ELSEVIER
Review of Palaeobotany and Palynology 109 (2000) 219–233
Review of Palaeobotany & Palynology
www.elsevier.nl/locate/revpalbo

Evaluation of Holocene pollen records from the Romanian Plain

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Received 19 April 1999; accepted for publication 6 December 1999

Abstract

This study is a critical review of pollen analyses carried out on Holocene sequences from 15 sites in and near the Romanian Plain. Three sites come from natural sediments, 10 sites are from anthropogenic deposits and two are from both anthropogenic and natural settings. The general reconstruction is of a steppe–forest–steppe vegetation through the Holocene. The nature of the deposits, however, casts doubts on this reconstruction. Deposits of archaeological sites generally yield pollen spectra that are influenced by human activities and thus unsuitable for vegetation reconstructions. Loess deposits are also unfavorable for pollen preservation because of high pH and porosity. Consequently, pollen spectra from loess deposits are strongly biased by selective pollen destruction. Research and experiments carried out by several authors suggest that spectra dominated by Asteraceae, Poaceae, Chenopodiaceae or *Pinus* pollen in soils and loess are a result of selective pollen destruction, especially if low pollen concentrations, progressive pollen deterioration or high frequencies of deteriorated or unidentifiable pollen are evidenced. The fact that pollen records from the Romanian Plain come from loess, alkaline peat or archaeological sites reduces their reliability for reconstructions of vegetation. The vegetation history of similar regions in Hungary, Bulgaria and Turkey suggests that early Holocene steppe vegetation was gradually replaced by forest or forest–steppe vegetation in the late Holocene. Records from lake sediments are required to find out whether the Holocene vegetation history of the Romanian Plain was similar. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: biased pollen spectra; Holocene vegetation; pollen-analytical information; pollen preservation; Romanian Plain; selective pollen destruction

1. Introduction

Little is known about the Holocene vegetation history of the Romanian Plain, although several papers touch upon this subject. The present paper reviews pollen studies from the Romanian Plain and assesses their reliability as records of regional vegetation history.

The Romanian Plain (also known as the Lower Danube Plain) is a low-lying region encompassed by the Carpathian–Balkan arc. It is bounded by the Carpathian foothills to the north and west and by the Balkan foothills (Pre-Balkan Plateau) to the south. The Danube valley marks the southern limit of the Romanian Plain. To the northeast, the plain stretches to the Moldavian Plateau, and at its eastern border, the Danube's floodplain separates the plain from the Dobrogean Plateau (Fig. 1). The altitudes are <100 m a.s.l. in most of the Romanian Plain. The lowest elevations

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PII: S0034-6667(99)00056-1

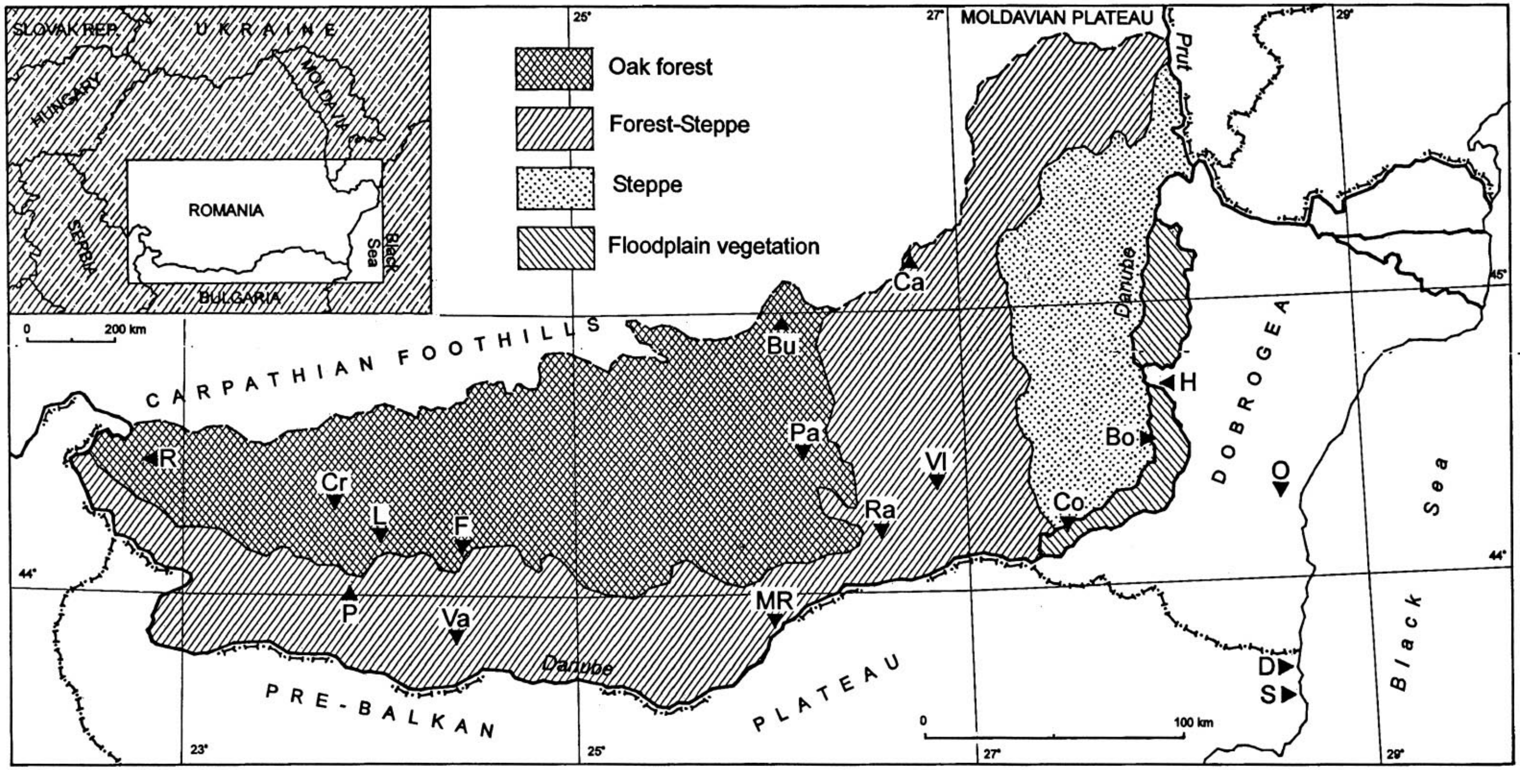

Fig. 1. Romanian Plain and its region. Geographic position, main vegetation units and sites with pollen analyses; Bo = Bordusani; Bu = Bucov; Ca = Carlomanesti; Co = Coslogeni; Cr = Craiovita; D = Durankulak; F = Farcasul de Sus; H = Harsova; L = Leu; MR = Malu Rosu; O = Ovidiu; P = Padea, Pa = Pantelimon, R = Rogova; Ra = Radivaby; S = Sgabka; Va = Vãdastra; Vl = Vladuceasca.

occur in the Danube's floodplain, whereas the northern and northwestern part reaches 200 to >300 m in elevation.

