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Earliest Holocene occurrence of the soft-shell clam, *Mya arenaria*, in the Greifswalder Bodden, Southern Baltic

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Abstract

Shells of *Mya arenaria* from the Greifswalder Bodden, southern Baltic Sea, were dated using aspartic acid racemisation. The soft shell clam occurs in the sediments of the bay to a depth of 20 cm and exceptionally to 36.5 cm. Consistent ages of 682±70 and 687±70 years before 1997 were obtained for three articulated shells recovered in life position. This places the first occurrence of *M. arenaria* clearly before the time of Columbus. These new data support earlier findings from northern Jutland, Denmark.

Keywords: Baltic; Holocene; amino acid dating; aspartic acid; *Mya arenaria*

1. Introduction

The postglacial history of the Baltic Sea has been divided into different stages named after the 'characteristic fossils': the Yoldia Sea, the Ancylus Lake, the Litorina Sea and the Limnea Sea (Dietrich and Köster, 1974). According to these authors, from about 500 years before present (BP) the soft-shell clam *Mya arenaria* has dominated the fossil fauna prompting Munthe already in 1894 to name this period accordingly the Mya Sea (Munthe, 1894).

There is, however, debate on the earliest occurrence of the soft clam *M. arenaria* in European waters. This species, present in the Pleistocene, became extinct during the last glaciation and was introduced by man to Europe only after deglaciation (Strauch, 1972; Strasser, 1999). Hessland (1946) argues that *Mya* could not have been re-introduced before the time of Columbus, i.e. before 1492, as larvae could not have been transferred from America to Europe by natural

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transport processes. Petersen et al. (1992), however, provide evidence from radiocarbon dating that *Mya* was present in Danish waters, i.e. at the Kattegatt coast in northern Jutland, already 720±80 years BP thus placing its earliest occurrence clearly before the voyage of Columbus. These authors attributed this early occurrence to a transfer from North America to Europe by the vikings. On the other hand, Duphorn et al. (1995) place the earliest occurrence of *Mya* shells in the Baltic to about 500 years BP.

In detailed sediment sampling of the Greifswalder Bodden, southern Baltic Sea, we found that *Mya* shells were restricted to the upper decimetres of the sediment column exclusively. However, the sedimentary environment did not provide clues as to the exact age of the shells. To obtain more information on this we used amino acid racemisation dating of *Mya* shells. Especially aspartic acid has the potential due to its fast racemisation rate to date Holocene samples younger than approximately 600 years (Goodfriend et al., 1992; 1996; Goodfriend and Stanley, 1996). Due to the reservoir effect these are difficult to date using the radiocarbon technique. For the southern Baltic reservoir ages ranging from 162±65 to 332±80 years have been reported (Engstrand, 1965; Håkansson, 1987; Olsson, 1980; see also http://radiocarbon.pa.qub.ac.uk/marine/).

2. Geological setting

The Greifswalder Bodden, one of the numerous bays bordering the southern coast of the Baltic Sea, is situated between the island of Rügen and the western Pomeranian mainland. It covers an area of 514 km^2 and reaches a maximum water depth of 13.8 m. The characteristics of both the shorelines and the sea floor topography originate from the configuration of the end moraines built up during the last glaciation, i.e. the Weichselian: Rügen Stage (e.g. Kolp, 1976). The depressions of this Pleistocene relief were filled with water during the Holocene transgression (Kolp, 1976). At 4000 years BP the present-day sea level was reached during phase 2 of the Litorina transgression. After a temporary slight regression at about 3300 BP the present sea level was reached again at 2000 years BP during the Litorina transgression phase 3 (Kliewe and Janke, 1982).

The coarse sediments of the marginal zone and the shallow areas in the eastern part of the Greifswalder Bodden originate from moraine material which, however, has undergone a complete marine reworking during the transgression. The fine-grained surface sediments of the western basin area are Holocene marine deposits (Niedermeyer et al., 1995).

The most conspicuous biogenic feature of the Greifswalder Bodden sediments is the occurrence of *M. arenaria* in the upper few decimetres of the sediment column. In the basin area in the western part of the bay the living *M. arenaria* population is less abundant and represented only in some of the box cores. In the marginal belt and in the ridge area of the eastern part most of the sites are populated by living *M. arenaria* down to a sediment depth of about 10 cm. Dead *M. arenaria* shells in life position extend to sediment depths generally not exceeding 20 cm. Only in two samples shells were found in deeper layers, i.e., down to 25 cm in core GB 115 and 36.5 cm in core GB 124. Thus, only the upper 20 cm of the profiles exhibited in the box cores regularly represent the Mya Period. However, this representation is not valid for the sediment surrounding the *M. arenaria* shells in life position found in deepest position in the cores. For endobenthic bivalves contemporaneous sediment is situated on the level of the siphon passage openings, i.e. considerably above burrowing depth. Accordingly, the "deepest *Mya* shell" from core GB 115 was sticking in older limnic deposits belonging to a pre-Litorina stage of the Baltic Sea.

Reworked *Mya* shells have been found only in box cores taken in water depths of less than 5.8 m. Three reworking horizons in 2, 8 and 15 cm sediment depth suggest an origin by three century-scale high magnitude storm events during the whole Mya Period (G. Hertweck, in preparation).

Along with *M. arenaria*, living specimens and dead shells of *Cerastoderma edule* and *Macoma balthica* were found in the upper portions of the box cores from the Greifswalder Bodden. Shell material of these two species also occurs in the deeper portion of the cores, together with shells of *Scrobicularia plana*. This species regularly populates the western Baltic Sea which has a higher salinity than the average value of 7.3‰ measured in the Greifswalder Bodden. Its absence in the contemporary southern Baltic and in the sediments of the Mya Period points to a decrease