First high resolution marinopalynological stratigraphy of Late Quaternary sediments from the central part of the Bulgarian Black Sea area

Първа маринопалинологична стратиграфия с висока резолюция на късноквaтернерни утайки от централната част на българското Черноморие

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Introduction

The almost isolated Black Sea is particularly sensitive to the paleoenvironmental changes. Therefore, the Black sea sediments provide an excellent opportunity for high-resolution studies of past climatic, vegetation and hydrological changes. Whereas previous palaeoecological studies were centered mainly on the analyses of marine sediments from the southern and northern part of the Bulgarian Black Sea area, its central part in front of the Cape of Emine was less investigated. That is why the aim of this study is to refine the understanding of Late Quaternary evolution of the western Black Sea area and the Eastern Balkan Range. For this purpose, a high-resolution multi-proxy study on Giant Gravity Core 18 from the Black Sea continental slope is conducted. These data allows the description of more detailed pollen stratigraphy and more precise palaeoecological reconstructions of the Bulgarian Black Sea area.

Material and methods

Spores, pollen and dinoflagellate cysts of Late Quaternary sediments were analyzed from GGC 18, recovered from a water depth of 971 m in the western Black Sea (42°46.569" N, 28°40.647" E) during cruise AK06 on the R/V Akademik (Institute of Oceanology, Bulgarian Academy of Sciences) in September 2006. The investigated length of the core is 203.5 cm. It includes 3 lithological units: Unit III (128–203.5 cm) is represented by light grey clay; Unit II (47–128 cm) contained sapropels; Unit I (47–2.5 cm) is coccolith-bearing ooze. The core was sampled at 5–10 cm intervals. Sampling of the interval 130.5–140.5 cm was carried out at every 1 cm. All 56 samples were processed with HF and acetolysis (Faegri, Iversen, 1992). The percentage spore-pollen diagram is divided into 6 local pollen assemblage zones (LPAZ) (GGC18-1 to GGC18-6). The trends in the vegetation dynamics and climate changes and the early history of migration of the majority of the arboreal taxa that nowadays occurring in the Eastern Balkan Range were traced out. The assemblages of dinoflagellate cysts and acritarchs were investigated to provide a reconstruction of surface seawater salinity (SSS) and surface seawater temperature (SST) changes. AMS radiocarbon dating of bulk organic carbon was performed on 18 selected sediment layers. The dates were determined in the National Ocean Sciences Accelerator Mass Spectrometry Faculty, Woods Hole Oceanographic Institution (NOSAMS). This chronological data gave opportunity for the first high-resolution pollen stratigraphy of Late Quaternary sediments from the western Black Sea area to be presented.

Results and Discussion

Vegetation dynamics

The pollen diagram shows a steppe phase during the Younger Dryas Stadial (LPAZ-1), that is characterized by the domination of xerothermic taxa such as *Artemisia* and Chenopodiaceae. The LPAZ-2 demonstrates a forest-steppe phase during the Early Holocene. A characteristic feature is the replacement of xerothermic herb communities by arboreal species up to 8650±40 yrs BP. The primary role in this initial stage of the vegetation palaeosuccession was taken by oak (*Quercus*) in contrast to the central and west-

ern Europe where *Corylus* appeared as a pioneer element on open areas prior to the other migrating trees. Open communities of various *Quercus* species with other thermophilous trees such as *Ulmus* and *Tilia* were spread. The main reason for the prevention of the development of dense arboreal vegetation could be the climate oscillations with increasing temperature but still insufficient moisture for a widespread forest cover. The identification of pollen grains of trees other than *Pinus* (*Quercus*, *Corylus*, *Ulmus*, *Tilia*, *Carpinus betulus* and *Fagus*) suggests their probable survival in suitable localities along the coast during the Late Glacial. This is in good conformity with results of previous palaeoecological studies of the Bulgarian Black Sea coast and the Balkan Range. In LPAZ-3, a sharp decrease of arboreal pollen (AP) and increase of *Artemisia* is observed. This could be associated with the climate cooling known in Europe as "8.2 kyrs BP cold event" (Magny et al., 2003). The palynological record in LPAZ-4 implies that the mixed oak forests with abundant *Ulmus*, *Carpinus betulus* and some *Tilia* and *Fraxinus excelsior* reached their maximal distribution between 6910±30 and 4990±30 yrs BP. After 6420± 30 yrs BP when the forest cover started to become denser, a diminishing of *Corylus* pollen production occurred with subsequent restriction in its distribution under the forest canopy. The presence of climbers such as *Hedera*, *Humulus* and *Cannabis* in the deciduous forest indicates increase of humidity and rise in mean annual temperatures. The areas occupied by *Fagus* expanded after 6420±30 yrs BP, while the increase of *Fagus* in the southern part of the Bulgarian Black Sea coast started earlier – at 8355±75 yrs BP. Along the northern Bulgarian Black Sea coast the spread of *Fagus* started later and its expansion maximum was at 3000 yrs BP. The presence of the mixed oak forests continued during the Subboreal until 3120±35 yrs BP (LPAZ-5). During the Subatlantic (LPAZ-6) destructive changes of the vegetation cover occurred, probably due to human impact. The most characteristic event was also the increase of *Alnus* and *Fagus* due to the increase of humidity and cooling of climate.

Dinocyst assemblages

Two main dinoflagellate cyst assemblages, one dominated by fresh- to brackish water species such as *Spiniferites cruciformis* and *Pyxidinopsis psilata* and a subsequent one, that is characterized by euryhaline marine Mediterranean species such as *Lingulodinium machaerophorum*, *Spiniferites belerius*, *S. bentorii*, *Operculodinium centrocarpum* and acritarch *Cymatiosphaera globulosa* testified a change in SSS from low salinity (<7 psu) to present day values after 8650± 40 yrs BP. The algal blooms especially of *Lingulodinium machaerophorum* and *Spiniferites belerius* coincide with high temperatures of the Holocene climate optimum (Atlantic: ~8000 to 4990±30 yrs BP) followed by a succession of species suggesting a decrease of temperature and salinity. It is followed by an unusual presence of *Spiniferites cruciformis* and the decrease of percentage values of the euryhaline marine species at the transition of the Unit II to Unit I, that coincides with the climate change records during the transition from the relatively dry and warm Subboreal to the relatively cold and wet Subatlantic. This palaeoenvironmental change indicates a decrease of SSS caused by the large freshwater influx into the Black Sea by the rivers Danube, Dniester, Dnieper and Don. Substantial freshening of the Black Sea surface waters from ~29 psu to approximate 19 psu, based on alkenones of the coccolithophorid *Emiliania huxleyi* in the last 3000 years is also suggested for the Black Sea waters by van der Meer et al. (2008).

Conclusions

1. The palynological record suggests that open oak forests were spread in the Eastern Balkan Range at the beginning of the Holocene and shows early migration of the major temperate arboreal species such as *Quercus*, *Ulmus*, *Tilia* and *Carpinus betulus*. The vegetation palaeosuccession continues with the spreading of mixed oak forests from 8650±40 until 3120±35 yrs BP followed by destructive changes due to the human impact and climate deterioration.
2. Cooling of Holocene climate that is well known in Europe as "8200 yrs cold event" is established for the first time in marine core from the Bulgarian Black Sea area.
3. Substantial freshening of Black Sea surface waters at 3150 yrs BP is established and connected with climate change.

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