**PROJECT TITLE:** How do vertebrate jaws work in living and extinct animals?

**University of Bristol Research Theme(s):** Climate/Environment, Digital/Data,

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**Project keywords:** jaw, feeding, biomechanics, evolution

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**Figure 1.** Jaw shape has been used to infer diet and ecology of extinct taxa (figure from Anderson et al. 2013).

**Figure 2.** Musculoskeletal model of a monitor lizard.

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**Project Background:**
Jaws, skulls and teeth are some of the defining traits of vertebrates. Nearly all living vertebrates possess a jaw, and its evolution was a key event in vertebrate history. The jaw and associated structures are responsible for capturing, securing and processing foodstuffs, meeting the energy requirements the animal needs to sustain itself. As such, we expect the jaw to be subject to selection to maintain and refine feeding behaviour, and jaw shape to reflect to some extant functional and mechanical demands associated with feeding. Jaw morphology has been therefore extensively used to infer diet and ecology of fossils, but many of these studies focuses on the skeletal tissues only. Yet, some studies on living animals have shown only a weak relationship between jaw shape, diet and feeding behaviour. Jaw functional traits such as mechanical advantage and jaw stress do relate to feeding behaviour but often only for certain clades or dietary categories. Moreover, the muscles, tendons and bones that comprise the jaws bear a close relationship to feeding behaviour and diet, but are not preserved in fossils. Muscles are hence either not included or greatly simplified when analysing fossil jaws. As such, a critical link between jaw shape and how it functions is omitted from consideration. This has implications for how we interpret form from function in the fossil record, especially across major transitions – the fish-tetrapod transition being a good example. Our preliminary studies suggest that species across fish, amphibians and lizards share similar jaw shapes while showing a great variation in muscle mass and structure. However, further understanding requires more detailed data on the musculoskeletal function and jaw mechanics among these living animals. In addition, studies on fossils spanning the fish-tetrapod transition have so far relied on 2D analyses to investigate jaw function. The development of detailed 3D, physiologically realistic biomechanical models in living analogue species is therefore critical to assess the accuracy and refine these palaeontological studies.
**Project Aims and Methods:**
The aim of this project is to establish (A) how jaws work in a sample of living animals ranging from fish (e.g. Amia, Polypterus, Latimeria) to amphibians, and amniotes; and (B) the relationship between the musculoskeletal system and diet, habitat and feeding behaviour, and then (C) apply this knowledge to fossils across the water to land transition to infer feeding function and behaviour. This will be achieved via collection and analysis of multiple datasets such as experimental bite force analysis, high-speed video capture, dissection, μCT scanning of fossils and living taxa, 3D digital reconstruction and computational modelling of function including multibody dynamics analysis (MDA) and finite element modelling (FEA). The project will involve the collation and analysis of large-scale digital datasets.

**Candidate requirements:**
The project will suit a student with a background in biology/zooology, palaeontology or geology interested in pursuing further study in vertebrate morphology, biomechanics and palaeontology. Ideally the student should feel comfortable working with specimens in a lab and working with digital datasets and computational functional analysis, yet prior experience is not required as full training will be provided.

**Project partners (if any):**

**Training:**
Training will be provided in experimental analysis, vertebrate comparative osteology and myology, evolutionary developmental biology, μCT-scanning, finite element and multibody dynamics analyses, and evolutionary comparative analyses.

**Background reading and references:**
Anderson PSL et al. 2013. Late to the table: diversification of tetrapod mandibular biomechanics lagged behind the evolution of terrestriality. *Integrative and Comparative Biology* 53: 197–208.
Ross CF & Iriarte-Diaz J. 2014. What does feeding system morphology tell us about feeding? *Evolutionary Anthropology* 23: 105-120. [Ask the same question as this project]

**Useful links**
http://www.bristol.ac.uk/earthsciences/courses/postgraduate/
**How to apply to the University of Bristol:**
http://www.bristol.ac.uk/study/postgraduate/apply/

The application deadline is Thursday 12th of January, 2023 at 2359 GMT. Interviews will take place in mid-February 2023.

**General Enquiries:**
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