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Seven *Micarea* (Pilocarpaceae) species new to Germany and notes on deficiently known species in the Bavarian Forest

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Abstract: Weber, L., Printzen, Ch., Bässler, C. & Kantelinen, A. 2021. Seven *Micarea* (Pilocarpaceae) species new to Germany and notes on deficiently known species in the Bavarian Forest. – Herzogia **34**: 5–17.

We report new records of 19, predominantly rare, *Micarea* species, mostly from dead wood in mixed montane forests characterized mainly by Norway spruce, European beech and silver fir in the Bavarian Forest National Park on the German-Czech border. Their ecology and key morphological features are discussed. *Micarea contexta*, *M. fallax*, *M. melanobola*, *M. pseudomicrococca*, *M. pusilla*, *M. soralifera* and *M. tomentosa* are reported for the first time from Germany. *Micarea anterior*, *M. byssacea*, *M. elachista*, *M. laeta*, *M. micrococca* and *M. nowakii*, in addition to the aforementioned, are reported as new for the Bavarian Forest National Park.

Zusammenfassung: Weber, L., Printzen, Ch., Bässler, C. & Kantelinen, A. 2021. Sieben *Micarea*-Arten (Pilocarpaceae) neu für Deutschland und Bermerkungen über ungenügend bekannte Arten im Bayerischen Wald. – Herzogia **34**: 5–17.

Eine Reihe interessanter Funde von 19, überwiegend seltenen, Flechtenarten der Gattung *Micarea* aus Fichten-Tannen-Buchen-Bergmischwäldern im Gebiet des Nationalparks Bayerischer Wald und seiner unmittelbaren Umgebung werden mitgeteilt. Ökologie und taxonomische Anmerkungen zu einigen der Taxa werden dargestellt. *Micarea contexta*, *M. fallax*, *M. melanobola*, *M. pseudomicrococca*, *M. pusilla*, *M. soralifera* und *M. tomentosa* werden als neu für Deutschland gemeldet, *Micarea anterior*, *M. byssacea*, *M. elachista*, *M. laeta*, *M. micrococca* und *M. nowakii* sind neu für den Nationalpark.

Key words: Bohemian Forest, dead wood, lignicole, microlichens.

Introduction

The genus *Micarea* Fr. comprises ca. 100 species and is considered to be paraphyletic, combining a large number of phenotypically variable species (Andersen & Ekman 2005, Sérusiaux et al. 2010). Their mostly simple thallus and apothecial anatomy in addition to small size makes identifying these taxa difficult. Even though the genus has been studied intensively in central Europe (e.g. Coppins 1983, Czarnota 2007) these challenges have led to an incomplete knowledge of the genus *Micarea* in Germany. Recent descriptions of many new species in the *Micarea prasina* group (i.e. Guzow-Krzemińska et al. 2016, 2019, van den Boom et al. 2017, Launis et al. 2019a, 2019b, Launis & Myllys 2019) became a motivation to revise numerous samples of *Micarea* that were collected during three thesis projects in the German national park "Bayerischer Wald" and its immediate surroundings in 2015, 2017 and 2019.

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Study Area

The Bavarian Forest is part of the Bohemian Massif, forming a natural border between the Czech Republic and Germany (outer coordinates: 49°6.968"N/13°13.197"E, 48°52.728"N/13°34.527"E). The mountain range reaches elevations of up to 1456 m and is geologically relatively uniform, consisting mainly of acidic rocks. It is situated at the transition zone from Atlantic to continental climate. Atlantic west winds result in high precipitation, in winter continental high-pressure areas often bring the "Böhm", a gusty dry wind, and temperatures down to -30 °C. The area is part of the main continental watershed divide between the North Sea and the Black Sea. The annual precipitation averages at 1500 mm and air humidity is likewise high, with fog being recorded on over 220 days per year in certain places. With an average temperature of 3.5 – 6.5 °C and up to 7 months of snow cover at high altitudes, the region is one of the coldest in Germany (Bayerisches Landesamt für Wasserwirtschaft 1998, Bauer 2002, Bässler 2004).

Most of the studied area is situated within the "Nationalpark Bayerischer Wald", founded in 1970 and extended in 1997. On its north-eastern side the area is bordered by the "Šumava National Park" in the Czech Republic. Together, these national parks comprise one of the largest continuous forest areas in Central Europe. Over 98 % of the park area is forested, from 650 m to 950 m beech forests predominate, followed by mixed montane forests of European beech (*Fagus sylvatica* L.), silver fir (*Abies alba* Mill.) and Norway spruce (*Picea abies* (L.) Karst.), which extend to an altitude of about 1200 m. At higher elevations high montane spruce forests, intermixed with *Acer pseudoplatanus* L. and *Sorbus aucuparia* L., take over. As a result of forest management, *Picea abies* is today widely intermixed and the higher altitudes are completely dominated by it (Bradtka et al. 2010). Since the mid-1980s, the National Park forests have undergone major changes: windthrow events and subsequent bark beetle proliferation have led to the widespread death of old spruce stands on about 35 % of the total park area (Bässler 2011). The large quantities of dead wood have not been removed or areas replanted, which has resulted in a great variety of forest structure (Bradtka et al. 2010).

