Pollen monitoring in surface samples in mosses and pollen traps from the Beglika region (W Rhodopes)

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Abstract. Pollen monitoring has been held during two consecutive years (2002–2003) on the basis of nine pollen traps and 16 surface samples in mosses taken in the coniferous belt from the Beglika region, Western Rhodopes (1550 m a.s.l.). Annual influence on the values of arboreal and non-arboreal pollen has been traced out and compared with the pollen production and effective dispersal distance. Data from different deposits has been compared. Conclusions have been drawn on the interrelations between the contemporary vegetation in the region and the pollen rain. The authors present data on the participation, productivity and preservation of the widest distributed taxa in recent pollen spectra in a mountainous relief.

Introduction

To interpret properly the fossil pollen spectra, it is necessary to determine the interrelations between the existing vegetation and the contemporary pollen "rain", considering the physico-geographical conditions in the region. Pollen analysis of surface pollen samples and pollen traps provide the most reliable information about the relationship between the contemporary vegetation and pollen rain in a given region. These methods make it possible to determine to what an extent the spectra formed by the pollen rain actually reflect the species composition of the contemporary plant communities that have produced them, as well as the correlation between their various components. Parallel with that they provide implicit information about relative pollen productivity, effectiveness of distribution and pollen preservation of the different taxa. Records of the influence of pollen productivity on various arboreal and non-arboreal taxa, of the ability of their pollen for distribution, deposit and preservation,

and determination of origin in the monitored regions contributes to a better reconstruction of the paleoecological conditions (vegetation and climate) in the investigated region.

While tracing out the Holocene vegetation succession and formation of the contemporary plant communities in the region, it was very important to retrace the participation of *Pinus sylvestris* L. and *Picea abies* (L.) Karst. in the composition of arboreal vegetation in the process of its development. These two taxa differ in pollen productivity, in pollen ability for long-distance transport and fossil preservation. All this called for determining to what an extent the pollen spectra reflect their actual participation in the plant communities under the concrete physico-geographical conditions of the studied area. It was necessary to know the relationship between contemporary vegetation and pollen rain so as to interpret the pollen spectra, because relaiable historical reconstruction of the vegetation in a given region on the basis of palynological investigations depended on it (Wright 1967).

Contemporary vegetation

Contemporary vegetation in the Rhodopes belongs to two physiognomically differentiated, but climatically linked types: forests and meadow formations of herbaceous vegetation, with an almost completely excluded tree element. Forests in the lower mountain belt are more xerophyllous (*Querceta*) and strongly affected by human activity. In the median mountain belt they are more mesophyllous (*Fageta*). At altitudes of 1500–1800–1900 m they are dominated by coniferous forests of *Pinus sylvestris* and *Picea abies* interspaced by meadow communities and peat bogs. According to Bondev (1997), white-pine forests prevail westwards of river Vucha, in the Dubrak and Batak regions, where spruce comes second. White-pine forests are well spread too, but strongly fragmented there.

Description of vegetation in the locations of pollen traps

The set pollen taps were divided into two groups: the fist group comprised the traps with numbers from 1 to 5 set in a meadow-and-pasture coenosis with southwestern exposition and terrain gradient of about 4–5°; the second group consisted of traps numbered from 6 to 9 and was situated in the boundary area between the pasture and a white pine forest.

In the coenosis of the first group traps the dominating role was played by: *Nardus stricta* L., *Festuca nigrescens* Lam., *F. dalmatica* (Hack.) K. Richt., *Agrostis capillaris* L., *Anthoxanthum odoratum* L., *Bellardiochloa violacea* (Bellardi) Chiov., *Bromus riparius* Rehmann, *Lerchenfeldia flexuosa* (L.) Schur, *Poa pratensis* L., *Carex ovalis* Good., *Carex caryophyllea* Latourr., *Luzula sudetica* (Willd.) DC., *Trifolium pratense* L., *T. repens* L., *Genista depressa* M. Bieb., *Chamaespartium sagittale* (L.) Gibbs., *Achillea millefolium* L., *Taraxacum officinale* Weber, *Ajuga genevensis* L., *Alchemilla flabellata* Buser, *Asperula cynanchica* L., *Bistorta major* S.F. Gray, *Campanula patula* L. subsp. *epigaea* (Janka) Hayek, *Carlina acanthifolia* All., *Cerastium arvense* L., *Crocus veluchensis* Herb., *C. flavus* Weston, *Cruciata laevipes* Opiz, *Dianthus deltoids* L., *Draba lasiocarpa* Rochel, *Euphorbia cyparissias* L., *E. myrsinites* L., *Euphrasia rostkoviana* Hayne, *Fragaria vesca* L., *Galium verum* L., *Gentiana cruciata* L., *G. verna* L., *Geum rhodopaeum* Stoj. & Stef., *Hieracium hoppeanum* Schult., *H. pilosella* L., *Hypericum maculatum* Crantz, *Lamium maculatum* L., *Leontodon autumnalis* L., *L. hispidus* L., *Linum capitatum* Kit. ex Schult.,

