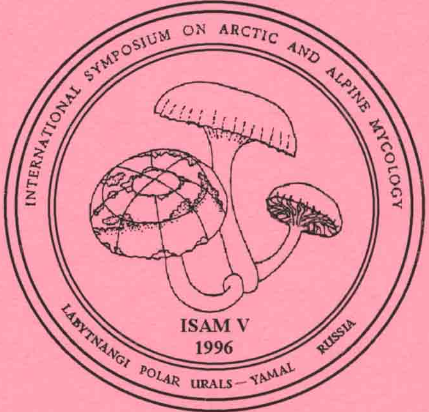
ARCTIC AND ALPINE MYCOLOGY

THE FIFTH INTERNATIONAL SYMPOSIUM ON ARCTO-ALPINE MYCOLOGY



ABSTRACTS

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INTRODUCTION

The first Symposium on Arcto-Alpine Mycology took place in 1980 in the USA where scientists, interests of whome concerned with the study of biodiversity and ecology of fungi of Arctic and alpine ecosystems, met for the first time. The following Symposia were held in Switzerland, Norway (Spitsbergen) and France (the Alps). The organization and conducting of the Symposium are entrusted to its President who is elected by direct voting of participants. The President provides publication of the Abstract-Volume by the beginning of the meeting and subsequently the special volume of the Symposium transactions.

The main principles of organization of meetings of such a kind are:

1) combination of scientific discussions and field works;
2) limited number of participants (up to 25 people);
3) duration of the Symposium is two weeks;
4) the Symposium is held every fourth year.

Undoubtedly, carrying out of the fifth Symposium in Russia will promote the increase of Russian mycologists' and ecologists' interest to the study of Arctic and alpine mycobiotas.

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The programme of the Symposium is orientated towards solution of two general groups of problems. The first is to sum up the results of studies on Arctic and alpine fungi have been carried out during 4 years since ISAM IV. There will be discussed biodiversity of fungi, ecological and geographical patterns of their distribution, their role in Arctic and alpine ecosystems, etc. For the first time it is contemplated to discuss the problems of the protection of fungi.

The second is to carry out field excursions in the Polar Urals and Arctic regions of the Yamal Peninsula which will take considerable time during the Symposium. The results of them will be published in special volume of the Symposium transactions.

The particular attention will be paid also to the discussion of joint programmes and projects orientated towards the development of international collaboration in the studies of Arctic and alpine regions.

Field excursions.

1. Mycobiota of mountain tundras and forests of the Polar Urals. The works are carried out in the valley of the Sob river, from eastern to western macroslope of the Urals range. They will take about 3-4 days with passing nights in field conditions. Transport is train.

2. One-day helicopter excursion to the northern larch forests of the Yagana-P limestone range in the Polar Urals.

3. Mycobiota of mountain tundras of the northern extremity of the Polar Urals. One-day helicopter excursion.

4. The excursion to the Arctic tundras of the Yamal Peninsula. It will take about 1-2 days. Transport is helicopter.

5. The field works in the southern shrub tundras and northern forests of the Yamal eninsula. 3 days. Transport is scientific ships of the permanent biological station in Labytnangi.

Natural conditions.

The Yamal Peninsula is situated in the north of Western Siberia (Russia). It is 750 km long and up to 240 km wide. In Nenets language «Yamal» means «end of the earth». The surface is flat. The peninsula is composed by sandy and clay sedimentations. Permafrost spreads in all areas.

The peculiarity of the Yamal is the predominance of surficial flow here. The longest rivers are Yuribei, Mordyiakha, Kharasavei and Syoiakha. There are more than 50 lakes here but most of them are not large.

The Yamal is situated in tundra zone which is devided to Arctic subzone in the north and Subarctic one (consisting of typical and southern tundras) in the other part of the Peninsula. The zone of larch (Larix sibirica) forest tundra stretches to the south.

The Arctic subzone is characterized by the absence of Betula nana and the dominance of *Salix polaris, S. nummularia, Dryas punctata, Carex arctisibirica, C. stans, Arctagrostis latifolia.* The moss-lichen cover consists of *Racomitrium lanuginosum, Dicranum elongatum, Polytrichum spp., Sphagnum spp.*, Cetraria spp., Alectoria spp. and other species.

In the typical tundras *Salix nummularia, S. polaris, Vaccinium uliginosum, Ledum spp., Empetrum nigrum* are the dominant species. *Betula nana, Salix glauca, Vaccinium vitis-idaea, Rubus chamaemorus* as well as *Arctagrostis latifolia, Poa arctica, Calamagrostis lapponica, Luzula spicata, Polygonum viviparum* are frequent. In the moss-lichen cover bryophytes *(Dicranum spp., Polytrichum spp., Hylocomium splendens, Pleurozium schreberi, Ptilium crista-castrensis)* play dominant role.

In the southern tundras the most frequent species are *Empetrum nigrum, Ledum spp., Vaccinium uliginosum, V. vitis-idaea, Salix polaris, S. glauca, S. phylicifolia, S. pulchra, Betula nana, Arctous alpina* as well as *Carex arctisibirica, Calamagrostis neglecta, Luzula frigida, Hierochloe alpina*. In the moss-lichen cover lichens *(Cetraria spp., Cladonia spp., Alectoria spp.)* play dominant role.

Moving along the river Ob to the south, you can see that forest tundra is replaced by the northern boreal subzone (northern taiga). Boggs prevail in the north of it, pine *(Pinus sibirica, P. sylvestris)* and larch-fir *(Larix sibirica, Picea obovata)* forests do in the south.

Range of the Polar Urals stretches to the west. It's covered with moss and lichen tundra with the elements of arctic flora. At low altitudes there are larch *(Larix sibirica)* forests with *Picea obovata and Betula tortuosa.* The highest summit here is Payer (1,472 m above sea level), and the hieght of mountains at the extremity of the Polar Urals is about 500 m. There are a lot of clean brooks and rivers. You can see wild reindeers there.

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Mycological studies in Arctic tundras of the Yamal Peninsula have not been carried out. In the typical tundras there were held rare research works. Our knowledge of mycobiota is limited, in general, by the data from southern tundras.

Mycological studies in the Polar Urals have been carried out on the mountain Rai-Iz only. The other regios are not investigated.

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BIOTA OF XYLOTROPHIC FUNGI OF THE IMPACTED FORESTS OF NADYM CITY

The influence of industry and urbanization on the diversity of xylotrophic fungi in hypoarctic forests of Nadym impact zone is studied. There were chosen 6 terrains experiencing different types and degrees of anthropogenic influence (fires, cuttings, recreation and others). There was made a route numerical registration of wood destroying fungi on the birch-trees numbering 100-160 specimens attacting the substrate. 744 fungi specimens were registered.

There were registered 21 species of aphyllophorous fungi, mainly polypores, well-recognized in field conditions. Three main ecologo-functional groups are presented: 1) trunk parasites (in discending order of occurance): *Phellinus igniarius, Inonotus obliquus;* 2) saprothrophes of the natural falling: *Piptoporus betulinus, Fomes fomentarius, Gloeoporus dichrous, Inonotus radiatus, Daedaleopsis confragosa, Phellinus laevigatus, Fomitopsis pinicola, Hapalopilus nidulans;* 3) wounded-ruderal saprothrophes: *Cerrena unicolor, Stereum hirsutum, Trametes ochracea, Cylindrobasidium evolvens, Trametes versicolor, Bjerkandera adusta, Irpex lacteus, Gloephyllum sepiarium, Merulius tremellosus, Trametes pubescens, Gloeoporus taxicola.*

The analysis shows that the studied species reflect the diversity of xylotrophic mycibiota as a whole. Being compared with the data by V.A. Mukhin (1984), Nadym's mycobiota takes the corresponding to its geographical position place in ecological north - south gradient of the region: a portion of trunk parasites regulaly decreases (Khadyta-Yakha - 91; hypoarctic open woodlands - 56; Polui - 42 and Nadym - 32%), a part of saprophytes of the natural falling increases (4, 37, 54 and 54% correspondingly). Anomalous impacted mycobiota of Nadym is characterized by large increase in a portion of ruderal and wounded saprophytes (5, 7, 4 and 14% correspondingly).

