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Biodiversity of algae inhabiting the basidiocarps of wood-decaying Basidiomycetes in the Central Ural

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Abstract

This article presents a list of 57 algae species inhabiting the basidiocarps of wood-decaying Basidiomycetes in the forests of the Central Ural. It includes 54 species of eukaryotic (45 – Chlorophyta, 5 – Charophyta, 4 – Ochrophyta) and 3 prokaryotic algae. Chlorophyta is the obligate component of mycobiont algal communities, all other algae groups are their optional part. Among the mycetobiont algae, unicellular coccoid algae prevail (48%), other types are less common: trichal (25%), colonial (18%), and monadic (9%). Among algae are no specialized mycobiont species and all of them are widespread soil and epiphytic algae as well as photobionts of ascolichens, which demonstrates the facultative nature of their symbiotic relationship with wood-decaying fungi. As a rule, algae inhabit annual basidiocarps and they do not manifest specificity to fungi species. The widest host-fungi spectrum of *Pseudococcomyxa simplex* occurs in the basidiocarps of 15 species. *Stichococcus bacillaris* and *Interfilum terricola* were found in the basidiocarps of 13 and 11 fungi species correspondingly. The largest numbers of algae species were found in the basidiocarps of *Cerrena unicolor* (24), *Trametes gibbosa* (12), *Trichaptum abietinum* (11), *T. bifforme* (22), *T. fuscoviolaceum* (17), *Stereum hirsutum* (11) and *S. subtomentosum* (19). The Occurrence and Checklist datasets of algae inhabiting the basidiocarps of wood-decaying Basidiomycetes in the Central Ural were uploaded to the GBIF.

Keywords: Agaricomycetes, Basidiomycota, biodiversity, Central Ural, ecology, symbiotic algae, wood-decaying fungi

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Introduction

The presence of algae in the basidiocarps of wood-decaying Basidiomycetes is a well-known phenomenon (Ryvarden and Gilbertson 1993, 1994; Hansen and Knudsen 1997; Bondartseva 1998), but only a few articles address this issue. Burdsall et al. (1996) reported two species of unicellular algae in the basidiocarps of *Oxyporus nobilissimus* W.B. Cooke. Zavada and Simoes (2001) found four species of Chlorophyta algae in the basidiocarps of *Trametes versicolor*. Voytsekhovich et al. (2013) found *Coccomyxa* sp. and *Elliptochloris* sp. in the basidiocarps of *Hyphodontia crustosa* (Pers.). J. Erikss. Stoyneva et al. (2015) described in the basidiocarps of *Fomes fomentarius* 3 species of Chlorophyta algae and Videv et al. (2017) reported 10 species: 9 belonged to Chlorophyta and 1 to Charophyta.

In 2012–2019, we carried out a large-scale special research on the biodiversity of algae inhabiting the basidiocarps of wood-decaying fungi (Basidiomycota, Agaricomycetes) in the Central Ural. The results were partially published (Mukhin et al. 2016, 2018a, 2018b; Neustroeva et al. 2017). In the present paper, annotated list of the algae inhabiting the basidiocarps of wood-decaying fungi in the Central Ural is presented for the first time.

Material and methods

Basidiocarps of 16 species wood-decaying fungi were analyzed for the species composition of the algae inhabiting in thereof: *Cerrena unicolor* (Bull.) Murrill, *Datronia mollis* (Sommerf.) Donk, *Eichleriella deglubens* (Berk. & Br.) D.A. Reid, *Fomes fomentarius* (L.) Fr., *Lenzites betulina* (L.) Fr., *Steccherinum ochraceum* (Pers.) Gray, *Stereum hirsutum* (Willd.) Pers., *S. subtomentosum* Pouzar, *Trametes gibbosa* (Pers.) Fr., *T. hirsuta* (Wulfen) Lloyd, *T. ochracea* (Pers.) Gilb. & Ryvarden, *T. trogii* Berk., *T. versicolor* (L.) Lloyd, *Trichaptum abietinum* (Dicks.) Ryvarden, *T. bifforme* (Fr.) Ryvarden, *T. fuscoviolaceum* (Ehrenb.) Ryvarden. A total of 64 basidiocarp samples were studied. The identification of fungi was obtained through traditional methods (Ryvarden and Gilbertson 1993, 1994; Hansen and Knudsen 1997).

