Post date: April 2010
Summary published in
MYCOTAXON 111: 91–94

# Myxomycete diversity of the Altay Mountains (southwestern Siberia, Russia)

YURI K. NOVOZHILOV[1*], MARTIN SCHNITTLER[2] ,
ANASTASIA V. VLASENKO[3] & KONSTANTIN A. FEFELOV[4]

*****_yurinovozhilov@gmail.com_
_[1,3]V.L. Komarov Botanical Institute of the Russian Academy of Sciences
197376 St. Petersburg, Russia,_

_[2]Institute of Botany and Landscape Ecology, Ernst-Moritz-Arndt University
D-17487 Greifswald, Germany,_

_[4]Institute of Plant and Animal Ecology of the Russian Academy of Sciences
Ural Division, 620144 Yekaterinburg, Russia_

**Abstract —** A survey of 1488 records of myxomycetes found within a mountain taiga-dry steppe vegetation gradient has identified 161 species and 41 genera from the southeastern Altay mountains and adjacent territories of the high Ob' river basin. Of these, 130 species were seen or collected in the field and 59 species were recorded from moist chamber cultures. Data analysis based on the species accumulation curve estimates that 75–83% of the total species richness has been recorded, among which 118 species are classified as rare (frequency < 0.5%) and 7 species as abundant (> 3% of all records). Among the 120 first species records for the Altay Mts. are 6 new records for Russia. The southeastern Altay taiga community assemblages appear highly similar to other taiga regions in Siberia but differ considerably from those documented from arid regions. The complete and comprehensive illustrated report is available at http://www.Mycotaxon.com/resources/weblists.html.

**Key words —** biodiversity, ecology, slime moulds

## Introduction

Although we have a solid knowledge about the myxomycete diversity of coniferous boreal forests of the European part of Russia (Novozhilov 1980, 1999, Novozhilov & Fefelov 2001, Novozhilov & Lebedev 2006, Novozhilov & Schnittler 1997, Schnittler & Novozhilov 1996) the species associated with this vegetation type in Siberia are poorly studied. So far, only a few local species inventories are available (Taimyr Peninsula: Novozhilov et al. 1999; southern part of the Krasnoyarsk territory: Kosheleva et al. 2008). Prior to this study, only 41 species had been recorded from the Altay Mts. in Russia (Barsukova 2000, Lavrov 1929, Novozhilov 1987). These data are based on published records, obtained mostly from field collections in different taiga communities of the central and north regions of the Altay Mts., especially at Lake Teletzkoe in the Altay State Nature reserve. More recently intensive studies of myxomycetes have been carried out in adjacent western Mongolia (Novozhilov & Schnittler 2008). However, the myxomycete assemblages of the arid regions of the southeastern Russian Altay have not been studied.

During four weeks in August 2008 the central and southeastern Altay Mts. and lowland forests near Barnaul city were studied by the first three authors, including extensive field work as well as substrate collecting for moist chamber cultures. This quantitative survey, together with a valuable set of collections especially of rare species from the fourth author and literature data was used to compile an annotated checklist of myxomycete species for the region. Objectives of this study were (1) to obtain baseline data on myxomycete abundance and biodiversity in the Russian Altay, (2) to determine to what extent myxomycete assemblages follow the vegetation and precipitation gradients in the region and (3) to use abundance data to estimate the degree of completeness that can be achieved in a quantitative survey.

## Materials and methods

STUDY SITES — The Altay Mountains are situated in the transition between two major vegetation zones: the boreal forests of Eurasia and the dry steppes of Central Asia, stretching from 44°30' to approximately 54°00'N and from 80°30' to approximately 98°00'E (Fig. 1). Geographically, the region covers about 550 000 $km^2$, divided among the territories of Russia, Kazakhstan, China, and Mongolia. The highest elevations occur in the Katunskiy range (the two Belukha peaks measure 4506 and 4400 m). Remarkable peculiarities are the vast high-mountain plateau between 2200–2400 m altitude; and the presence of two-level system of flat intermountain valleys at altitudes around 1400 and between 1800 and 1900 m. The climate is strongly continental and harsh, since no barrier exists in the North to prevent migration of arctic air. In addition, a highly complicated relief causes considerable differences in local climate in the region. Higher altitudes receive more precipitation but rainfall decreases sharply at the southeast-exposed slopes towards the Mongolian depression of Great Lakes, whereas the climate is less continental in valleys. Extremes in the studied part of the region are represented by Yaylyu settlement near Lake Teletzkoe (the Altay State Nature reserve, a valley 480 m above sea level) with average annual temperature and precipitation about 2.8°C and 855–1200 mm, respectively, and the Chuyskaya depression near Kosh-Agach (Kuray steppe, 1760 m above sea level) with figures of about −6.7°C and 100–150 mm, respectively.

The soils of the Altay region are extremely diverse (Kuminova 1960) due to the complex mesoclimate, relief and vegetation and include different types of chestnut soils (mostly Zaisan, the Barun-Khuray and the Chuyskaya depression). These soils are often salty and have developed as typical solonchaks (Dergacheva et al. 2007). In the low mountain belt of Northern Altay, chernozem soils predominate. Meadows with chernozems are also typical for tall-grass communities in the lowest part of subalpine forest steppes. In the lower forest belt in the northern and western Altay “podzol chernozem-like” soils predominate under aspen and birch forests (Kamelin et al. 2005), whereas darker, slightly podzolated soils characterize the mountain "chernevaya" taiga, even forming genuine podzols (dark, dark-gray, and gray forest) in the central Altay. Less podzolated variants developed under open larch forests (*Larix sibirica* Ledeb.) and mixed coniferous forests (*Pinus sibirica, Larix sibirica*) in the lowest subalpine zone.

Our study regions are situated in north, central and southeastern Altay: near Barnaul city (around the South-Siberian Botanical Garden); around Lake Teletzkoe (the Altay State Nature reserve); and numerous localities along state road M32 (Chuyskiy Trakt), which essentially follows the northwest–southeast rainfall gradient over several ridges of the Altay Mts. towards the Russian-Mongolian border. (Fig. 1).


Fig. 1. MAP OF THE ALTAY MOUNTAIN REGION. Sampled localities are indicated by black rectangles. Lakes, rivers and lowland forests are marked dark gray. A dotted black line indicates the borders between countries, and between Russian administrative political territories. INSET: geographical position of the study area. Sources: Microsoft Encarta Reference Library, 2002 and Google Earth (modified).

## Studied localities and vegetation types

The high variation in abiotic conditions, especially mesoclimate, sustains a highly diverse vegetation (Abdul'mianov 2008), we thus considered for the following ecological analysis of myxomycete assemblages only six major vegetation types (Kamelin et al. 2005). Localities were assigned to one of these major vegetation types; their numbers refer to Fig. 1.

### Semiarid vegetation types

I. STEPPE — The Tuvinian-Mongolian steppe province (coming from the east) reaches its border in the study region. It includes the Chuyskiy district of the Altay-Khangay subprovince of the Altay-Sayan province. It is characterized by a considerable altitudinal variation. In lower altitudes, dry steppes and semideserts, even North Gobian desert communities, can be found. Higher elevations harbor firm-bunch grass steppes at southern slopes and meadow-steppes combined with fragments of mesophilous shrub communities at northern slopes, together with a considerable number of alpine plants.

Notably, the large intermountain depressions receive extremely low amounts of precipitation (Kharlamova 2004), like the Chuyskaya depression (less than 200 mm, locally below 110 mm). Communities are made up of xerophilous herbs (often legumes), tussock grasses, *Artemisia* spp. (*A. frigida* Willd., *A. gmelinii* Weber. ex Stechm.), and shrubs (*Caragana leucophloea* Pojark., *Spiraea hypericifolia* L., or *Potentilla fruticosa* L. near rivulets in swampy habitats). Typical steppe plants include *Agropyron cristatum* (L.) Gaertn., *Astragalus* spp., *Chenopodium frutescens* C.A. Mey., *Kochia krylowi* Litv. *Potentilla astragalifolia* Bunge, *Stipa glareosa* P. Smirnov.

Kosh-Agach **Loc. 1:** shallow SW-exp. slope with very dry feather-grass steppe, 1850±50 m a.s.l., 49°58'46"N 88°53'07"E;

**Loc. 2**: shallow SW-exp. slope with very dry shrub/feather-grass steppe, 2082±50 m a.s.l., 50°00'05"N 88°56'52"E;

**Loc. 3**: shallow saddle with very dry, desert-like steppe, 2084±50 m a.s.l., 50°01'26"N 88°57'10"E;

**Loc. 5**: heavily grazed steppe vegetation on gneiss, NE-exp. steep slope, 2159±50 m a.s.l., 50°04'27" N 88°.54'21" E;

**Loc. 6:** extremely overgrazed dry steppe, 2030±50 m a.s.l., 50°05'00" N 88°54'28" E;

**Loc. 11:** steppe with shrubs of *Lonicera* spp. and *Artemisia* spp. at a S-exp. slope, 2252±50 m a.s.l., 50°07'16" N 88°52'56" E;

**Loc. 13:** dry steppe in shallow valley of the Chichke River (branch of the Akturu River), 1535±25 m a.s.l., 50°09'40"N 87°53'50"E;

**Loc. 14:** dry steppe in shallow valley of the Chichke River (branch of the Akturu River), 1535±25 m a.s.l., 50°09'41"N 87°53'49"E.

II. MOUNTAIN FOREST-STEPPE — In the Central and southeastern Altay the annual precipitation can reach 250–350 mm (Rusanov 1961), which allows forest-steppe communities with a park-like appearance to exist. Except for small pockets of spruce (*Picea obovata* Ledeb.) developing at northern slopes within river valleys, and some stands of cedar (*Pinus sibirica* (Ledeb.) Turcz.) near the timberline, these subalpine forests are composed entirely of *Larix sibirica*.

Kosh-Agach **Loc. 4:** second-growth subalpine light coniferous forest (*Larix sibirica*) at a N-exp. slope, 2229±50 m a.s.l., 50°04'16"N 88°54'07"E;

**Loc. 7:** second-growth subalpine light coniferous forest (*Larix sibirica*), at a N-exp. slope, 2126±50 m a.s.l., 50°05'46"N 88°53'11"E;

**Loc. 8**: overgrazed mountain steppe and scattered trees of *Larix sibirica* at a N-exp. slope, 2126±50 m a.s.l., 50°05'46"N 88°53'11"E;

**Loc. 9:** extremely overgrazed mountain steppe and scattered larch trees, 2098±50 m a.s.l., 50°05'56"N 88°53'36"E;

Kuray settlement **Loc. 10:** dry, grazed, opened mixed larch forest with *Populus laurifolia* Ledeb., with *Lonicera* sp. and *Juniperus sabina* L. in understory, 1750±50 m a.s.l., 50°07'04"N 88°20'42"E;

**Loc. 12:** subalpine light coniferous forest (*Larix sibirica*), steep N-exp.

canyon with coniferous forest, with community of *Comarum salessowii* Bunge near rivulet, 1615±50 m a.s.l., 50°08'11"N 87°53'26"E;

**Loc. 15:** steppe meadows with a larch gallery forest along the Kokoria river, 1535±25 m a.s.l., 50°10'13"N 87°53'50"E;

**Loc. 17:** steppe meadows with a larch gallery forest along the river, 1531±25 m a.s.l., 50°10'21"N 87°54'33"E;

**Loc. 18:** open steppe, mesophilous deciduous shrubs near a larch gallery forest, community with *Potentilla fruticosa* and *Salix* spp., swampy habitat near a river, 1530±25 m a.s.l., 50°10'27"N 87°54'00"E;

**Loc. 19:** transition belt from forest-steppe to coniferous mountain vegetation, shady coniferous forest with *Picea obovata* and *Larix sibirica* along a river, 1700±20 m a.s.l., 50°15'00"N 87°51'00"E;

Aktash settlement **Loc. 26:** mountain meadow at a former clear-cut in dry larch forest, 1530±75 m a.s.l., 50°33'32"N 87°47'54"E;

Kuray settlement **Loc. 29:** steppe meadows with larch gallery forest and meadow swamp (*Potentilla fruticosa* and *Salix* spp.), along a rivulet, 1530±75 m a.s.l., 50°10'27"N 87°54'00"E;

Onguday settlement **Loc. 37:** subalpine light coniferous forest (*Larix sibirica*), E-exp. rocky slope with steppe, 1051±50 m a.s.l., 50°37'14"N 86°18'24"E;

**Loc. 42:** subalpine light coniferous forest (*Larix sibirica*), dry steppe, 847±50 m a.s.l., 50°45'08"N 86°08'43"E.

### Group of semihumid types of vegetation

III. LIGHT CONIFEROUS TAIGA — Larch and pine forests in the southeastern Altay and Central Altay Mts. receive between 320 mm (near Onguday settlement) and 650 mm (near Lake Teletzkoe) annual precipitation. In the latter area, these communities form islands on south-exposed rocky slopes of the dark taiga in the low forest mountain belt.

Onguday settlement **Loc. 33:** light coniferous taiga, W-exp. slope, entry of a NW-exp. steep valley, 1203±50 m a.s.l., 50°36'28"N 86°18'51"E;

**Loc. 34:** S-exp. slope, light taiga with steppe islands, 1133±50 m a.s.l., 50°36'43"N 86°18'50"E;

**Loc. 39:** light taiga at a S-exp. slope with steppe, 1080±50 m a.s.l., 50°37'15"N 86°18'18"E;

**Loc. 40:** open larch forest with tall-herb meadow, 1090±50 m a.s.l., 50°37'21"N 86°18'03"E;

Chike-Taman mountain **Loc. 41:** light coniferous taiga with boreal coniferous mountain vegetation including brushwood community (*Salix/Caragana,* 950±50 m a.s.l., 50°39'00"N 86°17'00"E;

Topuchaya settlement **Loc. 46:** open larch forest at a S-exp. slope, 1560±50 m a.s.l., 51°06'01"N 85°39'12"E;

**Loc. 50:** open pine forest at a SW-exp. slope, 1808±50 m a.s.l., 51°06'36"N 85°40'24"E;

Yaylyu settlement **Loc. 57:** dry rock outcrops with light coniferous forest, 451±50 m a.s.l., 51°45'57"N 87°35'48"E;

**Loc. 66:** light coniferous forest with tall herbs at river valley, 546±50 m a.s.l., 51°46'31"N 87°35'23"E.

HYDROMESOPHYTIC FLOOD PLAIN FORESTS "UREMAS" — These extrazonal rich deciduous forests are composed of *Populus alba* L., *P. laurifolia, P. nigra* L., *Salix triandra* L., *S. alba* L., *S. viminalis* L., *Betula pendula* Roth, *B. microphylla* Bunge, *Padus avium* Mill. and are additionally supplied by ground water.

Malyy Yaloman **Loc. 25:** flood plain forest with *Populus laurifolia,* 720±50 m a.s.l., 50°30'00"N 86°34'00"E.

VI. STRIPE PINE FORESTS "LENTOCHNYE BORY" — These stripe pine and mixed forests with a rich herbaceous layer develop on sandy soils in the forest-steppe zone at the left bank of the Ob' river near Barnaul city, in the lowlands north of the Altay Mts. (Kuminova 1960). Annual precipitation varies from 400 up to 500 mm (Kharlamova 2004, Modina & Sukhova 2007).

Yuzhnyi settlement **Loc. 74:** stripe pine forest with tall herbs and shrubs, 200±25 m a.s.l., 53°15'20"N 83°39'39"E;

**Loc. 75:** very dry pine-birch forest on a shallow mound, sandy soil, 200±25 m a.s.l., 53°15'34"N 83°39'26"E;

**Loc. 76:** birch-pine forest, 200±25 m a.s.l., 53°15'51"N 83°41'06"E;

**Loc. 77:** dry pine-birch forest, 200±25 m a.s.l., 53°15'55"N 83°40'28"E;

**Loc. 78:** open, old-growth dry pine-birch forest, 200±25 m a.s.l., 53°15'55"N 83°40'28"E;

**Loc. 79:** open, old-growth dry pine-birch forest, 200±25 m a.s.l., 53°15'55"N 83°40'28"E;

**Loc. 80:** pine-birch forest along moist open roadsides, 200±25 m a.s.l., 53°15'55"N 83°40'28"E;

**Loc. 81:** moist birch-pine forest, 200±25 m a.s.l., 53°16'00"N 83°40'36"E;

**Loc. 82:** border between temporary bog and pine-birch-poplar forest, 200±25 m a.s.l., 53°16'44"N 83°44'42"E;

**Loc. 83:** dry pine forest with scattered birch trees, 200±25 m a.s.l., 53°16'45"N 83°44'01"E;

**Loc. 84:** dry pine-birch-poplar forest, 200±25 m a.s.l., 53°16'46"N 83°44'23"E.

### Humid boreal mountain vegetation

IV. DARK CONIFEROUS TAIGA — Monospecific or mixed shady forests of *Pinus sibirica, P. sibirica/Picea obovata, Picea obovata, P. obovata/Abies sibirica,* or *P. obovata/Larix sibirica*. Annual precipitation varies from 450 mm (near Aktash settlement) up to 850 mm (near Lake Teletzkoe), in the latter region the forest is often less dense with a closed layer of sometimes very tall herbs.

Kuray settlement **Loc. 16:** shady coniferous forest along the river, 1535±25 m a.s.l., 50°10'13"N 87°53'50"E;

**Loc. 20:** shady coniferous forest (*Picea obovata*, *Larix sibirica*), 1700±20 m a.s.l., 50°15'00"N 87°51'00"E;

Aktash settlement **Loc. 21:** dark coniferous forest, transitional belt between forest-tundra and coniferous mountain vegetation, 2100±20 m a.s.l., 50°19'00"N 87°42'00"E;

Ak-Boom Mt. **Loc. 22:** boreal dark coniferous mountain vegetation, 950±20 m a.s.l., 50°21'00"N 87°02'00"E;

Chagakel lake **Loc. 23:** transitional belt between forest-tundra and coniferous mountain vegetation, 2100±20 m a.s.l., 50°29'00"N 87°39'00"E;

Aktash settlement **Loc. 24:** shallow S-exp slope with dense coniferous forest, 2050±50 m a.s.l., 50°29'58"N 87°39'20"E;

**Loc. 27:** dark coniferous forest in a rivulet depression, 1530±75 m a.s.l., 50°33'32"N 87°47'54"E;

Kuray settlement **Loc. 28:** shady coniferous forest (*Picea obovata, Larix sibirica*) along a small river, 1530±75 m a.s.l., 50°10'27"N 87°54'00"E;

Topuchaya settlement **Loc. 43:** dark coniferous moist forest, 1268±50 m a.s.l., 51°05'47"N 85°37'35"E;

**Loc. 44:** dark moist spruce forest, resembling a mire near the river, 1268±50 m a.s.l., 51°05'47"N 85°37'35"E;

**Loc. 45:** dark coniferous forest with meadows and shrub thickets framing the river, 1268±50 m a.s.l., 51°05'47"N 85°37'35"E;

**Loc. 47:** dark spruce forest with tall herbs and creeks, W-exp. side valley, 1541±50 m a.s.l., 51°06'06"N 85°39'16"E;

**Loc. 48:** dark spruce forest with tall herbs, 1625±50 m a.s.l., 51°06'15"N 85°39'40"E;

**Loc. 49:** dark, rather dense larch forest with tall herbs, 1640±50 m a.s.l., 51°06'20"N 85°39'38"E;

**Loc. 51:** shady coniferous forest (*Picea obovata, Larix sibirica*), 1200±50 m a.s.l., 51°07'00"N 85°35'00"E;

Yaylyu settlement **Loc. 56:** dark forest with *Abies sibirica* Ledeb., *Picea obovata* and tall herbs, 451±50 m a.s.l., 51°45'00"N 87°40'00"E;

**Loc. 58:** dark coniferous forest with tall herbs, 438±50 m a.s.l., 51°45'58"N 87°35'25"E;

**Loc. 61:** dark coniferous forest with tall herbs, 482±50 m a.s.l., 51°46' 05"N 87°35'36"E;

**Loc. 62:** dark coniferous forest with dense tall herbs, 445±50 m a.s.l., 51°46'12"N 87°41'03"E;

**Loc. 64:** dark coniferous forest with tall herbs near a creek, 496±50 m a.s.l., 51°46'27"N 87°35'35"E;

**Loc. 65:** dark coniferous forest with tall herbs at a steep N-exp slope, 608±50 m a.s.l., 51°46'31"N 87°35'07"E;

**Loc. 69:** dark coniferous forest, almost pristine, small plain, 790±50 m a.s.l., 51°47'13"N 87°35'45"E;

**Loc. 70:** rather dense dark coniferous forest with tall herbs, 570±50 m a.s.l., 51°52'51"N 87°37'41"E;

Gorno-Altaysk **Loc. 73:** dark forest with *Picea obovata, Abies sibirica* and tall herbs, 300±50 m a.s.l., 52°18'00"N 82°51'00"E;

Korbu waterfall **Loc. 89:** dark coniferous mountain forest, 500±50 m a.s.l., 51°42'23"N 87°41'03"E;

Yaylyu settlement **Loc. 93:** dark coniferous mountain forest, 1250±50 m a.s.l., 51°50'46"N 87°41'10"E;

Malyy Il'gumen' **Loc. 94:** dark coniferous mountain forest, 1580±50 m a.s.l., 50°44'00"N 86°19'00"E;

Uimen' river **Loc. 95:** dark coniferous mountain forest, 1600±50 m a.s.l., 51°12'07"N 87°00'54"E;

Chebdar river **Loc. 96:** dark coniferous mountain forest, 1600±50 m a.s.l., 51°08'31"N 87°42'31"E;

Bol'shoi Yaloman **Loc. 97:** secondary mixed forest with tall herbs, 870±50 m a.s.l., 50°30'23"N 86°29'25"E.

