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# Modern Annual Deposition and Aerial Pollen Transport in the Lena Delta

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**Summary:** Studies of the annual pollen and spore deposition in different areas of the Lena Delta were undertaken for the first time in the Asian sector of the Arctic during the Russian-German "LENA 98" and "LENA 99" expeditions in the framework of the International "Laptev Sea System-2000" Project. To achieve this objective, three spore-pollen traps were set up along the meridional delta profile in accordance with the European Pollen Monitoring Programme for the period July 1998 to August 1999. A comparison between the results of spore-pollen analysis of the contents of traps and the surrounding vegetation was performed. The results confirmed the current spore-pollen spectra are comprised both of pollen and spores of the local plants and of long-distance pollen and spores. The dependence of the long-distance pollen deposition on the character of the wind regime of the region was established. The prevailing southerly and southeasterly wind direction determines the main pollen influx of tree species from the areas of their growth south of the delta. The features of the morphological structure and fossilization of pollen and the features of the productive capability and plant growing conditions are of large significance in the pollen transfer and deposition.

**Zusammenfassung:** Im Rahmen des internationalen Projektes "System Laptewsee 2000" wurden während der russisch-deutschen Expeditionen "LENA 98" und "LENA 99" erstmalig Untersuchungen zur jährlichen Deposition von Pollen und Sporen in verschiedenen Regionen des Lena-Deltas, im asiatischen Sektor der Arktis, durchgeführt. Drei Pollen/Sporen-Fallen wurden entlang eines meridionalen Deltaprofils aufgestellt (Juli 1998-August 1999) im Einklang mit der Methodik des "European Pollen Monitoring Program". Die Ergebnisse der Pollen/Sporen-Analyse des Inhaltes dieser Fallen wurden mit dem umgebenden Pflanzenreich verglichen. Die Resultate zeigten, dass sich die heutigen Pollen/Sporen-Spektren aus Pollen der lokalen Pflanzen und windeingetragenen Pollen zusammensetzen. Die Abhängigkeit der Ablagerung windeingetragener Pollen vom Charakter der Windbedingungen in dieser Region wird deutlich. Die dominierenden südlichen und südöstlichen Winde im Delta bedingen den Eintrag von Holzpflanzen-Pollen, deren heutige Verbreitungsgebiete sich südlich vom Lena-Delta befinden. Die Besonderheiten der morphologischen Struktur und der Pollenfossilisation, sowie die Bedingungen des Pflanzenwachstums und ihre Produktivität sind von großer Bedeutung für den Transport und die Ablagerung von Pollen.

## INTRODUCTION

Pollen and spore analysis is widely used in paleogeographical studies to reconstruct the vegetation and climate in the past. However, the results of paleogeographical reconstruction based on the interpretation of palynological data can be distorted to a great extent due to inconsistency between the spore-pollen spectrum and the actual vegetation that existed at a given time. The composition of the fossil palynospectrum depends on several factors. These are the composition of local vegetation at the time of spectrum formation, the abundance of long-distance pollen transported by air masses, atmospheric precipitation and factors influencing pollen preservation (HICKS 1999). The study of recent spore-pollen spectra allows us to determine the factors influencing their composition under arctic tundra conditions, which will make it possible in the future to more correctly interpret fossil palynospectra from Holocene age deposits.

Specific studies of the problem of pollen presence in the air of high latitudes began in the 1930s (KIL'DYUSHEVSKY 1955). In Russia, this problem was considered in articles about pollen transport to the Arctic from the south and its detection in the surface soil samples of the arctic regions (TIKHOMIROV 1950, KUPRIYANOVA 1951). In subsequent years, studies of current pollen rain, pollen and spore transport and their relationship with sub-fossil spectra and current vegetation were carried out on Severnaya Zemlya, Novaya Zemlya and Spitsbergen (KALUGINA et al. 1981, SEREBRYANNY et al. 1984, VAN DER KNAAP 1990).

Due to the European Pollen Monitoring Program developed in 1996, it became possible using one common sampling and processing methodology to determine the composition of annual recent spore-pollen spectra, compare them, investigate their change in time and space and identify and investigate the factors that determine the formation character of different spectra.

This study at the present stage aims to analyze data on the pollen rain deposition throughout the year in the Lena Delta, compare the results obtained with the composition of local vegetation and the wind regime character of the study area and reveal the factors influencing the formation of current spore-pollen spectra (SAVELIEVA et al. 2000, 2000a, DOROZHKINA et al. 2000).

## METHODS AND SITES

### *Field methods*

To reveal the pollen transfer character, three traps were set up in the Lena Delta along the meridional delta profile (PAVLOVA & DOROZHKINA 1999) (Fig. 1). The pollen traps were established in compliance with the requirements of the European Pollen Monitoring Program (HICKS et al. 1996).