Ligusticum mutellina (L.) Crantz, *Muscari botryoides* (L.) Mill., *Myosotis laxa* Lehm. subsp. *caespitosa* (Schultz) Hyl. ex Nordh., *Ornithogalum* sp., *Plantago media* L., *Polygala comosa* Schkuhr, *Potentilla crantzii* (Crantz) Beck ex Fritsch, *P. erecta* (L.) Raeusch., *Prunella vulgaris* L., *Ranunculus sartorianus* Boiss. & Heldr., *Rumex acetosella* L., *Sanguisorba minor* Scop., *Scilla bifolia* L., *Stellaria graminea* L., *Thlaspi kovatsii* Heuff., *Thymus* sp., *Verbascum densiflorum* Bertol., *Veronica chamaedrys* L., *V. rhodopaea* (Velen.) Degen ex Stoj. & Stef., *Viola rhodopeia* Becker, *V. tricolor* L., etc. Of the arboreal species there were single young specimens of *Pinus sylvestris* and *Picea abies* , and *Juniperus communis* L., etc. represented the shrubs.

The second group of pollen traps was placed peripherally between the meadow-and-pasture coenosis and a forest coenosis dominated by *P. sylvestris*. Owing to the formerly intensive economic use of the area, the forest community contained both typically arboreal and meadow species. The floristic composition was as follows: *Pinus sylvestris, Picea abies, Juniperus communis, Rosa pendula* L., *Rubus idaeus* L., *Vaccinium myrtillus* L., *V. vitis-idaea* L., *Agrostis capillaris, Brachypodium sylvaticum* (Hudson) P. Beauv., *Bromus riparius, Festuca nigrescens, Lerchenfeldia flexuosa, Poa nemoralis* L., *Chamaespartium sagittale, Lotus corniculatus* L., *Trifolium alpestre* L., *Carex ovalis, Luzula forsteri* (Sm.) DC., *Luzula luzuloides* (Lam.) Dandy, *Euphorbia amygdaloides* L., *Hypericum maculatum, Achillea millefolium, Taraxacum officinale, Ajuga genevensis, A. reptans* L., *Alchemilla flabellata, Aremonia agrimonoides* (L.) DC., *Campanula rapunculoides* L., *Corydalis solida* (L.) Schwarz, *Cruciata glabra* (L.) Ehrend, *Fragaria vesca, Galium rotundifolium* L., *G. verum, Geranium robertianum* L., *Gentiana cruciata, Knautia arvensis* (L.) Coult., *Linum capitatum* Kit. ex Schult., *Myosotis sylvatica* Ehrh. ex Hoffm., *Plantago media, Potentilla erecta, Primula veris* L., *Ranunculus ficaria* L., *Stellaria graminea, Teucrium chamaedrys, Thlaspi kovatsii, Veronica chamaedrys, V. officinalis* L., *Viola reichenbachiana* Jord. ex Boreau, *Viola riviniana* Rchb., etc.

Material and methods

The analysed samples were taken in the coniferous belt of the Beglika region, Western Rhodopes (1550 m, 41°51′09″N and 24°05′27″E). Most pol-

len traps were set on a straight line in the meadow, at consecutive intervals of 5 m into the forest (Fig. 1). Pollen monitoring in the Beglika region was held in two consecutive years (2002–2003), on the basis of a spore and pollen analysis of 16 surface samples in the forest and nine pollen traps. Lack of data in some of the traps (no. 9 in 2002 and no. 3 and 6 in 2003) was explained by various damages caused to the contraptions. The traps were set in October and replaced by new ones next year, in order to ensure pollen deposit for the entire period (a calendar year). The method of Hicks & al. (1996) was followed in trap setting and vegetation description.

Fig. 1. Map of the pollen monitoring area and schematic location of the pollen traps.

The standard methods applied in Quaternary palynology, including HCl, HF and acetolysis for 3 min (Faegri & Iversen 1989), were used in the laboratory processing of samples. Laboratory processing of the pollen trap contents started with the addition of two *Lycopodium* tablets (13 500 spores each) dissolved in distilled water, and was followed by the removal of excess material and water by sieving and centrifuging (Stockmar 1973). Identification of the pollen grains and spores was performed by using the reference collection of the Laboratory of Palynology, Institute of Botany, BAS, and the keys of Faegri & Iversen (1989), Moore & al. (1991), Chester & Raine (2001) and Beug (2004). Calculation of the pollen spectra was based on the total pollen sum, excluding the aquatic and spore plants. The percentage pollen participation of arboreal (AP) and non-arboreal (NAP) pollen types is presented as part of the total pollen sum (ΣP), including $\Sigma P = AP + NAP = 100\%$. The spores of *Pteridophyta* and the pollen of *Cyperaceae* and aquatic plants are excluded from the pollen sum. The results of statistical data processing obtained with the TILIA and TILIA-GRAPH programs (Grimm 1991) are presented in percentage (Figs 2, 3, 4) and in pollen influx (PI- grains/cm²/yr) diagrams (Figs 5, 6).

