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Late Quaternary Nile flows as recorded in the Levantine Basin: The palynological evidence

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ABSTRACT

This study aims to trace changes in the River Nile flows over the Late Quaternary and is based on palynomorphs which were embedded in the sea floor of the Levantine Basin. The palynomorphs were extracted from two marine sediment cores, which cover the last 86 ka and are located at the two ends of the Levantine Basin: MD-9509, at the southern part of the Levantine Basin, and MD-9501, at its northern part. Core MD-9509 was taken from the Nile cone and is characterized by high sedimentation rates and a good state of palynomorph preservation. The assemblages included palynomorphs which were transported via the Nile headwaters and therefore enabled the reconstruction of the River Nile flows. The results demonstrate that the last glacial period (~75–16 ka) was characterized by a decrease in Nile water discharge and an increase in sediment influx, while opposite trends were observed prior to the last glacial period as well as during the deglaciation and the Holocene. Based on the study of the spores, it is suggested that during the last glacial, the main contributors of freshwater and sediment load to the Eastern Mediterranean Sea were the Blue Nile and the Atbara and only during interglacials was there a more significant contribution of the White Nile. Within the northern core, MD-9501, pollen was preserved only during the formation of sapropels S3 and S1. The comparison of the sapropelic palynological spectra in both core sites clearly indicates that during sapropel deposition, climate conditions were more humid in the Northern Levant, reflecting the north-south regional Mediterranean climatic moisture gradient. Sapropel formation was a result of the intensification of the monsoonal climate system which was most probably related to the maximum insolation values at 65°N, while, currently, the Atlantic is the main influencing climate system in the region. One of the most interesting observations in this study is that during Heinrich Events H2-H6, which originated in the north Atlantic and were identified in MD-9509 based on minimum arboreal pollen percentages, pollen originating from tropical regions was not embedded in the Levantine Basin. These results lend support to the view that episodes of dryness in tropical/sub-tropical Eastern Africa were associated not only with low-latitude climate controls, but also with high-latitude glacial stress.

1. Introduction

Studying the paleoenvironmental conditions of the Levant region during the Late Quaternary is of a great importance since this area played a major role in the spreading and evolving of Neanderthals and early modern human groups (e.g., Bar-Yosef, 1995; Hovers et al., 1995; Bar-Yosef and Belfer-Cohen, 2013, pp. 36–39; Hershkovitz et al., 2015). Several marine palynological records which were extracted from the Levantine Basin enabled the reconstruction of regional changes in vegetation and climate during the Late Pleistocene (Rossignol, 1963; Rossignol-Strick, 1972, 1973; Cheddadi and Rossignol-Strick, 1995a,b; Kadosh et al., 2004; Langgut et al., 2011). Yet, these marine palynological studies focused mainly on changes in the Mediterranean vegetation zone on the eastern and northern coasts of the Levantine Basin, as well as on shifts in the steppe and Saharo-Arabian vegetation zone which mainly covers the eastern and southern parts of the region, respectively (Fig. 1a). In this study, new information is presented which enables the reconstruction of climate changes that occurred

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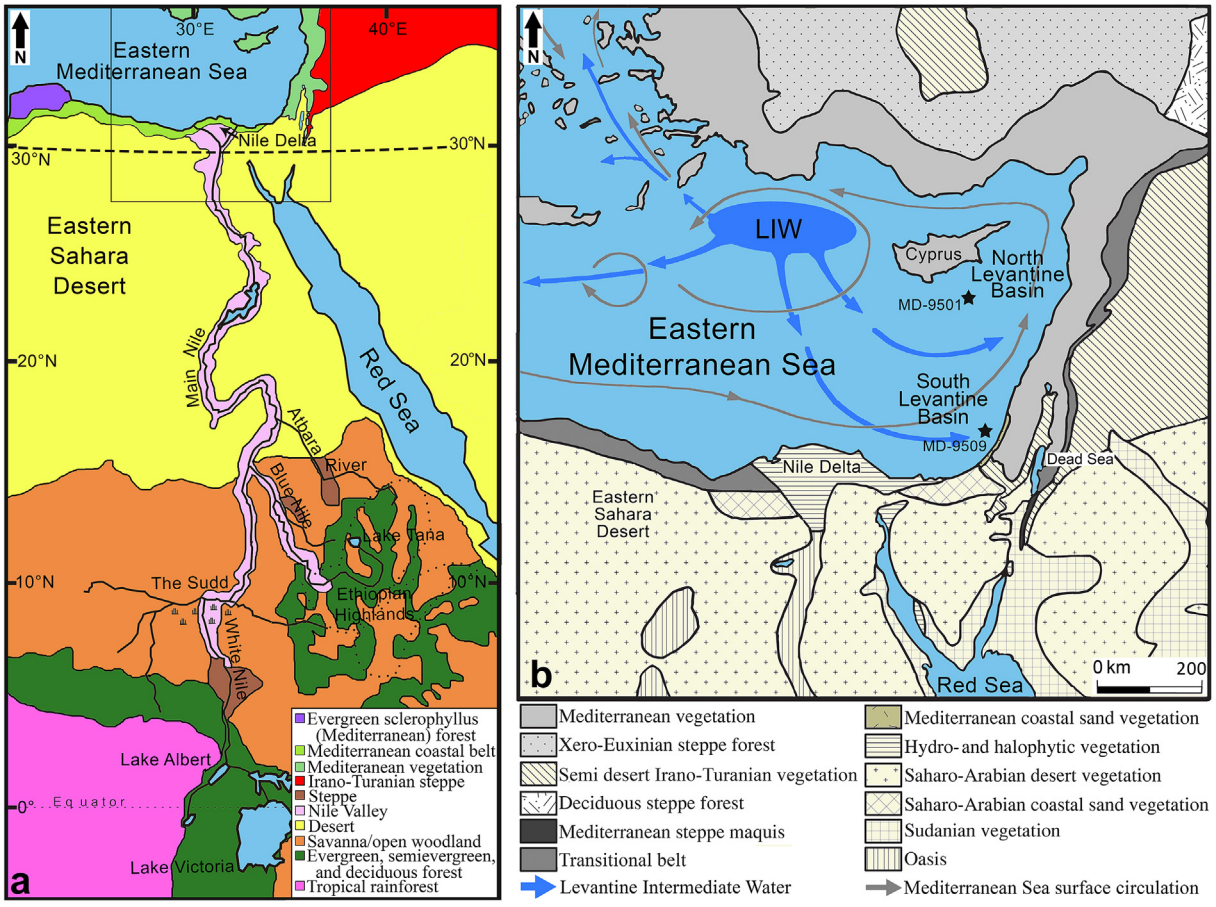