The basidiocarps at the beginning were examined under a Nikon Eclipse 80i and Leica DM2000 microscope and fragments of basidiocarps and flushing from their surface were transferred in agar and liquid nutrient media examined under a Nikon Eclipse 80i and Leica DM2000 microscopes, and then fragments of the basidiocarps and swabs from their surface were transferred in agar and liquid nutrient media: 3N BBM for Chlorophyta and Bg11 for Cyanoprokaryota (Andersen 2005). The algae were identified using Andreeva (1998), Komárek and Anagnostidis (1998, 2005), Komárek (2013), Ettl and Gärtner (2014) keys. Some species that required observation at specific stages of reproduction and development were determined to a genus level only and designated as “cf”.

The nomenclature of fungi, algae, and plants is given according to MycoBank (Mycobank Database 2020), AlgaeBase (Guiry and Guiry 1996–2020), and the Plant List (The Plant List 2013) respectively. Some pure strains of algae species are stored in the collection of the Institute of Biology, Komi Scientific Center

(<https://ib.komisc.ru/sykoa/home/>), such species are marked on the list as “the strain deposited in SYKOA” indicating the deposit number. In the list, the algae species appear in the alphabetical order, and for each of them fungi species in basidiocarps of which the algae were found, localities where fungi were collected, and its woody substrates are indicated. The following abbreviations of localities are used in the list: 1. UrFU – Biological station of the Ural Federal University, 56°36.05'N; 61°3.24'E. 2. Shig. – near Shigaevo, 57°21.01'N; 58°41.54'E. 3. Polev. – near Polevskoy, 56°27.00'N; 60°11.00'E. 4. Kir. – near Visim biosphere reserve, 57°26.00'N; 60°04.00'E. 5. SMP. – near Revda, 56°50.17'N; 59°49.49'E. 6. Ekb. – Ekaterinburg, 56°51.06'N; 60°36.43'E, Ekb (a) – Botanical Garden of the Ural Branch of RAS, Ekb (b) – Lake Chusovskoye, Ekb (c) – Uktus, Ekb (d) – Southwest Forest Park. Abbreviations for woody substrates (sub.) of fungi: Ab – *Abies sibirica* Ledeb., Al – *Alnus glutinosa* (L.) Gaertn., Bet – *Betula pendula* Ehrh., Pad – *Padus avium* Mill., Pic – *Picea obovata* Ledeb., Pin – *Pinus sylvestris* L., Pop – *Populus tremula* L., Sor – *Sorbus aucuparia* L.

List of Algae

Phylum: CYANOPROKARYOTA

Aphanocapsa muscicola (Menegh.) Wille. Fungi: *Lenzites betulina* (Loc.: Kir; sub.: Bet); *Trichaptum fuscoviolaceum* (Loc.: Kir; sub.: Ab).

Chroococcus minimus (Keissler) Lemmermann. Fungi: *Stereum subtomentosum* (Loc.: Polev; sub.: Al).

Desmonostoc muscorum (C. Agardh ex Bornet & Flahault) Hrouzek & Ventura. Fungi: *Cerrena unicolor* (Loc.: UrFU; sub.: Bet); *Trametes gibbosa* (Loc.: Ekb (c); sub.: Bet).

Phylum: OCHROPHYTA

Characiopsis sp. Fungi: *Trametes versicolor* (Loc.: Ekb (d); sub.: Pad).

Heterococcus sp. Fungi: *Cerrena unicolor* (Loc.: Ekb (a); sub.: Bet).

Vischeria helvetica (Vischer & Pascher) D.J. Hibberd. Fungi: *Cerrena unicolor* (Loc.: UrFU; sub.: Bet); *Trametes trogii* (Loc.: SMP, sub.: Bet).

Vischeria magna (Petersen) Kryvenda, Rybalka, Wolf & Friedl. Fungi: *Trametes trogii* (Loc.: SMP; sub.: Bet).

