EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Palaeohistological implications in the origin of jawed vertebrates and the fish/tetrapod transition revealed by the ESRF Synchrotron	**Experiment number**: EC 203
Beamline: ID 19	**Date of experiment**: From: 17/02/2008 to: 19/02/2008	**Date of report**: 01/03/2012
Shifts: 6	**Local contact(s)**: Paul Tafforeau	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

Experiment:

This second scan session was divided into two series with different aims: 1) we were interested in focusing on muscle attachment regions at high resolution in some of our samples. We therefore employed a multiscale approach from 7.46 to 0.678µm (voxel size) on these samples; 2) we were also interested in obtaining microanatomical data, i.e. information about vascularization and trabecular mesh. We therefore did a series of scans on a second series of samples at 7.46µm.

Once again, we decided to image specimens related to the two topics set out in the proposal (the 'fish-tetrapod transition' and the 'origin of early gnathostomes').

As planned in our proposal, this second scan session allowed us to:
1) generate new and better constrained hypotheses about the locomotory abilities of the limbs of early tetrapods based on changing patterns of trabecular architecture. A paper was published in 2010 in *Journal of Evolutionary Biology*.
2) learn about the ontogeny of early gnathostomes thanks to the microanatomy of dermal bone. A paper was published in 2010 in *Compte-rendus Palevol*.
3) determine the presence and distribution of muscles attaching to the anterior margin of the placoderm shoulder girdle. A paper is in the final stages of preparation for submission to *Proceedings of the Royal Society - B*.

Publication abstracts:

1) Sanchez S., Germain D., Ricqlès A. de, Abourachid A., Goussard F. & P. Tafforeau. **2010.** Limb-bone histology of temnospondyls: implications for understanding the diversification of palaeoecologies and patterns of locomotion of Permo-Triassic tetrapods. *Journal of Evolutionary Biology*, **23-10**: 2076-2090.

The locomotion of early tetrapods has long been a subject of great interest in the evolutionary history of vertebrates. However, we still do not have a precise understanding of the evolutionary radiation of their locomotory strategies. We present here the first palaeohistological study based on theoretical biomechanical considerations among a highly diversified group of early tetrapods, the temnospondyls. Based on the quantification of microanatomical and histological parameters in the humerus and femur of nine genera, this multivariate analysis provides new insights concerning the adaptations of temnospondyls to their palaeoenvironments during the Early Permian, and clearly after the Permo-Triassic crisis. This study therefore presents a methodology that, if based on a bigger sample, could contribute towards a characterization of the behaviour of species during great evolutionary events.

2) Dupret V., Sanchez S., Goujet D., Tafforeau P. & P. E. Ahlberg. **2010.** Bone vascularization and growth in placoderms (Vertebrata): the example of the premedian plate of *Romundina stellina* Ørvig, 1975. Dans G. Clement et D. Geffard-Kuriyama, (eds.). *L'imagerie 3D appliquée à la paléontologie et la paléoanthropologie*. Compte-rendus Palevol, Paris, **9** : 369-375.

The Placodermi (armored jawed fishes), which appeared during the Lower Silurian and disappeared without leading any descendants at the end of the Famennian (Latest Devonian), have the highest diversity of known Devonian vertebrate groups. As phylogenetically basal gnathostomes (jawed vertebrates), they are potentially informative about primitive jawed vertebrate anatomy and origins. Until recently, the study of their internal or histological structures has required destructive methods such as sectioning or serial grinding. Recent advances in tomography and imaging technologies, especially through the increasing use of synchrotron phase contrast imaging for the study of fossils, allow us to reveal the inner structures of the fossil nondestructively and with unprecedented three-dimensional level of detail. Here, we present for the first time the prerostral anatomy of the small acanthothoracid Romundina stellina, one of the earliest and most basal placoderms. Phase contrast imaging allows us to reconstruct the vascularization and nerve canals of the premedian plate and adjacent parts of the skeleton three-dimensionally in great detail, providing important clues to the growth modes and biology of the animal (Fig. 1).

