The fungi in the consortium of common juniper in Belarus*

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The structure of mycobiota in species consortium of a higher arboreous plant is analyzed on example of *Juniperus communis*

The present paper elucidates some problems of composition and role of fungal biota associated with a higher plant in frameworks of consortive connections. By a row of research these problems are belonged to the sphere of mycocoenology (Dudka et al., 1976).

Common juniper have been chosen by us as model plant for this study, and its advantages in this respect were shown by works of K. Holm and L. Holm (1977), Petrini (1978), and Barkman (1985).

Finally we regard the *species consortium* of common juniper — i.e. the organisms associated with all examined exemplars of this plant within the study area (Belarus Republic). Thus, species consortium is composed of *individual consortia* formed by these plant individuals.

Juniper in forests of Belarus

Common juniper (*Juniper communis* L.) is a typical element of boreal flora and well adapted to cool and relatively damp climate. It has vast areal of disjunctive pattern, lying in Eurasia and North America. On the territory of Belarus juniper grows on the total area of 152 960 hectares. Its edaphic and coenotical amplitudes almost completely overlap with pine formation and include most of the native types of pine forests in which juniper occurs mostly as undergrowth. Besides pine formation it inhabits spruce and birch formations and occasionally alder and oak formations too.

The territory of Belarus is crossed by southern boundary of the continuous distribution of *J. communis*. The main factor preventing spreading of it to southeast is deficient air humidity and soil moisture during the vegetation period. Therefore the distribution of juniper in the southeastern part of Belarus get insular character with populations confined to the places with optimal moisture.

The review of literature issued in former USSR shows that so far the mycologists who studied the juniper-associated mycobiota fixed attention only on certain groups of fungi but never made any attempt to consider the whole assemblage of fungal species in juniper consortium. For example, during the phytopathological studies of different forest types in Belarus from the beginning of 20th century to

* Summary of prepared Ph.D. thesis.

nowadays, most of the authors mentioned only common diseases of juniper — root rot caused by *Heterobasidion annosum* (Fr.) Bref., rust, and leaf necrosis caused by *Lophodermium juniperi* (Grev.) Darker.

Materials and methods

Our research were carried out by the next ways:

a) rout studies of communities with juniper;
b) observations and collections on permanent sample plots;
c) processing of specimens delivered to us by other collectors.

Field research were conducted in 1997–2001. The material was collected in the main areas populated by *Juniperus communis* in Belarus — in 14 different geobotanical districts belonged to 6 okrugs (provinces) of 3 geobotanical subzones.[1]

The collection was carried out by taking samples of near-root soil, roots and overground organs of juniper for subsequent laboratory processing. To estimate the intensity of host affection by pathogens we used 5-point scale proposed by Minkevich (1986). The presence and the type of mycorrhiza on the root tips was determined by direct microscopy following to Selivanov (1981). For isolation of micromycetes in pure culture we used the conventional methods described by Bilai (1982). The growing cultures were kept under standard conditions (*ibid*.). We carried out the purposeful collecting of all higher fungi — ascomycetes, basidiomycetes, and deuteromycetes. In the preparing of reference herbarium specimens we followed conventional technique (Hawksworth, 1974). The taxonomic position of fungal teleomorphs was determined according to the system accepted in the 8th edition of Ainsworth and Bisby's dictionary of the fungi (1995). For mitosporic fungi we accept more traditional and older units as *Deuteromycota*, *Hyphomycetes*, and *Coelomycetes*.

The data obtained were processed statistically by means of MS Excel software. To evaluate the similarity between species assemblages in different biocoenoses the Jaccard's and Sørensen–Czekanowski's coefficients of similarity were calculated.

The taxonomic structure of common juniper mycobiota

In process of herbarium specimens and isolates revision 207 species of fungi were identified. They utilize *J. communis* organs as nutritional substratum, participate in mutualistic association with it, or, as lichenized fungi, use it as non-nutritional substratum. The species belong to 133 genera, 48 families, 22 orders, and 5 classes (tab. 1).

