

## First data on plasmodial slime moulds (Myxomycetes = Myxogastrea) of Rdeysky Nature Reserve (Novgorod Region, Russia)

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**Abstract.** The results of the first study of the species diversity of myxomycetes of the Rdeysky State Nature Reserve are presented. The 201 field specimens of sporophores belonging to 56 morphospecies from 27 genera, ten families, and six orders were collected from September 30 to October 5, 2020. Fifty-two species of these were new for the Novgorod Region. The most common species at the reserve were *Arcyria affinis*, *Hemitrichia calyculata*, *Lycogala epidendrum*, *Metatrichia vesparia*, *Physarum album*, *Trichia decipiens*, and *T. varia*. Additionally, detailed morphological descriptions of two rare species *Amaurochaete trechispora* and *Trichia crateriformis* are given.

**Keywords:** *Amaurochaete trechispora*, Amoebozoa, *Trichia crateriformis*, biodiversity, bogs, check-list, species inventory.

### Первые данные о миксомицетах (Мухомycetes = Мухогастреа) государственного природного заповедника «Рдейский» (Новгородская область, Россия)

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**Резюме.** Приведены результаты первого исследования видового разнообразия миксомицетов Рдейского государственного природного заповедника. На основании изучения 201 полевых образцов спорофоров, собранных в период с 30 сентября по 5 октября 2020 г., выявлено 56 морфовидов из 27 родов, 10 семейств и 6 порядков. 52 вида впервые отмечены в Новгородской обл. Наиболее распространенными в заповеднике были *Arcyria affinis*, *Hemitrichia calyculata*, *Lycogala epidendrum*, *Metatrichia vesparia*, *Physarum album*, *Trichia decipiens* и *T. varia*. Кроме того, приводится подробное морфологическое описание двух редких видов *Amaurochaete trechispora* и *Trichia crateriformis*.

**Ключевые слова:** *Amaurochaete trechispora*, Amoebozoa, *Trichia crateriformis*, биоразнообразие, болота, инвентаризация видов.

Special studies of myxomycetes in the Novgorod Region have not been carried out before. The first records of myxomycetes from the Novgorod Region appear to be 11 species reported by A. A. Jaczewski (1907), and 3 of them reported by Yu. K. Novozhilov (2005).

Rdeysky Nature Reserve is located in the Kholmshy and Poddorsky districts of the Novgorod Region. It was founded in 1994, simultaneously with Polistovsky Nature Reserve, located in the Pskov Region. It has a common border with Rdeysky Nature Reserve. The main goal of both nature reserves are protection and study of the Polistovo-Lovatskaya raised bog system, which is situated in the southern part of the Priilmen Lowland on the watershed of the Polist and Lovat rivers (Yablokov *et al.*, 2006). It is one of the largest and best-preserved raised bog systems in Europe (Cherevichko, 2008).

To date, myxomycetes of Polistovsky Nature Reserve have been studied for three years. The results of the 2018 field season have already been published (Gmoshinskiy, Matveev, 2019). The data on the myxomycetes of Rdeysky Nature Reserve has not been published before.

The uplands that surround the raised bog system Polistovo-Lovatskaya and peatland islands are located within the reserve boundaries. The large portion of the reserve is covered by small-leaved deciduous and mixed forests less than 70 years old since in the mid-twentieth century nearly all suitable areas for agriculture and forest felling were used (Reshetnikova *et al.*, 2006; Nosova *et al.*, 2017).

The objective of the present paper is first to provide a comprehensive checklist of all species of myxomycetes reported from or known to occur in the Rdeysky Nature Reserve.

## **Material and Methods**

The present study is based on field specimens of sporophores collected and preserved according to the standard protocol (Wrigley de Basanta, Estrada-Torres, 2017). Specimens were identified to the lowest possible taxonomic level according to Martin and Alexopoulos (1969) but also using descriptions from the literature and more recent monographs (e.g., Ing, 1999; Poulain *et al.*, 2011; Lado, Eliasson, 2017), applying a morphospecies concept.

The localities were placed within different representative types of forest communities. All sites were located in the Kholmshy District of the Novgorod Region. Sporocarps were collected from 14 sites about 15 m in diam., from 30 September to 5 October 2020 (Table 1). We also collected substrate samples for moist chambers at 11 sites, and there were 4 sites, where we collected only substrates without any sporocarps (they are absent in the table below).

The specimens were examined using light microscope techniques with Micromed 3 var. 3 LED optical microscope with digital camera E3CMOS06300. Photographs of the appearance of sporophores were made by the same microscope and camera, but with top illumination. The series of pictures were taken in different optical sections and processed by Helicon Focus ver. 6.0.18 software. The sizes of spores, capillitium, and sporocarps were calculated via ToupView and ImageJ ver. 1.52a. The microscope slides were prepared with 4% KOH. The spore surface and structure of capillitium were studied using a Camscan-S2 scanning electron microscope (Cambridge Instruments, UK).

Table 1

Data on localities in the Rdeysky Nature Reserve

Number	Locality	Date	Latitude and longitude	Types of forest communities
1	Forest and bog border, 1 km west from Fryunino village	30 IX 2020	57.07747°N, 30.73317°E	Spruce forest with birch
2	Forest and bog border, 1 km west from Fryunino village	30 IX 2020	57.07580°N, 30.73447°E	Black alder forest with spruce, birch, and aspen
3	Southern end of the island, north-west from Fryunino village	1 X 2020	57.09136°N, 30.72548°E	Birch alder forest
4	Northern tip of the island, north-west from Fryunino village	1 X 2020	57.09343°N, 30.72402°E	Birch alder forest with spruce
5	Eastern tip of the island, north-west from Fryunino village	1 X 2020	57.09311°N, 30.72947°E	Ledum pine forest
6	Eastern tip of the island, north-west from Fryunino village	1 X 2020	57.09219°N, 30.72915°E	Pine, spruce, birch forest
7	Forest at the bog border, south-west from Fryunino village	2 X 2020	57.06966°N, 30.73573°E	Black alder forest with birch
8	Forest at the bog border, south-west from Fryunino village	2 X 2020	57.06797°N, 30.73731°E	Spruce forest
9	Forest at the bog border, south-west from Fryunino village	2 X 2020	57.06747°N, 30.73497°E	Black alder forest with birch and spruce
11	Eastern shore of the lake Rogovskoe	3 X 2020	57.09060°N, 30.70301°E	Pine forest with <i>Ledum palustre</i> L., and with alder
15	Forest at the bog border, south-west from Fryunino village	3 X 2020	57.06496°N, 30.73463°E	Birch forest with aspen, pine, and alder
16	Small island in the bog, 1 km west from Fryunino village	4 X 2020	57.08098°N, 30.72466°E	Birch and spruce forest
17	Forest and bog border, 1 km west from Fryunino village	4 X 2020	57.08290°N, 30.72396°E	Black alder forest with aspen, pine, birch, and spruce
18	Forest and bog border, 1 km west from Fryunino village	4 X 2020	57.07890°N, 30.72867°E	Spruce and black alder forest

All specimens were deposited into the Collection of Myxomycetes at the Department of Mycology and Algology of the Lomonosov Moscow State University (MYX), Moscow, Russia.

