Reconstruction of the trophic levels of a fossil fish community from the Late Jurassic Solnhofen Archipelago

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Trophic interactions of extinct fishes are central to our understanding of evolution, paleoecology and their role in the paleo-communities, but can be challenging, as these are limited by the incompleteness of the fossil record and by a lack of behavioural data. The extensive fossil record of Actinopterygii comes mostly from Conservation-Lagerstätten. They provide exceptionally rich information on fossil ecosystems and open outstanding windows into the evolution of life. The best-preserved Late Jurassic actinopterygians are known from the Solnhofen Archipelago, Germany. Despite that the diversity ichthyofauna of the Solnhofen Archipelago has been extensively explored in the last several decades, the dietary preferences of most fish remain unknown or have to be deduced by analogy from dentition and jaw morphology.

The aim of this study was to reconstruct the trophic levels of Late Jurassic fish assemblages using Sr/Ca and Ba/Ca measured from phosphatic fish remains, mostly ganoin and cycloid scales recovered from the Ettling locality, which is characterized by exceptionally well-preserved fossil fishes and moderate diagenetic alteration. We classified fish species into four trophic levels (durophagous, lower, middle, and higher trophic level) based on morphology available from the literature. Mean values of Sr, Ca, Ba and their ratios measured by Thermo Scientific iCAP Q inductively coupled plasma mass spectrometer in this study are in accordance with the mean values of previous studies. Differences in values between cleaned and uncleaned samples showed that the cleaning process successfully isolated primary dietary Sr content while dissolving away the diagenetic strontium present in carbonate in the pore spaces. All trophic levels showed low variation of Sr/Ca (0.003 - 0.008 μg/g) and high variation of Ba/Ca values (0.0003 - 0.0014 μg/g). The results showed significant differences between the middle and higher trophic levels (p = 0.03), while durophagous and lower trophic levels fell into the same range of values as the higher trophic level.

We demonstrate that enamel of fossil vertebrates from the Solnhofen Archipelago still contains near-in vivo Sr, Ba, and Ca. The clear distinction between middle and higher trophic levels offers a new functional perspective on the ecological and evolutionary relationships among fishes. However, future studies should not neglect the importance of diagenetic alteration of the samples; proper sample cleaning before measuring isotopic signatures, and careful selection of the
analyzed tissue (i.e. tooth enamel instead of scales or bones due to its resistance to diagenesis).

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