The discovery in a museum collection of the largest known skeleton of *Ichthyosaurus* in the world and its redisplay, including 3D-printing missing bones.

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Introduction

In 1955 a relatively complete ichthyosaur skeleton was discovered when digging drainage ditches in Lower Jurassic deposits on a farm in Shipston-on-Stour, Warwickshire. Unusually for Lower Jurassic specimens the skull bones largely retained their three dimensional integrity and the 80 cm-long skull was mounted for display at Birmingham Museum & Art Gallery (Fig 1). A recent conservation project for Birmingham’s Thinktank Science Museum to dismantle the skull and rebuild it more accurately involved micro-CT scanning skull elements, mirroring the data and printing 3D models to replace carved pieces of wood that previously represented missing elements on one side of the skull. This process digitally recorded the skull bones for future research before replacing them within the skull.

Whilst investigating the history of the specimen and looking for missing pieces of the skull, the postcranial material - which was separated from the skull a long time ago - was rediscovered. The morphologies of the skull, humerus, femur and pectoral girdle demonstrate that this individual is an example of the genus *Ichthyosaurus*. The mandible length suggests a minimum prefrontal body length of 3.5 to 4 m. The largest example of *Ichthyosaurus* previously reported is 3 m (Massare & Lomax, 2015). The specimen was subsequently cleaned and conserved for display. To help visitors to understand the skeleton more easily, the missing portions of the postcranial skeleton were recreated.

The left forefin and pectoral girdle bones were CT scanned, the data mirrored, and models of the right forefin were 3D printed and painted. The same process was undertaken for missing portions of the hindlimbs. Missing vertebrae were represented by casts of adjacent vertebrae made from Jesmonite acrylic resin using silicon rubber moulds. The skeleton is now the centrepiece of the new permanent Marine Worlds gallery at Thinktank, including an interactive focused on the conservation.

Studying, recording, dismantling and rebuilding the skull

The skull had been reconstructed from many small fragments of bone plus some metal rods and various pieces of carved wood to support them. Large amounts of glue and gap filler had to be removed so that the skull could be carefully dismantled (Fig 8) for the anatomical errors to be rectified. For instance the left and right spinels had been swapped around and were upside-down; the left side of the mandible was badly offset and overlapping itself by several inches; the basiphenoid was in the wrong place; the mandible and skull needed to be separated slightly; and some broken bones required repairing.

The skull was rebuilt with the bones in their correct positions (Fig 9) using the reversible polymer Paraloid B72 as an adhesive and consolidant. The 3D-printed model bones on the right of the skull were painted with artist acrylics and attached to the real bones with plaster of paris. Supporting metalwork was replaced with Perspex rods to facilitate CT scanning and a new storage plinth was made.

Conservation of the forensic

The bones of the left forefin had been stuck to shaped Perspex rather messily with excessive amounts of glue (Figs 10 & 11). Also, they were displayed in ventral aspect yet the skeleton would be displayed in life position. Therefore all the bones had to be removed and the bones and Perspex had to be cleaned of their old adhesive. Then the bones had to be reattached in a reversed order and the right way up. The glue was softened with acetone and removed with scalpels, then the bones and Perspex were cleaned with an airbrush using sodium bicarbonate powder. The bones were reattached with a paste of Paraloid B72 adhesive and glass beads (Larkin & Makridou, 1999).

Replicating missing postcranial bones

Neither of the limbs on the right side of the body were preserved. Therefore the conserved and reconfigured left forelimb and the left scapula and clavicle as well as the femur of the left hindlimb were CT scanned. The scans were sent to Steven Dey at ThinkSee3D who had 3D-printed the mirrored bones for the skull. He cleaned all the data, mirrored it and printed 3D models of the complete forelimb (including the pectoral girdle) and the left femur for the right side of the ichthyosaur.

Display

The new display (Fig 13) at Thinktank, Birmingham’s Science Museum, with the skeleton articulated in the foreground, Bob Nicholls’ artistic reconstruction of the ichthyosaur behind and a traditional ‘flattened’ ichthyosaur fossil hung on the wall.

In addition, throughout the project various video blogs describing the work in detail were uploaded to YouTube. These can be found by Googling ‘Thinktank ichthyosaur’.

Discussion

This partial skeleton from Lower Jurassic deposits is the largest *Ichthyosaurus* specimen reported, with a fairly complete skull including elements that are extremely well preserved in three dimensions, not flattened. These elements have been MicroCT scanned and the whole skull rebuilt to be more anatomically correct, femur and complete left forefin and pectoral girdle have been CT scanned, to aid research. This data was also useful for display purposes: by mirroring data and creating digital 3D models some missing elements were able to be 3D printed.

However, although the use of 3D printing technology in museums is increasing with every passing year, very little research has been undertaken so far on the stability of materials used, or their suitability to be in close proximity with museum specimens inside sealed display cases. Therefore Oddy tests and other analyses are currently being undertaken on commonly used 3D printing materials by Nigel Larkin, Gabriele Flexer & Julian Carter. The results should be published soon.

References


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