A total of 89 pollen taxa were identified: 28 from the AP group (trees and shrubs), 53 from the NAP group (herbaceous), and 8 taxa of local origin (L) including the pollen of *Cyperaceae*, hydrophytes and spores of mosses and pteridophytes.
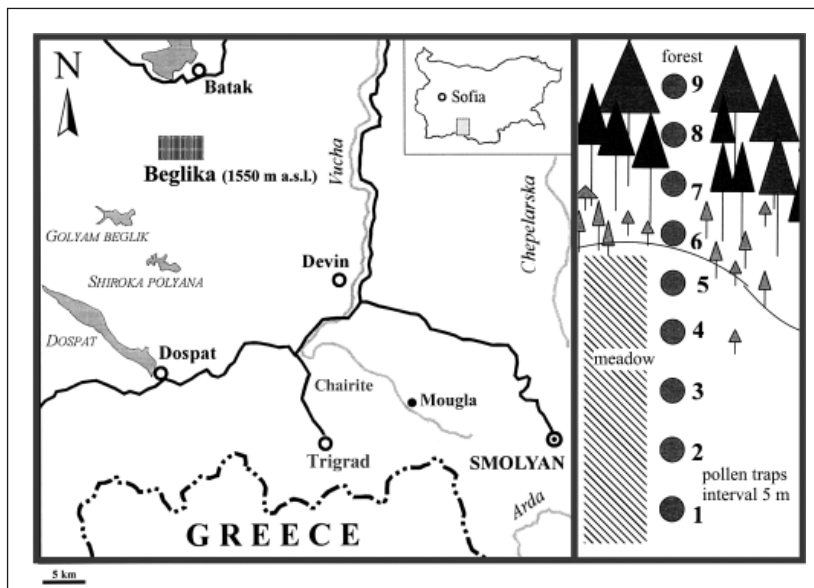
Results of the pollen analysis and discussion

The dominant taxa in the communities were adequately represented in the pollen traps and surface samples. In the surface samples, AP values varied between 85 % (no. 7) and 97 % (no. 10), and the values of NAP between 3 % (no. 10) and 15 % (no. 7) respectively. Local elements participated up to 2 % (no. 3), with a maximum of 6 % (no. 8) (Fig. 2). In 2002 pollen traps, AP values varied from 37 % (trap no. 7) to 55 % (trap no. 2), with a local maximum of 77 % (trap no. 6). NAP respectively were 45 % (trap no. 2) and up to 63 % (trap no. 7), with a local maximum of 23 % (trap no. 6). Local elements (L) reached 2.4 % (trap no. 8) (Fig. 3). In 2003 pollen traps, AP varied from 54 % (trap no. 7) up to 88 % (trap no. 9), NAP registered respectively from 13 % (trap no. 9) up to 46 % (trap no. 7). Local elements (L) did not exceed 2 % (trap no. 2) (Fig. 4).

The coniferous/deciduous pollen correlation also reflected realistically the present vegetation. The pollen of *Pinus* and *Picea* dominated in all pollen spectra, in samples from mosses up to 92.4 % (no. 14) (Fig. 2) and 72.7 % (trap no. 6, 2002, Fig. 3) and 81.4 % (trap no. 9, 2003, Fig. 4) in samples from traps. The deciduous pollen respectively up to 4.4 % (no. 14, Fig. 2) in samples from mosses and 4.1 % (trap no. 6, 2002, Fig. 3) and 5.9 % (trap no. 9, 2003, Fig. 4).

The *Pinus diploxylon*-type was presented with the highest percentage values in all surface samples. In all
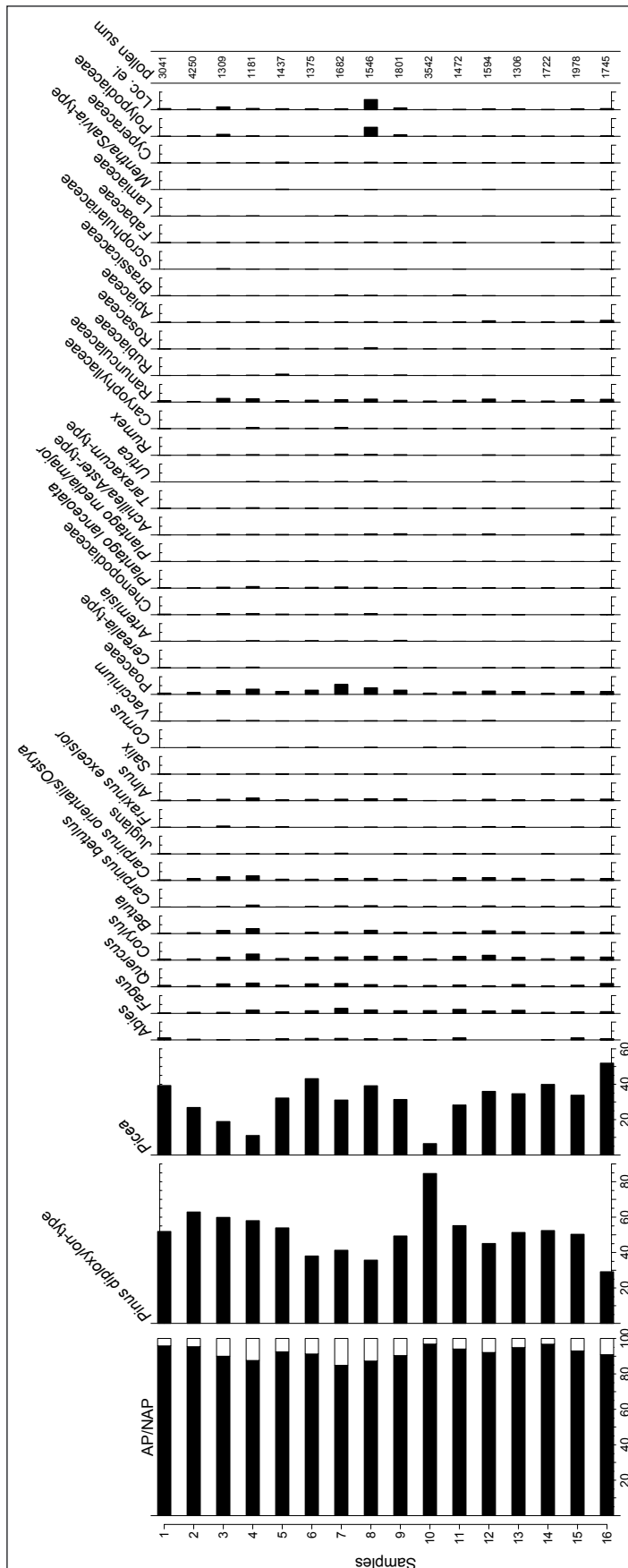
Fig. 2. Percentage pollen diagram of surface moss samples.

