

# Replacement of lab material: 3D scan and print of echinoderm larvae wax models

By Atticus Pinzon-Rodriguez

PhD student, Biology, Lund ([atticus.pinzon\\_rodriguez@biol.lu.se](mailto:atticus.pinzon_rodriguez@biol.lu.se))

The zoology course for undergraduate biology students comprises several practical sessions where the students use plastic models, wet and dry collected specimens and microscope slides to study diverse groups within the animal kingdom.

Among the models and specimens, there are several items that are more than 100 years old, which makes them unique and not ideal for constant manipulation by the students.

As an initial project, I selected a collection of 11 wax models representing different types and stages of development of echinoderm larvae, to be scanned in 3D and then printed in 3D. The new models would be then used in the study sessions from now on.



Figure 1. Original wax models of diverse echinoderm developmental stages.

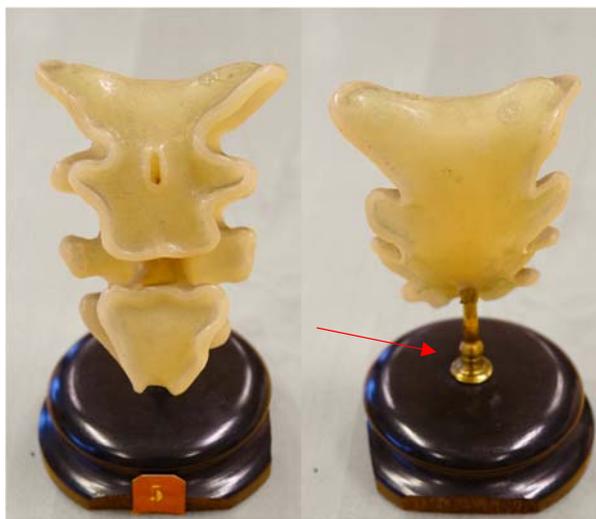


Figure 2. Individual model. Note the metal shaft to support the model (red arrow).

## Original models

The models are made out of wax, with little colouring on the edges of some models. They have a brass holder in the lower back side, that is used to connect the model to a wooden base with a brass shaft.

## Scanning

Due to the complex shape of the models and the available 3D scanners it was advised to scan the models either in an MRI (magnetic resonance imaging) scanner or CT (computer tomograph) scanner. From these options, MRI is not suitable because of the material, so CT scan was selected and later confirmed by the specialist as being a suitable technique to approach the problem.

The models were scanned at the Preclinical Nuclear Medicine platform, part of the Lund University Bioimaging Center. Each model was digitized without the base. The region where the brass ring was inserted into the model generated a lot of noise in the form of spikes emerging from the ring. Due to the amount of images produced in each CT scan, I decided to ignore the noise at this level, and correct it in a future step.

## File handling

The scanned files were delivered as DICOM files (.dcm). Such files can be opened and edited with SLICER 3D (ver. 4.6).

There was an unknown issue with the .dcm files: once imported into SLICER, one of the dimensions of the model (height) was deformed and the resulting 3D rendering was a slimmed model. This issue was corrected by saving the .dcm files to .nrrd files using SEG3D (ver. 2.2.1). The files in .nrrd format were correctly interpreted by SLICER and the resulting 3D rendering was correct.

