Science and Technology Group
Annual Report FY2022

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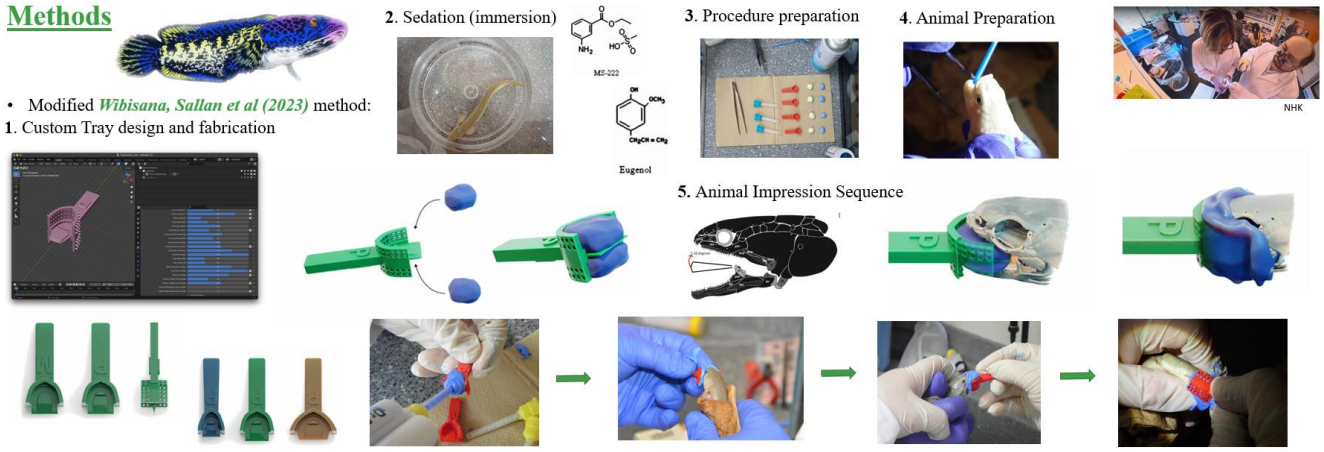
1 Introduction

To begin to understand the broader relationship between jaw and tooth morphological coevolution we must first begin to examine the environmental or conditional effects on both. Evolutionary adaptation and change is the culmination of traits evolved to respond to natural selection pressures and can shed a light into the mechanism of jaw and tooth coevolution. As a dentist and an odontologist I have been fascinated by tooth replacement in animals, a mechanism that is illustrated superbly in fishes. While tooth replacement or polyphyodonty is an important biological feature of nearly all species outside modern mammals and is thought to be the ancestral state for vertebrates, the cause and effect remains relatively unknown. Taking advantage of working with a macroevolution unit with a marine aspect, we started to investigate the relationship between tooth damage and tooth replacement.