We have found a number of species never registered in Belarus before (22 species of ascomycetes and 31 species of deuteromycetes). Among conidial fungi new for the republic, three species were noticed for the first time for Eurasia: *Cheiromoniliophora gracilis* R.F. Castaneda, Guarro et Cano, *Matsushimaea fasciculata* (Mats.) Subramanian, and *Ojibwaya perpulchra* B. Sutton. We have stated that *J. communis* can serve as a host for 14 species never described on this plant earlier.

[1] Following the geobotanical division of the territory by Yurkevich and Gel'tman (1965).

Tab. 1 — **The taxonomic structure of *Juniperus comminis* mycobiota in Belarus**

Classes, orders	Families / genera (number of species)
Divisio Ascomycota	
Ascomycetes:	
Diaporthales	*Valsaceae* Tul. et C. Tul. / *Valsa* Fr. (2)
Diatrypales	*Diatrypaceae* Nitschke / *Eutypa* Tul. et C. Tul. (1)
Dothideales	*Micropeltidaceae* Clem. et Shear / *Stomiopeltis* Theiss. (1) *Microthyriaceae* Sacc. / *Microthyrium* Desm. (1), *Seynesiella* G. Arnaud (1), *Teichospora* Fuckel (1) *Mycosphaerellaceae* Lindau / *Mycosphaerella* Johanson (1) *Mytilinidiaceae* Kirschst. / *Lophium* Fr. (1), *Mytilinidion* Duby (2) *Venturiaceae* E. Müll. et Arx / *Gibbera* Fr. (2)
Eurotiales	*Gymnoascaceae* Baran. / *Gymnoascus* Baran. (1) *Trichocomataceae* E. Fisch. / *Talaromyces* C.R. Benj. (2)
Hypocreales	*Hypocreaceae* De Not. / *Nectria* (Fr.) Fr. (2) *Niessliaceae* Kirschst. / *Niesslia* Auersw. (1)
Lecanorales	*Cladoniaceae* Zenker / *Cladonia* P. Browne (3) *Lecanoraceae* Körb. / *Lecanora* Ach. (1) *Parmeliaceae* Zenker / *Hypogymnia* (Nyl.) Nyl. (1), *Parmeliopsis* (Nyl.) Nyl. (1), *Vulpicida* Mattsson et M.J. Lai (1)
Leotiales	*Dermateaceae* Fr. / *Mollisia* (Fr.) P. Karst. (1) *Hemiphacidiaceae* Korf / *Didymascella* Maire et Sacc. (1) *Leotiaceae* Rehm / *Cenangium* Fr. (1), *Chloroscypha* Seaver (1), *Gremmeniella* M. Morelet (1), *Tympanis* Tode (1), *Velutarina* Korf (2) *Orbiliaceae* Nannf. / *Orbilia* Fr. (2) *Phacidiaceae* Fr. / *Phacidium* Fr. (1) *Sclerotiniaceae* Whetzel / *Rutstroemia* P. Karst. (1)
Pezizales	*Sarcoscyphaceae* Le Gal / *Pithya* Fuckel (2)
Rhytismatales	*Rhytismataceae* Chevall. / *Colpoma* Wallr. (1), *Lophodermium* Chevall. (1)
Sordariales	*Boliniaceae* Rick / *Endoxyla* Fuckel (1) *Coniochaetaceae* Malloch et Cain / *Coniochaeta* (Sacc.) Cooke (1)
Sphaeriales	*Chaetomiaceae* G. Winter / *Chaetomium* Kunze (1), *Thielavia* Zopf (1)
Xylariales	*Xylariaceae* Tul. et C. Tul. / *Anthostomella* Sacc. (1), *Barrmaelia* Rappaz (1)
In all	49

