

A 3D reconstruction of the skull of the West Indian Ocean coelacanth *Latimeria chalumnae*

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Abstract

We provide a 3D reconstruction of the skull of *Latimeria chalumnae* that can be easily accessed and visualized for a better understanding of its cranial anatomy. Different skeletal elements are saved as separate PLY files that can be combined to visualize the entire skull or isolated to virtually dissect the skull. We included some guidelines for a fast and easy visualization of the 3D skull.

Keywords: Coelacanth, Computed Tomography, Cranial osteology, *Latimeria*

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Inv nr.	MHNG 1080.070
Taxon	<i>Latimeria chalumnae</i>
Gender	Male
Weight	25-30 kg
Length	116 cm
Scan parameters	CTscanner: CT Lightspeed VCT; DFOV: 50 cm; SFOV: 50 cm; 512x512; 100 kV; 120 mA; Spatial resolution: 0.625 mm / 0.6 mm; Pitch: 0.531:1; Recon: BONE;

Table 1. Specimen information and CTscan parameters. Collection: Muséum d’Histoire Naturelle de Genève (MHNG), Geneva, Switzerland. CCC number (Coelacanth Conservation Council): CCC 49. Millot et al. (1972) no. C43

INTRODUCTION

The cranial osteology of the living coelacanth *Latimeria chalumnae* has been thoroughly described by Millot and Antony in 1958 and later integrated by further studies, the most comprehensive being the monograph from Forey in 1997. Such works are the main reference to understand cranial anatomy of extant and fossil coelacanths as well as other extinct sarcopterygians. However, the lack of easily accessible 3D models of the skull of *Latimeria chalumnae* made it difficult for the readers to understand complex anatomical structures from the drawings and photographs included in the literature. Therefore, we CTscanned the head of an adult specimen of *L. chalumnae* and segmented all the ossified and mineralized elements of the skull, to create a 3D reconstruction of the skull (Figure 1 and Table 1) that can be easily accessed by the scientific community. Some guidelines for fast visualization of the 3D skull of *L. chalumnae* are provided in the Methods section.

METHODS

CTscan, segmentation, rendering:

We CTscanned the head of the adult specimen of *L. chalumnae* housed in the spirit collections of the Museum of Natural History of Geneva, Switzerland. The specimen was captured on February 25, 1966 several hundred meters off Mutsamudu, Union of Comoros, at a depth of 350 meters (Nulens et al., 2011). The skull roof, neurocranium, hyoid and cleithrum show some artificial holes due to the pointed tool used to sacrifice the animal when it was captured (Figure 1E) and to a metal wire inserted by the preparator (Figure 1F). Apart from this minor damage, the skull was perfectly preserved. The specimen was transported to the Unit of Forensic Imaging and Anthropology, University Center of Legal Medicine, Geneva-Lausanne, where the CTscan was performed. Further information about the specimen and the scan parameters are reported in Table 1. Segmentation of the CT dataset was performed in Dragonfly 4.1 (ORS). Each ossified element of the skull has been segmented manually to generate 3D surfaces. The 3D surfaces were Laplacian smoothed (3 iterations) and vertex colorized in MeshLab, then imported in Blender for surface rendering and imaging. The CT dataset was imported in Amira (ThermoFisher) for volume rendering and imaging. Some surface and volume renderings are shown in Figure 1.

Guidelines for visualization of the 3D skull of *L. chalumnae*:

We provide 3D surfaces corresponding to different elements of the skull of *L. chalumnae*, saved as different PLY files that can be opened with any 3D-surface visualization software like Blender or MeshLab. In MeshLab go to “File>Import mesh”, select all the PLY files from the directory where you saved them.

MeshLab will open all the PLY files and combine them to reconstruct the complete skull. Scroll down the mouse wheel while holding “Shift” until the field of view is set to Orthographic. You can freely rotate the skull by holding the left mouse button and dragging the skull. You can hide different parts of the skull by inactivating them from the list on the right of the MeshLab interface. For further advice on 3D visualization please contact the corresponding author. The CT dataset is available upon request.