For an estimate of species abundance, the ACOR scale of Stephenson *et al.* (1993) was adapted. It is based on the proportion of species records to the total number of records: A – abundant (> 3% of all, more than 6 records in this survey); C – common (1.5–3%, 4–6 records); O – occasional (0.5–1.5%, 2–3 records); R – rare (<0.5%, 1).

We also used R package iNEXT (Hsieh *et al.*, 2016) to calculate analytic estimators of sample completeness values of order  $q = 0$  and  $q = 1$ : conventional measure (proportion of species that have been observed out of Chao1 estimator) and sample coverage, respectively (Chao *et al.*, 2020).

## Results

Two hundred one specimens of myxomycete sporophores were collected. In the annotated species list, which is arranged alphabetically, the following data are presented after every taxon name: abundance according to the ACOR scale, and a number of records. We had found the sporophores on grass, coarse woody debris, and mosses. The second sentence lists all localities where a species was found, followed by a colon by the number of records made in each place and MYX herbarium numbers in brackets.

Myxomycete nomenclature follows Lado (2005–2021).

A symbol (<sup>A</sup>) indicates the species recorded by A. A. Jaczewski, symbol (<sup>YN</sup>) indicates the species recorded by Yu. K. Novozhilov; species without these symbols are new for the Novgorod Region. An exclamation mark in superscript (!) indicates a species recorded as a new one for Russia.

**Amaurochaete atra** (Alb. et Schwein.) Rostaf. — **R** (1); on wood and bark of the conifer tree. Localities: **12** (MYX 16954).

**A. trechispora** T. Macbr. et G. W. Martin (Fig. 1; Plate I: 1, 2) — **R** (1); on living *Sphagnum* spp. Locality: **7** (MYX 16919).

Sporophores are presented by sessile or practically sessile sporangia gathered in dense groups, so they form pseudoaethalia up to 20 cm diam. Sporangia are cylindrical, sometimes with a slightly widened apex (clavate), dark olive-brown to grayish-yellowish-brown, forming a united structure at the bottom. Peridium disappears easily with sporangium maturation and remains only as small separate flakes, weakly connected to the peripheral capillitial fibers of not fully formed sporangia. Hypothallus is poorly developed, thin, membranous, shiny, dark yellowish-brown, with a purple tint; light brown in transmitted light. Stipe is poorly presented, up to 0.3 mm, black, solid, dark olive-brown at the bottom and horny, gradually turning into hypothallus. Columella has an irregular shape, often branched, with expansions, ending at the sporangium top, at branch points non-transparent or olive-brown in transmitted light. Capillitium is rather loose, developing along the entire columella, presented by thin (2–3  $\mu\text{m}$  in diam.) irregular fibers with small fusiform thickenings (5–7) and membrane-like expansions (up to 9  $\mu\text{m}$  in diam.) at branch points, that form new branches and anastomoses, producing a coarse mesh with a large number of free ends gradually becoming thin. Spores are dark olive-brown in mass, dark orange-yellow in transmitted light, spherical, sometimes slightly flattened, with an evenly thickened shell; ornamented with a coarse mesh that has 8–13 cells on the spore visible side. Spores 13–15  $\mu\text{m}$  in diam. are ornamented and the ones 10–12  $\mu\text{m}$  in diam. are not. Plasmodium white at first, then becoming red-brown and umber right before maturation.

The typical features of this species are the presence of dense pseudoaethalia, which develop on the surface of mosses at wetlands, and spores ornamented with ribs 1–2  $\mu\text{m}$  high, forming a reticulum with 8–13 meshes on the spore visible side.

This species appears to prefer the swamp wet habitats with *Sphagnum* mosses.

Other 4 species known in the genus *Amaurochaete*: *A. atra* (Alb. et Schwein.) Rostaf., *A. comata* G. Lister et Brändza, *A. tubulina* (Alb. et Schwein.) T. Macbr. (Martin, Alexopoulos,