A pollen trap presents a container (plastic bucket) of 5 liters with a tightly closing cone-like cover of 30 cm in diameter. In the center of the cover there is a hole of 5 cm in diameter. The container bottom is 3-5 cm covered with glycerin to which se-

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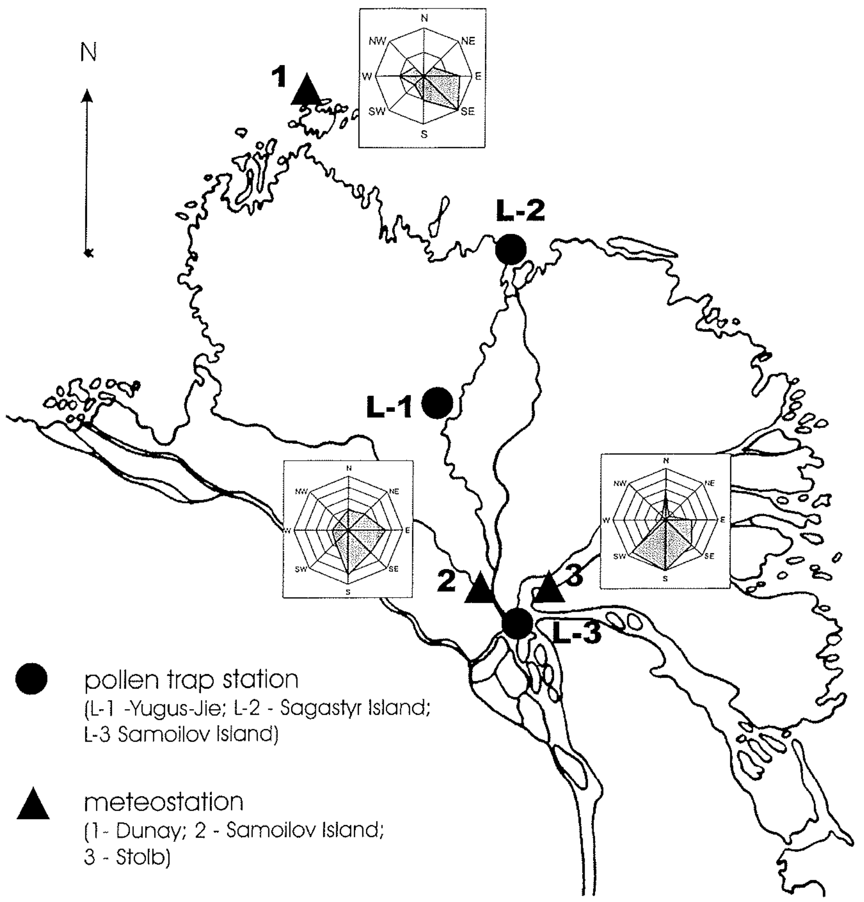


**Fig. 1:** Location of spore-pollen traps in the Lena Delta and wind rose-diagrams.

**Abb. 1:** Lage der Sporen-Pollenfallen im Lena-Delta und die zugehörigen Windrosen.

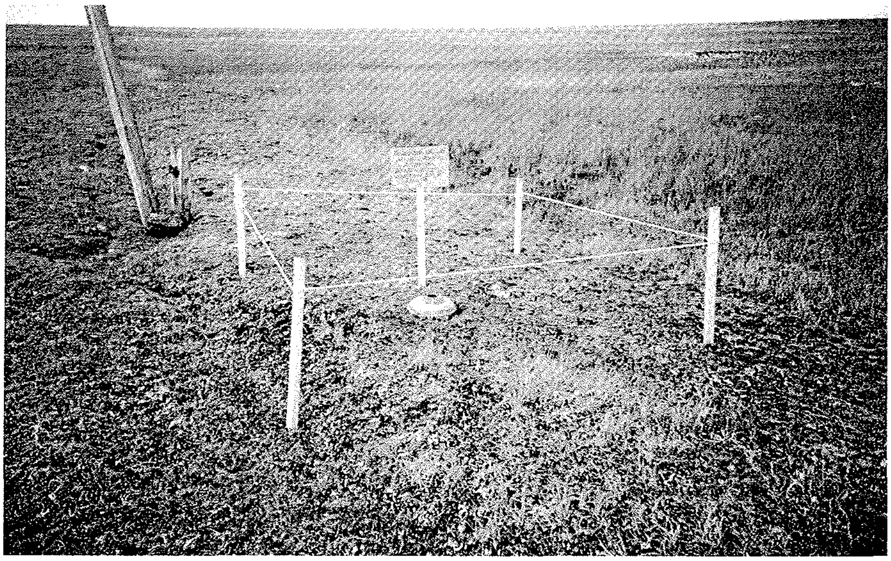

**Fig. 2:** Pollen trap set up on Sagastyr Island.

**Abb. 2:** Pollenfalle auf der Insel Sagastyr.

veral thymol crystals and 10-20 ml of formalin are added. The trap is buried into the ground so that its cover is at the same level with the surrounding surface (Fig. 2).

A herbarium was collected within a 30 m radius (according to guidelines for mapping the vegetation around the pollen traps, HICKS et al. 1996) from each trap and the species composition was determined (Tab.1).

