

## NOTES ON SOME BRYOPHILOUS PEZIZALES (FUNGI) IN THE MEDITERRANEAN PART OF BOSNIA AND HERZEGOVINA

### ZABILJEŠKE O NEKIM BRIOFILNIM GLJIVAMA REDA PEZIZALES (FUNGI) U MEDITERANSKOM DIJELU BOSNE I HERCEGOVINE

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#### Abstract

Results from bryomycological field studies in the Mediterranean part of Bosnia and Herzegovina are reported in the paper. Five bryophilous taxa of ascomycetes have been recorded on few locations around the city of Neum and on the Klek peninsula. Three of them are new for the mycobiota of Bosnia and Herzegovina – *Octospora gemmicola*, *Lamprospora miniata* var. *parvispora* and *Lamprospora miniata* var. *ratisbonensis*.

Macromorphology and micro-characters with ecology, phenology and distribution patterns for each species are presented and briefly discussed.

**Keywords:** Ascomycota, bryophily, *Lamprospora*, mosses, Neum, *Octospora*

## 1. INTRODUCTION / UVOD

Bryophilous Pezizales are widespread cosmopolite group of ascomycetes. They have been reported from all continents including Africa (Moravec, 1972; Wang & Kimbrough, 1992), Australia (McLennan & Cookson, 1926; Rifai, 1968), Asia (Egertová et al., 2018) and Antarctica (Dissing & Sivertsen, 1983; Olech & Mleczko, 2000). They live on different species of non-vascular land plants from the divisions Bryophyta and Marchantiophyta. Many of bryophilic operculate discomycetes are highly specialized and host-specific while other can inhabit multiple hosts within same or different genera (Benkert, 1995; Döbbeler & Facher, 2014). Different species of bryophilous Pezizales can have same hosts preferences but case of simultaneous infection and growth on the same host is still unrecorded.

A large number of species from bryophilic genera *Octospora* Hedw., *Lamprospora* De Not. and *Neottiella* (Cooke) Sacc. colonize terrestrial mosses that usually live on the pioneer habitats in the open areas. Still, as pointed in Eckstein & Eckstein (2009) some of these fungi are corticolous, other parasitizing on mosses that grow on rocky substrates and some even on ephemeral substrate like dung (Döbbeler & Facher, 2014).

Majority of these fungi parasitize on acrocarpous mosses and small number of species can be found parasitizing on pleurocarps. As stated by Benkert (2007) the most common host mosses are: *Barbula*, *Bryum*, *Ceratodon*, *Funaria*, *Grimmia*, *Phascum*, *Polytrichum*, *Pottia*, and *Tortula*.

Other bryophilic Pezizales with somewhat smaller ascomata are grouped within genera *Moravecchia* Benkert, Caillet & Moyne, *Octosporella* Döbbeler, *Octosporopsis* U. Lindem. & M. Vega and monospecific genera *Filicupula* Y.J. Yao & Spooner.

*Filicupula* and *Octosporella* infect liverworts species (Marchantiophyta) and are generally poorly known genera so far (Döbbeler, 2011).

Bryophilic Pezizales usually have reddish, orange or even yellowish disc shaped or cupuliform apothecia, 0.1–20 mm in diam., sometimes with more or less prominent and translucent marginal hairs, like those in *Octosporella* species, and with colourless hyphae that most frequently infect hosts' rhizoid, but in some cases can be found on the stem and leaves as well.

Morphology of the infectious apparatus of bryophilous Pezizales is uncovered and demystified not so long ago (Racovitza, 1959; Döbbeler, 1978, 1979).

Infectious structure consists of appressorium, a specialized fungal cell that is used to infect the host and haustorium that penetrates the host's tissue and draws nutrients from it (Eckstein & Eckstein, 2009).

The infection that happens to the host is quite specific type of symbiosis or parasitism. Various infection types are specified and described in Németh (2017).

Most of the terminology for this type of symbiosis is introduced by Benkert (2001). Infected species should be called "host moss" and other mosses around host moss should be called "associated mosses".

Bryophilous Pezizales were poorly or partially known until the last decades of 20<sup>th</sup> century.

The most important contribution to the knowledge of this group of fungi was done by Benkert (1987, 1993, 1995, 1998), Döbbeler (1978, 1979) and later by Eckstein & Eckstein (2009, 2013) and Eckstein et al. (2014).

Some of the Benkert's encouraging papers (Benkert, 1987, 1993, 1995, 2007) are the main cause for a rapid boost of interest for bryomycology. Several dozens of new species have been described in the last couple of decades with new bryophilic taxa constantly emerging (Benkert & Brouwer, 2004; Benkert & Kristiansen, 2008; Benkert, 2011; Döbbeler, 2011; Döbbeler & Facher, 2014; Vega et al., 2016; Vega et al., 2017; Egertová et al., 2018), bringing as results worldwide distribution patterns of bryophilous Pezizales more clear.

In the meantime, some relevant data gained from the material collected in Southeastern Europe has been published (Perić, 2002, 2011; Tóth, 2003; Benkert, 2006, 2007; Németh, 2017). Still, this part of Europe is probably among least explored territories in terms of bryomycology on an European scale.

In the past three years sporadic mycological field research in the Mediterranean part of Bosnia and Herzegovina has been undertaken. Occurrence of five bryophilic taxa in the Neum/Klek bay area has been recorded and some of the findings represent new species for the mycobiota of Bosnia and Herzegovina. Some of these results are briefly reported and discussed earlier in Jukić & Omerović (2017).

Published scientific material about earlier sporadic or systematic studies of bryophilous discomycetes in Bosnia and Herzegovina does not exist.