The same regularities are observed on separate investigated territories. So, it is found the same number of species (15) on the impact and control lots of inundated birch forests. On the first lot parasites come to 27, saprophytes - 43, and ruderals - 30%, on the second one - 34, 53 and 13% correspondingly. In the impacted forests due to the larger heterogeneity of substrates different ecologo-functional groups of fungi especially wounded-ruderal species are presented more completely. It is revealed the increase of Simpson's diversity index (6.58 and 4.78) and number of indicator species in registration (11.0 and 10.0, up to 50 registered specimens). But the indicator of the species' number on the same substrate, i.e. species capacity of cenocell, is lower on the impact lot (1.15 and 1.26). The qualitative differences between lots are found for three rare and one sufficiently numerous species - *Cylindrobasidium evolvens*, the so-called «warehouse fungi» which populates the cutting residues in the impact zone.

In the burnt forests of 1990 there was found the larger number of species (10-13, in total 15) than in the control forests (8-9, in total 11). In the lot with the absolutely burnt trees the number of species (13) is larger than in the lot with partially burnt trees (10). The increase of fungi diversity in the burnt forests is due not to the increase of substrates diversity but to their abundance and thermal changes of wooden substrates. There appear such species not typical for the birch as *Gloeophyllum sepiarium, Irpex lacteus; Piptoporus betulinus* (41-74%) predominates there. Simpson's index in the burnt forests is, on the contrary, low especially on the absolutely burnt lot.

So, the temperate anthropogenic changing of the hypoarctic forests implying a partial reserve of ecological niches creates some new niches mainly for ruderal biota of southern origin. This leads to the increase of mycobiota diversity as a whole. But according to the analysis of structural indicators the increase of biodiversity is of the unstable character as a result of considered destructive factors.

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COTINARIUS SUBGENUS TELAMONIA IN GREENLAND-I

As a part of the ongoing preparations for the flora of the Greenlandic basidiomycetes, a revision of c. 30 collections from Herbarium C and the authors private herbarium of the Greenlandic taxa of *Cortinarius subgenus Telamonia* sections *Telamonia, Sericeocybe, Armillati* and *Bicolores* has been undertaken. Full descriptions and some illustrations of *C. agathosmus Brandr., Lindst. & Melot, C. ionophyllus Moser, C. venustus P. Karst., C. paragaudis Fr. ssp. paragaudis, C. cf. evernius (Fr.: Fr.) Fr. and C. alboviolaceus (Pers.:Fr.) Fr.* are given. All of them are new to Greenland. Cortinarius cf. evernius might represent an undescribed species, but further studies are necessary. The remaining taxa are in accordance with modern concepts, except for slightly larger spores in some collections of *C. agathosmus* and *C. ionophyllus*. In these three taxa the presence of a plage (Arnold, 1993) was observed by light-microscopy. The taxa are so far recorded from S- and SW-Greenland only, up to Paamiut municipality (C. venustus also recorded from Qorqut near Nuuk). Only *C. agathosmus, C. alboviolaceus* and *C. venustus* are recorded from the subarctic, inner parts of southern Greenland. However, the taxa are assumed to have a larger distribution than it is known at present, when more areas are thoroughly investigated for *Cortinarius*. On the other hand, the true Greenlandic distribution of the treated taxa is most probably climatically limited, as they have not been recorded from the Disko Island at the upper border of the lowarctic area in spite of intensive investigation (Lamoure et al., 1982, Borgen & Elborne, unpublished). Except for *C. alboviolaceus* and *C. paragaudis* the taxa have not been recorded from lowarctic areas elsewhere. The taxa are probably forming mycorrhiza with *Betula glandulosa*, which is a new host, except for *C. venustus* which grows under the closely related B. nana, which is also a new host. In S-Greenland *C. agathosmus* and *C. venustus* also grow under planted *Picea glauca*. A survey of their distribution in oceanic and less oceanic areas around Paamiut (SW-Greenland) is given, except for *C. venustus*, which has not yet been recorded there. The taxa are confined to dwarf scrub heath, typically with *Betula glandulosa*, *Vaccinium uliginosum* and lichens in the fiords, except for C. paragaudis which also occurs in the coastal heaths dominated by *Empetrum hermaphroditum*.

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DRYADICOLOUS MICROFUNGI OF CIRCUMPOLAR AREA

Some 164 taxa of microfungi have so far been found on all *Dryas* species, among them eight on Dryas debris (Hayes & Rheinberg, 1975) and 64 species of endophytes (Fisher et al., 1995). Together 88 taxa (excluding endophytes) have been noted on *Dryas octopetala s.l.* The more detailed and local investigation of dryadicolous microfungi are best known from Europe (Holm, 1979; Holm & Holm, 1985, 1993; Nograsek, 1990; Nograsek & Matzer, 1991; Fisher et al., 1995; Chlebicki, 1995). Some data are also known from Arctic Canada (Barr, 1959) and Far East (Vasilyeva, 1979, 1987). However, only microfungi on *Dryas octopetala s.l.* are better investigated. These of *Dryas integrifolia, D. drummondii* and *D. grandis* are still incompletely known.

Number of taxa D. octopetala: 87; D. integrifolia: 18; D. drummondii: 8;

D. grandis: 5 The analysis of composition of microfungi has indicated that the more abundant in species are *Dothideales* and *Coelomycetes*. Some parasites are remarkably distinct and indicating a long period of coexistence of host-plant and fungi. There are: *Synchytrium cupulatum* noted in Europe and North America (Muller & Magnuson, 1987), *Isothea rhytismoides* with circumpolar and alpine distribution, *Sphaerotheca volkartii* restricted to the European mountains and *Hypoderma* dryadis widely distributed in north Asia and rarely in north Europe.

Number of dryadicolous species

Amphisphaeriales	4	Hyphomycetes	19
Chytridiales	1	Hypocreales	1
Coelomycetes	38	Hysteriales	1
Diaporthales	6	Ostropales	3
Dothideales	56	Phyllachorales	2
Erysiphales	2	Rhytismatales	2
Eurotiales	1	Sordariales	6
Helotiales	9	Xylariales	8

Parasites: 15 Saprophytes: 85 Endophytes: 64

The direction of migrational tracks in Central Europe and phylogeny of the genus has been evaluated, using the microfungi as markers. I have compiled literature data, my own collections from Tatra Mts., Kola Peninsula, environs of Abisko in Scandinavia and Polar Ural Mts. Apart of them I have extracted 250 samples of microfungi from phanerogam herbary in St. Petersburg including such areas as the Urals, Taimyr Peninsula, Yakutia, Chukotka Peninsula and the Caucasus.