The pollen traps were set up for a period of 1 year from July 1998 to August 1999. The content of the pollen traps when they were recovered, presented water (atmospheric precipitation) with numerous remains of insects (mosquitoes, caterpillars, etc.), excrements of mammals (musk-ox, lemmings) and a mineral fraction (clayey-sandy particles). The volume of the samples comprised 0.5-2 liters.

| Plant species | L-1 | L-2 | L-3 |
|---|---|---|---|
| Graminaceae (Poaceae) | | | |
| *Arctagrostis latifolia* | | x | |
| *Arctagrostis arundinacea* | | | x |
| *Deshampsia caespitosa ssp. borealis* | | x | |
| *Dupontia fisheri* | | x | |
| *Dupontia psilosantha* | | | x |
| *Hierochloe pauciflora* | | x | |
| *Koeleria asiatica* | x | x | |
| *Poa arctica* | x | x | x |
| *Poa paucispicula* | | | x |
| Cyperaceae | | | |
| *Carex aquatilis ssp. stans* | x | x | |
| *Carex concolor* | | | x |
| *Eriophorum polystachion* | x | | |
| *Eriophorum vaginatum* | x | | |
| Juncaceae | | | |
| *Juncus biglumis* | | x | |
| *Luzula confusa* | | | x |
| *Luzula multiflora* | | | x |
| *Luzula nivalis* | | | x |
| *Luzula tundricola* | | | x |
| Salicaceae | | | |
| *Salix glauca* | x | | x |
| *Salix nummularia* | | | x |
| *Salix pulchra* | | | x |
| *Salix reptans* | x | x | x |
| Polygonaceae | | | |
| *Polygonum bistorta ssp. ellipticum* | x | | |
| *Polygonum tripterocarpum* | x | | |
| *Polygonum viviparum* | | x | |
| Caryophyllaceae | | | |
| *Minuartia arctica* | | | x |
| *Stellaria ciliatosepala* | | x | |
| Ranunculaceae | | | |
| *Caltha arctica* | x | | x |
| *Caltha caespitosa* | | | x |
| *Delphinium brachycentrum* | x | | |
| *Ranunculus alpinis* | x | | |
| *Ranunculus pygmaeus* | | x | |
| Papaveraceae | | | |
| *Papaver angustifolium* | x | | x |
| *Papaver pulvinatum* | x | x | |
| Cruciferae (Brassicaceae) | | | |
| *Cardamine digitata* | | | x |
| *Cardamine pratensis* | x | | |
| *Draba borealis* | x | | |
| *Draba hirta* | x | | |
| *Draba juvenilis* | x | | |
| *Parrya nudicaulis* | x | | |

| Plant species | L-1 | L-2 | L-3 |
|---|---|---|---|
| Saxifragaceae | | | |
| *Chrysosplenium tetrandrum* | x | | |
| *Saxifraga cernna* | x | | |
| *Saxifraga foliolosa* | | x | |
| *Saxifraga hirculus* | x | x | x |
| *Saxifraga nelsoniana* | x | x | x |
| Rosaceae | | | |
| *Dryas octopetala* | x | x | x |
| *Dryas punctata* | | | x |
| Fabaceae | | | |
| *Astragalus umbellatus* | | | x |
| Ericaceae | | | |
| *Arctous alpina* | | | x |
| Vacciniaceae | | | |
| *Vaccinium uliginosum* | | | x |
| Plumbaginaceae | | | |
| *Armeria maritima* | | x | |
| Polemoniaceae | | | |
| *Polemonium boreale* | x | | |
| Boraginaceae | | | |
| *Myosotis asiatica* | x | x | x |
| Scrophulariaceae | | | |
| *Lagotis glauca ssp. minor* | x | | x |
| *Pedicularis lanata* | | | x |
| *Pedicularis oederi* | x | | |
| *Pedicularis sudetica ssp. interioroides* | x | x | x |
| *Pedicularis villosa* | | | x |
| Valerianaceae | | | |
| *Valeriana capitata* | x | x | |
| Compositae | | | |
| *Artemisia tilesii* | x | | |
| *Nardosmia frigida* | x | | |
| *Senecio congestus (arcticus)* | | x | |
| *Taraxacum ceratophorum* | x | | |
| Equisetaceae | | | |
| *Equisetum arvense ssp. boreale* | | x | |
| Mosses | | | |
| *Aulacomnium turgidum* | | | x |
| *Calliergon giganteum* | | x | x |
| *Drepanocladus sp.* | | | x |
| *Hylocomium splendens* | | | x |
| *Sphagnum orientale* | | x | |
| *Tomenthypnum nitens* | | x | x |

**Tab. 1:** List of plants observed in the area of establishment of pollen traps.

**Tab. 1:** Liste der Pflanzen in der Umgebung der Pollenfallen.

*Laboratory methods*

The content of pollen traps was treated using a method described by Hicks et al. (1996, 1999), which includes the following stages: centrifuging, filtering, boiling in 10 % NaOH and acetolysis. Before treatment, one tablet of *Lycopodium* spores was added to each pollen trap to calculate the concentration of pollen grains per unit area deposited during one year. For this, the pollen quantity contained in a trap was calculated relative to the quantity of spores added so that the final result can be expressed as a number of grains per $cm^2$/year. To reveal the fraction of participation of each pollen and spore taxon in the spectrum, its percentage of the total sum of pollen encountered was calculated. The pollen and spores were calculated in the entire precipitate formed in the test-tube after treatment. The results of the spore-pollen analysis are shown in tabulated form (Tab. 2).