An extensive checklist of the lichens of the Bavarian Forest and adjacent regions in accordance with Grummann (1963) was compiled in Kanz et al. (2005), a list of lichenized fungi of the national park is given in Bradtka (2011). More recent studies in the area are also available and have been considered for comparisons (Bässler et al. 2009, 2015, and unpublished results of the 2016 BIOKLIM study, Nationalparkverwaltung Bayerischer Wald).

Material and methods

While inventorying lichens on eight plots within and three plots close to the national park 472 specimens of *Micarea* were collected. In March 2015 the collections were made by Adrian Schneider, in August to September 2017 by Sophia Kern and in June 2019 by Lilith Weber at eleven locations in the Bavarian Forest (see below). The focus of the investigation was mainly on standing and fallen stumps, whereas rocks and soil were excluded. In 2015 and 2017 the investigations were exclusively focused on standing dead trees, but in 2019 the study also considered living trees and fallen logs.

Hand-cut apothecial sections and squashed thallus preparations were examined using a ZEISS Axioskop plus microscope and a ZEISS Stemi SV 11 stereomicroscope. Ascospores and other anatomical details were studied and measured in water and usually further examined in 10 % potassium hydroxide (K). Chemical spot tests were performed under a compound microscope

using sodium hypochlorite (C) and potassium hydroxide (K, Orange et al. 2001). Pigments were defined following the systems of Coppins (1983), Meyer and Printzen (2000) and Czarnota (2007). The secondary chemistry of selected specimens was analysed by thin-layer chromatography (TLC) in solvents A, B and C according to the methods of Orange et al. (2001). All specimens were revised by Annina Kantelinen (formerly Launis) in June and December 2019 and are deposited in FR.

List of study sites:

TS1: Nationalpark Bayerischer Wald, 4 km NE of Spiegelau and 5 km E of Althütte, forestry section Feistenhäng; windthrow in mixed deciduous and coniferous montane forest at 850–930 m elevation; 48°56.867"N/13°23.238"E.

TS2: Nationalpark Bayerischer Wald, 5 km NNE from Spiegelau and 4.5 km NE from Althütte, forestry section Schönort; windthrow in mixed deciduous and coniferous montane forest at 910–945 m elevation; 48°57.489"N/13°22.509"E.

TS3: Nationalpark Bayerischer Wald, 2 km N of Waldhäuser, forestry section Waldhäuser Wald; mixed montane forest with *Fagus sylvatica* (Luzulo-Fagetum beech forest) and *Picea abies* stumps resulting from bark beetle and air pollution damage at 1000–1100 m elevation; 48°56.757"N/13°28.157"E.

TS4: Nationalpark Bayerischer Wald, 2 km N of Waldhäuser, forestry section Waldhäuser Wald; mixed montane forest with *Fagus sylvatica*, *Abies alba* and *Picea abies* stumps resulting from bark beetle and air pollution damage at 1000–1100 m elevation; 48°56.450"N/13°28.711"E.

T1-30: Nationalpark Bayerischer Wald, 1.3 km NNE of Guglöd, closed forest of *Fagus sylvatica* and *Picea abies* at 833 m elevation; 48°56.250"N/13°25.274"E.

T3-36: Nationalpark Bayerischer Wald, Großer Falkenstein, 2 km N of Scheuereck, closed forest of *Fagus sylvatica* and *Picea abies* at 1080 m elevation; 49°05.037"N/13°18.454"E.

T4-40: Nationalpark Bayerischer Wald**,** virgin forest Mittelsteighütte of *Fagus sylvatica* and *Picea abies* at 782 m elevation; 49°06.019"N/13°15.145"E.

REH3: Bayerischer Wald, Rehberggraben, 3 km W Großarmschlag, closed forest of *Fagus sylvatica* and *Picea abies* at 630 m elevation; 48°53.160"N/13°21.430"E.

RIN14: Bayerischer Wald, 1.1 km E Ringelai, closed forest of *Fagus sylvatica* and *Picea abies* at 550 m elevation; 48° 48.965"N/13° 29.022"E.

SAL28: Bayerischer Wald, forest surrounding Kalter Brunnen, 1.8 km N Saldenburg, closed forest of *Fagus sylvatica* and *Picea abies* at 503 m elevation; 48°47.416"N/13°21.062"E.

TS-4: Nationalpark Bayerischer Wald, E shore of Rachelsee, dense beech-spruce forest at 1084 m elevation; 48°58.420"N/13°24.199"E.

Results and Discussion

A total of 358 of the sampled specimens could be identified to the species level. The vast majority were collected in the plots TS1 (81), TS2 (86), TS3 (104) and TS4 (66), those are also the localities with the greatest diversity of *Micarea* species (TS1: 12, TS2: 11, TS3: 11, TS4: 9).

