The discovery of a rare neonate *Ichthyosaurus communis* skeleton at the Lapworth Museum of Geology and the research to determine its lost provenance.

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Introduction

In 2016 a practically complete ichthyosaur skeleton (no.BU5289) in the collection of the Lapworth Museum of Geology (University of Birmingham) was conserved and cleaned for display (Fig 1). The careful removal of a thin film of matrix from the surface of the 630 mm long skeleton (using compressed air and sodium bicarbonate powder delivered with a Swamblaster airabrasive unit) revealed the specimen in more detail than before. This meant that the skeleton could be definitively identified. It has been assigned to *Ichthyosaurus communis* based on the morphologies of the hindfin, pelvis and skull.

Neonate features

The cleaning of the bones revealed that much of the skeleton, especially the humerus, vertebrae and phalanges of the fore and hind fins, exhibits a spongious-like cartilaginous texture which suggests that the elements were not fully ossified at the time of death. The small size of the specimen together with the poor ossification indicates that the skeleton is that of a neonate.

This is of note as relatively few neonate skeletons of *Ichthyosaurus* are known, although embryos have been described. Particularly, this is the first definitive neonate example of *Ichthyosaurus communis* reported. This will aid in the study of the developmental growth of the species, comparing this neonate with more ontogenetically mature specimens.

Fig 1. The cleaned and conserved neonate *Ichthyosaurus communis* skeleton

Fig 2. The poorly ossified femur of the hind limb.

Fig 3. Phalanges of the forelimb

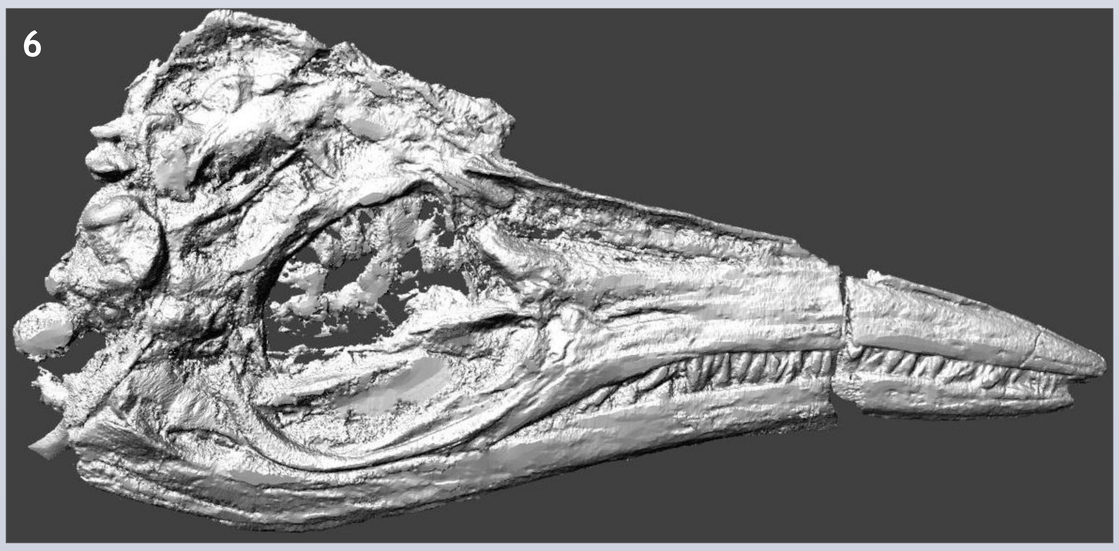
Fig 4. Phalanges of the forelimb

Fig 5. The ‘porous’ nature of the vertebrae (each about 10 mm diameter).

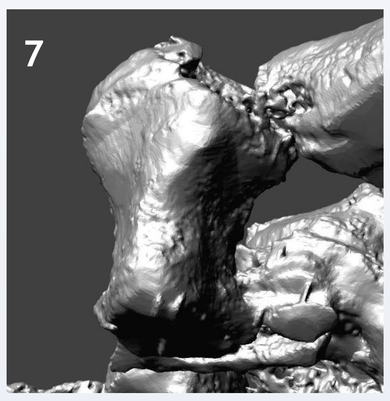
The sclerotic ring is well-preserved and complete (Fig 1). It fills the orbit entirely, which is a feature that has been used to separate juvenile examples from more mature individuals (Fernandez et al. 2005).

