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Early Eocene hyperthermal events ETM2, H2 and I1 as recorded by Tethyan planktic foraminifera in the Terche section (northernastern Italy)

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In the last years, several transient episodes of extreme warming, the so-called hyperthermals, have been recognized in addition to the well-know Paleocene-Eocene Thermal Maximum (PETM; ∼55.5 Ma), superimposed on the long-term Paleocene-early Eocene warming trend peaking in the Early Eocene Climatic Optimum (EECO). To the present, perturbations produced by hyperthermals are well documented in terms of isotopic variations whereas their influence on the biota is still largely unexplored.

The Terche section, located in the Venetian Pre-Alps (northeastern Italy), is an expanded latest Paleocene-lower Eocene succession deposited in a bathyal setting of a continental margin of the central-western Tethys. This section is particularly suitable to study post-PETM hyperthermals because it contains three well-exposed and expanded marly-clayey units (MUs) corresponding to intervals of negative carbon isotope excursions (CIEs). Calcareous plankton biostratigraphy allow us to refer them to the hyperthermals ETM2 (or H1; ∼53.7 Ma), H2 (∼53.6 Ma) and I1(∼53.3 Ma).

Here we present the first detailed quantitative analysis of planktic foraminiferal assemblages across these early Eocene hyperthermals events. Quantitative analysis of planktic foraminiferal genera shows a long-term trend of variation upon which higher frequency variations are superimposed. We interpret such long-term variation as the response to the long–term warming trend since it highlights a slight increase of the warm indicators, such as the acarininids, and decrease of the cold form subbotinids. The high frequency variations, instead, closely related to the CIEs and to the MUs, record a pronounced increase in acarininids (up to 68%) and a parallel marked decline in the abundances of subbotinids and other component of planktic foraminiferal assemblages. The MUs are also associated with an increase of the eutrophic radiolarians. This aspect, together with the dominance of acarininids, can be interpreted as a consequence of the extreme warmth coupled with eutrophic conditions of surface waters. The surface-dwelling acarininids, able to temporarily colonize warmer deeper and nutrient-richer waters previously occupied by Subbotina, better tolerated the relatively high eutrophic conditions which prevented the warm indices Morozovella to thrive. The increased eutrophic conditions can be related to accelerate hydrological cycle, in turn enhanced by the intense warming, as already observed for the PETM in the same area.

Calcareous plankton variations during the hyperthermals in a deep-water setting could be affected by selective dissolution susceptibility due to the lysocline rise associated to these events. The planktic foraminiferal Fragmentation Index calculated in correspondence to the MUs of the Terche section presents very low values compared with those observed in other sections of the Belluno Basin across the PETM and the X-event. This indicates that the planktic foraminiferal record is not biased by dissolution and the modifications of assemblages are genuine and representative of the different genera real distributions. Our data on planktic foraminifera prove the strong effect of the hyperthermals events on the biotic component of the upper water column and show that the most intense perturbation was induced by the ETM2 that is characterized by the most pronounced CIE.