The general distribution patterns of several *Dryas species* are well known, thanks especially to the considerable efforts by Steffen (1924), Porsild (1957), Hulten (1959), Meusel (1965), Yourtsev (1979) and Kozhevnikov (1984), both in mapping the areas of particular species and taxonomical classification. I accept the taxonomic approach of Hulten (1959) with four species: *Dryas octopetala, D. integrifolia, D. drummondii* and *D. grandis.* The genus *Dryas* is related with more primitive shrubs of *Cowania* and *Fallugia*, both occuring in the Cordilleras (Kuznetzov, 1922; Gajewski, 1957; Kozhevnikov, 1984). Moreover, in the same mountains three genera of ancient Cercocarpeae occur. They are supposed as ancestors of *Dryadeae* (Gajewski, 1957). Also the the most primitive species of the genus *Geum* belonging to the subgenera *Sieversia* and *Neosieversia* are most related to the Dryas. Sieversia pentapetalum and *S. selinifolium* grow in the Pacific regions of north-eastern Asia, whereas arising from them *Neosieversia* occurs in coastal region of Arctic Asia and America. It is noteworthy that centre of origin of the genus *Geum* is located in south Europe (Gajewski, 1957), whereas that of Dryas in Arctic (Steffen, 1924), Rocky Mountains (Kuznetzov, 1922), Yakutia (Juzepchuk, 1929), southern Asiatic mountains (Love & Love, 1974) and southern Beringia (Kozhevnikov, 1984). Gajewski (1957) supposed that the members of the genus Dryas are more primitive than these of *Eugeum*. Savile (1979) reported occurence of some relatively primitive rusts on *Geum* nor on *Dryas*. This contradictory information is difficult for explanation. Occurence on *Dryas spp.* of considerable group of lignicolous microfungi consisting of 30 species (38% of all microfungi) doesn't indicate remote connection with mentioned ancestral shrubs or small trees, but reflects an access for colonization of long-lived host. Also wide distribution of *Dryas* population during Pleistocene has been favourable for such colonization. Among 81 analized species, nearly 50% are restricted to the *Dryas* only. These microfungi reflect the relatively isolated position of *Dryas*. As pointed out by Holm (1979), «the mycoflora of *Dryas* has no rosaceous character; it is rather more reminiscent of the fungal flora of *Ericaceae*». I have noted 11 species of ericaceous character and only four species having connection with strictly rosaceous microfungi. Chlebicki (1995) noted that participation of ericaceous microfungi on *Dryas* increases towards the north.

The relationships between microfungi of particular *Dryas* species are doubtful. Also the most interested area with location of the greatest variety of species and subspecies of *Dryas* are poorly investigated by mycologists. In such a situation it is not yet possible to confirm any location of the centre of origin of the genus *Dryas*.

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THE MICROFUNGAL GROWTH FROM MYCELIAL FRAGMENTS AND FROM SPORES IN LOW TEMPERATURE CONDITIONS

In soil conditions the fungal colonies are formed both from mycelial fragments and from spores. But the difference between the asexual and vegetative reproduction patterns for soil microfungi in low temperature conditions is not examined..

The objects of study were three microfungal species typical for northern podzolic and primitive soils: *Alternaria alternata, Mucor hiemalis, Penicillium spinulosum. M. hiemalis* is a representative of class *Zygomycetes* and has a coenocytic, hyaline mycelium. *A. alternata* and *P. spinulosum* belong to the class *Deuteromycetes*, and the first has dark-coloured mycelium containing melanin in the cell wall, and the second has hyaline mycelium. The fungal mycelium and spores were grown in Chapek medium. The suspensions of spores and mycelial fragments were put on slides with nutrient media and incubated at 4, 18 and 25° C.

Both the fragment viability and the spore germination essentially decreased with the decreasing of the temperature. At low temperatures only large (>140 mkm) mycelial fragments were able to grow, but the shorter fragments were not viable. That situation was essential for hyaline mycelium of *M. hiemalis* and *P. spinulosum.*

The microfungal mycelial fragments and spores differed in their ability to mycelial growth in low temperature conditions. The ability to growth of *M. hiemalis* fragments was higher comparing with spores, whereas in the case of *A. alternata* the fragments growth capacities were lower than for spores. For *P. spinulosum* occurred, whereas the spores were not able to germinate at 4° C. The germination began only after increasing of the temperature to 9° C.

At low temperatures the growth delay both for mycelial fragments and for spores occurred. At the higher (20-25° C) temperature the mycelial growth both from fragments and from spores began immediately after putting fungal suspension on the solid medium, while at cold temperature the spore germination and fragment growth began 2-3 days later.

Some characteristics of fungal growth could change with decreasing of the temperature. The growth rate decreased for all examined fungal species at low temperature. The growth response in branching pattern did not depend on temperature for *M. hiemalis* and *P. spinulo-osum*. But for *A. alternata* branching paterns were higher (the hyphal growth unit decreased) in cold conditions.

At low temperatures some morphological modifications of fungal mycelium may occur. In these conditions the coenocytic mycelium of *M. hiemalis* forms the yeast-like cells. The distance between the septa in the mycelium of *A. alternata* decreases. As it was shown in our experiments, the mycelium with high septation frequency is more viable. All these data can be used for modelling mycelial growth in «cold» soils.

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RESULTS AND PROSPECTS OF RESEARCH OF RUSSIAN ARCTIC MYCOBIOTA

The level of investigations of a mycobiota of Russian Arctic (RA) now obviously concedes the research of biodiversity of higher and lower spore-bearing plants from this region. Such a backlog doesn't correspond to that role, which is played by fung as conducting components of their heterotrophic block in arctic ecosystems. The long term problem of mycologists consists in reduction and liquidation of this backlog. The study of a mycobiota of RA can be divided into two stages. The fist stage was carried out basically by efforts of Scandinavian mycologists, conducting a series of scientific expeditions to various regions of RA. Central to them there was the expedition of «Vega». A number of basic works on mycoflora of RA was published (Fuckel, Oudemans, Lind, Jorstad, Liro, Karsten , Kari and others) on materials of the expeditions. In these publications there was specified about 150 species of fungi for the territory of RA, including more than 30 new ones. The second stage of research of mycoflora of RA was carried out by efforts basically of Russian mycologists (V. Transhel, B. Vasilkov, Z. Azbukina, Lar. Vasiljeva, B. Tomilin, I. Stepanova, L. Kazantseva, I. Selivanov, V. Mukhin and others). The third (present) stage of research of a mycoflora of RA begins now. Distinctive feature of this stage is international cooperation between mycologists of different countries.

Up to the present time about 300 scientific papers on mycoflora of RA (territories within the borders accepted in «Flora of Arctic of USSR») have been published by 80 authors and co-authors. In these papers it is mentioned more than 1200 species of fungi growing on 600 species of plant hosts. These species are distributed to the largest taxonomical groups of fungi as follows : *Dothideales* - 300 species, *«Discomycetes»* - 250, *«Pyrenomycetes»* -100, *Erysiphales* - 22, *Uredinales* - 110, *Ustilaginales* - 60, *Coelomycetes* - 200, *Hyphomycetes* - 45. It is revealed about 200 soil fungi species, and 50 ones of yeasts. It is necessary to note that large defects of number of works have been elucidated. Many species of fungi indicated in lists require careful auditing, and their samples are absent in herbaria.

