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CORRELATION OF SUBFOSSIL POLLEN SPECTRA WITH RECENT VEGETATION OF THE EASTERN BORDER OF THE TRIALETI RANGE (THE TBILISI ENVIRONS)

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ABSTRACT. Surface pollen spectra of sediments of two lakes and from a transect Lisi-Lake, Bevreti-Mkhaldidi have been compared with the recent vegetation. The spectra of soils adequately reflect the surrounding vegetation, whereas samples of bottom sediments of lake gave some anormalities caused by the fenomen that saccate pollen grains stay longer on the water surface and are spread by the wind to the coastal area. In the central part of lakes coniferous pollen is very rare. Some other regularities between pollen spectra of soil under conopy of *Carpinus* and *Quercus-Carpinus* forests in Western and Easter Georgia have been stated.

KEY WORDS: Surface pollen spectra, Tbilisi environment

INTRODUCTION

The presents paper is a continuation of a series of publications concerning pollen spectra of surface samples and their relation to the recent vegetation cover in the known refuges of Tertiary relict forests. Hitherto our studies were carried out in Western Georgia (Stuchlik & Kvavadze, 1987; Kvavadze & Stuchlik, 1988, 1990a, 1990b). This paper deals with the central part of the Transcaucasia (the Tbilisi environs). The vegetation of this part of the Transcaucasian territory is under great anthropogenic influence and substantial part of it has been changed and destroyed (Sosnovsky, 1915; Avakov, 1982). We can get information on natural composition of vegetation from palynological studies of the Holocene profiles of lake sediments. Such investigations on the lake Lisi were carried out by Kvavadze (1990). Our studies are to show how the changed vegetation cover in synanthropic territories is reflected in subfossil pollen spectra and to help reconstruct the vegetation cover on the basis of palynological analysis of surface samples.

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PHYSICO-GEOGRAPHICAL CHARACTERISTICS

The Trialeti Range, situated in the central part of the Transcaucasia has almost latitudinal position and is a part of the mountain system of the Minor Caucasus (Fig. 1). The relief is characterized by flattened denudadion surfaces of various altitudinal levels. Volcanic formations of the Quaternary are widely spread. They have had rather a considerable effect on the relief morphology (Maruashvili, 1970). As a whole, the range is of medium height and stretches for 120 km. Its western part is higher (up to 2800 m a.s.l.), than its eastern part (up to 1274 m a.s.l.). The Trialeti Range consists of Paleogene rock masses, among which the Eocene formations play an important role (Gamkrelidze, 1936).

The climate of the western part is more humid than that in the eastern part (see "Climate and Climatic Resources of Georgia, 1971). The temperature regime is also different. Depending on the height of the mountains, the mean annual temperature varies from 11°C to 4°C (Fig. 2). The annual sum of precipitation also rises with altitude (from 550 to 800 mm). The mean wind velocity is 4–5 m/s. The wind duration is larger in summer. North-west winds are prevalent, their velocity often reaches 16–20 m/s.

The hydrographic network is very well developed. It mainly consists of rivers pertaining to the Kura basin. The longest of them are the Tedzami (68 km) and the Tana (46 km). There are only few lakes.

The vegetation cover of the Trialeti Range changes with altitude. In general, forests are spread up to 1000–1200 m, above this level there are steppe-like meadows. However, natural vegetation cover here is greatly changed and preserved its primary appearance only here and there. The vegetation of the eastern border of the Trialeti is represented by more xerophilic species in contrast to its western border. In the stand of trees the fir disappears, while the spruce grows together with broad-leaved species. In the piedmont part in place of the previous forests, secondary shrubs and steppe vegetation are spread. In the forest belt thin brown soils are mostly developed.

METHODICAL REMARKS

In the present paper the calculation of pollen spectra in the diagrams was made in an other way than in our previous papers of this series (Stuchlik & Kvavadze 1987, Kvavadze & Stuchlik 1988, 1990a, 1990b), where the Russian School (Grichuk 1948, Sladkov 1967, Kondratiene 1981 and others) have been followed. From every sample a sum of 300–500 sporomorphs was counted and the percentage values for every group (AP, NAP Spores) as well as for every taxon within the group was calculated from the total sum of sporomorphs in a sample.