Of the eight species of *Micarea* previously known from the area (Kanz et al. 2005, Bradtka 2011), four were encountered again: *Micarea denigrata* (Fr.) Hedl. was known from medium (800–890 m) and high elevations (>1400 m). We found only three samples of this otherwise common species on two plots (TS2, TS3) at 870 m, 881 m and 1118 m, growing on wood of dead standing Norway spruce. *Micarea prasina* Fr. was found in half of the plots of this study, spanning throughout the entire elevational gradient. *Micarea lignaria* (Ach.) Hedl. was only found once on the mountain Großer Falkenstein (T3-36), growing on the bark of *Fagus sylvatica*. *Micarea misella* (Nyl.) Hedl. was by far the most frequently sampled species (94 identified samples), present in seven plots on soft conifer wood. *Micarea botryoides* (Nyl.) Coppins was listed for the Bavarian Forest by Kanz et al. (2005) but is missing from the checklist

of lichenized fungi of the "Nationalpark Bayerischer Wald" (Bradtka 2011). However, we found this species exclusively in windthrows within the national park.

Three of the species listed in Kanz et al. (2005) (*M. myriocarpa*, *M. peliocarpa* and *M. turfosa*) prefer substrates that were excluded from this study. *Micarea cinerea* (Schaer.) Hedl. is very rare in Germany (Wirth et al. 2013) and might be overlooked.

In the following section species that are new to the Bavarian Forest (BayW) or Germany (GER) are discussed in more detail.

Micarea anterior (Nyl.) Hedl.

New to BayW

Micarea anterior is an inconspicuous lignicolous lichen that often occurs as an anamorph. This was also the case with the Bavarian specimens of which most were devoid of apothecia and only developed stalked pycnidia. The predominantly asexual stage of this species might have previously caused it to be overlooked or mistakenly identified as a non-lichenized fungus. With regards to other *Micarea* species it was most commonly found together with *M. misella*, a quite similar species. The two can, however, be separated by the colour of the apothecia and pycnidia and chemical spot tests. *Micarea anterior* is brown and its pycnidia are characteristically binate in colour, the lower part being paler and the upper part being dark brown. It shows no colour reactions in K or C, apart from a mild dulling effect in the first. The apothecia and pycnidia of *M. misella* are, by contrast, black and react K+ violet and C+ violet ('Sedifolia-grey'). From *M. botryoides*, which sometimes grows on similar substrates, it can be distinguished by an endoxylic or whitish thallus whereas the thallus of *M. botryoides* is green when found on lignum. Moreover, the pycnidia of *M. botryoides* are uniformly brown to black and react K± green. *Micarea anterior* is sometimes found growing on other lichens, such as apothecia of *M. prasina* and squamules of *Cladonia* spp.

The current German Red List classifies *M. anterior* as very rare and highly endangered (Wirth et al. 2011). We found it to be locally widespread, with 60 specimens collected in three locations, all being open windthrows and bark beetle clearings of Norway spruce in central parts of the national park. With two exceptions all of those were situated at more than 1000 m above sea level. In Finland, where the species has been studied quite a lot in recent years, it was recently evaluated as Near Threatened in 2019, whereas in the Red List 2010 it was considered Vulnerable (Pykälä et al. 2019). The change in category is based on an increase in knowledge about the species; new specimens have been found and sequenced increasingly within the last decade.

Selected specimens examined (n=60): TS2. Wood of standing stump of *Picea abies*, died in 1988. 27 Mar. 2015, A. Schneider (FR-0263714). TS3. Wood of standing stump of *Picea abies*. 27 Aug. 2017, S. Kern (FR-0267173) TS4. standing stump of *Picea abies*. 3 Sep. 2017, – S. Kern (FR-0267174).

Micarea byssacea (Th.Fr.) Czarnota, Guzow-Krzeminska & Coppins (Fig.1A)

New to BayW

Micarea byssacea was found within the national park growing on wood and bark of dead *Picea abies*. Due to its former inclusion within *Micarea prasina* and later in *Micarea micrococca*, this species is still insufficiently documented. Czarnota and Guzow-Krzemińska (2010) recognized it at species level, differing from *M. prasina* by the production of methoxymicareic acid instead of micareic acid and from *M. micrococca* by the presence of 'Sedifolia-grey'. The grey colour of the apothecia can be seen in Fig. 1A. Samples growing in shaded habitats produce less of the pigment and hence develop paler coloured apothecia. The thalli of the three species also differ slightly: *M. byssacea* forms a finely granular thallus whereas *M. micrococca* and *M. prasina* develop more aggregated granules.

Selected specimens examined (n=20): TS1. On bark of standing stump of *Picea abies*, died in 1999. 25 Mar. 2015, A. Schneider (FR-0263061). TS2. On wood of standing stump of *Picea abies*, died in 1988. 27 Mar. 2015, A. Schneider (FR-0267175).

