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Quaternary sedimentology and prehistory on the Mediterranean coastal plain of Israel

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ABSTRACT

The coastal plain of Israel is composed primarily of Nile-derived quartz sand carried northward in the Nile Littoral Cell and partly windblown on land. Occasional clay and gravel deposits originated in the mountains to the east are confined to the eastern end of the plain. The windblown sand was subsequently consolidated by $CaCO_3$, probably supplied mainly by shell fragments carried with the sand. Intervals between episodes of sand deposition gave sometimes rise to pedogenic process, coupled by the influx of atmospheric dust carrying silt/clay particles from the west, south and east. Normally mature reddish-brown loams (=hamra soils) were formed. Occasionally, immature, gray-brown sandy soils of the Regosol type have formed. A few red-brown hamra soils contain archaeological remains, but cultural remains are absent from all sandy sediments or immature sandy soils.

The coastal plain consists of two distinct parts: The eastern part is made of Early and Middle Pleistocene deposits while the western part contains Upper Pleistocene and Holocene deposits. The western part is characterized by several elongated, shore-parallel aeolianite ridges distributed on- and off-shore. Such ridges are absent in the eastern part of the coastal plain. On the other hand, unconsolidated sands form a considerable volume of the deposits in the eastern part but hardly exist in the western part. In the eastern part of the coastal plain there are numerous Lower Palaeolithic sites dated 1.2–0.2 My. The western part includes sites stretching from the Middle Palaeolithic (ca. 200 Ky ago) to the Chalcolithic period (ca. 5 Ky ago). The Mount Carmel coast is unique in the preservation of off-shore sites dated between the 9th to the 5th millennia BP, submerged between 12 m below sea level and the waterline. Human skeletal remains were not found on the coastal plain except in these submerged sites.

1. Introduction

Most researchers accept that humans appeared some 7 million years ago in the African continent (Brunet et al., 2002), whence they have subsequently migrated to settle across the world. A few out-of-Africa migration roads were available (Beyin, 2006): the strait of Bab-el Mandeb, the Levant and the straits of Gibraltar. The main migration road appears, however, along two parallel itineraries in the Levant – the Dead Sea Transform (=Jordan Valley) and the Mediterranean coastal plain.

Here we focus on the latter migration route. Our aim in this paper is (1) to provide an updated geoarcheological, paleoenvironmental and chronological framework for the Pleistocene beds on the Israeli coastal plain, and (2) to discuss the prehistoric cultural remains found in those beds.

The bulk of quaternary sediments on the coastal plain is composed of wind-blown sand beds cyclically accumulated (Emery and Neev, 1960; Issar, 1980). The Nile carries into the Mediterranean 860,000 m^3/yr of sediments (Zviely et al., 2007), mainly quartz sand (Emery and Neev, 1960). The load is then transported through wave-induced currents (Rosen and Kit, 1982) north-eastward in the Nile Littoral Cell along the eastern Mediterranean coast (Inman and Jenkins, 1984). Some 460,000 m^3/y of Nile sediments reach southern Israel, ~100,000 m^3/y of which reach central Israel. Some 90-80,000 m^3/y of Nile sediments enter Haifa bay, the farthest end of the Nile Littoral Cell (Inman and Jenkins, 1984).

A part of the transported sand was wind-blown on land, subsequently consolidated by carbonates and became sandstone (Yaalon and Dan, 1967; henceforth, aeolianite). Sand accumulated cyclically and sometimes soil formed between cycles-mostly reddish loams (=Hamra soil) (Farrand and Ronen, 1974). Hence, the Quaternary of the coastal plain consists of cycles of sand beds topped by soil (Fig. 1).

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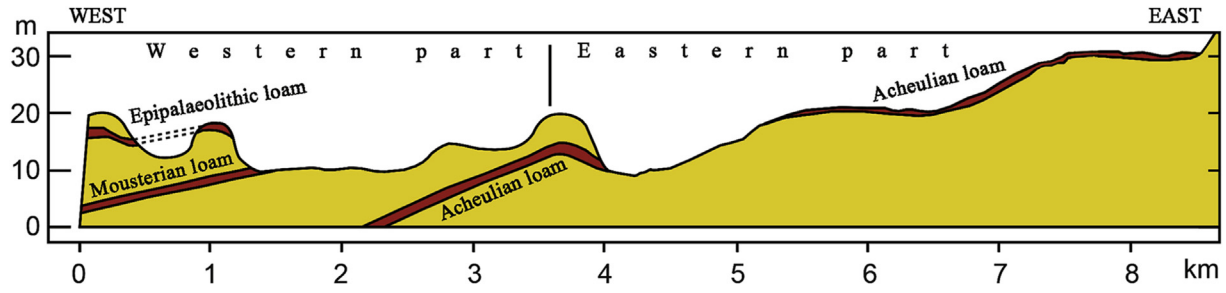

Fig. 1. Schematic cross-section of the coastal plain stratigraphy. The Acheulian and Mousterian horizons represent, each, an unknown number of superimposed loams. The Epi-Palaeolithic loam is not preserved on the Carmel and Galilee plains (adapted by G. Almagor from Ronen and Lamdan, 1990).

