

# Speciation in pebble beaches

ÖAW

Exploring an interstitial fish radiation

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## Background

Mostly invisible to the human eye, miniaturised and characterized by a hidden lifestyle, “cryptobenthic” fishes are among the scientifically least studied groups of vertebrates on this planet. Denoted as the “hidden half”<sup>1</sup>, cryptobenthic fish diversity is thought to be considerably underestimated, even in generally well studied biomes like the Mediterranean Sea. This is especially true for the monotypic clingfish genus *Gouania*, a Mediterranean endemic, inhabiting the interstitial of intertidal gravel beaches. Indeed, only few species of vertebrates worldwide cope with the life-hostile conditions prevailing in this particular environment<sup>2</sup>. However, the results of my Bachelor and Master theses revealed that the genus harbours at least five (four more than originally thought) fairly distinct species that have been diversifying since millions of years<sup>3</sup>. Additionally, *Gouania* come in two morphotypes, “slender” and “stout”, that convergently evolved in the Eastern Mediterranean and the Adriatic Sea. This independent evolution of morphology likely mirrors the adaptation to certain microhabitats which was shaped by different selective pressures acting in these environments. Using cutting edge technology (such as high quality genomic data), but also more classical approaches, I aim to illuminate this enigmatic system from different methodological angles in the course of my 3-year funded ÖAW DOC fellowship project (see right & below).



The major goal of this PhD-project is to investigate the underlying **taxonomic**, **evolutionary** as well as **bio- and ecological** factors that help to explain the radiation of the Mediterranean intertidal cryptobenthic fish genus *Gouania*.

- Top Left:** VGP VERTEBRATE GENOMES PROJECT. A PROJECT OF THE G10K CONSORTIUM. Image of a magnifying glass over a DNA sequence.
- Top Middle:** Two photographs of slender Gouania fish.
- Top Right:** Anatomical diagrams of G. willdenowi (Risso 1810) showing internal organs and skeletal structure.
- Middle Left:** Text: Investigating microevolutionary and biogeographical patterns involved in the diversification process. whole genome resequencing, population genomics.
- Middle Right:** Text: Finding the basis of morphological convergence and adaptations to the intertidal lifestyle. niche partitioning studies, behavioural experiments, Transcriptomics.
- Bottom Left:** Text: Exploring the recently produced *Gouania* Reference-Genome<sup>4</sup>. comparative genomics, phylogenomics.
- Bottom Middle:** Text: Conducting a taxonomic revision and a comprehensive diversity screening. DNA Barcoding, morphological investigations.
- Bottom Right:** Text: Understanding population connectivity and the role of life history and oceanic properties. Oceanographic modelling and biological observations.
- Bottom Center:** A phylogenetic tree showing relationships between populations from the Adriatic, EastMed\*(Crete), and EastMed\*(Altica) regions.
- Bottom Right (Image):** A photograph of a stout Gouania fish.
- Bottom Far Right:** Two photographs of slender Gouania fish.

## References

- <sup>1</sup>Brandl, S. J. et al. (2018). The hidden half: ecology and evolution of cryptobenthic fishes on coral reefs. *Biological Reviews*, 93(4), 1846-1873.  
<sup>2</sup>Yamada, T. et al. (2009). Adaptive radiation of gobies in the interstitial habitats of gravel beaches accompanied by body elongation and excessive vertebral segmentation. *BMC Evolutionary Biology*, 9(1), 1-14.  
<sup>3</sup>Wagner, M. et al. (2019). Diversification in gravel beaches: a radiation of interstitial clingfish (*Gouania*, *Gobiesocidae*) in the Mediterranean Sea. *Molecular Phylogenetics and Evolution*, 139, 106525.  
<sup>4</sup>Rhie, Arang, et al. "Towards complete and error-free genome assemblies of all vertebrate species." *bioRxiv* (2020).

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