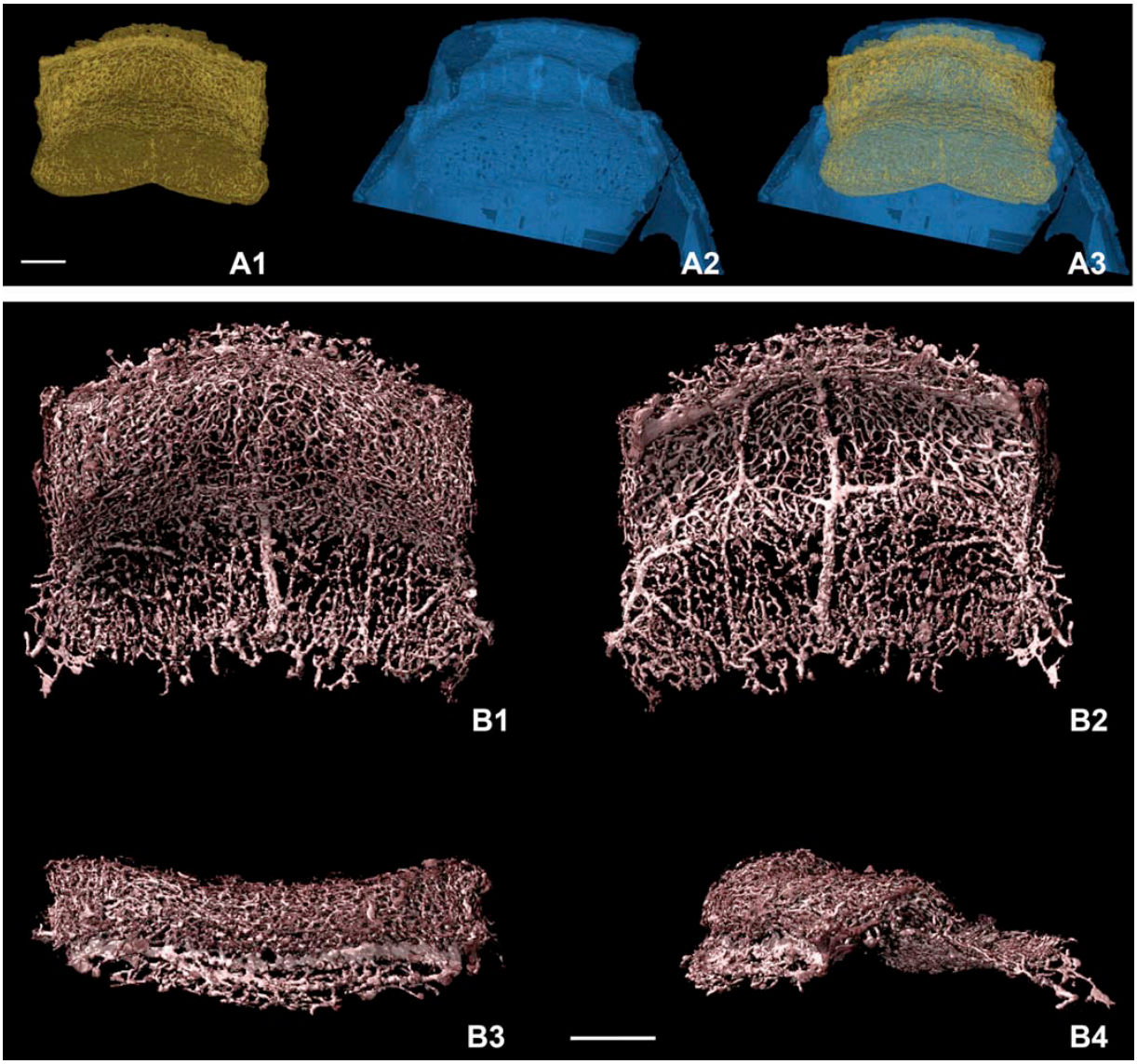

Figure 1: Romundina stellina Ørvig, 1975, specimen MNHN CPW 1. Prerostral region of the skull. **A**. Premedian plate (A1), underlying perichondral bone (A2), and both dermal structures (A3) in dorsal views, seen by transparency and showing the neurovascular web. **B**. Neurovascularization of the premedian plate and the underlying perichondral bone, in dorsal (B1), ventral (B2), anterior (B3) and oblique left anterolateral (B4) views. Scale bars: 1mm. **A** was made using Mimics® (Materialise) v. 12.3; **B** was made using VGStudio Max v. 2.0 (Volume Graphics).