Micarea contexta Hedl. (Fig.1B)

New to GER, BayW

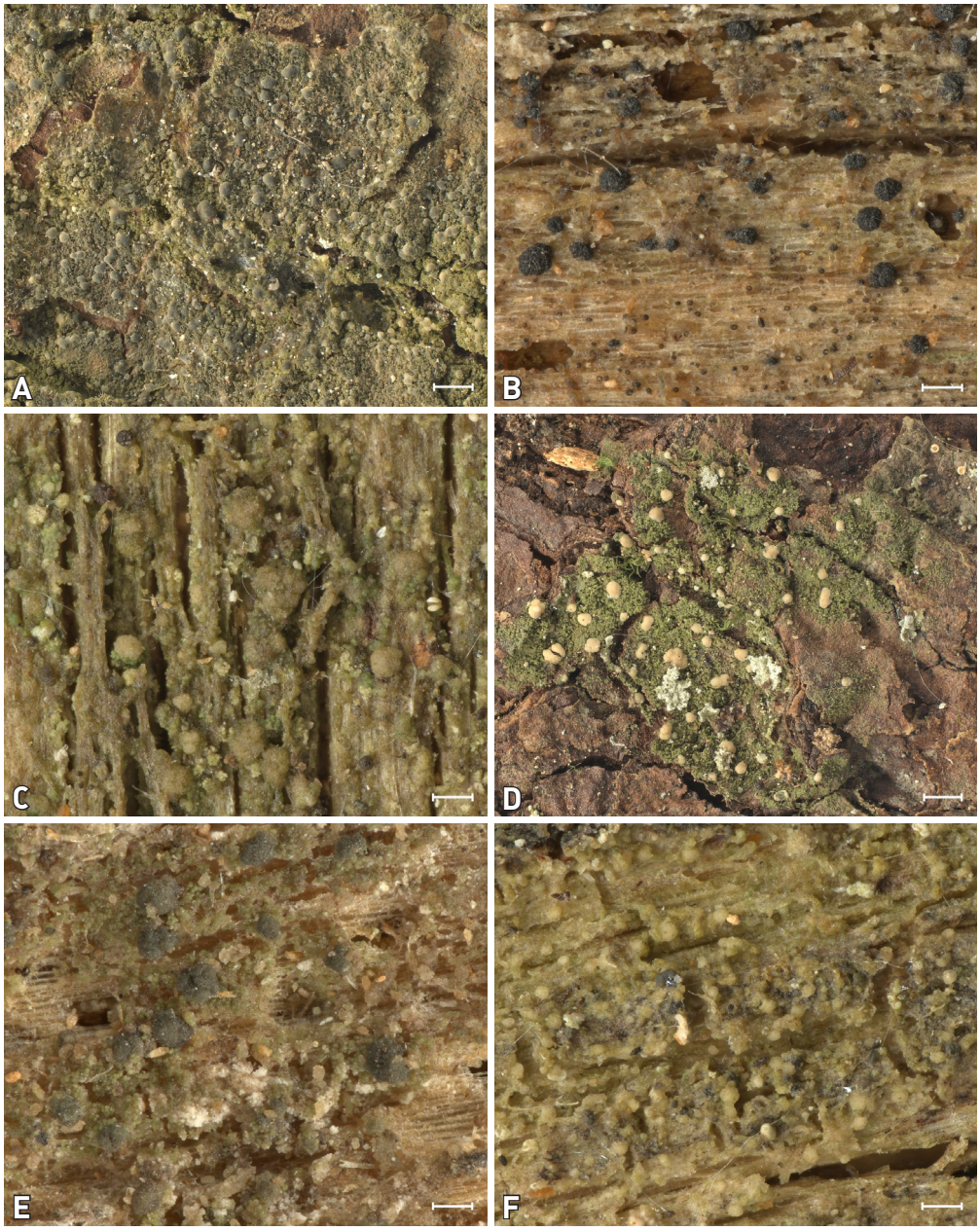

Fig. 1. **A** – *Micarea byssacea* (FR-0263209). **B** – *Micarea contexta* (FR-0267121). **C –** *Micarea fallax* (FR-0267123). **D** – *Micarea laeta* (FR-0263775). **E –** *Micarea melanobola* (FR-0267120). **F –** *Micarea pusilla* (FR-0267122). Scale bars: A & D 1 mm; B, C, E & F 0.2 mm

As an endoxylic species, *M. contexta* has a thallus that is inconspicuous, as are the very small black apothecia (0.1–0.2 mm). The epithecium and vertical streaks in the hymenium are coloured turquoise to dark green (K+ green intensifying) and the hypothecium is purple-brown. The ascospores

are 1-septate with the upper cell characteristically broader than the lower. The species resembles *Micarea nigella* Coppins and both grow on decaying wood in different stages of decomposition. The two species were found to co-occur in two locations dominated by Norway spruce. They can however be separated by the shape and septation of the ascospores, which are persistently simple in *M. nigella* and 1-septate in *M. contexta*, as well as the lack of stalked pycnidia in *M. contexta* (Coppins 1983).

