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THESIS OF DISSERTATION

Malacological analysis of a unique loess profile from the southern Great Hungarian Plain and palaeoclimatological reconstruction of the area for the Upper Weichselian

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Introduction and aims

Loessic sediments and prehistoric remains that developed during the Quaternary are investigated by several disciplines. Intensive attention and research are not accidental. These represent the youngest sedimentary strata, which were deposited under particular and changeable environmental circumstances. It is becoming a common knowledge in these days that human activity has concluded environmental crisis. Its local and regional conclusions are recognized even by the common man, however, only estimations can be made about its global effects. In order that we can appraise intensity, impact and consequences of the climate change, we do primarily have to learn all the changes that have already taken place in the past. Climatic changes happened even before the appearance of mankind, which naturally influenced the onetime flora and fauna. A considerable amount of scientific works and researches studying this subject prove that a series of climatic changes with cycle duration lasting from a couple of thousand to a hundred thousand years occurred during the Quaternary. Considering the latter changes we already know that the climate of the Earth is changing even without anthropogenic effects, nonetheless, it is difficult to estimate how much human activity can contribute to, or perhaps accelerate these natural processes. In order to see clearly and assess the aforesaid, we have to collect accurate information about the course, degree and effects of natural transformations. If we are curious about the course, degree and possible effects of climate change, it appears to be convenient that we primarily learn changes occurring in the Quaternary as much as possible. We are able to select from a wide variety of applied methods for such investigations. Geological and paleontological analyses have outstanding roles in revealing past events.

Loessic sediments that formed during the Quaternary accumulated in mutable climatic conditions. Changing circumstances fundamentally influenced temperature, the amount of precipitation and thus features of vegetation. Besides loess sedimentation, these processes unequivocally had impacts on the fauna as well, particularly mollusc species occurring in great numbers. Thus by accomplishing statistical analysis of paleoecological records on the malacofauna trapped in layers of sediment we may gain information about the development of loessic formations and the onetime environmental conditions (Krolopp-Sümegi, 1992; Sümegi-Krolopp, 1995).

The primary goal of my doctoral research was to process and perform a comparative analysis on the malacological assemblage of a southern Great Hungarian Plain loess section. I investigated the malacological material of an already learnt loess excavation during my research. In other words, my aim was not to "map" a still unknown area, but to present a more comprehensive, more detailed excavation of an existing spot. We managed to achieve this goal by means of decreasing sampling intervals and increasing the amount of collected sediment. Conclusively, we can reconstruct a more precise view of the climatic conditions in the Upper Würm, with special regard to temperature and humidity. Subsequently, I compared the dataset with regional and global stratigraphic sections, during which I managed to indicate identities and distinctions.

Methods

We applied the guidelines for standards of sampling fine-grained sediment determined by Endre Krolopp (Krolopp, 1983) with slight modification during sampling process (Sümegi, 1996/a; 1996/b). We basically changed two steps: we applied a resolution of 4 cm during sampling, and excavated the entire sediment block between units. The samples were scree-washed using a mesh of 0.5 mm. I could rely on scientific publications and definitions during the course of the malacological material's determination. As a result, I collected and identified altogether 110,795 specimens of 36 species of that 250 samples taken from the 10 m vertical loess profile at Madaras.

During data processing, I classified species into ecological groups – following the methods of several publications – with respect their temperature requirement. Thus I studied not only the dominance values of individual species but also the concomitance of species with similar demands. Subsequently, by means of the 'malaco-thermometer' method elaborated by Pál Sümegi (Sümegi, 1989, 1996/b) I calculated mean July paleotemperature for the entire section on the bases of 13 species.

I managed to consider three calibrated age data for dating the loess section by applying results of amino acid analyses.

After having processed and interpreted the malacological assemblage, I compared the fauna with the regional bio-, eco- and climatostratigraphical frameworks elaborated for the Upper Pleistocene in the first place, and then with global sedimentological units delimited by a North Atlantic ice core analysis. As a final step of the analysis, I compared my data to an inland loess section of similar age and identical resolution.

Statements of the Thesis

1.) I sectioned 9 paleotemperature horizons using values of the 'malaco-thermometer' along the profile, as in my opinion it presents greater stability than the assessment of dominance values.

2.) The analysis I completed reveals that accumulation of the loess dust was induced under warm and precipitative climatic conditions. Subsequently, the mean July paleotemperature decreased continuously with more or less fluctuation up until the upper, one and a half-meter-thick section. Two greater "cold snaps" can be detected during this fall in temperature, when the temperature dropped below 11 °C. Additionally, higher humidity values prevailed in the area on the basis of the malacofauna's composition.