The climate of the Romanian Plain is characterized by a high degree of continentality; the mean annual temperature range is >25–26°C, while the mean annual precipitation is about 500 mm (Roşu, 1980). The mean annual temperatures are about 11°C (and not less than 10°C). The mean January temperature ranges between −4 and −1°C, whereas the mean July temperature is >22°C and even exceeds 23°C on a narrow strip along the Danube. Summers are hot, while winters are cold, but short, and the frost period lasts about 100 days, from late October to early April. Slight variations in these climatic features across the Romanian Plain result in a climate with submediterranean influences in the western part, and an extreme continental climate in the eastern part.

The present vegetation in the Romanian Plain can be broadly divided into three zones (Fig. 1). The submesic–thermophilic oak forests are present north of 44°8′N and west of 26°27′E. These forests are dominated by *Quercus cerris* and *Q. frainetto* and can also include *Q. pedunculiflora* in the south and *Q. robur* in the east, that are accompanied by *Ulmus minor*, *Carpinus betulus*, *Tilia tomentosa*, *Fraxinus ornus*, *Acer tataricum*, *A. campestre*. The understory includes *Crataegus monogyna*, *C. pentagyna*, *Prunus spinosa*, *Rosa dumetorum*, *Evonymus verrucosa*, *Cornus mas*, *C. sanguinea*, *Ligustrum vulgare* and even *Cotinus*. The ground layer is dominated by *Poa angustifolia*, *Festuca valesiaca*, *Lychnis coronaria*, *Potentilla argentea*, *Geum urbanum* and *Fragaria viridis* (Şerbãnescu, 1975; Sanda et al., 1992).

South and east of this first vegetation zone is forest–steppe with subxeric–thermophilic oak groves. The dominant tree is *Quercus pubescens*; *Q. pedunculiflora* is more frequent in low regions. These species are accompanied by *Q. virgiliana*, *Q. cerris*, *Acer tataricum* and *Prunus mahaleb*. Understory trees are *Fraxinus ornus* and *Cotinus coggygria*; the latter is locally abundant. The herbaceous vegetation includes mainly *Stipa stenophylla*, *Poa angustifolia*, *Festuca valesiaca*, *Botriochloa ischaemum*, *Artemisia austriaca*, *Agrostis tenuis*, *Stipa capillata* and *Carex humilis*.

The north–south strip between the Danube (to the east) and approximately the 27°30'E meridian (to the west) supports steppe vegetation of Poaceae and dicotyledons. This vegetation consists of *Festuca valesiaca*, *Stipa ucrainica*, *Stipa capillata*, *Centaurea orientalis*, *Astragalus ponticus* and *Thymus marschallianus*.

The Romanian Plain is the main agricultural region of Romania, and most of the native vegetation has been destroyed in recent decades. As a result, it is encountered nowadays only in small areas scattered within cultivated fields. Most disturbed of the three, steppe vegetation is now preserved only on commons and high riverbanks.

In addition to the zonal vegetation units, Danube's floodplain and the other river valleys feature riparian forests, coppices and marshes. In the Danube valley *Salix*, *Populus* and *Alnus* coppices and *Tamarix ramosissima* bushes with *Calamagrostis tenuis* are present. Along other river valleys, the arboreal vegetation includes mainly *Quercus robur*, *Q. pedunculiflora*, *Fraxinus pallisae*, *F. angustifolia*, *Ulmus minor*, *U. glabra*, *U. laevis*, *Acer campestre*, *A. tataricum* and *Alnus glutinosa* and is accompanied by understory vegetation of *Cornus sanguinea*, *Frangula alnus*, *Viburnum opulus*, *Crataegus monogyna*, *Evonymus europaeus*, *Ligustrum vulgare* and *Prunus spinosa* (Sanda et al., 1992).

2. Pollen analyses in the Romanian Plain

Pollen analyses have been carried out in 15 sites in and near the Romanian Plain (Fig. 1). Of these sites, five are located on or near the margin of the plain–two at border of the Carpathian foothills and three near the margin of Dobrogea. The other sites are situated on the plain.

The first pollen analysis from the Romanian Plain was carried out by Pop (1957) in the peat bog of Craioviţa. Based on 14 analyzed samples, the sequence was assigned to the Boreal and Subatlantic periods. Iliescu and Cioflica (1964) published the results of an eight-sample analysis in loess sequences at Pantelimon (Bucharest). In the same year, Iliescu and Ghenea (1964) analyzed 20 samples from a 35-m-long core of loess from

Rogova. The deposits at Pantelimon were assigned to the Holocene, while the Rogova sequence was assigned to the early Holocene. At Radovanu, Cârciumaru (1996) presented the results of 30 samples taken from six sections up to 1 m deep, in the vicinity of a Neolithic settlement.

Most pollen analyses in the Romanian Plain have been carried out on archeological sites (Table 1); the relative chronology of the different cultures encountered in these sites is schematized in Table 2. The first pollen analysis of anthropogenic deposits from the Romanian Plain was carried out at Vãdastra (Leroi-Gourhan et al., 1967). The authors of the paper and Wasylikowa studied six Neolithic (Vãdastra, Sãlcuţa) samples and two from the layer between Neolithic and Paleolithic deposits; the latter were not dated and they may have been Holocene in age. The vegetation reconstruction was based on both palynology and the study of gastropod shells.

In 1970, Cârciumaru analysed 11 samples from a sequence containing Neolithic (Dudeşti, Vãdastra) and Iron Age deposits at Fãrcaşul de Sus. The results (Cârciumaru, 1996) were not accompanied by stratigraphic information. Cârciumaru (1972) reported on Middle Age deposits in the settlement of Bucov. The paper presented a table of pollen percentages for six samples and a diagram lacking stratigraphic information. The Bronze Age (Monteoru) and La Tène deposits at Cârlomãneşti were analyzed by Cârciumaru (1977). The results were presented in two diagrams, but stratigraphic information was omitted. Two Vinca–Dudeşti settlements, those of Padea and Leu, were studied by Cârciumaru (1979). Three samples of Leu and four samples of Padea were presented, and no stratigraphic information was given.

The Boian–Gumelniţa transition period was studied at Radovanu. Comşa (1990) presented pollen results by Cârciumaru, omitting stratigraphic information and even the number of samples. Results from nine samples from Radovanu analyzed by Alexandru (1990) also contained no stratigraphic information. Cârciumaru (1996) presented the results of the Radovanu analysis in a table of relative pollen frequencies.