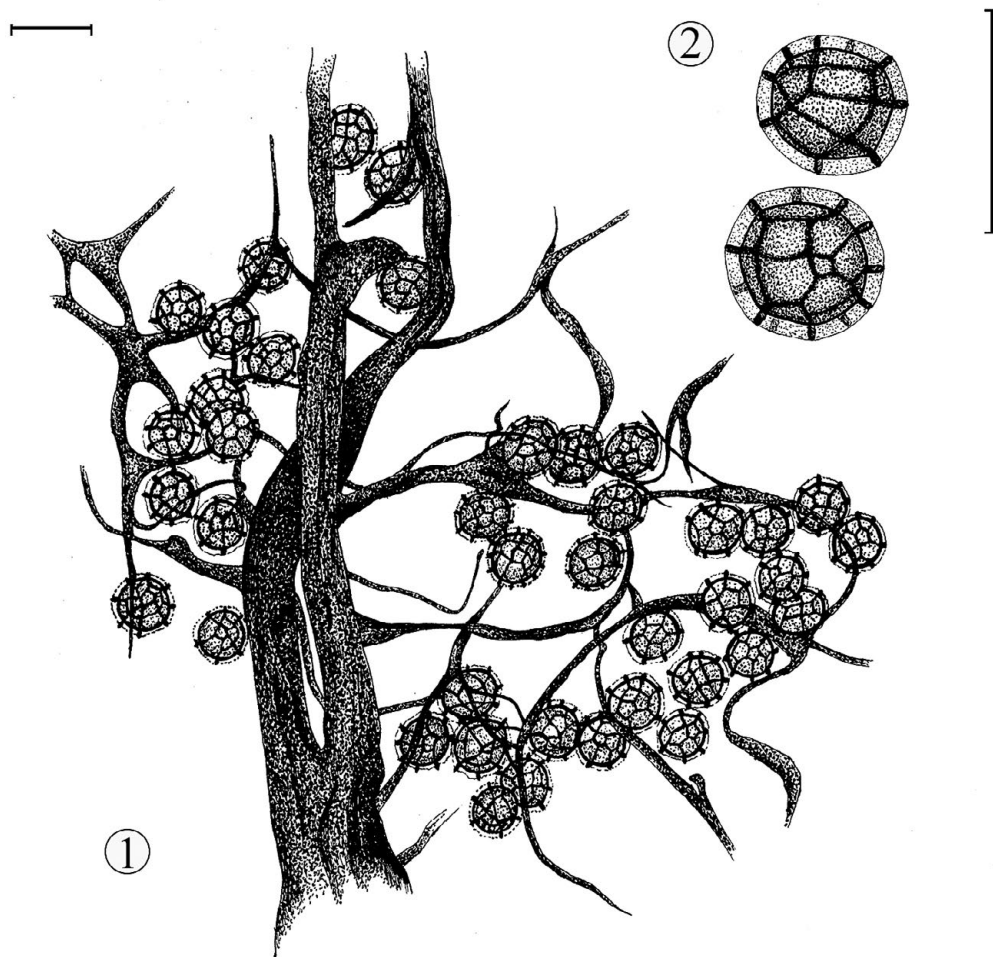


Fig. 1. *Amaurochaete trechispora* (MYX 16919) in light microscopy.

1 — spores  $\times 1000$ ; 2 — spores and capillitium  $\times 400$ .

Scale bars: 20  $\mu\text{m}$ .

1969), and *A. fusiformis* (Nann.-Bremek. et Härk.) H. Marx et Kuhnt (Kuhnt, 2019) have not reticulate spore ornamentation and form sporocarps on rotten coarse woody debris.

Among species of the closely related genus *Symphytocarpus*, there are only 3 with reticulate spores: *S. amaurochaetoides* Nann.-Bremek., *S. cristatus* Nann.-Bremek., and *S. trechispora* (Berk. ex Torrend) Nann.-Bremek. (Ing, Nannenga-Bremakamp, 1967). The last species could be considered to be the most morphologically similar to *Amaurochaete trechispora*. Spores of this species are ornamented with a fine mesh formed by ribs 0.5 or 1  $\mu\text{m}$  high. Both species form fruit bodies on mosses, mostly at sphagnum bogs. Spores of *Symphytocarpus amaurochaetoides* are ornamented with small warts, whose tops tend to fuse and form a fine reticulum similar to the spores of *Stemonitis fusca* Roth, whereas spores of *Symphytocarpus cristatus* are covered with separate ribs that sometimes merge and form some kind of irregular reticulum which is never complete.

*Amaurochaete trechispora* is the rarest species in the genus *Amaurochaete* (Eliasson, 2000). As U. Eliasson noted, aethalia of this species very fast destroy and often can be identified mistakenly in the field as a destroyed aethalia of *Fuligo septica*. In the database of GBIF (*Amaurochaete...*, 2021) only 30 records are registered. Fruiting bodies were found in Canada, the USA, Luxembourg, Sweden, and Japan.

In 1919, type material was gathered by J. H. Faull in the Temagami Forest Reserve and doubtfully identified by Miss Currie as *Stemonitis fusca* var. *trechispora* Berk. ex Torrend [= *Symphytocarpus trechisporus* (Berk. ex Torrend) Nann.-Bremek.]. In 1932, Macbride and Martin published a new species *Amaurochaete trechispora* (Martin, 1932: 89) after studying two specimens collected in Canada in 1919 and 1931. In the original description, they specified that “cortex dark, shining, evanescent, faintly tuberculate as though suggesting the tips component sporangia”. Later, Hagelstein studied the type material of *A. trechispora* and compared it with his specimens that he found at the Long Island bogs. He was certain that the type material did not bear any features distinguishing it from *Stemonitis trechispora* (Berk. ex Torrend) T. Macbr.: “There is nothing in the type material to indicate other characters than those that appear in *Stemonitis trechispora*. The collection is one that developed in the very wet area as seen by comparison with Long Island material” (Hagelstein, 1944). He also notes: “The more variable phases are in the wetter places, and the confluent character of some of the sporangia bears a strong resemblance to the genus *Amaurochaete*”. Hagelstein also pointed out that this species appeared in mass in wet regions, but only at the end of August, and was destroyed by insects in several days.

In 1967, B. Ing and N. E. Nannenga-Bremekamp described a new genus *Symphytocarpus*, whose specific features were sporangia gathered in dense groups without peripheral capillitium net and with peridium left as separate flakes connected to the capillitial fibers. In their paper, they considered only *Symphytocarpus trechisporus* and also specified that this species differs from *Amaurochaete trechispora* by a fine mesh on the spore surface. At the same time, there is no comparison of these species’ cortex (Ing, Nannenga-Bremekamp, 1967).

In the monograph “The Myxomycetes” G. Martin and C. J. Alexopoulos gave a relatively short description of *A. trechispora* morphology, where they mentioned that the cortex was dark, shiny, faintly tuberculate (Martin, Alexopoulos, 1969: 174). Meanwhile, they did not consider the separation of the genus *Symphytocarpus* and, as a result, the cortex structure and the presence of separate sporangia in a colony were not described extensively enough (Martin, Alexopoulos, 1969).

Ing did not describe *Amaurochaete trechispora*, although pointed at the morphological closeness to *Symphytocarpus trechisporus* (Ing, 1999).

In the Poulain and co-authors’ guide (Poulain et al., 2011), *A. trechispora* cortex is only slightly mentioned: it is “dark, shiny, faintly tuberculate”. However, the guide key states that *Amaurochaete* genus members must have a fugacious cortex that can detach, unlike cortex of the genus *Symphytocarpus* representatives, which is simply absent, and whose peridium sometimes remain as fragments. As additional feature authors note that *Amaurochaete* genus members form aethalia or pseudoaethalia, while *Symphytocarpus* genus members have sporocarps presented by pseudoaethalia consisting of cylindrical sporangia. These sporocarps of *Amaurochaete* species must be denser in comparison with the genus *Symphytocarpus*.

Our specimen (MYX 16594) does not have any developed cortex on the sporocarp surface. For this reason, it could be easily attributed to the genus *Symphytocarpus*. In our opinion, there should be further study of the morphogenesis processes and nucleotide sequences that would reliably assign this species to either *Symphytocarpus* or *Amaurochaete*. The results of comparison of the specimens of *Amaurochaete trechispora* (MYX 16594) and *Symphytocarpus trechisporus* (MYX 17489..., founded in Polistovsky State Reserve 14 VII 2021) indicate that these taxa are not conspecific.