3.) Considering Sümegi and Krolopp (1995), the onset of the Madaras loess excavation can be identified as the *Trichia hispida-Bithynia leachi* biozone-final section of the *Granaria frumentum-Vallonia enniensis* zonule of the *Catinella arenaria* subzone. Whereas a dominant portion of the profile developed during the *Semilimax kotulai* subzone. Boundaries of the paleotemperature horizons I delineated correspond to the boundary between zonules at many points. Zonules developed in significant thickness, except for the *Pupilla triplicata*– and the *Vallonia tenuilabris* zonules, which cover smaller section of the profile in relation to the type locality. Nevertheless, the *Vallonia costata* -, *Punctum pygmaeum-Vestia turgida-* and the *Pupilla sterri* zonules represent a remarkable portion of the profile. These alterations derive, by all means, from the finer resolution having been applied on the loess excavation. This is also verified by the deposition rate calculated from age data, which measures 0.965 mm/year. Nonetheless, the fact that not all

zonules have thicker character leads us to the conclusion that velocity of sediment deposition could have changed in the area.

Vallonia costata zonule's type locality is represented by the profile at the Lakitelek brickyard, where its 20-cm-thick formation can be studied (Sümegi-Krolopp, 1995). Based on faunal components, a 130-cm-thick section at Madaras can be associated with this zonule.

Columella columella zonule marks one of the cooling horizons of the Upper Pleistocene. The faunal composition demonstrates mixed, transitional character in the horizon that can be associated with this zonule.

Punctum pygmaeum-Vestia turgida zonule represents 50 cm of the loess section at the type locality, while this value is 210 cm at Madaras. It can be indicated similarly to other profiles (Krolopp-Sümegi, 1991, 2002; Hum, 1998, 1999; Sümegi-Krolopp, 2000/b, 2001/a; Krolopp, 2001) that the zonule comprises two sections. Significant dominance of cold-resistant, and smaller-degree of cold-loving elements intruded the horizon characterized by mesophilous and higrophilous species. Moreover, it is the profile section's feature that more peaks are presented in the dominance of the species *P. pygmaeum* in the zonule, and that *Semilimax semilimax* and *Vitrina pellucida* also appear simultaneously.

Pupilla sterri zonule developed in a lot greater degree, in a thickness of 280 cm in the area, as opposed to that 40-cm-thick profile section at its type locality.

4.) The comparison of our datasets with the North GRIP - GICC05 (Greenland Ice Core) Chronology (Andersen et al. 2006) proved to be successful. Therefore, in my opinion earlier sampling methods are worth being revised, as finer resolution enables a more accurate and detailed

analysis. As a consequence of the comparison, it may be stated that the dust accumulation of the Madaras loess began in GI-3 Interstadial period. The section also includes H2 and H1 stadials, and could have lasted even until the GI-1 interstadial's onset. A drastic fall in temperature did not occure during LGM period.

5.) Both the regional and the global stratigraphic collation verified my hypothesis (Thesis Statement 1) that the 'malaco-thermometer' calculated upon the 13 species presents greater stability, thus boundaries of horizons delineated by relying on them are more definite than those obtained from dominance values.

6.) Absolute parity with the characteristics of the loess wall of Katymár could not be indicated, but I was able to identify more matches in its portion above 7 meters. Occurrence and dominance of individual species are similar; we can only detect distinctions in their duration. Warm-loving species are represented by longer sections in the loess sequence at Madaras, whereas cryophilous species demonstrate more peaks in dominance; higrophilous species exhibit higher values in dominance and more permanent presence than in Katymár. Identical characteristics developed as a result of geographical proximity, whereas roots of differences can be traced in their distinct positions.

7.) Sub-Mediterranean climatic effect prevailing in the southern portion of the country (Sümegi-Krolopp, 2001/a, 2002) results in higher temperature values and precipitation input (Sümegi et al. 1991; Sümegi, 1996/b, 2007; Hum, 1998, 1999). In the case of Madaras only higher moisture content prevailed as a consequence of its north-facing position. Owing to this circumstance, higrophilous elements were fairly widespread along the section, particularly during the course of cool climatic phases, but they did not disappear from the sediment on the

occasions of more intensive cold snaps either. Therefore, we may arrive at the conclusion that for moisture-demanding species the area at Madaras could have functioned as a shelter. At the same time, its location being in the Great Hungarian Plain enabled southern elements – e.g. *Granaria frumentum* – to infiltrate this territory, too.

8.) *Punctum pygmaeum-Vestia turgida* zonule can be the most thoroughly investigated on the loess section at Madaras due to the 4 cm processing intervals; furthermore, the development of *Pupilla sterri* zonule is, by all means, remarkable. On the other hand, this loess profile reveals the MIS 3/2 transition under terrestrial circumstances the best, most meticulous and detailed way in the Carpathian Basin.

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