Spiridonova (1995) analyzed the Hamangia–Coslogeni deposits of the Grãdiştea–Coslogeni settlement. Eleven samples, presented in tables and two diagrams, were accompanied by vague stratigraphic information. At Malu Roşu, Stoian (1995) studied a 6 m deep loess sequence, the upper part of which contained post-Palaeolithic remains (no specific cultural attribution). Seven samples from this upper part were reported in summary pollen diagrams and an absolute pollen frequency diagram. Cârciumaru (1996) presented the results of pollen analyses from Vlãdiceasca in his synthesis on the palaeoethnobotany of Romania. Eighteen samples from the Boian (Vidra), Gumelniţa and La Tène deposits were accompanied by stratigraphic information. Tomescu (1997) analyzed seven samples from Gumelniţa and La Tène deposits at Borduşani–Popinã and found a very poor pollen preservation. In the *tell*-type settlement of Hârşova, Tomescu and Diot (2000) examined 56 samples from different types of anthropogenic deposits (Boian, Gumelniţa and Cernavoda cultures) and found a poor pollen preservation. Only five of the samples were considered rich in pollen.

3. Problems in interpretation of published pollen records

Inferences on the vegetation made by various authors on the basis of pollen analyses are shown in Table 2. The general picture is that of a steppe–forest–steppe vegetation during the Holocene. Craioviţa, Rogova, Pantelimon and Malu Roşu are not included in the table because of their poor dating; Craioviţa is probably Boreal and Subatlantic, Rogova is early Holocene, Pantelimon is Holocene and Malu Roşu is post-Palaeolithic in age.

Several issues have to be considered in assessing the reliability of the records, including the origin of the deposits, their lithology and chemistry, which influence pollen preservation and the susceptibility of different pollen taxa to degradation. In certain cases, these factors bias the results of pollen analyses so severely as to render them inadequate for vegetation reconstructions.

The studies can be broadly divided into those

Table 1
Archaeological sites with pollen analyses in the Romanian Plain (the number of samples is accompanied by the length of the sampled profile in meters)

Site[a]	Cultural attribution	Number of samples	Stratigraphic information	Diagram (D), table of frequencies (T)	Author
Bucov (Bu) (Prahova county)	Middle Age (VIIIth–Xth century)	6/0.5 m	None	D, T	Cârciumaru (1972)
Cârlomăneşti (Ca) (Buzău county)	La Tène Monteoru Ic4, Ic3, IIa	11/1 m and 13/1.3 m	None	D	Cârciumaru (1977)
Vlădiceasca (Vl) (Călăraşi county)	La Tène Gumelniţa A1, A2, B Boian–Vidra	18/4.9 m	Texture, color, structure, genesis	D	Cârciumaru (1996)
Radovanu (Ra) (Călăraşi county)	Boian–Gumelniţa transition	omitted	None		Comşa (1990)
		9/1 m			Alexandru (1990)
		10/omitted		T	Cârciumaru (1996)
Grădiştea Coslogeni (Co) (Călăraşi county)	Coslogeni	5/1 m	Texture, color	D, T	Spiridonova (1995)
	Transition (Hamangia–Coslogeni)	6/1 m			
	Hamangia				
Vâdastra (Va) (Olt county)	Sălcuţa Vădastra	8/1.7 m	Lithology, color	Partial D	Leroi-Gourhan et al. (1967)
Padea (P) (Dolj county)	Vinca–Dudeşti	4/0.5 m	None	D	Cârciumaru (1979)
Leu (L) (Dolj county)	Vinca–Dudeşti	3/0.2 m	None	D	
Fărcaşul de Sus (F) (Olt county)	La Tène Hallstatt Vădastra Dudeşti	11/1 m	Color	D	Cârciumaru (1996)
Malu Roşu (MR) (Giurgiu county)	Postpaleolithic	7/1.2 m	Lithology, color	D	Stoian (1995)

[a] Site code refers to Fig. 1.

Table 2
Vegetation history based on pollen analyses from the Romanian Plain (relative chronology as indicated by the authors)

Relative Chronology	VADASTRA	COSLOGENI	PADEA	LEU	RADOVANU			CARLOMANESTI	FARCASUL DE SUS	VLADICEASCA	BUCOV	Absolute chrono-logy
	Leroi-Gourhan *et al.*, 1967	Spiridonova, 1995	Carciumaru, 1979		Alexandru, 1990	Comsa, 1990	Carciumaru, 1996	Carciumaru, 1977	Carciumaru, 1996	Carciumaru, 1996	Carciumaru, 1972	
Middle Age											Sparse *Quercetum mixtum* forest; deforestation	950 AD
												750 AD
Iron Age – La Tène								Anthropogenic deforestation Sparse forest	Anthropogenic deforestation Extension of the forest			100 AD
Iron Age – Hallstatt												450 BC
Bronze Age – Monteoru – Coslogeni		Steppe; decrease of forest cover in floodplains						Sparse forest Forest–steppe Sparse forest				1250 BC
												1400 BC
		Steppe; trees multiply	Post-Hamangia Pre-Coslogeni									1700 BC
Gumelnita – Salcuta	Steppe				Steppe and forest–steppe with *Quercetum mixtum* groves; progressive steppe development	Forest–steppe / steppe alternance	Steppe with *Quercetum mixtum* groves			Steppe / forest–steppe alternance		4000 BC
Vadastra – Boian/Hamangia – Vinca–Dudesti	Forest–steppe with *Quercetum mixtum* groves	*Artemisia–Poaceae* steppe; rare *Quercus* and *Fraxinus* groves; isolated trees in Danube's floodplain	Forest–steppe; progressive steppe development	Forest–steppe				Boian–Gumelnita transition	Forest–steppe and floodplain forest			4600 BC
Dudesti												5000 BC
												5200 BC
												5350 BC
												5600 BC
	Forest–steppe	Post-Aurignacian Pre-Vadastra						Steppe	Pre-Bronze Age (Pleistocene?)			

from natural deposits (Rogova, Pantelimon, Craioviţa and Radovanu) and those from archeological deposits (all the others plus Radovanu). Pollen spectra from archaeological sites do not necessarily reflect the natural pollen rain because: (1) pollen may have been brought to the settlement on plants used for feeding, heating, construction and animal fodder; (2) stratigraphic disturbance and mixing may have occurred from human activities; and (3) materials (such as daub) may contain a mixture of pollen of different origins. In the last case, pollen may have been introduced in the loess used as raw material, on plants (mainly straw and chaff) added to solidify the material, and in the water used to prepare daub. The pollen in loess can sometimes be identified (at least in theory) by its poor state of preservation, but the two other components are impossible to separate. The same contamination also occurs in the material used for plastering dwelling floors and walls, and hearths and ovens. Experimental studies carried out on the material used nowadays to build adobe houses at Hârşova suggest that the pollen spectra in such material are variable but generally dominated by pollen of the plants and water added to the raw material (Tomescu and Diot, 2000).

