2022_53_DoLS_Brazeau: Deep vertebrate phylogeny and the origins of vertebrate reproductive modes: new insights from exceptionally preserved fossils

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Vertebrates represent over 65,000 living species with a stunning range of body forms and lifestyles. They have diverse reproductive modes broadly classified as either internal or external fertilisation. It is widely believed that external fertilisation (eggs laid outside the body and fertilised by releasing sperm into the environment) is the primitive mode of reproduction in vertebrates. Transitions to internal fertilisation (fertilisation of eggs within the mother through copulation) and associated strategies like live-bearing (viviparity) are considered evolutionarily derived states. It is unknown whether transitions from internal to external fertilisation have taken place in vertebrates. However, recent stunning fossil evidence of placoderms—armoured fishes from the Devonian period (420 to 360 million years ago)—suggests vertebrates underwent such a reversal, possibly including a reversal in viviparity to oviparity. The purpose of this project is to investigate a series of exceptionally preserved early placoderm fossils and use quantitative phylogenetic tools to re-investigate early gnathostome phylogeny and test this question.

To address this problem, the candidate will investigate articulated fossils of rhenanid placoderms using digital imaging techniques, like radiography and computed tomography (CT). Rhenanids help fill a crucial gap in internal fertilisation origins and jawed vertebrate origins generally. Despite being known from articulated specimens, they are poorly characterised, and their relationships are poorly established. However, rhenanids are known from fossils complete from snout to tip of tail. They reveal morphological details of the front and hind fins—which can be used to assess the timing and origin of internal fertilisation structures (i.e. pelvic claspers). The candidate will investigate three rhenanid taxa, including specimens completely new to science. The candidate will then use sophisticated phylogenetic techniques to refine early jawed vertebrate phylogeny and interrogate the evolutionary origins of morphologies associated with internal fertilisation. The candidate will be based at Imperial College, Silwood Park and will have access to facilities and support in the Department of Earth Sciences, Natural History Museum (macrophotography, radiography). CT-scanning will be performed at Core Research Labs, NHM. 3D volume rendering and visualisation will be performed at Imperial and the NHM, using the programs Avizo 9.0 and/or Materialise Mimics. A full range of digital rendering tools, photography equipment and examination space will be provided by the co-supervisors.

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