Black Sea and Caspian Basins in Late Pleistocene: sea-level changes, climate and early human settlement

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The climate of northern Eurasia during the Middle Wiirm/Valdai 'megainterstadial' (OIS 3), which lasted from c. 58 to 23 ka, was cool and unstable, with at least five milder oscillations (including the 'Bryansk interstadial'). The estimated summer and winter temperatures in Eastern Europe were lower than today by 4-6°C and 4-10°C, and the annual precipitation, as low as 150-250 mm (Frenzel et al.,1992).

The OIS 2 or Last Glacial Maximum (LGM), 20-18 ka, featured the maximum extension of ice sheets in northern Eurasia. A quantitative assessment (Tarasov et al., 1999) suggests a temperature depression of 20-29°C in winter and 5-10°C in summer, with annual precipitation 200-450 mm less than today, and a drought index showing extremely dry conditions in northern and mid-latitude Russia. Vegetation was dominated by 'periglacial' tundra and cold-resistant steppe in combination with open woodland of larch and birch (Velichko, 1984).

During all that time, both the Black and Caspian Seas constituted predominantly fresh-brackish water low-level mega-lakes (or land-locked seas). The Black Sea depression was taken up by the Lower Neoeuxinian basin with Caspian type molluscan fauna. At 30-25 ka B.P., its level stood at 87-90 m below NN. The exposed shelf jointly with the North-Pontic Lowland south of the Dnieper formed a huge erosion-depositional plain that included the Pra-Prut, Pra-Dniester and Pra-Bug alluvial plains (Dolukhanov, et al., 2007a).

In the Caspian basin, this period corresponded to the occurrence of the Atelian phase, during which mean level stood at -140 to -120 m absolute and an area about one third of the present-day Caspian Sea.

During the course of OIS 3, the southern part of the East European Plain and its mountainous fringes, notably Crimea and Caucasus, sustained considerable populations of Neandertal humans. These are witnessed by sites with Mousterian-type inventories in some cases (as in Crimea and Caucasus) that are associated with Neandertal skeletal remains. Chabai (2007) distinguishes three main periods of Mousterian occupation in the Crimean mountains: c. 125-60, 60-38, and 38-28/27 ka B.P.

Later occurrences of Mousterian sites are acknowledged in the Caspian Sea basin. The site of Sukhaya Mechetka in the city of Volgograd, which contains the Mousterian ('Eastern Micoquian') industry was found in the paleosol beneath the associated Atelian 'chocolate loam' (Zamyatin, 1961; Praslov, 1984). Animal bones include mammoth, red deer, wolf, saiga antelope, and aurochs. The overlaying Atelian loam contained the bones of wild horse and reindeer (Moskvitin, 1962). Pollen shows a cold-resistant vegetation of steppe and semi-desert type.

The Upper Palaeolithic (UP) industries associated with early modern humans (EMH) appeared on the East European Plain at 42–40 ka B.P. (Anikovich et al., 2007). They are signalled in the eastern Carpathian area at about 32.7 ka (Noiret, 2004). A similar age (30–28 ka B.P.) has been obtained in Crimea (Chabai, 2007) and northern Caucasus (Golovanova et al., 1999).

The existing proxy evidence suggests that the early Late Glacial warming started around 15 ka B.P. and reached the thermal maximum (with 16–18°C July) between 13–11 ka B.P. Precipitation generally increased, particularly in the southern part of the East European Plain (Velichko et al., 2002).

The Black Sea level rose from c. 50 to 30 m below NN during the Recent Neoeuxinian stage (18/17–14 ky B.P.). At that stage, the sea transgressed onto the deltaic accretion plain covering more than a third of the alluvial plain. At the final stage of the Neoeuxinian (12 ka B.P.), sea level reached 20 m below NN, submerging the greater part of the terraced alluvial plain. At this stage, the sea intruded deep into the lower reaches of the Dnieper and Dniester, forming huge estuaries, separated by small-sized watersheds.

In the Caspian basin, this period broadly coincided with the Khvalynian transgressions. The most reliable ^{14}C dates obtained for samples of both Lower and Upper Khvalynian deposits (Rychagov, 1997; Svitoch, 2003; Leonov et al., 2002) lie in the time-span between 10 and 17 ka, with 16–14 ka as the probable age of the Khvalynian transgression's maximum level (Fig. 1).