**Arcyria affinis** Rostaf. — **A** (8); on rotten wood of the deciduous tree (6); on rotten wood and bark of the deciduous tree, covered by mosses (1); on rotten wood of the conifer tree (1). Localities: **3** (MYX 16817, MYX 16907); **4** (MYX 16911); **8** (MYX 16937, MYX 16938); **9** (MYX 16842); **15** (MYX 16961); **17** (MYX 16860).

**A. denudata** (L.) Wettst. — **C** (6); on rotten wood of the deciduous tree (6). Localities: **2** (MYX 16815, MYX 16883, MYX 16888, MYX 16898); **3** (MYX 16902); **7** (MYX 16927).

**A. incarnata** (Pers. ex J. F. Gmel.) Pers. — **O** (3); on rotten wood of the deciduous tree (1); on the bark of the deciduous tree (2). Localities: **16** (MYX 16853, MYX 16854); **17** (MYX 16984).

**A. obvelata** (Oeder) Onsberg — **O** (3); on rotten wood (1) and bark (1) of the deciduous tree; on rotten wood of the conifer tree (1). Localities: **2** (MYX 16885); **7** (MYX 16931); **15** (MYX 16846).

**A. oerstedii** Rostaf. — **R** (1); on rotten bark of the deciduous tree. Locality: **7** (MYX 16921).

**A. stipata** (Schwein.) Lister — **C** (6); on rotten wood of the deciduous (5) and conifer (1) trees. Localities: **1** (MYX 16874, MYX 16878); **6** (MYX 16918); **7** (MYX 16920); **17** (MYX 16983); **18** (MYX 16863).

**Badhamia lilacina** (Fr.) Rostaf. — **R** (1); on rotten wood of the conifer tree. Locality: **16** (MYX 16857).

This species develops in abundance at the end of summer, at *Sphagnum* mosses, on edge of the swamps and forest with scattered small pine and spruce trees. Most likely, the majority of sporocarps did not remain intact to the moment of fieldwork. Further research at the end of summer will allow us to find more specimens of this species.

**B. utricularis** (Bull.) Berk. — **R** (1); on rotten bark and wood of the deciduous tree. Locality: **17** (MYX 16858).

**Barbeyella minutissima** Meyl. (Plate I: 3–6) — **R** (1); on rotten wood of the conifer tree. Locality: **16** (MYX 16964).

This species is characterized by minute fruiting bodies that do not exceed 0.9 mm high and sporangium diameter no more than 0.2 mm. It is frequently found with such species as *Colloderma oculatum* (C. Lippert) G. Lister, *Lamproderma columbinum* (Pers.) Rostaf, and *Lepidoderma tigrinum* (Schrad.) Rostaf. (Novozhilov *et al.*, 2020). *Barbeyella minutissima* is also associated with some species of liverworts (Schnittler *et al.*, 2000). The specimen MYX 16964 founded with *Cribraria microcarpa* (MYX 16965) on the same substrate fragment, which was a piece of waterlogged wood from the bottom side of a coniferous log undergoing intermediate stages of decomposition.

**Ceratiomyxa fruticulosa** (O. F. Müll.) T. Macbr. — **R** (1); on rotten wood of the conifer tree. Locality: **15** (MYX 16956).

**Clastoderma debaryanum** A. Blytt — **O** (3); on rotten wood of the deciduous tree (3). Localities: **1** (MYX 16869); **7** (MYX 16926); **16** (MYX 16975).

**Collaria arcyrionema** (Rostaf.) Nann.-Bremek. ex Lado — **R** (1); on rotten wood of the deciduous tree. Locality: **18** (MYX 16864).

**Comatricha elegans** (Racib.) G. Lister — **R** (1); on rotten wood of the deciduous tree. Locality: **2** (MYX 16813).

**C. nigra** (Pers. ex J. F. Gmel.) J. Schröt. — **O** (3); on rotten wood of the deciduous (2) and conifer (1) tree. Localities: **1** (MYX 16879); **7** (MYX 16832); **18** (MYX 16862).

**Cribraria argillacea** (Pers. ex J. F. Gmel.) Pers. — **R** (1); on rotten wood of the deciduous trees. Locality: **16** (recorded only by photo).