Phylum: CHLOROPHYTA

Bracteacoccus pseudominor H.W. Bischoff & H.C. Bold. Fungi: *Stereum subtomentosum* (Loc.: Ekb (c); sub.: Bet); *Trichaptum fuscoviolaceum* (Loc.: Shig; sub.: Pic).

Chlamydomonas debaryana var. *atactogama* (Korshikov) Gerloff. Fungi: *Cerrena unicolor* (Loc.: Ekb(a); sub.: Bet).

Chlamydomonas cf. *planoconvexa* J.W.G. Lund. Fungi: *Stereum subtomentosum* (Loc.: Ekb (c); sub.: Bet).

Chlamydomonas cf. *reinhardtii* P.A. Dang. Fungi: *Cerrena unicolor* (Loc.: SMP; sub.: Bet).

Chlamydomonas sp. Fungi: *Cerrena unicolor* (Loc.: UrFU, Ekb (b); sub.: Bet); *Datronia mollis* (Loc.: Ekb (a); sub.: Pad); *Stereum hirsutum* (Loc.: UrFU; sub.: Bet); *S. subtomentosum* (Loc.: UrFU; sub.: Bet); *Trametes trogii* (Loc.: SMP; sub.: Bet); *Trichaptum abietinum* (Loc.: Shig, Kir; sub.: Ab, Pic); *T. biforme* (Loc.: UrFU; sub.: Bet); *T. fuscoviolaceum* (Loc.: UrFU, Shig, SMP; sub.: Ab, Pic, Pin).

Chlorella vulgaris Beij. Fungi: *Cerrena unicolor* (Loc.: Ekb (a); sub.: Bet); *Trichaptum abietinum* (Loc.: Shig; sub.: Pic).

Chlorella vulgaris* f. *globosa V.M. Andreyeva. Fungi: *Lenzites betulina* (Loc.: Shig; sub.: *Bet*); *Trametes gibbosa* (Loc.: Ekb (c); su.: *Bet*); *Trichaptum abietinum* (Loc.: Shig; sub.: *Pic*).

***Chlorella* sp. 1.** Fungi: *Cerrena unicolor* (Loc.: Shig; sub.: *Bet*); *Trichaptum biforme* (Loc.: Ekb (c); sub.: *Bet*).

***Chlorella* sp. 2.** Fungi: *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Chlorococcum lobatum (Korshikov) F.E. Fritsch & R.P. John. Fungi: *Cerrena unicolor* (Loc.: Shig; sub.: *Bet*); *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Chloroidium ellipsoideum (Gerneck) Darienko, Gustavs, Mudimu, Menendez, Schumann, U. Karst., Friedl & Pröschold. Fungi: *Stereum subtomentosum* (Loc.: UrFU; sub.: *Bet*); *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Chloroidium saccharophilum (W. Krüger) Darienko, Gustavs, Mudimu, Menendez, Schumann, U. Karst., Friedl & Pröschold. Fungi: *Cerrena unicolor* (Loc.: Ekb (b), UrFU; sub.: *Bet*); *Lenzites betulina* (Loc.: Shig; sub.: *Bet*); *Stereum subtomentosum* (Loc.: Ekb (c); sub.: *Bet*); *Trametes hirsuta* (Loc.: Ekb (b); sub.: *Bet*); *T. gibbosa* (Loc.: Ekb (b); sub.: *Bet*); *T. ochracea* (Loc.: UrFU; sub.: *Bet*), the strain deposited in SYKOA (No Ch-059-15, <https://ib.komisc.ru/sykoa/collection/222/>); *Trichaptum abietinum* (Loc.: Shig; sub.: *Pic*); *T. biforme* (Loc.: UrFU; sub.: *Bet*); *T. fuscoviolaceum* (Loc.: UrFU; sub.: *Pin*).

***Chlorosarcinopsis* sp.** Fungi: *Steccherinum ochraceum* (Loc.: Ekb (a); sub.: *Sor*).

Coelastrella terrestris (Reisigl) E. Hegewald & Hanagata. Fungi: *Stereum subtomentosum* (Loc.: Polev; sub.: *Al*).