Divisio Basidiomycota	
Basidiomycetes:	
Ceratobasidiales	*Ceratobasidiaceae* G.W. Martin / *Ceratobasidium* D.P. Rogers (2)
Gomphales	*Ramariaceae* Corner / *Ramaricium* J. Erikss. (1)
Hericiales	*Gloeocystidiellaceae* (Parmasto) Jülich / *Vesiculomyces* E. Hagstr. (1)
Hymenochaetales	*Hymenochaetaceae* Donk / *Coltricia* Gray (1)
Poriales	*Coriolaceae* (Imazeki) Singer / *Heterobasidion* Bref. (1), *Phaeolus* (Pat.) Pat., *Trametes* Fr. (1), *Trichaptum* Murrill (1)
Stereales	*Atheliaceae* Jülich / *Amphinema* P. Karst. (1), *Athelia* Pers (1), *Leptosporomyces* Jülich (1), *Piloderma* Jülich (1) *Botryobasidiaceae* (Parmasto) Jülich / *Botryobasidium* Donk (1) *Hyphodermataceae* Jülich / *Hyphoderma* Wallr. (2) *Meruliaceae* P. Karst. / *Phanerochaete* P. Karst. (1) *Sistotremataceae* Jülich / *Sistotrema* Pers. (1), *Trechispora* P. Karst. (1) *Steccherinaceae* Parmasto / *Steccherinum* Gray (1) *Stereaceae* Pilát / *Amylostereum* Boidin (1) *Tubulicrinaceae* Jülich / *Tubulicrinis* Donk (1) *Xenasmataceae* Oberw. / *Phlebiella* P. Karst. (1)
Thelephorales	*Thelephoraceae* Chevall. / *Thelephora* Ehrh. (2), *Tomentella* Pat. (3)
Boletales	*Boletaceae* Chevall. / *Suillus* Gray (1), *Xerocomus* Quél. (1) *Paxillaceae* Lotsy / *Paxillus* Fr. (1)
Agaricales	*Amanitaceae* R. Heim / *Amanita* Pers. (2)
Tremellales	*Exidiaceae* R.T. Moore / *Exidia* Fr. (1)
In all	33
Teliomycetes:	
Uredinales	*Pucciniaceae* Chevall. / *Gymnosporangium* R. Hedw. (3)
Divisio Deuteromycota	
Hyphomycetes	*Acremonium* Link (3), *Alternaria* Nees (2), *Arthrobotrys* Corda (2), *Aspergillus* Link (6), *Asperisporium* Maubl. (1), *Aureobasidium* Viala et G. Boyer (2), *Bactrodesmium* Cooke (1), *Botrytis* P. Micheli (2), *Capnophialophora* S. Hughes (1), *Chalara* (Corda) Rabenh. (4), *Cheiromoniliophora* Tzean et J.L. Chen (1), *Chloridium* Link (2), *Chrysosporium* Corda (1), *Cladosporium* Link (3), *Coniothecium* Corda (1), *Costantinella* Matr. (1), *Curvularia* Boedijn (1), *Cylindrocarpon* Wollenw. (1), *Epicoccum* Link (1), *Excipularia* Sacc. (1), *Fusarium* Link (4), *Geotrichum* Link (1), *Gliocladium* Corda (3), *Gliomastix* Guég. (1), *Helicosporium* Nees (1), *Matsushimaea* Subram.

	(1), *Monilia* Bonord. (2), *Monodictys* S. Hughes (2), *Myrothecium* Tode (1), *Oedocephalum* Preuss (1), *Oidiodendron* Robak (2), *Ojibwaya* B. Sutton (1), *Paecilomyces* Bainier (3), *Penicillium* Link (11), *Ramichloridium* Stahel (3), *Sphaeridium* Fresen. (1), *Sporidesmium* Link (1), *Stachybotrys* Corda (1), *Stemphylium* Wallr. (1), *Stigmina* Sacc. (2), *Torula* Pers., (1), *Trichocladium* Harz (1), *Trichoderma* Pers. (4), *Trichothecium* Link (1), *Trimmatostroma* Corda (1), *Trinacrium* Riess (1), *Tripospermum* Speg. (1), *Tubercularia* Tode (1), *Ulocladium* Preuss (1), *Verticillium* Nees (3)
In all	97
Coelomycetes	*Camarosporium* Schulzer (1), *Coleophoma* Höhn. (2), *Cytospora* Ehrenb. (3), *Diplodia* Fr. (1), *Discosia* Lib. (1), *Kabatina* Schneid. et Arx (1), *Leptostroma* Fr. (2), *Microdiplodia* Tassi (1), *Microsphaeropsis* Höhn. (1), *Pestalotia* De Not. (2), *Pestalotiopsis* Steyaert (1), *Phoma* Sacc. (2), *Phomopsis* (Sacc.) Bubák (2), *Pleurophoma* Höhn. (1), *Sclerophoma* Höhn. (1), *Seimatosporium* Corda (2)
In all	24
Species altogether	207