The knowledge of the mycobiota of RA doesn't concede that of other large regions of Russia, but it concedes that of large regions of foreign Arctic. There is the urgent task of further inventory of species, and the purpose is to achieve its greatest completeness. According to our estimation, there are 4,700 - 5,000 fungi species widespread on the territory of RA. The Taimyr Peninsula where more than 700 species are known belongs to rather well investigated territories of RA. In mycological relation such regions as the Yamal, Yakutia, Chukotka and many arctic islands are poorly investigated. In taxonomical relation the fungi are also investigated irregularly. *Chytridiomycetes, Oomycetes, Deuteromycetes* and many groups of *Ascomycetes* belong to poorly investigated groups. The problem of study of fungi growing on lichens as of important components of arctic ecosystems is urgent.

Attention is drawn to the fact that obviously it is not enough theoretical works and integration analysis of the mycobiota of RA. On the whole it is possible to conclude that arctic mycoflora is rather young. The majority of species has developed in late Pliocene and Pleistocene. The mycologists can accept as a basis the way of formation of mycobiota of RA that of its flora of higher plants (A. Tolmachev, B. Yurtzev). According to these authors, the arctic flora is a derivative from Neogene Boreal area, the direct predecessors of which were floras of high mountains. These floras were lowered on the northern plains in late Neogene and were mixed here with other floras of forest areas.

We accept this way of formation of arctic flora and mycobiota as a whole, because historically fungi and the higher plants are closely connected with each other. The significant part of fungi accompanied this migration of plants. The mycobiota of European sectors of RA is connected by an origin with mycobiota of northern and central Europe, whereas the mycobiota of Asian sector has Beringian and North American genesis.

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ASSOCIATION OF SOIL MICROMYCETES FROM POLAR DESERT, ARCTIC TUNDRA AND TYPICAL TUNDRA OF THE TAIMYR PENINSULA AND THE ISLANDS OF THE NORTHERN LAND ARCHIPELAGO

Soil micromycetes are compulsory part of every natural biocenoses. Complexes of soil micromycetes of Arctic territory of Russia have been studied only fragmentary. There are only two works about soil micromycetes in the Taimyr Peninsula. In our work three northern zones of the Taimyr Peninsula were investigated: 1) the polar deserts, 2) the arctic tundra, 3) the typical tundra. Samples of soil were collected by standard methods in the peak time of life activity of microorganisms. To treat these samples standard methods were used.

The number of micromycetes in soil is at low level in all biocenoses of the Taimyr Peninsula. In our investigation the number of soil micromycetes ranges widely from 0.004 to 18.723 thousand germs (Colony Forming Units (CFU)) in 1 gram of dry soil. In polar deserts average value of the CFU of micromycetes was 0.363 thousand germs in 1 gram of dry soil. In arctic tundra the number of soil micromycetes was 0.672 thousand germs, and in typical tundra it was 8.656 thousand germs. The general reduction of fungal numbers was ofen noted in soil along the steep gradient from south to north. Within the same zone the number of soil micromycetes depends on the type of soil, vegetation and ecological condition (temperature, moisture, etc.). For example, the number of CFU is higher in peaty soil than in clay soil. The rise of soil temperature caused by anthropogenic disturbances of vegetation resulted in the increasing of fungal number. Within the same biocenose lichens covering the soil lead to reduction of number of micromycetes in the soil, but the mosses covering the soil tend to the increasing of CFU. The influence of rhizosphere leads to the increasing of the number of micromycetes in soil. The low anthropogenic pollution of environment by oil products resulted in the increasing of CFU number in clay soils.

For the purpose of estimation of the soil micromycetes association some indexes of diversity (alpha-diversity, beta-diversity and species diversity by Shannon (H)) were used. The alpha-diversity is the index of complicated association and it is at very low level in all zones of the Taimyr Peninsula. It increases from north to south (from 12+1.2 in polar deserts to 16+2 in typical tundras). The index of beta-diversity determines the rate of change along space and ecological gradient. It consequently increases from 3 in polar desert to 4.1 in typical tundra. The index of species diversity (H) is a model of system stability. It oscillates from 0.91 to 1.88 in polar deserts, from 1.2 to 2.4 in arctic tundra and from 1.6 to 2.75 in typical tundra. It consequently increases from north to south. By this means from north to south the diversity indexes of micromycete complexes and their stability increases.

To elucidate the regular distribution of soil micromycetes in different biocenoses and the range of its changes by the influence of outward factors the methods of correlation dendrites (plexus techniques) were used. Complicated dendrites with the higher level of correlation are formed in more favourable conditions. Conditions, affecting the soil micromycetes complexes, determine not only the structure of dendrite, but the composition of its components too. In different biocenoses of polar desert complexes of soil micromycetes form simple dendrites consistsing of 2-4 species; in biocenoses of arctic tundra dendrites consist of 4-7 species; and in typical tundra the level of correlation in dendrites increases and dendrites consist of a large number of species with complicated connection.

The cluster analysis between all biocenoses on the basis of frequency of occurence of 97 species was done. All the complexes diverge to three large groups which correspond to three zones. The resemblance between the polar desert and arctic tundra is higher than the one with typical tundra.

All research zones of the Taimyr Peninsula, being the arctic territories of Russia, are influenced by the extreme factors, but along the steep gradient from south to north the general changes of soil micromycete complexes have often been noted.

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FUNGI OF THE WESTERN SIBERIAN LOWLAND. PRELIMINARY RESULTS

During a collecting trip to the Yamal Peninsula in 1990 by the authors and in 1992 by the authors and colleagues from Russia, Denmark, Finland, Sweden and England (during the first Russian-Scandinavian Trans-Siberian Mycological Expedition) collections were made in 7 sites in the northern part of the West Siberian lowlands along the polar circle and in the southern Yamal. All groups of higher fungi were collected with main emphasis on basidiomycetes and collections were made in all vegetation types with emphasis on tundra, forest tundra, and thickets of *Alnus and Salix*. In 1990 the season seemed fairly normal but with a warm summer, whereas in 1992 the spring was unusually late, followed by a dry summer preceding the collecting period from the end of July to the middle of August in 1992. Thus, totally the recorded number of fungi was still rather low, c. 350 species.

A comparison of the northern Siberian mycota with that of Western Europe shows a very high resemblance between the two mycotas. Some groups with a special distribution, hosts or other specific characteristics will be mentioned: 1) a group of subarctic-arctic species: *Amanita nivalis, A. groenlandica, Collybia alpina, C. alkalivirens, Coprinus martinii, Helvella arctophila, Hygrocybe cinerella, Hypoxylon macrosporum, Lactarius pusillus, L. dryadophilus, L. lanceolatus, L. pseudouvidus, L. salicis-herbaceae, L. torminosulus, Marasmius epidryas, Mycena citrinomarginata, Multiclavula vernalis, M. corynoides, Omphalina rivulicola, Stropharia magnivelaris, Rickenella pseudogrisella;* 2) a group of Eastern-continental species: *Aleurodiscus lividocoeruleus, Gloeophyllum protractum, Trametes trogii, Boletinus asiaticus, Polyporus pseudobetulinus, Scutiger syringae;* 3) a group of species strongly connected to Alnus (fruticosa): *Amanita friabilis, Datronia scutellata, Exidiopsis griseobrunnea, Tectella patellaris, Plicatura nivea.*

It was noted that the ratio of trees infected by fungal parasites (mostly species of *Phellinus* and *Inonotus*) was significantly higher than at lower latitudes. The process of wood destruction by these fungi is characterized by three peculiarities.

Firstly, biodestruction of wood begins long before the death of tree, and ,therefore, large amounts of wood tissues (up to 80 per cent) are already being destroyed during its life.