Indirect human influence as a result of the ruderal vegetation associated with human settlements, also severely biases spectra recovered from archaeological deposits. The influence, be it direct or indirect, increases with the intensity of the site's occupation. In intensely occupied settlements, the pollen content of the deposits is closely related to the activity that generated each type of deposit. However, this information does not help much in interpretations, for neither the exact nature nor the intensity of the human influence can be known. Moreover, the intensity of occupation determines the rate of sedimentation, and individual pollen spectra may often represent too short a period to allow the reconstruction of the regional vegetation of the moment. Pollen spectra of the same age may be very different from each other. This is the case for the stratigraphic units that constitute the structure of a chalcolithic oven at Hârşova-tell. Although these units were laid in place almost concomitantly, the spectra differ in their dominant taxa (except for the Poaceae) — Chenopodiaceae and Malvaceae, Fabaceae and Asteraceae, and Pinaceae (Table 3). It clearly appears that even if the nature and genesis of anthropogenic deposits in archeological sites were known, the pollen of these deposits can seldom, if ever, be used to reconstruct regional vegetation.

Table 3
Pollen spectra of three samples recovered from the stratigraphic units that constitute the structure of a chalcolithic oven at Hârşova-tell

	H^{VA} 93 P15-A1	H^{VA} 93 P12-A1	H^{VA} 93 P16-A1
Pinus	1	2	5
Abies/Picea	–	2	15
Carpinus	1	–	–
Quercus	–	–	1
Ulmus	1	–	–
Chenopodiaceae	6	5	3
Ranunculaceae	1	–	–
Brassicaceae	3	–	–
Aristolochia	–	–	1
Rosaceae	5	1	–
Fabaceae	29	–	–
Malvaceae	3	5	1
Apiaceae	1	–	–
Plantago	1	–	–
Asteraceae	3	–	–
Artemisia	5	–	1
Typha	–	2	1
Poaceae	9	8	52
Polypodium	–	–	1
Monolete spores	1	3	4
Trilete spores	2	1	–
Indeterminables	48	71	17
Pollen and spore sum	120	100	102
Absolute frequency (pollen + spores per gram of dry sediment)	26	33	22

Pollen analyses from Rogova and Pantelimon were carried out on loess sequences. As shown by Ianovici and Florea (1963), loess deposits are among the main products of processes that generate at the scale of the planet the carbonate–siallitic type weathering crust. This type of weathering crust is characterized by the genesis of carbonates (especially $CaCO_3$). Gogălniceanu (1939) calculated a 10–25% calcium carbonate content by weight in Romanian loess, and a basic pH (around 8). The elevated porosity of loess permits circulation of air and water, and oxidation favors subsequent microbial attack that renders the pollen material soluble in dilute alkali (Havinga, 1964). Pollen is destroyed in environments with high pH (base-rich), oxidation and intense microbial activity. In the settlement of Gomolava (Serbia), Bottema and Ottaway (1982) record very low pollen sums in base-rich sediments. At Anzabegovo, a Neolithic site in Macedonia, high frequencies of corroded pollen are attributed to aeration of the sandy–clay deposits (Grüger, 1976). Pollen is also destroyed by high temperatures, caused by insolation (Besancon, 1981), fire (Havinga, 1967), and drought (Reille, 1978).

Spectra from loess sequences will be poor and biased due to pollen destruction. Indeed, in an analysis of the loess sequence at Pantelimon, Iliescu and Cioflica (1964) report that not all the samples had statistically valid pollen sums. For several stratigraphic horizons, pollen sums were based on several samples from a single horizon exposed in different quarries. This seems a very questionable procedure, considering that detailed stratigraphic correlations are difficult in loess sequences, and no specific information was given on how the stratigraphic correlation was made in this case.

At Rogova, Iliescu and Ghenea (1964) point to the difficulty of calculating pollen percentages for the samples from the top 8 m of the loess sequence, due to the scarcity of pollen. Even in the lower section, the arboreal pollen content of some samples was not detailed by species, although AP reached 29% of the pollen sum.

Poor pollen preservation also occurs in the loess of anthropogenic sediments at Vãdastra (Leroi-Gourhan et al., 1967). Here, the authors report scarce arboreal pollen and frequently deteriorated pollen. The archeologically sterile loess at the base of the anthropogenic deposits contained no arboreal pollen, although the land-snail fauna indicated a forest environment; such contradictory results point to poor pollen preservation. At Malu Roşu (Stoian, 1995), also in a loess sequence, pollen preservation was described as very good, although an absolute pollen frequency diagram showed a decrease in pollen concentration with depth. This type of progressive pollen deterioration was described by Hall (1981), i.e. a decrease in pollen concentration, accompanied by an increase in deteriorated, unidentifiable pollen, with depth. Of the seven Holocene samples of Malu Roşu, the three upper samples showed concentrations ranging between 1000 and 1500 pollen grains/g of sediment, while the four lower samples had pollen concentrations of 180–650 pollen/g. In the pre-Holocene part of the sequence, absolute pollen frequencies were <200 pollen/g, and several samples had pollen concentrations <50 pollen/g. Hall (1981) suggests that pollen concentrations <1000 pollen/g indicate highly deteriorated pollen assemblages that provide little information, and samples with <100 pollen/g (characteristic of loess deposits) offer no information at all. Poor pollen preservation was also recorded at Leu (Cârciumaru, 1979) and Bucov (Cârciumaru, 1972). At Leu, pollen was not well preserved, and at Bucov, pollen concentrations were high enough, but pollen grains were frequently broken, deteriorated and unidentifiable. In the sequence of Coslogeni, Spiridonova (1995) recorded the presence of reworked pollen in all samples. This category reached up to 20% in three of 11 samples; it must be borne in mind that percentages of reworked palynomorphs always represent minimum percentages. One of the Coslogeni samples showed a very low pollen concentration.

Pollen spectra recovered from loess sequences are usually poor and biased due to differential destruction and over-representation of resistant pollen taxa. Observations concerning the corrosion susceptibility of different pollen taxa were made as early as 1920 (Havinga, 1964). Havinga (1964) compared the susceptibility of various pollen taxa to oxidation in laboratory experiments and corrosion under natural conditions and found that preservation was directly correlated with the sporopollenin content of the taxa (Table 4). Experiments conducted later (Havinga, 1984) indicated that corrosion susceptibility was also influenced by soil type and pollen size. Moreover, individual pollen grains had differential susceptibility to destruction. None the less, the sporopollenin content was the best predictor of the corrosion susceptibility of a pollen taxon.