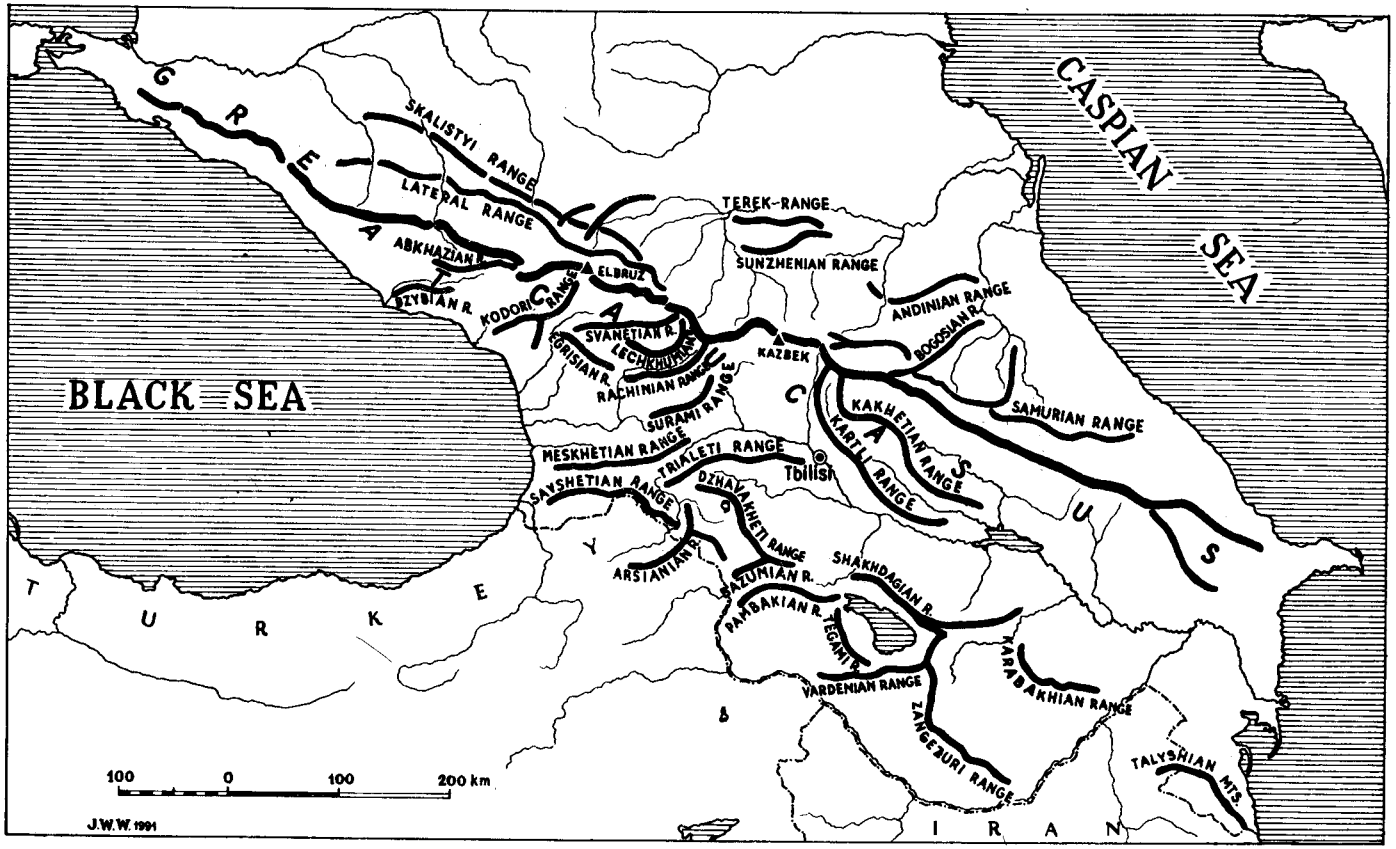

Fig. 1. Orography of the Caucasus (main mountain ranges of he Greater and Minor Caucasus), after Maruashvili 1970

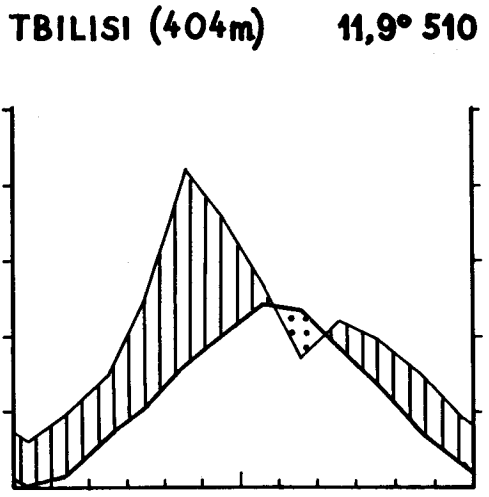

Fig. 2. Climate diagram of Tbilisi

SPORE-POLLEN SPECTRA OF LAKE SEDIMENTS

In the piedmonts of the eastern border of Trialeti Range, in the north-western patr of Tbilisi environs the bottom sediments of the lake Lisi and Tsodoreti have been studied. The former is situated at an altitude of 610 m (the lake area being 0.47 km^2), while the latter is at an altitude of 940 m (the lake has almost been overgrown and water covers only its central part which has an area of not more than 0.1 km^2). These water bodies are enclosed. The region is rather interesting, since here two vegetation belts (steppe and forest) meet. There is no natural forest vegetation in the vicinity of the lake Lisi. From the north one can see plantings of pine-trees. Swamp vegetation grows around the lake, and the slopes are covered with herbaceous xerophilous coenosia. The lake Tsodoreti is situated among terrains of hornbeam-oak forest.

The Lake Lisi

Samples were collected from different parts of the lake Lisi. Samples 1 was taken from the coast. The western (leeward) part of the lake is being intensively overgrown. Swamps are rapidly developing here. From this part of the terrain samples 2, 3, 4, 5 were taken, while from the central deepest part samples 6, 7 were collected.

The common feature for the pollen spectra (Fig. 3) is that there is some prevalence of the pollen of herbaceous plants (50–60%) over that arboreous ones (35–65%). There are very few sporiferous species (1–3%). In the spectra of arboreous pollen from the samples taken near the coast of the lake the conifers are predominant, while in the spectra of the samples taken from the central part of the lake the pollen of angiosperms prevails. There is much less pollen of conifers here, than in the coastal part, which can be explained by the fact that pollen sacs of conifers driven away by the wind, due to their morphological peculiarities do not sink into the water immediately, but float on its