Secondly, owing to the activity of the fungi, the longevity of tree life decreases the entry of wood into the chain of destruction of forest ecosystems speeds up. It is a favourable factor for the North ecosystems, because the longevity of wood life and the time of conservation of biological elements in the wood are 2-3 times higher here than in the middle and southern taiga regions.

Thirdly, after death of tree there is already developed mycelium inside its trunk, and it provides further active saprotrophic destruction of wood. In other words, it takes no time for colonization of the substrate by saprotrophic fungi. According to our estimations, in the subarctic regions this period lasts three years and more.

All these factors lead to the increase of intensity of turnover of substances composing wood. So, we consider becoming facultative fungi parasites the ecological dominants to be specific ecosystem adaptation contributing to the increase of intensity of biological turnover in subarctic forests.

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HOW TO PROTECT THE THREATENED POLYPORES IN FINLAND

In Finland there are 206 polypore species, and in total 60 species are threatened. In the Finnish classification, the following threath categories are used and the number of taxa in each category is given: Extinct = 1 species, Endangered = 7 species, Vulnerable = 14 species, Rare = 26 species, Care demanding = 10 species, Indeterminate = 2 species.

Finland belongs to the boreal coniferous vegetation zone (taiga) where the soils are characterized by low pH (about 4). Roughly, the climax tree is either pine *(Pinus sylvestris)* on dry soils, or spruce *(Picea abies)* on more humid soils. *Deciduous trees, such as Betula pendula, B. pubescens, Alnus incana, A. glutinosa, Salix spp.,* and *Populus* tremula are common in the early stages of succession, but decrease at the late climax stages. Species like *Quercus robur, Fraxinus excelsior, Ulmus glabra, U. laevis, Corylus avellana, Acer platanoides and Tilia cordata* have their main distribution area in the southern part of the country. They form only seldom pure stands, but are often intermixed with the common species in luxuriant growth sites where the pH is about 6.

The most common habitats of the threatened polypores are virgin heath forests. 60% (36 species) of the threatened species have their main populations in spruce or pine dominated primaeval forests. Most of the species are saprotrophes and are found only on dead, decaying trunks, which are lacking from managed forests. In southern and central Finland there are only a few old, natural forests left, whereas in eastern and northern Finland the situation is better. However, the paper industry is naturally very interested in the utilization of old forests. Therefore, a survey of natural old forests has taken place and a «old forest protection programme» has been prepared. Although the area of protected forests in southern Finland is propably going to be very small, we hope that it can help the most threatened species to survive until more forests are protected. During the last years the landscape ecological planning in the commercially utilized forests have taken place. In the planning regard has been paid to preserve ecological corridors and keystone habitats. For some species these are maybe helpful, but they cannot compensate strictly preserved areas.

Besides the «virgin forest species» a large group of threatened species grow on rare, southern hosts («noble deciduous trees»; in Finland *Quercus, Fraxinus, Acer* etc., see above). These hardwoods grow on the best soils, and therefore a great majority of them have been cleared for fields already centuries ago. Now the only way to protect the polypores on these «noble» hosts is to protect the last broad leaved grass - herb forests. However, if they are strictly protected, spruce may invade many of them and suppress the deciduous trees. Therefore, it is necessary to remove spruces from these woods.

Finally. There are no laws which forbid to collect threatened polypores or which prohibit to destroy a growth site of threatened species if the area (or a single tree) is not already protected by the law.

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WOOD-ROTTING BASIDIOMYCETES AND MYCETOPHILOUS COLEOPTERA (INSECTA) IN THE POLAR URALS AND SOUTHERN YAMAL

During 14 years I have been studying the relationships between wood-rotting fungi *(Basidiomycetes)* and insects (mainly, *Coleoptera*). In 1987 and 1990 I conducted the research in the Polar Ural (near the railway station «Red Stone») and the South Yamal (along the river Chadeta). For this purpose, I collected the insects from the fruiting bodies of the fungi and their surrounding wood and analysed all types of the fungus-insects connections. Totally, 2959 fruiting bodies of the 36 species of wood-rotting *Basidiomycetes* beloning to 2 orders and 6 families were investigated. The beetles were found in (on) 529 fruiting bodies of the 13 species wood-rotting Basidiomycetes from 2 orders and 4 families. Some results of my work are given in this paper.

Order Aphyllophorales, family Poriaceae.

Cerrena unicolor (Bull.:Fr.)Murr. (Betula). Cerylonidae: *Cerylon deplanatum Gyll.* (imago); Cisidae: *Cis comptus Gyll.* (all stages); Lathridiidae: *Corticaria linearis Pk.* (imago).

Daedaleopsis confragosa (Bolt.:Fr.)Schroet. (Betula, Alnus, Salix). Cisidae: *Cis comptus Gyll.* (all stages); Lathridiidae: *Corticaria obfuscata Strand.* (imago); Leiodidae: *Cyrtoplastus kabakovi Lafer* (imago).

Fomes fomentarius (L.:Fr.)Fr. (Betula). Lathridiidae: *Corticaria lapponica Zett.* (all stages), *C.linearis Pk.* (imago), *Enicmus rugosus Herbst.* (all stages); Melandryidae: *Orchesia micans Panz.* (all stages); Mycetophagidae: *Litargus connexus Geoffr.* (imago); Staphylinidae: *Lathrimaeum atrocephalum Gyll.* (imago).

Gloeoporus dichrous (Fr.)Bres. (Betula). Cisidae: *Cis comptus Gyll.* (imago).

Piptoporus betulinus (Bull.:Fr.)P.Karst. (Betula). *Cryptophagidae: Cryptophagus tuberculosus Pall.* (imago); Lathridiidae: *Corticaria longicornis Herbst.* (imago), *Stephostethus pandellei Bris.* (all stages); *Cisidae: Ennearthron sp.* (all stages).

Trametes pubescens (Schum.:Fr.)Pil. (Betula). Cisidae: *Cis comptus Gyll.* (all stages), *Cis hispidus Gyll.* (all stages), *Cis hispidus Gyll.* (all stages).

Trametes suaveolens L.:Fr. (Salix). Cisidae: *Cis hispidus Gyll.* (all stages), *Cis setiger Mel.* (imago), *Sulcacis affinis Mel.* (all stages); Cryptophagidae: *Atomaria semitestacea Rtt.* (imago).

Trametes versicolor (L.:Fr.)Pil. (Betula). Cisidae: *Cis comptus* Gyll. (all stages), *Cis hispidus Gyll.* (all stages), *Sulcacis affinis Gyll.* (all stages); Lathridiidae: *Lathridius consimilis Mnnh.* (all stages).

Trichaptum laricinum (P.Karst.)Ryv. (Abies, Picea). Cisidae: *Cis comptus Gyll.* (all stages).

Order Aphyllophorales, family Hymenochaetaceae.

Inonotus radiatus (Sow.:Fr.)P.Karst. (Alnus, Betula). Lathridiidae: *Lathridius consimilis Mnnh.* (imago); Nitidulidae: *Epuraea angustula Sturm.* (imago); Staphylinidae: *Atheta sp.* (imago).

Phellinus igniarius (L.:Fr.)Quel. (Alnus, Betula). Erotylidae: *Triplax scutellaris Charp.* (imago); Melandryidae: *Orchesia micans Panz.* (imago); Tenebrionidae: *Scaphidema metallicum F.* (imago).

Order Agaricales, family Polyporaceae s.str.