*Sites*

For location of traps from south to north (L-3, L-1, L-2) along the meridional delta profile see Figure 1. Trap L-3 was set up in the southern delta area on Samoylov Island (72° 22'43" N, 126° 31'08" E) at the first-above-the floodplain delta terrace, whose absolute height in the southern part comprises 10-13 m. The flat tussocky surface of the first-above-the floodplain terrace is characterized by the development of the polygonal and polygonal-roller microrelief. The polygons are up to 11 m in diameter. The swampy polygon segments are often occupied by lakelets. The vegetation is represented by herbaceous-dwarf shrub and dwarf shrub (*Dryas octopetala, Poa arctica, Carex concolor, Salix glauca, S. reptans, Saxifraga hirculus* ) moss (*Calliergon giganteum, Hylocomium splendens, Tomenthypnum nitens*) tundra in combination with polygonal bogs. The sample volume at recovery is 0.5 liters.

Trap L-1 was set up in the central delta area on Dzheppiries-Sise Island, urochishche Ugyus-Dzhie (72° 50'17" N, 125° 49'15" E). The trap is located in the high floodplain (with an absolute height of 8.6 m) at whose surface the polygonal and polygonal-roller microrelief is widespread. The polygons are characterized by a quadrangular shape reaching 10-11 m in diameter. The central depressed segments of polygons are swampy. The high floodplain is characterized by widespread mort and thermokarst lakes. In general within the Lena Delta, a high floodplain (4-9 m) is developed everywhere over the entire length of the channels presenting a water-flooded surface during the spring floods only in the individual rare years. The vegetation is represented by herbaceous-dwarf shrub and dwarf shrub (*Dryas octopetala, Carex stans, Salix glauca, S. reptans, Poa arctica, Papaver angustifolium, Draba borealis, Saxifraga nelsoniana, Delphinium brachyccentrum, Myosotis asiatica, Valeriana capitata, Artemisia tilesii*) tundra in combination with polygonal bogs. The sample volume at recovery was 2 liters.

Trap L-2 was set up in the northern delta area on Sagastyr Island (south coast of the Laptev Sea (73° 23'14" N, 126° 36'53"E) at the first-above-the floodplain terrace whose absolute height in the marginal delta area comprises 4 m. The microrelief of the first-above-the floodplain terrace was formed by roller polygons that often have a regular triangular shape and a size of up to 12-15 m in diameter. The central parts of polygons are swampy. The vegetation is represented by herbaceous-dwarf shrub (*Dryas octopetala, Salix reptans, Poa arctica, Papaver pulvinatum, Saxifraga foliolosa, Valeriana capitata)* moss *(Sphagnum orientale, Tomenthypnum niten)* tundra in combination with polygonal and herbaceous-hypnum bogs. The sample volume at recovery was 2 liters.

The northwestern and northeastern segments of the Lena Delta present in general the herbaceous-dwarf shrub (*Dryas octopetala, Salix polaris, S. nummularia, S. reptans, Carex stans, Poa arctica, Luzula nivalis, L. confusa, Saxifraga foliolosa*) moss (*Hylocomium splendens, Drepanocladus unsinatus, Tomenthypnum nitens*) and lichen southern arctic tundra in combination with herbaceous-hypnum and polygonal bogs. The main delta territory belongs to dwarf shrub and herbaceous-dwarf shrub (*Dryas octopetala, Salix glauca, Carex stans, Poa arctica, Luzula nivalis, Papaver pulvinatum, Valeriana capitata Saxifraga foliolosa*) moss (*Hylocomnium splendens, Aulocomnium turgidum, Tomenthypnum nitens*) and lichen northern sub-arctic tundra, in places in combination with herbaceous-hypnum and polygonal bogs (Labutin et al. 1985).

## RESULTS AND DISCUSSION

Pollen and spores were found in all traps, but their quantities, concentrations, proportions between the groups (AP = arboreal, NAP = non-arboreal, Sporae) and preservation differs between locations. The pollen and spores counted in each sample were conventionally subdivided into local and long-distance. All counted pollen grains and spores of the families and genera, whose representatives were encountered in the local flora, were referred to the pollen of local plants. The long-distance pollen includes plant species that do not grow in the Lena Delta with the northern boundary of their areas located much more southward.

The quantity of the calculated pollen and spore grains for trap L-3 comprises 319 grains, for L-1 530 grains and for L-2 300 grains (Tab. 2).

