EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

ESRF

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:** Characterisation of uniquely preserved soft-tissues and food residues in coprolites from Late Permian and Late Triassic terrestrial tetrapod localities	**Experiment number**: ES-415
Beamline: ID19	**Date of experiment**: from: 01/04/2016 to: 03/04/2016; and 03/07/2016-05/07/2016	**Date of report**: 27/02/2018
Shifts: 12 (+2)	**Local contact(s)**: Paul Tafforeau	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

A large number of coprolites (>100 specimens) were scanned at beamline ID19 during two experimental sessions in a total of 12 shifts (plus 2 extra shifts rewarded at the first session due to another experiment finishing early). The experiment was highly successful, releasing far more information from these structures than can be obtained by traditional techniques such as sectioning, and has so far generated two publications[1,2], which have already attracted nine citations in less than a year (Google Scholar). New discoveries are also constantly being made, resulting in ongoing preperation of new publications and conference contributions based on the data.

Because this project represented the first use of propagation phase contrast synchrotron microtomography (PPC-SRμCT) on coprolites, an initial paper was prepared to demonstrate the method and give examples of its benefits on coprolite material[1]. This paper was published in the highly-ranked journal *Scientific Reports* and was rewarded big attention in both media and the scientific community. The results were also presented as an oral presentation at the biggest annual conference for vertebrate paleontology (SVPs annual meeting), and the abstract was chosen for the press packet of the meeting. In this initial study, two examples of Triassic coprolites with remarkable food remains (one containg a semi-articulated fish and the other delicate beetle remains, Fig. 1) were used to illustrate how PPC-SRμCT opens up a lot more of the palaeoecological potential of coprolites because of the high-quality imaging of food inclusions (and their interior) throughout entire coprolite specimens.

Simultaneously, scans of two Devonian coprolites, tentatively attributed to coelacanths, were used together with a specimen with similar gut contents to present one of few examples of conodont-feeding animals yet known[2].

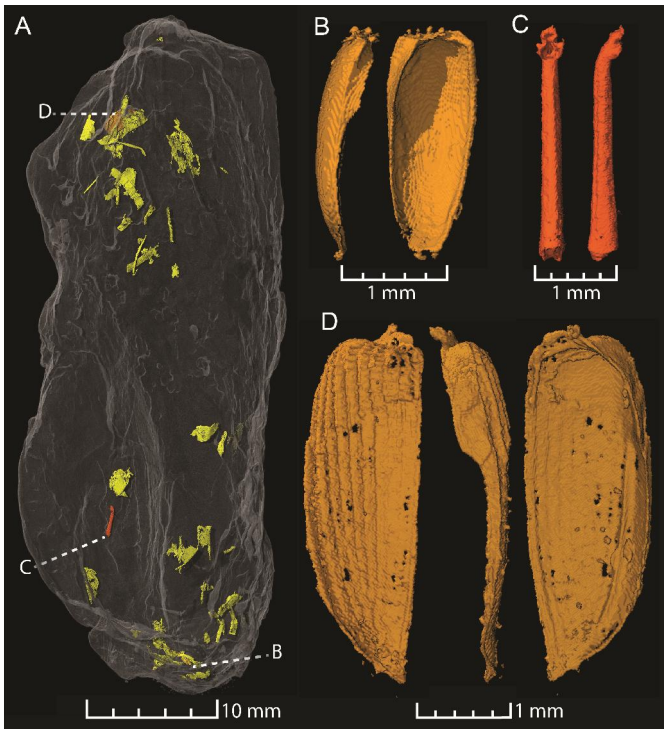

*Figure 1. **A**. Semi-transparent coprolite with highlighted beetle remains and unidentifiable insect inclusions. **B, D.** Two well-preserved beetle elytra with ornamentation, articulatory roots and interlocking processes. **C.** A beetle tibia. Modified from Qvarnström et al. (2017)*

Several other publications are in the pipeline. Two examples that are near submission are based on coprolites from the Upper Triassic of Poland. Firstly, three large coprolites from the Lipie Śląskie clay-pit at Lisowice were scanned and shown to contain large amounts of bone fragments (>50% of the total volume), including bones from dicynodonts and temnospondyls as well as crushed, serrated archosaur teeth. The coprolites as well as the serrated teeth are linked (by associated footprints and body fossils) to *Smok wawelski*, a large predatory archosaur with a poorly resolved systematic position. Our findings show that *Smok wawelski* was a top predator with a diverse menu, including frequent exploitation of bones (osteophagy) resulting in repeated destruction of its teeth. Osteophagy is rarely connected to extinct archosaurs, with the exception of the Late Cretaceous tyrannosaurids that lived some 140 million years later. These results were presented at the International Conference of Continental Ichnology (ICCI), held in South Africa last year. A manuscript is currently in the last steps of being submitted to a high-ranked international journal based on these results. Secondly, coprolites of one particular morphotype (i.e. a "population" of coprolites of similar shapes) from the rich Carnian locality Krasiejów are shown to contain abundant beetle remains (notably elytra), like the specimen illustrated in Figure 1. The size of the coprolites implies that the producer was not similar in size to small recent insectivores, but rather a medium-sized animal that specialized in catching small beetles. The best candidate from the locality is *Silesaurus opolensis*, a dinosauriform with an unusual anatomy including beak-like jaws. We hypothesize that this beak was used, in a manner similar to that of some modern birds, to peck beetles off the ground.

References

1. Qvarnström, M., Niedźwiedzki, G., Tafforeau, P., Žigaitė, Ž. & Ahlberg, P. E. Synchrotron phase-contrast microtomography of coprolites generates novel palaeobiological data. *Sci. Rep.* **7,** 1–6 (2017).
2. Zatoń, M., Broda, K., Qvarnström, M., Niedźwiedzki, G. & Ahlberg, P. E. The first direct evidence of a Late Devonian coelacanth fish feeding on conodont animals. *Sci. Nat.* **104,** 26 (2017).

Conference abstracts

Qvarnström, M., Niedźwiedzki, G., Tafforeau, P., Žigaitė, Ž. and Ahlberg, P. E. 2017. 3D-visualization of vertebrate coprolites through phase-contrast synchrotron imaging unravel new aspects of paleoecological relations. *In* A. Farke, A. MacKenzie & J. Miller-Camp (eds.) *Program and abstract volume of the 77th meeting of the Society of Vertebrate Paleontology*, p. 181.

Qvarnström, M., Niedźwiedzki, G. and Ahlberg, P. E. 2017. Contents of coprolites reveal feeding habits of the Late Triassic archosaur *Smok wawelski* (Lisowice, Poland). *Abstract volume of the 2nd International Conference in Continental Ichnology,* p. 69-70.