Coenochloris oleifera (Broady) Kostikov, Darienko, Lukešová & L. Hoffm. Fungi: *Steccherinum ochraceum* (Loc.: Ekb (a); sub.: *Sor*); *Trametes gibbosa* (Loc.: Ekb (b); sub.: *Bet*); *Trichaptum biforme* (Loc.: UrFU, Ekb (c), Shig; sub.: *Bet*); *T. fuscoviolaceum* (Loc.: UrFU, SMP; sub.: *Ab, Pin*).

Coenochloris signiensis (Broady) Hindák. Fungi: *Cerrena unicolor* (Loc.: UrFU; sub.: *Bet*); *Stereum hirsutum* (Loc.: Shig; sub.: *Bet*); *S. subtomentosum* (Loc.: UrFU; sub.: *Bet*); *Trichaptum abietinum* (Loc.: Shig; sub.: *Pic*); *T. biforme* (Loc.: UrFU, SMP; sub.: *Bet*); *T. fuscoviolaceum* (Loc.: UrFU, Shig; subs.: *Pic, Pin*).

Deasonia granata (R.C. Starr) H. Ettl & Komárek. Fungi: *Cerrena unicolor* (Loc.: Shig; sub.: *Bet*); *Trichaptum fuscoviolaceum* (Loc.: UrFU; sub.: *Pin*).

Deasonia multinucleate (Deason & Bold) H. Ettl & Komárek. Fungi: *Stereum hirsutum* (Loc.: Ekb (c); sub.: *Bet*), the strain deposited in SYKOA (No Ch-060-16, <https://ib.komisc.ru/sykoa/collection/240/>).

***Deasonia* sp.** Fungi: *Trichaptum abietinum* (Loc.: Shig; sub.: *Pic*).

Desmococcus olivaceus (Pers. Ex Ach.) J.R. Laundon. Fungi: *Cerrena unicolor* (Loc.: Ekb (a); sub.: *Bet*); *Steccherinum ochraceum* (Loc.: Ekb (a); sub.: *Sor*); *Trametes gibbosa* (Loc.: Ekb (c); sub.: *Bet*); *T. hirsuta* (Loc.: Ekb (b); sub.: *Bet*); *Trichaptum biforme* (Loc.: UrFU, SMP, Ekb (c); sub.: *Bet*); *T. fuscoviolaceum* (Loc.: Shig, Kir; sub.: *Ab, Pic*).

Diplosphaera chodatii Bialosuknia. Fungi: *Stereum hirsutum* (Loc.: Ekb (c); sub.: *Bet*); *S. subtomentosum* (Loc.: Ekb (d); sub.: *Pad*), the strain deposited in SYKOA (No Ch-061-16, <https://ib.komisc.ru/sykoa/collection/244/>); *Trametes gibbosa* (Loc.: Ekb (b); sub.: *Bet*); *T. trogii* (Loc.: SMP; sub.: *Bet*); *T. versicolor* (Loc.: Ekb (d); sub.: *Pad*); *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Elliptochloris bilobata Tscherm.-Woess. Fungi: *Eichleriella deglubens* (Loc.: UrFU; sub.: *Pop*); *Lenzites betulina* (Loc.: Shig; sub.: *Bet*); *Trichaptum fuscoviolaceum* (Loc.: UrFU, Kir; sub.: *Ab, Pin*).

Elliptochloris reniformis (S. Watan.) H. Ettl & G. Gärtner. Fungi: *Cerrena unicolor* (Loc.: Ekb (a); sub.: *Bet*); *Steccherinum ochraceum* (Loc.: Ekb (a); sub.: *Sor*); *Stereum subtomentosum* (Loc.: Ekb (d); sub.: *Pad*); *Trametes versicolor* (Loc.: Ekb (d); sub.: *Pad*); *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Elliptochloris subsphaerica (Reisigl) H. Ettl & G. Gärtner. Fungi: *Lenzites betulina* (Loc.: Kir; sub.: *Bet*); *Stereum subtomentosum* (Loc.: Polev; sub.: *Al*); *Trametes gibbosa* (Loc.: UrFU; sub.: *Bet*).