## 2. MATERIAL AND METHODS / MATERIJAL I METODE

All material is collected in the winter time period from January to the end of March from 2016 - 2018. This period generally offers most favourable ecological conditions (temperature, precipitation, moisture) for the fructification of bryophilic fungi in the Mediterranean zone of Bosnia and Herzegovina.

Vital characters of freshly collected fungi were preserved in order to follow laboratory methods of material treatment proposed by Baral (1992). All vital elements observed are marked and denoted with +, whilst dead elements observed in fresh analyzed material are marked with \*. Specimens were photographed both *in situ* and *ex*

*situ*. Macro-photographs were taken using Canon 700D camera, 100mm f/2.8L Macro IS USM lens, tripod and Canon Macro Ring Lite MR-14EX II.

Nikon SE type 102 compound light microscope was used for observing micro-morphological characters. Micro-photographs were taken using a Sony DSC-H2 camera.

Fresh material was cut by hand using a razor blade or smaller amount of tissue was taken by using a teasing needle in case of checking and analyzing smaller apothecia. All measurements were made in tap water mount unless otherwise stated. For every species 20 ascospores were measured to determine their length and width. Extreme values of measured ascospores and other structures are given in brackets. Asci, paraphyses and excipular cells length and width were determined by

measuring at least five samples. For staining ornamentation units of the ascospores Lactophenol Cotton Blue (CB) was used (Aneja, 2003).

For defining simple spore shape in accordance with Q value (ascospores length/width ratio) geometric delimitation criteria from Kušan et al. (2014) were used.

The analyses of the moss samples were done at the Faculty of Biology, University of Belgrade.

For mosses mentioned in the paper nomenclature follows Sabovljević et al. (2008).

All analyzed fungal material has been preserved and stored as exsiccata in a private fungarium (N.J. - Nedim Jukić) with relevant data entries into Mycological Society MycoBH Electronic Database (FAMU).

### 3. RESULTS AND DISCUSSION / REZULTATI I DISKUSIJA

#### ***Lamprospora miniata* De Not. var. *parvispora* Benkert 2000**

Figure 3 – h), j); Figure 4 – d), h), n), o), p); Figure 5

**Ascomata** apothecial, cupuliform to discoid, up to 2 mm in diam., safety orange to persimmon orange with distinctively pubescent and quite prominent margin.

**Asci** cylindrical, octosporous, 160–220 × 18.5–24.5 μm.

**Ascospores** hyaline, globose, uniseriate, (13.6) 14–16.3 (16.8) μm, uniguttulate, reticulate, ridges usually up to 1.0 μm high and up to 1.5 μm broad, rarely thickened and reaches up to 2.5 μm in width, ridges forming a regular large-meshed reticulum, meshes 2–6 μm in diam., 3–5 (6) meshes per spore diam. Additional more or less prominent warts and ornamentation units usually seen within meshes in CB.

**Paraphyses** straight, rarely branched, septate, slightly enlarged at the tips, up to 6.8 μm in wide, containing yellow-orange refractive pigment concentrated around septa and in the apical area.

**Excipulum** in the outer part made of irregular *textura globulosa-angularis*, cells up to 35 μm in diam., more brownish towards outside, medulla composed of *textura prismatica*.

**Material examined:** Klek Peninsula, (1.5 W from Neum City), 4 March 2018, leg. N. Jukić & S. Tomić, 110 m asl, 42.91698° N, 17.60075° E (50 m NE from the *L. miniata* var. *ratisbonensis* finding), numerous apothecia between shoots of *Barbula unguiculata*. - N.J./040318-Y14, assigned database code FAMU-0976.

**Distribution:** Not common throughout Europe – Germany, Norway, United Kingdom, Spain (Benkert, 2001; Rubio et al., 2002; Bryoparasitic Pezizales, 2018).

**Notes:** Other species within a group *Lamprospora miniata* s.l. differs by having larger ascospores and different host preferences. Ascospores measurements of *Lamprospora miniata* var. *parvispora* mentioned in Benkert (2000) and Bryoparasitic Pezizales (2018) are somewhat smaller if compared with the dimension of ascospores analyzed in this study.

*Lamprospora miniata* var. *parvispora* Benkert parasitize on mosses from the genus *Barbula* and has the smallest ascospores out of all varieties.

#### ***Lamprospora miniata* De Not. var. *ratisbonensis* Benkert 2000**

Figure 3 – i); Figure 4 – c), g), i), j), k)

**Ascomata** apothecial, quite small, up to 1 (1.5 mm) in diam., pale orange or honey colour, with prominent membranaceous and crenate margin.

**Asci** cylindrical, octosporous, 200–240 × 18–23.5 µm.

**Ascospores** globose, hyaline, mostly uniseriate, (14.2) 16.3–19.1 (19.2) µm in diam., ornamented with distinctive pattern composed of ridges, 0.5–0.8 µm broad and negligibly small in height, forming usually regular but often incomplete reticulum with 6–8 (9) meshes per spore diam., meshes 1–4.5 (5.5) µm in diam.

**Paraphyses** straight or slightly bent and narrowed in the apical area, septate, rarely swollen and enlarged, 3.0–6.5 (8.5) µm in diam., containing significant quantity of yellow-orange pigment distributed throughout the whole length.

**Excipulum** composed of mainly *textura angularis*, margin composed of moniliform pigmented and elongated cells 30–50 × 5–13 µm.

