Paleo-Dniester Holocene history: use of palynostratigraphy to assess the validity of dating by amino acid racemisation and C-14 ages of Black Sea shells

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AIM

The purpose of the present study is to re-examine the critical sections of peat inter-layered with peaty mud/silt, using palynology as a palynostratigraphic tool and for paleoenvironmental analysis of the early Holocene Paleo-Dneister environment.

INTRODUCTION

The history of the early Holocene marine transgression on the Ukrainian shelf of the Black Sea was investigated with a multidisciplinary study of ten samples from the uppermost part of Core 342 (Fig. 1), in order to compare results with those obtained from this shelf previously (1,2,3). According to AAR and AMS ^{14}C (4,5), the sedimentary strata on the Ukrainian Black Sea shelf were formed as the result of a prompt Mediterranean transgression that raised the water level of the pre-existing Neoeuxinian lake from approximately –100 m to the level of the Bosphorus sill (–35 m) in 300 years. Accordingly, the overlying units in Core 342 indicate a stabilizing water column, with significant mixing on the inner shelf of older and younger shells (4,5).

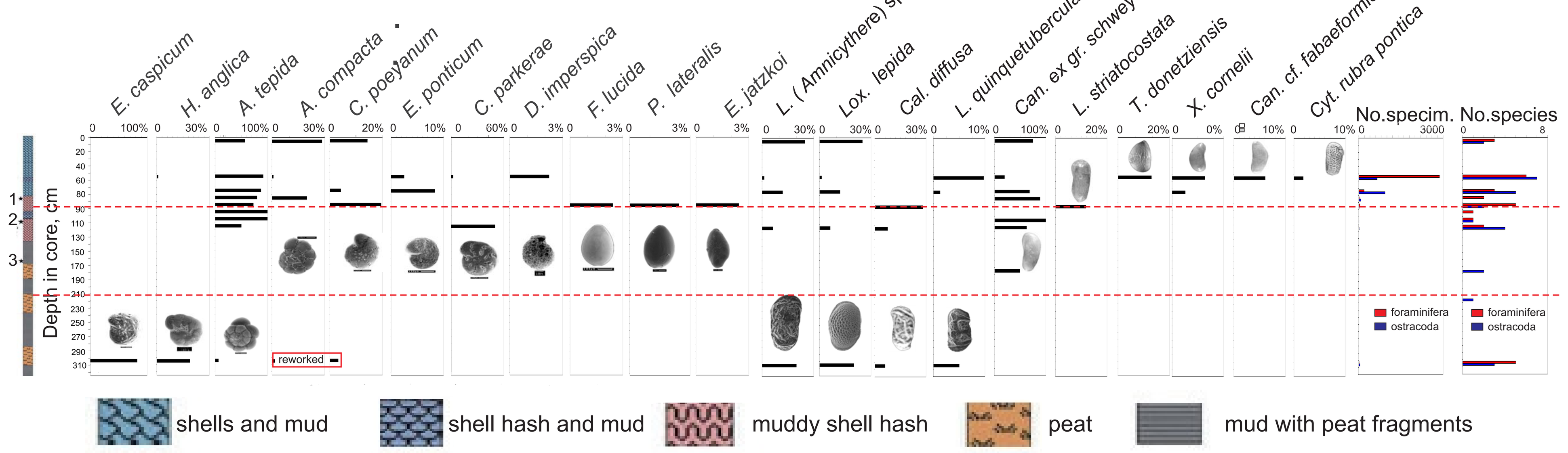
MATERIAL & METHODS

This multidisciplinary study focused on ten samples from the uppermost 3-m section of Core 342 (72.5 m long) taken from a present water depth of 30 m (Fig. 1). All samples were analyzed using palynological, microfaunal (foraminifera, ostracoda), macrofaunal (mollusks), and lithological methods. Palynological studies included analysis of pollen, spores and dinoflagellate cysts for palynostratigraphic correlation, and study of algal and fungal spores, zoomorphs, micro-charcoal, and other particulate plant material (kerogen) was conducted to determine the nature of the peat and the depositional environment.

