Vegetation and climate changes during the Early–Middle Pleistocene transition in the Eastern Mediterranean: A case study from Lake Acigöl in Southwestern Anatolia

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Résumé

The Early–Middle Pleistocene Transition (EMPT), spanning from ~1.4 to 0.4 Ma, marks a major shift in Earth's climate system response to orbital forcing. During this period, glacial–interglacial cycles evolved from ~40,000-year obliquity-paced intervals to longer, more asymmetric ~100,000-year cycles. This transition occurred without a significant change in the amplitude or pacing of orbital forcing (external forcings), suggesting that internal mechanisms within the climate system played a major role. However, the impacts of these forcings are still not fully understood, and remain understudied in some regions, such as the Eastern Mediterranean. In the Mediterranean Basin, the EMPT is associated with

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major vegetation shifts and a gradual decline in plant diversity. The Eastern Mediterranean is a key region due to its intermediate position between higher and lower latitudes (monsoon-influenced zones). This study aims to reconstruct environmental and climate changes during the EMPT using the Lake Acigöl sequence in southwestern Türkiye. We investigate vegetation dynamics, lake level changes, and quantitative climate reconstructions using a multi-proxy and multi-method approach, including the Modern Analogue Technique (MAT), Weighted Averaging Partial Least Squares regression (WA-PLS), Random Forest (RF), Boosted Regression Trees (BRT), and the Climatic Amplitude Method. The results indicate that steppe vegetation dominated during the EMPT around the lake Acigöl, with Amaranthaceae, *Artemisia*, and Poaceae, and very few trees, primarily deciduous *Quercus*. A progressive decrease in arboreal taxa is observed during the EMPT, along with alternating phases of Amaranthaceae-*Artemisia*-dominated steppe and grassland steppe with more Poaceae and trees. Lake dynamics reveal alternating dominance of the algae *Botryococcus* and Chrysophyceae, indicating water-level fluctuations. Climate reconstructions show a general decrease in precipitation during the EMPT, with alternating wetter and drier phases. A clear 41-ka cyclicity is observed around 1 Ma, which fades during the Middle Pleistocene. A similar 41-ka signal is reported throughout the Mediterranean region and is linked to obliquity forcing. In the Eastern Mediterranean, a 23-19 ka cyclicity, likely related to precession and monsoon influence, is also suggested, although the resolution of the record does not allow clear identification of this signal.

Mots-Clés: Vegetation dynamics, Paleoclimate reconstruction, Steppe ecosystems, Orbital forcing, Palynology, Transfer function, Mid, Pleistocene transition