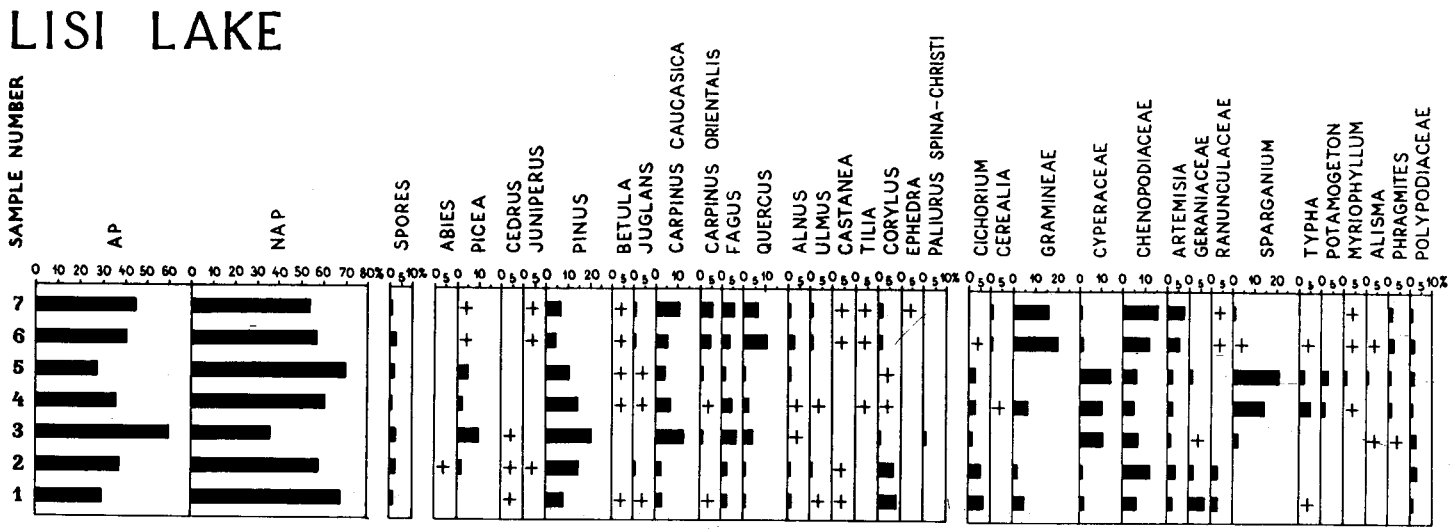

Fig. 3. Spore-pollen diagram of samples taken from the bottom sediments of the Lisi Lake

surface for rather a long time, and as a result of wave current, they are carried to the coast especially from the leeward side. Erdtman (1943) was the first to pay attantion to this phenomenon, when he observed water bloom on a lake and driving of pollen to the coast.

In pollen distribution of angiosperms the situation is reverse. In the bottom sediments in the central part of the lake the pollen amount is the largest. In samples 1, 2 the pollen of *Quercus* is prevalent (up to 38%), while in the spectra of the coastal sediments its quantity does not exceed 6–9%, which, probably, should be explained by different conditions of pollen conservation and preservation. All the samples are distinquished by a large amount of the *Carpinus* pollen (20–40%), which dominates among foliate trees. Then comes *Quercus*. The *Fagus* pollen is also represented by a considerable percentage (8–15%). Almost in equal proportion we can see pollen of *Alnus* and *Carpinus orientalis*. The portion of the latter in the bottom sediments increases. The pollen of *Picea* and *Cedrus* which grow in the nearby park is encountered in the form of single grains. One grain of *Cryptomeria* is also found, which was also brought here from the stands. The pollen of *Juglans* which is cultivated here is present in all spectra. The pollen of *Betula, Ulmus, Castanea, Tilia* is noted in small amounts. Among shrubs, the pollen of *Corylus* is predominant. *Juniperus, Paliurus spina-christi* and *Ephedra* can be met as single grains. The latter is found only in one bottom sample.

An interesting picture can be observed in the spectra of herbs. They are *Sparganium, Typha, Potamogeton, Muriophyllum, Phragmites*. In the spectra of the central part of the lake *Gramineae* (up to 16–20%) and *Chenopodiaceae* (12–16%) are predominant. The amount of *Artemisia* (up to 8%) is much higher here. *Cerealia* are continuously found. In the bottom sediments the content of herbs is not so rich as in swamps. *Umbelliferae, Polygonaceae, Labiatae, Ranunculaceae, Compositae* are noted only in the form of single grains. It is worth nothing that in the spectra of the coastal samples the pollen of *Plantago* is olmost absent, while in the bottom samples spectra its content amounts up to 2.5–3%. However, we cannot find the pollen of *Plumbaginaceae, Valeriana, Violaceae, Boraginaceae, Cichorium*, etc. which are encountered in the samples from swamps. Almost in all the spectra sporiferous species are represented by monolete spores of ferns without a perisporium.

It is interesting to mention a small amount of pollen grains of aquatic plants in the bottom samples which do not grow here presently. By the way, when taking the bottom samples we noticed the smell of hydrocarbon which is a hazardous symptom. This means that life in the lake is going to decay. Probably, to some extent, just the presence of hydrocarbon has favoured very good preservability of pollen and spores in the mentioned samples.

The Lake Tsodoreti

Six samples collected from the Lake Tsodoreti were studied. Samples 1, 2 were taken on the coast near the forest; samples 2, 3–in the thickets of *Eleocharis palustris (Cyperaceae)* near the coast; sample 4 was taken from the same site, but in the thickets of *Juncus maritimus*, while samples 5, 6–in the centre of the lake under water.