Fungi composing *J. communis* species consortium belong presumably to deuteromycetes (58.7% of species) and ascomycetes (23.8%); basidiomycetes constitute small portion (17.5%, fig. 1). The average number of species per a genus is 1.6.

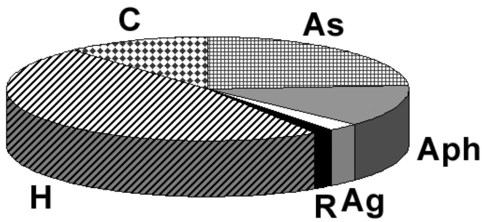

Fig. 1. The taxonomic structure (species proportion) of *J. communis* mycobiota. H —hyphomycetes, C — coelomycetes, As — ascomycetes, Aph — aphyllophoroid fungi, Ag — agaricoid (*incl.* boletoid) fungi, R — rust fungi.

Ecological and geographical analysis of common juniper mycobiota

The juniper-associated fungi listed above were classified in accordance of their areals types. We were guided by types of geographical elements described by Simonian (1981). The geographical analysis of juniper mycobiota in Belarus shows the prevalence of cosmopolitan (36.7% of total number of species) and holarctic (32.2%) elements, with smaller part of palearctic (13.6%), european (11.5%), mediterranean (3.4%), and adventive (2.6%.) ones.

The comparative studies of the juniper-associated mycobiota in different types of communities demonstrate evident dependence of fungal species composition on the type of plant community. Moss pine forests (*Pinetum pleuroziosum*)[2] have the richest assemblage of species (41% of the total number). Moss spruce forests (*Piceetum pleroziosum*)[3] and moss birch forests (*Pendulo-Betuletum pleuroziosum*) are the most poor of juniper-associated fungi (9–12% of species, fig. 2).

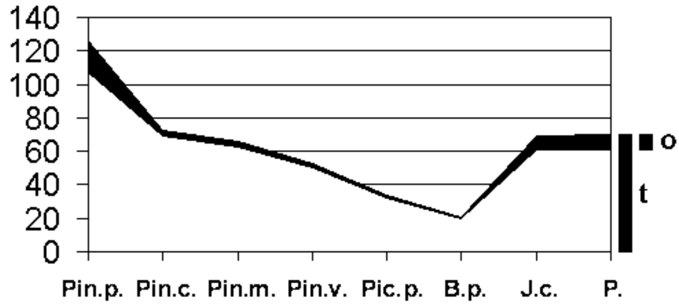

Fig. 2. Species richness of fungi associated with *Juniperus communis* in different types of communities. **Pin.p.** — *Pinetum pleuroziosum*, **Pin.c.** — *Pinetum cladinosum*, **Pin.m.** — *Pinetum myrtillosum* (*Vaccinium myrtillus–Pinus sylvestris* community), **Pin.v.** — *Pinetum vacciniosum* (*V. vitis-idaea–Pinus sylvestris* community), **Pic.p.** — *Piceetum pleuroziosum*, **B.p.** — *Pendulae-Betuletum pleuroziosum*, **J.c.** — *Juniperetum cladinosum*,[4] **P.** — plantations; **t** — total number of species, **o** — number of species registered only in the community type.

The biggest similarity based on Sørensen–Czekanowski's coefficient was detected between fungal assemblages on juniper in pine forests of different types while the biggest difference — between the assemblages in natural and cultivated communities.

Saprobic fungi constitute the leading component of juniper consortium (70.6% of species). The portion of biotrophs is 27.2% and mutualistic partners — 2.1%. Among saprotrophs the biggest portions of species reside in juniper rhizosphere (31%) and on decayed and recently dead wood (30.5%). The main part of biotrophs (10.7% of all junipericolous fungi) belong to obligate parasites of juniper needles (tab. 2).