Pleurotus pulmonarius (Fr.)Kumm. (Betula). Cerylonidae: *Cerylon deplanatum Gyll.* (imago); Erotylidae: *Triplax aenea Schall.* (all stages), *Triplax scutellaris Charp.* (all stages); Leiodidae: *Cyrtoplastus kabakovi Lafer* (imago); Nitidulidae: *Epuraea boreela Zett.* (imago); Staphylinidae: *Atheta sp.* (imago), *Lathrimaeum atrocephalum Gyll.* (imago); Tetratomidae: *Tetratoma ancora F.* (all stages).

Order Agaricales, family Tricholomataceae.

Armillaria mellea (Vahl.:Fr.)Kumm. (Betula, Alnus). Tetratomidae: *Tetratoma ancora F.* (imago).

Hence, the community of the Coleoptera, associated with some wood-rotting *Basidiomycetes* from the Polar Urals and the Southern Yamal includes 27 species of the beetles beloning to 12 families.

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SOIL MICROFUNGI IN SOME ALPINE AND SUBARCTIC NATURAL AND CONTAMINATED ECOSYSTEMS

Our researches in some Subarctic and tundra (the Kola Peninsula) and Alpine (the Ukraine Carpathian 1,800-2,000 m, the Caucasus 2,800 - 3,000 m above sea level) ecosystems demonstrate that in this environmental conditions the special and partly similar soil microfungal communities are formed.

The microfungal communities structure was examined in soils, litter, surrounding air. The isolation was made on solid media (CYA, water agar), 10-fold replication of samples. Cellulose-decomposing fungi was determined on cellulose plates, exposed in soils for 10-14 days and then transferred to the medium (Marfenina, 1988). The fungal species composition was characterized by counting species diversity, abundance and frequency of occurrence (%). Fungal biomass was determined by membrane filter method (Hanssen et al.,1974). The life cycles of some microfungi in soils were examined by membrane chamber technique (Marfenina et al., 1989).

The microfungal communities in the alpine soils are rather poor in their diversity, Shannon diversity indexes are low (H=2.0-2.8). The species of genus *Penicillium*, dark coloured microfungi and sterile forms usually dominate. The alpine soils have the particular fungal biomass structure. The mycelium biomass in the alpine soils was higher than in lower situated mountain-meadows and coniferous forest soils. The spore biomass in alpine soils was approximately 1/3 from the whole fungal biomass. The fungal spores in alpine soils were mainly small (2-3 mkm) and hyaline. The life cycles of examined microfungal species *(Ulocladium botrytis, P. spinulosum)* have a specific properties: long spore germination, slow mycelial growth, and usually microcyclic conidiation.

In the primitive and sandy podzolic soils in the Kola Peninsula the microfungal communities usually contain *Penicillium* species *(P. spinulosum, P. glabrum)*, sterile dark-coloured and hyaline mycelium as a dominants. Some species from genus *Trichoderma, Mortierella, Acremonium, Cladosporium, Aureobasidium* typical in primitive seaside marsh soils were isolated rather frequently. In that soils the *Penicillium* presence drastically decreased, but the species from *Acre-*

monium *(A. charticola, etc.)*, dark-coloured fungi *(Cladosporium, Curvularia, Ulocladium)*, some Mucor became more frequent.

The human impact causes sharp changes in the microfungal communities. The typical for alpine and some arctic ecosystems is air industrial pollution and recreation activity. In this stress conditions the microfungal communities are simplified, the mycelial biomass may decrease. The industrial polluted (the Pechenga nicel smelter) soils in the Kola Peninsula usually contain *Aspergillus* species typical for southern soils. Under the influence of acidic precipitation the amount of dark fungal mycelium may decrease.

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OBSERVATION ON THE ECTOMYCORRHIZAL GENUS HEBELOMA (FR.) KUMMER IN ARCTIC AND ALPINE TUNDRA IN ALASKA AND THE YUKON TERRITORY OF CANADA

There are a wide variety of Arctic and alpine tundra habitats in Alaska which include *Salix, Betula,* and *Dryas*, and support ectomycorrhizal species of fungi in three major genera. The diversity of potential ectomycorrhizal hosts is low along the Arctic coast which has a colder summer climate (5-7 C in summer) and where only dwarf species of *Salix* are found. Further south, in North Slope tundra, a more diverse assemblage of *Salix* species is found, including both dwarf species as well as shrub species in less exposed situations. Further south, at higher elevations, vast areas of alpine tundra support a more diverse assemblage of Salix species and where *Betula nana L.* and *Dryas octopetala L.* are common components of the alpine tundra flora. Areas of this type were sampled in this study at Eagle Summit over 100 miles north of Fairbanks and in McKinley (Denali) Park as well as alpine tundra sites in the St. Elias Mountains in the Yukon Territory of Canada. Analysis of over 40 collections reveals some interesting patterns of distribution which could be linked to host specific mycorrhizal associations. Along the Arctic coast with its low diversity of higher plants *Hebeloma pusillum J. Lange* and *H. pusillum v. longisporum Bruchet* along with *H. kuehneri Bruchet* are the dominant species. They are most often recorded in association with *Salix rotundifolia Tautv.* and *S. pulchra Cham.* In fact, *H. kuehneri* is found primarily on the North Slope in coastal tundra and recorded further south only once. By contrast *H. pusillum* and the variety longisporum are in both Arctic tundra and subalpine tundra from the North Slope where it is common to subalpine tundra in the Yukon Territory near Cultus Bay at Kluane Lake. It is also recorded from the Kaskawulsh nunatak, an isolated area of revegetation, in the Kaskawulsh Glacier in the Donjak Mountains near Kluane Lake, Yukon Territory, (Miller, 1987). *Hebeloma alpinum (Favre) Bruchet*, in sharp contrast, has not been found in the vicinity of the Arctic Coast but further inland, 60 miles from the coast, at the Meade River Tundra Biome Site and further south along the western coast of Alaska at

Kotzebue. In both cases it is associated with shrub species of *Salix* which are not distributed as far north as the North Slope coast. Two records of *H. crustuliniforme (Bull. ex Saint-Amans) Quelet* were found, one associated with bush willow at Meade River in North Slope tundra and the other in a taiga transition site associated with *Salix* along the Steese Highway. It is a common species in taiga and in the boreal forests in Alaska and Canada which was not the focus of this study. *Hebeloma remyi Bruchet* was found once at Barrow on the coast associated with dwarf willow and H. *bruchetti* Bon once in association with shrub *Salix* at Kotzebue. A new species of *Hebeloma* (OKM 11166) with larger spores than previously reported for any species in the genus except *H. gigaspermum Groger & Zschieschang*, was found at Meade River with shrub willows but there was insufficient data with the collection to describe it. Lastly, a new species of *Hebeloma* (OKM 11105) was found at Meade River in North Slope tundra. It appears to be related to *H. pusillum* but has more variable cheilocystidia and wider spores. In summary, a total of eight species and one variety are reported from Arctic and alpine tundra but the vast majority of records are of three species and one variety. These include *H. kuehneri, H. pusillum, H. pusillum v. longisporum,* and *H. alpinum*. These species appear to be associated with specific species of willow and perhaps other ectomycorrhizal hosts and have, therefore, distinctive distributional ranges in Alaska.

Miller, O.K. Jr. 1987. Higher fungi in tundra and subalpine tundra from the Yukon Territory and Alaska 287-297. IN: Arctic and Alpine Mycology II, Eds. Laursen, Ammirati, and Redhead, Plenum Press, N.Y. 364p.