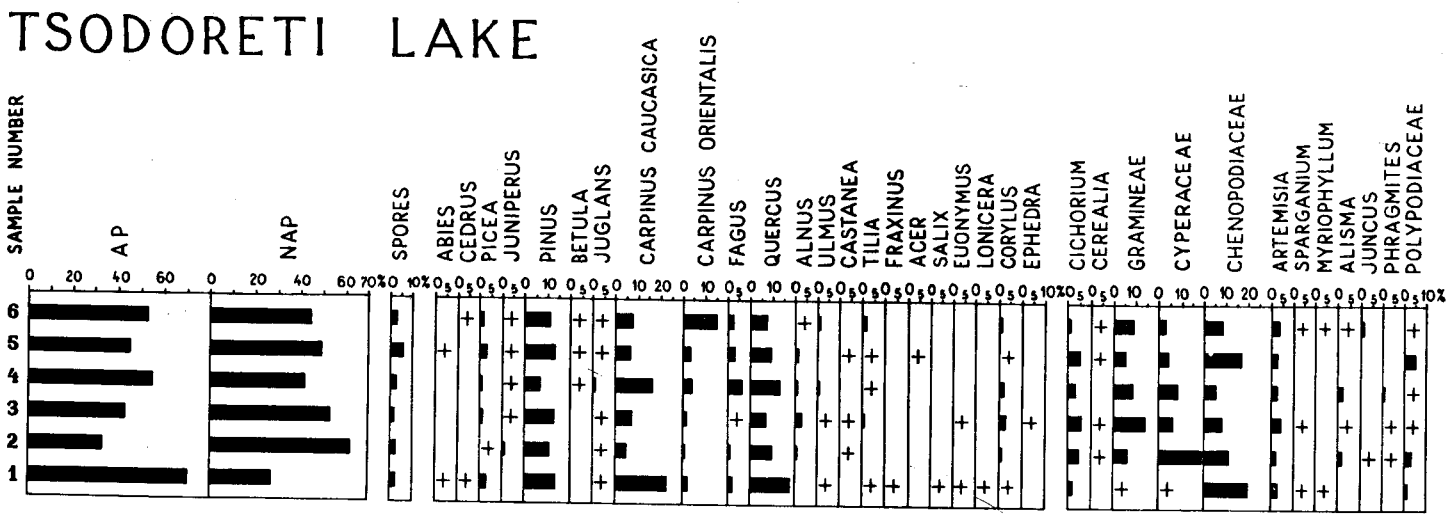

Fig. 4. Spore-pollen diagram of surface samples taken from the Tsodoreti Lake

Before turning to the discussion of the spore-pollen spectra, we should characterize the type of the forest growing on the slopes adjacent to the lake. Here the plot No. 2c was described. The forest is rather young. The height of trees does not exceed 6–7 m, the diameter of stems being up to 30 cm. In the first stratum (A) *Carpinus caucasica* is prevalent. *Quercus iberica, Fraxinus excelsior, Carpinus orientalis, Acer laetum* grow in equal amounts. *Cerasus avium, Cornus mas, Thelycrania australis* are encountered as single plants. The second stratum (B) consists of *Cornus mas, Carpinus caucasica, C. orientalis, Lonicera caprifolium, Crataegus, Euonymus europaea, Viburnum lantana, Ulmus*. There are a lot of herbaceous species (stratum C). They are mainly *Poa nemoralis, Polygonatum multiflorum, Asperula odorata, Viola mirabilis, Lathyrus hirsutus*, etc. The strata A, B, C cover 80%, 40% and 80% of the area, respectively.

The spore-pollen spectra (Fig. 4) showed almost equal proportion of arboreous and herbaceous pollen. only in samples 1, 4 and 6 the amount of arboreous pollen is somewhat prevalent. There are few sporiferous species. Among arboreous plants hardwood is prevalent over softwood. The content of *Pinus* does not exceed 20–32%. Unlike the lake Lisi, there is very little pollen of *Picea* (2–4%) in the spectra. *Abies* is found only as single grains. Among broad-leaved trees, the *Carpinus* and *Quercus* pollen predominates (20–80% and 16–38%, respectively). There is a lot of pollen of *Carpinus orientalis*. It is interesting to note that here we see the same situation. As in the spectra of the lake Lisi, the amount of *Carpinus orientalis* pollen considerably increases in the centre of the lake (sample 6). The amount of *Fagus* and *Alnus* pollen is almost the same. *Juglans, Tilia, Betula, Castanea* are represented by a smaller amount of pollen. *Ulmus, Acer* and *Salix* are mentioned only in the form of single pollen grains. Among shrubs *Corylus* and *Juniperus* predominate. There were found single pollen grains of *Lonicera, Euonymus* and *Ephedra*. As in the spectra of sediments from the lake Lisi, here *Ephedra* was found only in one sample. The herbaceous group is widely represented. The dominants are *Chenopodiaceae* (up to 19.9%), *Gramineae* (14%) and *Carex* (up to 21%). There is rather much pollen of *Artemisia* (up to 4.4%). The pollen of coastal and aquatic vegetation is represented rather poorly: *Sparganium, Myriophyllum, Alisma, Juncus, Phragmites*. Among terrestrial herbs we find pollen of *Ranunculaceae, Umbelliferae, Leguminosae, Polygonaceae, Plantago, Compositae, Viola, Boraginaceae, Labiatae, Caryophyllaceae, Dipsacaceae*. Almost in all the samples there is pollen of *Zea mais*. Sporiferous species are represented by ferns, mainly *Polypodium vulgare*.

Comparison of the obtained pollen spectra with that of vegetation shows that the spectra reflect the forest type and the dominants of each stratum, though some of the components of undergrowth were not reflected adequately. Thus, for instance, pollen of *Cerasus avium* and *Cornus* is not found in the spectra at all, which may be explained by some remoteness of the region of these plants growth from the area of their sedimentation, as well as probably, by low pollen productivity. Perhaps, for the same reason there is no pollen of some herbs in the spectra.

