PROJECT TITLE: **The evolutionary origin of teeth**
DTP Research Theme(s): Dynamic Earth, Living World, Changing Planet
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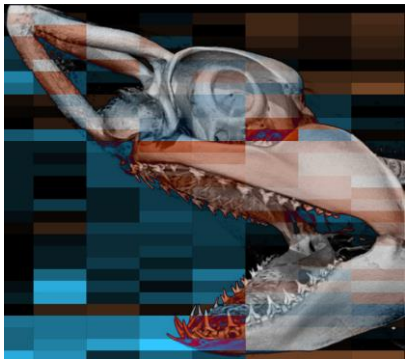
Project keywords: (evolution, teeth, skeleton, development, vertebrate, palaeobiology, biomechanics, transcriptomics)

Errivaspis, a heterostracan, is among the first of the ostracoderms with tooth-like structures, but are they teeth and what function did they perform in these jawless vertebrates?



Tooth development in sharks and boney fishes will provide the basis for interpreting the homology of cyclostome teeth

Project Background

Teeth constitute at once a key innovation that underpinned the evolutionary and ecological diversification of jawed vertebrates – and a model system for understanding the general principles of organ development – so why do we know so little of their evolutionary origin? The earliest jawed vertebrates already bore a toothy grin and so we must look to their jawless relatives for the answer. A number of lineages of extinct jawless vertebrates possessed toothlike structures but almost nothing is known of their composition, development and function. Living jawless vertebrates also possess poorly mineralised toothlets but nothing is known of their developmental genetics. This project will elucidate the evolutionary origin of teeth through synchrotron and computed tomography of living and fossil jawless vertebrate teeth and tooth-like structures, computed fluid dynamic and finite element analysis of their function, and comparative transcriptomics of the teeth of living jawed and jawless relatives.

Project Aims and Methods

This project aims to elucidate the evolutionary origin of teeth in two different but entirely complementary ways: (i) through analysis of the structure, development and function of toothlike structures in fossil jawless vertebrates, and (ii) comparative analysis of gene expression in the teeth of living jawless and jawed vertebrates. Combining both approaches will provide not only an integrative insight into the evolutionary origin of teeth, but will also serve as a fantastic means of obtaining an interdisciplinary training at the interface of the Earth and Life Sciences. Nevertheless, we would still be delighted to hear form candidates who might prefer to focus on just the palaeobiological or transcriptomic dimensions of the proposed project.

(i) New light shed on old bones: You will use synchrotron and computed tomography to elucidate the developmental biology of teeth and toothlike structures in fossil vertebrates – for comparison to tooth and skeletal development in living vertebrates. The resulting computer models will also serve as the basis for computed fluid dynamic and finite element analyses, to test hypotheses of their function of these tooth-like structures, which range from assisting filter or deposit feeding, to herbivory and predation//.

(ii) Molecular insights into toothy origins: In addition to studying tooth development in living jawless vertebrates using synchrotron and computed tomography, you will undertake a transcriptomic analysis of replacement teeth, focussing especially on genes that are implicated in tooth development in living vertebrates. There remains scope to extend this work into expression analysis, to suit the interests of the student.

Candidate Requirements

You will have a good degree in Earth Science, Palaeobiology, Zoology, Biological Sciences, Genetics, or a related degree. A PhD is a training vehicle and so we do not anticipate that any candidate will have the full range of skills and knowledge required – this will be provided by the supervision team.

CASE or Collaborative Partner

Zerina Johanson is a world expert in vertebrate skeletal and dental evolution. The Natural History Museum houses an unparalleled collection of fossil jawless and primitive jawed vertebrates.

Training

In addition to the general training in research skills provided by the GW4+ PhD programme, you will be provided with bespoke training in comparative histology and palaeohistology, synchrotron and computed tomography, computed fluid dynamics and finite element analysis, as well as the bioinformatic skills required for comparative transcriptomics and analysis of gene evolution.

References / Background reading list

Donoghue PCJ, Ruecklin M. 2016. The ins and outs of the evolutionary origin of teeth. Evolution & Development 18:19-30.

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Martin KJ, Rasch LJ, Cooper RL, Metscher BD, Johanson Z, Fraser GJ. 2016. Sox2+ progenitors in sharks link taste development with the evolution of regenerative teeth from denticles. Proc Natl Acad Sci U S A 113:14769-14774.

Rücklin M, Donoghue PC, Johanson Z, Trinajstic K, Marone F, Stampanoni M. 2012. Development of teeth and jaws in the earliest jawed vertebrates. Nature 491:748-751.

Links:

School URL – http://www.bristol.ac.uk/earthsciences/courses/postgraduate/

NERC GW4+ DTP Website:

For more information about the NERC GW4+ DTP, please visit http://nercgw4plus.ac.uk/

Bristol NERC GW4+ DTP Prospectus:

http://www.bristol.ac.uk/study/postgraduate/2020/doctoral/phd-great-western-four-dtp/

How to apply to the University of Bristol:

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The application deadline is 1600 hours GMT Monday 6 January 2020 and interviews will take place between 10 and 21 February 2020

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