Micarea contexta is considered a rare species, present in Finland (Myllys & Launis 2018), Scotland and Sweden (Coppins 1983, 2009) as well as in Canada, Norway, Poland, Russia and Switzerland (Groner 2006, Urbanavichus & Andreev 2010, Czarnota 2011, Holien 2016, Konoreva et al. 2021). It is also known from the nearby Šumava mountains (Czech Republic; Palice 1999). In this study, the species was found in two locations, but it has probably been overlooked previously. In Finland, for example, *Micarea* inventories within the last decade have resulted in a significant rise in records of this species (Myllys & Launis 2018).

Selected specimens examined (n=4): TS2. Wood of standing stump of *Picea abies*, died in 1988. 25 Mar. 2015, A. Schneider (FR-0267121). TS3. Wood of standing stump of *Picea abies.* 28 Aug. 2017, S. Kern (FR-0267176).

Micarea elachista (Körb.) Coppins & R.Sant.

New to BayW

Coppins (1983) described *M. elachista* to be a predominantly lignicolous species, growing on decorticated trunks or stumps of old trees. Czarnota (2007) found it to be restricted to natural, old, mixed or coniferous forests, but also growing on bark. The results of Saine et al. (2018) suggest that the species is not dead-wood dependent which is supported by recent collections from bark of old living trees of *Pinus sylvestris* L. (unpubl. observation Annina Kantelinen, Malíček et al. 2020) and *Betula pubescens* Ehrh. (Malíček et al. 2020). The species is considered an indicator for old-growth forests in Poland (Czyżewska & Cieśliński 2003). The site in the Bavarian Forest is a near-natural area with numerous old trees. The specimen grew on bark of a dead *Picea abies*, fitting those known habitat preferences. The German Red List classifies *M. elachista* as critically endangered.

Specimen examined: TS2. On bark of *Picea abies*, died in 1999. 28 Mar. 2015, A. Schneider (FR-0267177).

Micarea fallax Launis & Myllys (Fig. 1C)

New to GER, BayW

Micarea fallax was only recently described and has been found in a number of European countries (Launis et al. 2019a, Kantelinen et al. 2021) as well as the Russian Far East (Konoreva et al. 2019). It seems to be widespread, found on bark and lignum of different tree species and from old-growth as well as managed forests. It was present in nine of the studied plots, usually in high numbers, on the wood of standing and fallen logs of *Picea abies* and *Fagus sylvatica* in varying stages of decay. Within our study area this species preferred higher elevations, occurring mostly above 1000 m. Compared to others, this species was present in more shaded habitats, growing on logs underneath bushes.

This species was most likely previously recorded as *M. prasina*. On decaying wood *M. prasina* tends to form a more well-developed thallus and is more likely to contain 'Sedifolia-grey' pigment in its apothecia. The most reliable character however is the position of crystalline granules in the apothecia when viewed in polarized light. *Micarea fallax* produces those in the hymenium, in *M. prasina* s. str. the granules are mostly formed in the epihymenium; for illustrations see Launis et al. (2019a).

Selected specimens examined (n=68): RIN14. On hard wood of a fallen deciduous tree. 6 June 2019, L. Weber (FR-0267178). SAL28. On hard wood of a fallen deciduous tree on the forest floor between *Frangula alnus* Mill. undergrowth. 11 June 2019, L. Weber (FR-0267180). T1-30. On lignum of a rotten, lying trunk between young *Picea* saplings. 9 June 2019, L. Weber (FR-0267182). T4-40. On wood of a lying *Fagus sylvatica* trunk. 13 June 2019, L. Weber (FR-0267179). TS1. Wood of standing stump of *Picea abies*, died in 1999. 25 Mar. 2015, A. Schneider (FR-0263156). TS2. Wood of standing stump of *Picea abies*, died in 1999. 26 Mar. 2015, A. Schneider (FR-0267197). TS3. Wood of standing stump of *Picea abies*. 29 Aug. 2017, S. Kern (FR-0267183). TS4. Wood of standing stump of *Picea abies*. 4 Sept. 2017, S. Kern (FR-0267123). TS-4. 40 On wood of a lying *Fagus sylvatica* trunk. 7 June 2019, L. Weber (FR-0267181).

Micarea laeta Launis & Myllys (Fig. 1D)

New to BayW

One of the more easily visible species of the genus with a vivid green, granular to more continuous thallus, and usually numerous cream-coloured apothecia up to 0.6 mm in diameter. So far this recently described species has been known from Finland in managed and old-growth forests, Russia and Sweden (Launis et al. 2019b, Konoreva et al. 2019). Konoreva et al. (2019) also reported a specimen from the vicinity of Munich that was determined by Arnold as *Biatora micrococca* Körb. [H, Arnold 28 June 1892, Lich. Monacenses Exs. 243]. It is also likely that specimens collected in Germany have previously been determined as forms of *M. prasina* or *M. byssacea*. The presence of methoxymicareic acid separates *M. laeta* from the first and the lack of 'Sedifolia-grey' in the apothecia from the latter.