surface samples in mosses and in almost all samples from traps, pollen of the *Pinus diploxylon*-type (*P. sylvestris*) dominated up to 30 % (no. 16) – 63 % (no. 2), and registered a local maximum up to 84.6 % (no. 10) in the samples from mosses (Fig. 2) and between 72 % (PI-18390 grains/cm^2/yr, pollen trap no. 6, 2002, Fig. 3) and 75 % (PI-19400 grains/cm^2/yr, pollen trap no. 9, 2003, Fig. 4) in the samples from traps. The results showed 2003 as more favourable for this pollen productivity. The *Pinus diploxylon*-type was overrepresented in all pollen spectra, a fact established for the coniferous belt of the Rhodopes by Panovska (1993) and Filipovitch & Lazarova (1999). This is explained by the high pollen productivity of the species and its easy distribution related to the morphological specificities of the pollen (Andersen 1970, 1974; Faegri & Iversen 1989).

In the surface moss samples *Picea* registered values between 6.5 % (no. 10) – 43 % (no. 6), with a local maximum of 52 % (no. 16) (Fig. 2). In 2002 pollen traps *Picea* recorded 2.3 % (PI-2755 grains/cm^2/yr, pollen trap no. 2, Fig. 3) and in 2003 pollen traps up to 11.6 % (PI-7292 grains/cm^2/yr, pollen trap no. 9, Fig. 4). Data from the pollen spectra of the surface samples showed a much lower percentage of *Picea* than its real participation in the contemporary vegetation. That in why, in the reconstruction of fossil communities it was not the numerical values of Spruce in the pollen spectra that should be taken into consideration, but rather its correlation in comparison with the other tree species. When the percentage content of spruce pollen rated second in the tree pollen, it was widely disributed in the investigated area. The same was determined in the surface samples from the Koupena Biosphere Reserve in the Rhodopes (Panovska 1993), Western Rhodopes (Filipovitch & Lazarova 1999), as well as from other mountain regions (Panovska 1993; Stefanova 1996; Filipovitch & Lazarova 1997). That is why, in the reconstruction of fossil communities their correlation in comparison with the other arboreal species should be taken into consideration. When spruce pollen rates second in percent-

Fig. 3. Percentage pollen diagram of pollen traps, 2002.

age content among the arboreal species, this means that it is widely distributed in the studied area. Participation over 5% indicates proximity of a spruce forest. In pure spruce communities this participation reaches 20%, and 1% presence indicates wide distribution several hundred meters off the palce of the investigated sample. Apparently *Picea* pollen has poor long-distance distribution.

In the coniferous forests of the Rhodopes, *Abies* occurs as a not very frequent admixture. In the pollen spectra of most investigated samples fir participated with less than 1.2% (no. 11, Fig. 2) and in pollen traps with up to 1.4% (PI-1134 grains/cm²/yr, pollen trap no. 2, 2002, Fig. 5). Similarly to spruce, fir pollen was more poorly represented in the pollen spectra from traps and surface moss samples. Pollen productivity, the ability for long-distance transport and durability under fossilisation were inferior to those of pine. The presence of single pollen grains testified to its participation as an admixture in the forest vegetation.