V. "CHERNEVAYA" TAIGA — This vegetation forms the low mountain vegetation belt of the northern Altay, where the conditions are most favorable for myxomycetes. This vegetation type is extrazonal occuring near brooks or rivers in the central Altay. Communities are dominated by *Abies sibirica* with varying proportions of *Pinus sibirica* and a well-developed layer of nemoral herbs and mosses. Aspen forests (*Populus tremula* L.), sometimes mixed with *Betula pendula,* can replace coniferous trees as secondary vegetation or along rivers. Annual precipitation ranges from 450 mm (near Onguday settlement) up to 900 mm (near Lake Teletzkoe).

Onguday settlement **Loc. 30-31:** spruce-birch forest along a creek in a NW-exp. steep valley, 1156±50 m a.s.l., 50°36'25"N 86°18'46"E;

**Loc. 32:** spruce-birch forest, along the river, 1146±50 m a.s.l., 50°36'28"N 86°18'38"E;

**Loc. 35:** spruce-birch forest, 1051±50 m a.s.l., 50°37'14"N 86°18'24"E;

**Loc. 36:** spruce-birch forest, 1051±50 m a.s.l., 50°37'14"N 86°18'24"E;

**Loc. 38:** spruce-birch forest, 1051±50 m a.s.l., 50°37'14"N 86°18'24"E;

Chiri settlement **Loc. 52:** mixed coniferous forest with tall herbs, 850±50 m a.s.l., 51°21'00"N 87°44'00"E;

**Loc. 53:** mixed coniferous forest with tall herbs, 850±50 m a.s.l., 51°21'00"N 87°50'00"E;

Kokshi station of the Altay State Nature reserve **Loc. 54:** mixed coniferous forest with tall herbs, 451±50 m a.s.l., 51°29'00"N 87°41'00"E;

Yaylyu settlement **Loc. 55:** mixed coniferous forest with *Betula pendula, Pinus sibirica* and tall herbs, 451±50 m a.s.l., 51°45'00"N 87°40'00"E;

Artybash settlement **Loc. 59:** mixed coniferous forest with *Betula pendula, Pinus sibirica* and tall herbs, 438±50 m a.s.l., 51°46'00"N 87°22'00"E;

**Loc. 60:** mixed coniferous forest with *Betula pendula, Pinus sibirica* and tall herbs, 438±50 m a.s.l., 51°46'01"N 87°22'01"E;

Yaylyu settlement **Loc. 63:** secondary, birch forest, 472±50 m a.s.l., 51°46'14"N 87°36'49"E;

**Loc. 67:** secondary alder-birch forest, shallow S-exp slope near a creek, 475±50 m a.s.l., 51°46'35"N 87°37'24"E;

**Loc. 68:** mixed forest with tall herbs, SE-exp. slope, 490±50 m a.s.l., 51°46'52"N 87°35'32"E;

Gorno-Altaysk city **Loc. 71:** open place near a road with *Populus tremula,* 500±50 m a.s.l., 51°55'00"N 85°56'00"E;

**Loc. 72:** mixed coniferous forest with *Populus tremula* and *Acer* sp., 500±50 m a.s.l., 51°55'00"N 85°56'00"E;

Chiri settlement **Loc. 85:** mixed coniferous forest with tall herbs, 450±50 m a.s.l., 51°21'43"N 87°50'07"E;

Kyga river **86:** mixed forest with tall herbs, 480±50 m a.s.l., 51°20'35"N 87°51'15"E;

Kokshi settlement **Loc. 87:** mixed forest with tall herbs, 650±50 m a.s.l., 51°34'54"N 87°41'17"E;

Ok Porog bay **Loc. 88:** mixed forest with tall herbs, 450±50 m a.s.l., 51°45'59"N 87°38'09"E;

Left branch of the Kyga river **Loc. 90:** mixed forest with tall herbs, 600±50 m a.s.l., 51°19'53"N 87°51'40"E;

Atyshtu station of the Altay State Nature reserve **Loc. 91:** mixed forest with tall herbs, 1050±50 m a.s.l., 51°19'18"N 87°44'46"E;

Yaylyu settlement **Loc. 92:** mixed forest with tall herbs, 450±50 m a.s.l., 51°45'57"N 87°35'33"E;

Yurbuta settlement **Loc. 98:** mixed forest with tall herbs, 870±50 m a.s.l., 51°31'00"N 86°55'00"E;

Biryula settlement **Loc. 99:** mixed forest with tall herbs, 870±50 m a.s.l., 52°06'00"N 86°59'00"E;

Bashkaus river **Loc. 100:** mixed forest with tall herbs, 550±50 m a.s.l., 51°10'02"N 87°44'58"E.

## Substrate sampling

During our quantitative survey, a total of 510 substrate samples were collected for moist chamber cultures. These included bark from living trees and shrubs (91 samples), plant leaf litter (23), litter of grasses and herbaceous plants (19), decaying conifer cones on the ground (26), litter of small twigs (2), woody debris (318), and the dung (29) of herbivorous animals, such as camel, cow, horse, sheep, and various rodents. Moist chamber cultures were prepared according to Härkönen (1977). All cultures consisted of moist filter paper in Petri dishes (9 cm diam.) and were incubated under ambient light and at room temperature (20–24°C) for up to 90 days and examined for the presence of myxomycetes on six occasions (days 2–4, 6–8, 11–14, 20–22, 40–44 and 85–90). A record is defined herein as one or more fruiting bodies of a species that developed from a moist chamber culture.

## Data analysis

To estimate the extent to which the our survey was exhaustive, the quantitative part of the survey (every fructification was noted) was used to construct a species accumulation curve with the program EstimateS (Colwell 2006) and subjected to a regression analysis using the hyperbolic function $y = ax/(b + x)$, where $x$ is the number of samples, $y$ represents the number of species recorded, and the parameter $a$ refers to the maximum number of species to be expected.

Species diversity (alpha-diversity) was calculated using Shannon's diversity index $H' = -\sum P_i \log P_i$, where $P_i$ is the relative abundance (the proportion of the total number of individuals or records represented by a particular species, Shannon & Weaver 1963, Magurran 2004). The mean number of species per genus (S/G) was used as an indicator of overall taxonomic diversity. The myxomycete assemblages from different regions and substrates were compared by using the adjusted incidence-based Sørensen index developed by Chao et al. (2006), computed with EstimateS, and used for a cluster analysis by the weighted pair-group method (WPGMA) with the program Statistica 5.5. Graphs were created with SigmaPlot 10.0. Species classified as rare (relative frequency < 0.5 % of all records) were excluded from the above analyses.

For taxonomic determination, sporocarps were preserved as permanent slides in polyvinyl-lactophenol and/or glycerol gelatine, to distinguish between limeless and lime-containing structures. All microscope measurements and observations were made under a light microscope with differential interface contrast (DIC) Zeiss Axio Imager A1. Mean spore diameter was calculated from 10 spore measurements from each collection. Air-dried sporocarps were studied with a Zeiss Stemi 2000 stereomicroscope, and a JSM-6390 LA scanning electron microscope at 10–15 kV in the Komarov Botanical Institute of the Russian Academy of Sciences, St. Petersburg. For the latter, specimens were mounted on copper stubs using double-sided sticky film and sputter-coated with gold. Species were identified according to Martin and Alexopoulos (1969) and various original descriptions from the literature, basically applying a morphospecies concept. Nomenclature follows that of Lado (2001) and Hernández-Crespo & Lado (2005) except for the two genera *Collaria* Nann.-Bremek., *Stemonitopsis* Nann-Bremek. and the conserved names of several other genera (Lado et al. 2005) approved by the Committee for Fungi of the IAPT (Gams 2005). Authorities are cited according to Kirk & Ansell (1992). Voucher specimens have been deposited in their respective institutes by Novozhilov [Fungal Herbarium, Komarov Botanical Institute, Laboratory of Systematics and Geography of Fungi (LE)], Schnittler [Botanische Staatssammlung München (M)], and Fefelov [Institute of Plant and Animal Ecology of the Russian Academy of Sciences].

The following annotated checklist of the region was compiled from the results of our quantitative survey (all records and those specimens numbered with the prefixes sc, LE), the collections of the fourth author (prefix KAF) and published studies. Since the three publications available for the region (Barsukova 2000, Lavrov 1929, Novozhilov 1987) give rough annotations of abundance as well, we could assign an abundance estimate according to Stephenson et al. (1993) to all taxa. This estimate is based upon the proportion of a species in relation to the total number of records (1488 records in the current study): **R** – rare (< 0.5 % of all records), **O** – occasional (> 0.5–1.5 % of all records), **C** – common (> 1.5–3 % of all records), **A** – abundant (> 3 % of all records), with those taxa listed only for the qualitative part of the survey classifying as R. All additional data (preferences for substrate type and plant community) come from the quantitative part of the survey, which includes 1174 records, all originating from moist chamber cultures. The abbreviation '*cf.*' in the name of a taxon indicates that it could not be assigned to this name without remaining doubts, whereas '?' denotes a scanty and/or poorly developed collection. Abbreviations for myxomycete names in brackets refer to the Table 1 in the supplement of this paper and are followed by the estimate of abundance and the number of records obtained from the field and/or from moist chamber. An asterisk (*****) indicates a species recorded as new for the Altay Mts., whereas an exclamation mark (**!**) denotes a new record for Russia.

Next, the occurrence of a species in different vegetation types is listed (**I –** dry steppe, **II** – mountain forest-steppe, **III** – light coniferous taiga and hydromesophytic flood plain forests "uremas", **IV** – dark coniferous taiga, **V** – "chernevaya" taiga, **VI** – "lentochnye bory", stripe pine and mixed forests in submontane landscape in the forest-steppe zone. Names of vascular plants follow Czerepanov (1995). Occurrence on various substrate types differentiates **b** – bark of living trees and shrubs; **d** – dung of herbivorous animals; **ll** – leaf litter, **lt** – litter of twigs, **lg** – litter of grasses and herbaceous plants, **w** – large dead woody debris of trees and shrubs; **c** – decaying conifer cones; **f** – fruit bodies of fungi; **m** – mosses; and **s** – soil and living herbs on ground.

All localities where a species was found are given in parentheses, followed by all or some (indicated by the string "…") typical collections of the first author (LE) and/or the co-authors (sc = M. Schnittler, KAF = K.A. Fefelov). Letters indicate if a taxon is listed in one of the three published studies (L = Lavrov 1929, N = Novozhilov 1987, B = Barsukova 2000).

## Annotated species list

**MYXOMYCETES**

***Arcyodes incarnata*** (Alb. & Schwein.) O. F. Cook [ARDinc, **R**, 1/0] V: 1, w: 1 (Loc. 53, KAF 2996).

***Arcyria cinerea*** (Bull.) Pers. [ARCcin, **A,** 43/21] II: 1, III: 2, IV: 16, V: 32, VI: 13, b: 8, w: 53, c: 3 (Loc. 17, 28, 32, 35, 44, 52, 53, 55, 57, 58, 61–63, 67–69, 74, 77, 79, 85, 86, 89, LE 254940..., N, B).

***Arcyria denudata*** (L.) Wettst. [ARCden, **O,** 14/0] IV: 2, V: 12, w: 14 (Loc. 53, 63, 64, 65, 85, LE 255022..., N, B).

****Arcyria helvetica*** (Meyl.) H. Neubert, Nowotny & K. Baumann [ARChel, **R,** 7/0] IV: 1, V: 2, VI: 4, lt: 1, w: 6 (Loc. 53, 56, 71, 82, 84, LE 255359, 255374, 255382, 255384, KAF 3101, 3142, 3111). Described from the European Alps, this taxon can be recognized by the conspicuous peridium persisting partly in the upper part as a wine-red, iridescent, funnel-shaped to semi-globose calyculus. This species seems to prefer cooler microclimates only recorded from spruce/fir logs in coniferous forests.

***Arcyria incarnata*** (Pers. ex J. F. Gmel.) Pers. [ARCinc, **O,** 17/0] II: 3, III: 1, IV: 4, V: 8, VI: 1, b: 1, lt: 3, w: 13 (Loc. 19, 20, 35, 48, 50, 51, 53, 68, 75, 88, 93, LE 254741..., B).

***Arcyria insignis** Kalchbr. & Cooke [ARCins, **R,** 3/1] II: 1, IV: 1, V: 2, w: 3, c: 1 (Loc. 17, 35, 53, 93, LE 255179, 254771, KAF 3047, B).

***Arcyria minuta** Buchet [ARCmin, **R,** 2/1] III: 1, V: 1, VI: 1, b: 2, w: 1 (Loc. 41, 67, 77, LE 255287, 254676, KAF 3148).

***Arcyria obvelata*** (Oeder) Onsberg [ARCobv, **O,** 9/0] IV: 2, V: 6, VI: 1, w: 9 (Loc. 35, 48, 51, 53, 77, 85, 91, LE 254764..., N, B).

***Arcyria occidentalis** (T. Macbr.) G. Lister [ARCocc, **R,** 3/0] V: 3, w: 3 (Loc. 53, 54, KAF 3026, 3035, 3120). All specimens displayed a typical peridium with persistent lobes above the calyculus. The capillitium ornamentation consisted of warts and low transverse cogs that often appeared spirally arranged. Spores were very minutely spinulose, with scattered larger warts, 7–8 µm in diam.

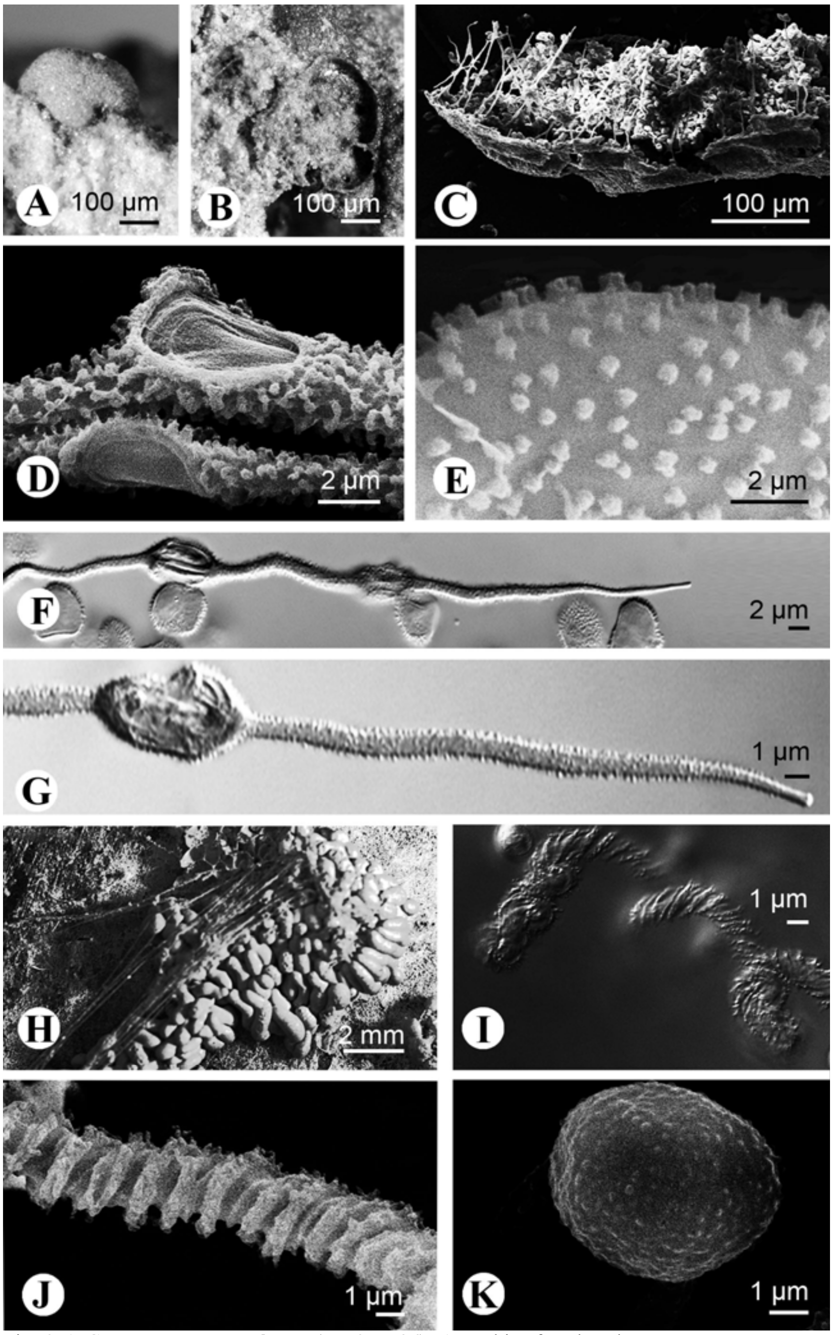

Fig. 2 A-G: *Dianema mongolicum* (LE 255586). A. Habit of a closed sporocarp, B an opened sporocarp. C. SEM micrograph of an opened sporocarp. D. Detail of capillitium as seen by SEM. E. Detail of spore ornamentation (SEM). F. Polyvinyl lactophenol mount of a capillitium thread and spores in optical section. G**.** Detail of a capillitial thread (DIC). H–K: *Hemitrichia imperialis*

(LE 255329). H. Habit of an opened sporocarp. I. Detail of a capillitial thread (DIC). J. Detail of capillitium (SEM). K. Spore (SEM).

***Arcyria oerstedii*** Rostaf. [ARCoer, **R,** 1/0] V: 1, w: 1 (Loc. 32, LE 254776). This record is based on only one collection; however, it represents typical form, displaying numerous spines on the threads of the capillitium and plates of peridium adhering to it. Comparisons with the description given by Rostafinski (1875) leave no doubt that the specimen from the Altay Mts. represents *A. oerstedii*.

***Arcyria pomiformis*** (Leers) Rostaf. [ARCpom, **O,** 6/2] II: 2, IV: 1, V: 3, VI: 2, ll: 1, lt: 1, w: 6 (Loc. 17, 19, 44, 54, 68, 76, 85, LE 255171..., N, B).

***Arcyria stipata*** (Schwein.) Lister [ARCsti, **R,** 4/0] V: 2, VI: 2, w: 4 (Loc. 52, 53, 84, LE 255371, 255378, KAF 3025, 3073). Our sporocarps are subsessile, gregarious and sometimes superimposed, with metallic red colors, fading brown with age, 2.5–3 mm in height. In habit, this species matches *Hemitrichia imperialis*. However, the capillitium of *A. stipata* possesses bulb-like thickenings and numerous free ends, the tubules are 3–5 µm diam., bearing 3–4 spirals intermixed with spines, cogs, half-rings or occasional rings and reticulations. The capillitium threads of *H. imperialis* are united into a loose net with few or without free ends (see above). The capillitium of both species is marked with three or four prominent spiral bands, but spore ornamentation differs. Spores of *A. stipata* are covered by small verrucae and large warts, whereas the spores of *H. imperialis* are evenly verrucose without large warts.

***Badhamia affinis*** Rostaf. [BADaff, **R,** 1/0] VI: 1, w: 1 (Loc. 76, LE 255314). Our specimen is characterized by flattened, grayish sessile sporangia with free, spinulose spores 13–14 µm in diam. These characters correspond well with the type description of this lignicolous species.

**!*Badhamia cinerascens*** G. W. Martin [BADcin, **R,** 1/0] V: 1, b: 1 (Loc. 72, KAF 3104). Our specimen includes typical globose or ellipsoid sessile sporangia with a strongly badhamioid capillitium and free irregularly spinulose spores of 13–15 µm diam.

***Badhamia dubia*** Nann.-Bremek. [BADdub, **R,** 0/7] II: 2, IV: 2, V: 3, b: 6, w: 1 (Loc. 9, 10, 28, 30, 32, 45, 67, LE 255137, 255115, 255182, 255198, 255229, 255234, 255589). Sporocarps spherical, 0.5–1 mm in diam., pale bluish-gray, shining and iridescent. The capillitium consists of a rather wide-meshed net of tubules, filled with white lime. Spores black in mass, purple-brown, 9–12 µm in diam., capped with spines or warts on the outside of a cluster including 7–12 spores but with only a few small warts at the inner side.