Five specimens of *Micarea laeta* were collected from one plot within the national park. These specimens grew on wood and bark of decaying stumps of *Picea abies*. One specimen was found on a fallen trunk outside of the park in a dense beech forest.

Selected specimens examined (n=6): REH3. On hard wood of a fallen deciduous tree, heavily shaded 13 June 2019, L. Weber (FR-0267185). TS2. Wood of standing stump of *Picea abies*, with bark remnants, died in 1999. 29 Mar. 2015, A. Schneider (FR-0263775).

Micarea melanobola (Nyl.) Coppins (Fig. 1E)

New to GER, BayW

Micarea melanobola was first described by Nylander in 1867 but has since been treated in different ways, e.g. as a species-level entity (Coppins 1983) and as a synonym of *M. prasina* by Czarnota (2007). A phylogenetic study by Launis et al. (2019a) found it to be a distinct species most closely related to *M. fallax* and *M. prasina* s. str. It is characterized by numerous, dark grey to black apothecia with a high amount of 'Sedifolia-grey', reacting K+ violet and C+ violet in sections. It can be separated from *M. prasina* by its slightly shorter ascospores (*M. melanobola*: 7–11 × 2.5–3.5 (–4) µm vs. *M. prasina*: 8–12(–14) × 3–4.5(–5) µm) and by the distribution of polarizing crystalline granules in the apothecia. *Micarea prasina* produces these granules mostly in the epihymenium whereas *M. melanobola* produces them in the hymenium; for illustrations see Launis et al. (2019a).

Micarea melanobola is confirmed from Finland (Launis et al. 2019a), Sweden (Kantelinen et al. 2021), and possibly also found in Estonia and Ukraine (Czarnota 2007, Voytsekhovich et al. 2011). In the Bavarian Forest it was found on lignum of *Picea abies* at three locations.

Selected specimens examined (n=12): T4-40. On inside of hollow and rotten spruce stump. 4 June 2019, L. Weber & C. Printzen (FR-0267186) TS2. On standing dead wood of *Picea abies*, died in 1988. 27 Mar. 2015, A. Schneider (FR-0267120). TS3. On standing dead wood of *Picea abies*. 25 Aug. 2017, S. Kern (FR-0267187).

Micarea micrococca (Körb.) Gams ex Coppins

New to BayW

The species was previously treated as a synonym of *M. prasina* but based on morphological and molecular characters is now understood to be part of a complex that includes eight distinct lineages, incl. *Micarea micrococca* s. str. (Guzow-Krzemińska et al. 2019). Twelve of our samples clearly represent *M. micrococca* while several other specimens could only be assigned to the *M. micrococca* complex due to poorly developed characters. The granular thallus is bright green and the apothecia whitish, never brownish or grey, and like the other species in the complex, *M. micrococca* produces methoxymicareic acid (Guzow-Krzemińska et al. 2019, Launis et al. 2019b).

Micarea micrococca is one of the most common species of the genus and has been reported from many European countries. It is especially frequent on bark of different trees and on hard wood of fallen logs in managed forests, including spruce monocultures (Czarnota 2007, Czarnota & Guzow-Krzemińska). All records in this study are from stands within the national park area. However, historically these stands have been influenced by forest management which has increased the proportion of spruce. It is possible that *M. micrococca* had been more common in the area before the establishment

of the park but might have been misidentified as *M. prasina*. *Micarea micrococca* showed a preference for lower elevations within our study area with a maximum of 925 m above sea level.

Selected specimens examined (n=12): T1-30. On wood of fallen *Picea abies* trunk. 9 June 2019, L. Weber (FR-0267188). TS1. On wood of standing stump of *Picea abies*, died in 1988. 24 Mar. 2015, A. Schneider (FR-0262965).

Micarea nigella Coppins

The thallus of this lignicolous species is mostly endoxylic or visible as a thin pale crust on the lignum. *Micarea nigella* develops numerous pycnidia that are characteristically short-stalked, often growing in clusters and extruding a white mass of conidia. In microscope preparations the walls of the pycnidia are dark purple-brown (K+ green). The species often grows as an anamorph, but if apothecia are present, they are black and exhibit a purple-brown pigment (K+ green) and simple ascospores.