In the three loess sequences from Rogova, Pantelimon and Vãdastra (Table 5), the most fre-

Table 4
Sporopollenin content of several pollen taxa (from Havinga, 1964; Brooks and Shaw, 1972)

Taxon	Sporopollenin content (percentages by weight of the original pollen grain)
Pinus sp.	24.4–19.6
Picea sp.	16.9–15.8
Tilia sp.	14.9
Festuca sp.	14.2–9.7
Chenopodium album	11.2
Cichorium intybus	9.2
Alnus sp.	10.8–8.8
Corylus sp.	8.9–8.5
Betula sp.	8.8–8.2
Carpinus betulus	8.2
Ulmus sp.	7.5
Acer negundo	7.4
Fagus silvatica	6.8
Rumex sp.	6.3–4.2
Quercus sp.	5.9–5.8
Lilium sp.	5.3–5.1
Chamaenerion angustifolium	5.1
Populus sp.	5.05–1.4
Phleum pretense	3.5
Narcissus pseudonarcissus	1.9

Table 5
Most frequent pollen taxa at Rogova, Pantelimon and Vădastra[a]

	Rogova	Pantelimon	Vădastra
AP			
Pinus	● ● ●	● ● ●	● ● ●
Betula	●	●	● ●
Tilia		● ●	●
Picea	● ●		
NAP			
Asteraceae	● ●	● ● ●	● ● ●
Chenopodiaceae	● ● ●	● ●	●
Poaceae	●	●	● ●
Total			
Asteraceae	●	● ● ●	● ● ●
Chenopodiaceae	● ●	● ●	●
Pinus	● ● ●	●	
Poaceae			● ●

[a] ● ● ●: most frequent taxon; ● ●: second frequent taxon; ●: third frequent taxon.

Overall frequencies of taxa were found by adding their relative frequency in each sample and dividing the sum by the number of samples; the frequencies thus obtained give a rough image of the participation of each taxon over the whole series of samples in one particular site (computed from Iliescu and Cioflica, 1964; Iliescu and Ghenea, 1964; Leroi-Gourhan et al., 1967).

quent arboreal pollen (AP) taxa were *Pinus*, *Betula*, *Tilia* and *Picea*. Their abundance is not surprising considering that *Pinus*, *Tilia* and *Picea* are three of the most corrosion-resistant pollen taxa. One exception is *Betula*, which is the second most abundant AP taxon, despite its medium corrosion susceptibility. The high frequencies of *Betula* may be explained by its initial abundance and its low susceptibility to corrosion in loess. In Havinga's corrosion susceptibility series, *Pinus* and *Tilia* are the most resistant, and the position of other AP taxa varies with soil type; the amplitude of these variations increases as the corrosion susceptibility of taxa increases. A switch of position between *Tilia* and *Picea* at Rogova, Pantelimon and Vădastra may thus be explained by their initial abundance at the moment of sedimentation. Similarly, the composition of fossil pollen spectra at Hârşova probably reflects that of the initial assemblage (Table 3). Pollen destruction, indicated by both a low pollen concentration (33 to 22 pollen grains/g) and abundant unidentifiable pollen, led to different spectra, depending on which pollen were initially embedded in each of the stratigraphic units.

Of the arboreal pollen, only *Pinus* occurred in high amounts in the spectra from Rogova, Pantelimon and Vădastra. At Rogova, AP varied between 20 and 79%, with most of the values at about 50%; in the majority of samples, *Pinus* represented more than half of the AP. At Pantelimon, AP represented 21–56% and was dominated by *Tilia* and *Pinus*. At Vădastra, AP was <8%. Non-arboreal pollen (NAP) taxa were dominant in the three sites, and the most frequent taxa were Asteraceae, Chenopodiaceae, *Pinus* and Poaceae (in decreasing order of their frequency). Unfortunately, a thorough investigation was not carried out on the differential corrosion susceptibility of the herbaceous taxa. Considering that the sporopollenin content is a good proxy for the corrosion susceptibility, data published by Brooks and Shaw (1972) on the sporopollenin content of several NAP taxa (Table 4) suggest that Asteraceae, Chenopodiaceae and Poaceae families should dominate. Havinga (1984) found that *Taraxacum* (Asteraceae family) ranks second among corrosion-resistant pollen types after *Pinus*.

The conclusions from these three loess sequences and the results of research and experiments on pollen susceptibility to corrosion suggest that spectra from soils and loess, dominated by Asteraceae, Poaceae or Chenopodiaceae, may be strongly biased in favor of these taxa. The dominance of *Asteraceae* pollen in several diagrams from prehistoric culture layers may be the result of pollen corrosion (Bottema, 1975). In spectra dominated by Asteraceae, Poaceae and Chenopodiaceae at Anzabegovo, Macedonia, Grüger (1976) suggests the possibility of selective destruction of certain pollen types. The same author mentions similar pollen assemblages in Neolithic culture layers from Divostin and Grivac in Serbia. Couteaux (1977) states that the abundance of *Asteraceae liguliflorae* necessarily implies strongly biased pollen spectra. Severe deterioration of pollen at Borduşani, in $CaCO_3$-rich loess or loess-like sediments, rendered samples unidentifiable except for Asteraceae–Cichorioideae pollen (Tomescu, 1997). Poor pollen preservation was accompanied by low pollen concentrations, progressive pollen deterioration and high frequencies of deteriorated or unidentifiable pollen. The results of the analyses carried out at Borduşani (Tomescu, 1997) and Hârşova (Tomescu and Diot, 2000) fit all of these conditions: pollen concentrations were very low, frequencies of unidentifiable pollen were high, and the dominant taxa were Poaceae, Chenopodiaceae, Asteraceae and *Pinus*.

Information on pollen concentrations (absolute pollen frequencies) in sediments has not been widely reported until recently. Of the analyses dealt with in this paper, only Malu Roşu (Stoian, 1995) recorded absolute pollen frequencies, but no mention was made of the progressive pollen deterioration at that site. Pop (1957) presented *pollen densities* at Craioviţa – the number of pollen grains counted on the 4 cm^2 area of a slide. Although densities are not equivalent to pollen concentrations, they provide a basis for assessing pollen concentration. Pop (1943) considered that pollen densities of <100 grains/slide may have been caused by pollen destruction. Pollen densities of >100 grains/slide occurred only in two of the 14 samples analyzed at Craioviţa. The high pH of the peat provided a good reason for the poor pollen preservation. Pollen concentrations are only discussed in qualitative terms in other analyses. Pollen concentrations were reported as insufficient in some samples from Rogova and Pantelimon, Coslogeni and Radovanu (Alexandru, 1990). Pollen concentrations at Bucov were described as sufficient. At Vãdastra, they were considered significant, but relatively low.

Low pollen sums can be inferred to represent low pollen concentrations, since a minimal number of pollen grains (usually between 300 and 500–Birks and Birks, 1980) are required for spectra to be reliable and reproducible. Pollen sums are not presented for most of the Romanian sites. At Vãdastra, the pollen and spore sum was between 300 and 552 in Holocene samples. Most samples from Coslogeni had pollen sums of <250 grains; the sum exceded 200 grains only in two samples, and was <100 pollen grains in two others. At Bucov, the pollen sums were >380, while at Radovanu, the pollen sums were about 500 grains, except for one sample with 245 grains and another that was considered too poor to be statistically valid.