***Badhamia macrocarpa*** (Ces.) Rostaf. [BADmac, **R,** 1/0] V: 1, w: 1 (Loc. 72, KAF 3106). The capillitium is physaroid with large nodes. Spores spherical, free, usually rather dark violaceous brown, finely but densely and somewhat irregularly verrucose, 12–14 µm in diam.

***Barbeyella minutissima*** Meyl. [BARmin, **R,** 6/0] III: 1, IV: 5, w: 6 (Loc. 46, 48, 70, LE 254822, 254717, 254718, 254719, 254733, 254991). As described by Ing (1994) and Schnittler et al. (2000), we observed the species only on strongly to slightly decayed, decorticated logs of *Abies sibirica* and

*Picea obovata,* overgrown by liverworts (40–100% coverage) and covered by a thin algal layer. The species can be identified easily by the tiny, black and long-stalked small sporocarps (Kowalski & Hinchee 1972). At maturity, the peridial plates open with a zipper-like structure, releasing the dark, spinulose warted spores. *Barbeyella* was found in association with *Colloderma oculatum* (2 times), *Licea pygmaea* (2) and *Lepidoderma tigrinum* (1). These additional collections from the Altay Mts. support the hypothesis that *Barbeyella* is characterized by a predominantly mountane distribution, realizing optimum conditions in montane to altomontane spruce-fir forests (Schnittler et al. 2000).

***Brefeldia maxima*** (Fr.) Rostaf. [BREmax, **R,** 1/0] V: 1, w: 1 (Loc. 99, L). The single record of this conspicuous species was registered on coarse woody debris of *Salix* sp. In spite of the large fruiting bodies that are virtually impossible to overlook in the field, this species is not common in Russia. It has a distinctive capillitium consisting of numerous, dark threads with expands into bladder-like chambers sometimes containing spores.

***Calomyxa metallica*** (Berk.) Nieuwl. [CALmet, **R,** 0/2] V: 1, VI: 1, b: 1, w: 1 (Loc. 67, 79, LE 255252, sc 23534).

***Ceratiomyxa fruticulosa*** (O. F. Mull.) T. Macbr. [CERfru, **R,** 25/0] II: 3, III: 2, IV: 12, V: 6, VI: 2, lt: 4, w: 21 (Loc. 19, 21–23, 35, 44, 47, 50–54, 61, 68, 69, 74, 77, 94, LE 254751…, L, B). This species has been classified as a protostelid by some authors (Olive 1975); however, this species seems to be a highly devirgent myxomycete (Fiore-Donno et al. 2009). Here we use the conserved name for this species as proposed by Lado et al. (2005) and accepted by the IAPT (Gams 2005).

***Clastoderma debaryanum*** A. Blytt [CLAdeb, **R,** 0/2] V: 2, w: 2 (Loc. 68, sc 23545, 23552).

***Collaria arcyrionema*** (Rostaf.) Nann.-Bremek. ex Lado [COLanm, **O**, 16/0] III: 1, IV: 6, V: 9, lt: 1, w: 15 (Loc. 41, 47, 48, 54, 61, 64, 85, 93, LE 254823…, N, B).

***Colloderma oculatum*** (C. Lippert) G. Lister [CODocu, **R,** 2/1 *****] IV: 3, w: 3 (Loc. 48, 70, LE 254720, 254721, sc 23536). This species exhibited a preference for slimy, algae-covered wood and was two times found to be associated with *Barbeyella minutissima*. Most sporocarps were still immature, as indicated by the white to grayish color and shrinkage when drying.

***Comatricha alta*** Preuss [COMalt, **R,** 1/0] IV: 1, w: 1 (Loc. 23, KAF 3181). Dark-brown sporocarps 5–6 mm tall, stalk reaching 3–4 mm height, black. Columella almost or completely reaching the apex of the sporotheca, with blunt tips. Capillitial threads branched and forming wavy loops, hardly anastamosing, with some free, swollen ends, the upper part of the capillitium falling away from the columella at maturity and extending as a plume.

***Comatricha elegans*** (Racib.) G. Lister [COMele, **R,** 6/0] IV: 2, V: 4, w: 6 (Loc. 35, 53, 61, 85, LE 254758, 254765, 255087, 255090, KAF 3097, N).

***Comatricha ellae*** Härk. [COMell, **C,** 0/28] II: 9, III: 2, IV: 9, V: 7, VI: 1, b: 19, ll: 1, w: 7, c: 1 (Loc. 9, 10, 12, 15–17, 24, 26, 27, 29–32, 35, 45, 46, 47, 62, 68, 75, LE 255136...). *C. ellae* Härkönen (Härkönen 1977, 1978) differs from *Comatricha nigra* by smaller size (0.5–1 mm), a shorter stalk, a well-developed surface net on the capillitium and the coppery color of sporocarps. Our specimens possess all these characters but the sporocarps are duller than the type description. This corticulous species is the most common and most widely distributed species in the Altay Mts, exhibiting a strong preference for substrates characterized by low pH values. It was most frequently found on the bark of living coniferous trees (19), but was also recorded from coarse woody conifer debris (13) and sporadically on the litter of needles (1) and cones of *Larix sibirica* (1).

***Comatricha laxa*** Rostaf. [COMlax, **R,** 2/0] IV: 1, VI: 1, w: 2 (Loc. 22, 77, LE 254682, KAF 3217).

***Comatricha nigra*** (Pers. ex J. F. Gmel.) J. Schröt. [COMnig, **C,** 29/3] II: 1, IV: 10, V: 17, VI: 4, lt: 2, w: 30 (Loc. 19, 21, 22, 23, 44, 48, 53, 54, 64, 72, 74, 76, 77, 85, 93, LE 254711..., N, B).

***Comatricha pulchella*** (C. Bab.) Rostaf. [COMpul, **R,** 7/0] IV: 2, V: 5, lt: 1, w: 6 (Loc. 23, 51, 53, 54, 68, 86, KAF 2989, 3121, 3132, 3187, 3215..., B).

***Comatricha tenerrima*** (M. A. Curtis) G. Lister [COMten, **R,** 1/0] IV: 1, lg: 1 (Loc. 89, N). Our collection consists of typical dark-brown sporocarps with long stalks, the latter representing 2/3–3/4 of the total height of the sporocarp.

***Craterium leucocephalum*** (Pers. ex J. F. Gmel.) Ditmar [CRAleu, **R,** 4/0] V: 4, ll: 3, lg: 1 (Loc. 52, 85, KAF 3057, 3061, 3064, N).

***Craterium minutum*** (Leers) Fr. [CRAmin, **R,** 2/0] IV: 1, VI: 1, ll: 1, lg: 1 (Loc. 77, 89, LE 254620…).

***Craterium obovatum*** Peck [CRAobo, **R,** 1/0] IV: 1, ll: 1 (Loc. 62, LE 254937). The single collection consisted of more than 1500 stipitate sporocarps 1–2 mm tall. Sporothecae were obovoid to slightly globose, 0.5–0.7 mm in diam., grayish with purplish brown tints. Peridium brittle, more persistent and darker below as a cup, merging into the stalk. Stalk erect, 0.5–1.3 mm height, purplish brown. Capillitium dense, white, badhamioid, sometimes condensed to a pseudocolumella. Spore-mass dark purple-brown. Spores with prominent isolated spines, mostly 13–14 μm in diam. The large colony was found on leaf litter under a strongly decayed log of a coniferous tree covered by mosses, liverworts and leafy debris. All characters agree with the type description. We are following the taxonomic treatment of Farr (1976) who considers that this species belongs to the genus *Craterium* due to the peridium that remains as a cup.

***Cribraria argillacea*** (Pers. ex J. F. Gmel.) Pers. [CRIarg, **O,** 17/0] III: 1, IV: 4, V: 12, b: 1, w: 16 (Loc. 48, 50, 51, 54, 56, 62, 85, LE 254842…, N, B).

***Cribraria aurantiaca*** Schrad. [CRIaur, **O,** 17/0] IV: 2, V: 13, VI: 2, w: 17 (Loc. 32, 54, 64, 75, 77, 85, 93, LE 254987..., N, B).

***Cribraria cancellata*** (Batsch) Nann.-Bremek. [CRIcan, **C,** 36/0] III: 1, IV: 17, V: 15, VI: 3, w: 36 (Loc. 23, 35, 44, 47, 50, 52, 53, 56, 61, 62, 64, 68, 70, 73, 77, 78, 85, LE 255088..., N, B)

***Cribraria intricata*** Schrad. [CRIint, **R,** 4/0] IV: 2, V: 1, VI: 1, w: 4 (Loc. 44, 77, 85, LE 254705, 254710, 254787…). All our specimens lack a distinct calyculus. The peridial net of the pseudocapillitium has numerous free ends and rather irregular meshes with thickened nodes 8–15 μm wide. The species may respresent a morphological form of *C. tenella*, which possesses a set of very similar characters (see below).

***Cribraria languescens** Rex [CRIlan, **R,** 6/1] IV: 5, V: 1, VI: 1, w: 6 (Loc. 47, 52, 64, 69, 74, LE 254631, 254830, 254901, 255072, 255077, sc 23522, KAF 3075). Sporothecae nut-brown to copper colored, 0.25–0.4 mm in diam.; cups shallow with smooth, even ridges, occupying 20–30% of the sporotheca. Peridial net consisting of threads connected by small, round nodes; granules are 1–1.5 µm in diam. Spores are verrucose to reticulate-verrucose, 5.5–6.5 µm in diam. The taxon differs from the closely related *Cribraria tenella* by having coppery brown sporothecae with a deeper, more definite calyculus comprising half of the height of the sporothecae and relatively longer stalks.

***Cribraria macrocarpa** Schrad. [CRImac, **R,** 1/0] IV: 1, w: 1 (Loc. 44, LE 254713). This record consisted of one small colony of sporocarps with large sporothecae 0.8–1 mm in diam. The peridial cup has numerous dark ribs radiating from the base and does not form a distinct net but possesses numerous irregular perforations in its upper part.

**!*Cribraria macrostipitata*** H. Neubert & Nann.-Bremek. [CRImst, **R,** 3/0] V: 3, w: 3 (Loc. 53, 55, KAF 3079, 3096, 3098). All specimens have sporocarps with 1–1.5 mm long stalks and a small spherical, brown sporotheca 0.3–0.5 mm in diam. Peridial cups are shallow, comprise about 30% of the sporotheca height and are radially thickened without concentric wrinkles. The pseudocapillitial net is attached to the teeth at calyculus margin and forms coarse triangular meshes with thickened, irregular nodes and 0–5 free ends. Spores are ochraceous in mass, light yellow in transmitted light, 6–7.5 µm in diam.

***Cribraria microcarpa** (Schrad.) Pers. [CRImic, **C,** 20/23] III: 2, IV: 31, V: 7, VI: 3, w: 43 (Loc. 32, 44, 50, 53, 61, 62, 64, 65, 68–70, 74, 77, LE 254881...). This species represented one of the most common species in the coniferous forests of the Altay Mts. It is easy to overlook in the field but readily obtained in moist chamber cultures from decaying wood. All records were from moderately or strongly decayed wood of coniferous trees.

***Cribraria minutissima*** Schwein. [CRImin, **R,** 5/0] IV: 2, V: 3, w: 5 (Loc. 47, 55, 68, 69, 85, LE 254839, 255075, KAF 3080, N, B). Nut to orange-brown, sometimes coppery sporothecae 0.1–0.2(–3) mm in diam., constricted cup about 50% of the sporotheca with longitudal rows of calcareous granules and very slightly expanded peridial nodes nearly without free ends were considered as the typical characters for this inconspicuous species.

***Cribraria piriformis** Schrad. [CRIpir, **R,** 1/0] V: 1, w: 1 (Loc. 53, KAF 3081).

***Cribraria purpurea*** Schrad. [CRIpur, **R,** 4/0] IV: 3, V: 1, w: 4 (Loc. 44, 64, 96, 100, LE 254707, 254908, L). This species was found to be rare; however, when encountered it was usually characterized by large colonies of sporocarps on the coarse woody debris of coniferous trees in cool and moist habitats.

***Cribraria rubiginosa*** Fr. [CRIrub, **R,** 1/0] V: 1, w: 1 (Loc. 85, N). Sporocarps up to 5 mm total height, often forming large colonies.

Sporothecae ellipsoid or subglobose, 1–2 mm wide. Stalk rugose, dark brown, 0.3–3.5 mm long, 0.2 mm wide. Hypothallus well-developed. Peridial cup iridescent, occupying 30–50% of the height of the sporotheca, not sharply separated from the peridial net, marked with numerous curved or horizontal lines, often in a reticulate pattern, and sparsely covered with dark calcareous granules 1–2 µm diam. Peridial net iridescent, consisting of slender, red-brown, rigid threads, the meshes up to 0.1 mm in diam., the nodes scarcely enlarged. Spore-mass dull crimson. Spores minutely punctate, 5–6 µm in diam. Plasmodium purple-black.

***Cribraria rufa*** (Roth) Rostaf. [CRIruf, **R,** 6/0] III: 1, IV: 2, V: 2, VI: 1, w: 6 (Loc. 23, 50, 51, 54, 68, 76, LE 254670, 255326, KAF 3130, 3188, B).

******Cribraria splendens*** (Schrad.) Pers. [CRIspl, **R,** 4/0] IV: 4, w: 4 (Loc. 61, 62, 64, 69, LE 254915, 254941, 255078, 255106).

******Cribraria tenella*** Schrad. [CRIten, **O,** 15/0] IV: 9, V: 2, VI: 4, w: 15 (Loc. 53, 61, 62, 64, 65, 68, 70, 75, 76, LE 254865...). This species differs from C. *intricata* by its smaller sporothecae (0.2–0.4 mm in diam.), the presence of a well developed calyculus (40–60% of the total height of the sporotheca), and a much more regular net of pseudocapillitium with larger (15–20 µm in extent) and more thickened nodes almost without free ends.

******Cribraria violacea*** Rex [CRIvio, **O,** 4/5] IV: 3, V: 5, VI: 1, b: 3, w: 6 (Loc. 21, 30, 32, 54, 63, 64, 67, 77, LE 255282...).

***Cribraria vulgaris*** Schrad. [CRIvul, **R,** 4/1] V: 4, VI: 1, lt: 1, w: 4 (Loc. 52, 53, 55, 77, 85, sc 23547, KAF 3074, 3099, 3078, N).

******Dianema corticatum*** Lister [DNMcor, **R,** 1/0] IV: 1, w: 1 (Loc. 65, LE 254917).

**!*Dianema mongolicum*** Novozh. [DNMmon, **R,** 0/1] II: 1, b: 1 (Loc. 10, LE 255586). The prominent characters of this species are the stiff capillitium with rounded, elliptic or acetabuliform swellings of 1–10 µm diam. (Fig. 2 C-G), a thick peridium appearing opaque yellowish-brown that is impregnated with refuse material (Fig. 2 A-B), and pale yellow, spinulose spores (9.5–)10.0–10.5(–11.0) µm in diam. This rare corticolous species has been described from Mongolia (Baianhongor aimak, Novozhilov & Golubeva 1986) on bark of *Populus diversifolia* (LE 46281) and was recently found on bark of *Artemisia tridentata* in Arizona and New Mexico (David Mitchell, pers. comm.). All of our sporocarps were found on the bark of *Populus laurifolia* in moist chamber cultures near the Russian-Mongolian border in dry mixed opened larch-poplar forest with scattered shrubs of *Lonicera* sp. and *Juniperus sabina*. Our locality lies about 900 km north-west of the type locality but has a similar climate.

******Dictydiaethalium plumbeum*** (Schumach.) Rostaf. [DITplu, **R,** 1/0] III: 1, w: 1 (Loc. 50, LE 254675).

***Diderma hemisphaericum*** (Bull.) Hornem. [DIDhem, **R,** 1/0] V: 1, w: 1 (Loc. 88, B).

******Diderma radiatum*** (L.) Morgan [DIDrad, **R,** 2/0] VI: 2, w: 2 (Loc. 74, LE 254807, 254808).

******Diderma testaceum*** (Schrad.) Pers. [DIDtes, **R,** 0/1] IV: 1, lg: 1 (Loc. 70, LE 255232).

***Diderma umbilicatum** Pers. [DIDumb, **R,** 1/0] VI: 1, w: 1 (Loc. 77, LE 254782). Our collection is macroscopically similar to *Diderma montanum* but differs in slightly larger spores: 10–11 (vs. 8.5–9.5 µm diameter in *D. montanum*) and larger columellae: 0.8–0.9 (vs. 0.2–0.4) mm.

***Didymium anellus** Morgan [DDYane, **R,** 1/0] II: 1, w: 1 (Loc. 19, KAF 3161).

***Didymium clavus** (Alb. & Schwein.) Rabenh. [DDYcla, **R,** 1/0] V: 1, ll: 1 (Loc. 52, KAF 3062).

***Didymium difforme** (Pers.) Gray [DDYdif, **R,** 0/7] II: 1, III: 4, IV: 2, b: 1, d: 5, w: 1 (Loc. 4, 33, 34, 39, 43, 44, 46, LE 255168, 255196, 255192…).

***Didymium iridis** (Ditmar) Fr. [DDYiri, **R,** 1/0] IV: 1 (Loc. 47, LE 254825).

***Didymium ovoideum** Nann.-Bremek. [DDYovo, **R,** 1/0] V: 1, ll: 1 (Loc. 52, KAF 3082).

***Didymium** cf. **quitense** (Pat.) Torrend [DDYqui, **R,** 0/1] II: 1, d: 1 (Loc. 26, LE 255177). The collection consists of numerous sessile scattered sporocarps 0.5–1.5 mm in diam. occurring in moist chamber on decayed horse dung together with the coprophilous species *Kelleromyxa fimicola* and *Licea tenera*. Peridium double, outer layer white or cream, shell-like, composed of compact crystals conglutinated together. Inner layer of peridium membranous, bluish iridescent. Capillitium sparse, consisting of short threads appearing very pale under transmitted light but possessing dark extensions. Spore size matches well *D. quitense* as described by Martin & Alexopoulos (1969); spores appear purplish brown under transmitted light, (10–)11–13(–14) µm in diam., densely spinulose with spines more or less united to form an imperfect reticulate pattern. However, *D. quitense* is described with strongly warted spores, which leaves some doubt about the taxonomic assignment of our specimen.

***Didymium squamulosum** (Alb. & Schwein.) Fr. [DDYsqu, **O,** 9/3] IV: 1, V: 8, VI: 3, ll: 9, w: 1, c: 1 (Loc. 28, 52, 53, 74, 77, LE 255398…).

***Echinostelium brooksii** K. D. Whitney [ECHbro, **R,** 0/2] IV: 1, V: 1, b: 2 (Loc. 24, 68, LE 255204…). Recently this species was found in south-central Siberia (Kosheleva et al. 2008). This species is close to *Echinostelium corynophorum*, but is distinguished by the dark color of the columella under transmitted light and spores without raised, circular areas at points of spore-to-spore contact. Recorded from bark of *Larix sibirica* and bark of *Betula pendula* in moist chamber culture (mean pH 6.17±0.15).

***Echinostelium colliculosum** K. D. Whitney & H. W. Keller [ECHcol, **R,** 0/3] II: 3, b: 3 (Loc. 10, LE 255111, 255132…). Our specimens include large colonies of shining, pinkish or colorless, very small (60–100 µm in height) sporocarps, spores clustered in groups of 20–50, bearing discs at points of spore-to-spore contact, always with a spore-like columella. The articular surfaces of spores of *E. colliculosum* are less prominent than those of *Echinostelium coelocephalum*, and are not of uniform thickness (Whitney & Keller 1980).

**!Echinostelium corynophorum** K. D. Whitney [ECHcor, **R,** 0/7] II: 3, III: 1, IV: 2, V: 1, b: 4, w: 1, c: 2 (Loc. 9, 16, 28, 29, 40, 68, LE 255109, 255125, 255113, 255185…). Reported first from California by Whitney (1980) on bark of *Juniperus occidentalis* Hook. All collections were obtained on slightly acidic substrates (mean pH 6.03± 0.07) including bark, cones and wood of *Larix sibirica* and *Picea obovata* in moist chamber culture and exhibit the typical characters of this species (Fig. 3F-J). This species is close to *Echinostelium brooksii,* from which it is separated by the light lenticular columella in transmitted light and spores with spores with articular surfaces (Fig. 3G) at points of spore-to-spore contact.

***Echinostelium cribrarioides*** Alexop. [ECHcri, **R,** 0/1] II: 1, b: 1 (Loc. 10, LE 255133). The overall habit of this specimen fits best that of *E. cribrarioides*, given that the capillitium forms a complete globose net with large meshes, which is unique for this genus.