**C. cancellata** (Batsch) Nann.-Bremek. — **R** (1); on rotten wood of the conifer tree. Locality: **16** (MYX 16967).

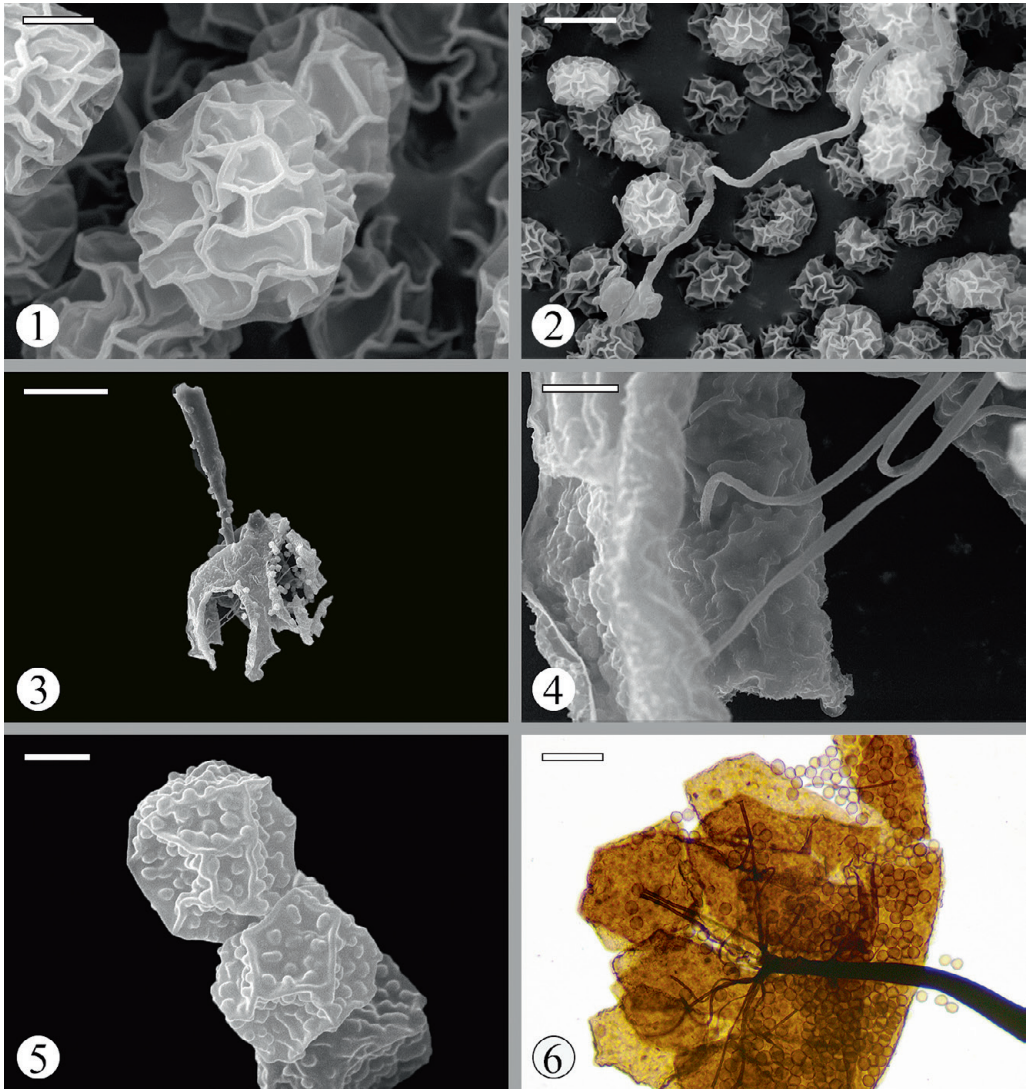


Plate I. 1, 2 – *Amaurochaete trechispora* (MYX 16919): 1 – spores (SEM); 2 – spores and capillitium (SEM); 3–6 – *Barbeyella minutissima* (MYX 16964): 3 – sporangium (SEM); 4 – peridium with capillitium fibers (SEM); 5 – spores (SEM); 6 – sporangium (LM).  
Scale bars: 1, 5 – 3  $\mu\text{m}$ ; 2, 4 – 10  $\mu\text{m}$ ; 6 – 40  $\mu\text{m}$ ; 3 – 100  $\mu\text{m}$ .

**Cribraria microcarpa** (Schrad.) Pers. — **O** (2); on rotten wood of the conifer tree. Locality: **16** — (MYX 16965, MYX 16968).

**C. purpurea** Schrad. — **R** (1); on rotten wood of the conifer tree. Locality: **16** (MYX 16973).

**C. rufa** (Roth) Rostaf. — **O** (3); on rotten wood of the conifer tree. Localities: **16** (MYX 16966); **17** (MYX 16986).

**Diderma testaceum** (Schrad.) Pers. (Plate II: 1–4) — **C** (4); on rotten wood (2) and bark (1) of the deciduous tree; on deciduous leaf litter (1). Localities: **3** (MYX 16819, MYX 16900); **7** (MYX 16831).

Sporocarps were formed on the surface of moss leaves. The two-layer peridium surface was light pink, however columella was red-brown, and lime was distinctly pinkish, which allows us to attribute these specimens to *D. testaceum*.

**Didymium minus** (Lister) Morgan — **R** (1); on conifer litter. Locality: **3** (MYX 16899).

**Fuligo laevis** Pers. — **R** (1); on rotten bark of the deciduous tree. Locality: **9** (MYX 16952).

This species is close to *Fuligo leviderma* and differs from it by unevenly thickened spore shell and yellow color of the cortex (Poulain *et al.*, 2011).

**F. leviderma** H. Neubert, Nowotny et K. Baumann — **C** (5); on rotten wood (2) and bark (2) of the deciduous tree; on mosses (1). Localities: **6** (MYX 16825, MYX 16828, MYX 16915); **8** (MYX 16838).

**F. septica** (L.) F. H. Wigg. — **O** (2); on rotten wood of the deciduous tree covered by mosses (1); on rotten wood of the conifer tree (1). Localities: **8** (MYX 16939); **16** (MYX 16856).

**F. septica var. candida** (Pers.) R. E. Fr. — **R** (1); on rotten wood of the deciduous tree. Locality: **16** (MYX 16981).

**Hemitrichia calyculata** (Speg.) M. L. Farr — **A** (7); on rotten wood of the deciduous tree (6) covered by mosses (1). Localities: **1** (MYX 16867); **3** (MYX 16908); **7** (MYX 16923, MYX 16928, MYX 16929); **8** (MYX 16942); **16** (MYX 16851).

**H. clavata** (Pers.) Rostaf. — **C** (5); on rotten wood (4) and bark (1) of the deciduous tree. Localities: **3** (MYX 16903); **8** (MYX 16836); **9** (MYX 16948, one sample not inserted in herbarium); **18** (MYX 16994).

**H. serpula** (Scop.) Rostaf. ex Lister — **O** (2); on rotten wood of the deciduous tree. Localities: **2** (MYX 16890); **18** (MYX 16991).

**Leocarpus fragilis** (Dicks.) Rostaf. — **C** (4); on rotten wood of the deciduous (1) and conifer (1) tree; on rotten bark of the deciduous tree (2). Localities: **4** (MYX 16820); **5** (MYX 16823); **15** (MYX 16848); **17** (MYX 16859).

**Licea pygmaea** (Meyl.) Ing — **O** (2); on rotten wood of the deciduous tree. Localities: **1** (MYX 16880); **18** (MYX 16865). Samples were found together with the *Physarum album* (MYX 16882) and *Trichia botrytis* (MYX 16866).

**Lycogala epidendrum** (L.) Fr. — **A** (16); on rotten wood of the deciduous tree (12), covered by mosses (1); on rotten bark of the deciduous tree (1); on leaf litter of the deciduous tree (1). Localities: **1** (MYX 16868, MYX 16877); **2** (MYX 16896, MYX 16897); **3** (MYX 16816); **6** (MYX 16829, MYX 16913, MYX 16916); **7** (MYX 16925, MYX 16930); **8** (MYX 16837, MYX 16934, MYX 16936); **9** (MYX 16843, MYX 16951); **17** (MYX 16988).

**Metatrachia floriformis** (Schwein.) Nann.-Bremek. — **O** (3); on rotten wood of the deciduous tree (2); on rotten wood and bark of the deciduous tree (1). Locality: **16** (MYX 16971, MYX 16974, MYX 16979).