Only qualitative estimates were made of the pollen preservation state. At Craioviţa, Pop (1957) suggested that the peat structure indicated selective destruction of pollen. The high frequencies of Asteraceae pollen in the samples of Padea were attributed to selective destruction. At Leu the pollen was not well preserved, and at Vãdastra arboreal pollen was frequently deteriorated. At Bucov, frequent occurrences of highly fragmented, deteriorated and unidentifiable pollen were reported. For the Malu Roşu and Coslogeni samples, the authors reported very good to good pollen preservation, but evidence of progressive pollen deterioration was present at Malu Roşu, and pollen sums were low at Coslogeni. The frequency of unidentifiable pollen was only recorded at Rogova — it occurred in small quantities in four samples.

4. Vegetation history

Features that reduce the reliability of pollen analyses in sites of the Romanian Plain are summarized in Table 6. A common feature of all sites (except for Malu Roşu) is the evidence of selective pollen destruction–spectra dominated by corrosion-resistant taxa such as Asteraceae, Poaceae, Chenopodiaceae, and *Pinus*. For the sequence of Malu Roşu, the dominant taxa could not be determined because only a summary diagram of ecologically related taxa groups was published (Stoian, 1995). The records from Padea, Fãrcaşul de Sus, Vlãdiceasca, Cârlomãneşti and Radovanu seem more reliable than others, but this appearance may be caused by a lack of information (marked '?' in Table 6) on several key aspects. For the majority of sites, the information on stratigraphy (Table 1) and pollen preservation is quite limited, and for several sites, it is minimal. The anthropogenic origin of sediments in most sites raises doubts about their usefulness for vegetation reconstructions. No absolute dating exists for any of the sites under consideration. Samples from archaeological sites were dated in relation to their archaeological context, and samples from natural sequences have no independent age determinations.

One particular case is that of the peat bog at Craioviţa. The pollen spectra were different from those of other sites in showing high AP values (especially *Quercus*, *Corylus* and *Tilia*). Pop (1957) infers that as early as the Boreal–Early Atlantic period, the region was located between the forest–steppe with large groves of *Quercus*, *Ulmus* and *Tilia* and vast, compact *Quercus* forests. However, the evidence suggests that pollen spectra may be biased because of the basic pH of the peat, low pollen concentrations and selective pollen destruction. The biostratigraphic scheme on which the chronology of the sequence was based was not calibrated by radiometric dating.

To conclude, no reliable picture of Holocene vegetation of the Romanian Plain is likely to be inferred from the published pollen data shown in Table 2. Information on the vegetation history must consequently be looked for elsewhere. One such attempt was based on pedology. Chişu (1971) assumed that each soil type formed under a specific vegetation cover, which in turn is the effect of a specific climate. In this sense, the succession of fossil soils in a profile tells the story of both climate and vegetation. Unfortunately, no radiometric dating supports the reconstructions. Except for the information provided by the most recent soil, considered by the author to be formed during the Subatlantic period, the existence of fossil steppe soils under recent forest soils only suggests prior existence of steppe vegetation. As early as 1924, on the basis of fossil soils, Enculescu assumed that forests advanced over the steppe and retreated several times during the Holocene, without dating these events. The recent soils suggest that forests reached their greatest extent of postglacial times in the Subatlantic period, covering areas of present-day forest and forest–steppe (Chişu, 1971). For the last part of the Subatlantic, historical documents confirm this picture of wide forested zones (Enculescu, 1924; Chişu, 1971).

It is helpful to look at pollen records from regions adjacent to the Romanian Plain or with similar climate and vegetation types at present. For instance, Dobrogea is the eastern extension of the Romanian Plain in terms of its present-day climate and vegetation. A pollen analysis at Ovidiu (Conea, 1970) was undertaken on the recent chernozem and the underlying loess to a depth of 1.25 m. Spectra dominated largely by Asteraceae and Chenopodiaceae implied selective pollen destruction, and no reconstruction was possible.

Pop (1957) analyzed samples from the peat bog of Berveni–Ecedea in the plain region of northwest Romania. The present oak forest and forest–steppe vegetation of the region, as well as its climate, are similar to those of the Romanian Plain, with a mean annual temperature of 10–11°C, a mean annual temperature range of 25–26°C, a mean January temperature of -3 to -2°C, a mean July temperature 21–22°C, and a mean annual precipitation of about 600 mm (Roşu, 1980). The author considered that steppe covered the region during the second half of the Preboreal and the Boreal periods, but pollen densities were very low, and pollen preservation was poor. Again, the reconstruction is suspect.

Farther to the west, pollen analyses were carried out by Jarái-Komlódi (1968) on the Hungarian Plain, a region whose present oak forest–steppe vegetation and climate are very similar to those of the Romanian Plain. The mean annual temperature range is 22–25°C, the mean January temper-

Table 6
Features that reduce the reliability of pollen analyses and the most frequent taxa for the sites of the Romanian Plain

Site[a]	Natural (N)/Anthropic (A) sediments	Loess[b]	Low pollen concentrations[b]	High frequency of deteriorated pollen[b]	Low pollen sums[b]	Selective pollen destruction[b]		Other
Rogova (R) Iliescu and Ghenea (1964)	N	+	(+)	?	?	+	*Pinus* Chenopodiaceae Asteraceae	
Pantelimon (Pa) Iliescu and Cioflica (1964)	N	+	(+)	?	?	+	Asteraceae Chenopodiaceae *Pinus*	
Vădastra (Va) Leroi-Gourhan et al. (1967)	N, A	+	(+)	(+)	–	+	Asteraceae Poaceae Chenopodiaceae	
Malu Roşu (MR) Stoian (1995)	A	+	+	(–)	?	?	?	Progressive pollen deterioration
Grădistea–Coslogeni (Co) Spiridonova (1995)	A		(–)	(–)	+	+	Poaceae *Artemisia* Chenopodiaceae	
Padea (P) Cârciumaru (1979)	A		?	?	?	+	Asteraceae Poaceae *Pinus*	
Leu (L) Cârciumaru (1979)	A		?	(+)	?	+	Poaceae Asteraceae Plantaginaceae	
Fărcaşul de Sus (F) Cârciumaru (1996)	A		?	?	?	+	Asteraceae Poaceae *Quercus*	
Vlădiceasca (Vl) Cârciumaru (1996)	A		?	?	?	+	Asteraceae Poaceae Alismateceae	
Cârlomăneşti (Ca) Cârciumaru (1977)	A		?	?	?	+	Asteraceae Poaceae Cyperaceae	
Radovanu (Ra) (archaeological) Alexandru (1990)/Cârciumaru (1996)	A		(–)	?	–	+	Asteraceae Poaceae/Alismataceae Chenopodiaceae/Poaceae	
Radovanu (Ra) (natural) Cârciumaru (1996)	N		?	?	?	+	Asteraceae Poaceae Alismataceae	
Bucov (Bu) Cârciumaru (1972)	A		(–)	(+)	–	+	Asteraceae Poaceae *Corylus*	
Craiovitaa (Cr) Pop (1957)	N		+	?	?	+	*Quercus* *Corylus* *Tilia*	Basic pH

[a] Site code refers to Fig. 1.

