

ORAL

## PLANKTONIC FORAMINIFERA AS PROXIES OF HOLOCENE CLIMATIC VARIABILITY (TYRRHENIAN, MEDITERRANEAN SEA)

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**Introduction.** The focus of this study is the paleoclimatic reconstruction of the southern Tyrrhenian between ~9.2 and 2.9 ka, through the study of planktonic foraminiferal assemblages and stable isotopes, and comparing data with other coeval intervals. Several authors have studied the climatic sensitivity of Holocene planktonic foraminifera in different parts of the Mediterranean. Planktonic foraminifera produce good records of Holocene climatic variability, especially as regards the sub-orbital events such as *Bond events* (Bond et al., 1997) and other cooling/warming oscillations. Therefore, the obtained eco-biostratigraphy has allowed us to analyze how climatic forcing influenced sea surface temperature (SST) and water column structure during the Holocene in this sector of the southern Tyrrhenian Sea.

**Methodology.** A sedimentary core (196 cm long) was collected in the Gulf of Palermo at the base of the upper continental slope (990 m bsl) and sub-sampled every 2 cm. Micropaleontological and geochemical analyses were performed on 98 samples, and three AMS <sup>14</sup>C dates were determined. Micropaleontological analyses consisted of qualitative and quantitative characterization of the planktonic foraminiferal assemblages, in the size fraction greater than 125 µm. Geochemical analyses were performed on 8–10 specimens of *Globigerina bulloides*.

**Results.** The calibrated AMS <sup>14</sup>C ages, together with planktonic foraminiferal fluctuations and *G. bulloides* oxygen isotope records, were used to develop an age model of the studied interval. In order to obtain additional age control points, the studied records were also tuned to the NGRIP δ<sup>18</sup>O (GICC05) (Svensson et al., 2008) and GISP2 ice core temperature (Alley, 2000) records (Fig. 1). Twenty species and eco-morphotypes were recognized in the planktonic foraminiferal assemblage and grouped depending upon their climatic and feeding affinity. The warm-water species, minus the typical cold-water species, were used to obtain the paleoclimatic curve, whilst the herbivorous/carnivorous ratio has permitted us to reconstruct the trophism of the southern Tyrrhenian. In particular, between ~8 and 6.4 ka, an important warming phase was recognized, clearly indicated by the increase of *Globigerinoides* gr. *ruber* and *G. gr. quadrilobatus*. This interval corresponds to the deposition of Sapropel S1b-equivalent stage (Sprovieri et al., 2003; Lirer et al., 2013; Siani et al., 2013), when high SSTs and oligotrophy characterized the entire Mediterranean region, especially during the summer seasons. Between ~5.9 and 4.2 ka, another warming phase occurred in the Gulf of Palermo, differing from the previous one due to the enhanced winter mixing of the water column, testified by the high abundance of deep dweller species, such as *Globorotalia truncatulinoides* and *Globorotalia inflata* left coilings. The last important warming phase corresponds to the *Minoan Warm Period*, briefly interrupted by a rapid cooling event (at ~3.5 ka).

Among these warm climatic phases, several rapid cold-cool events were recognized. In particular, *Neogloboquadrina pachyderma* and *Turborotalita quinqueloba* represent the best cold-water indi-

cators, increasing in abundance during the *Bond events* (B2, B3, B4, B5, B6) and other rapid cooling events that characterized the western (M3, M4, M5, M6, M7) (Frigola et al., 2007) and central Mediterranean (TC2, TC3, TC4) (Cacho et al., 2001) during the 9.2–2.9 ka interval.

**Conclusions.** Planktonic foraminifera and oxygen isotope variations highlight the climatic oscillations of the relatively stable Holocene stage. These oscillations are linked to the North Atlantic millennial scale climatic variability that forced cool/high productivity periods and warm/oligotrophic conditions. In particular, during the ~8–6.4 (S1b-equivalent), ~5.9–4.2, and ~3.7–3.2 (Minoan Warm Period) ka intervals, warm surface waters characterized the Gulf of Palermo. On the contrary, during rapid climatic phases, centered at 9.1, 8.2, 7.2, 6.2–5.9, 5.4, 4.7, 3.9, 3.5, and 3 ka, cool/high productivity conditions occurred in this sector of the southern Tyrrhenian.

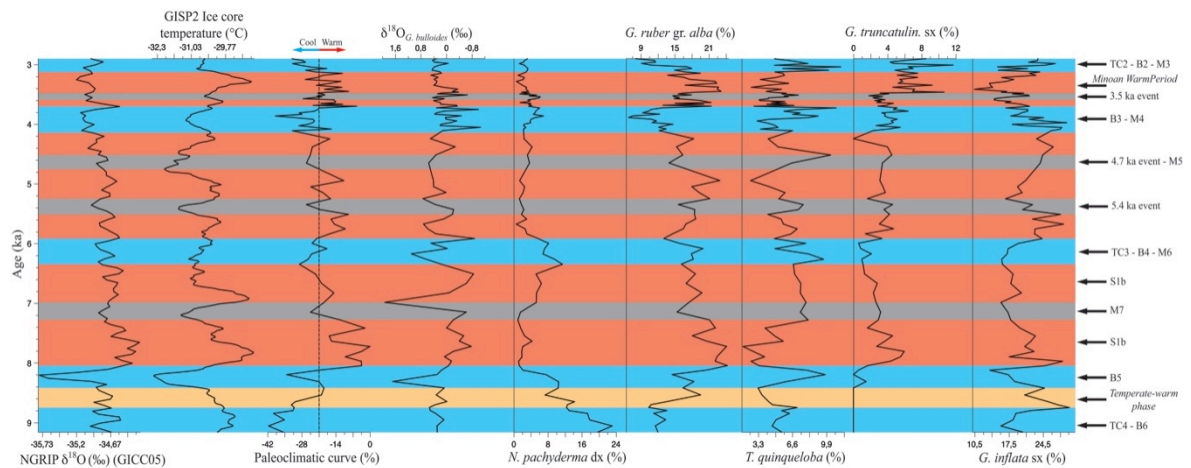


Figure 1. NGRIP  $\delta^{18}\text{O}$  (Svensson et al., 2008), GISP2 ice core temperature (Alley, 2000), and PU-MA09–C4 core paleoproxies. Climatic events are listed on the right of the plot. Blue, red, and orange horizontal bars indicate the cold-cool, warm, and temperate-warm climatic phases, respectively.

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