Selective pollen destruction in archeological sediments at Grădiştea Coslogeni (Călăraşi county, Romania)

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Rezumat: *Rezultatele analizelor efectuate asupra a patru probe (una din nivelul Cernavodă şi trei din nivelurile Coslogeni) din aşezarea Grădiştea Coslogeni (jud. Călăraşi) pun în evidenţă existenţa în sedimentele sitului a unor fenomene de distrugere progresivă a materiei organice (inclusiv polen) şi de distrugere selectivă a polenului. Acestea sunt dovedite de scăderea concentraţiilor materiei organice insolubile şi a frecvenţelor polinice absolute ale probelor cu adâncimea şi de puternica dominanţă polenului de Asteraceae (Compositae). Deşi frecvenţele polinice absolute sunt relativ mari, gradul de conservare a palinomorfelor din cele patru probe este foarte redus. Toate acestea se datoresc în principal proceselor foarte active de umezire–uscare şi de încălzire a depozitelor analizate. Această situaţie sugerează că depozitele aşezării sunt puţin favorabile unei bune conservări a palinomorfelor şi că rezultatele obţinute prin analizarea lor nu se pretează unei interpretări în termeni de vegetaţie regională. Rezultate cu un grad de încredere mai ridicat ar putea fi obţinute prin analizarea de probe prelevate chiar în momentul interceptării fiecărui strat, în timpul săpăturilor.*

Cuvinte cheie: *sedimente arheologice, cultura Cernavoda, cultura Coslogeni, Holocen, analize de pollen, conservarea polenului.*

Keywords: *archeological sediments, Cernavoda culture, Coslogeni culture, Holocene, pollen analysis, , pollen preservation.*

The archeological site of Grădiştea Coslogeni is located on an ancient alluvial bar in Balta Borcei. A large island encompassed by two arms of the Danube River, Balta Borcei is part of the river floodplain. The stratigraphy of the site comprises deposits attributed to several periods: Neolithic, Eneolithic to Bronze Age transition, late Bronze Age, Iron Age, Pre-feudal and Medieval (V. Cavruc, M. Neagu 1995).

Pollen analyses were previously carried out at Grădiştea Coslogeni by E. Spiridonova (1995). Based on results from eleven samples, she inferred that during the Hamangia occupation (Neolithic, approximately 5000–4600 BC; C. Bem, pers. comm.), the regional vegetation was represented by Poaceae (Gramineae) and *Artemisia* (mugwort) steppe with rare *Quercus* (oak) and *Fraxinus* (ash) groves, and with isolated trees in the vicinity of the Danube. She noted an increase in number of the trees for the second part of the Hamangia period. The Eneolithic – Bronze Age transition period, (Cernavoda; somewhere between 4000–3000 BC) was also characterized by steppe vegetation, but trees were more numerous. As for the Coslogeni period (late Bronze Age, approximately 1400–1250 BC), the author described a steppe vegetation witnessing a progressive thinning of the arboreal vegetation. However, the low pollen sums recovered in these analyses, as well as the dominance of Poaceae, Chenopodiaceae and Asteraceae pollen in all samples, suggest poor pollen preservation, questioning the reliability of such reconstructions of the regional vegetation – as demonstrated by M. Tomescu (2000).

This paper presents the results of analyses performed on four samples from Grădiştea Coslogeni, suggesting that selective destruction of organic matter, pollen included, occurred in the sediments. This questions the reliability of results from pollen analyses in such sediments, as means of reconstructing the vegetation.

1. Materials and method

The samples were taken from the western profile of section S1 (see the excavation plans in V. Cavruc, M. Neagu 1995) for the exact profile location and are presented in stratigraphic order (beginning with the oldest).

Sample 1 was taken in dark brown, compact silty clay with rare bivalve shell fragments. The sediment has the appearance of a natural soil horizon. Based on its stratigraphic position, the layer is considered to be of Cernavoda age (somewhere between 4000–3000 BC). The very rare anthropogenic remains (bones, potsherds), all of very small size, may represent allochthonous material dislocated from overlying layers by bioturbation.

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Sample 2 consists of yellowish silty clay. The tabular structure of the dried up sediment, formed of 1–3 mm thick and 1–2 cm wide flakes, as well as its compactness, are in accord with the archeological hypothesis according to which it represents an anthropogenic deposit – termed “platform” by archaeologists (V. Cavruc, M. Neagu 1995).

Sample 3 was taken in grayish–brown, homogeneous silt containing charcoal and burnt daub fragments; it may also contain ash. In the opinion of archeologists this layer represents an ash deposit.

Sample 4 also consists of grayish–brown, homogeneous silt containing rare bones, potsherds. It is less cohesive than the one in sample 3 and considered to represent an ash deposit.

Samples 2, 3 and 4 belong to the Coslogeni occupation level (approximately 1400–1250 BC).

Processing of the samples included treatments with hydrochloric and hydrofluoric acids, potassium hydroxide, heavy liquid floatation, 160 μm sieving, fuchsine staining, volume measuring and mounting of the insoluble organic fraction in glycerol.