Fig. 1. (**a**). River Nile Basin including its main tributaries and main vegetation zones; (**b**). Eastern Mediterranean vegetation map (modified after Zohary, 1973), together with the location of core MD-9509 at 32°01 N, 34°16 E, from the Nile cone, representing the South Levantine Basin, and core MD-9501 at 34°32 N, 33°59 E, southeast of Cyprus, representing the North Levantine Basin. The two cores reflect sedimentation under the influence of two different climate regimes. While core MD-9501 was mostly under the influence of the North Atlantic/Mediterranean climate system, the MD-9509 sequence was also strongly influenced by the River Nile input, which originates in the low-latitude monsoonal system. Arrows indicate the prevailing surface currents (in grey) and the Levantine Intermediate Water (in blue; modified after Schmiedl et al., 2010). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

in the area extending from the Nile headwaters in tropical East Africa, and up to the Eastern Sahara Desert (Fig. 1a). The new data include aquatic pollen, algae, dinoflagellate cysts and trilete and monolete spores, which had been embedded in the sea floor of the southern Levantine Basin. Palynological evidence for the accumulation of sapropels in both the Northern Levantine Basin and the Southern Levantine Basin is also presented in this study.

The Nile River is the greatest contributor of freshwater into the Eastern Mediterranean Sea. The Nile encompasses a wide variety of climates, vegetation zones and river regimes – from the Equatorial Lakes Plateau of the White Nile headwaters to the delta in the Eastern Mediterranean Sea (Fig. 1a; Woodward et al., 2007). Therefore, the palynological spectra from Nilotic origin which are embedded in the sea floor of the South-Eastern Mediterranean Basin are from diverse origins and include palynomorphs such as tropical pollen, different types of fresh water algae and varies spores. East African climatic belts migrated considerably during the Late Quaternary, modifying Nile discharge and sediment influx into the Eastern Mediterranean Basin. Climatic fluctuations have been recorded by paleoclimate proxies along the Nile course and in its delta (Adamson et al., 1980; Williams and Adamson, 1980; Foucault and Stanley, 1989; Woodward et al., 2001, 2007, 2015; Stager et al., 2003; Revel et al., 2010; Williams et al., 2010, 2015; Marshall et al., 2011; Macklin et al., 2013, 2015 and references therein; Macklin and Lewin, 2015) and by well-defined depositional cycles, mainly of sapropel layers, in the Levantine Basin (Stanley and Maldonado, 1977; Stanley and Warne, 1993; Fontugne et al., 1994; Krom et al., 2002; Almogi-Labin et al., 2009; Box et al., 2011; Blanchet et al., 2013; Hennekam et al., 2014, 2015; Revel et al., 2014). In this study mostly palynomorphs were used in order to trace Late Quaternary climate changes in Nile discharge and sediment load.

The research is based on two marine sediment sequences which cover the last 86 ka and are situated in the northern and southern parts of the Levantine Basin (Fig. 1b; Langgut, 2008). The northern core, MD-9501, is located southeast of Cyprus and is mainly influenced by the mid-latitude westerly Atlantic/Mediterranean climate system. The southern core, MD-9509, which represents the Southern Levantine Basin, is located at the distal part of the River Nile cone, whose sources are dominantly influenced by the monsoonal system. The northern core is situated where Mediterranean vegetation and climate conditions are prevalent while the southern core is located closer to the vast Sahara-Arabian desert belt, a region generally characterized by more arid climate conditions. The location of the cores at the two ends of the Levantine Basin enabled the evaluation of the extent of the influence of the River Nile through time in the Levantine Basin. The identification of tropical elements which originated from the Nile headwaters and were eventually deposited on the sea floor of the Levantine Basin allowed the evaluation of possible links between the monsoonal and the westerly Atlantic climate systems.