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Ecological and evolutionary response of Tethyan planktonic foraminifera to the Middle Eocene Climatic Optimum (Alano di Piave section, NE Italy)

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The transient (ca. 500 kyr) climatic warming event at ca. 40 Ma, known as Middle Eocene Climatic Optimum (MECO), significantly interrupted the overall cooling trend of the Middle Eocene. Originally documented in several deep sea sites at the Southern Ocean (Bohaty and Zachos, 2003), now it appears to be recorded worldwide by pronounced changes of the δ^{13}C and δ^{18}O values and coeval oscillations in global CCD (Tripati et al, 2005). Information on the planktonic foraminiferal response to this event is so far lacking. Here we present a detailed planktonic foraminiferal analysis of the MECO interval from a marginal basin of the central-western Tethys (Alano di Piave section, northeastern Italy). The expanded and continuous Alano section provides an excellent record of this event and offers an unique opportunity to better understand the role of climate upon calcareous plankton evolution. The initiation of the MECO occurs within magnetochron C18r at ca. 40.5 Ma with minimum δ^{18}O and δ^{13}C values achieved at the base of C18n.2n ca. 40.13 Ma, which are interpreted to represent peak warming conditions. Two sapropel-like, organic-rich intervals coincide with the major change in δ^{13}C record at Alano (Agnini et al., 2007a; Spofforth et al., 2008). The MECO event correlates the E12 (P13) and lower E3 (P14) planktonic foraminiferal zones. The high-resolution quantitative planktonic foraminiferal analysis performed on both $>$38 μm and $>$63 μm fraction reveals pronounced and complex changes indicating a strong environmental perturbation that parallels the variations of the stable isotope curves. These changes are primarily represented by the marked increase in abundance of the eutrophic subbotinids and of the small, low-oxygen tolerant *Streptochilus*, *Chiloguembelina* and *Pseudohastigerina,* by the consistent and significant entrance of the eutrophic opportunist triserial *Jenkynsina* and of *Pseudoglobigerinella bolivariana*, typical species of high-productivity, upwelling areas. The environmental variations related to the MECO thus induced a pronounced shift from oligotrophic to eutrophic, opportunist, low-oxygen tolerant planktonic foraminiferal assemblages suggesting increased nutrient input and surface ocean productivity. These results are supported by the increase of calcareous nannofossil eutrophic indicators and by the occurrence of radiolarians as well. These observed changes show certain analogies with the PETM event recorded in the same area (Agnini et al., 2007b; Luciani et al., 2007). Our data indicate that the definitive decline in abundance of the large acarininids occurs within the MECO just following the major δ^{18}O negative excursion. These warm-indices muricate forms dominated the Eocene greenhouse planktonic foraminiferal assemblages and became extinct near the middle/late Eocene boundary. Remarkably, our data highlight that the evolutionary appearances of two species belonging to the *Turborotalia cerroazulensis* lineage (*T. cerroazulensis* and *T. cocoaensis*) occur in correspondence to the MECO event. Furthermore, the total range of the marker *Orbulinoides beckmanni* at Alano is almost perfectly coincident with the major oxygen isotope excursion corroborating the hypothesis that this peculiar species might represent for the MECO an equivalent of the PETM excursion taxa (see also Edgar et al., 2007).

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