



## **Seasonality and life history in a Jurassic ecosystem: isotopic evidence from the Great Estuarine Group of Scotland**

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A multi-isotope study was conducted to characterize the Jurassic ecosystem of the Great Estuarine Group (GEG) of the Inner Hebrides, Scotland. The GEG has long yielded exceptionally well-preserved aragonitic remains of vertebrate and invertebrate fauna. The group includes sediment that accumulated in water ranging from fresh ( $S‰ = 0$ ) to marginal marine, on the basis of macroinvertebrate and microinvertebrate fossil assemblages as well as isotope data.

Oxygen isotope values and temperatures derived in this study correspond to the meteorologic and hydrologic parameters of a mid-latitude maritime climate with low seasonality, a mean annual temperature of 23°C, and abundant precipitation. In a previous study of whole otoliths, it was suggested that fish were migrating to and from the restricted GEG lagoon. Indeed, micromilling of fish otoliths reveals an isotope record of an ecosystem rich in species of fish with distinctive behaviors. Several species originate in freshwater environments, migrating to marine water during ontogeny (anadromy) whereas other species emerge in marine waters to ultimately migrate into fresh water (catadromy) presumably for reproductive reasons. Micromilled mollusks provide details of isotope variability that record temperature and precipitation fluctuation throughout the year.

Estuarine water oxygen isotope values are calculated to range from  $-5$  to  $-2‰$ , VS-MOW, with the fresh water endmember estimated to be  $-6‰$ , VSMOW. This range is

similar to that observed in modern low-latitude fresh water dominated estuaries. Stable isotope values obtained in this study represent the most ancient quantitative fish life history stable isotope data including fish paleodiet, paleoecology, and migratory behavior to date.