EARTHSCIENCES

Integrating living species and the fossil record to unravel cnidarian evolution

Primary supervisor:	Luke Parry (Earth Sciences Department, Oxford University)
Co supervisor(s):	Frances S. Dunn (OUMNH)
Key words:	Cnidaria, palaeontology, paleontology, invertebrates, phylogenetics, molecular clock
Research theme(s):	• Palaeobiology and Evolution
Eligible courses for this project:	• DPhil in Earth Sciences • Environmental Research (NERC DTP) • Interdisciplinary Bioscience (BBSRC DTP)

Overview

Cnidarians are a familiar animal group that encompasses jellyfish (Medusozoa) and corals and anemones (Anthozoa). They are an ancient group and have colonised the pelagic, benthic and freshwater realms since their first appearance more than half a billion years ago. They are globally significant, with coral reefs acting as biodiversity hotspots and jellyfish blooms becoming an increasingly pervasive product of anthropogenic impacts on marine ecosystems.

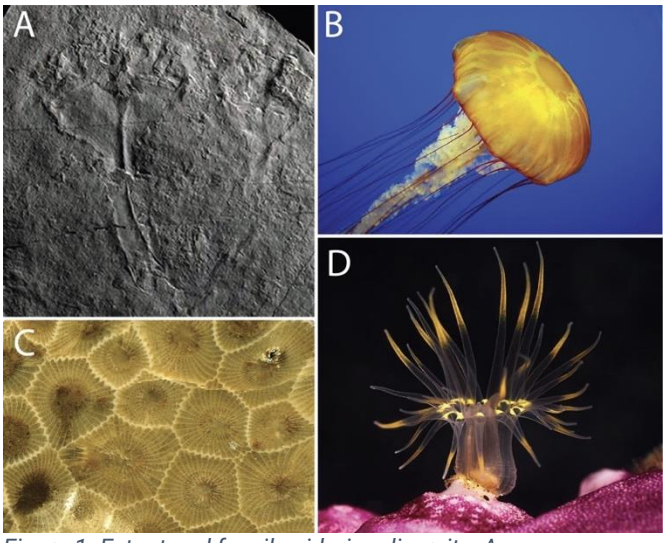

Figure 1- Extant and fossil cnidarian diversity. A – Auroralumina attenboroughii from the Ediacaran of the UK. B – the jellyfish Chrysaora fuscescens. C – a colonial rugose coral, Hexagonaria percarinata. D – a sea anemone (images C-D from Wikimedia commons under CC 2.0 licenses. Authors - Dan90266, Christian Gloor, James St. John.

While some cnidarians, such as biomineralised corals, have an extremely dense fossil record, most cnidarians are soft bodied and as a consequence we know very little about when many groups and their corresponding phenotypic and ecological novelties emerged. Even for groups with good fossil records (e.g. rugose and tabulate corals and the extinct conulariids) their positions in the cnidarian tree of life are uncertain, limiting the extent to which they can be used to understand major events in cnidarian evolution. We know very little about the timescale of cnidarian evolution, how different groups have waxed and waned through time and how cnidarian groups have responded to changing environmental conditions (e.g. through repeated evolution of a biomineralised skeleton).

While cnidarian fossils preserving soft tissues are extremely rare, a diversity of examples are known from the early fossil record (i.e. Ediacaran and Cambrian Periods) shedding light on

the body plans of early medusozoans, in particular. However, there are competing phylogenetic interpretations of many of these, which obscures their true significance for understanding cnidarian origins. Nevertheless, the phylogeny of extant cnidarians is increasingly well resolved from molecular data but these key insights from living species have seen little integration from the fossil record.

In this project, the student would study significant fossil material housed in museum collections both within the UK and internationally to produce a new, holistic, morphological phylogenetic dataset of the Cnidaria, allowing a robust estimate of the affinities of fossil groups/species. The student will then integrate this morphological data with the ever-increasing volume of next generation sequence data now available for living cnidarians to estimate the timescale of cnidarian evolution using cutting edge total evidence and node dating methods. Using time calibrated phylogenetic trees, we will be able to assess how these iconic organisms have responded to major events in Earth History for the first time.

Methodology

The student will study the morphology of fossil cnidarians using a variety of non-destructive imaging techniques, including macrophotography, photogrammetry and computed tomography. The student will visit museums nationally and internationally. This novel morphological information will be used, alongside existing morphological and genetic data from other cnidarian taxa, to perform phylogenetic analyses to assess the interrelationships of fossil groups and perform molecular clock analyses to assess the timescale of cnidarian evolution.

Timeline

Year 1: Doctoral training courses (10 weeks), literature review, museum visits and specimen data collection

Years 2 and 3: Museum visits and specimen data collection, phylogenetic analyses and molecular clock analyses.

Year 4: Final analyses, thesis and paper completion, conference presentations.

Training & Skills

Your supervisors will offer expertise in comparative morphology, animal phylogeny, non-destructive imagine and 3D morphology reconstruction. Additionally, your supervisors will provide expertise in phylogenetic and molecular clock analyses. Throughout the project you will learn to work with museum collections and will have the opportunity to visit domestic and international museums.

References & Further Reading

Jerre, F., 1994. Anatomy and phylogenetic significance of *Eoconularia loculata*, a conulariid from the Silurian of Gotland. *Lethaia*, *27*(2), pp.97-109.

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lineages and insights on the origins of key organismal traits. *BMC evolutionary biology*, *18*, pp.1-18.

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Further Information

Contact: Luke.parry@earth.ox.ac.uk