**!*Echinostelium fragile*** Nann.-Bremek. [ECHfra, **R,** 0/6] III: 1, IV: 3, V: 1, VI: 1, b: 6 (Loc. 24, 35, 44, 46, 70, 77, LE 255202, 255219…). The holotype of this species was found on bark of *Aesculus* sp. from the Netherlands in moist chamber (Nannenga-Bremekamp 1961). Our specimens from the Altay Mts. conform nicely the original description. Key characters are spores with multiple protoplasts (Fig. 3C, E) and a long columella 5–10 µm in length (Fig. 3A, B). *E. apitectum* has one protoplast per spore and a shorter columella (up to 4 µm) enclosed in a globose cover (Whitney 1980). Both columella and spore morphology are constant in all our specimens. Collapsed spores attached to the collar-like structure (Fig. 3D) show flattened warts in SEM that are in a compound microscope only clearly distinguishable at high magnification with DIC (Fig. 3C, E). At lower magnification, even with a good optical system, the spores appear to be smooth. The spore size and other characters also agree perfectly with *Echinostelium fragile*. Our specimens, coming from an arid environment, developed between 7 and 14 days in moist chamber culture. Attempts to culture spores on agar have been unsuccessful.

***Echinostelium minutum*** de Bary [ECHmin, **O,** 1/18] II: 2, III: 1, IV: 6, V: 4, VI: 6, b: 12, lt: 1, c: 6 (Loc. 9, 12, 28, 30, 47–49, 57, 61, 67, 72, 75, 77, 79, 80, LE 255127...).

***Enerthenema papillatum*** (Pers.) Rostaf. [ENEpap, **O,** 6/13] II: 1, III: 2, IV: 11, V: 5, b: 11, lt: 1, w: 7 (Loc. 16, 19, 23, 24, 28, 30, 43, 44, 48–50, 54, 61, 68, 85, LE 255122..., N, B).

***Fuligo cinerea*** (Schwein.) Morgan [FULcin, **R,** 1/0] V: 1, w: 1 (Loc. 91, B). This species was found to be common in several arid regions of Eurasia (Novozhilov et al. 2006). Surprisingly, this species was only encountered once in the taiga (Barsukova, 2000) of the Altay Mts. and it was not found in our survey including arid regions of the Chuyskaya depression.

***Fuligo leviderma*** H. Neubert, Nowotny & K. Baumann [FULlev, **R,** 4/0] III: 1, IV: 2, VI: 1, w: 4 (Loc. 58, 66, 69, 76, LE 254930, 254960, 255081, 255308). All our specimens form aethalia up to 5 cm wide and 2.5 cm high with a rather smooth, yellow- to red-brown cortex. Spores are usually 7–8 µm in diam., verrucose, dark violet-brown.

***Fuligo muscorum*** Alb. & Schwein. [FULmus, **R,** 1/0] IV: 1, w: 1 (Loc. 95, L).

***Fuligo septica*** (L.) F. H. Wigg. [FULsep, **C,** 30/0] IV: 7, V: 19, VI: 4, lg: 1, w: 29 (Loc. 35, 44, 47, 52, 53, 62–64, 68, 72, 75–77, 85, 86, 93, LE 254755…, N, B).

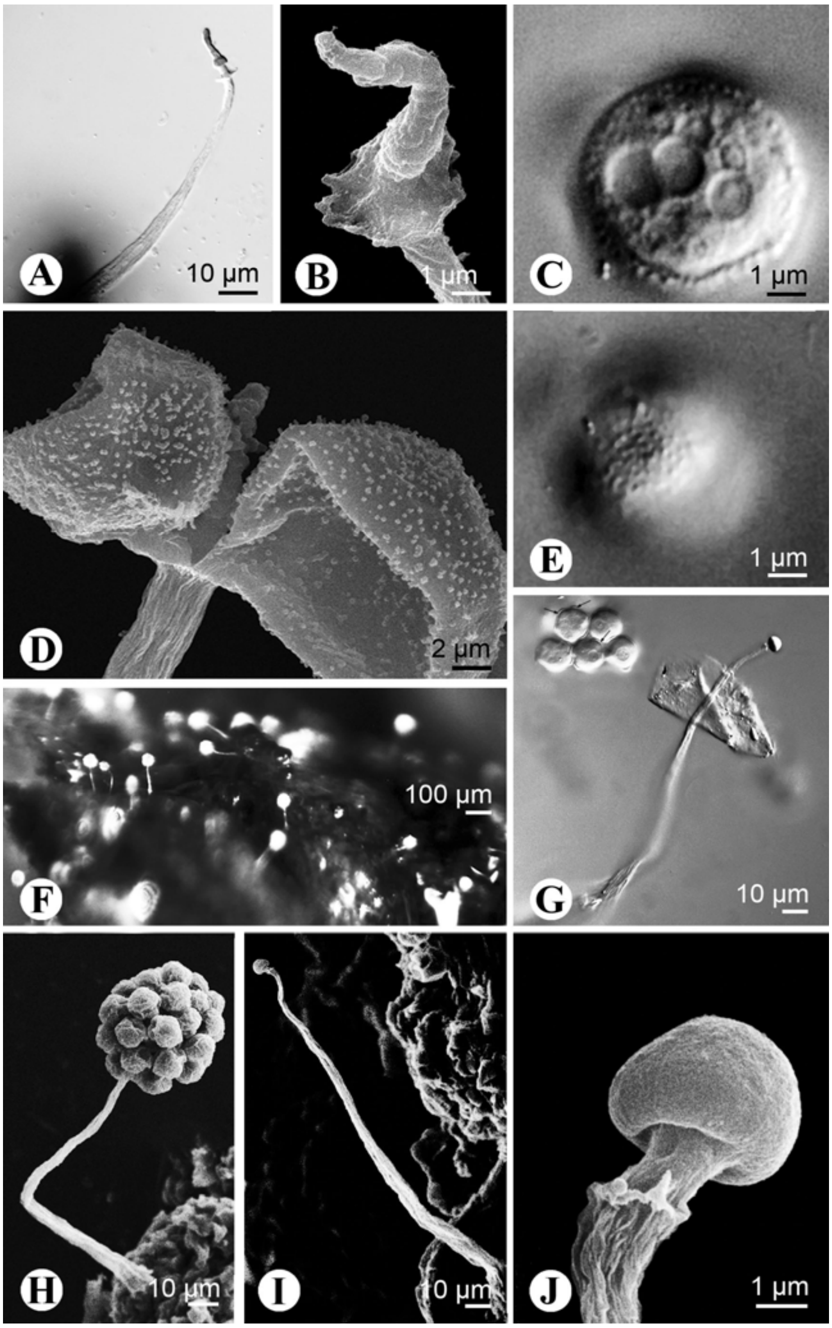

Fig. 3 A-E: *Echinostelium fragile* (LE 255119). A. Polyvinyl lactophenol mount of an opened sporangium in optical section. B. SEM micrograph of an upper part of sporangia showing stalk, collar and the columella. C, E. Spores in different optical sections with ornamentations visible with DIC (100x). D. SEM micrograph of an opened sporangium. F-J: *Echinostelium corynophorum* (LE 255109). F. Colony of white sporocarps. G. Polyvinyl lactophenol mount of an opened sporangium in optical section (DIC) and spores with articular surfaces (arrows). H**.** SEM micrograph of a closed sporangium with spores. I. Habit of opened sporangium (SEM). J. Columella under SEM.

***_Fuligo luteonitens_** L.G. Krieglst. & Nowotny [FULlut, **R,** 1/0] V: 1, w: 1 (Loc. 53, KAF 3024). Our specimen consists of pulvinate aethalia 3 cm in diam. on a flat base. Cortex chrome yellow, persistent, surface bullate and veined. Pseudocapillitium consisting of a reticulum of fine hyaline threads with numerous white rounded to filiform nodes, 20–30 x 20–50 µm. Spore-mass black. Spores gray-brown, oval, with clustered warts, (7–)8–10 µm in diam.

***_Fuligo septica_** var. **_candida_** (Pers.) R.E. Fr. [FULsepcan, **R,** 1/0] V: 1 (Loc. 53, KAF 3040). This form differs from *F. septica* in the white or almost white aethalia (sometimes cream to pale gray); all the lime in the pseudocapillitium is white, lime nodes are sometimes sparse or absent.

***_Hemitrichia abietina_** (Wigand) G. Lister [HEMabi, **R,** 3/0] IV: 3, w: 3 (Loc. 20, KAF 3167, 3168, 3171).

***Hemitrichia calyculata*** (Speg.) M.L. Farr [HEMcal, **R,** 4/0] V: 2, VI: 2, w: 4 (Loc. 76, 84, 85, LE 255306, 255388, B).

***Hemitrichia clavata*** (Pers.) Rostaf. [HEMcla, **C,** 31/1] III: 1, IV: 1, V: 23, VI: 7, w: 32 (Loc. 35, 41, 52, 53, 55, 60, 63, 67, 68, 77, 84, 85, 93, 99, LE 254749…, L, N, B).

**!_Hemitrichia imperialis_** G.Lister [HEMimp, **R,** 2/0] VI: 2, w: 2 (Loc. 76, LE 255329, 255331). The collections from the Altay Mts. agree with the original description of *H. imperialis* by their reddish copper color fading to dull tawny, a rather persistent peridium (Fig. 2H) with very elastic threads that are marked with three or four prominent spiral bands (Fig. 2I, J) and are united into a loose net hardly showing any free ends (Lister 1929). Spores possess numerous small verrucae (Fig. 2K) and lack larger warts. However, Martin & Alexopoulos (1969) pointed out that this species may simply respresent a variety of *Arcyria stipata*. We do not agree with this opinion, because the structure of the capillitium and the spore ornamentation of the two taxa appear to be different. Our specimens of *A. stipata* (see above) differ from *H. imperialis* in the capillitium with numerous free ends and spores with larger warts.

***_Hemitrichia pardina_** (Minakata) Ing [HEMpar, **R,** 0/3] IV: 1, VI: 2, ll: 2, lg: 1 (Loc. 44, 74, 77, LE 255255, 255262, 255267).

***Hemitrichia serpula*** (Scop.) Rostaf. ex Lister [HEMser, **C,** 23/2] IV: 8, V: 15, VI: 2, b: 1, w: 24 (Loc. 54, 55, 58, 61, 62, 64, 67, 68, 70, 81, 82, 85, 88, LE 254957…, N, B).

***_Kelleromyxa fimicola_** (Dearn. & Bisby) Eliasson [KELfim, **R,** 0/7] I: 1, II: 4, III: 1, IV: 1, d: 7 (Loc. 12, 13, 18, 24, 26, 29, 34, LE 255139, 255158, 255160, 255169, 255175, 255183, 255243). Our records constitute the second observation of this species for Russia. It was previously found on the dung of herbivorous animals from several localities in the deserts of the Caspian lowland (Novozhilov et al. 2006). All specimens were found in the driest part of the Altay Mts. – the Chuyskaya depression. This species exhibits a strong preference for dung. The distinguishing characteristics of this species are shiny black, spindle-shaped sporangia (Fig. 4C); a rather thick, cartilaginous peridium (Fig. 4A) often dehiscing by preformed sutures; a simple capillitium consisting of solid threads (Fig. 4B) and thick-walled spores ornamented by scattered, rarely aggregated, large spines (Fig. 4D).

***Lamproderma atrosporum*** Meyl. [LAMatr, **R,** 1/0] IV: 1, ll: 1 (Loc. 93, B). Together with *Physarum alpinum* (see below), this record confirms the existence of nivicolous myxomycetes in the Altay Mts; however, no additional collections were made since our survey took place during the summer.

***Lamproderma columbinum*** (Pers.) Rostaf. [LAMcol, **R,** 2/0] V: 2, w: 2 (Loc. 55, 85, KAF 2973, N).

***Lamproderma scintillans** (Berk. & Broome) Morgan [LAMsci, **R,** 1/3] II: 1, III: 1, V: 1, VI: 1, b: 2, ll: 1, w: 1 (Loc. 33, 37, 52, 77, LE 255248, 255265, 255280, KAF 3069).

***Leocarpus fragilis*** (Dicks.) Rostaf. [LEOfra, **R,** 7/0] II: 1, IV: 4, V: 2, ll: 1, lt: 2, w: 3 (Loc. 19, 20, 47, 48, 85, LE 254832, 254837, 254734, KAF 3152, 3196, B).

***Lepidoderma tigrinum** (Schrad.) Rostaf. [LEPtig, **R,** 3/0] IV: 1, V: 2, w: 3 (Loc. 53, 70, LE 254990, KAF 2963, 3100).

***Licea kleistobolus** G. W. Martin [LICkle, **O,** 0/9] III: 1, IV: 5, VI: 3, b: 8, w: 1 (Loc. 46, 48, 61, 62, 70, 75, 79, 80, LE 255260...).

***Licea minima*** Fr. [LICmin, **O,** 9/1] IV: 5, V: 5, lt: 1, w: 9 (Loc. 23, 47, 53, 54, 61, 69, 85, LE 255076..., N).

***Licea parasitica** (Zukal) G. W. Martin [LICpar, **O,** 0/13] II: 2, IV: 8, V: 3, b: 8, lt: 1, w: 4 (Loc. 10, 17, 27, 30, 32, 35, 44, 47, 49, 61, 62, LE 255140...).

***Licea pygmaea** (Meyl.) Ing [LICpyg, **R,** 7/0] IV: 7, w: 7 (Loc. 48, LE 254716, 254722, 254724, 254725, 254728, 254730, 254731). Under the dissecting microscope the peridium appears brown inside and conspicuously shining, but granulose and mat outside, breaking along dehiscence lines, under transmitted light bright yellow-brown, smooth, but with prominent warts of 0.8–1.0 µm diameter along dehiscence lines. Spore-mass black, under the microscope grayish brown, globose to ovoid, ornamented with very fine, regularly distributed warts and a thin-walled germination pore occupying less than one tenth of the optical section, (11) –11.5–12.5–(13) µm in diam.

***Licea tenera** E. Jahn [LICten, **R,** 0/4] I: 1, II: 1, III: 1, IV: 1, d: 4 (Loc. 5, 16, 26, 34, LE 255172, 255178, 255193…). This species approaches *Perichaena liceoides* in habit and substrate preferences. Our specimens of *Licea tenera* have a peridium with amorphous deposits in which the outer layer lacks the granular deposits characteristic for *Perichaena liceoides*. Spores are minutely roughened (verrucose), requiring oil immersion for visibility but appear delicately warted under SEM, with warts 0.2–0.5 µm width. This is another example of a strictly coprophilous myxomycete.

***Licea testudinacea** Nann.-Bremek. [LICtes, **R,** 0/1] II: 1, ll: 1 (Loc. 17, LE 255164). Found in moist chamber on needle litter of coniferous trees. This species is recognized by the petaloid dehiscence of the shiny, very dark brown to black sporocarps and very dark brown spore-mass. The peridium is divided into numerous small platelets, each with a single row of tubercles regularly placed at the margins, yellow-brown or orange-brown by transmitted light. The spores are verrucose and gray with a large conspicuous pale thin area, (10–)11–13(–15) µm in diam. *Licea testudinacea* appears to be most closely related to *L. minima* and *L. chelonoides*. It is distinguished from *L. minima* by the darker, more olive and not rusty-colored spore mass. In the latter species, the spores are always reddish brown by transmitted light. *L. chelonoides* differs by having dull black sporocarps not shining when dry, platelet margins with 5 or more rows of tubercles, and spores measuring 15–18 µm in diam.

***Licea variabilis*** Schrad. [LICvar, **R,** 1/0] V: 1, w: 1 (Loc. 68, B).

***Lycogala epidendrum*** (L.) Fr. [LYCepi, **A**, 55/0] II: 2, III: 1, IV: 8, V: 21, VI: 23, w: 54 (Loc. 19, 35, 42, 44, 47, 50, 51, 53, 54, 68–70, 74, 76, 77, 81, 82, 84, 85, 87, 88, 93, LE 254700..., N, B).

***Lycogala exiguum** Morgan [LYCexi, **R,** 5/0] II: 1, IV: 2, V: 1, VI: 1, lt: 1, w: 4 (Loc. 19, 53, 61, 64, 74, LE 254636, 254872, 254886, KAF 2953, 3163…).

***Lycogala flavofuscum*** (Ehrenb.) Rostaf. [LYCfla, **R,** 2/0] III: 1, V: 1, b: 1, w: 1 (Loc. 25, 85, KAF 3201, B).

***Macbrideola oblonga** Pando & Lado [MACobl, **R,** 0/1] II: 1, b: 1 (Loc. 10, LE 255129). This species was found only once in the arid Chuyskaya depression. The oblong shape of the sporotheca and the presence of free spores distinguish this species from *Macbrideola synsporos*. Comparisons with material obtained from Kazakhstan (Schnittler & Novozhilov 2000; Zemlyanskaya, Adamonyte, Krivomaz and Novozhilov, unpubl. data), Mongolia (Novozhilov & Schnittler 2008), the Orenburg area of Russia (Novozhilov & Kosheleva 2006), the Colorado Plateau of the western United States (Novozhilov et al. 2003) allow us to assign our specimens to *M. oblonga*. This species is found to be common in arid and semiarid regions.

***Macbrideola synsporos** (Alexop.) Alexop. [MACsyn, **R,** 0/1] III: 1, c: 1 (Loc. 50, LE 255216).

***Metatrichia floriformis** (Schwein.) Nann.-Bremek. [METflo, **R,** 3/0] IV: 2, V: 1, w: 3 (Loc. 63, 64, 65, LE 254924, 254978, 255016).

***Metatrichia vesparia*** (Batsch) Nann.-Bremek. ex G. W. Martin & Alexop [METves, **A**, 58/4] III: 1, IV: 12, V: 31, VI: 18, b: 1, ll: 1, w: 59 (Loc. 41, 52–54, 58, 61, 63–65, 67–69, 76, 77, 82, 84–86, LE 254968..., N, B).

***Mucilago crustacea** F. H. Wigg. [MUCcru, **R,** 5/0] IV: 1, V: 3, VI: 1, w: 1 (Loc. 22, 82, 85, LE 255364, KAF 3200, B).

***Paradiacheopsis fimbriata** (G. Lister & Cran) Hertel ex Nann.-Bremek. [PARfim, **C,** 0/27] II: 6, III: 4, IV: 11, V: 1, VI: 5, b: 22, w: 3, c: 2 (Loc. 4, 7, 9, 16, 17, 24, 26, 28, 29, 35, 40, 43, 44, 49, 50, 57, 61, 69, 74, 75, 77, 79, 80, LE 255154...). Our material includes numerous sporocarps obtained in moist chamber culture, with typical capillitial threads ending with swollen and club-shaped tips. This species was noticeably associated with the acidic bark of *Larix sibirica* (pH 5.86±0.05).

***Paradiacheopsis rigida*** (Brândza) Nann.-Bremek. [PARrig, **R,** 2/3] IV: 5, b: 2, w: 2, c: 1 (Loc. 16, 21, 43, 48, LE 255112, 255239, 255256, KAF 3191, 3197). Our material includes numerous sporocarps with stout, rigid and lax, dichotomously branched capillitium. Spores are 9–10 µm in diam., minutely warted (Fig. 4E-H). This species prefers slightly acidic substrates (pH 6.14±0.24): cones of *Larix sibirica* (1), wood of *Pinus sibirica* (2) and bark of *Picea obovata* (2).

***Perichaena chrysosperma*** (Curr.) Lister [PERchr, **R,** 0/1] IV: 1, b: 1 (Loc. 27).

***Perichaena depressa*** Lib. [PERdep, **R,** 0/1] II: 1, d: 1 (Loc. 17, LE 255180).

***Perichaena liceoides*** Rostaf. [PERlic, **R,** 0/4] II: 1, III: 1, IV: 1, V: 1, b: 1, d: 3 (Loc. 29, 39, 43, 67, LE 255173, 255291, 255591…). Our material consists of sporocarps that lack a capillitium. Prominent differences between this species and *Licea tenera* include the structure of the peridium and spore ornamentation (Novozhilov et al. 2006). Spores have two types of ornamentation, the first consisting of spines 0.8–1.0 µm high with small lateral appendices up to 8 per spine and the second consisting of very small verrucae scattered among the spines. This species appears to be common in arid regions, where it has been found on litter and dung of herbivorous animals (Novozhilov et al. 2003, 2006, Novozhilov & Schnittler 2008).

