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Ostracods from water bodies in hyperarid Israel and Jordan as habitat and water chemistry indicators

Steffen Mischke[a,b,*], Hanan Ginat[c], Bety Al-Saqarat[d], Ahuva Almogi-Labin[e]

[a] Institute of Earth and Environmental Science, Universität Potsdam, Karl-Liebknecht-Str. 25/H27, 14476 Potsdam-Golm, Germany
[b] Institute of Geological Sciences, Freie Universität Berlin, Malteserstr. 74-100, 12249 Berlin, Germany
[c] The Dead Sea and Arava Science Center, Tamar Regional Council, Dead-Sea Mobile Post 86910, Israel
[d] The Al al-Bayt University, PO Box 130040, Mafraq 25113, Jordan
[e] Geological Survey of Israel, Jerusalem, Israel

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ABSTRACT

The hyperarid region of Israel and Jordan covers a large area where numerous sites of Pleistocene lake sediments suggest that climate conditions were significantly wetter during the Pleistocene. This region experienced a significant increase in aridity in recent decades and the number of existing surface waters is diminishing rapidly. We studied ostracod shells from 49 pond and stream sites to determine the species distribution and to infer ecological preferences especially with respect to general differences in water movement, conductivity and ion composition. Twenty-two ostracod species were identified in total of which 12 taxa occur at three or more sites. Among the rarer species, *Cyprinotus scholiosus* was identified for the first time after two records from Plio- and Pleistocene sites in Yemen and Saudi Arabia. Further, *Paracypretta amati* was recorded and its ecological preferences discussed for the first time following the description of the species from its type locality in Sudan. *Cypridopsis elongata* is the only typical inhabitant of lotic habitats, strictly preferring freshwater conditions and waters with an alkalinity/Ca ratio around 1 and cations dominated by Ca^{2+} and anions by HCO_3^-. In contrast, *Cyprideis torosa*, *Limnocythere inopinata* and *Heterocypris incongruens* apparently prefer waters dominated by Na^+ associated with cations and Cl^- associated with anions. *Heterocypris salina* and *C. torosa* occur over a wide conductivity (or salinity) range and in waters with alkalinity/Ca ratios around 1 and with significant alkalinity depletion. *Humphcypris subterranea*, *Ilyocypris* spp. and *H. salina* are the only taxa which do not show any preference with respect to both the cation and anion dominance of the waters. The ecological preferences of the ostracod species from water bodies in the study area are discussed in detail and can be used for a qualitative assessment of the hydrodynamical and hydrochemical conditions of former water bodies in the presently hyperarid environment based on ostracod species composition analysis of Pleistocene aquatic sediments.

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1. Introduction

Recent climate change and groundwater exploitation have a strong impact on surface waters in southern Israel and Jordan (Black, 2009; Kafle and Bruins, 2009; Ginat et al., 2010; Sherzer, 2010). Water bodies in the hyperarid region diminished due to a general decrease of precipitation in the last 15 years and its effects on groundwater-depending surface waters, locally accelerated by groundwater pumping (ibid.). This situation is alarming due to its impact on local social and economic systems and the loss of regional biodiversity and aquatic refuges. Furthermore, the disappearance of surficial water bodies causes a reduction in potential analogues of Pleistocene aquatic habitats in the region. Pleistocene lake sediments are abundant in the presently hyperarid Negev Desert and in the northwestern part of the Arabian Desert which apparently experienced a considerable landscape change in the Quaternary and reacted sensitively to climatic conditions (Bender, 1968; Issar and Bruins, 1983; Livnat and Kronfeld, 1990; Avni, 1998; Abed et al., 2000; Ginat et al., 2003; Moumani et al., 2003; Davies, 2004; Petit-Maire et al., 2010; Vaks et al., 2010). In contrast to the relatively good knowledge of the geographical distribution of the Pleistocene lake sites, few information is available with respect to their timing and their palaeoenvironmental and palaeoclimatic significance (ibid.). The calcitic shells of ostracods (micro-crustaceans)

* Corresponding author at: Institute of Earth and Environmental Science, Universität Potsdam, Karl-Liebknecht-Str. 25/H27, 14476 Potsdam-Golm, Germany. Tel.: +49 3319775805; fax: +49 3319775700.
E-mail address: smischke@geo.uni-potsdam.de (S. Mischke).