<sup>4/</sup> **M. vesparia** (Batsch) Nann.-Bremek. ex G. W. Martin et Alexop. — **A** (14); on rotten wood of the deciduous tree (10), covered by mosses (1); on rotten bark of the deciduous tree (3). Localities: **1** (MYX 16871); **2** (MYX 16887, MYX 16889); **3** (MYX 16818, MYX 16905);

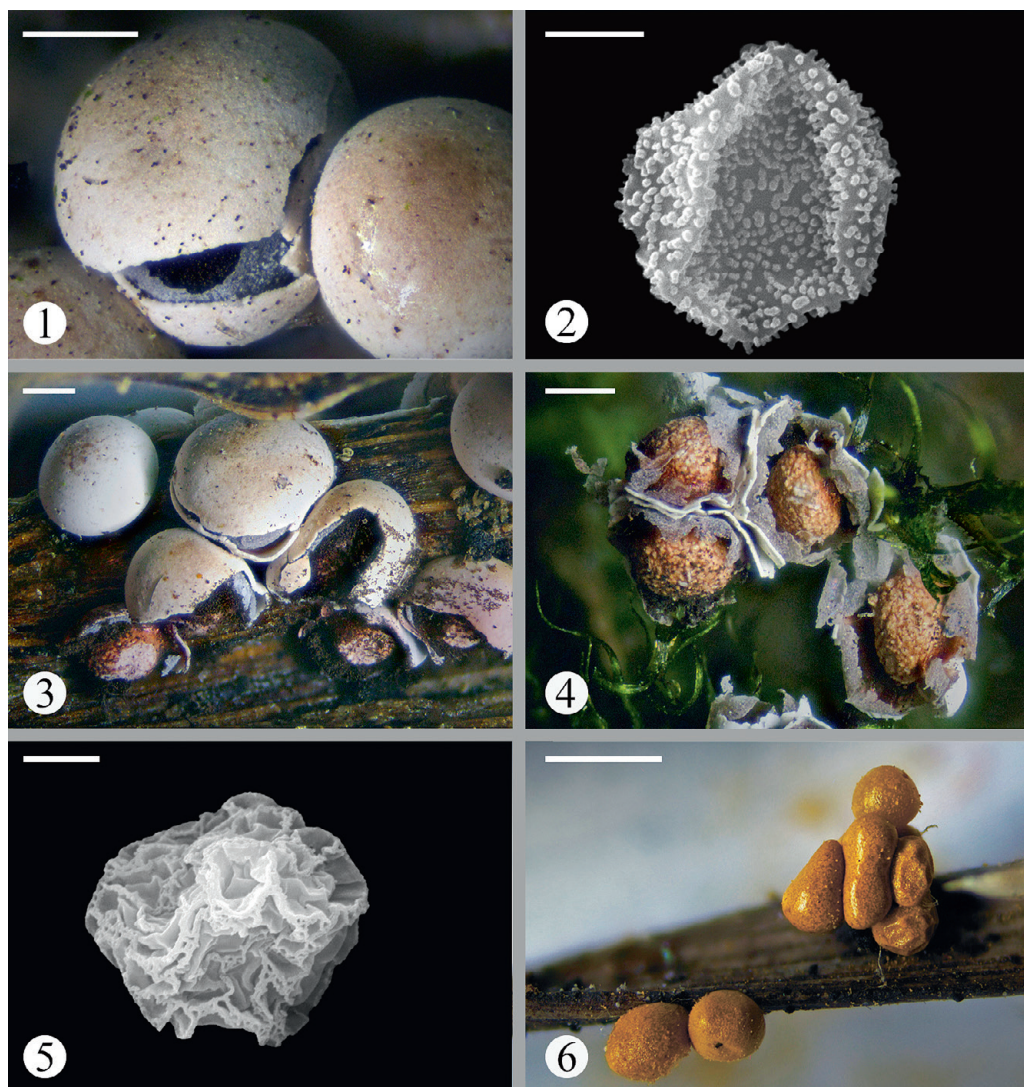


Plate II. 1–4 – *Didyma testaceum*: 1 – two-layer peridium (MYX 16900); 2 – spore, SEM (MYX 16831); 3 – sporangia with light-pink peridium (MYX 16900); 4 – pinkish-brown columella and two-layer peridium (MYX 16819); 5–6 – *Oligonema flavidum* (MYX 16901): 5 – spore (SEM); 6 – sporophores.

Scale bars: 2, 5 – 3  $\mu\text{m}$ ; 1, 3, 4 – 300  $\mu\text{m}$ ; 6 – 500  $\mu\text{m}$ .

7 (MYX 16922); 8 (MYX 16943); 9 (MYX 16844); 15 (MYX 16959); 16 (MYX 16972, MYX16976); 17 (MYX 16987); 18 (MYX 16992, MYX 16997).

**Mucilago crustacea** P. Micheli ex F. H. Wigg. — **O** (2); on rotten wood of the deciduous tree; on unidentified grass. Localities: 2 (MYX 16891); 8 (MYX 16940).

**Oligonema flavidum** (Peck) Peck (Plate II: 5–6) — **R** (1); on leaf litter of the deciduous tree. Locality: 3 (MYX 16901).

It is rare species. It differs by cylindrical sporangia that form dense clusters, spores ornamented with a large mesh, and a strongly reduced capillitium of short fibers, that almost lack helical thickenings. In the territory of Russia that species had been found in Pskov, Leningrad, Murmansk, Rostov, and Volgograd regions (Bortnikov *et al.*, 2020).

**Perichaena corticalis** (Batsch) Rostaf. — **C** (4); on rotten wood of the deciduous tree. Localities: 4 (MYX 16909); 9 (MYX 16947, two samples not inserted in herbarium).

**Physarum album** (Bull.) Chevall. — **A** (10); on rotten wood (8) and bark (1) of the deciduous tree; on rotten wood of the conifer tree (1). Localities: 1 (MYX 16882); 2 (MYX 16812); 3 (no sample in herbarium); 4 (MYX 16821); 6 (no sample in herbarium); 15 (no sample in herbarium); 16 (no sample in herbarium); 17 (MYX 16982).

**P. contextum** (Pers.) Pers. — **R** (1); on rotten wood of the deciduous tree. Locality: 8 (MYX 16935).

**P. daamsii** Nann.-Bremek. — **O** (3); on rotten wood of the deciduous tree. Localities: 8 (MYX 16840); 9 (MYX 16953); 16 (MYX 16977).

