

**Project title:** The completeness of the tetrapod fossil record

**Institution:** University of Birmingham

**Dept/School/Faculty:** School of Geography, Earth & Environmental Sciences

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**Co-supervisors:** Professor Paul Upchurch (University College London)  
Dr Philip Mannion (Imperial College London)

**Application Deadline:** Friday 23<sup>rd</sup> January 2015

**Funding:** Funded PhD Project (Students Worldwide)

### **Project description**

How complete is the fossil record? This question is one of the most fundamental posed by palaeontologists. Its answers have major ramifications for our understanding of deep time evolution, biogeography, ecology and diversity.

New approaches to estimating fossil record completeness have recently been developed (Mannion & Upchurch 2010), and applied to tetrapods (four-limbed vertebrates). For a given taxonomic group, these 'completeness metrics' estimate the proportion of the skeleton of each individual species that is known, and changes in skeletal completeness are then typically plotted against geological time. These approaches open up the possibility of assessing whether apparent peaks and troughs in species richness represent real biodiversity change, or reflect only changes in the quality of fossil material available for palaeontologists to study.

Completeness metrics have been investigated for a rapidly growing number of tetrapod clades, including dinosaurs, pterosaurs, birds, parareptiles, and synapsids, with ongoing work focusing on a number of other Palaeozoic and Mesozoic groups. So far, however, all studies have been focused on individual clades with limited ability to draw wider conclusions about the tetrapod fossil record. Moreover, nearly all clades studied to date are terrestrial.

This project will address these major gaps by drawing together for the first time published and novel completeness metric datasets for numerous groups of tetrapods spanning the entire Phanerozoic and the full diversity of body sizes, ecological strategies, and habitat preferences (including marine taxa). Statistical analysis of these datasets will be used to address a series of key questions, including: (1) Is the marine tetrapod fossil record more complete than the terrestrial record? (2) Are similar patterns of completeness shared by major clades with similar ecological categories, habitat preferences, and/or body sizes? (3) Are changes in completeness correlated with major changes and shifts in global tetrapod diversity, including evolutionary radiations and mass extinctions? (4) How do changes in completeness correlate with broader estimates of fossil record sampling through time and space?

The student will initially carry out a comprehensive literature review to extract and compile existing completeness datasets. Subsequently, new completeness estimates will be generated for a broad range of Palaeozoic–Cenozoic clades, from both terrestrial and marine environments. These estimates will primarily utilise the ‘character completeness metric’ (CCM). A diverse range of statistical approaches will be applied to the resulting datasets in order to answer the project’s key questions.

This project is funded as part of a broader European Research Council (ERC) Starting Grant on Phanerozoic terrestrial tetrapod diversification. The studentship is fully funded for four years, with a research and training grant to support training, conference attendance, and computer hardware/software. Funding is potentially available to UK, EU and international candidates. The student will join a dynamic palaeobiological research group at the University of Birmingham including additional ERC-funded postdoctoral and PhD researchers. Additional supervision and support will be provided by co-supervisors at Imperial College (Mannion) and UCL (Upchurch).

### **Training and skills**

The student will receive a broad training in quantitative approaches to palaeobiology, including use of the software R. Training will also be provided in tetrapod anatomy and systematics, stratigraphy, use of the *Paleobiology Database*, the presentation and publication of scientific results, and public outreach. This training will be designed to prepare the student for a career in palaeobiological research at a university or museum.

The successful candidate will have a strong background in a relevant subject such as geology, palaeobiology, zoology, biology, or ecology. Demonstrable strong quantitative skills will be highly beneficial, as will experience in programming and use of relevant software.

### **Additional reading**

- Brocklehurst N et al. 2012. The completeness of the fossil record of Mesozoic birds: implications for early avian evolution. *PLoS ONE* 7(6):e39056.
- Brocklehurst N, Fröbisch J. 2014. Current and historical perspectives on the completeness of the fossil record of pelycosaurian-grade synapsids. *Palaeogeography, Palaeoclimatology, Palaeoecology* 399:114–126.
- Mannion PD, Upchurch P. 2010. Completeness metrics and the quality of the sauropodomorph fossil record through geological and historical time. *Paleobiology* 36:283–302.
- Walther M, Fröbisch J. 2013. The quality of the fossil record of anomodonts (Synapsida, Therapsida). *Comptes Rendus Palevol* 12:495–504.