Based on the degree of specialization to the host we divide the juniper-associated fungi into five groups.

1) True stenoxenes[5] — the species strictly confined in their development to the genus *Juniperus*.

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[2] Identification and Latin nomenclature of forest types is according to Yurkevich (1980).

[3] Sometimes named *Piceetum hylocomiosum*.

[4] The Latin name for this type of shrub vegetation was introduced by us using the analogy with *Cladonia–Pinus* communities.

[5] We use the terms *stenoxene* and *euryxene* as English variants of the words from Russian edition of Gäumann's handbook (Gäumann, 1954).

2) Species developing on coniferous plants;
3) Species developing on different woody plants;
4) True euryxenes —non-specialized, commonly widespread species;
5) Occasional species, i.e. normally confined to other hosts but accidentally colonizing the juniper. These species were not involved in the analysis.

Tab. 2 — **Trophical structure of *Juniperus communis* mycobiota**

Trophical group (Acronym)[6]		Number of species				
		Asco-	*Basidio-*	*Hypho-*	*Coelo-*	In
		mycota		*mycetes*		all
	Biotrophs					
Obligate	On needles (F)	8	1	4	9	22
	On bark (C)	6	3	0	3	13
	On roots (R)	0	2	0	0	2
Facultative[7]	On needles (F)	4	0	1	2	7
	On bark (C)	5	0	3	3	11
	On roots (R)	1	0	6	1	7
	On galbuli (G)	0	1	3	0	4
	Mutualists					
	Mycorrhiza-forming (Mr)	0	5	0	0	5
	Saprotrophs					
	On fallen non-wood debris (Fd)	2	3	12	0	17
	On recently dead wood (Lei)	6	14	12	2	34
	On well decayed wood (Lep)	0	19	10	0	29
	On roots (Lh)	4	4	54	2	63
	On still-attached needles (Fe)	1	2	12	3	18

The degree of host specialization in different taxonomical groups of juniper-associated fungi is shown on fig. 3.

The phenomenon of narrow specialization is displayed to the greatest extent by ascomycetes: 38.5% of them develop only on *Juniperus* spp., 33.3% — on *Pinopsida*, 15.4% have wider spectrum of hosts, and only 12.8% may be regarded as euryxenes.

Basidiomycetes in juniper consortium are usually less specialized. More than a half of them (51.5%) are the species associated in their development with a wide variety of arboreous hosts. Only rust fungi in their teliosporic stage are strictly con-

[6] The trophical groups and acronyms are following Kovalenko (1980) with our additions.

[7] The meaning of the term *facultative biotrophs* used here implies the fungi capable to act both as saprotrophs and biotrophs (regardless the frequency of their occurring in these roles in nature).

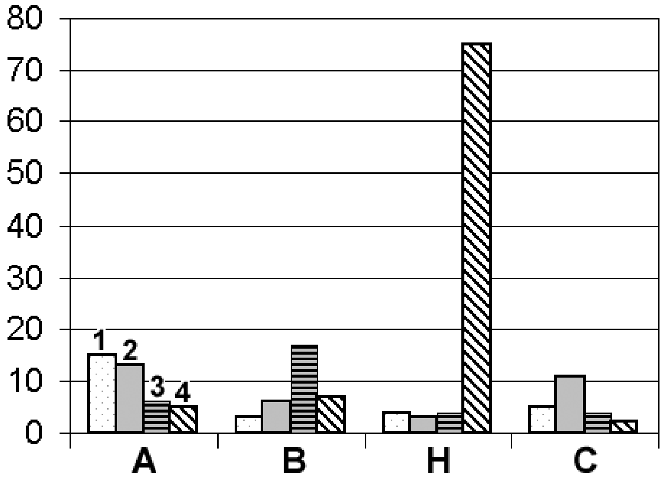

Fig. 3. The degree of specialization of the fungi of different taxonomic groups registered in *Juniperus communis* consortium. A — ascomycetes, B — basidiomycetes, H — hyphomycetes, C — coelomycetes; 1 — species restricted to the genus *Juniperus*, 2 — species confined to coniferous plants, 3 — species developing on different arboreous plants, 4 — unspecialized species.

fined to juniper. Almost all the aphyllophoroid fungi found in juniper consortium have wide range of hosts. Agaricoid macromycetes forming mycorrhiza with juniper belong to species for which the preferred phytobiont is *Pinus sylvestris*.

