertz-Kraus [a], Klaus Peter Jochum [d], Bernd R. Schöne [a,*]

[a] Institute of Geosciences, University of Mainz, Mainz, Germany
[b] College of Fisheries, Guangdong Ocean University, Zhanjiang, China
[c] Leibniz Institute for Baltic Sea Research Warnemünde, Rostock, Germany
[d] Climate Geochemistry Department, Max Planck Institute for Chemistry, Mainz, Germany

HIGHLIGHTS

- High-resolution dissolved oxygen concentrations were estimated from shell Mn/Ca.
- The seasonal deoxygenation was already present in the mid-19th century.
- Late 20th century dissolved oxygen variability was controlled by saltwater inflows and nutrient levels.
- Ba/Ca_{shell} profiles likely associated with diatom community structure changes.

GRAPHICAL ABSTRACT



ARTICLE INFO

Editor: Filip M.G. Tack

Keywords:
Bivalve shell
Manganese-to-calcium
Barium-to-calcium
Dissolved oxygen
Arctica islandica

ABSTRACT

The Baltic Sea serves as a model region to study processes leading to oxygen depletion. Reconstructing past low-oxygen occurrences, specifically hypoxia, is crucial to understand current ecological disturbances and developing future mitigation strategies. The history of dissolved oxygen (DO) concentration in some Baltic Sea basins has been investigated in previous studies, but temporally well-constrained, inter-annual and better resolved DO reconstructions are still scarce. Here, we present precisely dated, high-resolution DO record since the mid-19th century reconstructed from Mn/Ca_{shell} values of *Arctica islandica* (Bivalvia) collected in the Mecklenburg Bight. According to the data, this area experienced similar low oxygenation during the second half of the 19th century and the late 20th century, but DO variability increased: A 12–15-yr oscillation prevailed in the 19th century, but a 4–6-year period dominated in the late 20th century. Shortly after the onset of the Industrial Revolution around 1850, Mn/Ca_{shell} values increased, indicating a DO decrease, probably caused by strong anthropogenic nutrient input. More recently, phosphate levels and inflows of oxygen-rich North Sea water have been identified as major factors controlling the bottom water oxygenation. For example, the increase in DO in the mid-1990s was linked to the decrease in phosphate content and several Major Baltic Inflows. The strong Ba/Ca_{shell} rise between the 1860s and the turn of the century most likely reflects changes in diatom community structure rather than a bloom of mass phytoplankton. This is supported by largely unchanged Mn/Ca_{shell} and shell growth. Decadal and multi-decadal cycles of shell growth rate correlated strongly with the Atlantic Multidecadal Variability, likely reflecting changes in atmospheric circulation patterns, precipitation rate and riverine nutrient supply. To further improve the management and protection of ecosystems in the Baltic Sea, a larger number of such high-resolution retrospective studies covering long periods of time and large regions are needed.

* Corresponding authors.
E-mail addresses: xizhihuang25@gmail.com (X. Huang), bernd.schoene@uni-mainz.de (B.R. Schöne).

http://dx.doi.org/10.1016/j.scitotenv.2023.164011
Received 20 February 2023; Received in revised form 4 May 2023; Accepted 4 May 2023
Available online 11 May 2023