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Pollen-based Holocene palaeolandscape reconstructions in the Varna Lake area using modelling and simulation approach

Палеоландшафтни реконструкции в района на Варненското езеро през Холоцена по данни от спорово-поленов анализ

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Analysis of the fossil pollen assemblages of lacustrine sediments can be used to study the vegetation dynamics and human impact on the natural vegetation. Different models describe the spread and accumulation of pollen around the sample site and provide an excellent opportunity for quantitative reconstruction of vegetation coverage.

The rich prehistoric human life along the lake determines the large human pressure on natural vegetation. Simulations and reconstructions give good possibility to investigate not only the human influence from Eneolithic to present days, but the development of cultural landscapes and interaction between humans and the landscape.

The Varna Lake is the largest by volume and deepest liman along the Bulgarian Black Sea Coast, and therefore, pollen found in its sediment samples is representative of the regional vegetation from a large area.

This study aims to create a calibrated model on the basis of modern pollen, vegetation and environmental data and then to reconstruct the past vegetation and to simulate landscapes in the GIS environment.

A detailed pollen analysis was performed on the 870 cm of the 995 cm Core-3 obtained from the Varna Lake at a water depth of 6 m. An age/depth model based on 7 AMS radiocarbon dating was constructed (Filipova-Marinova et al., 2013). The Extended R-Value (ERV) model was used to relate pollen percentages to vegetation composition within a certain area, by taking the pollen productivities and fall speed of different taxa into account (Sugita, 1994). Models of pollen dispersal and deposition were applied in order to reconstruct likely past landscape scenarios from fossil pollen assemblages using the software suite HUMPOL v.3 (Bunting, Middleton, 2005).

The modern pollen samples together with the corresponding vegetation data were collected and digital maps were created. Five vegetation communities are recognized as well as two types of non-pollen producing areas. The application of the ERV model for simulation of contemporary landscape around Varna Lake calculates distance weighted plant abundance estimates of pollen productivity for use as correction factors. Measurement of goodness-of-fit between pollen and vegetation data are presented as the Relevant Source Area of Pollen (RSAP) by calculating the likelihood function scores against the distance from the sample point. Three submodels of the ERV model are tested and show similar results but ERV model 3 was selected and gives an RSAP of 4300 m for this landscape.

Standard intuitive interpretation of the pollen assemblages suggests six stages of development of the vegetation in the Varna Lake area. The vegetation communities and their composition were simulated in GIS environments and possible vegetation maps were drawn. Numerous 50 km by 30 km landscape simulations were performed at ten time-windows in the past (Fig. 1).

The first time window covers the period between 7870–7781 cal years BP and is characterised by the absence of anthropogenic activities. Mixed oak forests were widespread and reached their maximal distribution. Grasslands occupied limited areas from 8.23% of the pollen-producing areas.

The second simulated period is from 6139 to 5821 cal years BP and corresponds to the Late Eneolithic. Percentage composition of the vegetation