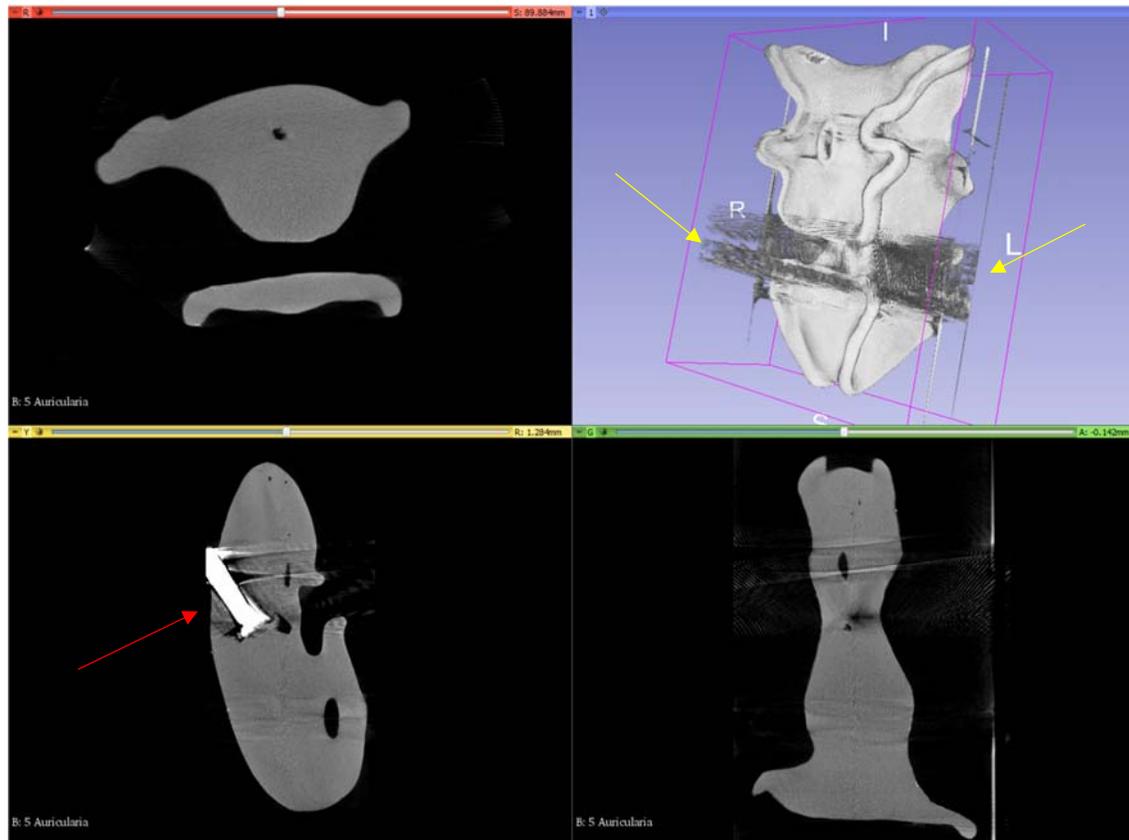
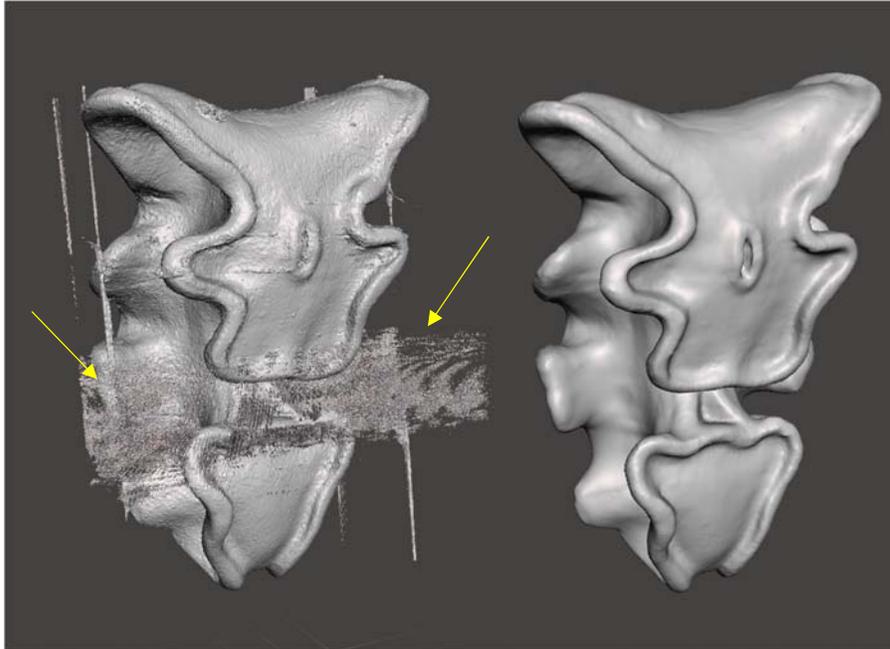


Figure 3. Screenshot from Slicer3D. Axial, sagittal and coronal views from the CT scanned model. The top right panel shows the reconstructed 3D model. The metal shaft looks bright on the scan (red arrow). Noise and artefacts caused by the metal shaft on the 3D rendered model (yellow arrows).

Once the 3D model is rendered in Slicer3D, it can be exported as .stl file (3D printer friendly file).

### 3D editing and sculpting

STL files were edited with Autodesk Meshmixer (ver 3.1). The noise coming from the DICOM files resulted in 3D “spikes” and “blobs” around the area where the metal ring was. Most of those artefacts were cut away from the main model and the remaining irregularities were fixed with the sculpting tool (both surface and volume).



Once the model was clean from noise, the “hollow” tool was used to produce an empty model, suitable for printing.

Figure 4. Left: original 3D rendering. Note the irregularities and artifacts (yellow arrows). Right: clean model.

