Geophysical Research Abstracts
Vol. 16, EGU2014-9995, 2014
EGU General Assembly 2014

Waxing and waning of dreissenid pavements as a possible result of astronomical forcing

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Human induced range expansions of invasive dreissenid bivalves are of great concern. However, the underlying biological processes are only poorly understood, partly due to the lack of information on natural expansion events. Here we use the extinct bivalve species Sinucongeria primiformis as a model organism for testing natural (i.e. pre-Anthropocene) blooms of dreissenid species in a lacustrine system of Lake Pannon during the Tortonian (∼10.5 Myr; Late Miocene). 600 samples from a consecutive core were evaluated for the relative abundance of this pavement-forming mollusc, which cover about 8 millennia of Late Miocene time with a decadal resolution. The formation of these pavements occurred in repetitive cycles, which were also documented for carious other geophysical and geochemical and biotic proxies. The investigated bivalve was among the most successful species settling in offshore environments of Lake Pannon, where it formed vast pavements. The tolerance for poorly oxygenated lake bottoms close to the epilimnion/hypolimnion boundary was probably the key adaptation to outcompete other species in this lacustrine offshore environment.
We document that solar forcing might have played an important role for lake hydrology, which in turn allowed population blooms during phases of improved ecological conditions. The repeated establishment of dysoxic conditions was lethal for the populations and is reflected by pyrite incrustations in the shell cavities. The cyclicities might be expressions of the Gleissberg cycles and the 500 yr cycle, indicating that bottom water oxygenation was strongly influenced by these solar cycles. This example shows that dreissenid bivalves may be pioneers, which quickly dominate aquatic ecosystems even in pre-Anthropocene records. The surprisingly strong influence of solar forcing on the success of the Miocene dreissenids is an overlooked aspect for predicting the population dynamics of extant dreissenids.

This study was supported by the Austrian Science Fund (FWF grants P21414-B16 and P25365-B25).