**Material examined:** Klek Peninsula, (1.5 km W from Neum City), 4 March 2018, leg. N. Jukić & S. Tomić, 110 m asl, 42.91698° N, 17.60075° E, single apothecia on *Didymodon* aff. *luridus*, shady place beneath wet carbonate rock. – N.J./040318-Y8, assigned database code FAMU-0970.

**Distribution:** Quite rare species but scattered throughout Europe: Czech Republic, Cyprus, Estonia, France, Germany, Greece, Hungary, Netherlands, Norway, Spain (Benkert, 2001; Rubio et al., 2002; Bryoparasitic Pezizales, 2018), sometimes it is probably overlooked due to its size.

**Notes:** *Lamprospora miniata* s.l. is a species complex with different varieties adopted by a different host mosses. Authentic material of holotype specimen of *Lamprospora miniata* (De Not., 1863) has been lost and Benkert (2001) proposed neotypification of this species based on the collection from Germany. Neotype specimen was registered on the rhizoids of the moss from genus *Pottia*. Other recorded host mosses for *Lamprospora miniata* are *Phascum* and *Encalypta* (Benkert, 2001; Bryoparasitic Pezizales, 2018).

*Lamprospora miniata* var. *ratibonensis* is associated with the mosses from the genus *Didymodon*. As Benkert (2001) stated most common host mosses from the genera *Didymodon* usually inhabit rocky habitats.

It is most probable that there are more intraspecific taxa within this complex yet to be discovered as

pointed out in Schumacher (1986), Benkert (2001) and Eckstein & Eckstein (2009).

***Octospora coccinea* (P. Crouan & H. Crouan) Brumm. 1967**

Figure 1 – a), b), c), g); Figure 2 – a), b), d), e), g), h), i)

**Ascomata** apothecial, disk shaped, 0.5–2.5 mm in diam., hymenium plane, orange to salmon orange with conspicuous, sometimes almost white and generally brighter and pubescent margin, 0.6–2.5 mm in diam.

**Asci** cylindrical-clavate, octosporous, with distinctly subtruncate apical part, 130–160 × 18.5–23 µm, very specific way of operculum opening is observed and recorded on several asci. Central apical part in form of equal sided depression is collapsing inward when ascospores are being ejected (Figure 2g).

**Ascospores** hyaline, smooth, uni- or biseriate, narrowly ellipsoid to fusiform, inequilateral with prominent obtuse ends, (22.7) 25.5–29.5 (31.1) × (8.2) 8.5–9.6 (10.3) µm, containing two large oil drops, 6–7 µm in diam., in mature ascospores usually accompanied with two smaller ones close to the poles, 1.8–3.2 µm in diam.

**Paraphyses** cylindrical, septate, containing yellow-orange pigment, in the apical part sometimes irregularly enlarged, up to 6.5 µm in diam.

**Excipulum** in the outer part composed of *textura globulosa-angularis*, medulla made of *textura intricata*.

**Material examined:** Klek Peninsula, (1.2 SW from Neum City), 29 January 2017, leg. N. Jukić, S. Tomić & A. Gajić; 4 March 2018, leg. N. Jukić & S. Tomić, 61 m asl, 42.91759° N, 17.59528° E, in the open habitat, on disturbed soil, in small groups, first finding on undetermined *Bryum* species, second finding on *Bryum caespitium*. Presence of *Phascum cuspidatum* as associated moss and liverwort species from the genus *Riccia* are recorded. – N.J./290117-Y2; N.J./040318-Y12 & N.J./040318-Y12a (duplex), assigned database code FAMU-0935.

**Distribution:** Very common in Europe, known also from North America (Bryoparasitic Pezizales, 2018).

**Notes:** Benkert (1995) mentioned that this species prefers open habitats and sites that are exposed to the higher mean temperature during the year, as it is a case in this study. *Acaulon muticum* is listed as host moss in Eckstein et al. (2014).

*Octospora coccinea* var. *tetraspora* Benkert is a variety that infects mosses from the genus *Bryum* too. It is quite uncommon and rare, known only from some parts of Central and Northern Europe (Benkert, 1998).

### ***Octospora excipulata* (Clem.) Benkert 2008**

Figure 1 – d), e), f), h); Figure 2 – c), f), j), k)

**Ascomata** apothecial, sessile, disc shaped, concave (sometimes even cupuliform) to flat, 1–6 mm in diam., yellow-orange to pumpkin orange, usually with prominent and in some ascomata more or less brighter coloured margin.

**Asci** cylindrical, octosporous, with distinctly obtuse apical part with operculum, 200–260 × 17–21 µm.

**Ascospores** hyaline, smooth, uniseriate, (21) 21.5–25.3 (26) × (13.4) 13.7–16.1 (16.6) µm, broadly ellipsoid to ellipsoid, rarely slightly inequilateral, with one large slightly ex-centric oil drop (up to 11 µm in diam.) and often with the few smaller ones.

**Paraphyses** cylindrical and septate, slightly enlarged below apical part, up to 7 µm wide, containing large quantities of yellow-orange pigment.

**Excipulum** mainly consists of prominent and long-celled *textura globulosa-angularis*, cells 15–55 µm in diam.

**Material examined:** Klek Peninsula, (1.2 km SW from Neum City), 10 February 2018, leg. N. Jukić & Z. Jukić; 4 March 2018, leg. N. Jukić & S. Tomić. 61 m asl, 42.91759° N, 17.59528° E, in open habitat, on disturbed soil, gregarious to very abundant, between shoots of *Funaria hygrometrica*. Presence of *Barbula unguiculata*, *Bryum* sp. and *Dicranella* sp. is also recorded – N.J./100218-Y7 & N.J./040318-Y11, assigned database code FAMU-0932.