**P. flavicomum** Berk. — **R** (1); on rotten wood of the deciduous tree. Locality: 1 (MYX 16876).

**Reticularia lycoperdon** Bull. — **C** (4); on rotten wood of the deciduous tree. Localities: 1 (MYX 16875); 6 (MYX 16827); 9 (MYX 16946).

**Siphoptychium reticulatum** Leontyev, Schnittler et S. L. Stephenson (Plate III: 1) — **R** (1); on rotten wood of the deciduous tree. Locality: 16 (MYX 16852).

This species had been described only in 2019. It is very close to *S. violaceum* Leontyev, Schnittler et S. L. Stephenson and differs by a lighter peridium color and the presence of light lines on the sporangium top, which resemble a kind of net ornamentation (Leontyev *et al.*, 2019). Currently, in the territory of Russia, there is information about its records only in Lapland Reserve, located in the Murmansk Region (Novozhilov *et al.*, 2020). However, a thorough revision of collections will help obtain more information about the range of this species.

**Stemonitis axifera** (Bull.) T. Macbr. — **O** (3); on rotten wood (1) and bark (2) of the deciduous tree. Localities: 15 (MYX 16845); 16 (MYX 16849); 17 (MYX 16985).

**S. fusca** Roth — **O** (3); on rotten wood (2) and bark (1) of the deciduous tree. Localities: 9 (MYX 16841, MYX 16950); 17 (MYX 16989).

**S. pallida** Wingate — **R** (1); on rotten wood of the deciduous tree. Locality: 7 (MYX 16830).

**Stemonitopsis amoena** (Nann.-Bremek.) Nann.-Bremek. — **O** (2); on rotten wood of the deciduous tree (1), covered by mosses (1). Localities: 2 (MYX 16886); 8 (MYX 16933).

<sup>4</sup>**S. typhina** (F. H. Wigg.) Nann.-Bremek. — **O** (3); on rotten wood (2) and bark (1) of the deciduous tree. Localities: 1 (MYX 16873); 7 (MYX 16924); 8 (MYX 16834).

**Trichia botrytis** (J. F. Gmel.) Pers. — **O** (2); on rotten wood of the deciduous (1) and conifer (1) tree. Localities: 16 (MYX 16855); 18 (MYX 16865).

**T. crateriformis** G. W. Martin (Plate III: 2–3) — **O** (2); on rotten wood of the deciduous tree. Localities: 2 (MYX 16884); 17 (MYX 16990).

Our specimen fully conforms to the description of typical *Trichia decipiens* var. *olivacea* sporocarps. It differs from *T. decipiens* var. *decipiens* by olive-yellowish sporangia with almost fully

destroyed peridium at the top. As a result, there remains only a deep cap with smooth edges. Spores are 9–11 µm in diam., evenly ornamented with bacula grouped in crests. Via SEM, it can be seen that spores ornamented with rough warts joined to form short crests and irregular lines. In the database Eumycetozoa *T. decipiens* var. *olivacea* is given as a heterotypic synonym of *T. crateriformis* (Lado, 2005–2021). It is related to the fact that G. Moreno and A. Castillo in 2013 studied type specimens of *T. crateriformis* and *T. decipiens* var. *olivacea* and offered to synonymize them, mentioning *T. crateriformis* as having priority. In the article, there were type specimen illustrations and photographs that were obtained both with the use of light and scanning electron microscopy. This allows us to unequivocally agree with the authors' conclusions about the conspecificity of these type specimens (Moreno, Castillo, 2013). In 2020, Ing published a new name in a new rank, *T. meylanii*, for which *T. fallax* var. *olivacea* Meyl. was specified as a "basionym" (actually a replaced name), and *T. decipiens* var. *olivacea* (Meyl.) Meyl., as a homotypic synonym (Ing, 2020). Morphological differences between the described taxon, and *T. crateriformis* were not considered in the article, and references to the abovementioned study on the type material were not provided too. That is why we consider it is right to specify *T. meylanii* Ing as a synonym of *T. crateriformis*.

It should be mentioned that *Trichia crateriformis* was considered very rare before G. Moreno and A. Castillo (2013) publication. It can be connected with the fact that in G. Martin and C. J. Alexopoulos's classic monograph (Martin, Alexopoulos, 1969: fig. 102) was given the color illustrations of *T. crateriformis*, where its sporangia were dark brown. Furthermore, while assembling the description of type specimens, G. Martin compared *T. crateriformis* not with *T. decipiens* but with *T. botrytis*, which had a much darker peridium color, although in protologue it was pointed out that sporangia were from yellow-brown to dark brown. As a result, it seems that this species could be incorrectly interpreted by later researchers. That was fully corrected by the publication of high-quality photographs of type specimens of *T. crateriformis* and *T. decipiens* var. *olivacea* (Moreno, Castillo, 2013).

**TAXONOMIC CONCLUSIONS:** *Trichia crateriformis* G. W. Martin, 1963, *Mycologia* 55(1): 131.

= *T. fallax* var. *olivacea* Meyl., 1908, *Bull. Soc. Vaud. Sci. Nat.* 44: 300, non *Trichia olivacea* With., 1796, *Arr. Brit. pl.*, ed. 3, 4: 398. [= *T. decipiens* (Pers.) T. Macbr. var. *olivacea* (Meyl.) Meyl., 1924, *Bull. Soc. Vaud. Sci. Nat.* 55: 244. ≡ *T. decipiens* f. *olivacea* (Meyl.) Y. Yamam., 1998, *The Myxomycete Biota of Japan* (Tokyo): 237. ≡ *Trichia meylanii* Ing, 2020, *Field Mycol.* 21(4):130].

***Trichia decipiens*** (Pers.) T. Macbr. (Plate III: 4–5) – **A** (12); on rotten wood (7) and bark (3) of the deciduous tree; on rotten wood of the conifer tree (2). Localities: **2** (MYX 16895); **3** (MYX 16904); **4** (MYX 16822, MYX 16910); **8** (MYX 16941); **15** (MYX 16955, MYX 16957); **16** (MYX 16850, MYX 16962, MYX 16970, MYX 16980).

<sup>AJ, YN</sup>***T. favoginea*** (Batsch) Pers. – **O** (3); on rotten wood (1) and bark (2) of the deciduous tree. Localities: **2** (no sample in herbarium); **7** (MYX 16932); **16** (MYX 16969).

