

Stable isotope analysis of Swiss freshwater fish from medieval and early modern sites

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Introduction

The evaluation of medieval and modern fish remains can provide evidence on freshwater fish stocks, the ecological condition of their habitats and anthropogenic influences on aquatic ecosystems (organic and inorganic pollution). Therefore, we measured carbon (C) and nitrogen (N) isotope ratios of 140 fish bones. 35 samples had suitable C (>13‰) and N (>4.5‰) content and produced results within the C:N ratio range of 2.9-3.6. For species identification we used classic archaeozoological analysis.

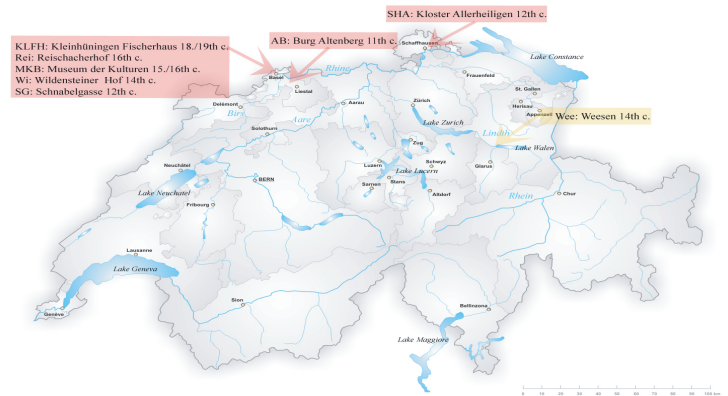


Fig. 1: Map of Switzerland. Samples with suitable C:N ratios and C/N content came from eight archaeological sites. Most possible provenance of the fishes: Lake Walen for Weesen samples (yellow) and Rhine area for all others (red).

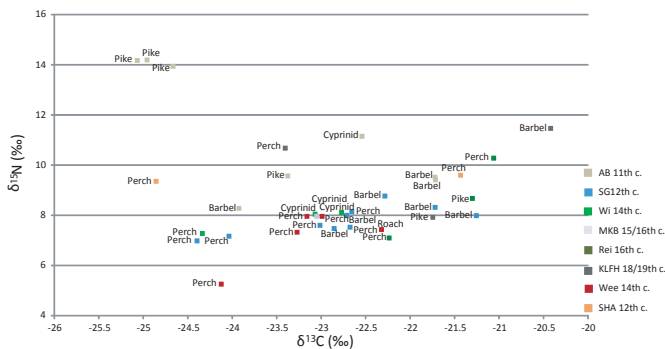


Fig. 2: C and N stable isotope ratio from fish samples (n = 35), classified by sites and century.

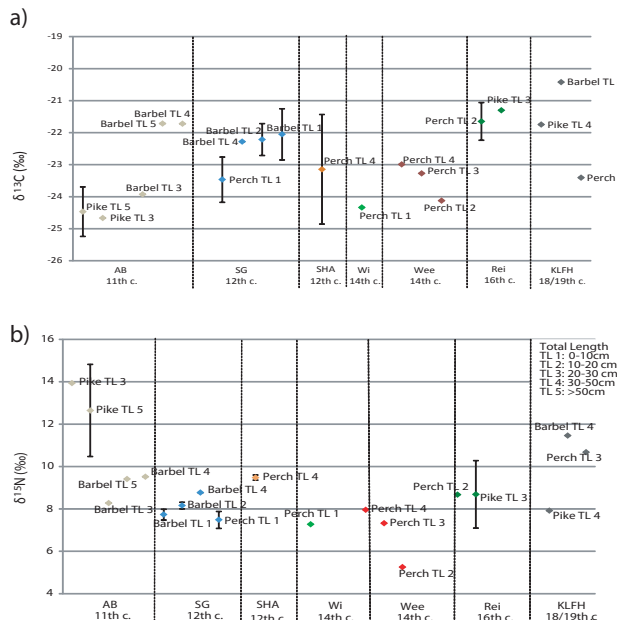


Fig. 3 a and b: Mean $\pm$ SD $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results of Pike, Barbel, Perch in relation to total length (TL), diachronically plotted by site.

References

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Results and Discussion

Feeding habits of fish...

As a top level carnivore, pike (*Esox lucius*) shows the most enriched $\delta^{15}\text{N}$ values (mean $\pm$ SD: $11.4 \pm 2.7\text{‰}$) and a high intra-species variability, which can be attributed to the broad spectrum of food and feeding grounds (Fuller *et al.* 2012). Although perch (*Perca fluviatilis*) is also a carnivore, the results revealed lower $\delta^{15}\text{N}$ signatures ($8.0 \pm 1.4\text{‰}$) and less intra-species variability, because most of the samples came from small, non-adult individuals, that fed on invertebrates. Adult barbels (*Barbus barbus*) show $\delta^{15}\text{N}$ values of $8.8 \pm 1.2\text{‰}$. They mostly feed on soil invertebrates and even plants.

...and their ecological context

So as to evaluate the potential of stable isotope analysis to reveal differences between watersystems, detect water pollution and even the provenance of fish, we would like to discuss a few samples' signatures.

The perch and the barbel from KLFH both show enriched $\delta^{15}\text{N}$ values compared to perches and barbels of same size from other sites. Does their isotopic signature provide information about pollution of the Rhine in these times?

Do the $\delta^{13}\text{C}$ -enriched values of the same barbel from KLFH (-20.4‰) tell that it might originate from different, brackish waters or do they indicate a special diet?

Pike and Barbel from AB differ from each other in their $\delta^{15}\text{N}$ values, indicating different feeding habits. Concerning the $\delta^{13}\text{C}$ values the species do not cluster; the grouping might also represent two water systems.

Outlook

Although the database is small, it allows a preliminary elucidation of the species' isotopic characteristics. Sulphur isotope analysis might have potential for answering the questions above, because sulphur can document the onset of pollution, particularly "industrial" activities in water (Van Neer *et al.* 2009) and detect the provenance of organisms (Nehlich *et al.* 2011).

The next step in this project is the analysis of a further 62 archaeological and 49 modern fish samples to achieve a larger and statistically significant database.