In trap L-3 set up in the southern part of the delta on Samoylov Island, 319 pollen and spore grains were identified with the total pollen and spore influx rate comprising 529.3 grains per $cm^2$/year (Tab. 2). The tree and shrub pollen detected in the trap comprised 57.8 %, herb pollen 40.6 % and spores 3.5 %. The concentration of the deposited tree pollen for the trap comprised 48.6 grains per $cm^2$/years, shrubs 257.7 grains per $cm^2$/year, herbs 209.1 grains per $cm^2$/year and spores 13.9 grains per $cm^2$/year. The pollen of shrubs and herbs dominates. Among the deposited pollen of arboreal species, pollen of *Pinus* s/g *Haploxylon* and *Betula* sect. *Albae* (13.4 grains per $cm^2$/year each) predominate. Single grains of *Picea* pollen were detected. Among the deposited shrub pollen, pollen of *Alnaster* (130.5 grains per $cm^2$/year) and *Betula nana* (107.1 grains per $cm^2$/year) prevails with the insignificant presence of *Betula* sect. *Fruticosae* (11.7 grains per $cm^2$/year) and *Salix* (8.4 grains per $cm^2$/year). Among the deposited pollen of herbaceous plants, the pollen of the families Poaceae (72 grains per $cm^2$/year), Cyperaceae (40.2 grains per $cm^2$/year), Asteraceae (20.1 grains per $cm^2$/year) and Scrophulariaceae (16.7

| | Pollen trap L-1 | | | Pollen trap L-2 | | | Pollen trap L-3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1) | (2) | (3) | (1) | (2) | (3) |
| Picea | - | - | - | - | - | - | 5 | 8.4 | 1.6 |
| *Pinus s/g Haploxylon* | 5 | 62.8 | 1 | 3 | 5.8 | 1.5 | 8 | 13.4 | 2.6 |
| *Pinus s/g Diploxylon* | - | - | - | 3 | 5.8 | 1.5 | - | - | - |
| *Pinus sp.* | - | - | - | - | - | - | 5 | 8.4 | 1.6 |
| *Betula* sect. *Albae* | - | - | - | 8 | 15.5 | 4.1 | 8 | 13.4 | 2.6 |
| *Betula* sect. *Fructicosa* | 2 | 27.3 | 0.4 | 2 | 3.9 | 1 | 7 | 11.7 | 2.3 |
| *Betula* sect. *Nanae* | 14 | 191.1 | 2.7 | 8 | 15.5 | 4.1 | 64 | 107.1 | 20.8 |
| *Salix* | 1 | 13.6 | 0.2 | 4 | 7.8 | 2 | 5 | 8.4 | 2.6 |
| *Alnaster* | 25 | 341.2 | 4.9 | 26 | 50.4 | 13.2 | 78 | 130.5 | 25.3 |
| *cf. Alnus* | - | - | - | 4 | 7.8 | 2 | 3 | 5 | 1 |
| Cyperaceae | 31 | 423.1 | 6 | 57 | 110.5 | 29 | 24 | 40.2 | 7.8 |
| Poaceae | 157 | 2142.7 | 30.4 | 54 | 104.7 | 27.5 | 43 | 72 | 14 |
| *Artemisia* | 4 | 54.6 | 0.8 | 11 | 21.3 | 5.6 | 3 | 5 | 1 |
| Asteraceae | - | - | - | - | - | - | 12 | 20.1 | 3.9 |
| Rosaceae | 92 | 1255.6 | 17.8 | 1 | 1.9 | 0.5 | 2 | 3.3 | 0.6 |
| Scrophulariaceae | - | - | - | - | - | - | 10 | 16.7 | 3.3 |
| Caryophyllaceae | 2 | 27.3 | 0.4 | - | - | - | - | - | - |
| Fabaceae | 10 | 136.5 | 2 | - | - | - | - | - | - |
| Fabaceae (*cf. Oxitropis*) | - | - | - | - | - | - | 8 | 13.4 | 2.6 |
| Brassicaceae | 28 | 382.1 | 5.4 | - | - | - | - | - | - |
| Brassicaceae (*cf. Cardamine*) | - | - | - | - | - | - | 6 | 10 | 1.9 |
| Ranunculaceae | 44 | 600.5 | 8.6 | - | - | - | - | - | - |
| Ranuculaceae (*cf. Delphinium*) | - | - | - | 3 | 5.8 | 1.5 | - | - | - |
| *Ranunculus* (*cf. lapponicus*) | - | - | - | 1 | 1.9 | 0.5 | - | - | - |
| *Raununculus sp.* | - | - | - | 2 | 3.9 | 1 | - | - | - |
| *Valeriana cf. capitata* | - | - | - | 2 | 3.9 | 1 | - | - | - |
| Lamiaceae | 5 | 68.2 | 1 | - | - | - | - | - | - |
| Saxifragaceae | 8 | 109.2 | 1.6 | 1 | 1.9 | 0.5 | 1 | 1.7 | 0.3 |
| Ericaceae | - | - | - | 3 | 5.8 | 1.5 | - | - | - |
| Polygonaceae | 5 | 68.2 | 1 | - | - | - | - | - | - |
| *Polemonium sp.* | 1 | 13.6 | 0.2 | - | - | - | - | - | - |
| *Viola sp.* | 2 | 27.3 | 0.4 | - | - | - | - | - | - |
| *cf.* Papaveraceae | 20 | 273 | 3.9 | - | - | - | - | - | - |
| *cf.* Crassulaceae | 12 | 163.8 | 2.3 | - | - | - | - | - | - |
| *cf.* Gentiana | - | - | - | - | - | - | 2 | 3.3 | 0.6 |
| *cf.* Orchidaceae | - | - | - | - | - | - | 4 | 6.7 | 1.3 |
| *cf.* Juncaceae | - | - | - | 1 | 1.9 | 0.5 | - | - | - |
| Unknown pollen of herbs | 46 | 627.8 | 9 | 3 | 5.8 | 1.5 | 10 | 16.7 | 3.3 |
| Total pollen grains counted | 514 | 7056 | - | 197 | 382 | - | 308 | 515.4 | - |
| *Lycopodium clavatum* | - | - | - | - | - | - | 1 | 1.7 | 0.3 |
| Polypodiaceae | - | - | - | - | - | - | 2 | 3.3 | 0.6 |
| *Sphagnum* | 1 | 13.6 | 0.2 | 3 | 5.8 | 1.5 | 3 | 5 | 1 |
| *cf. Bryales* | 15 | 204.7 | 3 | 100 | 193.8 | 50.7 | 5 | 8.4 | 1.6 |

