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Diversity in the internal functional feeding elements of Arctic charr, *Salvelinus alpinus*, morphs in Lake Thingvallavatn, Iceland

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Introduction

- Feeding behaviour and prey processing are among the main driving forces of evolution and adaptations and morphological adaptations of functional feeding elements have allowed many vertebrate groups to specialize on particular food types[1].
- Fishes are one of the most diverse groups of vertebrates[1,2]. The number of skeletal elements in their heads are far greater than that of other vertebrate skulls. This presents evolutionary opportunity and the skulls of fishes have undergone spectacular diversification into a number of ecological niches[1].
- The fish species Arctic charr, *Salvelinus alpinus*, shows extensive phenotypic variation throughout its distribution[3].
- In Lake Thingvallavatn, Iceland, there coexist four ecomorphs of Artic charr, *S.alpinus*: large benthivorous (LB) and small benthivorous (SB), planktivorous (PL) and piscivorous (PI) charr[3].
- These morphs are characterized by large differences in head shape and feeding morphology which relate to distinct feeding habits and habitat selection[3,4,5].
- It was hypothesized that the internal functional feeding elements also reflect morphological adaptations and one prior study[6] found evidence of differences in specific structures between the morphs.

Research questions

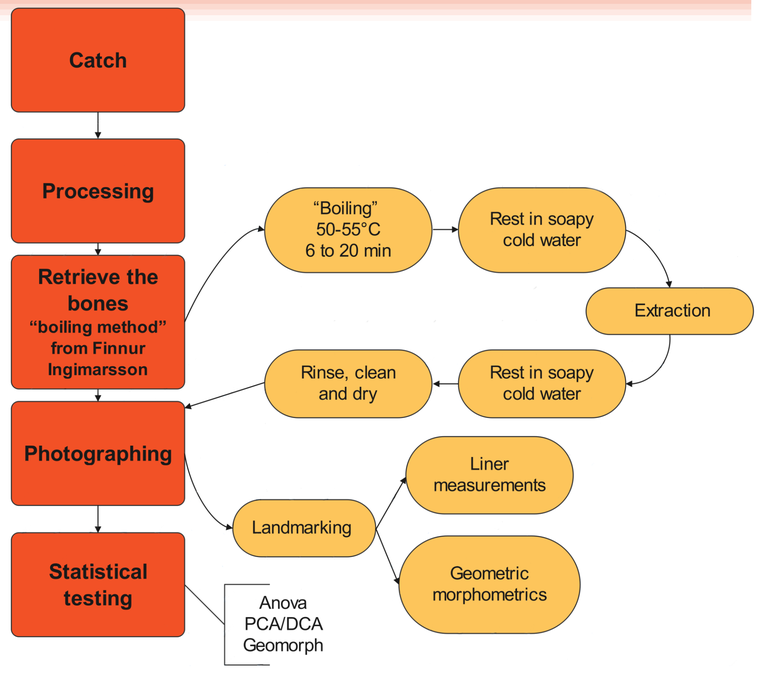
1. Do the functional feeding elements vary among the four adult sympatric Arctic charr (*Salvelinus alpinus*) morphs in Lake Thingvallavatn?
    1. Which specific structures vary, and which aspects of the elements differ?
    2. Which morphs are most alike, and which are most different?
    3. Does it correlate to the ecological divergence of Arctic charr?
2. How independent/integrated are traits in different bones/sections of the feeding apparatus?
    a) Which traits within/between bones are tightly correlated?
    b) Are some internal bone traits tightly correlated with certain features of external morphology?
3. Have some traits changed between 2000 and 2021?

Image 1: Photograph of lower jaw bones (Dentary, Articular-angular, Quadrat, Sympletic, Hyomandibular, Ceratohyal and Epihyal) from SB.

Image 2: Photograph of Parasphenoid, Supraethmoid, Glossohyal and Vomer from SB.

Methods

- In this project we are examining skeletal elements which could relate to feeding behaviour, prey processing and jaw movements.
- The lower jaw bones, image 1
- The upper jaw bones, image 5.
- The operculum, the gill cover, image 7.
- Glossohyal, a toothed bone in the tongue. Parasphenoid and vomer two bones in the palate and Supraethmoid, image 2



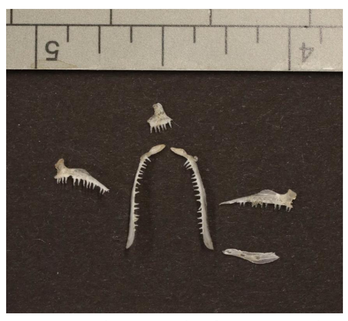


Image 5: Photograph of upper jaw bones (Maxilla, Premaxilla, Supramaxilla and Autopalatine), from SB.