Thorough archaeological surveys of the coastal plain (Garrod and Gardner, 1935; Brunnacker et al., 1982; Olami, 1984; Boenigk et al., 1985; Ronen and Chernikov, 2010) revealed cultural remains of various periods embedded in red loams, but not in sand/aeolianite beds. Hence loams seem to have offered favorable conditions for human presence while the sand beds were apparently unfavorable. The reason for this occupation pattern may have been environmental: the vast sand beds likely accumulated under fierce sand storms which probably rendered life on the plain physically unattractive. The continuous influx of sand probably hindered plant growth which in turn prevented animal presence. With the absence of plant and animal food resources, humans too had to avoid the sand-stricken, desert-like coastal plain. During soil formation the deposition of sand has stopped, enabling the influx of fine sediments (silt and clay particles) through dust storms. The fines form 50–70% of the loams (Yaalon and Dan, 1967). Abundant plant and animal food now supported human existence on the soil.

The coastal plain divides into two parts, the eastern and the western, distinguished by their deposits, age and cultural remains (Fig. 1). The dividing line between the two parts is the Hadera aeolianite ridge which starts at Ali Muntar in the south (Fig. 2), runs through Kibbutz Maabarot and Pardesiya in the center up to Mount Carmel and continues in the Evron ridge up to Gesher Haziv on the northern end of the Israeli coastal plain.

2. The eastern plain

The eastern coastal plain is rather flat with a gentle hilly topography. This is the largest part of the plain, The bulk of the sediment is unconsolidated sand with a few aeolianite areas. The unconsolidated sands are possibly due to a lack of calcitic binding material, i.e. shell fragments. The paucity of shell may denote scarce shells in the source area along the shore, or a transport distance too great to carry any particles beyond fine quartz grains; There are on the eastern plain deposits of Early (1.5–0.8 My ago) and Middle (0.8–0.2 My ago) Pleistocene. Lower Palaeolithic sites and find spots are contained in at least 5 superimposed red loams (the actual number of buried loams is unknown). The oldest sites hitherto uncovered in the coastal plain are in the eastern part: Bizat Ruhama of the lower Pleistocene in the north-eastern Negev (Zaidner et al., 2010 and references therein) and the later lower Pleistocene Evron Quarry site on the Galilee coastal plain (Issar and Kafri, 1969; Ronen, 1991, 2003 and references therein).

2.1. The Oldowan

The prehistoric site Bizat Ruhama is exposed in a river channel in the Ruhama badlands (Fig. 3) some 25 km from the present shoreline, ca. 100 m above sea level. Bizat Ruhama is unique in Israel by its material culture and its faunal assemblage. Abundant cultural remains – flint tools and animal bone fragments – are embedded in a sandy clay exposed over a few hundred square meters (Ronen et al., 1998; Laukhin et al., 2001; Zaidner et al., 2010). The stone industry belongs to the oldest technological tradition in human history, the Oldowan complex (Zaidner et al., 2010; Zaidner, 2011, 2013) where the basic tools of the human tool kit were shaped: sharp flakes to cut with and chopping tools for hammering.

The faunal remains at Bizat Ruhama contain an early form of horse (*Equus* cf. *tabesi*) and a Eurasian spiral-horned antelope) either *Pontoceros* or *Spirocerus* sp.) (Yeshurun et al., 2011). The site is well preserved thanks to a quick cover by thick alluvial clays (Fig. 3). The geological setting, the plant remains and the animal species attest to environmental conditions largely similar to those at present, on the desert fringe with scarce water sources (Yeshurun et al., 2011). The stratigraphy, fauna, the tool assemblage and paleomagnetic analyses, all place Bizat Ruhama among the most ancient stops on the human out-of-Africa migration road, in the interval of 1.96–0.78 My before present (Zaidner et al., 2010; Yeshurun et al., 2011).

2.2. The Early Acheulian

The Evron Quarry site is located in the Galilee coastal plain slightly east of the Evron aeolianite ridge (Fig. 4), 3 km from the present shore, ca. 15 m above sea level. The stone industry is Early Acheulian, which followed the Oldowan culture complex. The Evron quarry site was apparently inhabited by a human group which left Africa somewhat later than the Bizat Ruhama group. Stone tools and animal remains were discovered in the quarry site (Issar and Kafri, 1969) in a clay hydromorphic layer (Gley) (Boenigk et al., 1985), below a thick alluvial cover and a gravel bed (Ronen and Amiel, 1974; Gilead and Ronen, 1977; Ronen, 1991, 2003, 2006). The typical Acheulian artifact is the hand-axe (Fig. 5), a bifacial tool shaped on both faces. Producing a hand-axe required a considerable planning and the investment of a large amount of work. This knapping procedure testifies to a higher cognitive capacity of the Acheulian hominins than in the former Oldowan culture.

The fauna at the Evron Quarry site contains ancient forms – elephants (*Elephas trogonrheii*), hippo (*Hippopotamus amphibious*) and an ancient species of African pig (*Metridiochoerus evronensis*) (Tchernov et al., 1994). The Lower Palaeolithic faunal assemblages in the Levant are characterized above all by the presence of elephants (Rabinovich et al., 2012) which became extinct around 400 Ky ago (Ben-Dor et al., 2011). The Lower Palaeolithic fauna reveals humid environmental conditions on the coastal plain. Subsistence apparently relied upon plant food gathering and game hunting or scavenging. Stratigraphy (Fig. 4), the stone industry (Fig. 5), the fauna (Tchernov et al., 1994) and thermoluminescence dating (Ron et al., 2001; Porat and Ronen, 2002), combine to place