SPORE-POLLEN SPECTRA OF THE SOILS ALONG THE TRANSECT LAKE LISI-BEVRETI-MSKHALDIDI

The eastern border of the Trialeti Range is a limit for spread of *Picea orientalis*, whose areal does not stretch beyond the Tbilisi meridian. To study spruce and spruce-beech forests, we have made a transect from the western coast of the lake Lisi up to the villages of Bevreti and Mskhaldidi. Hypsometrically the highest point is at altitude 1319 m a.s.l. The gradient between the terminal points under ivestigation is 710 m. Within this range the following vegetation belts take turns with elevation of the locality. The environs of the lake Lisi are occupied by steppe vegetation. In the village of Tsodoreti (910 m) the mountain slopes are covered with hornbeam-oak forests and near the village of Bevreti these forests give way to beech-oak forests, while still higher (at the village of Mskhaldidi) there are spruce-beech or beech-spruce forests. Phytosociological description of the studied sites carried out by the Braun-Blanque method (1958) is presented in Table 1.

Hornbeam Forest

At an altitude of 910 m on the western slopes we have studied a site plot 2b of a secondary forest consisting of hornbeam and beech trees. The height of tall trees is 15 m, their stem diameter being 40 cm.

In the stratum A the following species grow: *Carpinus caucasica, Fagus orientalis, Acer campestre, Quercus iberica.*

The stratum B consists of *Carpinus caucasica, Corylus avellana, Fagus orientalis, Carpinus orientalis, Thelycrania australis, Acer laetum, Lonicera caprifolium, Carasus avium, Quercus iberica, Pyrus communis.*

The stratum C comprises of *Poa nemoralis, Lapsana communis, Dentaria bulbifera, Primula macrocalyx, Melica nutans, Sanicula europaea, Viola mirabilis, Fragaria vesca, Circea lutetiana, Carpinus caucasica, C. orientalis, Acer campestre.*

Here samples 9, 10 and 11 were taken. As it is seen from the pollen diagram (Fig. 5), the amount of herbaceous plants pollen is gradual increasing while that of arboreous plants decreases. Among the latter the amount of hornbeam pollen rises as well as that of adventitious pollen of pine, because the forest is becoming increasingly open. The *Carpinus* content amounts to 26–27%. The *Quercus* proportion is 7–12%. In sample 10 collected just under a maple-tree the pollen content of *Acer* is 8%. However, this happens rather rearly. Usually the amount of the *Acer* pollen is very low. Low values are characteristic of the pollen of *Fagus* (2–3%), *Picea, Betula, Carpinus orientalis, Ulmus, Alnus. Juglans, Tilia* and *Castanea* are found as single pollen grains. Shrubs are represented by *Corylus, Juniperus* and *Cornus* with *Corylus* being prevalent (28%). Herbs are represented by *Chenopodiaceae* (up to 24.6%) and *Artemisia* (up to 3.5%). There is little pollen of *Ranunculaceae, Gramineae, Polygonaceae, Carex, Labiatae,* etc.. There are very few sporiferous species. They are represented by single spores of *Polypodium vulgare* and monolete spores of ferns, without perisporium. The pollen spectra obtained reflect the existing vegetation quite adequately.

Table 1. Communities of the Querco-Fagetea class

Number of plot		1	2	2a	2b	2c
Date		27.5 1989	27.5 1989	13.6 1989	13.6 1989	13.6 1989
Altitude above sea level in m		1310	1200	1150	910	940
Exposure		E	E	E	W	0
Slope, degrees		0	45	15	15	0
Height of trees (maximum) in m		40	25	15	15	7
Diameter of tree stem (maximum) in cm		80	50	50	40	30
Cover of tree layer in %	(a)	80	80	100	90	80
Cover of shrub layer in %	(b)	10	30	10	60	40
Cover of herb layer in %	(c)	60	20	30	40	80
Trees:						
Fagus orientalis	a	1.1	3.3	4.4	1.1	–
	b	–	1.1	2.2	1.1	–
	c	+	+	–	–	–
Quercus iberica (micranthea)	a	3.3	–	4.4	1.1	1.1
	b	–	–	–	+	+
Carpinus caucasica	a	4.4	1.1	2.2	4.4	4.4
	b	1.1	–	+	2.2	1.1
C. orientalis	a	–	–	+	+	1.1
	b	–	–	–	1.1	+
Picea orientalis	a	4.4	–	–	–	–
	b	3.3	–	–	–	–
	c	+	–	–	–	–
Acer campestre	a	2.2	+	+	+	–
	b	+	–	1.1	–	–
	c	+	–	–	–	–
A. laetum	a	1.1	–	+	+	1.1
	b	+	1.1	+	+	–
	c	–	+	–	–	–
Fraxinus excelsior	a	3.3	–	–	–	1.1
	b	+	–	–	–	–
Tilia caucasica	a	+	–	–	–	–
	b	–	+	–	–	–
	c	–	+	–	–	–
Shrubs:						
Thelycrania australis	a	–	–	–	–	+
	b	–	–	–	1.1	+
Cornus mas	a	–	–	–	–	+
	b	–	–	–	–	3.3
Lonicera caucasica		1.1	1.1	+	+	1.1
Ulmus sp.		–	+	–	–	+

cont.

Table 1. Continued.