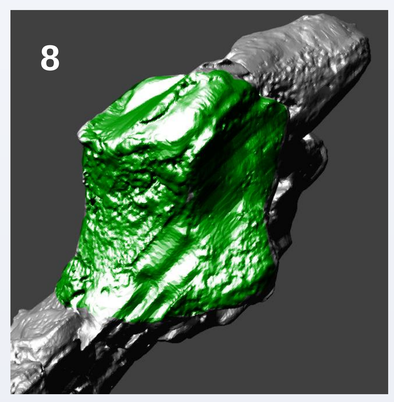
MicroCT scanning the specimen

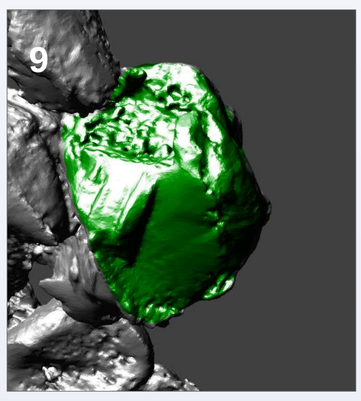
The specimen was MicroCT scanned to aid analysis of the very small bones, some of which were partially embedded in matrix. The scanner used in the Department of Zoology at the University of Cambridge was a Nikon XTH 225 MicroCT Scanner, with the following settings: X-ray power 165 kV; 160 uA; Filtration 0.5mm copper; Resolution 125um; Projections 1080. Particular attention was paid to the skull and limb bones as these are the most useful diagnostically and they displayed clear neonate characteristics.



6. MicroCT scan of the skull.







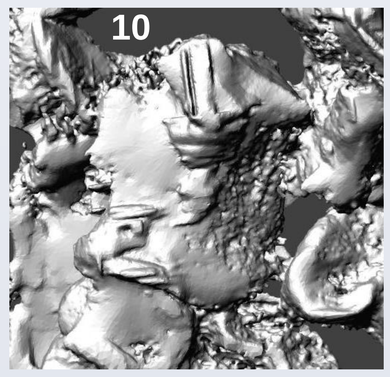
7. Right humerus, which is partially embedded in matrix, positioned in anterior view – dorsal surface to the left and ventral surface to the right.

8. Right humerus, dorsal view. Note the approximately central dorsal process. Green highlight is the entire humerus.

9. Right humerus, proximal view. Dorsal to the right, ventral to the left. Green indicates proximal portion of humerus.

10. Left humerus, which is buried in the matrix, positioned in dorsal view, anterior to the left.

The element appears to be incomplete but this is probably due to the poor resolution of the data.



Only a small portion of the presumably right forefin is exposed in this specimen. Although the unusual ossification morphology is of interest, it is not possible to examine the humeri, of which one (the right) is partially exposed and the other buried, or much of the proximal fin. However, the microCT scan has revealed the entire right humerus, the left humerus (which was previously untraceable as it is buried beneath the coracoids) and the articulation of the left humerus with some of the fin. This has enabled the positive identification of the two humeri, their orientation and morphology.

Determining the provenance and age of the specimen

Unfortunately, this specimen lacked any original provenance information. However, during the conservation project a small (12g) sample of the matrix was taken from the rear of the specimen to be analysed for microfossils. This sample was disaggregated in ~1% solution of H2O2 for 30 mins, rinsed, dried and sorted under a binocular microscope. The analysis of the sample revealed good calcareous microfossils and the following taxa were identified:

FORAMINIFERA
Marginulina prima incisa
Astacolus speciosus
Paralingulina tenera tenera
Mesodentalina matutina
Ichthyolaria sulcata ssp.'B'
Dentalina pseudocommunis
Lenticulina sp.

OSTRACODA
Monoceratina frentzeni
Ogmoconcha hagenowi
Polycope sp.
Ogmoconchella aspinata
Paracypris sp.

The above suite of taxa is known to occur at the Lower Lias site at Hock Cliff, Gloucestershire from which *Ichthyosaurus* remains are known (Benton & Spencer, 1995) so this is one possible source of the specimen. Occurrence of particular taxa indicates the age of JF3 Foraminifera Zone (after Copestake & Johnson, 2014) spanning a range from the base of the *Complanata-Depressa* Ammonite Subchronozone to top of *Conybeari* Ammonite Subchronozone (the very latest Hettangian to very early Sinemurian).

Conclusions

This ichthyosaur skeleton is the only known definitive example of a neonate *Ichthyosaurus communis*. Microfossil analysis of the matrix strongly provides a very late Hettangian to very early Sinemurian age and a possible site provenance of Hock Cliff, Gloucestershire, a location that is not particularly well-documented for the occurrence of this genus. Through further study of this specimen it will enable a detailed examination of the ontogenetic development of *I. communis* which shall provide further information regarding the diagnostic features of this species. This project demonstrates the usefulness of conservation to research and highlights the use of microfossil analyses to provide an age and possible source site for the many marine reptile specimens in museum collections that currently lack a provenance, thereby greatly increasing their research potential.

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