[b] '+' presence, '–' absence, '?' no information concerning the topic, '(+)'/'(–)' only qualitative comments; overall frequencies of taxa were found by adding their relative frequency in each sample and dividing the sum by the number of samples. The frequencies thus obtained give a rough image of the participation of each taxon over the whole series of samples in one particular site.

ature −1.5°C, the mean July temperature 21°C, and the mean annual precipitation 500–600 mm (Jarái-Komlódi, 1968). The vegetation history was reconstructed from four sequences and compared with other data in the region. By the Boreal period, steppe vegetation (with Poaceae, *Artemisia*, Chenopodiaceae, Asteraceae) of the Preboreal was progressively replaced by forest–steppe (first with *Pinus* and then with *Quercetum mixtum*). The Atlantic witnessed the climax of the *Quercetum mixtum* forest–steppe, which began to thin out by the Subboreal, due to both climatic change and human activity.

Bozilova and Filipova (1986) analyzed cores from lakes Durankulak and Shabla in the Bulgarian part of Southern Dobrogea, on the Black Sea coast, close to the Romanian border (Fig. 1). The present climate is continental and dry with a mean annual temperature of over 11°C, a mean annual temperature range of 21–24°C, a mean January temperature of 0–1°C, a mean July temperature of 21–23°C, and a mean annual precipitation of 400–500 mm. The region supports a forest–steppe vegetation (Roşu, 1980; Bozilova and Filipova, 1986). One may assume a vegetation history similar to that of the Romanian Plain. The Durankulak and Shabla records are supported by 10 radiocarbon dates. The early Holocene vegetation consisted of steppe with Poaceae, Asteraceae, Chenopodiaceae, *Artemisia* and groves of *Quercus*, *Carpinus*, *Corylus*, *Ulmus* and *Alnus* at low elevations. Beginning at 7000 BC (that is approximately 8000 cal. BC), trees spread slowly, and by 5500 BC (approx. 6200 cal. BC), the region was covered by forest–steppe vegetation. Woods (mostly *Quercetum mixtum*) were present at low elevations, and the plateaus supported xerophilic herbs and trees.

Although remote and at higher elevations, the regions of Van Golü (Lake Van, southeast Turkey — 1650 m a.s.l.) and of the marsh of Karamik Batakligi (south-central Turkey — 1000 m a.s.l.) have present climate and vegetation types similar to those of the Romanian Plain. The mean annual precipitation varies largely between 300 and 800 mm in the region of Lake Van, where oak forest and forest–steppe vegetation is present. At Karamik Batakligi, a region with steppe vegetation, the mean January temperature is 0°C, the mean July temperature is 22°C and the mean annual precipitation reaches about 480 mm (Bottema and van Zeist, 1981). The vegetation history of these two regions is reconstructed by Bottema and van Zeist (1981). At Van Golü, desert steppe with Chenopodiaceae, *Ephedra*, *Artemisia* was progressively replaced by oak forests. At Karamik Batakligi, steppe vegetation changed to continuous forest of *Cedrus* and *Pinus* after 8000 BP (approx. 6800 cal. BC).

The records from the Hungarian Plain, Durankulak, Shabla, Van Golü and Karamik Batakligi suggest that early Holocene steppe was progressively replaced by forest or forest–steppe, mostly as a result of increased humidity on the Hungarian Plain and at Van Golü and Karamik Batakligi in southern Turkey (Jarái-Komlódi, 1968; Bottema and van Zeist, 1981) and increased temperature at Durankulak and Shabla in northeastern Bulgaria (Bozilova and Filipova, 1986). In all four regions, trees thin out progressively in the late Holocene as a result of increasing human activity. An examination of lake sediments cores is required to find out whether the Holocene vegetation history of the Romanian Plain is similar to one of these regions; floodplain lakes, oxbow lakes and fluvial barrier lakes, present especially in the eastern part of the plain, are suitable for such analyses.

5. Conclusion

In their 'Textbook of pollen analysis', Faegri and Iversen (1975) (p. 125) suggest that "as all manipulation of the pollen sum must be based on certain assumptions, and represents a certain personal judgement, the material should be presented in such a way that the original counts are available". As emphasized earlier, the lack of information for most of the studies from the Romanian Plain (Table 6), renders them difficult to interpret. As in any scientific pursuit, interpretations in palynology are based on objective data. Pollen counts or at least pollen sums should accompany the pollen diagram or table of percentages, as well as an explanation for the basis of percentage calculation. The number or percentage of indeterminable pollen in each sample, the frequency of deteriorated pollen and an assessment of the pollen preservation should also be present. In addition, information concerning absolute pollen frequencies (when available) is crucial to assess the analyzed sequences. In order to be complete, studies should include a detailed stratigraphy of the sequences, a lithologic description of the samples and an interpretation of the genesis for archaeological deposits. Contributing pollen records to the European Pollen Database available through the National Oceanic and Atmospheric Administration would also help standardize the analysis and presentation of pollen data.

The Holocene vegetation history of the Romanian Plain is poorly known from the available pollen records. Lacking radiocarbon dates, pedologic information only proves that both forest and steppe vegetation were present at successive moments and that during the Subatlantic period, forests reached their greatest extent. This suggests that the Romanian Plain might have been locally more forested than southern Dobrogea or the Hungarian Plain, where pollen records suggest that forest–steppe replaced early–Holocene steppe vegetation.

References

Alexandru, M., 1990. Analiza palinologicã a profilului 'La Muscalu' de la Radovanu. Culturã şi civilizaţie la Dunãrea de Jos 8, Muzeul Dunãrii de Jos, Cãlãraşi. 116–117.

Besancon, J., 1981. Stratigraphie et chronologie du Quaternaire continental du Proche Orient. In: Préhistoire du Levant. Colloques Internationaux du CNRS 598, Maison de l'Orient, Lyon, 10–14 June 1980. Editions CNRS, Paris, pp. 33–53.

Birks, H.J.B., Birks, H.H., 1980. Quaternary Palaeoecology. Edward Arnold, London.

Bottema, S., 1975. The interpretation of pollen spectra from prehistoric settlements (with special attention to Liguliflorae). Palaeohistoria 17, 17–35.

Bottema, S., van Zeist, W., 1981. Palynological evidence for the climatic history of the Near East, 50 000–6000 BP. In: Préhistoire du Levant. Colloques Internationaux du CNRS 598, Maison de l'Orient, Lyon, 10–14 June 1980. Editions CNRS, Paris, pp. 111–132.

Bottema, S., Ottaway, B.S., 1982. Botanical, malacological and archaeological zonation of settlement deposits at Gomolava. J. Archaeol. Sci. 9, 221–246.

Bozilova, E., Filipova, M., 1986. Paleoecological environment in Northeastern Black Sea area during Neolithic, Eneolithic and Bronze periods. Studia Praehistorica 8, 160–165.

