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Dominant dextral to sinistral coiling change in planktic foraminifera Morozovella during the Early Eocene Climatic Optimum in the Atlantic Ocean

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Coiling direction is a basic characteristic of trochospiral planktic foraminifera. However, although modifications in the coiling direction within ancient planktic foraminiferal populations may reflect important changes in evolution or environment, they remain scarcely discussed. Here we present data on fluctuations in the coiling direction within morphologically defined Morozovella species from successions that span the interval of peak Cenozoic warmth, the Early Eocene Climatic Optimum (EECO; ~53-49 Ma). We selected three widely separated Ocean Drilling Program (ODP) sites in the Atlantic Ocean: the subtropical Site 1051, the equatorial Site 1258 and the temperate south Atlantic Site 1263. The surface-dwelling genus Morozovella is of particular interest because it dominated tropical-subtropical early Paleogene assemblages and suffered an abrupt and permanent decline in abundance and taxonomic diversity at the start of the EECO. At all ODP sites investigated, morozovellids display a dominant dextral coiling preference during the interval preceding the EECO. However, all species became at all sites prevailing sinistral within the EECO. Specifically, the switch from dominant dextral to sinistral coiling occurred at all sites ~ 300 Kyr after the K/X event (~52.8 Ma). The coiling switch occurred ~550 kyr to ~650 kyr after a distinct drop in abundance. We provide therefore evidence of a coiling variation during the warmest interval of the early Paleogene. Our records highlight that the recorded coiling variations might provide a biostratigraphic tool for correlation of early Eocene marine strata. In order to establish whether this coiling switch was related to changes in morozovellid ecological niche we estimated stable carbon isotopes on dextral and sinistral species from samples located below and above the recorded coiling change. Results suggest that sinistral species moved higher in the mixed-layer after the coiling switch. It is thus possible that only species sinistrally coiled were able to keep the optimal environmental conditions for their survivorship. We need however more effort to understand the meaning of these modifications, such to verify whether variations in sea surface temperature or other parameters directly corresponded to the coiling change. Coiling switches can relate to ecophenotypic adaption (when a single species changes morphology in response to variation in environmental parameters, such as temperature) or genetic variance (when two almost identical morphotypes have different genetic signatures so they represent 'cryptic' species from a morphological point of view). Previous interpretations of coiling flips in planktic

foraminifera in the early Eocene, especially including morozovellids, have favoured a genetic explanation rather than an ecological response. Our present data cannot validate or disprove this idea, but should stimulate renewed thought on the matter.