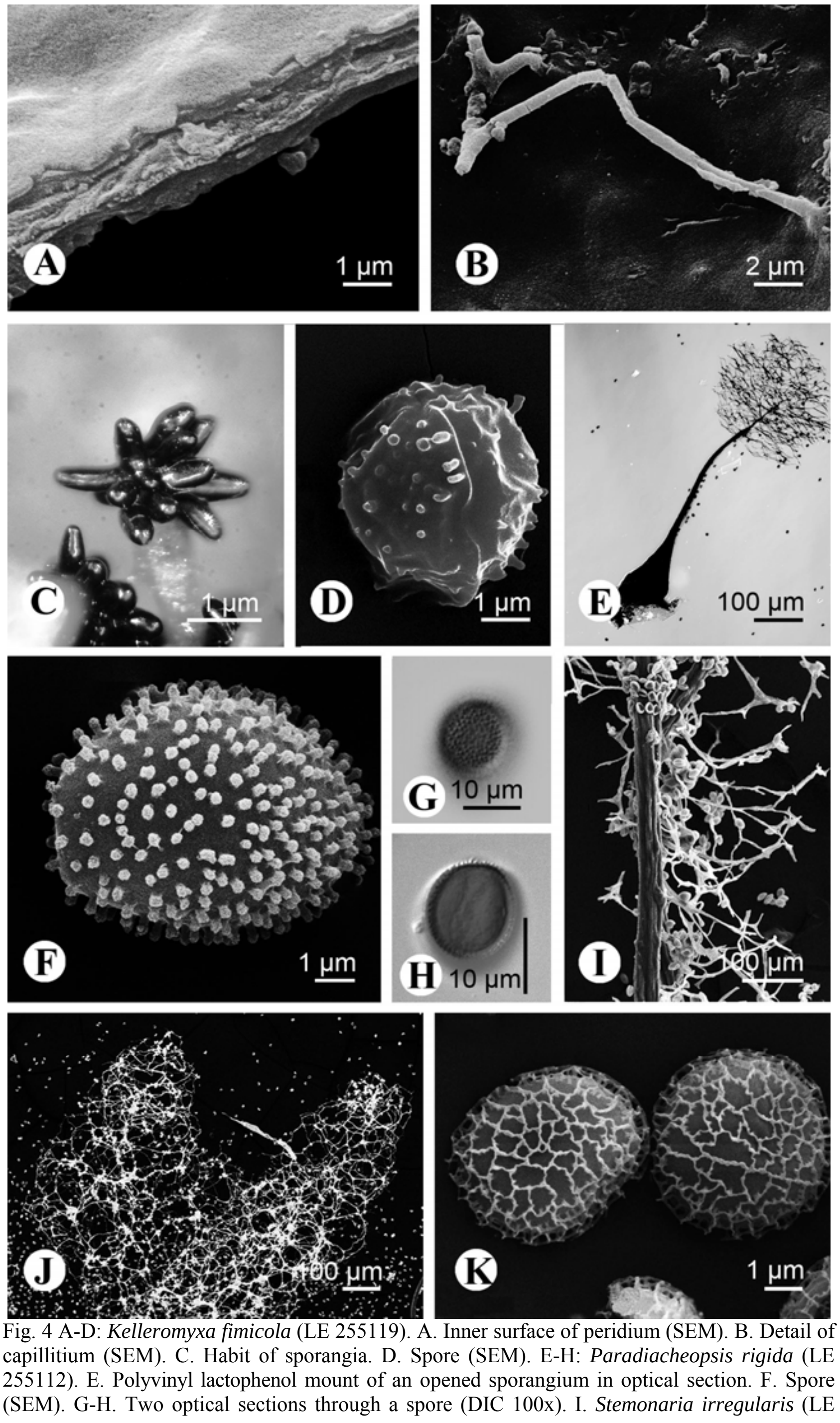


Fig. 4 A-D: *Kelleromyxa fimicola* (LE 255119). A. Inner surface of peridium (SEM). B. Detail of capillitium (SEM). C. Habit of sporangia. D. Spore (SEM). E-H: *Paradiacheopsis rigida* (LE 255112). E. Polyvinyl lactophenol mount of an opened sporangium in optical section. F. Spore (SEM). G-H. Two optical sections through a spore (DIC 100x). I. *Stemonaria irregularis* (LE

255332), columella and capillitium (SEM). J. *Symphytocarpus amaurochaetoides* (LE 255019), open sporocarps (SEM). K. Spores (SEM).

***Perichaena luteola** (Kowalski) Gilert [PERlut, **R,** 0/3] I: 1, II: 2, d: 3 (Loc. 10, 13, 29, LE 255170, 255174, 255184). The distinguishing characters of this species are the transparent thin peridium with smooth inner surface, olive shiny globose sporocarps with a bright yellow spore-mass appearing as a dense globe within the sporocarp when observed with a dissecting microscope. Capillitium yellow, composed of a network of branched and intricate tubules 1–4 µm in diam, with a few free ends that are weakly attached to the peridium.

***Perichaena** cf. ***pedata*** (Lister & G. Lister) Lister ex E. Jahn [PERped, **R,** 0/2] IV: 1, V: 1, b: 1, c: 1 (Loc. 30, 62, LE 255236…). Sporocarps with a spherical sporotheca 0.15–0.25 mm in diam. on a stalk 1.5–2.5 times longer than the sporotheca. Capillitium sparingly branched, consisting of thin (2.5–3.5 µm wide) wrinkled threads ornamented with ridges and short spines, very similar to that of *Pericahena chrysosperma*. The limited number of sporocarps recovered in the current study are not sufficient for a definite determination.

***Perichaena vermicularis** (Schwein.) Rostaf. [PERver, **O,** 0/12] I: 1, II: 1, III: 1, IV: 4, V: 5, b: 5, ll: 1, w: 4, c: 2 (Loc. 2, 28, 29, 31, 32, 35, 44, 48, 50, 70, LE 255247…).

***Physarum album*** (Bull.) Chevall. [PHYalb, **C,** 31/4] IV: 14, V: 14, VI: 7, ll: 3, lt: 1, w: 30 (Loc. 53, 55, 58, 61, 62, 64, 68, 69, 72–75, 77, 80, 85, 89, LE 254961..., B).

***Physarum alpinum*** (Lister & G. Lister) G. Lister [PHYalp, **R,** 1/0] V: 1, w: 1 (Loc. 86, B).

***Physarum bivalve** Pers. [PHYbiv, **O,** 2/6] III: 1, IV: 3, V: 4, b: 3, lg: 2, c: 1 (Loc. 27, 30, 35, 44, 46, 49, 53, LE 255290...).

***Physarum cinereum*** (Batsch) Pers. [PHYcin, **R,** 2/4] II: 2, IV: 1, V: 2, VI: 1, b: 2, lt: 1, w: 2, c: 1 (Loc. 17, 24, 53, 74, 86, LE 255166, 255167, 255270, KAF 3009..., B).

***Physarum compressum** Alb. & Schwein. [PHYcom, **R,** 1/0] V: 1, w: 1 (Loc. 72, KAF 3105). We found only one but well developed colony of sporocarps with white or gray, fan-shaped, compressed-globose sporotheca. Peridium single, thin, squamulose. Dehiscence by an apical cleft or irregular. A mainly tropical species.

***Physarum confertum** T. Macbr. [PHYcon, **R,** 1/0] V: 1, w: 1 (Loc. 35, LE 254745). Our collection consists of violet brown heaped and subglobose sporocarps 0.2–0.4 mm in diam. Peridium single, thin, translucent, often without calcareous deposits but usually sprinkled with lime globules. Capillitium sparse, with small, fusiform nodes and hyaline tubules, the junctions often without calcareous deposits. Spore-mass black. Spores violet-brown, 10–13 µm in diam., verrucose.

***Physarum decipiens** M. A. Curtis [PHYdec, **O,** 1/9] I: 1, II: 4, IV: 1, V: 2, VI: 2, b: 5, ll: 2, lt: 1, lg: 1, w: 1 (Loc. 9, 11, 17, 18, 32, 61, 68, 77, 79, LE 255580…).

***Physarum diderma*** Rostaf. [PHYdid, **R,** 3/0] V: 3, w: 3 (Loc. 52, KAF 3066, 3070, 3072).

***Physarum didermoides*** (Pers.) Rostaf. [PHYdmo, **R,** 1/0] V: 1, w: 1 (Loc. 52, KAF 2971).

***Physarum flavicomum*** Berk. [PHYfla, **R,** 0/1] VI: 1, b: 1 (Loc. 74, LE 255254).

***Physarum globuliferum*** (Bull.) Pers. [PHYglo, **O,** 15/0] IV: 4, V: 6, VI: 5, b: 1, ll: 2, lt: 1, w: 10 (Loc. 52, 53, 58, 69, 70, 77, LE 255085...). All our specimens are characterized by typical sporangia with short, conical white columella. Capillitium dense, delicate, with numerous lime-free axils, nodes small, rounded, white. Spore-mass dark gray-brown. Spores violet, 7–9 µm diam., verrucose and faintly cluster-warted.

***Physarum lateritium*** (Berk. & Ravenel) Morgan [PHYlat, **R,** 0/4] IV: 1, V: 3, b: 3, w: 1 (Loc. 32, 35, 44, LE 255278, 255244, 255273, 255279). Small colonies of gregarious, sessile sporocarps and short plasmodiocarps, 0.3–0.6 mm in diam., orange or yellow-red. Peridium thin, wrinkled, mottled with red calcareous scales. Capillitium delicate, consisting of pale yellow tubules, the nodes often membranous, without calcareous globules, or filled with pale yellow lime, with red or deep yellow conglomerates. Spore-mass violet-brown. Spores clear violet, 7–9 µm diam., verrucose.

***Physarum leucophaeum*** Fr. [PHYleu, **R,** 2/0] V: 2, w: 2 (Loc. 35, 68, LE 254769, B).

***Physarum leucopus*** Link [PHYlcp, **R,** 4/0] IV: 2, V: 2, ll: 1, w: 3 (Loc. 53, 85, 89, KAF 3010, N, B).

***Physarum*** cf. ***notabile*** T. Macbr. [PHYnot, **O,** 3/14] I: 4, II: 6, III: 2, IV: 1, V: 3, VI: 1, b: 6, d: 2, ll: 2, lt: 1, lg: 3, w: 3 (Loc. 2, 6, 10, 13, 14, 17, 18, 33, 35, 53, 66, 67, 79, 93, LE 254746..., B). According the literature (Martin & Alexopoulos 1969), *P. notabile* is most commonly reported on wood from temperate, boreal deciduous and coniferous forests and characterized by the dark, limeless cupulate base of sporotheca and an isodiametric capillitial net. Our field specimens from taiga forests (LE 255249, 255200, 254746, 255588, 255251) fit to this description. However, specimens from arid regions (LE 255116, 255130, 255131, 255134, 255159, 255162, 255200, 255230, 255249, 255581, 255587, 255593) obtained in moist chamber cultures fit to a form recently described from western Kazakhstan (Schnittler & Novozhilov 2000), the Caspian Lowland (Novozhilov et al. 2006) and Mongolia (Novozhilov & Schnittler 2008).

***Physarum psittacinum*** Ditmar [PHYpsi, **R,** 3/0] V: 3, w: 3 (Loc. 53, 85, KAF 2968, N, B).

***Physarum pulcherrimum*** Berk. & Ravenel [PHYpul, **R,** 4/0] V: 4, w: 4 (Loc. 53, 54, KAF 3038, 3051, 3085, 3127). All specimens with stalked, gregarious sporangia; sporothecae globose (0.2–)0.4–0.6(–0.7) mm in diam., reddish violet or purple. Stalk cylindrical, impregnated with lime, concolorous or darker, approaching 50–80% of the total height. Columella small, conical. Capillitium delicate, dense, the numerous, small, rounded, purple-red nodes connected by pinkish threads, with larger, often with irregular nodes towards the center. Spore-mass dark brown. Spores pale pinkish lilac, globose, verrucose, the warts sometimes aggregated in clusters, 7.5–8.5 µm in diam.

***Physarum viride*** (Bull.) Pers. [PHYvir, **O,** 19/1] IV: 9, V: 8, VI: 3, lt: 1, w: 19 (Loc. 23, 48, 60, 61, 62, 64, 72, 77, 85, LE 254904…, N).

***Prototrichia metallica*** (Berk.) Massee [PROmet, **R,** 1/2] IV: 2, V: 1, b: 1, w: 2 (Loc. 27, 70, 85, LE 255157, 255233, N).

***Reticularia lycoperdon*** Bull. [RETlyc, **R,** 2/0] V: 2, w: 2 (Loc. 53, 68, KAF 3030, B).

******Reticularia splendens*** Morgan [RETspl, **R,** 3/0] V: 3, w: 3 (Loc. 35, 67, 68, LE 254740, 255039, 255054).

***Stemonaria irregularis*** (Rex) Nann.-Bremek., R. Sharma & Y. Yamam. [STAirr, **R**, 4/0] IV: 2, V: 1, VI: 1, w: 4 (Loc. 76, 96–98, LE 255332, L). Sporocarps tufted, 2–5 mm in total height. Sporothecae cylindrical, dark brown to nearly black, semi-erect or drooping. Stalk black, relatively long, taking 33–50% of the total height. Columella slender, flexuous, reaching to the apex of the sporotheca where it can expand into a small, irregular disk. Capillitium forming a large-meshed net towards the centre, with numerous hyaline free ends, appearing hoary after spore dispersal (Fig. 4I).

***Stemonitis axifera*** (Bull.) T. Macbr. [STEaxi, **A**, 51/0] II: 1, IV: 11, V: 27, VI: 12, ll: 1, w: 50 (Loc. 32, 35, 42, 47, 48, 53, 58, 61, 62, 64, 68, 75–77, 82, 84–86, 88, 91, LE 254870..., N, B).

***Stemonitis fusca*** Roth [STEfus, **C,** 25/1] III: 1, IV: 6, V: 13, VI: 6, b: 2, w: 24 (Loc. 35, 44, 47, 50, 63, 64, 69, 75, 77, 85, 86, 88, LE 254702..., N, B).

******Stemonitis herbatica*** Peck [STEher, **R**, 1/0] VI: 1, w: 1 (Loc. 77, LE 254687).

***Stemonitis pallida*** Wingate [STEpal, **R**, 3/0] V: 3, w: 3 (Loc. 68, 85, 91, B).

***Stemonitis smithii*** T. Macbr. [STEsmi, **O,** 10/0] III: 1, IV: 1, V: 6, VI: 2, w: 10 (Loc. 50, 53, 54, 56, 77, 85, 92, LE 254613..., N, B).

***Stemonitis splendens*** Rostaf. [STEspl, **R**, 6/0] V: 4, VI: 2, w: 6 (Loc. 77, 85, 86, 91, LE 254637, 254643, B).

******Stemonitopsis aequalis*** (Peck) Y. Yamam. [STPaeq, **R**, 1/0] V: 1, w: 1 (Loc. 52, KAF 2956).

******Stemonitopsis amoena*** (Nann.-Bremek.) Nann.-Bremek. [STPamo, **R**, 7/0] II: 1, IV: 5, VI: 1, w: 7 (Loc. 42, 44, 48, 64, 77, LE 254739, 254701, 254703, 254665, 254845, 254911, 254791). Our specimens were found on coarse woody conifer debris: *L. sibirica* (4 records), *Pinus sibirica* (1 record), *Picea obovata* (2 records) with acidic pH (5.23±0.25). Sporocarps appeared in small groups, 2–3.5 mm tall; stalks reaching up to 30% of total height. Sporotheca rust to dark brown. Columella gradually tapering into the upper part of the sporotheca and branching into the capillitium just below the apex. Capillitium dark, the internal reticulum with expansions at the branches, usually with 3–4 meshes across the radius. Surface net delicate, fragmentary, the meshes angular and irregular in size and shape, often with short thread-like, free ends that are pointing outwards. Spores pale red-brown in transmitted light, 6.0–7.5 µmin diam., with a conspicuous reticulum with of irregular meshes consisting of rows of spines partly connected by low ridges, with 5–6 meshes across the hemisphere.

***Stemonitopsis gracilis*** (G. Lister) Nann.-Bremek. [STPgra, **R**, 3/0] IV: 2, VI: 1, w: 3 (Loc. 44, 58, 77, LE 254693, 254796, 254955). Sporocarps up to 2 mm high but stalk 0.2–0.5 mm only, black and shiny in reflected light, rather fibrous in its upper part. Columella dissipating into the capillitium just below the sporotheca apex. Capillitium a dense; internal net with rather small meshes, especially towards the periphery, threads more or less sinuous, expanding partly when branching, becoming gradually thinner towards the periphery where the internal net merges into the surface net; the latter nearly complete, composed of very slender threads forming angular meshes, lacking free ends. Spores pale violet-gray by transmitted light, very faintly warted, 5–7 µm in diam.

***Stemonitopsis hyperopta*** (Meyl.) Nann.-Bremek. [STPhyp, **R,** 3/0] V: 3, w: 3 (Loc. 53, 85, KAF 2998, 3043, N).

***Stemonitopsis typhina*** (F. H. Wigg.) Nann.-Bremek. [STPtyp, **C,** 37/0] II: 2, IV: 14, V: 19, VI: 2, b: 1, w: 35 (Loc. 35, 42, 44, 47, 51, 53, 58, 61, 64, 65, 68, 69, 70, 75, 77, 85, 88, 91, LE 254760..., B).

***Symphytocarpus amaurochaetoides*** Nann.-Bremek. [SYMama, **R,** 2/0] IV: 1, V: 1, w: 2 (Loc. 61, 63, LE 254877, 255019). Sporothecae sessile and about 0.5 mm in diam., black, when fresh sometimes dark brown or dark purple-brown. Within one pseudoaethalium columella forms vary from absent to irregular, sometimes a columella branches in its upper part. Capillitial threads thick and dark, forming a wide-meshed reticulum with some expanded axils and with short stiff free ends at the periphery (Fig. 4J). Spores lilac-brown, 8–10 µm diam., spinose-reticulate (Fig. 4K).

***Symphytocarpus confluens*** (Cooke & Ellis) Ing & Nann.-Bremek. [SYMcon, **R**, 1/0] V: 1, w: 1 (Loc. 85, B).

***Symphytocarpus flaccidus*** (Lister) Ing & Nann.-Bremek. [SYMfla, **R,** 2/0] V: 2, w: 2 (Loc. 35, 60, LE 254759, KAF 2950).

***Trichia botrytis*** (J. F. Gmel.) Pers. [TRIbot, **O,** 17/0] IV: 3, V: 13, VI: 1, w: 17 (Loc. 23, 53, 73, 77, 85, 93, LE 254783…, N, B).

***Trichia contorta*** (Ditmar) Rostaf. [TRIcon, **R,** 1/0] V: 1, w: 1 (Loc. 54, KAF 3134).

***Trichia decipiens*** (Pers.) T. Macbr. [TRIdec, **A**, 69/0] IV: 32, V: 22, VI: 15, b: 1, ll: 1, w: 67 (Loc. 32, 44, 47, 48, 52–54, 56, 61, 62, 64, 65, 68–70, 76–78, 82, 84–86, LE 254650..., N, B).

***Trichia erecta*** Rex [TRIere, **C,** 20/3] III: 1, IV: 14, V: 6, VI: 2, w: 21, c: 2 (Loc. 30, 32, 44, 47, 53, 57, 61, 62, 64, 68–70, 74, 77, LE 254880...). This species was found to be associated with the acidic (pH 5.66±0.10) coarse woody debris of conifers, including *Abies sibirica* (10 records), *Larix sibirica* (4), *Pinus sibirica* (1), *P. sylvestris* (1), *Picea obovata* (3), and litter of cones of *Pinus sibirica* and *P. sylvestris* (2). Only two specimens were recovered from deciduous logs (*Sorbus aucuparia* L., *Betula pendula*). Sporocarps stalked, scattered or combined in small colonies, 1–2.5 mm tall. Stalk 0.1–1.0 mm long and 0.2–0.3 mm in diam., dark brown to almost black. Sporotheca spherical to obconical, 0.4–0.8 mm in diam., purple-brown to black, with a reticulum of sutures for peridium dehiscence, appearing as yellow bands, in the upper part. Elaters bright yellow or orange-yellow, 3.5–5.0 µm diam., with 4 spirals, which are either smooth or decorated with widely separated spines, the elater tips either blunt or ending in sharp points, about 7–10 µm long. Spores and capillitium mass bright yellow. Spores pale yellow, 11–13 µm diam., verrucose.

***Trichia favoginea*** (Batsch) Pers. [TRIfav, **A,** 46/0] II: 2, IV: 24, V: 11, VI: 9, b: 2, ll: 1, w: 42 (Loc. 19, 23, 48, 52, 53, 55, 56, 58, 61–64, 67, 69, 70, 74, 76, 77, 82, 84, 85, 93, LE 254660..., N, B).

******Trichia flavicoma*** (Lister) Ing [TRIfla, **R,** 5/1] IV: 5, V: 1, w: 5, c: 1 (Loc. 23, 48, 51, 54, LE 255272, KAF 3177, 3179, 3184, 3213, 3124).