**Distribution:** Very common species in Europe and North America. It has been also recorded in Montenegro (Perić, 2002).

**Notes:** Based on the author's private records, this species was previously recorded parasitizing on shoots of *F. hygrometrica* on two localities in Bosnia and Herzegovina (Nišići, 44.06854° N, 18.50022° E and river Baščica near Idbar, 43.65462° N, 17.88075° E, Jukić & Omerović (2017)).

Eckstein & Eckstein (2013) mentioned *Physcomitrium sphaericum* as host moss for *O. excipulata*.

### ***Octospora gemmicola* Benkert 1998**

Figure 3 – a), b), c), d), e), f), g); Figure 4 – a), b), e), f), l), m)

**Ascomata** apothecial, orange, hymenium most often flattened, in immature specimens almost cup-shaped, with barely noticeable weakly developed margin and scattered protruding and transparent pseudo-hairs, up to 1.5 mm in diam.

**Asci** cylindrical-subclavate, octosporous, very rarely 6–7 spored, 40–200 × 18.5–22.5 µm.

**Ascospores** hyaline, smooth, uni- or biseriolate, elongated ellipsoid to subfusiform, (22.1) 23.8–25.9 (26.6) × (9.9) 10.5–12.1 (12.7) µm, containing usually one larger oil drop (7.5–9.5 µm in diam.), 2–3 medium sized (3.5–5.0 µm in diam.) and several smaller ones.

**Paraphyses** straight, septate, slightly enlarged and curved in the apical area, up to 6.5 µm in diam., containing orange pigment.

**Excipulum** predominantly composed of *textura globulosa-angularis*, cells 15–40 µm in diam.

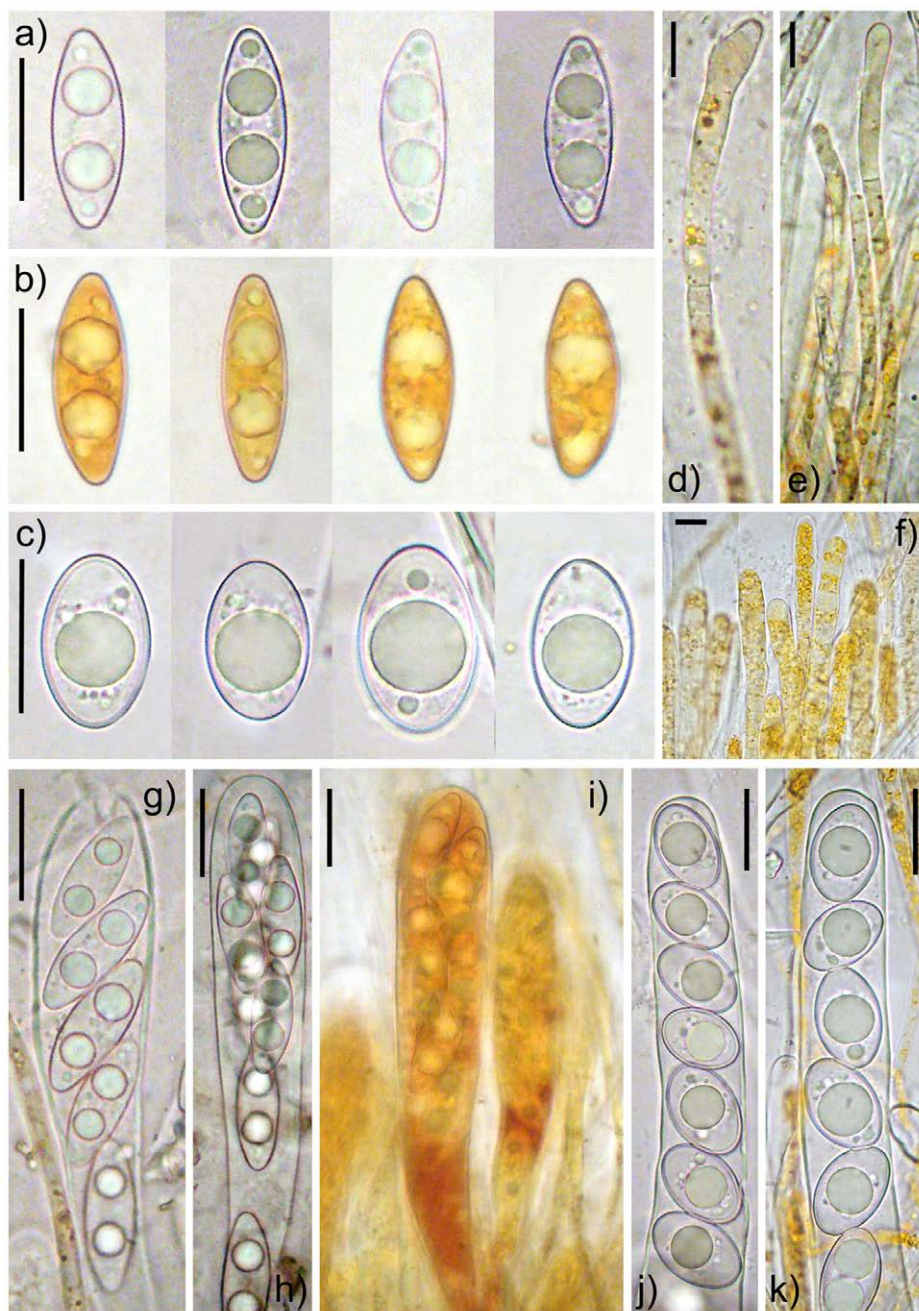
**Material examined:** Neum, City park near the Hotel Jadran, 4 March 2018, leg. N. Jukić & S. Tomić, 122 m asl, 42.92498° N, 17.61615° E, near minute seasonal water course on very wet and muddy soil, 5–6 ascomata scattered on *Bryum caespiticium*. Apart from the host moss, presence of *Fissidens taxifolius* is recorded too. – N.J./040318-Y5, assigned database code FAMU-0968.