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ALPHA, BETA-DIVERSITY OF WOOD-DECAYING BASIDIOMYCETES OF WESTERN SIBERIAN SUBARCTIC

Polar timberline in Subarctic of Western Siberia is formed by the flood plain forests.They are refuges of boreal flora exsisting from the Holocene Atlantic time - period of maximum northward expansion of forests in the area. That is why they make an especially interesting subject for the mycologists.

Investigations in this direction were started in 1978 and concerned the Yamal refuges (Mukhin, 1979, 1984). In 1992 the investigations were spread to other parts of Western Siberian Subarctic - Taz and Gydan Peninsulas. It became possible thanks to international collaboration of Russian and Scandinavian mycologists.

According to our investigations, the wood-decaying *Basidiomycetes* biota along the polar timberline in Subarctic of Western Siberia consists of more than 160 species. Mainly they belong to *Aphyllophorales*. Alpha-diversity of the local mycobiotas is 48-96 species, with respective representation of the local mycobiotas 30-59%.

We have not found any trends in changing of species richness of wood-decaying fungi. But it is possible to say that species richness demonstrate the maximum values at the Yamal and Gydan Peninsulas. There are good-developed flood plain forests consisting of *Larix sibirica, Picea obovata, Betula pubescens, Alnus fruticosa* and different *Salix* species.

But the analysis of species richness of fungi associated with *Larix sibirica* (being a very common species not limiting the fungi distribution) indicates to a good trend: species number increases 1.5 fold eastwards. Specificity of fungal *Larix*-complexes increases in the same direction. For example, in the Yamal mycobiotas specificity of the complexes equals to 13% whereas in those from the Gydan - 35%. We concern this to depend upon the distribution of *Larix sibirica* nearer to the Urals making the western bound of the continuous *Larix* area. Earlier we reported (Mukhin, 1993) that at the boundaries of the continuous tree areas species richness decreases as well as specificity level of the fungal complexes. Beta-diversity (differences between the localities) of fungi associated with *Larix sibirica* makes 0,44-0,72. This character does not increase together with the increasing distance between localities. This makes us to consider that all local mycobiotas belong to the same biotic community: Subarctic Western Siberian biota of wood-decaying *Basidiomycetes*.

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MYXOMYCETES OF RUSSIAN ARCTIC. PRELIMINARY REPORT

Up to the present time the myxomycete biota of high latitude, cold-stressed environments is poorly studied. Russia, with its vast arctic territories are not exception and remains a «white spot» in this respect. Available data on the myxomycetes of the Russian arctic are fragmentary and rather meager. Only a few papers with lists of species of the Khibin Mountains and Chukotka have been published previously. This study presents the preliminary report on the myxomycete diversity of the Russian part of Arctic. The collections were made mainly from the Chukotka near the Mainitz lake (63 35 N, 176 45 E) and Magadan and the Khibin mountains, in the central part of the Kola Peninsula (67° 36′ – 67° 55′ N, 33° 23′ – 34° 12′ E). The study in the Taimyr Peninsula was carried out at the next collecting sites: 1) 72° 00′ N, 102° 00′ E; 2) 71° 30′ N, 103° 00′ E; 3) 72° 17′ N, 103° 22′ E; 4) 72° 28′ N, 104° 15′ E; 5) 69° 29′ N, 88° 32′ E. At the present time 65 species of 27 genera are recorded from the north polar region of Russia. These are: *Arcyodes incarnata, Arcyria cinerea, A. incarnata, A. obvelata, A. pomiformis, Badhamia utricularis, Ceratiomyxa fruticulosa, Comatricha laxa, C. nigra, C. typhoides, Craterium leucocephalum, Cribraria aurantiaca, C. cancellata, C. violacea, Diacheopsis effusa, Diderma deplanatum, Diderma niveum, Didymium clavus, D. difforme, D. dubium, D. melanospermum, Didymium squamulosum, Echinostelium minutum, Enerthenema papillatum, Enteridium lycoperdon, E. olivacea, Hemitrichia clavata, Lamproderma arcyrioides, L. fuscatum, L. sauteri, L. scintillans, Leocarpus fragilis, Lepidoderma aggregatum, L. granuliferum, Licea biforis, L. kleistobolus, L. minima, Lindbladia tubulina, Lycogala epidendrum, Mucilago crustacea, Perichaena chrysosperma, P. minor, Physarum bivalve, Ph. cinereum, Ph. flavicomum, Ph. leucophaeum, Ph. nutans, Ph. oblatum, Ph. virescens, Ph. viride, Prototrichia metallica, Stemonitis axifera, S. hyperopta, S. smithii, S. virginiensis, Trichia alpina, T. botrytis, T.*

contorta, T. decipiens, T. erecta, T. favoginea, T. lutescens, T. munda, T. varia, Tubifera ferruginosa. This data show that myxomycetes can adapt to the life in Arctic. Interestingly, collections from the Khibin mountains, where the climate is transitional between continental and marine, include 12 species which can be regarded as nival *(Diacheopsis effusa, Diderma niveum, Didymium dubium, Lamproderma arcyrioides, L. carestiae, L. fuscatum, L. sauteri, Lepidoderma aggregatum, L. granuliferum, Physarum cinereum, Trichia alpina).* It is possible, that some nival species are the commonest in Arctic areas with strong influence of oceanic climate. They are connected with very special habitats. Indirectly it is confirmed by collections of *Diderma niveum, Lamproderma arcyrioides, Lepidoderma carestianum* from the Khibin mountains, the Polar Urals and Chukotka. But this special ecological group of myxomycetes is not represented among the collections from the Taimyr Peninsula and the study site in the central Alaska, which is characterized by a continental climate. For all species mentioned the abundance is estimated, microhabitat preferences are described and discussed. The «true» nivicole species require: open ground; more or less thick layer of herbaceous plant remains; high snow cover in winter and an exposition, providing enough water from the melting snow to keep the substrate wet over 2-3 weeks; relatively high daily temperatures. The commonest species in study sites in Russian Arctic are: *Arcyria cinerea, A. incarnata, Ceratiomyxa fruticulosa, Comatricha laxa, C. nigra, C. typhoides, Didymium difforme, D. melanospermum, D. squamulosum, Echinostelium minutum, Enerthenema papillatum, Lycogala epidendrum, Mucilago crustacea, Perichaena chrysosperma, Physarum bivalve, Ph. nutans, Prototrichia metallica, Trichia decipiens, T. varia.* More work is needed to determine, whether there may be an association between the myxomycete biota and habitats in tundra and forest tundra.

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INOCYBE (BASIDIOMYCOTA, AGARICALES) IN THE KEEWATIN AND FRANKLIN AREAS ARCTIC CANADA, N.W.T.

The collections of Inocybe were made by E. and M. Ohenoja in 1971 and 1974 at Baker Lake, Rankin Inlet and Repulse Bay. Associated vascular plants and mosses were checked.

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THE INFLUENCE OF FOREST FELLING ON THE LARGER FUNGI IN FINNISH LAPLAND

The influence of forest felling on larger fungi was studied in northeastern Lapland (68° 52′ N lat., 27° 05′ E long.) in 1993. The forests studied were Scots pine (*Pinus sylvestris L.*) forests. Part of the stands were cut during wyinter 1992-1993. Seed-trees and the logging waste were left on the stands. Fungi were collected from 30 permanent sample plots each 0.01 ha in size. Vegetation and humus samples were analyzed. The fungal yield was 41 kg/ha, fresh weight, on the felled plots and 107 kg/ha on the control plots. 50 fungal species were identified from the felled plots and 76 from the control plots. The yield of the genus *Cortinarius* was 6 kg/ha, fresh weight, on the felled plots and 25 kg/ha on the control plots.