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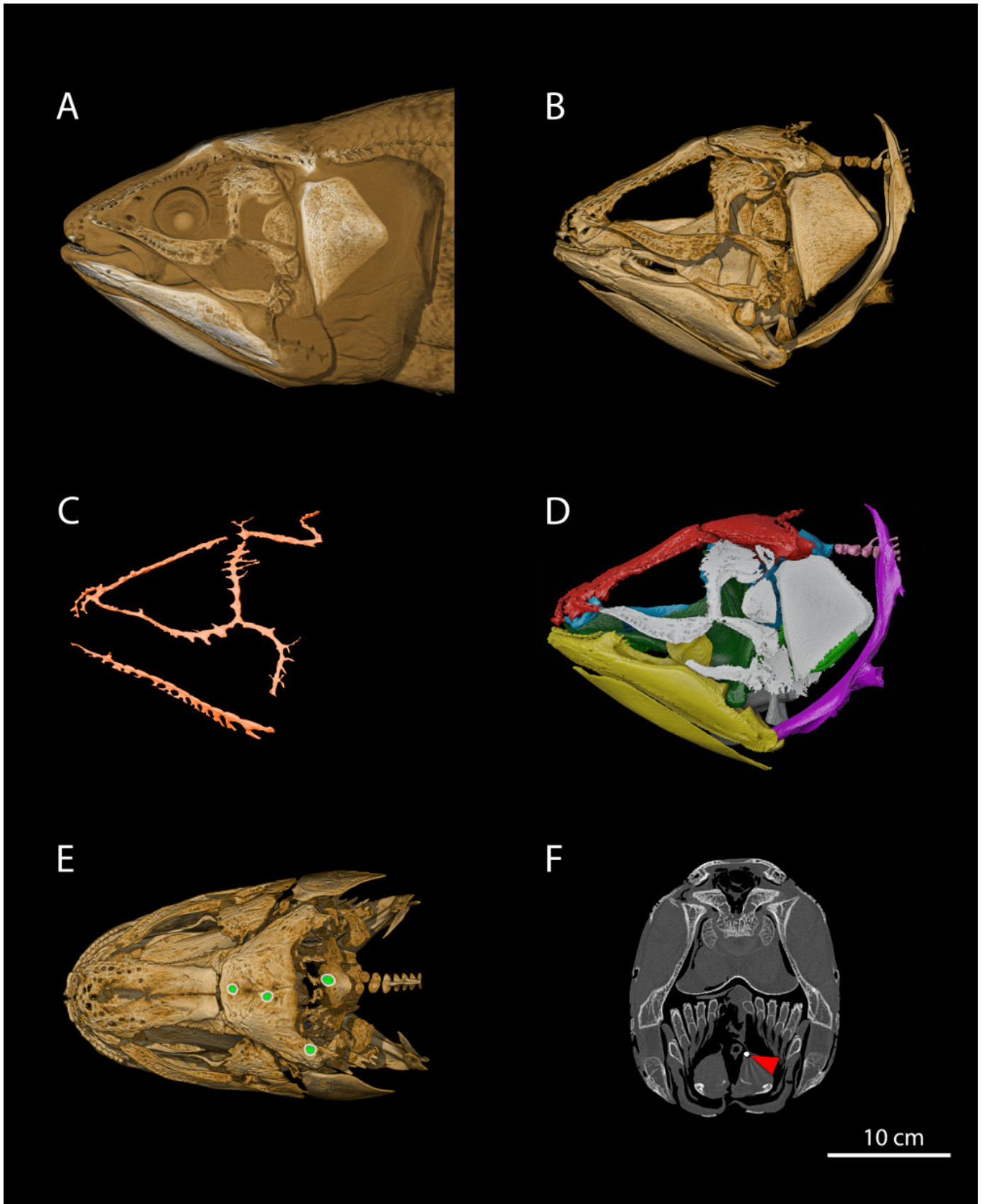


Figure 1. examples of volume and surface renderings of the 3D skull of *L. chalumnae*. A – lateral view of volume rendering of the CT dataset. B – lateral view of volume rendering of the CT dataset after removing all the soft tissue and the metal wire. C – lateral view of surface rendering of the bone cavities corresponding to the path of the sensory canals. D – lateral view of surface rendering of the segmented skull. E – dorsal view of volume rendering of the CT dataset after removing all the soft tissue and the metal wire, with four artificial holes labelled in green. F – section through the CT dataset at the level of the intracranial joint. The red arrow points at the metal wire inserted by the preparator.