In the British Isles and Denmark, where the species was described by Coppins (1983), *Micarea nigella* is known from native pine forests and mature conifer plantations, growing on rather soft lignum. The species is reported here for the second time from the Bavarian Forest (Zwieseler Waldhaus, Palice 2006 in Wirth et al. 2013) and supposedly the fourth time for Germany (Kison et al. 2016, Meinunger 2019) after it was erroneously described as new for Germany by Kison et al. (2016). It has also been recorded from Alaska (Spribille et al. 2020), Belgium and France (Sérusiaux et al. 1999), the Czech Republic (Palice 1999), Finland (Myllys & Launis 2018), Norway (Holien 2001), Poland (Czarnota & Coppins 2000), the north Caucasus region of Russia (Urbanavichus & Urbanavichene 2017) Slovakia (Vondrák et al. 2015), Sweden (Andersson 1992) and Ukraine (Coppins et al. 2005). Since its description, the species has been found growing on decaying wood of *Abies alba*, *Picea* spp. and *Pinus* spp., as well as on decaying wood and bark of *Picea abies*, often in old-growth forests (Czarnota 2012, Vondrák et al. 2015, Urbanavichus & Urbanavichene 2017, Wieczorek et al. 2017, Myllys & Launis 2018). In this study *M. nigella* was found on decorticated *Picea abies* stumps in three different plots within spruce windthrows, further showing a preference for conifer lignum.

Selected specimens examined (n=4): TS1. On wood of standing stump of *Picea abies*, died in 1988. 23 Mar. 2015, A. Schneider (FR-0262855) TS3. On wood of standing stump of *Picea abies*. 23 Aug. 2017, S. Kern (FR-0267189). TS4. On wood of standing stump of *Picea abies*. 4 Sept. 2017, S. Kern (FR-0267196).

Micarea nowakii Czarnota & Coppins

New to BayW

Micarea nowakii is characterised by a greyish green warted-areolate thallus, black apothecia, small 1-celled ascospores (6–8 (–8.5) × 2–3 µm) and emergent or shortly stalked pycnidia that often extrude a white mass of conidia. It resembles *M. misella*, *M. denigrata* and *M. herbarum* but differs in the presence of micareic acid and the absence of gyrophoric acid (Czarnota 2007, van den Boom 2017).

Micarea nowakii was described from Poland (Czarnota 2007) and has also been reported from Sweden (Svensson & Westberg 2010), Finland (Myllys & Launis 2018), the northern Caucasus region of Russia (Urbanavichus et al. 2020) and the Czech Republic, including the Šumava mountains (Malíček et al. 2014). This is the second record from Germany with one previously known occurrence in the Harz mountains (Czarnota et al. 2014). In the Bavarian Forest it was found in well-lit windthrows on hard spruce wood, which is in accordance with the habitat requirements detailed in Czarnota (2007) and Myllys & Launis (2018).

Selected specimens examined (n=4): TS1. On standing wood of *Picea abies*, died in 2003. 21 Mar. 2015, A. Schneider (FR-0263218). TS3. On standing wood of *Picea abies*. 29 Aug. 2017, S. Kern 2017 (FR-0267190). TS4. On standing wood of *Picea abies*. 8 Sept. 2017, S. Kern (FR-0267191).

Micarea pseudomicrococca Launis & Myllys

New to GER, BayW

This recently described species resembles the closely related *M. micrococca* but differs by having an olive-green instead of brightly green thallus, narrower ascospores (*M. pseudomicrococca*: 8–14(–15) × 2.0–3.2 µm vs. *M. micrococca*: 10–12(–16) × 3–4.5 µm) and two types of paraphyses that are up to 3 µm wide at the apices (Launis et al. 2019b). So far it was only known from three old-growth forests

in Finland, on the bark of *Alnus incana* (L.) Moench, *Betula* spp. and wood of *Picea abies*, one location in Scotland on the bark of *Prunus padus* L. (Launis et al. 2019b), four locations in Sweden on *Alnus glutinosa* (L.) Gaertn., *Salix caprea* L., *Quercus robur* L. and on wood of *Picea* spp. (Kantelinen et al. 2021) and two locations in the Kaliningrad region of Russia, on the bark of *Picea abies* and lignum of *Alnus glutinosa* (L.) Gaertn. (Konoreva et al. 2020). In this study, 12 specimens were found in four different plots, all being windthrows of *Picea abies* in nearly natural mixed montane forests. *Micarea pseudomicrococca* was found growing on wood of stumps representing different stages of decay.

Selected specimens examined (n=13): TS1. On standing wood of *Picea abies*, died in 1999. 25 Mar. 2015, A. Schneider (FR-0263076) TS2. On standing wood of *Picea abies*, died in 1988. 27 Mar. 2015, A. Schneider (FR-0263691). TS3. On standing wood of *Picea abies*. 27 Aug. 2017, S. Kern (FR-0267192). TS4. On standing wood of *Picea abies*. 4 Sept. 2017, S. Kern (FR-0267193).

Micarea pusilla Launis, Malíček & Myllys (Fig. 1F)

New to GER, BayW

Micarea pusilla is a recently described species known from the Czech Republic, Finland and Russia (Caucasus and Dagestan) (Launis et al. 2019a) and has since also been recorded from north-west Russia (Tarasova et al. 2020). The previously known records are from bark of *Picea abies* and *Prunus padus* as well as decaying lignum of *Picea abies.* The Bavarian material was found on stumps of decorticated Norway spruce trunks in a mixed spruce-beech forest.