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LEAD AND CADMIUM CONTENTS OF BASIDIOMYCETES ALONG A HEAVILY TRAFFICATED HIGH MOUNTAIN PASS ROAD IN THE AUSTRIAN ALPS

Along a heavily trofficated high mountain pass, in the Austrian Alps, the road over the Timmelsioch leading from the Oets valley to Italy, 23 collections of 9 basidiomycetes species were made, and their heavy metal (Cd, Pb) content was measured. The maesured lead concentrations (range: 1.47-25.5 mkg/g dry weight, mean value: 9.53 mkg/g dw) were much higher than those reported from an investigation carried out in the Swiss Alps by Irlet & Rieder (1995). The cadmium values varied between 0.44 and 6.51 *g/g dw (mean value: 4.14 mkg/g dw), and were lower than the Swiss values. Among the 9 tested basidiomycetes *Cotinarius favrei Henders.* exhibited a particular ability to accumulate both lead and cadmium. This species also complies with several other criteria for a suitable bioindicator of heavy metal pollution in alpine environments. The further study will provide more data about the constancy of the accumulation behavior of this mycorrhizal basidiomycete.

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CHARACTERISTICS OF MOUNTAIN MYCOBIOTA OF THE NORTH BAIKAL

The northern extremity of the Baikal basin is formed by the Baikalsky and Barguzinsky ranges extending meridianally. The mycocomplexes analyzed in the present work have been examined in plant communities of mountainous plateau of both ranges, i.e. tundra lichen open woodlands of larch and *Pinus pumila (Larix gmelini, P. pumila, Betula rotundifolia, Juniperus communis, Cladonia spp.* and *Empetrum nigrum)*. The population dynamics of abundant mountainous species was recorded in all altitude belts. The pseudo sub-goltsy belt formed on the Baikal coast (450-460 m above sea level) was of the particular interest.

Phellinus chrysoloma, Ph. igniarius, Trichaptum laricinum, Gloeophyllum sepiarium, Stereum sanguinolentum are the most abundant species of mycocomplexes of mountain thin forests of the North Baikal and zonal forest-tundra communities in the lowland (Mukhin, 1993; Kotiranta, 1996). However, the spectrum of abundant species in the area examined slightly differs, for instance, from Western Siberian forest-tundra mycocomplexes by the presence *of Trametes ochracea, T. hirsuta, Trichaptum abietinum, Gloeophyllum protractum, Fomitopsis cajanderi, Dichomitus squalens.* The abundant species of Western Siberian forest tundra zone, *Inonotus obliquus, Phellinus nigrolimitatus, Testella patellaris, Cerrena unicolor*, are actually absent here; they occur in the dark coniferous forest belt. The abundance of Okhotsk-Beringiya flora species in the western boundary of the area gives an «eastern» character to the mycobiota examined.

The belt distribution of abundant species can be compared with zonal characteristics of the mycobiota of the Western Siberian lowland (Mukhin, 1993). For example, *Tr. laricinum*, a lowland synecological optimum of which is in the zones of forest-tundra and middle taiga, acts as a dominant species in mountainous tundra of the Pribaikalsky range and in the pseudo sub-goltsy belt. It actually disappears in the dark coniferous forest belt where *Tr. fusco-violaceum* is abundant, lowland synecological optimum of which is in the southern taiga. In the dark coniferous forest belt *Tr. abietinum*, one of the dominant species of the mountainous part of the ranges, does occur. Its ecological optimum in the lowland is within the middle taiga zone and to a lesser degree in the southern one. It is likely to have a low competing ability in the lowland or to be of a mountainous origin. The species of the *Fomitopsis* genus are distributed in a similar manner, thus, *F. cajanderi* occuring as an abundant species in high mountains and in the pseudo sub-goltsy belt is substituted in the dark coniferous forest belt for *F. rosea* with a synecological optimum in the southern taiga zone (Mukhin, 1993). Some species dropping out of the dark coniferous forests are no longer met as abundant species in the pseudo sub-goltsy belt, thus, *Boletinus paluster* inhabiting high mountains of the Baikalsky range is substituted for *B. asiaticus* in low belts, and *Hygpophorus lucorum* is substituted for *H. spesiosum* respecitively. An obvious pair of abundant substituting for each other species is formed at the genus level by *Phellinus igniarius* inhabiting high mountains and *Fomes fomentartus* being a subdominant species in taiga belts.

In mid-September when weather conditions are highly changeable in high mountains a phenomenon called «under-snow growth» of the fungi is observed. The fruit bodies of *S. grevillei f.badius, Hygrophorus lucorum, Boletus pinicola, Boletinus paluster* are frozen during the night and continue their growth after thawing out in the afternoon until the next complete freezing. The stems of some frozen specimens have a swelling at the place of the cap attachment.

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ARE THERE ARCTO-ALPINE COPROPHILOUS DISCOMYCETES?

During prolonged studies of coprophilous *Discomycetes* about 1700 dung samples of 144 animal species belonging to 5 classes, 23 orders and 43 families were investigated. The samples were collected from various regions of flora and climate at different territories of Russia and neighbouring countries. 102 species of coprophilous and taxonomically related *Discomycetes* from 15 genera were found. Among them 80 species belonging to 14 genera were selected which were recorded in Arctic (from the Kola Peninsula to Chukotka) and mountain regions from 2,000 to 3,630 m above sea level. 58 species belonging to 9 genera were registrated from Arctic floristic Province. However, it is possible to characterize as definitely arctic species only two ones - *Ascobolus carletonii* and *Saccobolus quadrisporus*. The rest *Discomycetes* are widespread outside of that region. The group of alpine *Discomycetes* includes 60 species belonging to 12 genera, but these species as well as arctic *Dicomycetes* are widespread in plain localities of different floristic and climatic zones. In my previous investigations there was demonstrated cosmopolitan character of geographical distribution of coprophilous *Discomycetes* (Prokhorov, 1992). The same species were found from subtropical to arctic regions and from lowland to about 4,000 m above sea level. Although some localizations were observed within certain regions of flora for variuos groups of coprophilous *Discomycetes*, these data are insufficient for designation of geographical or floristic groups of coprophilous *Discomycetes*.

Prokhorov, V.P. The analysis of geographical distribution of coprophilous *Discomycetes* and their relations with animals. IN: Mycol. and Phytopath. 1992. Vol. 26, No 6. P. 471-475. (In Russian).

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SHORT ACCOUNT ON THE FLORA OF MACROFUNGI ASSOCIATED WITH DRYAS OCTOPETALA, MAINLY ON SPITSBERGEN

The presentation will be based on 1) records published in the literature (for example Vare et all., 1992) and 2) material collected by the author when participating in botanical expedition to Svalbard in 1957 (Bjornoya), 1958 (Spitsbergen), 1960 (Spitsbergen), and 1983 (Bjornoya).

The account covers both ectomycorrhizal and saprophytic fungi. *Cortinarius subtorvus* will be chosen as an example of the ectomycorrhizal species; in arctic areas it also forms ectomycorrhiza with small *Salix* species. It is common on the island of Spitsbergen and as far as we know also on other islands in the archipelago of Svalbard.

Marasmius epidryas is one of the saprophytic species that is associated with *Dryas*. Based on information from the literature and material in Norwegian herbaria, maps showing the distribution of this species in Svalbard and the Scandinavian mountain chain, will be presented.

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