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Early Eocene climatic optimum (EECO) temperatures in the Belgian Basin inferred from otolith stable isotope geochemistry

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According to recent research the early Paleogene greenhouse period appears to be highly variable, challenging paleoclimatologists to modify their current knowledge about the climate system. The Belgian Basin, part of the southern North Sea bight, comprises a fairly continuous Paleogene sedimentary record. It is dominated by fossiliferous sands and clays, which have suffered only minor deformation. This marginal setting presents an opportunity to link deep-sea and continental records, increasing our understanding about the impact of climate changes on local marine ecosystems. During the past decade, the use of fish otoliths as (paleo)environmental indicators has increased. In our study, otolith δ^{18}O signatures are used as a paleotemperature and paleoseasonality proxy, because they are thought to precipitate in equilibrium with sea water temperature. Otoliths of several levels and locations within the interval of the early Eocene climatic optimum (EECO) have been manually polished, drilled with a micromilling apparatus for bulk and incremental microsamples, and subsequently analyzed by an automated carbonate extraction device coupled to an isotope ratio mass spectrometer. The selected species, *Paraconger papointi*, *P. sauvagei* (Congridae), *"Neobythitinorum" subregularis* and *Glyptophidium polli* (both Ophidiidae) are known as quasi non-migratory bottom-dwellers, and hence should reflect bottom water temperatures. The paleotemperature equation of Thorrold *et al.* (1) was used because it is based on marine species; $\delta_w$was chosen at -1.00 ‰ assuming an ice-free world during the EECO. The average MAT as inferred from bulk microsamples is 32.4 ˚C. This high temperature suggests a 20 ˚C difference with deep sea benthic foraminifera records (2). It approximates TEX_{86} SST from the East Tasman Plateau and New Zealand (3), which is not unusual given the shallow water depth in the Belgian Basin at that time, the lower paleolatitude of the Belgian Basin compared with these regions, and the low latitudinal SST gradients during the early Eocene. It is also in line with expectations based on middle Eocene to Oligocene otolith temperatures of the Belgian Basin (4). However, a δ^{18}O and δ^{13}C crossplot of the Congridae and Ophidiidae, shows that the isotope data of these two groups can be clearly distinguished. When converted to temperatures, there seems to be a difference of ca. 9 ˚C between both families (Ophidiidae lowest), involving a reinterpretation of calculated temperatures. A possible explanation for this discrepancy could be an offset between different families of fishes in the incorporation of isotopic signatures in their otoliths. This would argue for taxon-specific paleotemperature equations to be established. Another explanation could be a different way of life of both families, which would imply that Ophidiidae spent much of their life at larger depths than Congridae, or that Congridae lived closer to freshwater influx areas then Ophidiidae. Incremental microsample analyses of species of both families consistently show a seasonality (MART) of 9.5 ˚C. This value is comparable to the results of similar analyses cited in literature, and to current seasonality in the North Sea Basin.

Key References:

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