Interfilum terricola (J.B. Petersen) Mikhailyuk, Sluiman, A. Massalski, Mudimu, Demchenko, Friedl & S.Y. Kondr. Fungi: *Cerrena unicolor* (Loc.: UrFU, Ekb (a), Ekb (b), Shig, Kir; sub.: *Bet*); *Lenzites betulina* (Loc.: Kir; sub.: *Bet*); *Stereum hirsutum* (Loc.: Shig, Ekb (c); sub.: *Bet*); *S. subtomentosum* (Loc.: UrFU, Ekb (c), Ekb (d); sub.: *Pad*); *Trametes gibbosa* (Loc.: Ekb (b), Ekb (c); sub.: *Bet*); *T. hirsuta* (Loc.: Ekb (b); sub.: *Bet*); *T. trogii* (Loc.: SMP; sub.: *Bet*); *T. versicolor* (Loc.: Ekb (d); sub.: *Pad*); *Trichaptum abietinum* (Loc.: Shig; sub.: *Pic*); *T. biforme* (Loc.: UrFU, Ekb (c), SMP; sub.: *Bet*); *T. fuscoviolaceum* (Loc.: UrFU, Kir, SMP; sub.: *Pin, Ab, Ab*), the strain deposited in SYKOA (No S-002-15, <https://ib.komisc.ru/sykoa/collection/207/>).

Interfilum sp. Fungi: *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Leptosira terricola (Bristol) Printz. Fungi: *Stereum subtomentosum* (Loc.: Ekb (d); sub.: *Pad*).

Leptosira sp. Fungi: *Lenzites betulina* (Loc.: Kir; sub.: *Bet*); *Trametes trogii* (Loc.: SMP; sub.: *Bet*).

cf. *Microglena media* (G. A. Klebs) Nakada. Fungi: *Trametes hirsuta* (Loc.: Ekb (b); sub.: *Bet*).

Myrmecia bisecta Reisigl. Fungi: *Cerrena unicolor* (Loc.: Ekb (a); sub.: *Bet*).

Myrmecia sp. Fungi: *Stereum subtomentosum* (Loc.: Ekb (c); sub.: *Bet*); *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*); *T. fuscoviolaceum* (Loc.: Shig, SMP; sub.: *Ab, Pic*).

Neochlorosarcina sp. Fungi: *Trametes gibbosa* (Loc.: Ekb (c); sub.: *Bet*).

Parietochloris alveolaris (H.C. Bold) S. Watan. & G.L. Floyd. Fungi: *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*); *T. fuscoviolaceum* (Loc.: Shig; sub.: *Pic*).

Pseudococcomyxa chodatii (Jaag) Kostikov, Darienko & L. Hoffm. Fungi: *Cerrena unicolor* (Loc.: Ekb (b); sub.: *Bet*).

Pseudococcomyxa simplex (Mainx) Fott. Fungi: *Cerrena unicolor* (Loc.: Kir, UrFU, Shig, SMP; sub.: *Bet*); *Eichleriella deglubens* (Loc.: UrFU; sub.: *Pop*); *Fomes fomentarius* (Loc.: UrFU; sub.: *Bet*); *Lenzites betulina* (Loc.: Shig; sub.: *Bet*); *Steccherinum ochraceum* (Loc.: Ekb (a); sub.: *Sor*); *Stereum hirsutum* (Loc.: UrFU, Shig, SMP, Ekb (c); sub.: *Bet*); *S. subtomentosum* (Loc.: Polev, Ekb (d), Ekb (c), UrFU; sub.: *Bet, Pad*); *Trametes gibbosa* (Loc.: UrFU, Ekb (b); sub.: *Bet*); *T. hirsuta* (Loc.: Ekb (b); sub.: *Bet*); *T. ochracea* (Loc.: UrFU; sub.: *Bet*); *T. trogii* (Loc.: SMP; sub.: *Bet*); *T. versicolor* (Loc.: SMP, Ekb (d); sub.: *Bet, Pad*); *Trichaptum abietinum* (Loc.: Shig; sub.: *Pic*); *T. biforme* (Loc.: UrFU, Shig, SMP, Ekb (c); sub.: *Bet*); *T. fuscoviolaceum* (Loc.: UrFU, Shig, SMP; sub.: *Ab, Pic, Pin*).