**Tab. 2:** Pollen trap results 1998/1999. (1) number of pollen and spores grains counted; (2) influx ($cm^{-2}$/year); (3) pollen and spores percentages from total sum of pollen grains counted (%).

**Tab. 2:** Ergebnisse der Pollenuntersuchungen 1998/1999. (1) Anzahl der Pollen und Sporen; (2) Eintrag ($cm^{-2}$/Jahr); (3) Pollen- und Sporenanteile an der Gesamtzahl der gezählten Pollenkörner (%).

grains per $cm^2$/year) predominate. The pollen and spore grains are well preserved.

In trap L–1 set up on Dzheppiries-Sise Island in the central delta area, 530 pollen and spore grains were observed with the pollen and spore influx rate comprising 7,274.3 grains per $cm^2$/year (Tab. 2). The percentage of arboreal and shrub pollen detected in the trap comprised 8.8 %, herb pollen 91.2 % and of spores 32 %. The maximum influx of pollen and spore grains was determined in the trap both in general and within the AP, NAP and Sporae groups. The pollen of herbs and shrubs dominate. The arboreal pollen influx for the trap comprised 62.8 grains per cm$^2$/year, shrubs 573.2 grains per cm$^2$/year, herbs 6,420 grains per cm$^2$/year and spores 218.3 grains per cm$^2$/year. The pollen of tree species was exclusively represented by *Pinus* s/g *Haploxylon*. Among the pollen of shrubs, pollen of *Alnaster* (341.2 grains per cm$^2$/year) and *Betula nana* (1,911 grains per cm$^2$/year) prevails with the presence of pollen of *Betula* sect. *Fruticosae* (27.3 grains per cm$^2$/year) and *Salix* (13.6 grains per cm$^2$/year). The herb pollen dominates in the spectrum being characterized by a diverse species composition of the pollen of herbaceous plants (pollen of 15 families and Genera was defined in the trap). The pollen of the families of Poaceae (2,142.7 grains per cm$^2$/year), Rosaceae (1,255.6 grains per cm$^2$/year), Ranunculaceae (6,005 grains per cm$^2$/year) and Cyperaceae (423.1 grains per cm$^2$/year) prevails. All pollen and spore grains were well preserved.

In trap L-2 set up in the northernmost delta area on Sagastyr Island, 300 pollen and spore grains were detected with the pollen and spore influx rate comprising 558.2 grains per cm$^2$/year (Tab. 2). The percentage of arboreal and shrub pollen in the trap comprised 28.3 %, herbs 71.7 % and spores 33.5 %. The arboreal pollen comprised 34.9 grains per cm$^2$/year, shrubs 77.6 grains per cm$^2$/year, herbs and dwarf shrubs 246.1 grains per cm$^2$/year and spores 199.6 grains per cm$^2$/year. Pollen of herbs and dwarf shrubs dominates. A typical spectrum feature is the abundance of spores. Among the tree species, the pollen of *Betula* sect. *Albae* (15.5 grains per cm$^2$/year) predominates, grains of *cf. Alnus* (7.8 grains per cm$^2$/year) are noted and in equal proportion (5.8 grains per cm$^2$/year), the pollen of *Pinus* s/g *Diploxylon* and *P.* s/g *Haploxylon* is present. The pollen of shrubs is mainly represented by *Alnaster* (50.4 grains per cm$^2$/year) and *Betula nana* (15.5 grains per cm$^2$/year) with participation of *Salix* (7.8 grains per cm$^2$/year) and *Betula* sect. *Fruticosae* (3.9 grains per cm$^2$/year). Among the pollen of herbaceous plants, the pollen of the families Cyperaceae (110.5 grains per cm$^2$/year) and Poaceae (104.7 grains per cm$^2$/year) sharply dominates with a significant presence of the genus *Artemisia* (21.3 grains per cm$^2$/year). The participation of the herb pollen of other families and genera is minimal. Among the well-preserved spores and pollen, some mineralized and deformed grains are noted.