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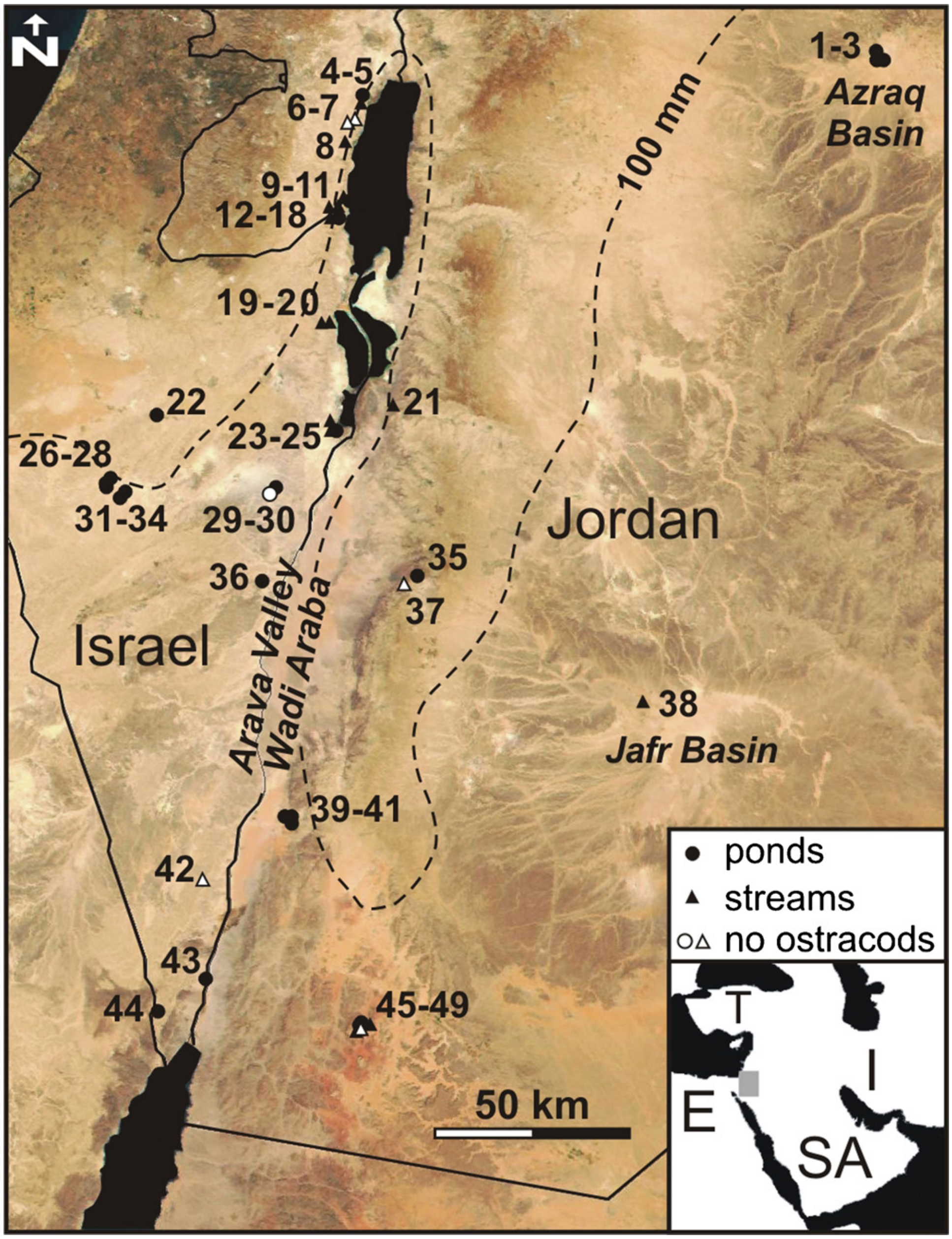

Fig. 1. Sampling locations in hyperarid Israel and Jordan. White fills represent water bodies without ostracod record. Broken line represents 100 mm isohyet. Refer to Table 1 for ID number of water bodies. Inset shows Near East region and the study area marked as grey box (T, Turkey; E, Egypt; SA, Saudi Arabia; I, Iran).

were commonly recorded from the Pleistocene lake sediments in hyperarid Israel and Jordan but were not used for a detailed palaeoenvironmental assessment since information with respect to the present ostracod species distribution in hyperarid Israel and Jordan and ecological conditions is lacking (Blaustein and Margalit, 1991; Abed et al., 2000; Ginat et al., 2003; Moumani et al., 2003). This situation provided the motivation for our study of ostracods and their ecological significance in hyperarid Israel and Jordan. Still existing, mainly spring-fed streams and ponds in hyperarid Israel and Jordan were sampled to determine the ostracod species composition and relevant habitat characteristics with the aim to provide the basis for a qualitative assessment of the Pleistocene lake habitats in hyperarid Israel and Jordan. A good understanding of the Pleistocene environments in hyperarid Israel and Jordan is a prerequisite for understanding the intensely disputed and spatially complex Quaternary and present climate change in the Levant (Enzel et al., 2008).

2. Study area

The sampling area in hyperarid Israel and Jordan has a North–South extension of 250 km and a West–East scale of 200 km (Fig. 1). The relief in this vast area ranges from large and flat basins such as the Azraq Basin to the tectonic graben escarpments in the Arava/Araba Valley, inselberg topography in Wadi Rum and steeply incised desert gorges. The regional geology is largely dominated by the Dead Sea Rift which is a 1000 km long and narrow valley along the Dead Sea Fault, the plate boundary between the Arabian plate and the Sinai sub-plate. It is a relatively young morphotectonic feature, developed in the Late Miocene or Early Pliocene (Garfunkel and Ben-Avraham, 1996).

Along the margins of the rift valley Upper Cretaceous to Paleogene carbonates and mud- and sandstones are the common rock units (Picard, 1951; Bender, 1968; Aghanabati, 1993; Garfunkel, 1997; Avni, 1998). The East Jordan Limestone Plateau is

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