2. Results

Samples 3 and 4 proved quite rich in calcium carbonate and in alkali–soluble organic matter. Samples 2, 3 and 4 contain frequent, millimetric charcoal. The general pollen–analytical information on the four samples is summarized in tab. 1.

Concentrations of the insoluble organic matter (microlitres/gram of dry sediment) in the four samples are as follows: sample 1 – 3.87 μl/g; sample 2 – 28.00 μl/g; sample 3 – 109.67 μl/g; sample 4 – 218.17 μl/g. Concentrations of palynomorphs (per gram of dry sediment) in the four samples are: sample 1, 1163.1/g; sample 2, 2116.8/g; sample 3, 6360.7/g; sample 4, 8377.6/g. Both insoluble organic matter concentrations and palynomorph concentrations show a decrease with depth.

There are great differences in palynofacies and in the state of pollen preservation between sample 1, on one hand, and samples 2–4, on the other hand. The palynofacies of samples 2–4 is characterized by the presence in large amounts of very small size (micrometric and sub–micrometric) fragments of oxidized (brown) vegetal material, which renders observation of pollen very difficult. Concentrations of the oxidized vegetal fragments decrease with depth. Samples 2–4 contain very rare microscopic charcoal. The palynofacies of sample 1 is, on the contrary, very clean, with rare fragments of oxidized vegetal material or other components.

Pollen preservation is poor in sample 1: only 46.3% of the 752 palynomorphs counted are identifiable taxonomically. In samples 2–4 pollen and spores could be identified and counted only based on their shape, size, and color from to fuchsine staining, but none of the palynomorphs are unidentifiable taxonomically. They are unidentifiable because of very poor preservation, comparable to that described by E.J. Cushing (1967) for his “degraded” pollen. The characteristic features of palynomorphs look as if melted to a certain degree: they are corroded on one hand, and thickened on the other hand, which results in loss of relief of their features. Small size fragments of oxidized vegetal material are occasionally attached to them. The same type of deterioration is observed on the rare un-oxidized vegetal tissue fragments. Palynomorphs in sample 1 show similar, but less pronounced, deterioration characteristics.

The spectrum of sample 1 (tab. 2) is strongly dominated by herbaceous pollen (NAP, 96.0% of the palynomorphs identified taxonomically), whereas arboreal pollen (AP) is very rare (1.4%). Among NAP, Asteraceae and *Tribulus terrestris* are the most frequent taxa (more that two thirds of the total identified taxonomically), followed by *Convolvulus* (bindweed) and Chenopodiaceae. Diameters of the Poaceae pollen range 25.1–42.1 μm.

3. Discussion

The marked difference in palynofacies between sample 1 on one hand and samples 2–4 on the other hand is very likely due to differences in the genesis of layers that produced the samples. The high content of oxidized vegetal fragments in samples 3 and 4 demonstrates that the sediment in the two layers contained originally large amounts of vegetal material. Although it comes form a layer interpreted as having a very different genesis than the layers that produced samples 3 and 4, sample 2 has a very similar (although somewhat lower) content of oxidized vegetal fragments. This may be due to infiltration of material from the layer that produced sample 3 in the fissures of the underlying layer of sample 2, a process favorized by the structure of the latter.

The palynofacies of samples 3 and 4, characterized by high contents of oxidized vegetal material and rare microscopic charcoal, does not support the archeological hypothesis according to which the layers that produced these samples represent ash deposits.

Absolute concentrations calculated for the four samples show rich pollen contents of the sediments at Grădiştea Coslogeni. The decrease of palynomorph concentrations with depth nevertheless represents evidence for progressive pollen deterioration, as demonstrated by S.A. Hall (1981). This conclusion is supported by the parallel decrease of the insoluble organic matter with depth, which suggests progressive destruction of total organic matter as a whole. A similar situation suggesting progressive pollen deterioration is recorded in the analyses by L. Stoian (1995) at Giurgiu *Malu Roşu*.

Sample 1, including 53.7% taxonomically unidentifiable palynomorphs, is dominated by Asteraceae pollen. According to several authors (A.J. Havinga 1967; idem 1984; S. Bottema 1975; M. Couteaux 1977; M. Weinstein–Evron 1986), Asteraceae pollen has good preservation potential and is resistant to deterioration. This is at least partly due to the relatively thick exine of the pollen and its high sporopollenin content in most Asteraceae. High relative frequencies of Asteraceae pollen therefore represent good evidence for selective pollen destruction, especially when supported by additional evidence from other sources. The situation at Grădiştea Coslogeni is not singular, and Asteraceae – dominated pollen spectra are not rare in the region. They are present in the Romanian Plain at Pantelimon (V. Iliescu, G. Cioflica, 1964), Vădastra (A. Leroi–Gourhan *et alii* 1967), Bucov (M. Cârciumaru 1972), Cârlomăneşti (M. Cârciumaru 1977), Padea (M. Cârciumaru 1979), Radovanu (M. Alexandru 1990; M. Cârciumaru 1996), Fărcaşul de Sus and Vlădiceasca (M. Cârciumaru 1996). The other taxa frequent in sample 1 (*Tribulus terrestris, Convolvulus* and Chenopodiaceae) also produce pollen with thick exine and/or high sporopollenin content and are corrosion–resistant.

