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# Changing Miocene seasonality patterns in Central Europe deduced from the Crassostrea isotope archive

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The Western Tethyan estuarine oyster *Crassostrea gryphoides* is an excellent climate archive due to its large size and rapid growth. The bivalve was a specialist for estuarine habitats, which, as junction between terrestrial and marine environments, are strongly modulated by climatic parameters such as precipitation and discharge. Seasonal rhythms of the climate may thus be detected from the Crassostrea isotope archive.
The analysed shells of the giant oyster *Crassostrea gryphoides* document a distinct change in seasonality patterns from the Miocene Climate Optimum (MCO) into the Miocene Climate Transition (MCT). The Burdigalian and Langhian shells exhibit a markedly regular seasonality with regularly occurring seasons of high precipitation, reflected by increased freshwater discharge into the estuaries. Individual growth rates are about 2-3 times faster than in geologically younger oysters in the Paratethys Sea. In contrast to the MCO shells, with parallel $\delta^{18}$O and $\delta^{13}$C profiles, the early MCT shell indicates phytoplankton blooms during autumn, reflected by a slight phase lag. MCO water temperatures ranged between 17-19°C during cool seasons and c. 28°C in warm seasons with a characteristic seasonal range of 9-10°C. An extremely long 4-decade-record of the huge oyster from the early MCT still suggests a strong seasonality. A slight cooling might be expressed by the annual temperature range from c. 16-25°C. Soon after, the Serravallian shells of Central Europe document a drastic change of patterns. Successions of dry years with irregular precipitation events occur, whereas the $\delta^{18}$O record suggests a continuous regular alternation of warm and cool seasons. The breakdown of isotope correlation may thus be related to suboptimal nutrition supply which would also explain the small shell-sizes during that time.
In terrestrial climates the MCO/MCT transition is characterized by an increase in mean annual range of temperature, mainly due to decreasing cold month temperatures. This trend is not so obvious in the data presented here for the shells from the late MCT. Rather warm Paratethyan sea water temperatures during the late Serrvallian, however, are also indicated by the wide spread ooid formation, which contradicts a pronounced cooling at that time. Therefore, unstable precipitation on a multi-annual to decadal scale, rather than a simple temperature decline, may thus be an important forcing mechanism for the MCT climate in Central Europe.
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