Among hyphomycetes 4.7% of species are stenoxenes and 87.2% are euryxenes, the others display intermediate properties. Among coelomycetes 22.7% of species belong to stenoxenes, 50.1% are confined to coniferous plants, only 9.0% are euryxenes. The occasional species which as a rule develop on other hosts constitute 5% of the total number.

Summarizing the data presented above, we conclude that hyphomycetes is the leading group in fungal component of *J. communis* consortium. Most of these fungi are typical saprobic euryxenes with cosmopolitan or boreal distribution, growing on roots and overground wood of *J. communis*.

Types of consortive relations between juniper and fungi

We based our study mostly on the theory of *consortium* worked out by Rabotnov (1974) and at the later time extended by works of Selivanov (1974, 1981). The classifications of consortive relations were profoundly described in publications of Teterevnikova-Babajan and Simonian (1965), Cheremisinov (1973), and Simonian (1981). These classifications are based on the degree of obligation or stability of connection between the consortium-forming species (*inconsort*) and fungi. The additional criterion for classification is the possible harmful effect on the inconsort.

We studied all the types of consortive relations[8] between fungi and juniper: mutualistic,[9] indifferent, negative, and antagonistic. The most part of fungi in juniper consortium are in indifferent relations with the host — 90.7% of the total number of species. The portions of species involved in negative, antagonistic, and mutualistic relations are 5.3%, 1.8%, and 2.1% respectively.

Mycorrhizal association with *J. communis* make agaricoid macromycetes (ectomycorrhiza) and zygomycetes (endomycorrhiza). The following species most probably take part in formation of ectomycorrhiza: *Suillus luteus* (Fr.) Gray, *Xerocomus badius* (Fr.) Gilb., *Amanita gemmata* (Fr.) Bertillon and *A. muscaria* (L.) Pers. We assume the association between *J. communis* and *Paxillus involutus* (Fr.) Fr. too.

Negative relations with juniper make *Asperisporium juniperinum* (Geogescu et Badea) B. Sutton et Hodges, *Cladosporium cladosporioides* (Fresen.) de Vries, *Colpoma juniperi* (P. Karst.) Dennis, *Cytospora pinastri* Fr., *Gymnosporangium clavariiforme* (Pers.) DC., *G. cornutum* Arth., *G. tremelloides* (A. Braun) Hartig, *Lophodermium juniperi* (Grev.) Darker, *Heterobasidion annosum*, *Phacidium lacerum* Fr., *Stigmina deflectens* (P. Karst.) M.B. Ellis, *Thelephora terrestris* Ehrh. and some other species.

Antagonistic relations are uncommon in juniper consortium. Examples may be the attack of host by *Lophodermium juniperi* and *Heterobasidion annosum* when the disease runs up to the scale of epiphytotic.

The rest of the fungal species (189, i.e. the vast majority) are indifferent participants of juniper consortium.

Following Bykov (1970) and Selivanov (1974) the consorts are united in several groups defined by the position of a species with respect to living or dead organs of the inconsort. We regard four such groups (or *forms of consortia*): *epibiontic*, *endobiontic*, *exobiontic*, and *necrobiontic*.[10] The most of species (57.7%) are capable to participate in several such topical groups of consorts, and the pattern of a fungus role depends first of all on the condition of host. To explain the meaning of the terms listed above it can regard such a species, *Trichoderma viride* Pers. It occurs as soil fungus in juniper rhizosphere, and in this case must be belonged to *epibiontic* form of consortium with *neutral* type of interactions; the pattern of trophical connection with host is called *eccrisotrophy*[11] (i.e. using the excretions of living plant). Though, if *T. viride* is isolated directly from root tissue, in this case the species must be belonged to *endobiontic* form of consortium with *neutral*[12] type of interactions; the pattern of trophical connection with host is biotrophy. In the case of root rot development we

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[8] The fungi on invertebrates consuming organs of *J. communis* and forming the second order block of consorts were not involved in our research.

