The effects of the Jenkyns Event on the radiation of Early Jurassic dinoflagellate cysts

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Abstract: This contribution is an overview of the Early Jurassic dinoflagellate cysts of the Lusitanian Basin in Portugal, with particular emphasis on the effects of the Jenkyns Event (Toarcian Oceanic Anoxic Event) on the evolution of this planktonic group. We review and discuss data from 214 samples from six Lower Jurassic successions (upper Sinemurian to upper Toarcian) in the Lusitanian Basin. The late Pliensbachian radiation of dinoflagellate cysts was well recognized in this basin. The pre-Jenkyns Event interval is highly productive, with maximum abundance and species richness values. However, this palaeoenvironmental perturbation severely affected the evolution of this group for the remainder of the Early Jurassic. The prolonged recovery of the dinoflagellates in the Toarcian following the Jenkyns Event is not typical of the northern regions (Arctic and Boreal realms), where new species began to evolve earlier compared with southern European basins.

Dinoflagellates, together with coccolithophores and diatoms, comprise the bulk of the marine eukaryotic phytoplankton and are extremely significant primary producers. The bioproductivity and distribution of dinoflagellates are influenced by, for example, light, nutrients, ocean currents, salinity, temperature and water depth. As part of their life cycle, many dinoflagellates form resting cysts, and these have a rich fossil record from the Late Triassic onwards (e.g. Dale 1983; Fensome *et al.* 1996*a*, *b*, 1999; Falkowski *et al.* 2004). Dinoflagellate cysts are used as biostratigraphical markers, and palaeoclimatological and palaeoecological proxies (e.g. Stover *et al.* 1996; Riding and Hubbard 1999; Sluijs *et al.* 2005).

This contribution is a review of how dinoflagellate cysts responded to a major Early Jurassic global environmental perturbation, the Toarcian Oceanic Anoxic Event (T-OAE), currently renamed the Jenkyns Event (Müller *et al.* 2017; Reolid *et al.* 2020). However, the present authors propose using 'T-OAE' only for marine deposits with oxygen-depleted conditions and the term 'Jenkyns Event' for general early Toarcian global palaeoenvironmental changes. This event, which occurred at *c.* 183 Ma, was characterized by marine anoxia–euxinia, global warming and the extensive burial of organic matter. It was probably caused by greenhouse gas release linked to volcanism from the Karoo–Ferrar large igneous province, and it was accompanied by major changes in global geochemical cycles with a rapid negative shift in organic-carbon isotope records. The rise in palaeotemperatures increased the hydrogeological cycle. Consequently, the concomitant more intense weathering regime contributed to elevated levels of nutrients, thereby promoting higher bioproductivity and hence more carbon burial. Studies on this palaeoenvironmental change are extensive, and it has been documented worldwide (e.g. Jenkyns 1988; Hesselbo *et al.* 2000, 2007; Kemp *et al.* 2005, 2019; Them *et al.* 2017; Xu *et al.* 2017; Fantasia *et al.* 2018*a*, *b*; Fonseca *et al.* 2018; Izumi *et al.* 2018; Rodrigues *et al.* 2019, 2020*a*, *b*, *c*; Jin *et al.* 2020; Krencker *et al.* 2020; Ruebsam *et al.* 2020*a*, *b*).

Specifically, we herein review regional trends in the Early Jurassic dinoflagellate cyst record based mostly on the Lower Jurassic (upper Sinemurian to upper Toarcian) reference sections in the Lusitanian Basin, Portugal, and compared them with published data from elsewhere. The main emphasis is on the characterization of the pre- and-post-Jenkyns Event dinoflagellate cyst assemblages and the impact of the associated palaeoenvironmental changes on dinoflagellate evolution.

From: Reolid, M., Duarte, L. V., Mattioli, E. and Ruebsam, W. (eds) *Carbon Cycle and Ecosystem Response to the Jenkyns Event in the Early Toarcian (Jurassic)*. Geological Society, London, Special Publications, **514**, https://doi.org/10.1144/SP514-2020-255