2 Activities and Findings

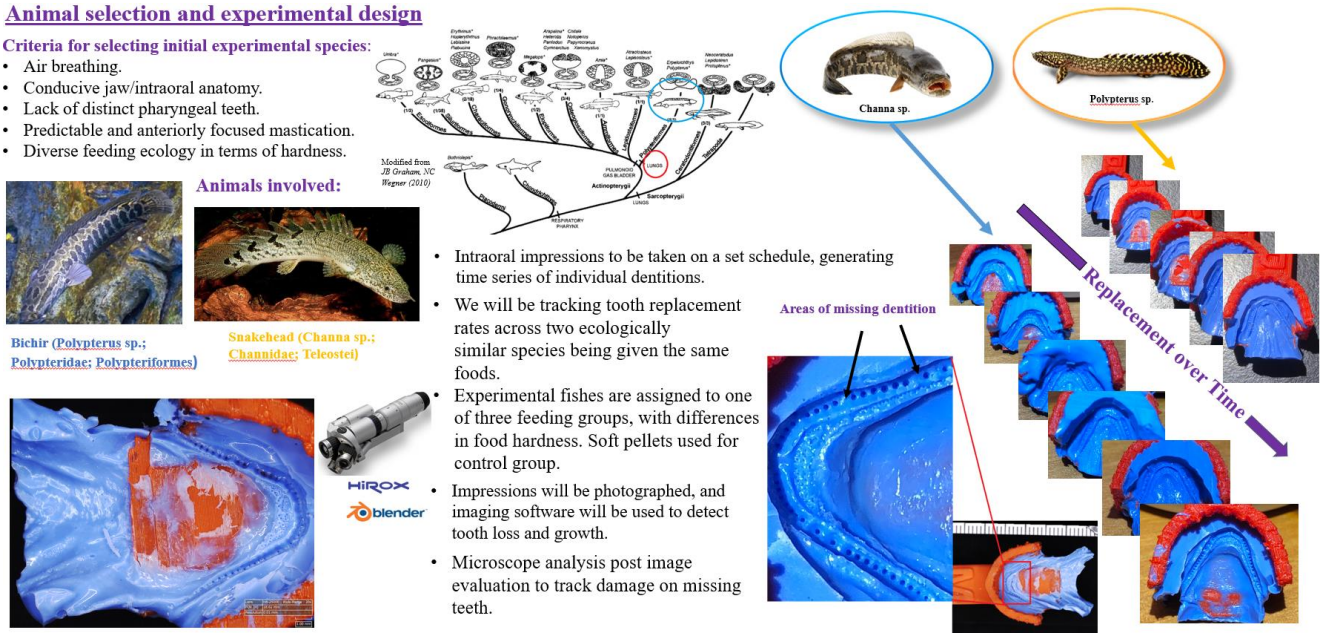
First, we started our research by developing a method to quantify tooth replacement rates. Unlike all previous studies, we decided to do this in vivo and keep the specimen alive. Which presented a challenge that we solved through applying modern human dentistry methods. Method outlined in *Wibisana, Sallan et al (2023)* is designed to maintain healthy fish while periodically collecting intraoral records.



Here, we aim to use our new method to test if there is 1) a relationship the between tooth loss and feeding ecology and/or tooth damage, or 2) a predetermined rate of tooth replacement across fishes or within species independent of feeding. We plan to use living Snakehead (Channa sp.; Channidae; Teleostei) and bichir (Polypterus sp.; Polypteridae; Polypteriformes), which are distantly related fishes (divergence ~360 million years ago; (12)) which are convergent in terms of feeding ecology, lifemode, and overall morphology. We will monitor tooth loss and replacement rates, as well as tooth damage, in individuals of these two species kept under identical feeding regimens involving foods of different hardness known to cause different degrees of damage in Polypterus (ongoing experiment).

Comparison of replacement and damage in specimens from species and feeding regimens will reveal whether: 1) replacement rate is a function of tooth damage, 2) tooth replacement occurs independent of feeding damage. Recorded rates of replacement will also be informative for understanding the evolution of this trait across fishes. If there is a difference between rate and/or the plasticity of rate in Channa or Polypterus, then this may be reflective of changes during the evolution of these two groups. If Polypterus and Channa show similar rates independent of feeding mode, then it may reflect a deep

characteristic of ray-finned fishes. Comparisons with published reconstructed (not observed) rates for other teleosts, and possible future observations with other fishes, will help select among these hypotheses.



3 Collaborations

- Sallan Unit, OIST (Prof. Lauren Sallan)
- Johannes N. Wibisana, OIST (Sallan unit rotation student, Currently Luscombe Unit)
- Pavel Puchenkov, OIST (Scientific Computing and Data Analysis Section)
- Tai Kubo (Former Sallan Unit Post doc, Currently at Waseda University)

4 Publications and other output

1- (Preprint) *Modification of clinical dental impression methods to obtain dental traits from living and whole non-mammalian vertebrates* Johannes N. Wibisana, **Ray A. Sallan**, Tai Kubo, Lauren Sallan
bioRxiv 2023.11.21.567763; doi: https://doi.org/10.1101/2023.11.21.567763

2- Poster Presentation, OIST STG annual meeting.
The relationship between feeding ecology and tooth replacement in bichir (Polypterus sp.) and snakehead (Channa sp.)
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