**Distribution:** Common and widespread across Europe. (Bryoparasitic Pezizales, 2018).

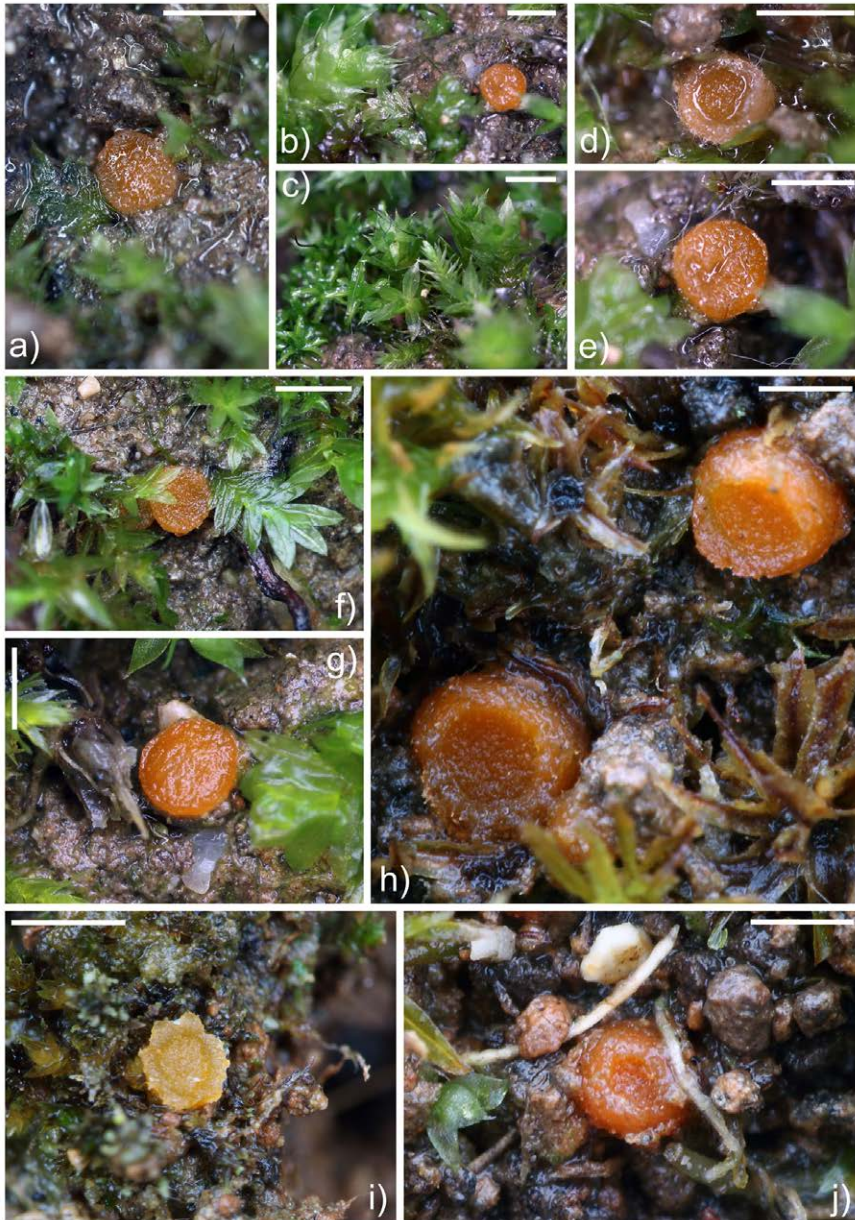
**Notes:** This species usually parasitizes on the *Bryum* species. It has been discovered quite recently (Benkert, 1998). *O. gemmicola* infects rhizoids, but also stems and leaves. Benkert (1998) pointed out that some of the asci are 6–7 spored too.



**Figure 1.** *Octospora* species recorded in the Neum/Klek bay area: **a), b), c), g)** – ascomata of *Octospora coccinea* (N.J./290117-Y2) parasitizing on *Bryum* sp., **c), g)** - *in situ*, **a), b)** - *ex situ*; **d), e), f), h)** – ascomata of *Octospora excipulata* (N.J./100218-Y7) parasitizing on *Funaria hygrometrica*, **h)** - *in situ*, **d), e), f)** - *ex situ*; **Bars: a), b), c), d), e), f), g), h)** – 0.1 cm / **Slika 1.** Vrste roda *Octospora* zabilježene na području zaljeva Neum/Klek: **a), b), c), g)** – plodišta *Octospora coccinea* (N.J./290117-Y2) na mahovini roda *Bryum* sp., **c), g)** - *in situ*, **a), b)** - *ex situ*; **d), e), f), h)** – plodišta *Octospora excipulata* (N.J./100218-Y7) na mahovini *Funaria hygrometrica*, **h)** - *in situ*, **d), e), f)** - *ex situ*; **Mjerne skale: a), b), c), d), e), f), g), h)** – 0.1 cm.

