

A marine vertebrate fauna from the Toarcian-Aalenian succession of southern Beaujolais, Rhône, France

Guillaume Suan¹, Peggy Vincent², Jeremy E. Martin³,
Valentin Fischer⁴, Bouziane Khalloufi⁵
and Baptiste Suchéras-Marx⁶

¹UMR CNRS 5276 LGL-TPE, Université Claude Bernard Lyon 1 - Ecole Normale Supérieure Lyon, Campus de la DOUA, Bâtiment Géode, 69622 Villeurbanne cedex, France. guillaume.suan@univ-lyon1.fr

²Staatliches Museum für Naturkunde, Rosenstein 1, D-70191 Stuttgart, Germany. pvincent@mh.n.fr

³School of Earth Sciences, University of Bristol, Wills Memorial building, Queen's Road, BSS 1RJ, Bristol, UK.

⁴Département de Géologie, Université de Liège, Liège, Belgium. v.fischer@ulg.ac.be

⁵Departamento de Zoologia, Instituto de Biologia, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil.

⁶UMR CNRS 5276 LGL-TPE, Université Claude Bernard Lyon 1 - Ecole Normale Supérieure Lyon, Campus de la DOUA, Bâtiment Géode, 69622 Villeurbanne cedex, France. baptiste.sucheras@pepsmail.univ-lyon1.fr

The Early Jurassic period is marked by important eustatic, climatic and biotic changes (Suan et al., 2010). A particularly severe episode of biological crisis occurs towards the Pliensbachian-Toarcian boundary and continues during the early Toarcian (Caswell et al., 2009). This phase of increased biotic loss seems to have ensued from marked temperature changes and broadly coeval onset of seawater oxygen deficiency, termed the Toarcian Oceanic Anoxic Event (T-OAE; Jenkyns, 1988). The impact of this crisis on the marine vertebrates, however, remains poorly understood (Benton, 1993).

In this context, the abundant invertebrate and vertebrate specimens spanning the whole Toarcian and part of the Aalenian stage from the Beaujolais area in France might provide fundamental clues about the diversity through space and time of this critical interval. A previously undocumented marine vertebrate fauna comprising ichthyosaur, plesiosaur, marine crocodylian and fish remains from the Toarcian-Aalenian succession at Lafarge quarry, southern Beaujolais, Rhône, France is described on the basis of both historical collections and new discoveries. Several groups are recorded for the first time in the Toarcian-Aalenian succession of France, implying new palaeobiogeographical interpretations and allowing discussion of the evolution of diversity among marine reptiles during that interval. The Toarcian-Aalenian succession of the Lafarge Quarry of the southern Beaujolais contains the following marine vertebrates: actinopterygians, the ichthyosaurian taxa *Temnodontosaurus* as well as an indeterminate stenopterygiid, crocodylians and indeterminate plesiosaurians.

The ichthyosaur fauna from the Toarcian-Aalenian succession of the Beaujolais area in France shows close affinities, both in terms of relative proportions and composition, with those of the northern basin of England and Germany. Comparisons with other localities cannot be performed for the two other groups of marine reptile, as their partial remains are not identifiable at a genus level in the study site. Nevertheless, the completeness and temporal extension of the Lafarge quarry succession extend the stratigraphic range of the ichthyosaurs genus *Temnodontosaurus* to the upper Toarcian and confirm the presence of stenopterygiids in the uppermost middle Toarcian. The reported occurrences of these successful taxa, combined to their apparent absence in Middle Jurassic strata, suggest that their disappearance occurred after the Toarcian and was unrelated to the T-OAE.

Given the very seldom occurrences of marine vertebrates reported from the Middle Jurassic, it is difficult to determine whether the extinction of those taxa, diversified and abundant during the Early Jurassic, was gradual or rapid and potentially the result of severe environmental perturbations. Similarly, pre T-OAE

specimens (i.e. from the upper Pliensbachian and lowermost Toarcian) are relatively scarce, hence preventing detailed reconstruction of extinction and diversification dynamics of marine vertebrates over this interval. In this context, the almost continuous record of vertebrate specimens from the biostratigraphically well-constrained marine succession of Beaujolais opens an interesting avenue of research for further high-resolution tracing of the evolution of vertebrate fauna across this key interval.

Acknowledgements

We acknowledge the generous logistical support of Lafarge and the financial support from the Musée des Confluences de Lyon. We also warmly thank all the volunteers that provided crucial help and entertainment during the fieldwork campaign. G. Suan is grateful to the Alexander von Humboldt Foundation for financial support.

References

- BENTON, M.J. 1993. Reptiles. *In: The fossil record 2 (M.J. Benton, Ed)*. Chapman and Hall, London, 681-715.
- CASWELL B.A., COE, A.L. and COHEN, A.S. 2009. New range data for marine invertebrate species across the early Toarcian (Early Jurassic) mass extinction. *Journal of the Geological Society, London*, 166: 859-872.
- JENKYNS, H.C. 1988. The Early Toarcian (Jurassic) Anoxic Event - stratigraphic, sedimentary, and geochemical evidence. *American Journal of Science*, 288: 101-51
- SUAN, G., MATTIOLI, E., PITTET, B., LÉCUYER, C., SUCHÉRAS-MARX, B., DUARTE, L.V., PHILIPPE, M., REGGIANI, L. and MARTINEAU, F. 2010. Secular environmental precursors to Early Toarcian (Jurassic) extreme climate changes. *Earth and Planetary Science Letters*, 290: 448-458.