Results I. Palynostratigraphy (Fig. 3). Arboreal pollen spectra show a succession from pre-Boreal *Pinus-Picea* woodland older than ~9 ka to Boreal *Pinus-Picea-Quercus-Ulmus* forest, then more temperate Boreal forest with *Carpinus*, *Castanea*,*Tilia*, *Juglans*, and *Olea*. Cluster analysis shows the *Dreissena* and Cardiid shell grouped in a pollen zone of younger age.

Results II. Palynofacies analysis includes study of algal and fungal spores, zoomorphs, micro-charcoal and other particulate plant material (kerogen) determine the nature of the peat and the depositional environment. Fig. 4 shows the distributions of terrigenous and brackish/marine palynomorphs and kerogen types (4b) that characterise deltaic and coastal environments (4a). Fig. 4c shows the corresponding proportions of these markers in Core 342 samples, and amounts of reworked pre-Quaternary pollen and dinocysts/sample

Fig. 6. Foraminifera, ostracoda and molluscs in Core 342.



1 - 4360±50 BP (*Mytilus*), 5675±30 BP (*Mytilus*), 9140±60 BP (*Cardium*); 2 - 9020±70 BP (peat?), 9600±60 BP (Dreissena); 3 - 8920±60 BP (peat)

RESULTS AND DISCUSSION

Fig. 1. Location map

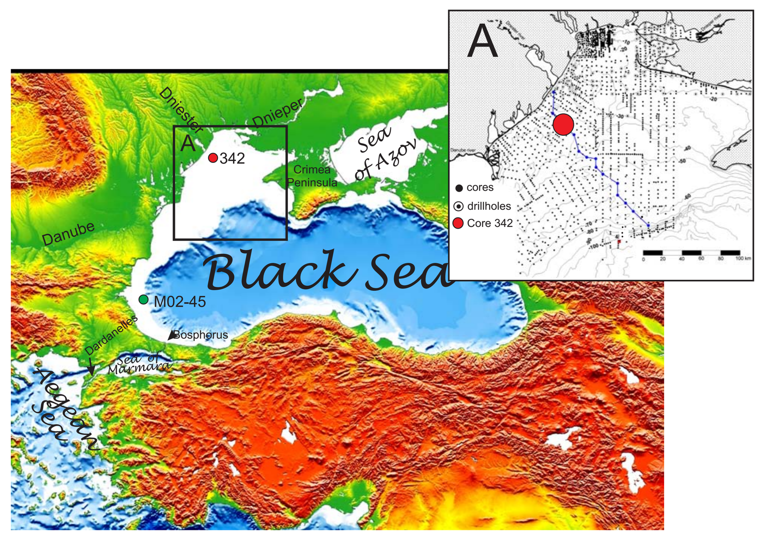


Fig. 2. Geological transect across UkrainianBlack Sea shelf.

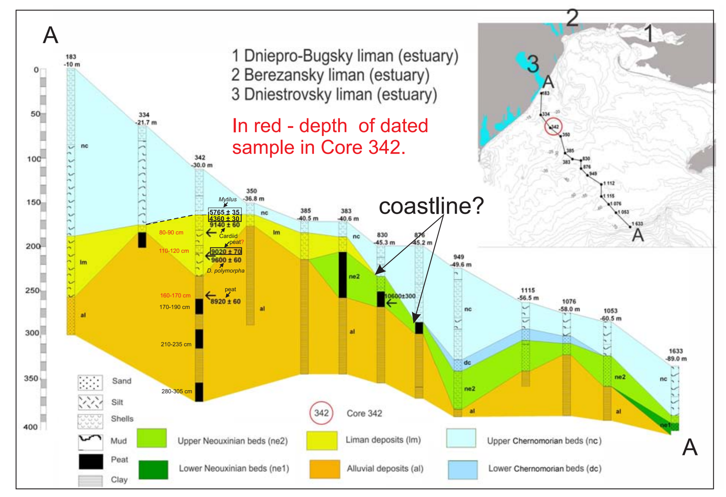
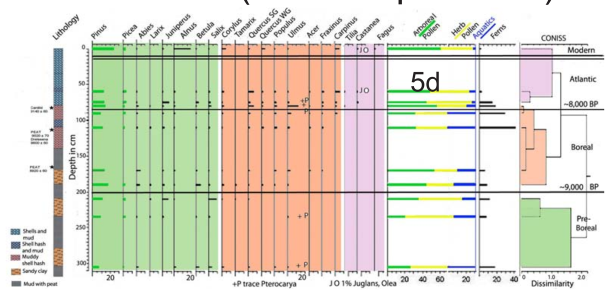


Fig. 3. Palynostratigraphy.