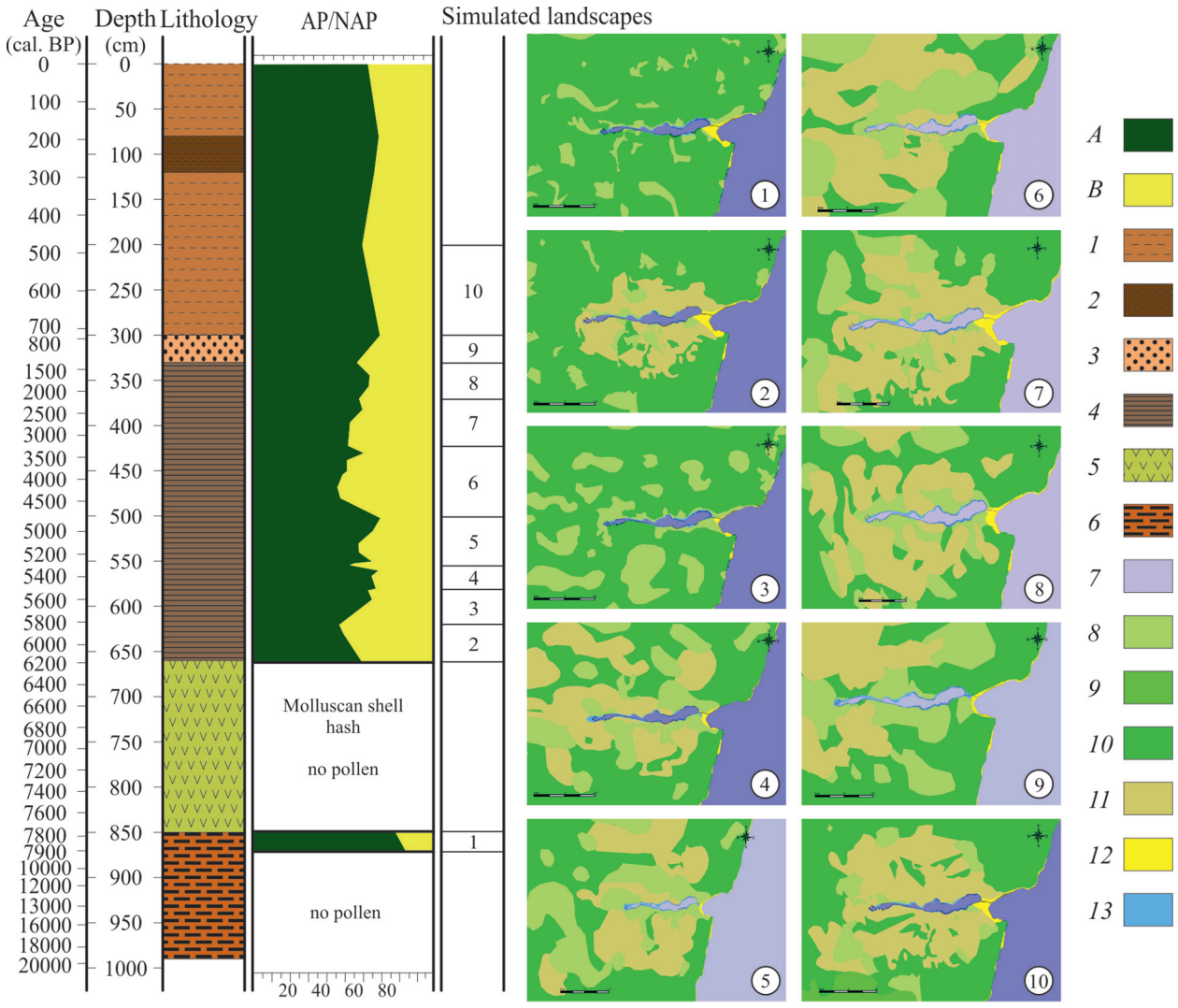

Fig. 1. Simulated landscapes around the Varna Lake in four time-windows: *A*, arboreal plants (AP, trees and shrubs); *B*, non-arboreal plants (NAP, herbaceous plants); lithological description of the Core-3: *1*, beige-grayish clays, enriched in sand, *2*, grayish clay, *3*, grayish-yellow sandy-clayey layer, *4*, laminated clay – alternation of light gray and dark gray laminae, *5*, molluscan shell hash, *6*, massive brownish-gray clay; non-pollen producing areas: *7*, present water surface; vegetation communities: *8*, grassland, *9*, riverine forests (longoz forests), *10*, mixed oak and hornbeam forest, *11*, arable areas, *12*, psammophytic communities, *13*, marshy areas

obtained from the ERV model shows decrease in forest areas (45.75%) due to the human impact and enlargement of arable areas (39.37%).

Pollen counts from the samples of the third simulated period (3750–2350 cal years BP) suggest decrease of arboreal vegetation with re-expansion of cereals and anthropophytes. The percentage values of forest areas is 41.14%, arable areas – 46.81%.

The pollen data from the fourth time window (650–290 cal years BP) could be interpreted as decrease of mixed oak and hornbeam forest. The simulation data suggest some pollen signals, which indicate the riverine-flooded forests (4.6%) along the river valleys of the Bulgarian Black Sea coast. The most characteristic feature is the formation of modern vegetation communities along the coast.

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