***T. persimilis*** P. Karst. – **R** (1); on rotten wood of the conifer tree. Locality: **2** (MYX 16814).

***T. scabra*** Rostaf. – **O** (3); on rotten wood (2) and bark (1) of the deciduous tree. Localities: **2** (MYX 16893, MYX 16894); **18** (MYX 16996).

<sup>AJ, YN</sup>***T. varia*** (Pers. ex J. F. Gmel.) Pers. – **A** (22); on rotten wood (16) and bark (5) of the deciduous tree, and on lichen on surface of the deciduous tree (1). Localities: **1** (MYX 16870, MYX 16872); **2** (MYX 16892); **3** (MYX 16906); **6** (MYX 16824, MYX 16826, MYX 16912, MYX 16914, MYX 16917); **8** (MYX 16835, MYX 16839, MYX 16944); **9** (MYX 16945, MYX 16949); **15** (MYX 16847, MYX 16958, MYX 16960); **16** (MYX 16978); **18** (MYX 16993, MYX 16995).

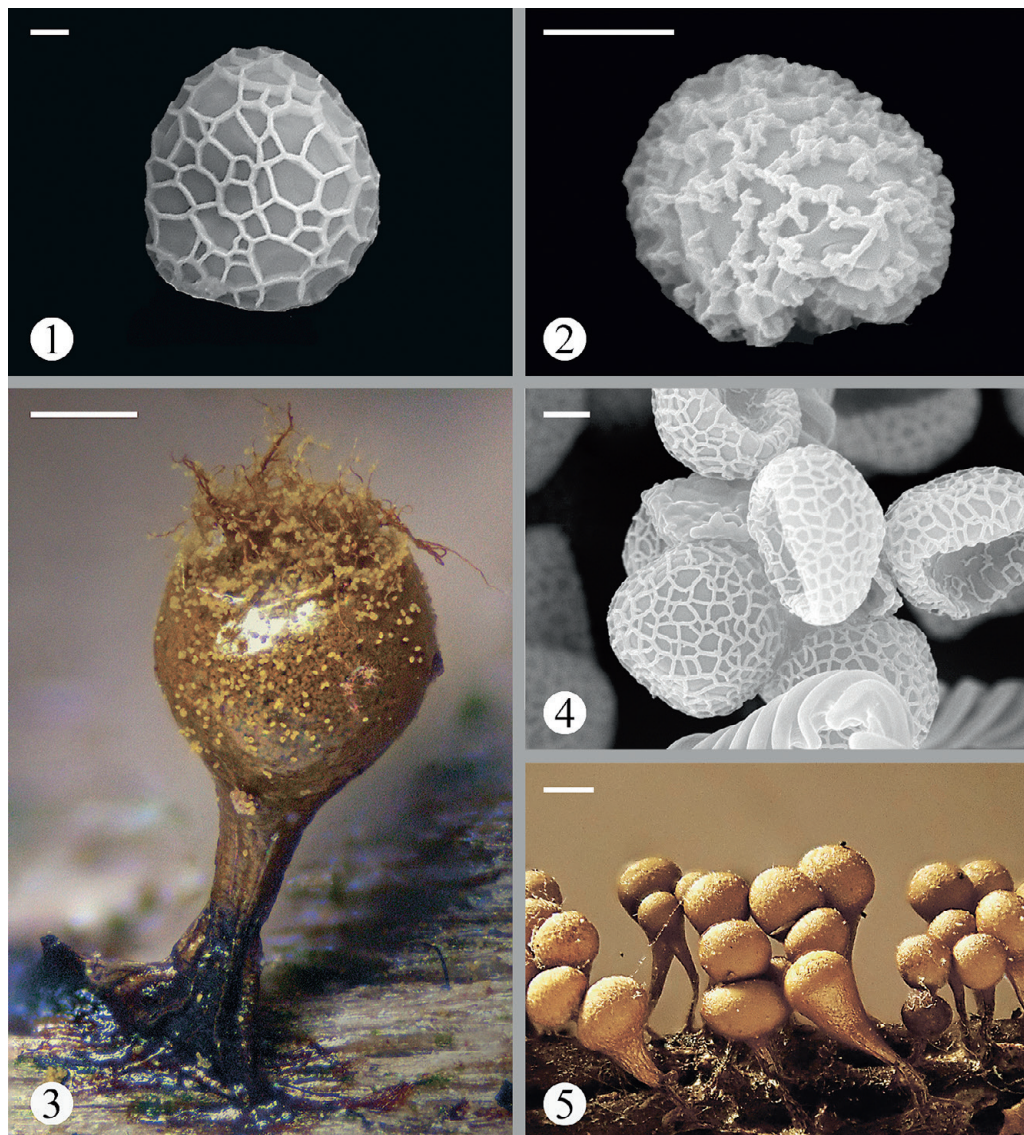


Plate III. 1 — *Siphoptychium reticulatum* (MYX 16852), spore (SEM); 2, 3 — *Trichia crateriformis* (MYX 16884): 2 — spore (SEM); 3 — sporangium; 4, 5 — *Trichia decipiens* (MYX 16895): 4 — spores (SEM); 5 — sporangia.

Scale bars: 2, 4 — 3  $\mu\text{m}$ ; 1 — 1  $\mu\text{m}$ ; 3 — 200  $\mu\text{m}$ ; 5 — 1 mm.

**Tubifera ferruginosa** (Batsch) J. F. Gmel. – **R** (1); on rotten bark of the deciduous tree. Locality: **8** (MYX 16833).

## Discussion

This study resulted in 201 records representing 56 species and one variety from 27 genera and 10 families. We report 52 species (93% of all registered species) for the first time for the Novgorod Region. Thus, the species list of this region increased from 11 to 63.

The majority of species in our study belongs to the order Trichiales (20 species/35.7% of the total species number), Physarales (13 species and 1 variety/23.2%), Cribrariales and Stemonitidales (10/17.9% in each). Orders Echinosteliales and Ceratiomyxales have less number of species – 2/3.6% and 1/1.8%, respectively.

Of the 56 morphospecies, only seven are considered abundant (representing > 3% of the total abundance) including *Arcyria affinis*, *Hemitrichia calyculata*, *Lycogala epidendrum*, *Metatrichia vesparia*, *Physarum album*, *Trichia decipiens*, and *T. varia*.

The value of sample completeness, defined as observed richness divided by the Chao1 species richness estimator, is 64.1%.

In the future, the study should be continued using the moist chamber technique. This approach was used successfully in our studies of myxomycetes in the city of Moscow and the Moscow Region and has increased the species list by 16.7% of the total number of species (Gmoshinskiy, 2013).

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