Number of plot	1	2	2a	2b	2c
Evonymus europaea	–	+	+	–	+
Rubus hirtus	–	1.1	+	–	–
Crataegus sp.	–	–	+	–	+
Herbs:					
Asperula odorata	1.1	+	1.1	+	1.1
A. taurica	1.1	–	1.1	–	–
Dentaria bulbifera	–	2.2	2.2	+	–
Geranium robertianum	2.2	–	+	+	+
Sanicula europaea	+	2.2	–	+	+
Moechringia trinervia	+	–	–	+	1.1
Polygonatum multiflorum	2.2	+	+	+	1.1
Poa nemoralis	2.2	–	1.1	2.2	3.3
Primula macrocalyx	1.1	–	1.1	1.1	1.1
Viola mirabilis	3.3	+	+	+	+
Lathyrus hirsutus	+	+	1.1	1.1	1.1
Melica nutans	1.1	1.1	1.1	1.1	1.1
Anthriscus sp.	–	–	1.1	+	–
Fragaria vesca	+	–	+	+	–
Cephalanthera rubra	–	–	+	+	–
Platanthera bifolia	–	–	+	–	+
Lapsana communis	–	–	–	2.2	+
Veronica chamaedrys	–	–	–	+	1.1
Galium aparine	–	–	+	+	–
Chaerophyllum aromaticum	1.3	–	+	–	–
Polypodium vulgare	–	1.1	–	–	1.1
Geum urbanum	+	–	–	+	–
Dryopteris filix-mas	+	+	–	–	–
Alliaria officinalis	+	–	–	–	+

Sporadic species: in plot nr 1: Trees: *Pirus communis* 1.1, *Viburnum lantana* +, Herbs: *Galeobdolon luteum* 1.1, *Lamium album* 1.1, *Hesperis* sp. 1.1, *Vicia* sp. +, *Ranunculus* sp. +, *Orobanche* sp. +, *Stellaria media* +; in plot 2: *Luzula silvatica* +, *Lathyrus niger* +, *Lathrea squamaria* +; in plot 2a: *Cerratula* sp. +, *Dryopteris spinulosa* +, *Silene italica* +; in plot 2b: *Calystegia sepium* +, *Circaea lutetiana* +, *Clinopodium vulgare* +, *Galeopsis* sp. +, *Rosa* sp. +, *Salvia glutinosa* +; in plot 2c: *Asplenium trichomanes* +, *Carex digitata* 1.1, *Geranium columbinum* +, *Helleborus caucasicus* 1.1, *Hypericum* sp. +, *Lithospermum* sp. +, *Orobus laxiflorus* +, *Pimpinella rotundifolia* +, *Stachys* sp. +.

As was already mentioned, on the coast of the lake Tsodoreti a terrain of a hornbeam-beech forest has been studied, from which samples 13, 14, 15 were collected. The geobotanical description of terrain 2c was given in the previous paragraph (see page). Here we shall dwell only upon spore-pollen spectra. The content of the total sum of arboreous plants pollen decreases to 48%. The amount of herbs is equal to 37–38% and that of spores – to 9–12%. Among arboreous species there is much pollen of *Quercus* (up to 38%), *Pinus* (up to 34%) and *Carpinus* (up to 27%). The percentage of the *Carpinus*

