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Leibniz-Institute for Baltic Sea Research (IOW) • Royal Netherlands Institute for Sea Research (NIOZ) • University College London

Rapid mid-Holocene warming triggered the onset of a farming society in Northern Europe

In a recently published article in the renowned journal Scientific Reports, an international team of geologists, geochemists, archaeologists, fishery biologists and ecosystem modellers present the results of their detailed studies on the temperature development during the Holocene in the Baltic region. Their temperature record reveals explanations for simultaneously occurring human demographic and cultural changes.

It is for the first time that the so called biomarker TEX86, acting as a proxy for sea surface temperature, was applied on a sediment core from the central Baltic Sea covering the time span from 7.100 – 3.000 years before present (BP) in high resolution. It reveals a fascinating temperature history, which provides an explanation why the transition from hunter-gatherer-fishing-groups to farming society (the Neolithic revolution) reached the Baltic area as late as 1.500 years after it appeared in the neighbouring areas in the South.

“The TEX86 biomarker serves as a kind of paleothermometer”, explains Lisa Warden, a former PhD student at the NIOZ Royal Netherlands Institute for Sea. “It is based on the remains of certain microorganisms, so-called Thaumarchaeota. The composition of their membrane lipids change according to sea temperature. When the Thaumarchaeota die and sink to the seafloor, this information gets archived and can be retrieved by chemical analysis of these fossils.” During the investigated time span, these analyses showed a temperature range from 14.5 to 17.5 °C in the sea surface in summer. The TEX86 record detects a prolonged unstable but generally colder phase from 7.000 to 6.000 BP, followed by a distinct and rapid warming, which culminates in two temperature maxima at 5.600 and 4.500 years BP. Thus, in the Baltic Sea region the “Holocene Thermal Optimum” lasted only from 5.900 to 4.400 years BP.

“Comparing these results with archaeological findings shows a striking parallel development.” Stephen Shennan, archaeologist at the University College London, has analysed the population development during the respective period. “From shortly after 6.000 years BP on we recognize a sharp increase in the population density parallel to the warming phase. We also see by the archaeological evidence that this goes with the onset of farming in the western Baltic Sea region. „With the significant increase in temperature, the scene was set for successful farming and an expansion of agrarian groups from the South. “Our study suggests a rapid human reaction within only two to

three generations to these new opportunities emphasizing the remarkable plasticity humans can demonstrate in response to climate change,” resumes Shennan.

The backbone of the analyses was the recovery and dating of high resolution sediment cores. “We have developed a multi-proxy approach in order to drag as much information from the sediment cores as possible.” Matthias Moros, geologist at the Leibniz-Institute for Baltic Sea Research (IOW) coordinated all analyses related to the sediment archives. Together with his colleague Jaap Sinninghe Damsté, a biogeochemist at NIOZ and professor at Utrecht University, he designed the scientific approach of this study. “We knew already from the sediments that there was a distinct shift around 6.000 years BP: the sediment structure changed completely from homogenous to laminated. This is clear evidence for a change in the oxygen conditions at the sea floor. We know now, that this was triggered by the temperature rise.” His colleague, IOW ecosystem modeller Thomas Neumann, showed that this was not a local but a regional phenomenon influencing the Baltic as a whole. He concludes: “Our model provides a causal mechanism between temperature change and environmental conditions as reflected in the sedimentary record.”

“We also speculated that the spread of anoxia must have affected the fish stocks in the Baltic at that time and that this must have been a trigger for the observed cultural changes” Jaap Damsté adds “but the archaeological data were not strong enough to claim this.” He concludes: “This study clearly reveals the strength of multidisciplinary studies to understand human history”.

The whole article is available under www.nature.com/articles/s41598-017-14353-5

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