The pollen of deciduous tree species was poorly represented in the pollen spectra. *Betula* was represented best in the pollen spectra of all samples, with up to 2.8% (no. 4, Fig. 2), or a maximum of 1782 grains/cm²/yr-PI (pollen trap no. 2, 2002, Fig. 5). Its distribution in the contemporary vegetation was adequately reflected in the spectra of surface samples, as well and as in the pollen traps. *Corylus* occurred as undergrowth in the thinned forests. Its participation in the pollen spectra was up to 3.5% (no. 4) in the samples (Fig. 2), and up to 1134 grains/cm²/yr-PI (pollen trap no. 2, 2002, Fig. 5) and 1115 grains/cm²/yr-PI, (pollen trap no. 1, 2003, Fig. 6) in the traps. That corresponded to its real participation in the vegetation composition. According to Andersen (1970), this species showed higher pollen productivity, when growing outside the forest canopy.

The pollen of *Alnus* was registered in small quantities in all samples, up to 1.5% (no. 4, Fig. 2), which corresponded to its contemporary distribution. The values registered in 2003 traps were higher and reached up to 2% or 305 grains/cm²/yr-PI, (pollen trap no. 4, 2003, Fig. 6) and an absolute maximum of 4.7%, or 984 grains/cm²/yr-PI, (pollen trap no. 1, 2003,
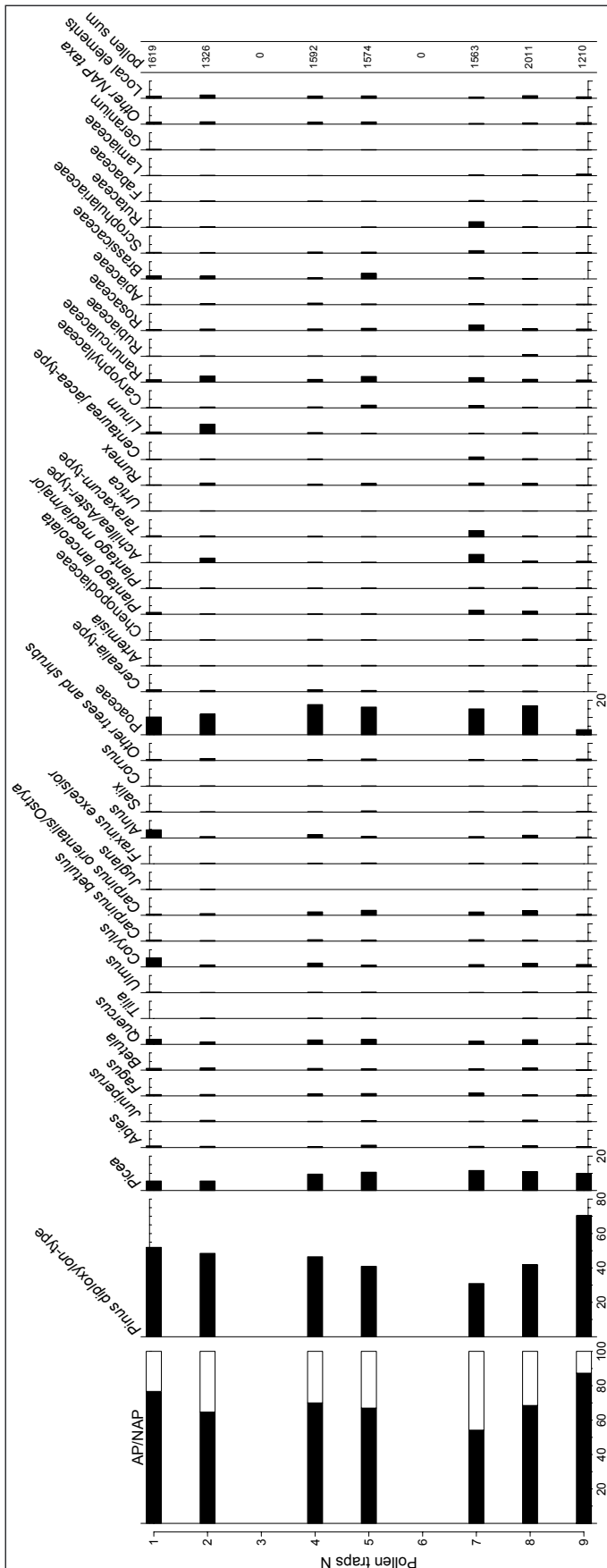
Fig. 4. Percentage pollen diagram of pollen traps, 2003.

Fig. 6). Apparently 2003 was more favourable for the flowering of *Alnus glutinosa*.

In some moss samples (Fig. 2) and in all pollen traps single pollen grains of *Salix* (Figs 3, 4) were registered during both years. A maximum value of 650 grains/cm^2/yr-PI (pollen trap no. 2, 2002, Fig. 5) was reached in places with specimens in close proximity to the sampling place. It is well known that the pollen of *Salix* is very poorly represented in the pollen spectra, owing to damage after depositing (Bradshaw 1978).