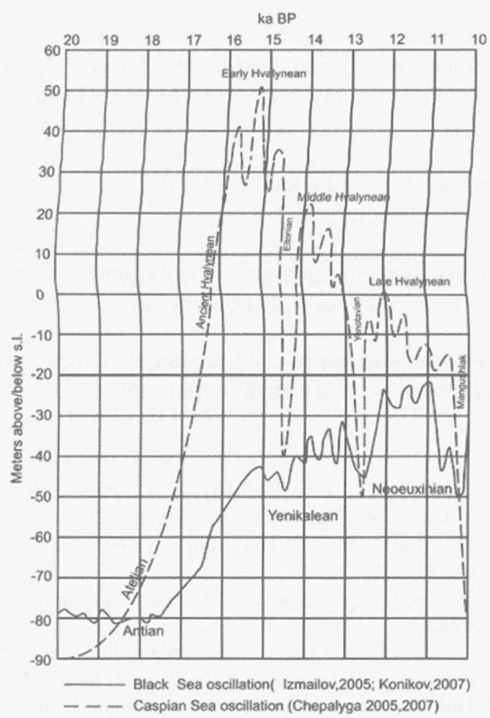

Figure 5. Late Pleistocene oscillations of the Caspian (dotted line) and the Black Sea (solid line).

The maximum rise of the Khvalynian basin reached +50 m absolute and led to the spilling of excess water into the Black Sea via the Manych-Kerch waterway. This 'spillway' is viewed as an element of the 'Extreme Inundation Epoch', and part of a 'Cascade of Eurasia Basins' (CEB) (Chepalyga, 2007), caused by the combined effect of increased river runoff, melting snow, and frozen ground.

During the Early Khvalynian transgression maximum, summer paleotemperatures were close to those of the present-day; both paleotemperature and salinity reached their maximum values. Spring temperatures were also high, which contributed to an intense snow melting, and reduced salinity, thus making the water isotopically 'lighter' by 3–4 ‰ as compared to its summer values, while the total oxygen isotopic composition was by 1–2 ‰ 'heavier' than at the initial transgression phase. During the Late Khvalynian regression, both the spring and summer seawater temperatures were +5°C lower than at its transgression phase. The oxygen isotopic composition of water was the 'lightest' for the entire period of the Khvalynian Sea.

The spring and summer seawater temperatures further increased in the Late Khvalynian Basin by 2–3° C compared to the Early Khvalynian regression phase; the spring and summer salinity in the western part of the Northern Caspian became almost identical to recent ones. The overall seawater oxygen isotopic composition became 'heavier' by 1 ‰ without notable seasonal changes.

Recently summarized evidence (Dolukhanov et al., 2007b) indicates the correlation of Mousterian deposits with the Early and Late Khvalynian coastal forms in various parts of the Caspian basin: Manas-Ozen in Dagestan, Saratysh Bay on Mangyshlak, and Belek on Krasnovodsk Peninsula. Supposedly, the specific environments that arose in the Caspian basin during the course of the Khvalynian transgression favored a prolonged conservation of the Mousterian technique, and, possibly, a survival of Neandertal populations. As a possible factor, one might mention the CEB that included the Caspian-Black Sea spillway across the Kumo-Manych Valley, which effectively isolated the Caucasian-Central Asian area. The spread of Upper Paleolithic technology in that area became possible only in the aftermath of the Late Khvalynian transgression, 12.5–12 ka B.P.

Conclusions

The fluctuations of both the Black and Caspian Sea level were largely controlled by river discharge, thus reflecting the global pattern of climate change (Arpe and Leroy, 2007; Kislov and Toropov, 2007).

Correspondingly, the LGM, which featured a substantial decrease in river discharge, corresponded to the emergence of low-level mega-lakes in both basins;

Rise in the levels of both basins (Neoeuxinian and Khvalynian) occurred in an environment of Late Glacial increased temperature, precipitation, and snow melting;

Hyperarid climate and an effective isolation of the Caspian area contributed to the prolonged survival of Mousterian technology and, possibly, Neandertal populations.

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