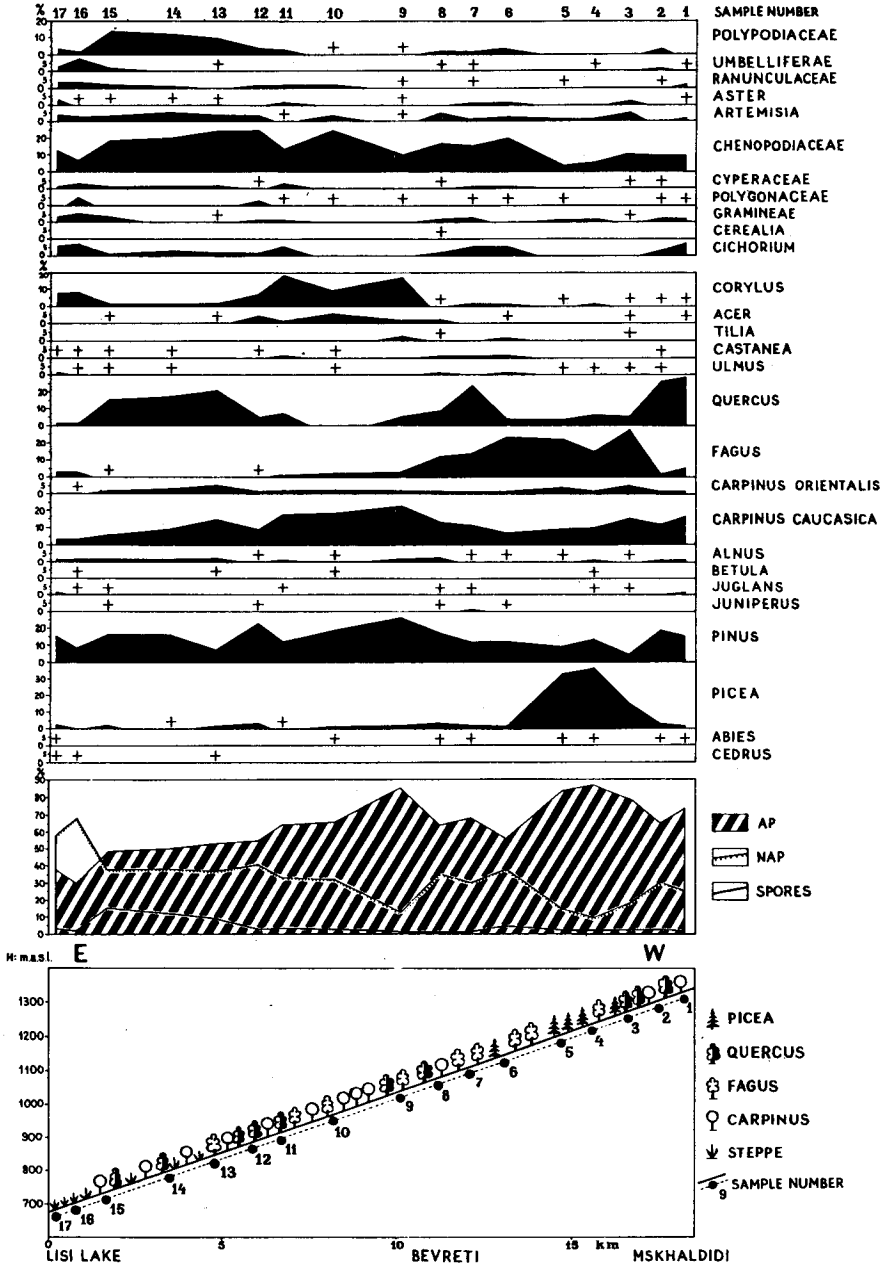

Fig. 5. Spore-pollen diagram of surface samples of soils taken along the transect Lisi Lake – Bevreti-Mskhaldidi

orientalis pollen amounts up to 10%. Pollen of *Alnus, Ulmus, Juglans, Acer* is always noted in the spectra. *Betula, Salix, Castanea, Cedrus, Pterocarya* are represented by

single grains. Most of them must have been brought from park plantations. Among shrubs pollen of *Corylus, Cornus, Juniperus* and *Palinrus spinachristiis* is found. *Chenopodiaceae* and *Artemisia* are prevalent among herbs as usual. In addition to them. pollen of *Compositae, Carex, Gramineae, Umbelliferae, Caryophyllaceae, Labiatae, Polygonaceae, Ranunculaceae, Plantago* is noted. In sample 15 pollen of *Sparganium* was found. Spores are represented only by ferns. *Polypodium vulgare* has been determined at the species level.

The soil sample 16, 17 were taken on the western coast of the lake Lisi (610 m a.s.l.). The treeless landscapes characteristic of this locality are very well reflected in the pollen spectra: in the whole group of plants herbs are prevalent (up to 70%).

Beach Forest

At an altitude of 1150 m (the border of the village of Bevreti) a terrain of a beech-oak forest has been examined plot 2a. The slope is of the eastern exposition. The forest is young. The height of tall trees is 15 m, stem diameter being 50 cm.

In the stratum A there grow *Fagus orientalis, Carpinus caucasica, Quercus iberica, Acer campestre.*

The stratum B consists of *Fagus orientalis, Acer campestre, Carpinus caucasica, Euonymus europaea, Acer laetum, Lonicera caprifolium, Rubus hirtus, Philadelphus coronarius.*

The stratum C consists of *Dentaria bulbifera, Asperula odorata, Acer laetum, Viola, Vicia, Anthriscus silvestre, Melica nutans, Primula macrocalyx, Galium aparine, Poa nemoralis, Asperula taurica.*

The cover areas for A, B, C are 100%, 10% and 30%, respectively.

Samples 6, 7, 8 are taken here, whose spectra are characterized by predominance of arboreous plants (56–68%). The proportion of herbs is equal to 30–38% and that of spores – to 1–5%. Among arboreous species the following are predominant: *Fagus* (up to 39%), *Carpinus* (up to 19%) and *Quercus* (up to 14%). There is much pollen of *Pinus* (up to 26%), which in almost all the samples is of adventitious character. The content of the *Picea* pollen reaches 3–4%. *Abies* is represented by single pollen grains. *Ulmus, Alnus, Castanea, Tilia, Acer, Carpinus orientalis* and *Juglans* are distinquished by low content of pollen. Shrubs are represented by *Juniperus, Corylus* and *Ephedra.* Among herbs three groups are predominant: *Chenopodiaceae* (up to 19.8%), *Compositae* (up to 5.2%) and *Artemisia* (up to 2.9%). There is some pollen of *Polygonaceae, Gramineae, Carex, Plantago, Caryophyllaceae, Ranunculaceae, Umbelliferae,* etc. Single pollen grains of *Sparganium* are encountered. Sporiferous species comprise *Ophioglossum,* Polypodium vulgare and other *Polypodiaceae.*

Beech-Spruce Forest

Samples 3, 4, 5 were taken at an altitude of 1200 m in a spruce-beech forest plot 2 on a steep (48°) slope, descending to the Bevreti tribute. This forest is of uneven age. The height of tall trees reaches 25 m, the stem diameter being 50 cm.

The stratum A consists of *Picea orientalis, Fagus orientalis, Carpinus caucasica.*

The stratum B consists of *Picea orientalis, Lonicera caucasica, Fagus orientalis, Rubus hirtus, Acer campestre, A. leaetum, Ulmus, Tilia cucasica, Euonymus europaea.*

The stratum C consists of *Sanicula europaea, Dentaria bulbifera, Lathyrus vernus, Luzula silvatica, Viola mirabilis, Melica uniflora, Polygonatum multiflorum, Fagus orientalis, Asperula odorata, Polypodium vulgare, Dryopteris filix-mas, Acer laetum, Lathrea squamaria, Tilia caucasica.*

The cover areas for A, B and C strata are 80%, 30% and 20%, respectively.