***Trichia lutescens*** (Lister) Lister [TRIlut, **R,** 1/0] V: 1, w: 1 (Loc. 88, B).

***Trichia persimilis*** P. Karst. [TRIper, **R,** 2/0] IV: 2, w: 2 (Loc. 61, LE 254851, 254858).

***Trichia scabra*** Rostaf. [TRIsca, **O,** 18/0] IV: 7, V: 7, VI: 4, w: 18 (Loc. 48, 53, 56, 58, 63, 65, 68, 76, 77, 84, 89, LE 254715…, B).

******Trichia subfusca*** Rex [TRIsub, **R,** 1/0] IV: 1, w: 1 (Loc. 51, KAF 3214). Sporocarps stalked, rarely sessile, subglobose to pyriform, scattered to gregarious, total height 0.8–1.5 mm. Sporotheca dull tawny brown, 0.4–0.8 mm diam., without clearly marked dehiscence lines but with thin areas in the peridium suggesting those. Capillitium and spore-mass bright straw-yellow, elaters cylindric, 4–6 µm diam. with 4 rather uneven, smooth spirals, ending in abrupt, often curved tips. Spores yellow, minutely warted, 11–15 µm diam.

***Trichia varia*** (Pers. ex J. F. Gmel.) Pers. [TRIvar, **A,** 59/0] II: 3, III: 1, IV: 18, V: 23, VI: 14, b: 2, lt: 1, w: 53 (Loc. 19, 20, 22, 35, 44, 46–48, 51, 53, 61, 64, 65, 68, 69, 74–77, 82, 84, 85, 89, LE 254770..., N, B).

***Tubulifera arachnoidea*** Jacq. [TUBara, **C,** 26/0] III: 2, IV: 4, V: 19, VI: 1, w: 25 (Loc. 35, 48, 50, 55, 64, 65, 68, 73, 75, 85, 86, LE 254754..., N, B).

***Tubulifera*** cf. ***microsperma*** (TUBmic, Berk. & M. A. Curtis) Lado [**R**, 2/0] V: 2, w: 2 (Loc. 68, 85, B). This species is typically considered a tropical species (Novozhilov & Fefelov 2001) with hemispherical pseudoaethalia, sessile upon a conspicuous stem-like hypothallus with umber-brown spore mass. The spores are reticulate over about two-thirds of the surface, globose, 4.5–5.5(–6.0) µm in diam. We did not see the material from the Altay Mts. but the description given by Barsukova (2000) seems to fit this species well.

## Results and discussion

SPECIES DIVERSITY — This study was based on a total of 1488 records representing 161 taxa from 41 genera and 11 families. However, 118 taxa were classified as rare for whole study area (< 0.5 % records). We report 120 taxa for the first time for the Altay Mts. of which 6 are new records for Russia.

The quantitative part of the survey considers 1174 records representing 152 species. Of these, a total of 315 records were derived from 510 moist chamber cultures (61 records of non-fruiting plasmodia were not counted), which served to complement the field component (Fig. 5). Approximately

40% of the species determined to be common (19 of 45) were observed in the field as well as in moist chamber cultures. In contrast, most lignicolous species and those found to inhabit the forest floor litter were only found in the field (102 species, 805 records in total). Almost all records of (59 of 81) from dry steppe and forest-steppes originate from moist chamber cultures.

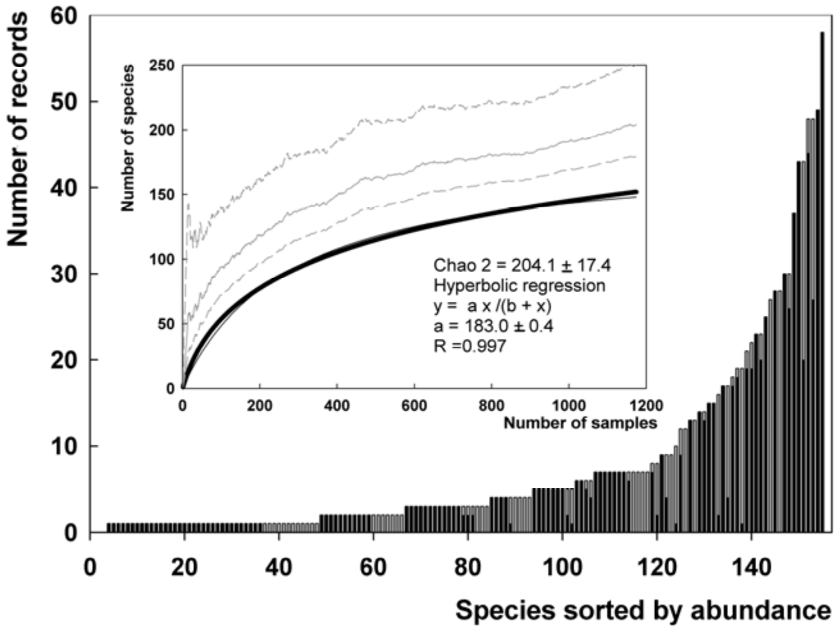


Fig. 5. The abundance distribution of 1174 records belonging to 152 species for the quantitative survey carried out in August 2008, where every fructification was recorded. Black sections of the bars indicate field records, gray those observed in moist chamber cultures. Inset: Species accumulation curve (thick line) smoothed by rarefaction together with the Chao 2 estimator of species richness (gray solid line, final value 204) and its 95% confidence intervals (gray dotted line). In addition, the species accumulation curve was fitted by a hyperbolic function, where an estimate of 183 expected species was obtained.

DISTRIBUTION PATTERNS OF MYXOMYCETES WITHIN VEGETATION TYPES OF THE ALTAY MTS. — Despite the high number of 161 species recorded, only 27 taxa were found to be widely distributed (present in 10 or more of the 100 studied localities, see Table 1 in the supplement). Collectively the species observed in the field and those recovered from moist chamber cultures, displayed a pronounced trend of increasing alpha-diversity and species richness moving from vegetation type I (dry steppe, 6 species, H′= 1.6) to type IV (dark coniferous taiga and secondary mixed aspen and birch forests, 99 species, H′= 4.1) and to type V ("chernevaya" taiga and mixed forests, 116 species, H′= 4.2) and then decreased again moving to type VI (stripe pine and mixed forests in submontane landscape in the forest-steppe zone, 65 species, H′= 3.7, Table 1). In addition, the species/genus (S/G) ratio was rather low in the dry steppe vegetation.

Table 1. Statistical data for myxomycetes from six vegetation types of the Altay Mts. (Russia)

| Parameter | VEGETATION TYPES I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|
| Mean elevation (m) | 1945 | 1657 | 1054 | 1176 | 700 | 200 |
| Mean annual precipitation (mm) | 110 | 300 | 475 | 578 | 708 | 495 |
| Sampled localities | 8 | 14 | 10 | 30 | 27 | 11 |
| Rec (fc/mc) | 9 (0/9) | 81 (22/59) | 50 (20/30) | 492 (374/118) | 625 (567/58) | 231 (190/41) |
| S (fc/mc) | 6 (0/6) | 38 (14/26) | 37 (18/19) | 99 (75/39) | 116 (101/26) | 65 (51/21) |
| G | 4 | 20 | 24 | 34 | 36 | 24 |
| S/G | 1.50 | 1.90 | 1.54 | 2.91 | 3.22 | 2.71 |
| H´ | 1.6 | 3.4 | 3.5 | 4.1 | 4.2 | 3.7 |
| D | 0.36 | 0.04 | 0.04 | 0.02 | 0.02 | 0.04 |
| mc prepared | 19 | 55 | 36 | 217 | 93 | 90 |
| positive (%) | 52.6 | 63.6 | 52.8 | 36.9 | 48.4 | 33.3 |
| Substrate pH, mean ± SE | 7.21± 0.03 | 6.79± 0.03 | 6.29± 0.05 | 4.72± 0.05 | 5.77± 0.04 | 6.47± 0.05 |
| Rec (mc) | 13 | 75 | 36 | 139 | 77 | 51 |
| S/mc | 0.68 | 1.36 | 1.0 | 0.64 | 0.83 | 0.57 |

Note: **I** = dry steppe/dwarf shrub communities of the plains, treeless landscapes; **II** = mountain forest-steppe with subalpine “park” larch forest and deciduous tall shrub communities; **III** = mountain light coniferous taiga and hydromesophytic flood plain forests "uremas"; **IV** = mountain dark coniferous taiga and secondary mixed aspen and birch forests; **V** = “chernevaya" taiga and mixed forests; **VI** = stripe pine and mixed forests in submontane landscape in the forest-steppe zone. Mean elevation and mean annual precipitation was calculated for all localities of the respective vegetation type. Rec (fc/mc) include all records of determined taxa from the field (fc) as well as obtained from moist chamber cultures (mc), Rec (mc) only the latter ones (including undetermined taxa and non-fruiting plasmodia). S – number of species G = number of genera; S/G = species/genus ratio, calculated for all records; H´ = Shannon’s diversity index; D = Simpson’s dominance index.

In the steppe and forest steppe (type I) only two species (*Comatricha ellae* and *Physarum notabile*) were recorded at a frequency greater than 5%, thus resulting in a high dominance value for these particular species. Overall dominance decreased sharply towards type III (dominant species: *Didymium difforme* and *Paradiacheopsis fimbriata*), IV (*Arcyria cinerea, Cribraria cancellata, C. microcarpa, Trichia decipiens, T. favoginea, T. varia*) and V (*Arcyria cinerea, Fuligo septica, Hemitrichia clavata, Stemonitis axifera, Stemonitopsis typhina, Trichia decipiens, T. varia, Tubulifera arachnoidea*) but increased again in the drier “stripe” pine forests (vegetation type VI) near Barnaul (*Lycogala epidendrum, Metatrichia vesparia*).

The proportions of species among myxomycete families differed between steppe and taiga vegetation zones (Fig. 6). Steppes and forest steppes of the Chuyskaya depression were relatively rich in *Physaraceae* (21 species), *Trichiaceae* (16 species), *Stemonitidaceae* (14 species); however, species of *Cribrariaceae,* which were found to be widely distributed in taiga communities were nearly absent. Members of the *Echinosteliaceae* clearly represented a higher proportion of the total number of species in steppe and forest-steppe communities compared to the different types of taiga vegetation. On the other hand, the proportion of members from the *Cribrariaceae* and *Trichiaceae* increased in the taiga communities. In both families, the two largest genera by far exhibited a preference for woody substrates (*Cribrariaceae*: 176 of 186 records, *Trichiaceae*: 235 of 249 records). In the taiga, species of *Echinostelium* were found to largely inhabit the bark of living trees. However, in steppe communities some members of this genus were able to develop on the bark of shrubs and dwarf-shrubs, but occured as well on woody debris and the litter of conifer cones in arboreal communities of the forest-steppe (*E. corynophorum*, 1 record on wood and 2 on cones; *E. minutum*, 6 records on cones).

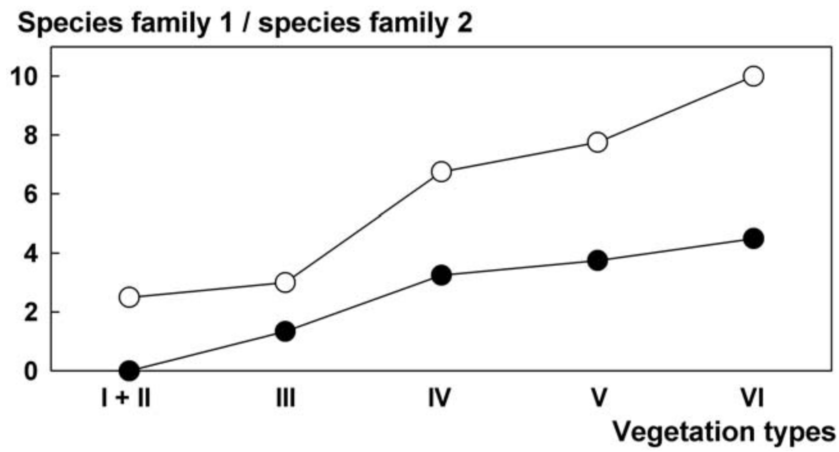


Fig. 6. Ratios between pairs of myxomycete families in different vegetation types of the Altay Mts. Open circles denote the ratio Cribrariaceae / Echinosteliaceae, closed circles the ratio Trichiaceae / Echinosteliaceae.

The Chuyskaya depression, our southernmost study region characterized by an extremely continental dry climate, produced the poorest (6 species in dry steppe vegetation and 38 species in larch mountain forest-steppe) yet most distinctive myxomycete assemblage (Fig. 7). The average coefficient of similarity for myxomycete assemblage from this vegetation with those from taiga vegetation of the Altay Mts. was very low (Cs = 0.10 ± 0.05, see Table 2 in the supplement). But data from the Chuyskaya depression fit well into patterns obtained for other arid but winter-cold regions (Mangyshlak peninsula, western Kazakhstan (Schnittler 2001); Caspian Lowland, southern Russia (Novozhilov et al. 2006); western Mongolia (Novozhilov & Schnittler 2008).

A comparison based on the adjusted incidence-based Chao-Søerensen similarity index Cs (Fig. 7) shows that the myxomycete assemblage of the Chuyskaya depression is most similar to this of the depression of Great Lakes in western Mongolia (Cs = 0.67). Some rare species in the Altay Mts. have been found only in this area (e.g. *Didymium quitense, Dianema mongolicum, Echinostelium colliculosum, Macbrideola oblonga, Perichaena luteola*).

In the steppe and forest-steppe typical lignicolous species like *Arcyria incarnata, Comatricha ellae, Stemonitis axifera* and *Stemonitopsis amoena* were recorded only once; whereas, *Lycogala epidendrum, Ceratiomyxa fruticulosa* and *Stemonitopsis typhina* were encountered only twice, mostly on small woody debris. However, these species are widely distributed and often abundant in temperate deciduous and boreal coniferous forests. This suggests that the zonal limits of myxomycete distribution are relative and can be detected reliably only in studies recording the abundance of species (frequency of occurrence).

Myxomycete diversity was found to differ considerably between the forest steppe, which includes arboreal habitats, and zonal open dry steppe and desert habitats (see Table 1 in the supplement). The number of rare species was found to decrease as the proportion of abundant species increased within the more uniform habitats characterized by treeless steppes. Species dominance in the treeless dry steppe was found to be higher (D = 0.26) when compared to the forest steppe where it is likely that lignicolous myxomycetes could potentially find shelter and substrates in the forest islands, e.g. near rivulets (D = 0.05).

*Physarum* cf. *notabile* was found to be most abundant in steppe and forest steppe habitats (>5% of the 76 records). Other common species (3–4% of all records) were *Arcyria incarnata*, *Comatricha ellae*, *Echinostelium colliculosum*, *Paradiacheopsis fimbriata*, and *Kelleromyxa fimicola* (the latter is obligate coprophilous species). About 20% of the 34 species recorded in this vegetation type are common in Eurasian deserts. Prominent examples include *Echinostelium colliculosum, Kelleromyxa fimicola, Macbrideola oblonga* and *Physarum cf. notabile* (Novozhilov et al. 2006, Novozhilov & Schnittler 2008). Interestingly, *Fuligo cinerea* was found only once in the taiga community of the Altay Mts. (Barsukova 2000) but not in the Chuyskaya depression. This species is common in the dry steppes and deserts of the Caspian lowland and adjacent western Kazakhstan (Novozhilov et al. 2006) but very rare in Central Asia (eastern Kazakhstan, western Mongolia, Novozhilov & Schnittler 2008). This example would support a hypothesis about moderate endemism of some species within Eurasian arid zones.

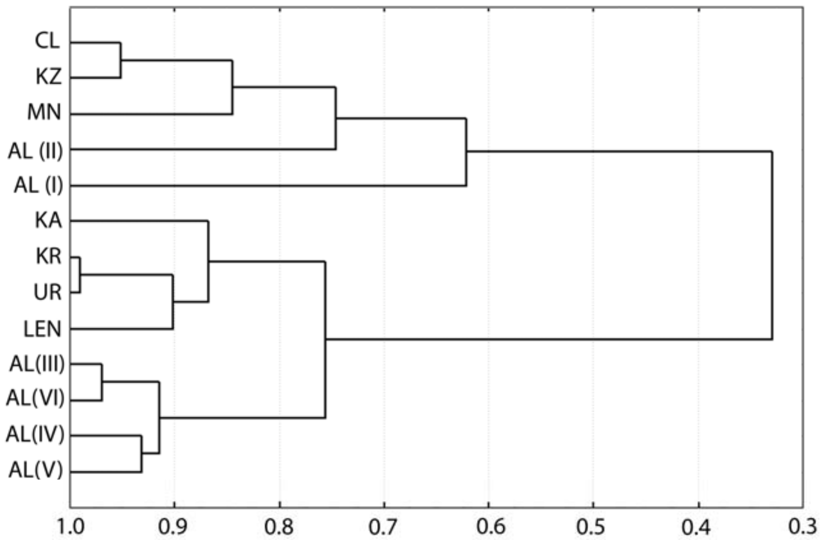


Fig. 7. Dendrogram of similarity based on the incidence-based Chao-Søerensen similarity index (see Table 2 in the supplement) for relative occurrence of 320 myxomycete taxa. Study regions are abbreviated as CL = Caspian Lowland, treeless zonal dry steppe and desert communities (Novozhilov et al. 2006); KA = Russian northern Karelia (Schnittler & Novozhilov 1996); KR = Krasnoyarsk Territory, the State Nature reserve «Stolby» (Kosheleva et al. 2008); KZ = arid regions of Kazakhstan, Novozhilov, Zemlyanskaya, pers. data); LEN = Leningrad region (Novozhilov 1980, 1999); MN = Western Mongolia, depression of Great Lakes (Novozhilov & Schnittler 2008); UR = Sverdlovsk region (Novozhilov & Fefelov 2001) and for this study as AL(I) = dry steppe, Chuyskaya depression; AL(II) = mountain forest steppe; AL(III) = light coniferous taiga; AL(IV) = dark coniferous taiga; AL(V) = "chernevaya" taiga; AL(VI) = stripe pine and mixed lowland forest.

A comparison of the myxomycete assemblages found in different vegetation types of the Altay Mountains with surveys in other regions of the world (usually characterized by more homogenous vegetation) indicates that the high species number recorded for the region in the current study stems largely from the heterogeneity in climate and vegetation. Myxomycete assemblages of the semihumid and humid vegetation types III to VI are very similar to each other (incidence-based Chao-Søerensen similarity index Cs = 0.90 ± 0.01, see Fig. 7 and Table 2 in the supplement). Their species composition resembles those of other taiga regions of Russia (Cs = 0.78 ± 0.02), but differs considerably from other Eurasian arid regions (Cs = 0.44 ± 0.06) and the Chuyskaya depression (types I and II, Cs = 0.06 ± 0.01).

The majority of the lignicolous species observed in the current study are widely distributed. Twenty two of the 27 common species recorded in this study were also reported from four well-studied taiga regions in Russia and can be regarded as regularly occurring in the taiga zone. A notable exception is *Trichia erecta,* which is commonly found in the Altay Mts. and in the boreal forests of eastern North America (Stephenson et al. 1993) but not in other taiga regions of Russia. Almost all of the 8 common species recorded in the semihumid vegetation (types III and VI) are also common in cryohumid boreal forests (see Table 1 in the supplement). Consequently, the myxomycete assemblages of the light coniferous taiga and stripe pine forest can be regarded as depauperate versions of the dark coniferous forests. In dark coniferous forests (IV), and “chernevaya” taiga (V), 36 of the 161 species recorded for the Altay Mts. were classified as at least common (together making up >50% of the total records for these vegetation types, see Table 1 in the supplement).

The total number of records as well as the total number of species recovered, displayed a trend of increase with increasing precipitation among investigated vegetation types (Fig. 8) for field collected specimens; however, this trend did not hold for the proportion of positive moist chamber cultures. This suggests that the moist chamber technique may work better in arid regions (53–64% positive cultures) than in forests (43–62%). A possible explanation would be the higher abundance of dormant stages in desert myxomycetes (*Physarum* cf. *notabile, Echinostelium* spp.).