3a. Core 342 (water depth 30 m).



3b. Core MAR02-45

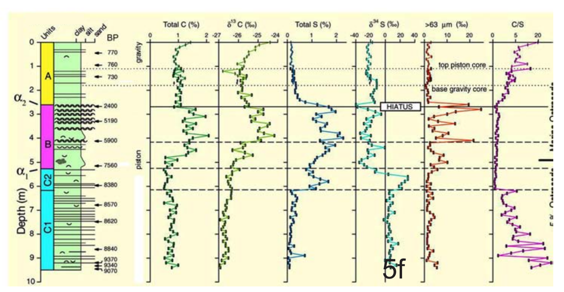
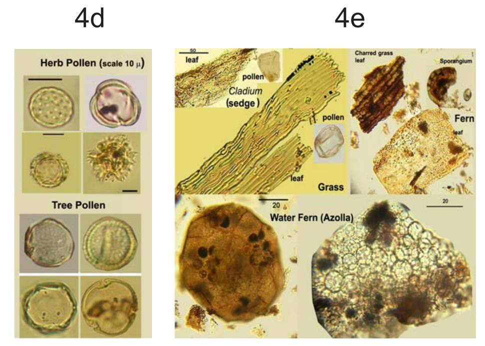
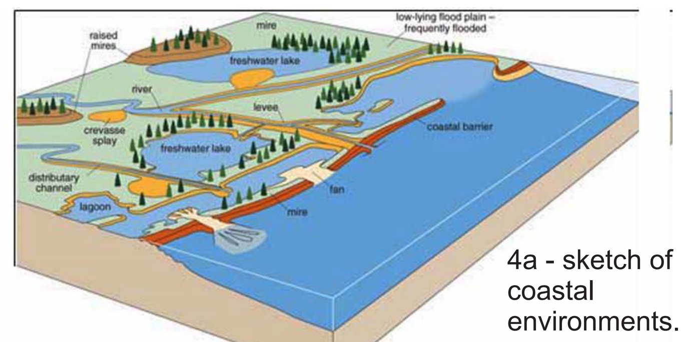
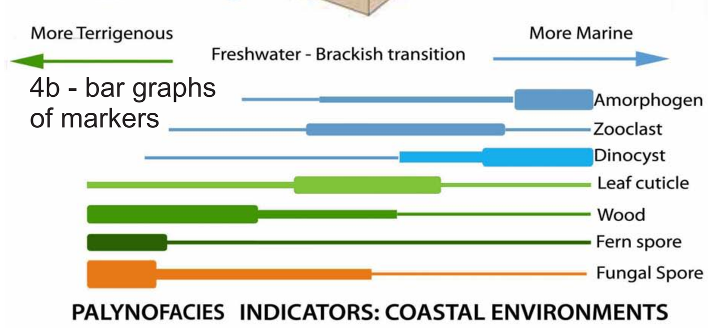


Fig. 4. Palynofacies analysis (a-c), key pollen indicators (d), and main peat types (e) sedge, grass, fern.







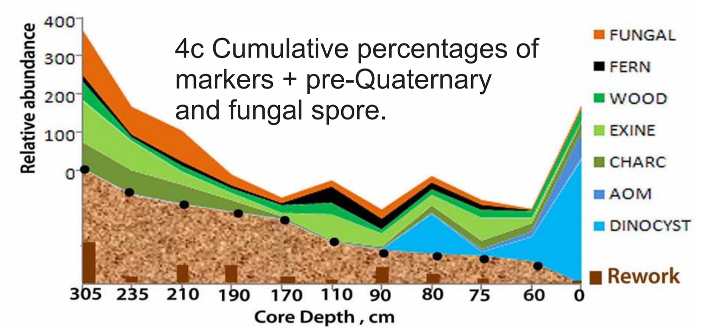
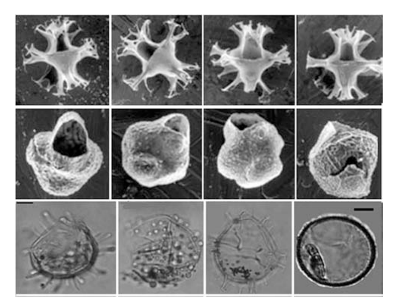


Fig. 5 Dinocysts.