Brooks, J., Shaw, G., 1972. Geochemistry of sporopollenin. Chem. Geol. 10, 69–87.

Cârciumaru, M., 1972. Analiza polinicã a stratelor de la Bucov (jud. Prahova). SCIV 23, 3, Bucureşti. 427–432.

Cârciumaru, M., 1977. Cercetãri paleoclimatice şi paleobotanice în staţiunea de la Cârlomãneşti (jud. Buzãu). Date privind cultivarea unor cereale şi plante de culturã. SCIVA, 28, 3, Bucureşti, 353–364.

Cârciumaru, M., 1979. Analyse pollinique des couches néolithiques de Padea et de Leu (dép. de Dolj) Dacia N.S. 23. Editura Academiei RSR, Bucureşti. pp. 65–68.

Cârciumaru, M., 1996. Paleoetnobotanica. Studii în preistoria şi protoistoria României. Ed. Glasul Bucovinei Helios, Iaşi.

Chiţu, C., 1971. Modificãri ale învelişului vegetal natural în Holocen, pe teritoriul R.S. România. Buletinul Societãţii de Stiinţe Geografice din R.S.R., Bucureşti 1 (71), 83–91.

Comşa, E., 1990. Complexul neolitic de la Radovanu. Culturã şi civilizaţie la Dunãrea de Jos 8, Muzeul Dunãrii de Jos, Cãlãraşi.

Conea, A., 1970. Formaţiuni Cuaternare în Dobrogea (loessuri şî paleosoluri). Editura Academiei RSR, Bucureşti.

Couteaux, M., 1977. A propos de l'interprétation des analyses polliniques de sédiments minéraux, principalement archéologiques. Le milieu végétal, les faunes et l'homme, Suppl. Bull. AFEQ 47, 259–276. Chapitre II.

Enculescu, P., 1924. Zonele de vegetaţie lemnoasã din România îin raport cu condiţiunile oro-hidrografice, climaterice, de sol şi de subsol. Memoriile Institutului Geologic al României 1, Cartea Româneascã, Bucureşti.

Faegri, K., Iversen, J., 1975. Textbook of Pollen Analysis. third revised ed., Munksgaard, Copenhagen.

Gogãlniceanu, S.M., 1939. Analiza chimicã, mecanicã şi microscopicã a loesului românesc. Ph.D. thesis, Facultatea de Stiinţe din Iaşi, Laboratorul de Mineralogie Generalã 49, Imprimeria Naţionalã, Bucureşti.

Grüger, E., 1976. Pollen analysis (2.). In: Gimbutas, M. (Ed.), Neolithic Macedonia as Reflected by Excavation at Anza, Southeast Yugoslavia. Monumenta Archaeologica 1, Los Angeles, CA, pp. 294–299.

Hall, S.A., 1981. Deteriorated pollen grains and the interpretation of Quaternary pollen diagrams. Rev. Palaeobot. Palynol. 32, 193–206.

Havinga, A.J., 1964. Investigation into the differential corrosion susceptibility of pollen and spores. Pollen et Spores 6 (2), 621–635.

Havinga, A.J., 1967. Palynology and pollen preservation. Rev. Palaeobot. Palynol. 2, 81–98.

Havinga, A.J., 1984. A 20-year experimental investigation into the differential corrosion susceptibility of pollen and spores in various soil types. Pollen et Spores 26, 3–4, 541–558.

Ianovici, V., Florea, N., 1963. In: Tipurile de scoarţã de alterare şi rãspândirea lor pe teritoriul RPR. Studii tehnice şi economice, seria C, Pedologie 11, Comitetul Geologic, Bucureşti, 5–39.

Iliescu, V., Cioflica, G., 1964. Studiu palinologic asupra carierelor de la Pantelimon. Dãri de Seamã ale edinţelor 49 (1961–1962), 1 Comitetul Geologic, Bucureşti, 113–118.

Iliescu, V., Ghenea, C., 1964. Observaţii geologice şi palinologice asupra unor depozite loessoide din Câmpia Olteniei. Dãri de Seamã ale edinţelor 49 (1961–1962), 1, Comitetul Geologic, Bucureşti, 119–127.

Jarái-Komlódi, M., 1968. The late glacial and Holocene flora of the Hungarian Great Plain. Ann. Univ. Scientiarum Budapest, Sect. Biol. 9–10, 199–225.

Leroi-Gourhan, Arl., Mateesco, C.N., Protopopesco-Pake, Em., 1967. Contribution à l'étude du climat de la station de Vãdastra du Palolithique supérieur à la fin du Néolithique. Bulletin de l'Association francaise pour l'étude du Quaternaire 4, 271–279.

Pop, E., 1943. Faza pinului din Basinul Bilborului (jud. Ciuc). Buletinul Grãdinii Botanice şi al Muzeului Botanic dela Universitatea din Cluj la Timişoara 23, 3–4, Cluj-Napoca. 97–116.

Pop, E., 1957. Analize de polen în regiuni de câmpie. Buletin Stiinţific, Secţia de biologie şi Stiinţe agricole (Seria botanicã) 9, 1, Academia RPR, Bucureşti. 5–32.

Reille, M., 1978. A propos de la disparition du pollen dans certains sédiments minéraux. Apport des techniques récentes en palynologie, Liège, 19–23 septembre 1977, Annales des Mines de Belgique 6ᵉ livraison. 707–712.

Roşu, A., 1980. Geografia fizicã a României. Editura Didacticã şi Pedagogicã, Bucureşti.

Sanda, V., Popescu, A., Paucã-Comãnescu, M., 1992. Vegetaţia Munteniei şi Olteniei. In: Ivan, D. (Ed.), Vegetaţia României. Editura Tehnicã Agricolã, Bucureşti.

Şerbãnescu, I., 1975. Harta geobotanicã a Republicii Socialiste România Thesis 1:1.000.000. Notã explicativã. Institutul de Geologie şi Geofizicã, Bucureşti.

Spiridonova, E., 1995. Les résultates préliminaires de l'examen polinilogiques du site Coslogeni Culturã şi civilizaţie la Dunãrea de Jos 13–14. Muzeul Dunãrii de Jos, Cãlãraşi, pp. 81–94.

Stoian, L., 1995. Studiul palinologic al depozitelor cuaternare din aşezarea paleoliticã de la Giurgiu — Malu Roşu. SCIVA 46, 1, Bucureşti. 51–62.

Tomescu, M., 1997. Palynology (3.7.). In: Marinescu-Bîlcu, S. et al., (Eds.), Archaeological researches at Borduşani-Popinã (Ialomiţa county) Preliminary report 1993–1994 Cercetãri arheologice 10. Muzeul Naţional de Istorie a României, Bucureşti, pp. 128–131.

Tomescu, M., Diot, M.-F., 2000. Apports des analyses palynologiques à l'étude du tell de Hârşova. Cercetãri arheologice 11. Muzeul Naţional de Istorie a României, Bucureşti, in press.