Small amounts of pollen of other deciduous species that were not in close proximity to the sampling place were registered in all pollen samples and traps. Apparently that pollen resulted from a long-distance transport from the lower mountain slopes. This was pollen of: *Fagus*, in the moss samples up to 2.9% (no. 7, Fig. 2) and a maximum of 1.7%, or 217 grains/cm^2/yr-PI (pollen trap no. 7, 2003, Fig. 6) in the traps; *Quercus*, with about 2% in the samples (no. 4) and in the traps up to 3%, or 605 grains/cm^2/yr-PI (pollen trap no. 1, 2003); *Carpinus orientalis/Ostrya* with up to 2.6% in the samples (no. 4) and up to 2.9%, or 387 grains/cm^2/yr-PI (pollen trap no. 5, 2003) in the traps; *Carpinus betulus* with up to 1.1% in the samples (no. 4) and in the traps up to 2%, or 485 grains/cm^2/yr-PI (pollen trap no. 2, 2002). These data corroborated comparatively good pollen productivity and transport abilities of these taxa (Bottema 1974; Tauber 1977). *Ulmus, Fraxinus excelsior* and *Tilia* were represented sporadically or with values under 1%.

A comparison of the correlation of pollen of deciduous taxa occurring in the coniferous belt (*Betula, Alnus, Corylus*) with the pollen of deciduous species from lower altitudes (below the coniferous forests: *Fagus, Quercus, Tilia*) has shown that the correlation of deciduous admixture from coniferous forests and that of the pollen originating from the deciduopua forests was realistically reflected in the pollen spectra of the surface samples and pollen traps (Figs 2, 3, 4).

Cornus, Viburnum, Euonymus, Sambucus, Vaccinium, Vitis, Humulus/Cannabis, etc. were registered with single pollen grains in some moss samples and in some traps. In the pollen
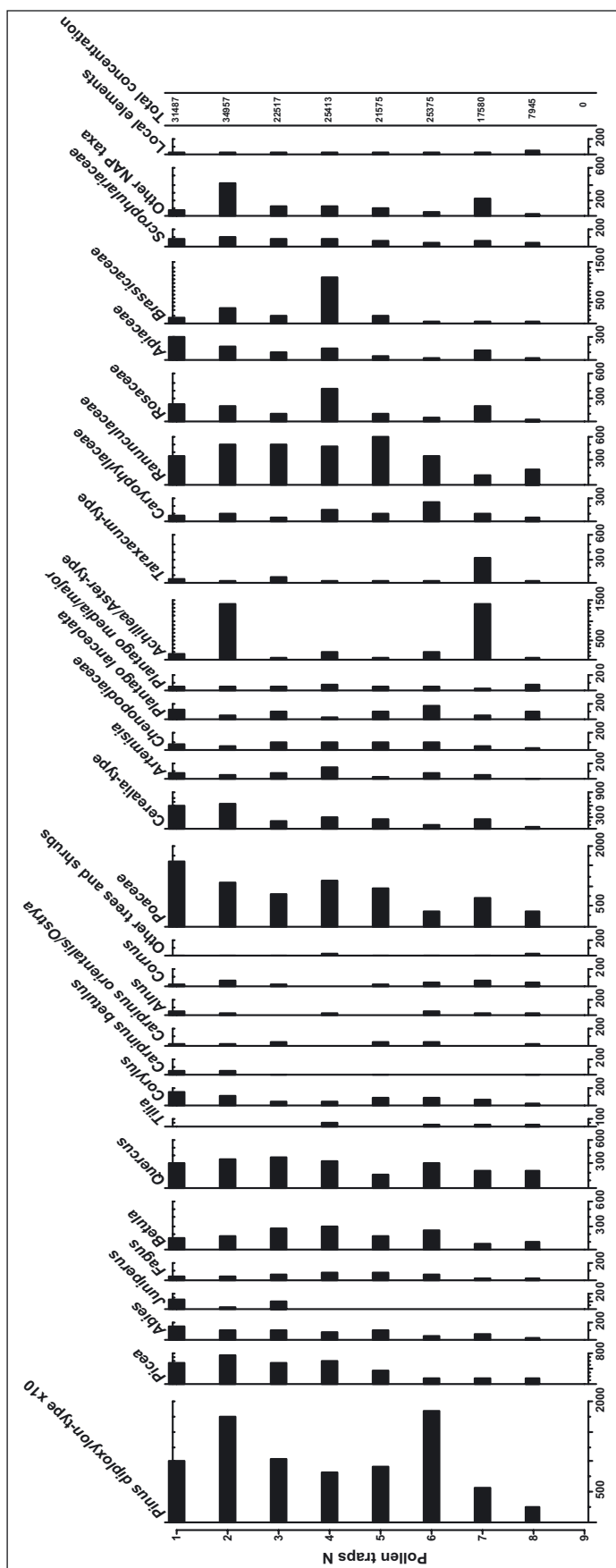
Fig. 5. Pollen influx diagram of pollen traps, 2002.

diagrams, their presence is recorded generally as "Other trees and shrubs" (Figs 3, 4).

Poaceae showed significantly higher values in the surface samples, up to 5.7 % (no. 7, Fig. 2), and in the traps up to 51 % (Fig. 3), or 16235 grains/cm^2/yr, (trap no. 1, 2002, Fig. 5) and up to 17.5 % (Fig. 4), or 2705 grains/cm^2/yr, (trap no. 4, 2003, Fig. 6), owing to the fact that most traps were in the open areas or at the forest boundary, where the diversity and presence of herbaceous taxa were higher. The *Poaceae* pollen was represented by the highest percentage values of the identified herbaceous types in all surface samples.