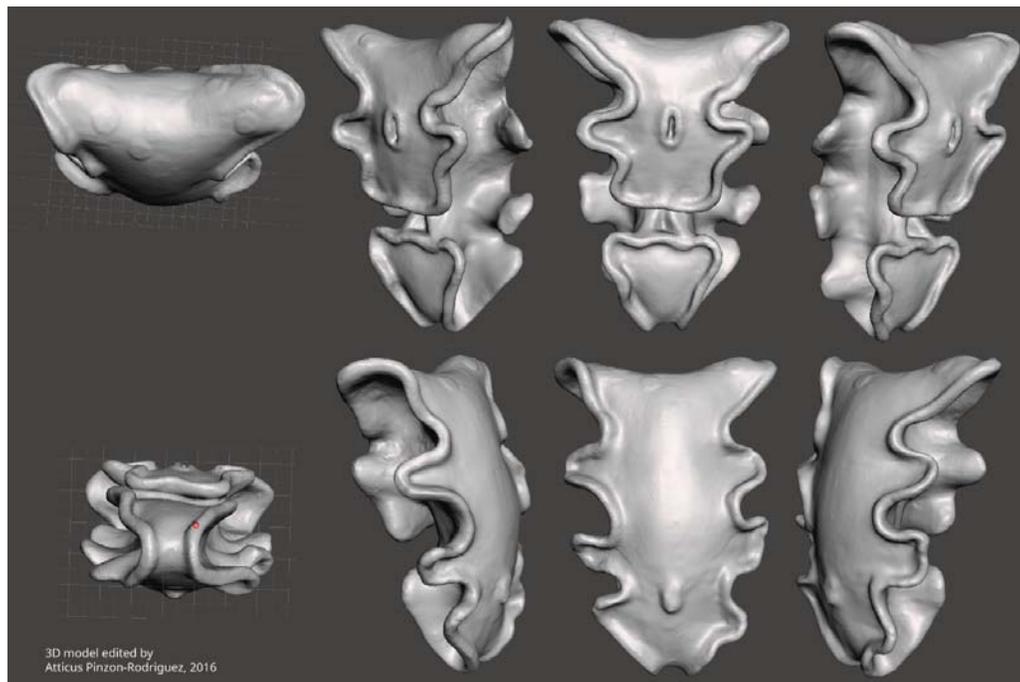


Figure 5. Different views of the final model.

### 3D printing

Once edited and cleaned, the STL files for the 11 models were sent to the 3D Printing Laboratory (Department of Design Sciences, Faculty of Engineering, LTH), to be printed in a Selective Laser Sintering machine, on white nylon powder.

The models included a hollow connector in the back, so a custom-made base could be attached.

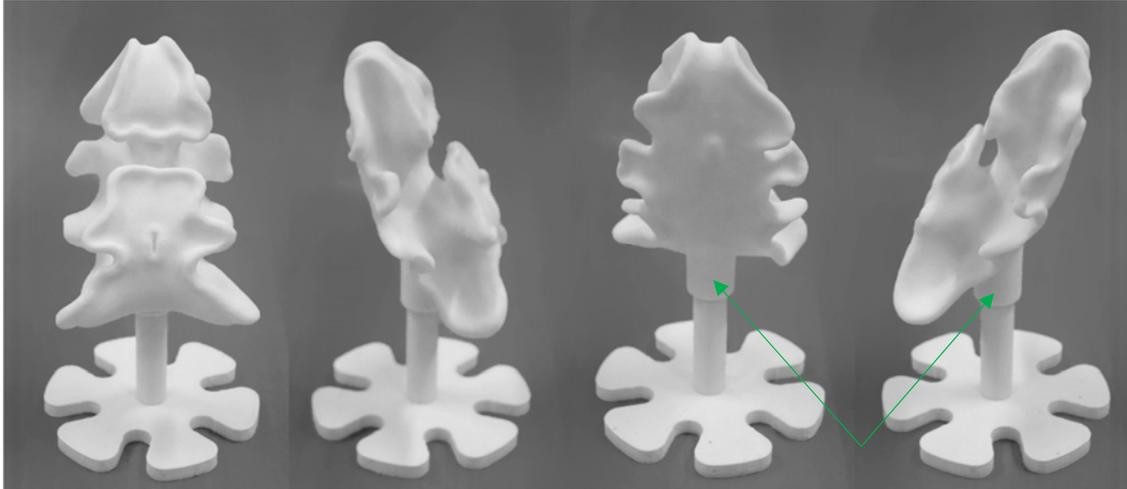


Figure 6. Printed version of the example model. Note the base holder on the back of the model (green arrow).

The final printed model looks upside down when compared to the original waxed model. This is due to the realization that the inverted position is biologically correct, and the original models were probably made that way to preserve fragile features of the larvae.

To protect the models, a layer of matt finishing varnish was applied.



Figure 7. Final collection.

## Links

CT Scan Facility

[http://www.med.lu.se/bioimaging\\_center/user\\_support/preclinical\\_nuclear\\_medicine\\_pet\\_spect\\_ct](http://www.med.lu.se/bioimaging_center/user_support/preclinical_nuclear_medicine_pet_spect_ct)

3D Print Laboratory <http://www.design.lth.se/index.php?id=140861>

SEG3D <http://www.sci.utah.edu/cibc-software/seg3d.html>

SLICER3D <https://www.slicer.org/>

Quick tutorial from SLICER to 3D print <https://www.youtube.com/watch?v=MKLWzD0Pilc&t=591s>

Autodesk Meshmixer <http://www.meshmixer.com/>