The spore-pollen spectra are distinquished by maximum content of the arboreous species (82–87%). The herbs content is equal to 10–18%, that of spores does not exceed 2–3%. Among trees the pollen of *Picea* (39–41%) and beech (26–35%) prevail. *Fagus* can be concidered as the thrid dominant (up to 19%). The participation of *Quercus* and *Carpinus orientalis* is also significan: up to 7% and 6%, respectively. There is a few pollen of *Juglans, Alnus, Tilia, Acer* and *Betula.* Among shrubs there are *Corylus* and *Eounymus* in small amounts. As in previous spectra (samples 1, 2), among herbs adventitious pollen of *Chenopodiaceae* and *Artemisia* is predominant. There is little pollen of *Gramineae, Carex, Compositae, Ranunculaceae, Polygonaceae, Umbelliferae, Plantago.* In the spectrum of the soil sample, taken on the bank very close to the river, pollen of aquatic-paludal vegetation was revealed (*Sparganium, Myriophyllum*). Sporiferous species are represented by *Polypodium vulgare* and Dryopteris *flix-mas* and monolete spores of ferns without perisporium. Comparison of the pollen spectrum composition with that of the vegetation, groving on the experimental plot, shows that they are adequate.

Oak-Beech Forest

At an altitude of 1310 m we described the vegetation on plot No 1, which represents a secondary forest on the watersheds of the rivers Vere and Digmistskali. The height of trees reaches 10–15 m, the stem diameter being up to 40 cm.

The forest is of uneven age. In the first stratum (A) there grow *Carpinus caucasica, Quercus iberica, Fraxinus excelsior, Acer campestre, Fagus orientalis, Acer laetum, Pirus communis, Tilia caucasica.*

The second stratum (B) is represented by *Lonicera caucasica, Carpinus caucasica, Crataegus, Viburnum lantna, Rosa, Ribes, Acer campestre, Acer laetum.*

The third stratum (C) consists of *Geranium robertianium, Asperula odorata, A. taurica. Melica nutans, Polygonatum multiflorum, Lathyrus niger, Poa nemoralis, Galeobdolon lutenum, Sanicula europaea, Lamium album, Chaerophyllum aromaticum, Geum urbanum, Hesperis, Primula macrocalyx, Viola mirabilis.*

The cover areas for the A, B, C strata are 80%, 10% and 60%, respectively.

The spore-pollen spectra (Fig. 5) of samples 1, 2 are characterized by the following peculiarities. In general the arboreous plants are prevalent (up to 73%). The percentage of herbs amounts to 20–30%, while that of spores is as low as 1–3%. Among arboreous species the pollen of *Quercus* (up to 40%) and *Carpinus* (up to 21%) is prevalent, which agrees with the geobotanical description of the terrain under study quite well. We can see the pollen of *Fagus* (up to 7%), *Carpinus orientalis* (up to 2%), *Picea* (2–3%). Also there are single pollen grains of *Abies, Acer, Alnus, Juglans, Ulmus.* Among shrubs there

is only *Corylus*. The group of herbs is rather rich. *Chenopodiaceae* (9.9%) and *Compositae* (7.3%) are prevalent. The value of *Artemisia* and *Gramineae* is rather high: up to 5.6–2% respectively. We can continuously observe the pollen of *Carex, Caryophyllaceae, Ranunculaceae, Polygonaceae, Boraginaceae, Umbelliferae, Labiatae, Dipsacaceae*, etc. Among sporiferous species *Polypodium vulgare* is determined as well as *Ophioglossum* and monolete spores of ferns without perisporium.

As we can see, the spectra reflect almost all the dominants of the first stratum, except of *Fraxinus*. The pollen of species which grow here as single trees (*Tilia, Pyrus*) is not encountered in the spectra. *Crataegus, Viburnum, Ribes, Lonicera* are poorly reflected, which can be explained not only by bad preservability, but also by their inactive participation in undergrowth and, probably, by low pollen productivity of the species growing there.

CONCLUSION

Comparison of the spore-pollen spectra of sediments of enclosed small lakes, swamps as well as soils with recent vegetation has shown adequacy of the former. At the same time, depending on remoteness from the coast and character of wave action, the pollen spectra of lakes are distinguished by a number of peculiarities. In the coastal windward belt composition of herbs and conifers having pollen sacs is much richer. This must be taken into consideration when interpreting fossil pollen spectra. The pollen of such herbaceous groups as *Geraniaceae, Plumbaginaceae, Dipsacaceae* and some others does not reach the central part of the lakes under study, which probably happens because of large size of their grains, and so, the pollen is poorly spread by the wind.

Sediments of the central and deepest part of the lakes are characterized by better conditions of pollen and spores conservation.

Spectral analysis of the soil samples collected under the canopy of hornbeam and hornbeam-oak forests has made it possible to observe a very interesting regularity. The percentage of *Carpinus* and *Quercus* pollen here is distinquished by higher values, than in similar forests of more humid part of Western Georgia. These indices on the territory of Eastern Georgia increase almost by a factor of 3 or 4, which suggests that pollen productivity of the mentioned species, in connection with changes in ecological conditions is not stable. It is also worthwhile nothing that the pollen amount of such mesophilous species as *Fagus* and *Castanea*, on the contrary, substantially decreases in more arid conditions of Eastern Georgia.

As to pollen brought by the wind from one belt to another, it should be pointed out that in close forests this phenomenon is limited. In more lighted forests, however, the amount of adventitious pollen increases considerably. Among arboreous plants this mostly relates to the pollen of *Pinus*, and among herbs – to the pollen of *Chenopodiaceae* and *Artemisia*.

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