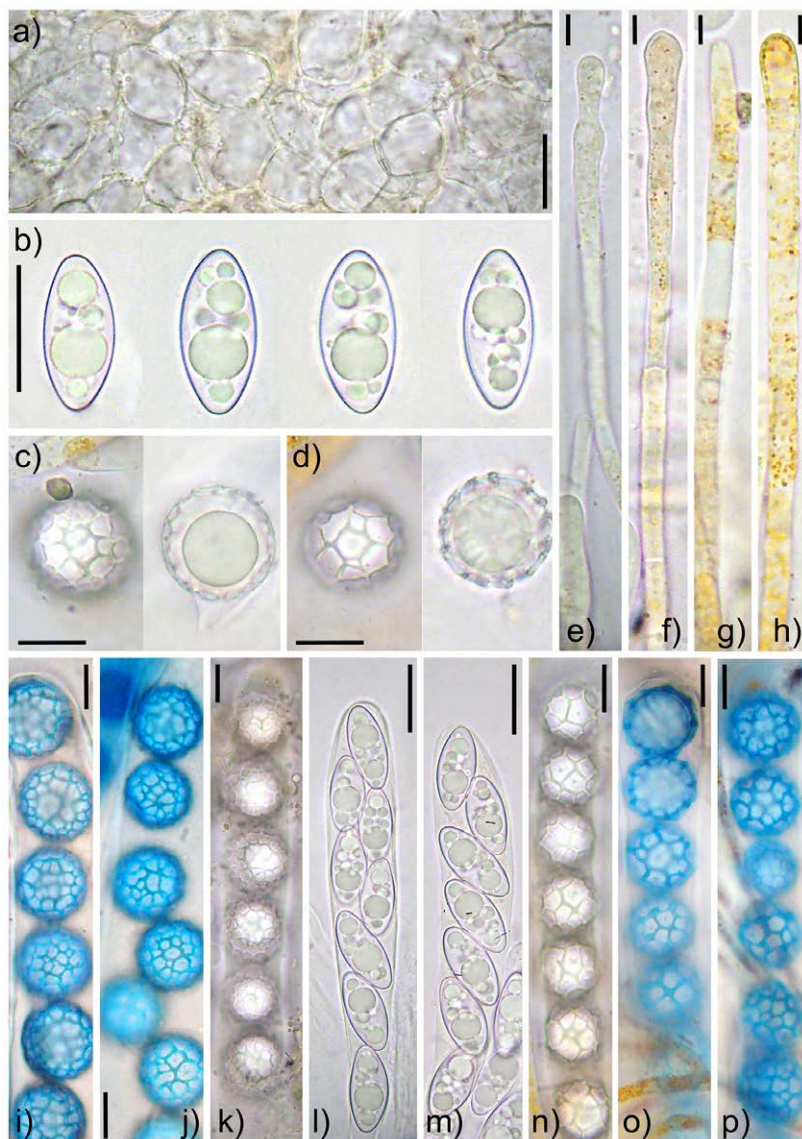


**Figure 2.** Micro characters of some bryophilic Pezizales : **a), d), e) g), h)** – \*ascospores, \*paraphyses and +asci of *Octospora coccinea* (N.J./290117-Y2) in tap water mount; **b), i)** - mature ascospores and asci of *Octospora coccinea* (N.J./290117-Y2) in IKI; **c), f), j), k)** – \*ascospores, \*paraphyses and +asci of *Octospora excipulata* (N.J./100218-Y7) in tap water mount; **Bars: a), b), c), g), h), i), j), k)** – 20 µm; **d), e), f)** – 10 µm / **Slika 2.** Mikro karakteristike nekih briofilnih vrsta reda Pezizales: **a), d), e), g), h)** – \*askospore, \*parafize i +askusi vrste *Octospora coccinea* (N.J./290117-Y2) u vodovodnoj vodi; **b), i)** - zrele askospore i askusi vrste *Octospora coccinea* (N.J./290117-Y2) u Lugolovoj otopini; **c), f), j), k)** – \*askospore, \*parafize i +askusi vrste *Octospora excipulata* (N.J./100218-Y7) u vodovodnoj vodi; **Mjerne skale: a), b), c), g), h), i), j), k)** – 20 µm; **d), e), f)** – 10 µm.



**Figure 3.** Some bryophilic Pezizales recorded in the Neum/Klek bay area: **a), b), d), e), f), g)** – ascomata of *Octospora gemmicola* (N.J./040318-Y5) parasitizing on *Bryum caespiticium*, **a), b), d), e)** - *ex situ*; **f), g)** - *in situ*; **c)** – host and associated mosses, finding spot of *Octospora gemmicola* (N.J./040318-Y5); **h), j)** - ascomata of *Lamprospora miniata* var. *parvispora* (N.J./040318-Y14) on *Barbula unguiculata*, photographed *in situ*; **i)** ascoma of *Lamprospora miniata* var. *ratisbonensis* (N.J./040318-Y8) on *Didymodon* aff. *luridus*. **Bars:** **a), b), c), d), e), f), g), h), i), j)** – 0.1 cm / **Slika 3.** Neke briofilne vrste reda Pezizales zabilježene na području zaljeva Neum/Klek: **a), b), d), e), f), g)** – plodišta vrste *Octospora gemmicola* (N.J./040318-Y5) na *Bryum caespiticium*, **a), b), d), e)** - *ex situ*; **f), g)** - *in situ*; **c)** – mahovina domaćin i druge mahovine u zajednici, mjesto pronalaska vrste *Octospora gemmicola* (N.J./040318-Y5); **h), j)** - plodišta vrste *Lamprospora miniata* var. *parvispora* (N.J./040318-Y14) na *Barbula unguiculata*, *in situ*; **i)** plodište vrste *Lamprospora miniata* var. *ratisbonensis* (N.J./040318-Y8) na *Didymodon* aff. *luridus*. **Mjerne skale:** **a), b), c), d), e), f), g), h), i), j)** – 0.1 cm.