In all pollen traps, the pollen of tree species (*Pinus, Picea, Betula* sect. *Albae*) was revealed. However, these tree species are completely absent in the vegetation cover of the Lena Delta whereas the northern boundaries of their areas are located many kilometers (between 200-1800 km) southward of the delta (Fig. 3). The pollen of tree species detected in the traps is entirely long-distance pollen.

When comparing the deposited pollen concentrations in the traps, one observes a tendency towards the decreased deposition of long-distance pollen of tree and shrub plants from south to north within the delta (Tab. 2). To reveal the character of the wind regime in the Lena Delta over the period July 1998 - August 1999, the wind rose-diagrams were plotted for Samoylov, Dunai and Stolb Islands. Data on the wind direction and speed for Samoylov Island were kindly provided by J. Boike (AWI, Potsdam) and for Dunai and Stolb islands by A. Gukov (TUGKS). The wind rose-diagrams for Samoylov, Dunai and Stolb islands show the prevailing southerly and southeasterly wind direction (Fig. 1).

The main transfer of arboreal pollen of *Pinus, Picea* and *Betula* sect. *Albae*, is probably from the south and southeast along the Lena River valley from the areas of tree species growing south of the delta (Fig. 3). Thus, a clear relationship between the concentration of the deposited long-distance tree plant pollen and the wind regime character in the territory is traced.

We note that in general, the largest influx of long-distance arboreal pollen is observed for *Pinus* s/g *Haploxylon* (between 5.8-62.8 grains per cm$^2$/year). This is probably due to the pine pollen morphology features (the presence of two large pollen bags) and as a result, its ability to overcome significant distances with the wind air flow (TIKHOMIROV 1950, KUPRIYANOVA 1951, FEDOROVA 1952).

The minimum frequency of occurrence among the deposited tree species pollen in the traps was noted for *Picea*. In trap L-3, the pollen influx comprised 8.4 grains per cm$^2$/year, while the pollen of *Picea* in the traps located northward was not observed at all. These data are in agreement with the opinion that the pollen of *Picea* is mainly deposited within the area of its growth with only a very small quantity being transferred by air to the nearby territories (FEDOROVA 1952).

The pollen of shrubs *Betula* sect. *Nanae* and *Salix* growing throughout the delta and *Alnaster*, whose northern boundary passes across Samoylov Island was encountered in all traps (USSR AREAS 1977). In general, the tendency for decreasing concentration of the deposited pollen from south to north is also observed for the pollen of shrubs, which can be related to the wind regime character in the territory. However, there is one typical peculiarity. In all three regions of the established pollen traps, several shrub species of the genera *Salix* (*Salix glauca, S. nummularia, S. pulchra, S. reptans*) are noted in herbaria collected near the traps, which play a significant role in the formation of the vegetation cover of the delta in general. But the concentration of the deposited pollen of shrubs of the family *Salix* in all three traps is minimum at this (7.8-13.6 grains per cm$^2$/year). Probably, the low pollen concentrations of willow are connected with the features of its preservation or a low productivity of plants in the observation year.

Most herb pollen species found in the traps present the pollen of plants growing in direct proximity to the trap location. The distribution of the deposited pollen concentrations among different families (with the lead role of pollen of the families Poaceae, Cyperaceae, Rosaceae. Ranunculaceae) corresponds to the plants dominating in the vegetation communities of the territories under consideration.

The maximum concentrations of the herbaceous plant pollen are typical of the central delta area (trap L-1). This can be attributed to the best plant vegetation conditions within the high floodplain in the vicinity of the Ugyus-Dzhiye urochishche. In general, the concentration of the deposited herbaceous plant pollen is in good agreement with the character of the local herbaceous vegetation.

The spore influx in the traps range from 13.9-218.3 grains per cm$^2$/year. The maximum concentrations of the deposited spores are typical of the northernmost delta area (trap L-2). We note that the low plants occupy a significant place in the vegetation cover of Sagastyr Island.