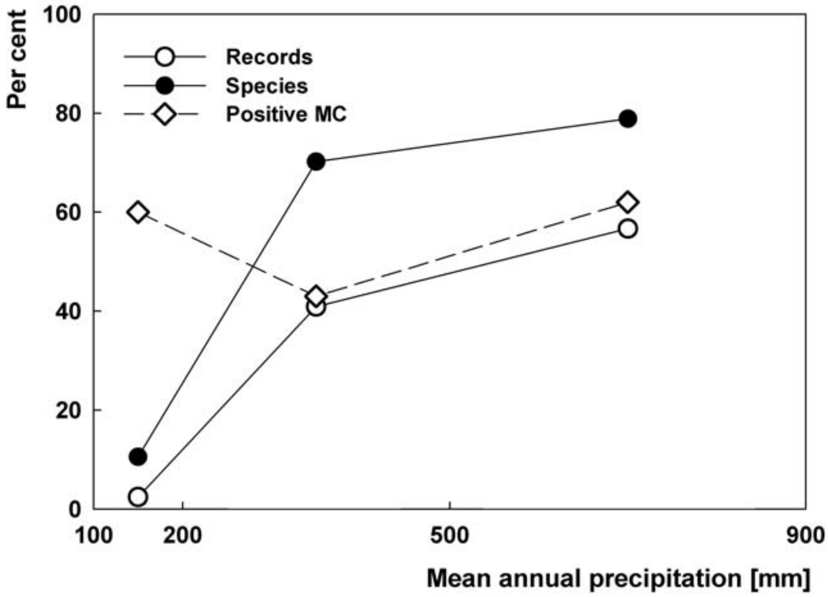


Fig. 8. Percent records, species and positive moist chamber cultures along a precipitation gradient of the Altay Mts. Three ranges of precipitation were differentiated, corresponding to three vegetation groups: semiarid (100–200 mm annual precipitation, vegetation types I, II; 17 species from 36 records), semihumid (200–500 mm, III, VI; 23 species from 609 records) and humid (500–900mm, IV, V; 127 species from 844 records).

SUBSTRATE-SPECIES RELATIONSHIPS — Both species richness and diversity varied considerably within groups of substrates (Table 2), with wood housing the most diverse myxomycete community. However, in spite of a high number of samples processed, wood performed poor in moist chambers when compared to field collections. Species such as the minute *Cribraria microcarpa* readily develop in wood cultures; however, the amount of substrate usually sampled (5-10 g dry mass) may not allow lignicolous species with large fructifications to develop, since their plasmodia probably require long development times. Thus, utilizing the moist chamber technique without accompanying field surveys underestimates the diversity of myxomycete communities especially for wood and litter.

Table 2. Statistical data for all investigated substrate types

| | FIELD RECORDS | | | MOIST CHAMBER RECORDS | | | |
|---|---|---|---|---|---|---|---|
| Substrate types | Number of records | Number of species | H' | Number of records | Number of species | H' | Positive mc (%) |
| b | 15 | 13 | 2.52 | 153 | 34 | 3.05 | 85.7 |
| d | 0 | 0 | 0.00 | 26 | 8 | 1.90 | 62.1 |
| ll | 26 | 15 | 2.38 | 13 | 10 | 2.24 | 47.8 |
| lt | 24 | 17 | 2.69 | 4 | 4 | 1.39 | 100 |
| lg | 4 | 4 | 1.39 | 8 | 5 | 1.49 | 68.4 |
| c | 0 | | | 26 | 15 | 2.50 | 76.9 |
| w | 1085 | 118 | 4.01 | 84 | 28 | 2.75 | 23.9 |
| f | 5 | 4 | 1.33 | 0 | | | |
| m | 7 | 7 | 1.95 | 1 | 1 | | |
| s | 8 | 5 | 1.49 | 0 | | | |
| Total | 1174 | 131 | 4.09 | 315 | 59 | 3.53 | |

Note: Abbreviated as b = bark of living plants; d = dung of herbivorous animals; ll = leaf litter; lt = litter of coniferous needles and small twigs; lg = litter of grasses and herbaceous plants; w = coarse woody debris; c = decayed conifer cones; f = fruit bodies of fungi; m = mosses and liverworts; s = soil, grasses and herbaceous plants.

As shown in Fig 7, the myxomycete communities clearly separate into three clusters: semiarid (type I and II), semihumid (III, VI) and humid boreal (IV, V) vegetation. A similarity analysis of the myxomycete communities for the more intensely studied substrate types (Fig. 9) suggests that this difference is partly due to substrate preferences: in vegetation types I and II, many substrate types like tree bark (b), wood (w) or woody litter (lt) were in short supply, whereas substrates, like litter (ll, lg) and dung (d) were overrepresented.

As expected, the similarity between the myxomycete assemblages associated with decayed wood (w) and twigs (lt) was very high (Cs = 0.90). Wood-inhabiting (lignicolous) myxomycetes represented the largest myxomycete assemblage in the Altay Mts. and were mostly encountered in the field (108 species, 1085 records). Only a few species (28 species, 84 records) were found to occur regularly in moist chamber cultures, e.g., *Arcyria cinerea* (10 of 53 records in total) and *Cribraria microcarpa* (23 of 43 records). Of the 130 species inhabiting wood, 79 were found exclusively on this substrate (see Table 3 in the supplement). Common species that were only recorded as field records from wood were *Lycogala epidendrum* (54 records), *Cribraria microcarpa* (43), *Hemitrichia clavata* (32), *Tubifera arachnoidea* (25), *Trichia erecta* (21), *T. scabra* (18), *Cribraria aurantiaca* (17), *Trichia botrytis* (17), *Cribraria tenella* (15), *Arcyria denudata* (14), *Stemonitis smithii* (10), and *Arcyria obvelata* (9). Thirty-four of the species recovered from twigs (lt) and cones (c) were also found on bark and/or wood. The latter myxomycete assemblage displays also a high level of similarity with the assemblage on bark (Cs = 0.77), differing considerably from assemblages on other substrates (Fig. 9).

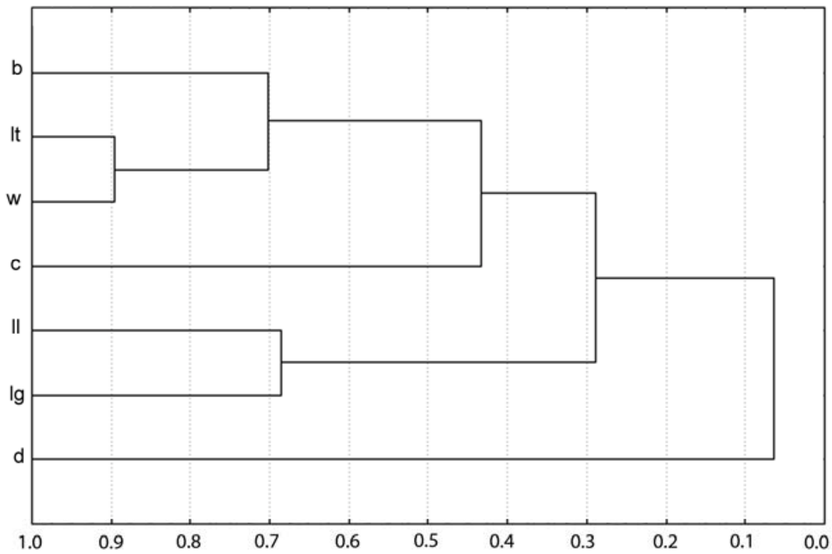

Fig. 9. Dendrogram based on the incidence-based Chao-Søerensen similarity index (WARD algorithm, see Table 4 in the supplement) of the relative occurrence of the more common 116 species found on different substrates in the field and moist chamber cultures (abbreviations for substrates are b = bark of living trees and shrubs, lt = woody litter, w = decaying wood, c = decaying fallen conifer cones, ll = leafy, lg = grassy litter, and d = dung).

Already well known is the specific myxomycete community associated with tree bark, with 9 of 44 species recorded in the current study exclusively inhabiting this substrate. The most abundant corticolous species were *Paradiacheopsis fimbriata* (22 of 168 records from bark), *Comatricha ellae* (19), *Echinostelium minutum* (12), and *Enerthenema papillatum* (11), although some of the less abundant species of *Echinostelium* were found exclusively on bark.

Substrate specifity values were significantly lower for litter (ll and lg, 7 out of 27 species preferring this substrate), and nearly all taxa found exclusively on litter are represented by only one record (*Diderma testaceum, Comatricha tenerrima, Craterium obovatum, Didymium clavus,* and *Licea testudinacea*).

An unexpected result of this study was the discovery quite rich myxomycete assemblage on decaying conifer cones (26 records, 15 species, H′ = 2.5). This substrate is slightly acidic (pH = 6.35 ± 0.06), and all species were recorded from moist chambers. Most common was *Echinostelium minutum* (32 % of the 19 records in total) and *E. corynophorum* (29% of 7 records). As one may expect, this assemblage is very similar to that found on bark of living trees (Cs = 0.70).

Three species were found exclusively associated with dung from moist chamber cultures: *Kelleromyxa fimicola* (7 records), *Licea tenera* (4), and *Perichaena luteola* (3). Although species-poor, this community has the highest level of specifity compared with other substrate types (Cs = 0.06 ± 0.02). Most species formed fruiting bodies in moist chamber cultures after 30–40 days. Coprophilous myxomycetes could not be found in the humid vegetation types V and VI due to the rapid decay of dung.

In the cryohumid types of vegetation in the Altay Mts., a number of species considered as rare were found on fully shaded, mossy algae-covered logs of *Picea obovata, Abies sibirica* and *Larix sibirica.* This community included *Barbeyella minutissima* (6 records), *Colloderma oculatum* (3 records) and *Licea pygmaea* (7 records). One common feature of these species (in temperate regions occurring in late-autumn) is their ability to develop under cool conditions (Schnittler et al. 2000). Due to the low night temperatures (even in the summer) in the Altay these species fruit earlier in the year.

Some species, *Mucilago crustacea* (3 records), *Physarum bivalve* (2), *Didymium squamulosum* (1), *D. iridis* (1), commonly develop on living grasses, likely inhabiting the uppermost soil layer in humid steppes.

The productivity of moist chamber cultures (percent of positive moist chamber cultures of the total number of cultures) varies widely among substrate types, ranging from 19.5% for wood from sites with semihumid vegetation to 91.5% for bark of trees collected in sites with humid boreal vegetation (see Table 3 in the supplement). Comparing the results for the series of moist chambers prepared from one substrate type, only the bark of living tree exhibited a clear pattern of increasing productivity with increasing precipitation. Interestingly, this trend was least pronounced for wood and cones (Fig. 10) and seemed to reverse for leaf litter.

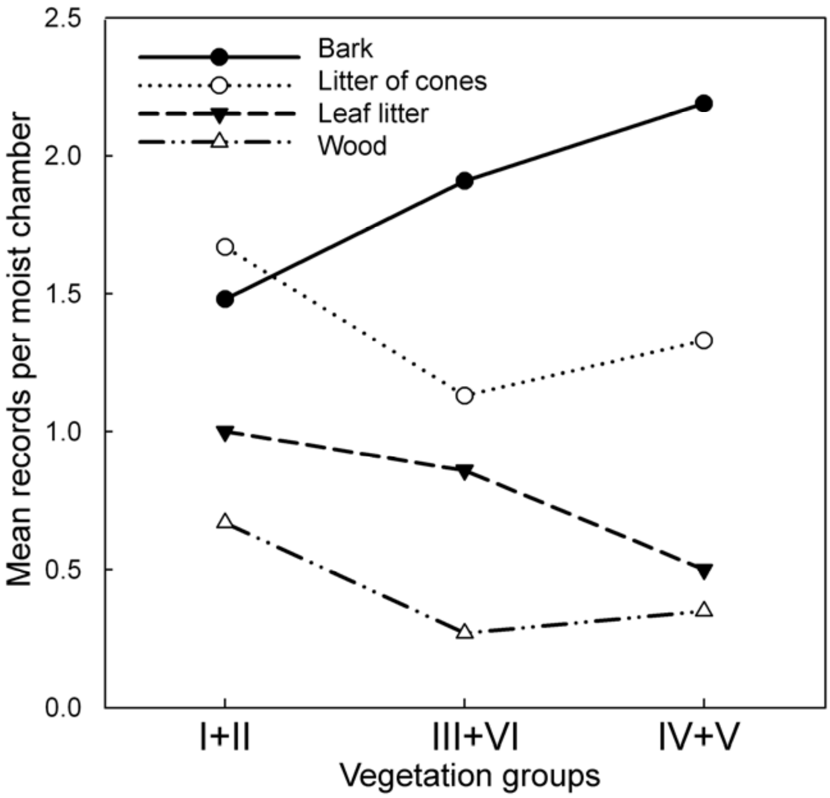


Fig. 10. Productivity of moist chamber cultures prepared with samples of substrates from Altay Mts. Each dot represents the mean number of records per culture (including plasmodia) with substrates collected in three vegetation groups: semiarid vegetation (I, II), semihumid vegetation (III, VI) and humid boreal mountain vegetation (IV, V).

An examination of the proportions of the five orders of myxomycetes for each of the five main substrates (Fig. 11) detects a much higher proportion of members of the *Physarales* on litter (ll, lg 69% of the 51 records on this substrate type), whereas members of the *Trichiales* prefer coarse wood debris (w, 41% of the 1169 records). It appears that members of the *Physarales* and Trichiales demonstrate a maximum of ecological flexibility with respect to substrates whereas the *Echinosteliales* seem to be more specialized (Fig. 11). This tendency becomes even clearer when comparing the number of records instead of just the presence/absence of species.

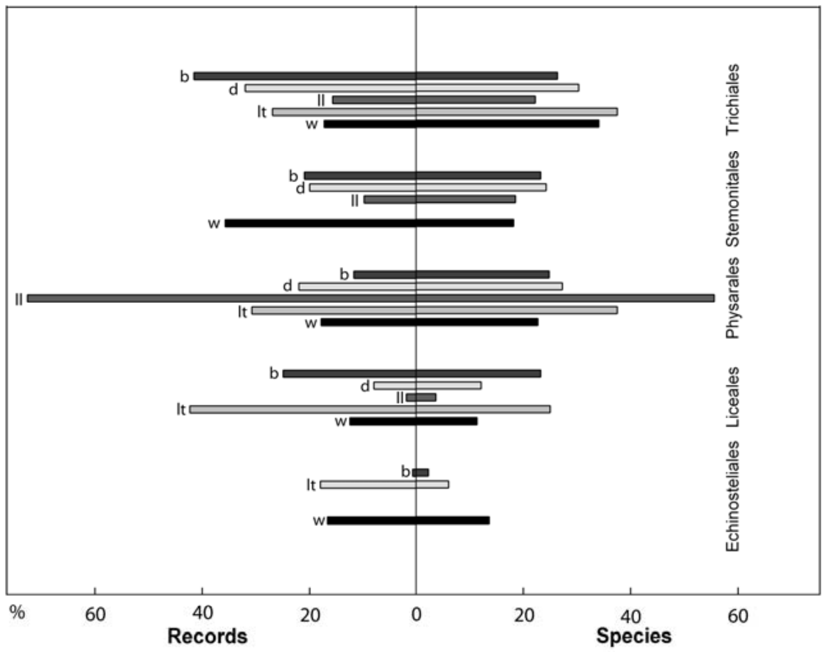


Fig. 11. Proportional contribution of each order to the myxomycete community for substrates studied in different vegetation types of the Altay Mts., based on the total number of records (%) for each substrate type (b – bark of living plants; d – dung of herbivorous; ll – leaf litter and litter of grasses; lt – litter of small twigs and cones of coniferous; w – woody debris.

In summary, there seems to be numerous explainations for the relatively astoundingly high diversity of myxomycetes in the Altay Mountains (a region with ca. 2700 vascular plants, Kamelin 2005), where 161 species of myxomycetes are now known when compared with other regions. For example, Mexico (> 30 000 vascular plants), a much larger, more intensively studied Neotropical country with a more pronounce rainfall gradient has only 323 myxomycetes listed from 138 publications. Furthermore, the well-studied country of Costa Rica, with mostly humid to moist tropical forests (ca. 10 500 vascular plants) has only 143 reported species (Wrigley de Basanta et al. 2008).

First, the rainfall gradient and the diverse vegetation types associated with it allow desert myxomycetes (*Physarum* cf. *notabile, Echinostelium* spp.) as well as species adapted to moss-covered wood (*Barbeyella minutissima, Colloderma oculatum*) to exist. Second, the continental climate results in fairly high summer temperatures, allowing some species with mainly tropical distributions (*Cribraria languescens, Physarum globuliferum, Tubulifera microsperma*) to persist. In general, pronounced fluctuations (both in temperature and rainfall) seem to favor myxomycetes with their various dormant stages over the true fungi, supporting the hypothesis of a reverse pattern of global diversity in myxomycetes, with deserts and temperate forests being more diverse than moist tropical forests.

## Acknowledgements

We gratefully acknowledge logistical help provided by the director of the South-Siberian Botanical Garden, A.I. Shmakov, the staff members at the Altay State Nature reserve, as well as technical support of SEM by L.A. Kartzeva (Komarov Botanical Institute, St. Petersburg). Travel and laboratory work were supported by a grant (07–04–00353-a; 08–04–10128-k) from the Russian Foundation for Basic Research as well as a scientific program "Bioraznoobrazie" from the Russian Academy of Science and partly by the National Science Foundation (USA) grant DEB 0316284. We are grateful to Dr. Gražina Adamonytė (Institute of Botany, Vilnus, Lithuania) and Dr. Adam W. Rollins (Lincoln Memorial University, USA) for comments, discussion during manuscript preparation and language correction.

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## Supplement

Taxa found in 10 or more of the 100 studied localities are: *Arcyria cinerea, A. incarnata, Comatricha ellae, C. nigra, Cribraria cancellata, Cribraria microcarpa, Echinostelium minutum, Enerthenema papillatum, Fuligo septica, Hemitrichia clavata, H. serpula, Licea parasitica, Lycogala epidendrum, Metatrichia vesparia, Paradiacheopsis fimbriata, Perichaena vermicularis, Physarum album, Ph.* cf. *notabile* (a complex taxon most probably composed of several closely related biospecies), *Stemonitis axifera, S. fusca, Stemonitopsis typhina, Trichia decipiens, T. erecta, T. favoginea, T. scabra, T. varia,* and *Tubulifera arachnoidea.*

Table 1. Occurrence of myxomycetes in the six vegetation types of the Altay Mts.