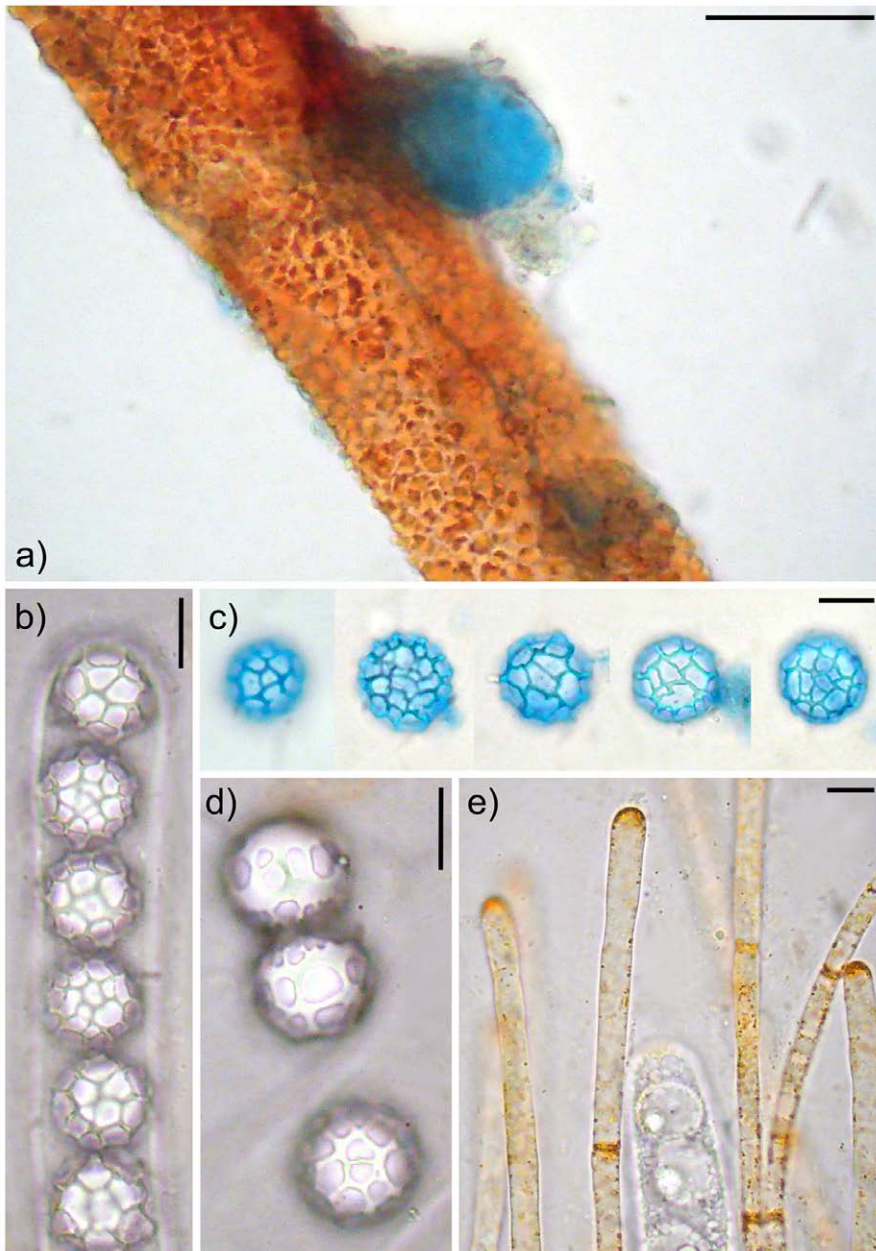




**Figure 4.** Micro characters of some bryophilic Pezizales: **a)** - ectal excipulum cells of *Octospora gemmicola* (N.J./040318-Y5) in tap water mount; **b), e), f), l), m)** - \*ascospores, \*paraphyses and +asci of *Octospora gemmicola* (N.J./040318-Y5) in tap water mount; **c), g), k)** - \*ascospores, \*paraphyses and +asci of *Lamprospora miniata* var. *ratisbonensis* (N.J./040318-Y8) in tap water mount; **i), j)** - asci of *Lamprospora miniata* var. *ratisbonensis* in CB mount; **d), h), n)** - \*ascospores, \*paraphyses and +asci of *Lamprospora miniata* var. *parvispora* (N.J./040318-Y14) in tap water mount; **o), p)** - asci of *Lamprospora miniata* var. *parvispora* in CB mount.

**Bars:** **a), b), l), m)** - 20  $\mu\text{m}$ ; **c), d), i), j), k), n), o), p)** - 10  $\mu\text{m}$ ; **e), f), g), h)** - 5  $\mu\text{m}$  / **Slika 4.** Mikro karakteristike nekih briofitnih vrsta reda Pezizales: **a)** - vanjski dio ekscipuluma *Octospora gemmicola* (N.J./040318-Y5) u vodovodnoj vodi; **b), e), f), l), m)** - \*askospore, \*parafize i +askusi vrste *Octospora gemmicola* (N.J./040318-Y5) u vodovodnoj vodi; **c), g), k)** - \*askospore, \*parafize i +askusi vrste *Lamprospora miniata* var. *ratisbonensis* (N.J./040318-Y8) u vodovodnoj vodi; **i), j)** - askusi vrste *Lamprospora miniata* var. *ratisbonensis* u pamučno plavom; **d), h), n)** - \*askospore, \*parafize i +askusi vrste *Lamprospora miniata* var. *parvispora* (N.J./040318-Y14) u vodovodnoj vodi; **o), p)** - askusi vrste *Lamprospora miniata* var. *parvispora* u pamučno plavom.