[9] The term *mutualism* is used here instead of *symbiosis sensu* Soviet investigators mentioned above (modern meaning of the term *symbiosis* includes all types of consortive relations, when two living organism are in close physiological contact).

[10] The words *exobiontic* and *necrobiontic* are derivative from Russian ones, published in Bykov (1970) and Selivanov (1974). Factually these groups are the structural subdivisions inside individual or species consortium.

[11] The word is derivative from Russian one, used by Soviet researchers.

[12] Regardless the presence of *T. viride* hyphae in host tissue, root rot is absent.

observe *endobiontic* form of consortium, *negative* type of interactions and biotrophy. In conclusion, if *T. viride* grows on a dead and decaying organ of juniper, we must belong the fungus to *necrobiontic* form of consortium, *neutral* type of interactions, and saprobic type of trophical connections. It is essential to note that such the lability in consortive connection formation is peculiar presumably to facultative biotrophic[13] species with cosmopolitan distribution.

Near a quarter of species (25.3%) were registered in epibiontic group only. In endobiontic and necrobiontic groups 2.5% and 15.5% of species were recorded respectively. Only 2 non-lichenized species were observed in exobiontic group and topical connection with juniper.

Endophytic fungi in juniper needles are a good example of long-term *neutral* interactions between inconsort and consorts and belong to *endobiontic* form of consortium. From the host tissue we isolated in pure culture 5 species of ascomycetes, 18 — hyphomycetes, and 9 — coelomycetes. Our list of endophytes considerably differs from analogous work of Petrini (1978), but the general principle is that unspecialized species constitute major part of the list.

Thus, the predominant type of consortive connections is trophical ones, and the major forms of juniper-based fungal consortia are epibiontic and necrobiontic ones.

Another interesting aspect of the functional role of fungi in the consortium is the variety of interactions between fungal individuals belonging to different taxa. Considering the fungal synusia associated with juniper we observed the cases of commensalism (the most common type of relations), stimulation (e.g., needles disease caused by *Lophodermium juniperi* promotes the developement of *Cladosporium cladosporioides*), suppression (*Lophodermium juniperi* suppresses the development of *Seynesiella juniperi* (Desm.) Arnaud) and hyperparasitism (developement of *Trinacrium subtile* Riess on *Alternaria alternata* (Fr.) Keissl.).

The initial and the final stages of fallen material decay are accomplished by fungal synusia associated with needles (phyllophilous) and wood (lignicolous), and consisting mostly of hyphomycetes (75 species) and ascomycetes (12 species). The period of variable duration between these marginal stages of decay is occupied by activity of aphyllophoroid fungi, especially corticioid ones (18 species), becoming the main tissue-destroying agents.

The associations of fungi under consideration should be regarded as synusia of the second and the third order (aggregations and congregations). Should be marked the *chorosynusial*[14] component (e.g., *Heterobasidion annosum* has ability to colonize living plant tissue and later plays certain role in dead wood decay) and the *chronosynusial* component (e.g., *Stomiopeltis juniperina* (Grove) K. et L. Holm appearing on certain stage of juniper needles dying and never surviving on fallen needles for more than a month).

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[13] See footnote No. 7.

[14] The words *chorosynusial* and *chronosynusial* are derivative from Russian terms used by Sukachev (1947).

Phytopathological evaluation of juniper populations in Belarus

The most common diseases of juniper provoked by basidiomycetes and observed by us were "root sponge" caused by *Heterobasidion annosum* and oppressing of young plants caused by *Thelephora terrestris* Ehrh. According to Negrutskii (1960) *J. communis* is commonly infected by *pine form* of *H. annosum*.