The most frequently occurring types of herbaceous pollen were: *Achillea/Aster,* up to 1 % in the surface samples (no. 9, Fig. 2) and with a local maximum of 8.1 %, or 1430 grains/cm^2/yr (trap no. 7, 2002, Fig. 5), and with 4.8 % or 630 grains/cm^2/yr, (trap no. 7, 2003, Fig. 6) in the traps; *Taraxacum,* up to 1 % in the surface samples and up to 2 % (Fig. 3), or 330 grains/cm^2/yr (trap no. 7, 2002, Fig. 5), and 3.7 % or 480 grains/cm^2/yr (trap no. 7, 2003, Fig. 6) in the traps; *Brassicaceae,* under 1 % in the surface samples and 4.4 %, or 1128 grains/cm^2/yr (trap no. 4, 2002), and 3.2 % or 430 grains/cm^2/yr (trap no. 5, 2003); *Ranunculaceae* up to 2.1 % in the surface samples (no. 3, Fig. 2) and up to 2.7 %, or 582 grains/cm^2/yr (trap no. 5, 2002, Fig. 5), and up to 3.5 % or 633 grains/cm^2/yr (trap no. 2, 2003, Fig. 6); *Apiaceae* up to 1.2 % in the surface samples (no. 16) and up to 1 % or 295 grains/cm^2/yr, (trap no. 1, 2002, Fig. 5), and 1 % or 147 grains/cm^2/yr, (trap no. 4, 2003, Fig. 6); *Caryophyllaceae,* up to 1 % in the surface samples (no. 7) and up to 1 % or 150 grains/cm^2/yr (trap no. 6, 2002, Fig. 5), and 1.6 % or 215 grains/cm^2/yr (trap no. 5, 2003, Fig. 6); *Rosaceae* up to 1 % in the surface samples and up to 1.6 % (Fig. 2) or 354 grains/cm^2/yr (trap no. 4, 2002, Fig. 5), and up to 3.3 % or 425 grains/cm^2/yr (trap no. 7, 2003, Fig. 6), etc. They often represented the herbage in the coniferous belt of the Rhodopes.

In terms of reflection of the anthropogenic impact in the pollen spectra and in the traps, it was interesting to note the occurrence of some pollen types: *Chenopodiaceae,* up to 1 % in the surface samples and up to 1 %, or
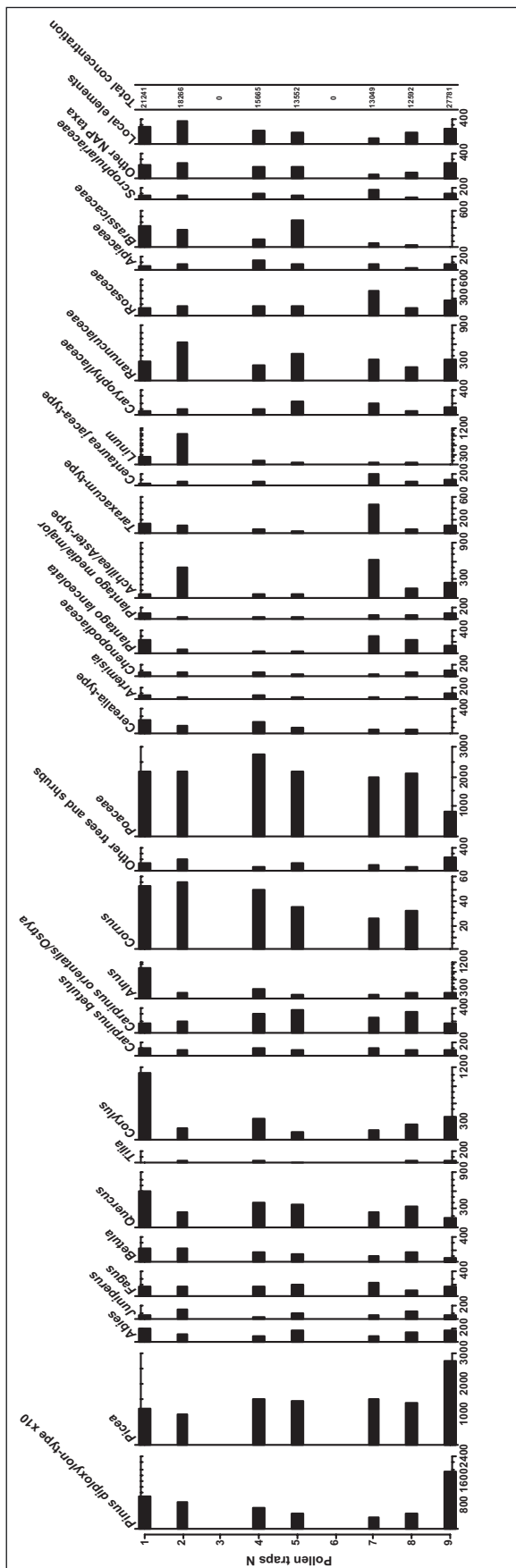
Fig. 6. Pollen influx diagram of pollen traps, 2003.

