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Reconstruction of climate and environmental changes in the Bornholm Basin during the last 6000 years, based on foraminiferal assemblages

Anna Binczewska (1), Irina Polovodova Asteman (2), Matthias Moros (3), and Joanna Sławińska (4)

(1) Paleoceanography Unit, Faculty of Geosciences, University of Szczecin, Szczecin, Poland (anna.binczewska@gmail.com), (2) Uni Research Climate, Bjerknes Centre for Climate Research, Bergen, Norway (Irina.Asteman@uni.no), (3) Leibniz Institute for Baltic Sea Research, Warnemünde, Germany (matthias.moros@io-warnemuende.de), (4) Department of Geology and Paleogeography, Faculty of Geosciences, University of Szczecin, Szczecin, Poland (joanna@internetmail.pl)

The Baltic Sea is the largest brackish sea in the world connected to the Atlantic Ocean through the narrow and shallow Danish Straits. The hydrography of the Baltic Sea is strongly dependent on inflows from the North Sea and its environmental conditions are influenced by meteorological and anthropogenic factors. To improve our understanding of the natural variability and forcing factors driving changes in the Baltic ecosystem, detailed analyses of palaeoecological archives are needed. Here we present a high-resolution study of foraminiferal assemblages together with sediment geochemistry (LOI, TOC, TIC, CNS) from a 8-m long gravity core (GC) and a 42-cm long multi core (MUC) taken in the Bornholm Basin in 2013. Both cores were investigated in order to reconstruct bottom water mass variability during the mid- and late Holocene. Cores were dated by AMS 14C (mostly on Macoma balthica shells), 210Pb and 137Cs. Age-model allowed us to place variability of foraminiferal assemblages in time and link them with the Holocene climate extremes and the Major Baltic Inflows (MBIs).
High absolute abundances (ind./g wet sed.) of foraminifera are found within a core interval corresponding to the Dark Ages and the Medieval Warm Period (∼AD 400-1200). The Little Ice Age is represented by rare to absent foraminiferal shells, while significant changes of foraminiferal abundances occur in the lower part of core(∼ BC 2050-2995). The dominant species found in both cores are Cribroelphidium excavatum, C. excavatum f. clavatum, C. albiumbilicatum and C. incertum, all adapted to an ecologically unstable environment with high fluctuations of salinity and oxygen. The arenaceous species Reophax dentaliniformis strongly occurs at ∼ AD 1450-1600, where calcareous species were rare. Presence of agglutinated foraminifera and prevailing small size of individuals in all studied material suggest bottom water undersaturation with respect to calcium carbonate. In the Baltic Sea, bottom waters characterized by long-term hypoxic to anoxic conditions, low salinity and organic-rich sediments create unfavourable environment for benthic fauna and affect their preservation state in fossil record. In our study we observed different stages of carbonate dissolution: from completely intact tests to opaque individuals, loss of two chambers and test deformations. Foraminiferal tests with different state of preservation were treated and counted separately. Upon poor shell preservation, remaining inner organic linings (IOLs) were useful to obtain information about assemblages and to improve interpretation of past changes in the study area. Peaks in abundance of foraminiferal shells and IOLs were linked to saline water inflows and increased ventilation of the Bornholm basin bottom waters. This suggest a strong effect of saline and well oxygenated water inflows from the Atlantic Ocean on the Baltic Sea ecosystem, which might be linked to the major climate transitions over the last 6 millennia.