Mjerne skale: **a), b), l), m)** - 20  $\mu\text{m}$ ; **c), d), i), j), k), n), o), p)** - 10  $\mu\text{m}$ ; **e), f), g), h)** - 5  $\mu\text{m}$ .



**Figure 5.** Micro characters of *Lamprospora miniata* var. *parvispora* (N.J./040318-Y14): **a)** - infection structure and apparatus (appresorium with hyphae) on rhizoid of *Barbula unguiculata* observed in CB mount; **b)** - +asci and \*ascospores in tap water mount; **c)** - mature ascospores and reticulation patterns in CB mount; **d)** - mature \*ascospores with prominent thickened ridges in tap water mount; **e)** - \*paraphyses with refractive vacuoles and pigment in tap water mount; **Bars:** **a)** - 20  $\mu$ m; **b), c), d), e)** - 10  $\mu$ m / *Slika 5.* Mikro karakteristike vrste *Lamprospora miniata* var. *parvispora* (N.J./040318-Y14): **a)** - infektivna struktura i aparat (apresorij sa hifama) na rizoidima mahovine *Barbula unguiculata* u pamučno plavom; **b)** - +askusi i \*askospore u vodovodnoj vodi; **c)** - zrele askospore i ornamentacijski uzorak u pamučno plavom; **d)** - zrele \*askospore sa izraženo zadebljanim grebenima u vodovodnoj vodi; **e)** - \*parafize sa refraktivnim tjelašcima i pigmentom u vodovodnoj vodi. **Mjerne skale:** **a)** - 20  $\mu$ m; **b), c), d), e)** - 10  $\mu$ m

#### 4. CONCLUSIONS / ZAKLJUČCI

Three taxa of bryophilous Pezizales from Neum/Klek bay (*Octospora gemmicola*, *Lamprospora miniata* var. *parvispora* and *Lamprospora miniata* var. *ratisbonensis*) are newly recorded for Bosnia and Herzegovina.

Open and generally or partially dry habitats with disturbed soil settled by pioneer bryophytes are the most favorable habitat types for bryopezizalean fungi in this area.

*Octospora coccinea* and *O. excipulata* are recorded at the same location sharing the same habitat and ecological preferences but having different host mosses and phenology.

The most frequent hosts are the pioneer bryophytes from the genus *Bryum* spp., and most species have been found in the first half of March.

*Lamprospora* species were registered on mosses growing in the shady rocky sites with high percentage of substrate moisture and have different ecological preferences than most of the registered *Octospora* species.

*O. gemmicola* is the only *Octospora* species recorded in the habitat characterized with high percentage of moisture (stream banks of small seasonal water course).

All results presented in this paper are the product of three mycological field excursions conducted in two years.

Unlike Central and Northern Europe, Southeast Europe has not been an object of systematic

bryomycological studies and therefore relatively small number of bryophilic Pezizales is currently known in this area (Benkert, 2007). In comparison with countries from Central and Northern Europe published papers and official data for the Balkan peninsula are quite deficient (Benkert, 2006; 2007; Perić, 2002; 2011; Jukić & Omerović, 2017).

Although most of the recorded species are not considered rare or endangered in other European countries, it is obvious that diversity of bryophilous Pezizales in the Mediterranean part of Bosnia and Herzegovina is significant and definitely worth to be investigated in the future. Even brief and sporadic mycological studies performed in this area resulted in recording substantial number of bryophilic Pezizales associated with different host mosses species. Four registered species of *Octospora* and *Lamprospora* should be considered just as a projection and small part of total diversity of bryophilous Pezizales in the Mediterranean area of Bosnia and Herzegovina.

Future field studies and bryomycological excursions in this part of Mediterranean should be organized continuously in order to ascertain the biodiversity of diversity of bryophilic fungi in this area.

This paper should be considered as brief introduction to the bryomycology of Bosnia and Herzegovina and it should represent encouraging element and solid basis for all young bryomycologists in the time that comes.

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## Sažetak

U radu su prezentirani rezultati nekoliko terenskih mikoloških istraživanja provedenih u mediteranskom pojasu Bosne i Hercegovine (zaljev Neum/Klek). Predstavljeno je pet taksona briofilnih pezizala iz rodova *Octospora* i *Lamprospora*, od čega su tri taksona (*Octospora gemmicola*, *Lamprospora miniata* var. *parvispora* i *Lamprospora miniata* var. *ratisbonensis*) nova za mikobiotu Bosne i Hercegovine.

Za svaku vrstu su ukratko izloženi najvažniji taksonomski detalji i karakteristike, njena ekologija te fenologija.

S obzirom da je tokom sporadičnih istraživanja u prethodne tri godine zabilježen značajan broj briofilnih vrsta gljiva reda Pezizales, vjerovatno je da registrovane vrste predstavljaju samo projekciju ukupnog diverziteta briofilnih gljiva zaljeva Neum/Klek, ali i cjelokupnog neumskog zaleđa.

Imajući u vidu navedeno, nužno je u budućnosti organizovati kontinuirana sistematska briomikološka istraživanja kako bi se u što većoj mjeri upotpunila slika o ukupnom diverzitetu briofilnih gljiva u mediteranskom pojasu Bosne i Hercegovine.

**Ključne riječi:** Ascomycota, briofilija, *Lamprospora*, mahovine, Neum, *Octospora*