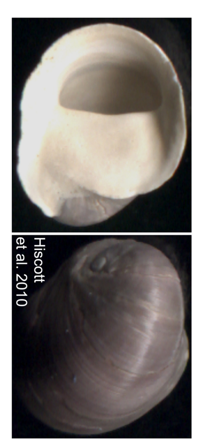


Fig. 7. *Caspia* sp. Core MAR02-45, 14C 9 ka BP brackish water facies.

Results III. Tree pollen and terrestrial herb pollen assemblages in coeval early Holocene sediments from Core 342 (Fig. 3a) and MAR02-45 (Fig. 3b) are essentially the same, indicating a cool moist climate, with local coastal ponds and saltmarshes. However, in comparison to the Turkish shelf core MAR02-45, assemblages of Ukrainian shelf Core 342 contain much more sedge, grass, and swamp fern spores (*Thelypteris palustris*), and large amounts of herbaceous kerogen, typical for a deltaic marsh environment like the present Danube Delta. In contrast, in MAR02-45, lower aquatic pollen abundances, absence of peat, and presence of diverse assemblages of Caspian-type dinocysts (Fig. 5) confirms that this ca. 30 m deep water site was already fully submerged by 9.3 ka, hence validating the sedimentological-based interpretation of Hiscott et al. (5,6).

Results IV. Microfaunal analysis of Core 342 indicates three basic depositional environments (Fig. 6): freshwater ponds in the Paleo-Dniester delta (320–210 cm), brackish Paleo-Dniestrovian liman (210–85 cm), and marine inner shelf (85–0 cm). The dominance of stricto- and polyhaline species, and the disappearance of freshwater and brackish forms from 85 cm upwards, indicate that present-day conditions on the Ukrainian shelf began at ca. 7.5 ka BP. In the Early Holocene, the site of Core 342 was located above sea level, which stood at that time at ca. –45 m (Fig. 2) and was submerged much later in the course of the Novochernomorian (New Black Sea) transgression (1,2,3) similar to the NE and SW Black Sea shelf, where present-day conditions started at ~5.6 ^{14}C ka BP (8,9).

CONCLUSIONS

Results show that the peat section from 2.37–1.7m was a sedge-cattail type with undercover of marsh fern (Thelypteris palustris) like the floating mats in the modern Danube delta. Two bulk 14 C peat ages show that the sedge peat developed rapidly near sea level about 8920±60 yrBP when the flood-land of paleo-Dniester formed a series of freshwater ponds during a temporary regression. Next, the delta was transformed into a Dniestrovian liman (samples 1.15–0.55m) during the Medi-terranean transgression. By ~ 8.5 ka, sea level was at least -31.2m (30m water depth of the core +1.2m depth in core). Pollen (*Pinus-Picea-Ulmus*) and dinocyst assemblages (*Spiniferites cruciformis-Pyxidinopsis psilata*) place the age of the youngest sample (0.55m) as older than 7,500 yrBP. An AMS-calibrated amino acid racemisation (AAR) age off 6,200 BP obtained for *Mytilus* fragments in a *Dreissenia* shell layer at 0.85m is clearly too young, and an AMS age of 9,140±60 yrBP for *Cardium* in this layer is much too old. By comparison with data from Core MAR02-45, it can now be calculated that from 9.5–8.5 ka, the Black Sea water rose from ca.-49m on the Turkish shelf to -31.2m on the Inner Ukrainian shelf at a rate of ca. 1.7cm a-1, similar to the rate of change caused today by summer heating and eddy formation.

ACKNOWLEGEMENTS

This paper is a contribution to IGCP 521-INQUA 501 as well as the Russian-Ukrainian project № Ф28/428-2009 "The Northwestern Black Sea Region and Global Climate Change: Environmental evolution during the last 20 ka and forecast for the 21st century" sponsored by the State Fund for Fundamental Research, Ukraine.

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