| | | | VEGETATION TYPES | | | | | |
|---|---|---|---|---|---|---|---|---|
| Acronym | Loc. | Est. | I+II | III | IV | V | VI | Total |
| ARCcin | 22 | ***A*** | R 0/1 | O 0/2 | ***A*** 9/7 | ***A*** 27/5 | C 7/6 | 64 |
| ARCden | 5 | O | | | R 2/0 | C 12/0 | | 14 |
| ARChel | 5 | R | | | R 1/0 | R 2/0 | O 4/0 | 7 |
| ARCinc | 11 | O | O 3/0 | O 1/0 | O 4/0 | O 8/0 | R 1/0 | 17 |
| ARCins | 4 | R | R 0/1 | | R 1/0 | R 2/0 | | 4 |
| ARCmin | 3 | R | | O 1/0 | | R 0/1 | R 1/0 | 3 |
| ARCobv | 7 | O | | | R 2/0 | O 6/0 | R 1/0 | 9 |
| ARCocc | 2 | R | | | | R 3/0 | | 3 |
| ARCoei | 1 | R | | | | R 1/0 | | 1 |
| ARCpom | 7 | O | O 1/1 | | R 0/1 | R 3/0 | R 2/0 | 8 |
| ARCsti | 3 | R | | | | R 2/0 | R 2/0 | 4 |
| ARDinc | 1 | R | | | | R 1/0 | | 1 |
| BADaff | 1 | R | | | | | R 1/0 | 1 |
| BADcin | 1 | R | | | | R 1/0 | | 1 |
| BADdub | 7 | R | O 0/2 | | R 0/2 | R 0/3 | | 7 |
| BADmac | 1 | R | | | | R 1/0 | | 1 |
| BARmin | 3 | R | | O 1/0 | O 5/0 | | | 6 |
| BREmax | 1 | R | | | | R 1/0 | | 1 |
| CALmet | 2 | R | | | | R 0/1 | R 0/1 | 2 |
| CERfru | 18 | C | O 3/0 | O 2/0 | C 12/0 | O 6/0 | R 2/0 | 25 |
| CLAdeb | 1 | R | | | | R 0/2 | | 2 |
| CODocu | 2 | R | | | O 2/1 | | | 3 |
| COLanm | 8 | O | | O 1/0 | O 6/0 | O 9/0 | | 16 |
| COMalt | 1 | R | | | R 1/0 | | | 1 |
| COMele | 4 | R | | | R 2/0 | O 4/0 | | 6 |
| COMell | 20 | C | ***A*** 0/9 | O 0/2 | C 0/9 | O 0/7 | R 0/1 | 28 |
| COMlax | 2 | R | | | R 1/0 | | R 1/0 | 2 |
| COMnig | 15 | C | R 1/0 | | C 8/2 | C 17/0 | O 3/1 | 32 |
| COMpul | 6 | R | | | R 2/0 | O 5/0 | | 7 |
| COMten | 1 | R | | | R 1/0 | | | 1 |
| CRAleu | 2 | R | | | | O 4/0 | | 4 |
| CRAmin | 2 | R | | | R 1/0 | | R 1/0 | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CRAobo | 1 | R | | | R 1/0 | | | 1 |
| CRIarg | 7 | O | | O 1/0 | O 4/0 | C 12/0 | | 17 |
| CRIaur | 7 | O | | | R 2/0 | C 13/0 | R 2/0 | 17 |
| CRIcan | 17 | C | | O 1/0 | ***A*** 17/0 | C 15/0 | R 3/0 | 36 |
| CRIint | 3 | R | | | R 2/0 | R 1/0 | R 1/0 | 4 |
| CRIlan | 5 | R | | | O 4/1 | R 1/0 | R 1/0 | 7 |
| CRImac | 1 | R | | | R 1/0 | | | 1 |
| CRImic | 13 | C | | O 0/2 | ***A*** 15/16 | O 3/4 | R 2/1 | 43 |
| CRImin | 5 | R | | | R 2/0 | R 3/0 | | 5 |
| CRImst | 2 | R | | | | R 3/0 | | 3 |
| CRIpir | 1 | R | | | | R 1/0 | | 1 |
| CRIpur | 4 | R | | | O 3/0 | R 1/0 | | 4 |
| CRIrub | 1 | R | | | | R 1/0 | | 1 |
| CRIruf | 6 | R | | O 1/0 | R 2/0 | R 2/0 | R 1/0 | 6 |
| CRIspl | 4 | R | | | O 4/0 | | | 4 |
| CRIten | 9 | O | | | C 9/0 | R 2/0 | O 4/0 | 15 |
| CRIvio | 8 | O | | | O 2/1 | O 2/3 | R 0/1 | 9 |
| CRIvul | 5 | R | | | | O 4/0 | R 0/1 | 5 |
| DDYane | 1 | R | R 1/0 | | | | | 1 |
| DDYcla | 1 | R | | | | R 1/0 | | 1 |
| DDYdif | 7 | R | R 0/1 | ***A*** 0/4 | R 0/2 | | | 7 |
| DDYiri | 1 | R | | | R 1/0 | | | 1 |
| DDYovo | 1 | R | | | | R 1/0 | | 1 |
| DDYqui | 1 | R | R 0/1 | | | | | 1 |
| DDYsqu | 5 | O | | | R 0/1 | O 8/0 | R 1/2 | 12 |
| DIDhem | 1 | R | | | | R 1/0 | | 1 |
| DIDrad | 1 | R | | | | | R 2/0 | 2 |
| DIDtes | 1 | R | | | R 0/1 | | | 1 |
| DIDumb | 1 | R | | | | | R 1/0 | 1 |
| DITplu | 1 | R | | O 1/0 | | | | 1 |
| DNMcor | 1 | R | | | R 1/0 | | | 1 |
| DNMmon | 1 | R | R 0/1 | | | | | 1 |
| ECHbro | 2 | R | | | R 0/1 | R 0/1 | | 2 |
| ECHcol | 1 | R | O 0/3 | | | | | 3 |
| ECHcor | 6 | R | O 0/3 | O 0/1 | R 0/2 | R 0/1 | | 7 |
| ECHcri | 1 | R | R 0/1 | | | | | 1 |
| ECHfra | 6 | R | | O 0/1 | O 0/3 | R 0/1 | R 0/1 | 6 |
| ECHmin | 15 | O | O 0/2 | O 0/1 | O 0/6 | O 1/3 | O 0/6 | 19 |
| ENEpap | 15 | O | R 1/0 | O 0/2 | C 2/9 | O 3/2 | | 19 |
| FULcin | 1 | R | | | | R 1/0 | | 1 |
| FULlev | 4 | R | | O 1/0 | R 2/0 | | R 1/0 | 4 |
| FULlut | 1 | R | | | | R 1/0 | | 1 |
| FULmus | 1 | R | | | R 1/0 | | | 1 |
| FULsep | 17 | C | | | O 7/0 | ***A*** 19/0 | O 4/0 | 30 |
| FULsepcan | 1 | R | | | | R 1/0 | | 1 |
| HEMabi | 1 | R | | | O 3/0 | | | 3 |
| HEMcal | 3 | R | | | | R 2/0 | R 2/0 | 4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| HEMcla | 14 | C | | O 1/0 | R 1/0 | ***A*** 23/0 | O 6/1 | 32 |
| HEMimp | 1 | R | | | | | R 2/0 | 2 |
| HEMpar | 3 | R | | | R 0/1 | | R 0/2 | 3 |
| HEMser | 13 | C | | | C 7/1 | C 14/1 | R 2/0 | 25 |
| KELfim | 7 | R | O 0/4 | O 0/1 | R 0/1 | | | 7 |
| LAMatr | 1 | R | | | R 1/0 | | | 1 |
| LAMcol | 2 | R | | | | R 2/0 | | 2 |
| LAMsci | 4 | R | R 0/1 | O 0/1 | | R 1/0 | R 0/1 | 4 |
| LEOfra | 5 | R | R 1/0 | | O 4/0 | R 2/0 | | 7 |
| LEPtig | 2 | R | | | R 1/0 | R 2/0 | | 3 |
| LICkle | 8 | O | | O 0/1 | O 0/5 | | R 0/3 | 9 |
| LICmin | 7 | O | | | O 4/1 | O 5/0 | | 10 |
| LICpar | 11 | O | O 0/2 | | C 0/8 | R 0/3 | | 13 |
| LICpyg | 1 | R | | | O 7/0 | | | 7 |
| LICten | 4 | R | O 0/1 | O 0/1 | R 0/1 | | | 4 |
| LICtes | 1 | R | R 0/1 | | | | | 1 |
| LICvar | 1 | R | | | | R 1/0 | | 1 |
| LYCepi | 22 | ***A*** | O 2/0 | O 1/0 | C 8/0 | ***A*** 21/0 | ***A*** 23/0 | 55 |
| LYCexi | 5 | R | R 1/0 | | R 2/0 | R 1/0 | R 1/0 | 5 |
| LYCfla | 2 | R | | O 1/0 | | R 1/0 | | 2 |
| MACobl | 1 | R | R 0/1 | | | | | 1 |
| MACsyn | 1 | R | | O 0/1 | | | | 1 |
| METflo | 3 | R | | | R 2/0 | R 1/0 | | 3 |
| METves | 18 | ***A*** | | O 1/0 | C 10/2 | ***A*** 30/1 | C 17/1 | 62 |
| MUCcru | 3 | R | | | R 1/0 | R 3/0 | R 1/0 | 5 |
| PARfim | 23 | C | O 0/6 | ***A*** 0/4 | C 0/11 | R 0/1 | O 0/5 | 27 |
| PARrig | 4 | R | | | O 2/3 | | | 5 |
| PERchr | 1 | R | | | R 0/1 | | | 1 |
| PERdep | 1 | R | R 0/1 | | | | | 1 |
| PERlic | 4 | R | R 0/1 | O 0/1 | R 0/1 | R 0/1 | | 4 |
| PERlut | 3 | R | O 0/2 | | | | | 3 |
| PERped | 2 | R | | | R 0/1 | R 0/1 | | 2 |
| PERver | 10 | O | O 0/1 | O 0/1 | O 0/4 | O 0/5 | | 12 |
| PHYalp | 1 | R | | | | R 1/0 | | 1 |
| PHYalu | 16 | C | | | C 13/1 | C 13/1 | O 5/2 | 35 |
| PHYbiv | 7 | O | | O 0/1 | O 0/3 | O 2/2 | | 8 |
| PHYcin | 5 | R | O 0/2 | | R 0/1 | R 2/0 | R 0/1 | 6 |
| PHYcom | 1 | R | | | | R 1/0 | | 1 |
| PHYcon | 1 | R | | | | R 1/0 | | 1 |
| PHYdec | 9 | O | O 0/4 | | R 1/0 | R 0/2 | R 0/2 | 10 |
| PHYdid | 1 | R | | | | R 3/0 | | 3 |
| PHYdmo | 1 | R | | | | R 1/0 | | 1 |
| PHYfla | 1 | R | | | | | R 0/1 | 1 |
| PHYglo | 6 | O | | | O 4/0 | O 6/0 | O 5/0 | 15 |
| PHYlat | 4 | R | | | R 0/2 | R 0/3 | | 5 |
| PHYlcp | 3 | R | | | R 2/0 | R 2/0 | | 4 |
| PHYleu | 2 | R | | | | R 2/0 | | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PHYnot | 14 | O | ***A*** 0/6 | O 0/2 | R 1/0 | R 2/1 | R 0/1 | 17 |
| PHYpsi | 2 | R | | | | R 3/0 | | 3 |
| PHYpul | 2 | R | | | | O 4/0 | | 4 |
| PHYvde | 9 | O | | | C 8/1 | O 8/0 | R 3/0 | 20 |
| PROmet | 3 | R | | | R 0/2 | R 1/0 | | 3 |
| RETlyc | 2 | R | | | | R 2/0 | | 2 |
| RETspl | 3 | R | | | | R 3/0 | | 3 |
| STAirr | 4 | R | | | R 2/0 | R 1/0 | R 1/0 | 4 |
| STEaxi | 20 | ***A*** | R 1/0 | | C 11/0 | ***A*** 27/0 | C 12/0 | 51 |
| STEfus | 12 | C | | O 1/0 | O 5/1 | C 13/0 | O 6/0 | 26 |
| STEher | 1 | R | | | | | R 1/0 | 1 |
| STEpal | 3 | R | | | | R 3/0 | | 3 |
| STEsmi | 7 | O | | O 1/0 | R 1/0 | O 6/0 | R 2/0 | 10 |
| STEspl | 4 | R | | | | O 4/0 | R 2/0 | 6 |
| STPaeq | 1 | R | | | | R 1/0 | | 1 |
| STPamo | 5 | R | R 1/0 | | O 5/0 | | R 1/0 | 7 |
| STPgra | 3 | R | | | R 2/0 | | R 1/0 | 3 |
| STPhyp | 2 | R | | | | R 3/0 | | 3 |
| STPtyp | 18 | C | O 2/0 | | C 14/0 | ***A*** 19/0 | R 2/0 | 37 |
| SYMama | 2 | R | | | R 1/0 | R 1/0 | | 2 |
| SYMcon | 1 | R | | | | R 1/0 | | 1 |
| SYMfla | 2 | R | | | | R 2/0 | | 2 |
| TRIbot | 6 | O | | | O 3/0 | C 13/0 | R 1/0 | 17 |
| TRIcon | 1 | R | | | | R 1/0 | | 1 |
| TRIdec | 22 | ***A*** | | | ***A*** 32/0 | ***A*** 22/0 | C 15/0 | 69 |
| TRIere | 14 | C | | O 0/1 | C 14/0 | O 4/2 | R 2/0 | 23 |
| TRIfav | 22 | ***A*** | R 1/0 | | ***A*** 24/0 | C 11/0 | O 9/0 | 46 |
| TRIfla | 4 | R | | | O 4/1 | R 1/0 | | 6 |
| TRIlut | 1 | R | | | | R 1/0 | | 1 |
| TRIper | 1 | R | | | R 2/0 | | | 2 |
| TRIsca | 11 | O | | | O 7/0 | O 7/0 | O 4/0 | 18 |
| TRIsub | 1 | R | | | R 1/0 | | | 1 |
| TRIvar | 23 | ***A*** | O 3/0 | O 1/0 | ***A*** 18/0 | ***A*** 23/0 | C 14/0 | 59 |
| TUBara | 11 | C | | O 2/0 | O 4/0 | ***A*** 19/0 | R 1/0 | 26 |
| TUBmic | 2 | R | | | | R 2/0 | | 2 |

Note: Species abbreviations are listed in the text; Loc. refers to the number of localities from which a species was recorded, Est. gives the abundance estimated according to Stephenson et al. (1993). This estimate is based upon the proportion of a species in relation to the total number of records (1488): **R** – rare (< 0.5 % of all records), **O** – occasional (> 0.5–1.5 % of all records), **C** – common (> 1.5–3 % of all records), **A** – abundant (> 3 % of all records), with those taxa listed only for the qualitative part of the survey. Numbers indicate myxomycetes records from the field / from moist chamber cultures.

Table 2. Pair wise comparisons of myxomycete assemblages of the Altay Mts. with well studied myxomycete assemblages of Eurasian regions

| | CL | KA | KR | KZ | LEN | MN | UR | AL(I) | AL(II) | AL(III) | AL(IV) | AL(V) | AL(VI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CL | - | 0.54 | 0.74 | 0.95 | 0.61 | 0.88 | 0.56 | 0.40 | 0.72 | 0.51 | 0.49 | 0.55 | 0.53 |
| KA | 44 | - | 0.90 | 0.58 | 0.90 | 0.41 | 0.78 | 0.14 | 0.60 | 0.65 | 0.79 | 0.75 | 0.70 |
| KR | 49 | 74 | - | 0.74 | 0.93 | 0.57 | 0.99 | 0.13 | 0.68 | 0.97 | 0.97 | 0.80 | 0.75 |
| KZ | 71 | 47 | 51 | - | 0.64 | 0.81 | 0.55 | 0.43 | 0.84 | 0.60 | 0.58 | 0.59 | 0.70 |
| LEN | 57 | 95 | 84 | 61 | - | 0.34 | 0.87 | 0.06 | 0.51 | 0.65 | 0.76 | 0.83 | 0.75 |
| MN | 34 | 19 | 21 | 32 | 22 | - | 0.36 | 0.67 | 0.71 | 0.48 | 0.26 | 0.21 | 0.33 |
| UR | 45 | 71 | 81 | 47 | 94 | 20 | - | 0.02 | 0.56 | 0.74 | 0.81 | 0.82 | 0.83 |
| AL(I) | 5 | 3 | 4 | 4 | 3 | 5 | 2 | - | 0.70 | 0.28 | 0.08 | 0.05 | 0.03 |
| AL(II) | 24 | 24 | 25 | 24 | 25 | 18 | 22 | 6 | - | 0.91 | 0.67 | 0.56 | 0.64 |
| AL(III) | 18 | 26 | 26 | 19 | 27 | 11 | 23 | 4 | 18 | - | 0.89 | 0.90 | 0.97 |
| AL(IV) | 32 | 62 | 61 | 40 | 67 | 18 | 61 | 5 | 30 | 34 | - | 0.93 | 0.94 |
| AL(V) | 39 | 66 | 68 | 48 | 81 | 17 | 72 | 3 | 26 | 30 | 72 | - | 0.93 |
| AL(VI) | 24 | 42 | 44 | 28 | 48 | 12 | 47 | 2 | 19 | 24 | 53 | 53 | - |

Note: The total numbers of all specimens observed in the field as well as in moist chamber cultures were used for the calculation of the adjusted incidence-based Chao-Søerensen similarity index. Both the similarity index (upper right) and number of species shared (lower left) are givenStudy regions are abbreviated as CL = Caspian Lowland, treeless zonal dry steppe and desert communities (Novozhilov et al. 2006); KA = Russian northern Karelia (Schnittler & Novozhilov 1996); KR = Krasnoyarsk Territory, the State reserve «Stolby» (Kosheleva et al. 2008); KZ = arid regions of Kazakhstan (Schnittler & Novozhilov 2000, Schnittler 2001, Novozhilov, Zemlyanskaya, pers. data); LEN = Leningrad region (Novozhilov 1980, Novozhilov 1999); MN = Western Mongolia, depression of Great Lakes (Novozhilov & Schnittler 2008); UR = Sverdlovsk region (Novozhilov & Fefelov 2001); and for this study AL(I) = dry steppe of the Chuyskaya depression; AL(II) = mountain forest steppe; AL(III) = light coniferous taiga; AL(IV) = dark coniferous taiga; AL(V) = "chernevaya" taiga; AL(VI) = stripe pine and mixed forest in submontane landscape.

Table 3. Statistical data for four basic substrate types in three vegetation groups in the Altay Mts. (Russia)

| All study area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Field records | | | Data from moist chambers | | | | |
| Substrate types | Records (fc) | Species (fc) | H' (fc) | Records (mc) | Species (mc) | H'(mc) | % of positive mcs | Species per mc |
| b | 15 | 13 | 2.52 | 153 | 34 | 3.05 | 85.7 | 1.96 |
| d | 0 | 0 | 0.00 | 26 | 8 | 1.90 | 62.1 | 1.00 |
| ll | 26 | 14 | 2.38 | 13 | 10 | 2.25 | 47.8 | 0.83 |
| lt | 24 | 17 | 2.69 | 4 | 4 | 1.39 | 100 | 3.00 |
| lg | 4 | 4 | 1.39 | 8 | 5 | 1.49 | 68.4 | 0.79 |
| w | 1085 | 108 | 4.01 | 84 | 28 | 2.75 | 76.9 | 1.35 |
| c | 0 | 0 | 0.00 | 26 | 15 | 2.50 | 23.9 | 0.34 |
| Semiarid vegetation (I+II) | | | | | | | | |
| | Field records | | | Data from moist chambers | | | | |
| Substrate types | Records (fc) | Species (fc) | H' (fc) | Records (mc) | Species (mc) | H'(mc) | % of positive mcs | Species per mc |
| b | 1 | 1 | 0.00 | 26 | 14 | 2.40 | 71.4 | 1.48 |
| d | 0 | 0 | 0.00 | 15 | 7 | 1.77 | 52.4 | 0.86 |
| ll | 0 | 0 | 0.00 | 8 | 6 | 1.73 | 60 | 1.10 |
| lt | 9 | 8 | 2.04 | 4 | 4 | 1.39 | 100 | 3.00 |
| lg | 0 | 0 | 0.00 | 4 | 2 | 0.56 | 80 | 1.20 |
| c | 0 | 0 | 0.00 | 8 | 6 | 1.73 | 33.3 | 0.67 |
| w | 10 | 7 | 1.89 | 3 | 3 | 1.10 | 66.7 | 1.67 |
| Semihumid vegetation (III+VI) | | | | | | | | |
| | Field records | | | Data from moist chambers | | | | |
| Substrate types | Records (fc) | Species (fc) | H' (fc) | Records (mc) | Species (mc) | H'(mc) | % of positive mcs | Species per mc |
| b | 2 | 2 | 0.69 | 38 | 16 | 2.51 | 87 | 1.91 |
| d | 0 | 0 | 0.00 | 6 | 4 | 1.24 | 100 | 2.00 |
| ll | 2 | 2 | 0.69 | 5 | 4 | 1.33 | 42.9 | 0.86 |
| lt | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0.00 |
| lg | 1 | 1 | 0.00 | 0 | 0 | 0.00 | 0 | 0.00 |
| c | 0 | 0 | 0.00 | 6 | 5 | 1.56 | 0 | 0.27 |
| w | 204 | 53 | 3.47 | 16 | 11 | 2.22 | 87.5 | 1.13 |
| Humid boreal vegetation (IV+V) | | | | | | | | |
| | Field records | | | MCs | | | | |
| Substrate types | Records (fc) | Species (fc) | H' (fc) | Records (mc) | Species (mc) | H'(mc) | % of positive mcs | Species per mc |
| b | 12 | 11 | 2.37 | 89 | 25 | 2.92 | 91.5 | 2.19 |
| d | 0 | 0 | 0.00 | 5 | 4 | 1.33 | 80 | 1.00 |
| ll | 24 | 14 | 2.36 | 0 | 0 | 0.00 | 33.2 | 0.33 |
| lt | 15 | 13 | 2.49 | 0 | 0 | 0.00 | 0 | 0.00 |
| lg | 3 | 3 | 1.10 | 4 | 3 | 1.04 | 0 | 0.75 |
| c | 0 | 0 | 0.00 | 12 | 9 | 2.09 | 9 | 0.35 |
| w | 871 | 109 | 4.04 | 65 | 23 | 2.59 | 75 | 1.33 |

Note: The more intensely studied substrate types are abbreviated as b = bark of living plants; d = dung of herbivorous animals; ll = leaf litter; lt = litter of coniferous needles and small twigs; lg = litter of grasses and herbaceous plants; w = coarse woody debris; and c = decaying conifer cones. Listed are records, species, Shannon diversity H' from the field (fc) and from moist chamber cultures (mc); for the latter the proportion of positive cultures and the average number of species per culture is given.

Table 4. Pairwise comparisons of myxomycete communities for the more intensely studied substrates from the Altay Mts.

| | b | d | ll | lt | lg | w | c |
|---|---|---|---|---|---|---|---|
| b | - | 0.09 | 0.52 | 0.63 | 0.17 | 0.77 | 0.70 |
| d | 3 | - | 0.07 | 0.06 | 0.13 | 0.01 | 0.00 |
| ll | 9 | 1 | - | 0.44 | 0.69 | 0.75 | 0.38 |
| lt | 9 | 1 | 6 | - | 0.17 | 0.90 | 0.15 |
| lg | 3 | 1 | 5 | 2 | - | 0.10 | 0.07 |
| w | 31 | 2 | 15 | 20 | 3 | - | 0.18 |
| c | 10 | 0 | 3 | 2 | 1 | 11 | - |

Note: Total numbers of all specimens observed in the field as well as in moist chamber cultures were used for the calculation of the adjusted incidence-based Chao-Søerensen similarity index. Both the similarity index (upper right) and number of species shared (lower left) are given. Abbreviations for substrates are as given in Table 3.