The interesting peculiarity of rust on juniper is more rare occurring of teliospore stage in comparison with spermogonial and aecial stages on *Rosaceae*. We confirmed the data of Azbukina (1974) on capability of *Gymnosporangium cornutum* haploid mycelium to hibernate on branches of intermediate hosts. It fact explains total absence of rust on juniper along with abundant rust infection of *Sorbus aucuparia* in separate years. Thus, *Gymnosporangium* spp. cause sufficient damage of intermediate hosts only.

From our observations the most frequent disease of hyphomycetous nature was "drying" of needles caused by *Asperisporium juniperinum*. This species was registered for the first time in Belarus. The first record of the species in CIS countries was made by Melnik in 1997 (Melnik, 2000). Nevertheless, it was stated that *A. juniperinum* is the main pathogen of *J. communis* in Belarus and the scale of its distribution in northern part of the republic is higher than *Lophodermium juniperi*.

The damage and necrosis of young shoots of *J. communis* is caused by *Cladosporium cladosporioides* and *C. herbarum* (Pers.) Link.

The main diseases mentioned above have certain seasonal dynamics.

The pathogenic aphyllophoroid species were almost absent on *J. communis* in conditions of cultivation (parks, nurseries, blocks of settlements, cemeteries), together with much less degree of harmfulness caused by *Lophodermium juniperi*. Additional peculiarity of cultivated juniper is the presence of adventitious species like *Pestalotia funerea* Desm. var. *conigena* (Lev.) Grove and *Pithya cupressina* (Batsch) Fuckel, evidently passing on juniper from exotic cultivated plants (Fedorov, 1978).

Conclusion

During our studies in Belarus we registered 207 species of fungi utilizing the juniper organs, forming mutualistic relations with it, or using it as attach substratum. The species belong to 133 genera, 48 families, 22 orders, and 5 classes.

The dominant group of juniper-associated fungi is hyphomycetes. In main mass they are true non-specialized saprobic cosmopolitan or boreal species developing on roots and overground woody parts of *J. communis*.

Reasoning from the previous fact, indifferent consortive relation is the leading type of interactions, involving 81.5% of species. Small portions of species form negative and antagonistic relations (12.6%) and mutualistic association with host (2.3%).

The main forms of juniper-based fungal consortia are epibiontic and necrobiontic ones; the predominat type of consortive connections is trophical one.

However, most of the species are capable to enter in one or another functional groups of consorts depending on the host condition and other factors.

In general features the structure of juniper-associated mycobiota can be applied to consortia formed by other arboreous plants, especially coniferous ones. Of course, this conclusion should to do with some quota of caution, taking into consideration that mycologists possess limited information on full spectrum of fungi associated with any woody plant species.

Acknowledgements

We are grateful to Dr. V.A. Melnik (V.L. Komarov Botanical Institute, St.-Petersburg, Russia), Dr. Ch. Scheuer (Institute of Botany, Karl-Franzens-University Graz, Austria), Dr. L.N. Vasil'eva (Institute of Biology and Soil Sciences, Vladivostok, Russia), Dr. A. Raitviir (Institute of Zoology and Botany, Estonian Agricultural University, Tartu), Dr. L. Holm (Uppsala, Sweden) for kind help in identification and revision of a number of herbarium specimens. Sincere thanks go to Dr. O. Petrini (Comano, Switzerland) for consulting on the questions of cultural study of juniper-associated fungi.

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SUMMARY: The structure of mycobiota associated with a higher arboreous plant was studied on example of *Juniperus communis* in Belarus. In species consortium of juniper 207 species of fungi were registered. Among they there are 49 species belonging to *Ascomycota*, 33 species of *Basidiomycota*, 97 species of hyphomycetes, and 24 species of coelomycetes. The fungi form the next types of consortive relations: trophical (saprotrophs and parasites), mutualistic (mycorrhiza-forming species), and topical — the use of juniper organs as attach substratum, like lichenized fungi. The dominant group of fungi is saprobic hyphomycetes, developing on roots and overground woody parts of juniper.

Key words: *Ascomycetes*, *Basidiomycetes*, *Deuteromycetes*, *Juniperus communis*, consortive connection, disease, species consortium, trophical group.

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