100 grains/cm²/yr (trap no. 3, 2002, Fig. 5), and 1 % or 114 grains/cm²/yr (trap no. 9, 2003, Fig. 6); *Artemisia,* maximum up to 1 % or 144 grains/cm²/yr (trap no. 4, 2002, Fig. 5); *Urtica,* below 1 % and a maximum of 1.1 % or 288 grains/cm²/yr (trap no. 4, 2002, Fig. 5); *Rumex,* up to 1.1 % or 125 grains/cm²/yr (trap no. 3, 2002, Fig. 5) and 1.4 % or 175 grains/cm²/yr (trap no. 7, 2003, Fig. 6); *Plantago lanceolata,* up to 1 % in the surface samples and up to 1.3 % or 165 grains/cm²/yr (trap no. 8, 2002, Fig. 5), and 2.4 % or 308 grains/cm²/yr (trap no. 7, 2003, Fig. 6) in the traps, etc. They were recorded in all surface samples and pollen traps, with single grains or participation up to 2.4 %, depending on theior location, and are actually regarded as indicators of the anthropogenic presence (Behre 1981).

Cerealia-type pollen was recorded in amounts up to 1 % in the surface samples and up to 2 %, or 265 grains/cm²/yr (trap no. 4, 2002, Fig. 5), and up to 1.2 % or 144 grains/cm²/yr, (trap no. 1, 2003, Fig. 6) in the traps. It should be allowed for some wild-growing species producing pollen of the *Cerealia* type, such as *Triticum boeoticum* Boiss., *Secale montanum* L., *Agropyrum* and *Hordeum* (Faegri & Iversen 1989). Thus, the *Cerealia*-type pollen could have originated not only from the cultured but from the wild-growing flora, too, considering the fact the agricoculture is practically non-existant in the investigated regions in the Rhodopes.

All other types of herbaceous pollen occured with single grains or with very low percentage values in the different samples and traps, depending on the composition of the grass cover in the proximity of the sampling place. The most frequently encountered pollen types were: *Potentilla*, *Geum*, *Filipendula*, *Achillea/Aster*, *Taraxacum*, *Brassicaceae*, *Ranunculaceae*, *Lamiaceae,* etc. In the coniferous belt of the Rhodopes, they are the most frequent representatives of the herbage.

In the coniferous belt of the Rhodopes the pollen of all herbage representatives actually reflects the local composition of the grassy cover in the locations of surface samples and pollen traps. The local character of the herbaceous pollen is demonstrated by the presence of *Linum*, which varies from complete absence in the surface samples to up to 1.6 %, or 492 grains/cm²/yr (trap no. 1, 2002, Fig. 5), and a local maximum of 5.5 %, or 991 grains/cm²/yr (trap no. 2, 2003, Fig. 6) in places where samples of *Linum* were registered in close proximity to the set traps. In all other traps the *Linum* pollen was registered with single grains, or up to 1 %.

Conclusions

The results of the pollen analysis of the moss surface samples series in the coniferous belt of the Rhodopes, as well as of the pollen traps in the Beglika region, adequately reflect the main arboreal and non-arboreal taxa in respect to their pollen productivity and abilities for pollem distribution, deposit and preservation.

In interpretation of the fossil pollen diagrams and reconstruction of vegetation by fossil pollen spectra it should be allowed for the overrepresented pollen of the *Pinus diploxylon*-type and the comparatively poor representation of *Picea*. In the reconstruction of Quaternary vegetation, correlation of the different arboreal components in the pollen spectra is of prime importance. When the fossil pollen spectra are comparable with their contemporary analogues, then the latter could be successfully used in the reconstruction of the plant communities in the respective time periods (Bottema 1974).

The present investigation traces out the annual impact on the values of the arboreal and non-arboreal pollen and compares the pollen productivity and effective pollen distribution. Data from the different deposits have been compared. The dominating taxa in the communities are adequately reflected in the surface samples and pollen traps. In all surface samples in mosses and in most of the traps the *Pinus diploxylon*-type (*P. sylvestris*) pollen prevails, with a participation maximum up to 85 % in the moss samples and between 50–70 % in the traps. In the surface pollen samples, *Picea* is registered with values up to 43 % and a local maximum of 53 %, as well as a maximum up to 12 % in the traps. *Poaceae* showed much higher values in the traps, owing to the fact that most of the traps were set in open spaces, or at the forest boundary, where herbage diversity and participation is higher. In the moss samples, the pollen deposits are registerd for more than one year and this inevitably reflects on the reported results in the form of greater species diversity or higher values for some of the taxa.

At this stage, observations cover a short time period and it is difficult to make any definite assumptions about the cyclic flowering of single taxa. Information has been obtained on the relationship of contemporary vegetation and pollen rain. Some concrete conclusions have been drawn about the investigated region, the earlier data have been corroborated and new data and considerations are presented on the participation of the various taxa, which are of prime importance in the interpretation of the fossil pollen spectra on which the reliable historical reconstruction of vegetation depends.

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