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Stable isotope compositions of Unionidae shells from Lake Balaton (Hungary): Behaviour of recent shells and archaeological applications

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Stable oxygen and carbon isotope compositions of bivalve carbonate (Unio sp.) were measured in order to understand how climate conditions are reflected by the isotopic compositions of shell material from Lake Balaton (Hungary). Samples were taken also from Anodonta and Dreissena species from the same period and were also analysed to study interspecies variation. Monitoring of physical parameters and oxygen isotope composition of lake water was conducted between 1999 and 2005 and between 2007 and 2009 and the data were compared with the stable isotopic compositions of Unio shell specimens grown in the same period. Sampling conducted at high resolution revealed variations related to seasonal fluctuations. The period studied contain wet and extremely dry periods beyond the normal years that made the studied period appropriate to determine if the shells can be used for climate studies. As we have seen, the Unio shells systematically and reliably reflect temperature and isotopic variations, so these shells can potentially be used to reconstruct past environmental conditions.

Past climate reconstructions based on isotopic variations in shell carbonate have been demonstrated in two archaeological studies on excavation materials of Copper and Bronze Ages.

Within the Late Copper Age several subphases have been distinguished that are covered by the excavation sites in Balatonkeresztur (Southern part of Lake Balaton). Settlement migration to higher locations (suggesting a significant rise in lake or groundwater level) and a gradual shift in animal remnants from the dominance of sheep and goat (preferring dryer climate) to swine (suggesting a wetter climate) have been observed between the Boleraz (5460-5310 calBP) and Early Classical Baden (5310-5060 cal BP) subphases. Based on geomorphological and archaeozoological studies, a dry to wet climate change can be suggested which have been detected by palynological analyses as well.

Based on stable isotopic compositions of shell material from archaeological periods, the period of Boleraz subphase can be characterized by warm/dry climatic condition. Around 5310 calBP (between Boleraz and Early Classical Baden) the climate turned into a more variable condition and became wet/cold in agreement with archaeological and palynological studies. Subsequent positive shifts in isotopic compositions in the subphase of Early Classical Baden suggest an increasingly arid condition, which is not shown in archaeological studies. This observations suggests that the advantegous agriculture achieved during the wet period was kept in spite of the subsequently warming and less humid conditions.

Isotopic compositions of bivalve samples from the Bronze Age from Ordacsehi (Southern part of Lake Balaton) were also analysed, whose data suggest that the Early Bronze Age (3690 cal BP) can be characterized with stable conditions, while shells collected from the Middle to the Late Bronze Age (3690 calBP) indicate variable, wet climatic conditions. The wet/cold climatic conditions in Middle Bronze Age have also been detected by archaeological studies and stable isotopic analyses of a speleothem of a nearby cave, supporting the conclusions by independent evidences.