Master thesis proposal

Testing how salinity habitat influences shape evolution in deep-time

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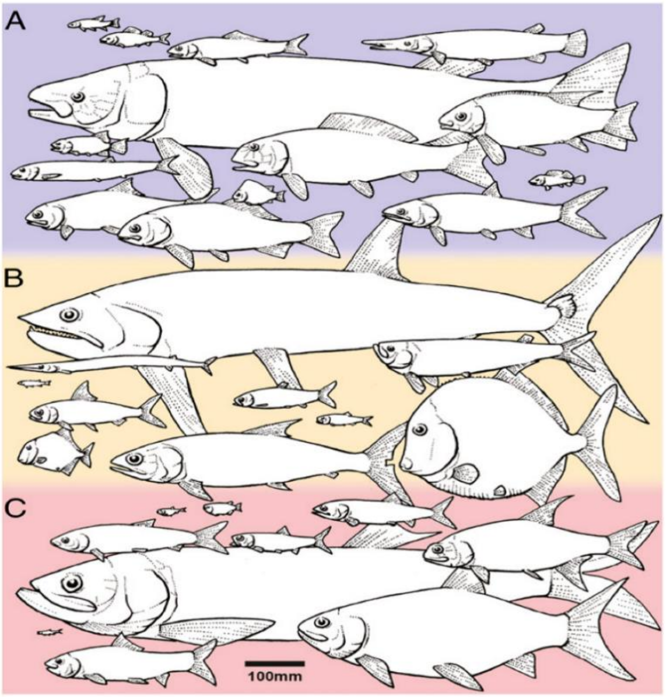
The vast, but poorly studied diversity of Mesozoic fishes will be your dataset for this work. These include **A**: the holostean fishes, highly diverse in the past, but known from only bowfin and gars today. **B**: fossil stem teleost fishes; and **C**: fossil crown teleost fishes.



Teleost fishes, with 32000+ extant species, represent half of vertebrate diversity. To compliment this species diversity, they also display a vast variety of body shapes and six orders of magnitude variation in body size.

It is plausible that their impressive biodiversity might be underpinned by the nature of the relationship between size and shape. For example, if the relationship between size and shape is strong, so that only very specific body shapes can be "unlocked" at specific sizes, this may restrict the variety of shapes a group of organisms can explore. Alternatively, a weak relationship between size and shape might allow species to easily adapt either to whatever selective forces are present in an environment, ultimately encouraging the evolution of a greater variety of sizes and shapes.

A study of 2939 Indo-Pacific reef fishes (Friedman et al. 2019) found that the relationship between size and shape in those fishes is indeed weak, and suggested this may have helped promoted phenotypic variety in reef fishes and teleost fishes more generally.

There were also two additional main findings from this study. The first was that rates of shape evolution tended to decrease with increasing body size, and the second was that, despite these lower rates, body shape variety tended to increase at larger body sizes. In the light of these findings, the central goal of this project is to reveal whether these findings can be replicated in an ancient radiation of fishes that lived between 250 and 100 million years ago, a dataset assembled by John Clarke, of which some taxa are visualised in the figure. This may illuminate whether fishes have actually become more, or less, adaptable over evolutionary time. The student could:

- repeat the analyses of Friedman et al. 2019 upon the size and shape dataset of fossil fishes, in an identical fashion, to enable results to be directly compared with previous study.

- repeat these analyses but with many modification changes to the methodology employed in the study. For example, there are many alternative methods to quantify rates of evolution (BAMM, BayesTraits, mvSLOUCH), and thus, it would be interesting to learn whether they do, or do not, report consistent results

- more deeply examine the relationship between size and shape evolution using OUOU and OUBM models within R package mvSLOUCH, developed in house by Krzysztof Bartoszek (Bartoszek et al. 2012). It is possible these relationships vary by clade, environment (reef vs. freshwater) and time period (Triassic, Jurassic, Cretaceous).

- examine how the relationships between size and shape vary by environment (e.g. open ocean, near shore, reef, brackish, and freshwater settings) and within different clades of fishes. It is possible that the focus on reef fishes in living fishes vastly skews our understanding of the relationship between size and shape.

Bartoszek K. (2012) A phylogenetic comparative method for studying multivariate adaptation. Journal of Theoretical Biology

Friedman et al. 2019. The influence of size on body shape diversification across Indo-Pacific shore fishes. Evolution.