Poor pollen preservation is principally due to physico–chemical processes very active in the region at present and in the past. High porosity of the sediments allows good circulation of air in the soil, causing pollen oxidation. The reduced vegetal cover present today, the texture and, in some cases, the carbonate content of the sediments, all contribute to making them a hot environment (Ph. Duchaufour 1995) during the summer season. This renders the sediments highly unfavorable to pollen preservation, as heating and drying have been demonstrated to severely damage pollen (M. Reille 1978; J. Besancon 1981).

The most important process leading to pollen deterioration under such conditions is probably the repeating of daily wet–dry cycles. Experiments conducted by R.G. Holloway (1989) show that pollen grains exposed to only 25 cycles of alternating moisture conditions were very much altered. According to I.D. Campbell and C. Campbell (1994) pollen is rapidly degraded, with a significant loss of pollen of the samples, after only ten wet–dry cycles.

The position of the site in the Danube floodplain is responsible for abundant humidity (e.g., morning dew, fog), which deeply humidifies the porous sediments. In summer, these are subsequently dried and strongly heated (because of the scarcity of vegetal groundcover) during the day. Beside alternating wetting and drying, chemical and biochemical processes (e.g., oxidation, microbial degradation) must have also played a part in pollen deterioration. Poor pollen preservation that must have been caused principally by similar conditions and processes is reported at Vădastra (A. Leroi–Gourhan *et alii* 1967), Borduşani–Popină (M. Tomescu 1997) and Hârşova *tell* (M. Tomescu, M.–F. Diot, in press).

The clear–cut difference in pollen preservation between sample 1 on one hand, and samples 2–4 on the other hand, may be the result of different exposure of the sampled layers to the action of pollen–degrading agents. The four samples were taken from a profile that had been cut at least one year before sampling. Although the profile was carefully cleaned and scraped prior to sampling, samples probably still fell within the depth range of pollen–degrading agents. Considering the period of at least one year of exposure of the samples to the action of these agents, the poor preservation of pollen is fully explainable. The better preservation of pollen in sample 1 may be due to the fact that at the greater depth where this sample was taken, the profile had been covered until sampling took place, with sediment discarded during subsequent excavations.

This particular situation does not contradict the evidence of selective pollen destruction and progressive deterioration of the organic matter (including pollen) mentioned above, which support the conclusions already inferred by M. Tomescu (2000) on the basis of pollen spectra published by E. Spiridonova (1995) and other authors.

4. Conclusions

Although absolute pollen frequencies are quite high in the four samples, poor pollen preservation, as well as the evidence of selective destruction of organic matter including pollen, render impossible the taxonomic identification of palynomorphs in three of the samples (samples 2–4) and forbid any interpretation of sample 1 in terms of regional vegetation. It is nevertheless worth mentioning that the five arboreal pollen grains identified taxonomically correspond to five different genera, which points to the taxonomic diversity of the arboreal vegetation.

Information yielded by the four samples analyzed at Grădiştea Coslogeni raises once again the problem of the reliability of results coming from pollen analyses carried out in such sediments, as means of reconstructing the vegetation. This reliability proved to be very low so far (M. Tomescu 2000).

In the particular case of this site, more reliable results could possibly be obtained by analyzing samples of fresh sediment, taken immediately after the interception of each layer. As suggested by the situation in sample 1, this would avoid the exposure of sediments to pollen–destructing agents and processes and improve the reliability of the results. As long as palynological samples are taken otherwise, the reliability of the analyses will remain low.

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Tab. 1. Palynological information on the Grădiştea Coslogeni samples.

		Sample 1	Sample 2	Sample 3	Sample 4
Insoluble organic matter concentration (μl/gram of dry sediment)		3,87	28,00	109,67	218,17
Palynomorph concentration (per gram of dry sediment)		1163,1	2116,8	6360,7	8377,6
Palynomorphs counted		752	–	–	–
Unidentifiable		404	–	–	–
Unidentifiable (%)		53,7	100	100	100
Identified		348	–	–	–
Identified (%)		46,3	–	–	–
Identified	AP (%)	1,4	–	–	–
	NAP (%)	96,0	–	–	–
	Spores (%)	0,6	–	–	–
	Algae (%)	2,0	–	–	–
	Deteriorated (%)	26,1	–	–	–

Tab. 2. Palynomorph spectrum of sample 1 from Grădiştea Coslogeni.

Taxon	Count
Pinus cf. *nigra*	1
Corylus	1
Alnus	1
Ulmus	1
Tilia	1
Chenopodiaceae	11
Tribulus terrestris	102
Convolvulus	18
Asteraceae Asteroideae	127
Asteraceae Cichorioideae	68
Typha	1
Sparganium	1
Poaceae	6
Polystichum	2
Total	**341**
Concentricystes	1
Algae	6
Total	**348**
Unidentified	404
TOTAL	**752**