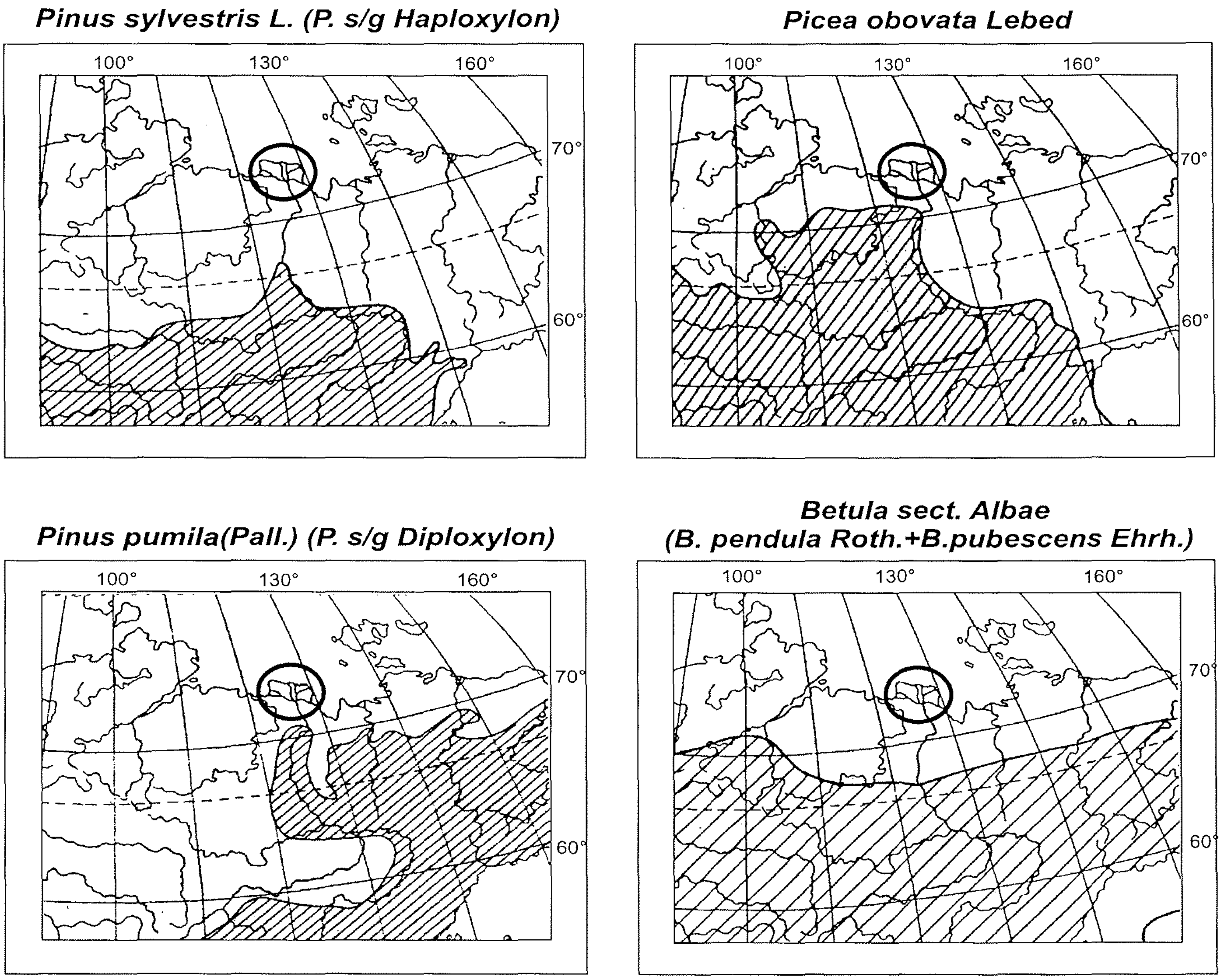


**Fig. 3:** Northern boundaries of current areas of the tree species whose pollen were detected in pollen traps (modified from USSR AREAS 1977).

**Abb. 3:** Nördliche Verbreitungsgrenzen der Bäume, deren Pollen in den Pollenfallen nachgewiesen wurden (modifiziert nach USSR AREAS 1977).

We intend to continue pollen monitoring on Samoylov Island which will allow us to obtain data on the change of intensity of the annual pollen deposition over time. New data will make it possible to more accurately reveal the role of long-distance pollen in the formation of the current spore-pollen spectrum and specify the influence of the productive capability of local plants on the annual deposition of their pollen. In addition, it is necessary to undertake studies to compare the results of a spore-pollen analysis of the trap contents with the surface samples to clear up the pollen and spore fossilization processes.

## CONCLUSIONS

The results of the executed study have confirmed the conclusion that the current spore-pollen spectra are comprised both of pollen and spores of the local plants and of long-distance pollen and spores (KALUGINA 1979).

The pollen of tree plants within the Lena Delta is long-distance and does not reflect the character of the local vegetation. The pollen influx of tree species depends on the wind regime character of the territory, location of the northern boundary of the tree species development areas and the morphological pollen structural features. The character of the wind regime accounts primarily for the decreasing concentration of the tree plant pollen from south to north of the delta. The prevailing southerly and southeasterly wind direction determines the main pollen influx of tree species from the areas of their growth south of the delta. The pollen of shrubs in the traps is both long-distance and local.

The detected pollen corresponds to a great extent to the character of local vegetation in general. However, the deposited pollen concentrations do not reflect quite accurately the composition of dominating species. For the long-distance shrub pollen, the dependence on the wind regime is also established.

The pollen of herbaceous plants is local reflecting to the greatest extent the character of the local vegetation cover. The distribution of the deposited pollen assemblages among the different families of herbs corresponds to the plants dominating in plant communities of the study areas.

The features of the morphological structure and fossilization of pollen and the features of the productive capability and plant growing conditions are of large significance in the pollen transfer and deposition.

Thus, the need for further studies to determine the annual pollen deposition in the Lena Delta and reveal the factors influencing the pollen transfer and deposition is obvious. In this respect, in 2000, two traps were set up in the Lena Delta: L-4 (on Samoylov Island and L-5 (on Kuogastakh Island, southwestern delta area), which will be investigated in 2001.

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