Spongiococcum tetrasporum Deason. Fungi: *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Sporotetras polydermatica (Kütz.) Kostikov, Darienko, Lukesová & L. Hoffm. Fungi: *Cerrena unicolor* (Loc.: Kir, UrFU; sub.: *Bet*); *Stereum hirsutum* (Loc.: UrFU; sub.: *Bet*); *S. subtomentosum* (Loc.: Polev; sub.: *Al*); *Trametes hirsuta* (Loc.: Lake Chus; sub.: *Bet*); *T. ochracea* (Loc.: UrFU; sub.: *Bet*); *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*); *T. fuscoviolaceum* (Loc.: UrFU; sub.: *Pin*).

Stichococcus bacillaris Nägeli. Fungi: *Cerrena unicolor* (Loc.: Kir, UrFU, SMP; sub.: *Bet*); *Lenzites betulina* (Loc.: Shig; sub.: *Bet*); *Steccherinum ochraceum* (Loc.: Ekb(a); sub.: *Sor*); *Stereum hirsutum* (Loc.: Shig; sub.: *Bet*); *S. subtomentosum* (Loc.: UrFU, Ekb (c); sub.: *Bet*); *Trametes gibbosa* (Loc.: UrFU, Ekb (b); sub.: *Bet*); *T. hirsuta* (Loc.: Ekb (b); sub.: *Bet*); *T. ochracea* (Loc.: UrFU; sub.: *Bet*); *T. trogii* (Loc.: SMP; sub.: *Bet*); *T. versicolor* (Loc.: Ekb (d), SMP; sub.: *Bet*, *Pad*); *Trichaptum abietinum* (Loc.: Kir; sub.: *Ab*); *T. biforme* (Loc.: UrFU, Shig, SMP, Ekb (c); sub.: *Bet*); *T. fuscoviolaceum* (Loc.: UrFU, Shig, SMP; sub.: *Ab*, *Pic*, *Pin*).

Stichococcus minor Nägeli. Fungi: *Cerrena unicolor* (Loc.: Ekb (a), Shig; sub.: *Bet*); *Eichleriella deglubens* (Loc.: UrFU; sub.: *Pop*); *Stereum hirsutum* (Loc.: Ekb (c); sub.: *Bet*); *Trametes gibbosa* (Loc.: Ekb (c); sub.: *Bet*); *T. ochracea* (Loc.: UrFU; sub.: *Bet*); *Trichaptum abietinum* (Loc.: Shig; sub.: *Pic*).

Tetracystis cf. aeria R.M. Br. & H.C. Bold. Fungi: *Cerrena unicolor* (Loc.: SMP; sub.: *Bet*), the strain deposited in SYKOA (No Ch-062-16, <https://ib.komisc.ru/sykoa/collection/215/>)

Tetracystis macrostigmata Nakano 1737200859. Fungi: *Stereum subtomentosum* (Loc.: Ekb (c); sub.: *Bet*).

Trebouxia corticola (P.A. Archibald) G. Gärtner. Fungi: *Trichaptum fuscoviolaceum* (Loc.: SMP; sub.: *Ab*).

Trebouxia sp. Fungi: *Cerrena unicolor* (Loc.: SMP; sub.: *Bet*); *Fomes fomentarius* (Loc.: UrFU; sub.: *Bet*); *Steccherinum ochraceum* (Loc.: Ekb (a); sub.: *Sor*); *Stereum hirsutum* (Loc.: UrFU; sub.: *Bet*); *S. subtomentosum* (Loc.: Ekb (c); sub.: *Bet*); *Trametes gibbosa* (Loc.: Ekb (b); sub.: *Bet*); *T. versicolor* (Loc.: SMP; sub.: *Bet*); *Trichaptum biforme* (Loc.: UrFU, Shig, *Bet*, Ekb (c); sub.: *Bet*); *T. fuscoviolaceum* (Loc.: Shig, SMP; sub.: *Ab*, *Pic*).

Ulothrix tenerrima (Kütz.) Kirchner. Fungi: *Datronia mollis* (Loc.: Ekb (a); sub.: *Pad*); *Trametes ochracea* (Loc.: UrFU; sub.: *Bet*).

Ulothrix zonata (F. Weber & Mohr) Kütz. Fungi: *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Phylum: CHAROPHYTA

Cylindrocystis sp. Fungi: *Trichaptum biforme* (Loc.: UrFU; sub.: *Bet*).