Micarea pusilla is an inconspicuous species with very small 0.1–0.15 mm wide pale apothecia, that are numerous and crowded. The ascospores are small, 7–9 (–9.5) × 2–3 µm. The species produces methoxymicareic acid and has no 'Sedifolia-grey'-pigment or crystalline granules in the apothecia. *Micarea pusilla* resembles *M. micrococca* and *M. pseudomicrococca* but can be distinguished by its small and crowded apothecia, small spores and usually thinner thallus. It is also similar to pale forms of *M. fallax* which however has much larger apothecia that contain crystalline granules in the hymenium and produces micareic acid. *Micarea pusilla* has likely been overlooked in the past due to its small size.

Selected specimens examined (n=3): TS3. On stump of *Picea abies*. 30 Aug. 2017, S. Kern (FR-0267194). TS4. On stump of *Picea abies*. 4 Sept. 2017, S. Kern (FR-0267122).

Micarea soralifera B.Guzow-Krzemińska, P.Czarnota, A.Łubek & M.Kukwa

New to GER, new to BayW

Micarea soralifera is characterized by a thallus developing delimited greyish-green soralia (K+ violet, C+ violet), and the presence of 'Sedifolia-grey' in the apothecia that vary from light to dark grey in colour. The apothecia are quite similar to those of *M. prasina* s. str., and both species contain micareic acid. However, the thallus of *M. prasina* consists of goniocysts and does not form soralia.

Micarea soralifera is so far known from Finland, Poland, Russia, Sweden, Slovakia, the Czech Republic and Ukraine (Guzow-Krzemińska et al. 2016, Svensson et al. 2017, Urbanavichus & Urbanavichene 2017, Guttová et al. 2018, Myllys & Launis 2018, Malíček et al. 2018a). We found specimens outside and within the park at low elevations, growing on lignum of standing and fallen conifer trees. The species is very likely to have been recorded as *M. prasina* in the past.

Selected specimens examined (n=4): RIN14. On lying trunk of coniferous tree. 6 June 2019, L. Weber (FR-0267195). TS1. On standing wood of *Picea abies*, died in 1999. 25 Mar. 2015, A. Schneider (FR-0263047).

Micarea tomentosa Czarnota & Coppins

New to GER, BayW

Micarea tomentosa is characterized by a bright green, granular thallus and shortly stalked, pale to brown-pinkish pycnidia which are distinctly tomentose. It resembles *M. hedlundii* Coppins which differs by having a darker thallus, taller pycnidia and brown, often tuberculate apothecia. The apothecia of *M. tomentosa* are pale pinkish to straw coloured. In addition, *M. tomentosa* lacks the dull orange pigment 'Intrusa-yellow' (K+ violet, C+ violet) within its goniocysts. *Micarea tomentosa* also resembles *M. fennica* Launis & Myllys, a rare lignicolous species that develops stalked, clearly tomentose pycnidia that are dark grey to brown in colour. These pycnidia are, however, taller than those of *M.*

tomentosa (*M. fennica* up to 1 mm vs. *M. tomentosa* up to 0.3 mm). In addition, *M. fennica* produces micareic acid (Launis & Myllys 2019). The thallus of *M. tomentosa* can resemble that of *M. prasina*, but the latter produces micareic acid whereas *M. tomentosa* does not contain any substances detectable by TLC (Czarnota 2007).

The species was described from Poland and has also been reported from Finland, Estonia, Slovakia, Sweden, Russia and southern Bohemia (Czech Republic) where it occurs mostly within large complexes of intact forest ecosystems and nature reserves (Czarnota 2007, Kukwa et al. 2008, Urbanavichene & Urbanavichus 2017, Malíček et al. 2018b, Myllys & Launis 2018). This is also the case for the new record from Germany. The species was found in one locality in an old nearly natural spruce stand within the national park at an altitude of about 900 m, growing on soft lignum of *Picea abies*.

Specimen examined: TS1. Standing wood of *Picea abies*, died in 1999. 25 Mar. 2015, A. Schneider (FR-0263200).

Conclusions

Our findings show the importance of old, standing dead wood for diverse communities of *Micarea* lichens. The most species-rich localities of this study were characterised by open canopies and dead wood diversity, caused by heavy infestation with bark beetles or windthrows. This structural diversity allows sites to host species assemblages that include both generalists and specialists, thereby increasing the overall species richness. While several of the species like *Micarea byssacea* and *M. pseudomicrococca* seem to be specialized and confined to old-growth forests within the core areas of the national park, others like *M. fallax* and *M. soralifera* also occurred in the managed forests surrounding the park. Whether these ecological preferences would apply universally and could permit the use of the species as indicators remains to be studied in the future.

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