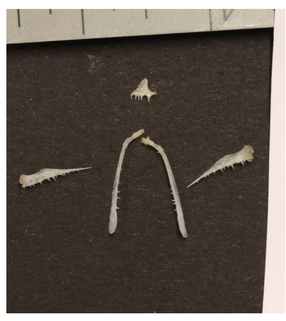


Image 6: Photograph of upper jaw bones from PL. Notice the differences in slop of maxilla teeth.

Image 7: Photograph of the operculum (Preopercular, Opercular, Interopercular and Subopercular) from SB.

Hypotheses and Preliminary Results

- Based on[6] results we hypotheses that the shape of the dentary and maxilla bones will be significantly different between the ecomorphs, image 3 and 4.
- Image 8 was made by reanalyzing data [6] and shows the covariation in linear distances in upper jaw bones.
- There is not much positive correlation between bone are even with bone. However, there is a negative correlation between the width of the maxilla bone and the length of the supramaxilla, image 8.

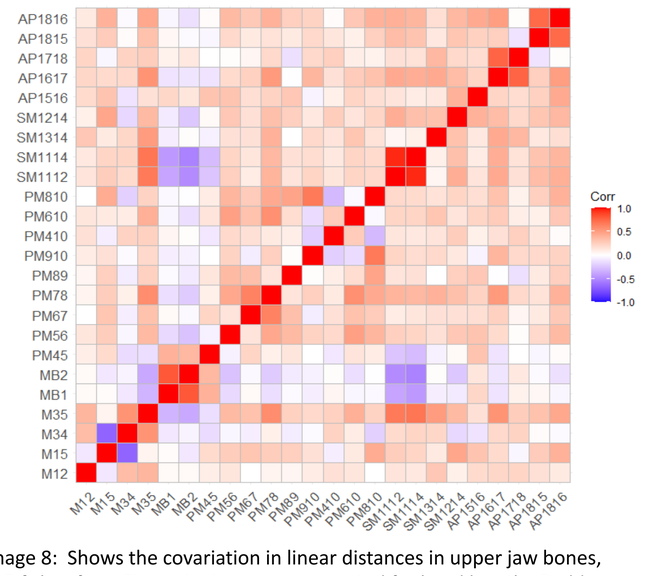


Image 8: Shows the covariation in linear distances in upper jaw bones, 125 fishes from Finnur Ingimarsson, corrected for head length, Redder colours show positive correlation however, blue colour show negative correlation. The abbreviations stand for liner measurements, between two numbered points in each bone, M(maxilla), MB(maxilla width), PM(premaxilla), SM(supramaxilla) and AP(autopalatine).

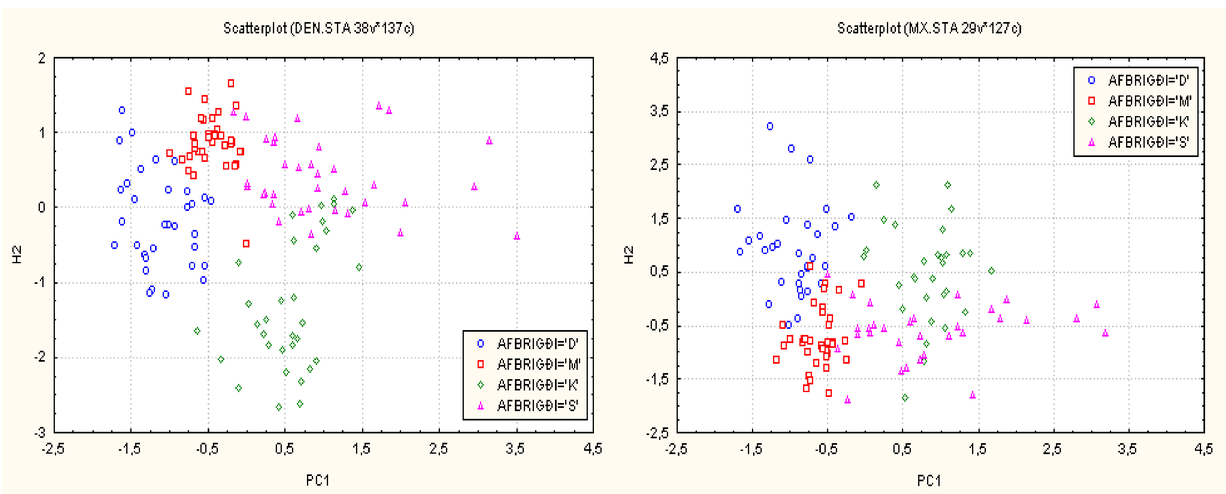


Image 3: Figures from Ingimarsson, 2002. PCA plot showing the differences in the dentary shape between the ecomorphs. The ecomorphs are shown in different colours, blue = SB, red = PL, green = LB and pink = PI.

Image 4: Figures from Ingimarsson, 2002. PCA plot showing the differences in the maxilla shape between the ecomorphs. The ecomorphs are shown in different colours, blue = SB, red = PL, green = LB and pink = PI

References Acknowledgements

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