Klebsormidium flaccidum (Kütz.) P.C. Silva, Mattox & W.H. Blackw. Fungi: *Cerrena unicolor* (Loc.: UrFU, Ekb (a), Shig; sub.: *Bet*); *Stereum subtomentosum* (Loc.: Ekb (c); sub.: *Bet*); *Trichaptum abietinum* (Loc.: Shig; sub.: *Pic*); *T. biforme* (Loc.: UrFU; sub.: *Bet*).

Klebsormidium pseudostichococcus (Heering) H. Ettl & G. Gärtner. Fungi: *Stereum hirsutum* (Loc.: Ekb (c); sub.: *Bet*), the strain deposited in SYKOA (No S-006-15, <https://ib.komisc.ru/sykoa/collection/226/>); *S. subtomentosum* (Loc.: Ekb (c); sub.: *Bet*); *Trametes trogii* (Loc.: SMP; sub.: *Bet*).

Klebsormidium sp. Fungi: *Trichaptum fuscoviolaceum* (Loc.: UrFU; sub.: *Pin*).

Mesotaenium cf. chlamydosporum de Bary. Fungi: *Trametes versicolor* (Loc.: SMP; sub.: *Bet*).

Discussion

In the Central Ural, 57 species of algae inhabiting the basidiocarps of wood-decaying Basidiomycetes are found. As a rule, those are fungi with annual and overwintering basidiocarps. The largest numbers of algae species were found in the basidiocarps of *Cerrena unicolor* (24), *Trametes gibbosa* (12), *Trichaptum abietinum* (11), *T. biforme* (22), *T. fuscoviolaceum* (17), *Stereum hirsutum* (11) and

S. subtomentosum (19). This group of algae is quite diverse and includes Chlorophyta (45 species), Charophyta (5 species), Ochrophyta (4 species) and Cyanoprokaryota (3 species). Chlorophyta is not only the largest group of mycobiont algae, but also their obligate component, other algae (Charophyta, Ochrophyta, Cyanoprokaryota) are irregular, facultative components. The mycobiont algae mainly unicellular coccoid organisms (27 species, 48%), other types are less common: trichal (14 species, 25%), colonial (10 species, 18%), and monadic algae (5 species, 9%).

The algae inhabiting the basidiocarps of wood-decaying Basidiomycetes are not specialized mycobionts – all of them are free-living organisms: hydrobionts, pedobionts, aerobionts, and photobionts of lichens. They do not demonstrate any specificity to fungi species, and most of them have been found in the basidiocarps of two or more fungi. The widest host spectrum are of *Pseudococcomyxa simplex*, *Stichococcus bacillaris*, and *Interfilum terricola* that occur in the basidiocarps of 15, 13 and 11 fungi species correspondingly. About 40% of algae are found in the basidiocarps of one of the 16 studied fungi species. In our opinion, these may be referred to as algae rarely and occasionally occurring in mycobiont communities.

We find it possible to characterize the relationship between the algae and wood-decaying fungi as associative symbiosis, and their symbiotic associations as lichen-like (Neustroeva and Mukhin 2013; Mukhin et al. 2018a). The mutually beneficial nature of the relationship between the algae and fungi is quite obvious: the algae receive some protection from the environment, as well as carbon dioxide and water produced by fungi, and the fungi receive an additional nutrition source of carbon and nitrogen (Zavada et al. 2004; Neustroeva and Mukhin 2013; Mukhin et al. 2016, 2018b). The Occurrence and Checklist datasets of algae inhabiting the basidiocarps of wood-decaying Basidiomycetes in the Central Ural were uploaded to the Global Biodiversity Information Facility, GBIF (Neustroeva et al. 2020a, 2020b).

Conclusion

The basidiocarps of wood-decaying Basidiomycetes are inhabited by many species and groups of algae, where Chlorophyta constitutes the largest and obligate part, and other groups (Charophyta, Ochrophyta, Cyanoprokaryota) are optional. These are all widespread soil and epiphytic algae, photobionts of lichens, for which, as well as for the fungi, symbiosis is not obligate, but mutually beneficial, and can be defined as associative, and their symbiotic association as lichen-like.

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