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SHORT COMMUNICATION

Artomyces microsporus (*Auriscalpiaceae*), a rare species that may be confused with *A. pyxidatus*

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Abstract. *Artomyces microsporus*, a lignicolous basidiomycete first reported in Europe from Ukraine almost two decades ago, is morphologically quite similar to *A. pyxidatus*, the most commonly encountered species of the genus across the temperate zone of the Northern Hemisphere. This survey is aimed at defining useful characters for the reliable distinction of these species in the field, in addition to species identification based on molecular data. Both morphological characters of the basidiomes and host/substrate preferences of *A. microsporus* are considered. The defined characters for identification of *A. microsporus* can be widely used by citizen scientists providing observations of the fungal occurrences for biodiversity repositories and social media networks. The reliable data for the species identification will contribute to determining the distribution patterns of *A. microsporus* regionally and worldwide.

Keywords: *Artomyces*, *Basidiomycota*, citizen science, *Clavicorona*, distribution, host preference, morphology

Introduction

Data gathering by non-professionals, commonly known as citizen science or community science, provides a substantial contribution to the knowledge of biodiversity. Using numerous online applications, amateur scientists can share their observation records through various data collection initiatives. A large amount of species occurrence records on the world's fauna, flora and funga is continuously uploaded to a global publicly available online platform for sharing biodiversity data, iNaturalist (https://www.inaturalist.org), and, eventually, to GBIF (Global Biodiversity Information Facility, https://www.gbif.org), the largest biodiversity repository in the world.

Given the highly restricted number of professional mycologists worldwide, the additional records of fungi uploaded by volunteers are of particular scientific value. The species observations of fungi are submitted directly to the major international platforms and/or to some specialised networks dedicated to documenting fungal records on the national level. Since recently, they are widely used in mycological research, including large-scale studies on fungal diversity, ecology, distribution and conservation (Heilmann-Clausen et al., 2016, 2019; Haelewaters et al., 2024 and references therein).

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The primary data on species occurrence is also collected by various social media platforms, such as biodiversity observation groups on Facebook. They are a valuable source of information for professional scientists but still remain largely unexploited, mainly due to less structured data and the bias of some data. However, the accuracy of taxa identification is usually assessed by group moderators and scientific expertise, as, for example, is done in the Facebook community "*Fungi of Ukraine*" ("*Гриби України*", https://www.facebook.com/groups/1054204501266549/); see Shevchenko et al., 2021; Heluta et al., 2022; Martyniuk et al., 2024).

Here below is the case of two similar species of fungi, a lesser-known species that may be confused with more familiar one, and some additional data to reduce taxonomic uncertainty in the online records of these fungi.

Artomyces or *Clavicorona*?

The genus *Artomyces* Jülich (*Auriscalpiaceae*, *Russulales*) is composed of lignicolous species with coralloid, pyxidately branched basidiomes. Microscopically, basidiomes of the genus are distinguished by the presence of gloeoplerous hyphae, hymenium gloeocystidia and small, white to hyaline, amyloid basidiospores. Formerly, these taxa were placed in the genus *Clavicorona* Doty, namely the subgenus *Ramosa* Dodd, thus being separated from those in the subgenus *Clavicorona* with clavarioid unbranched basidiomes growing on plant litter (Dodd, 1972). Walter Jülich (1981) raised *Clavicorona* subgen. *Ramosa* to the genus rank and established the new genus *Artomyces*, with *A. pyxidatus* (Pers.) Jülich as the type species. However, the name *Artomyces* was not instantly accepted and *A. pyxidatus* was continuously referred to as *Clavicorona pyxidata* (Pers.) Doty (Wu, Petersen, 1992; Wu et al., 1995).

In the early 2000s, extensive morphological and molecular studies confirmed the generic segregation between *Artomyces* and *Clavicorona*, and new combinations in *Artomyces* were provided (Lickey et al., 2003). Moreover, it has been demonstrated that the two genera are not phylogenetically related and *Clavicorona* is a close match to euagarics. In subsequent phylogenetic research (Birkebak et al., 2013), a single stem lineage was revealed for *Clavicorona* within the *Clavaria* clade in the *Clavariaceae* (*Agaricales*).

Occurrence of *Artomyces* species globally and in Europe

Currently the genus *Artomyces* comprises 17 accepted species (https://www.indexfungorum.org/). Of them, nine species occur in Australasia (with the highest species diversity, including endemics, in New Zealand and Australia), six in North America (USA, Costa Rica, Canada), three in South America (Argentina, Chile) and one or two species are reported from each of several countries in Southeast and East Asia (Lickey et al., 2003; Lee et al., 2014; Liu et al., 2023; https://www.gbif.org/). About a half of *Artomyces* species have a narrowly restricted range or are known from a single or several collections only. One of such rare species, *Artomyces nothofagi* R.J. Kneal & M.E. Sm., recently described from Chile (Kneal, Smith, 2015), has been assessed for the IUCN Red List as an Endangered species globally (Furci, Smith, 2020).

In Europe, at present three species of *Artomyces* are known to occur: *A. pyxidatus*, *A. cristatus* (Kauffman) Jülich and *A. microsporus* (Qiu X. Wu & R.H. Petersen) Lickey. A well-known species of the genus, *A. pyxidatus*, is the most common and widely distributed throughout the temperate zone of the Northern Hemisphere (Lickey et al., 2002). *Artomyces cristatus*, described from the USA and previously known from the USA, Canada and Northern Europe (Lickey et al., 2003), is now repeatedly recorded in Norway and Sweden (https://www.gbif.org/). *Artomyces microsporus*, originally described from Japan (Wu, Petersen, 1992) and first reported in Europe from Ukraine (Fraiture et al., 2008), is apparently also known from several European countries (GBIF.org, 2024).

Artomyces microsporus versus *A. pyxidatus*

Of the three mentioned above species of *Artomyces* occurring in Europe, *A. cristatus* can be easily distinguished by rather small, simple, unbranched to rarely twice branched basidiomes (Lickey et al., 2003), whereas *A. pyxidatus* and *A. microsporus* have similar macromorphological characters such as quite large, coralloid, profusely and pyxidately branched basidiomes. Microscopically, *A. microsporus* can be distinguished by its smaller (shorter) basidiospores, 3.0–3.8 × 2.0–2.8 vs. 3.6–4.8 × 2.4–2.8 μm in *A. pyxidatus* (Lickey et al., 2003; Fraiture et al., 2008). The delimitation of these two species

was also supported by their mating incompatibility (Wu, Petersen, 1992) and by phylogenetic analysis of the rDNA ITS sequences (Lickey et al., 2003). Identification of the Ukrainian specimens of *A. microsporus* has been also confirmed by rDNA ITS sequencing (Fraiture et al., 2008).

Undoubtedly, the most reliable method for identification of the *Artomyces* spp. is microscopic examination with measuring spore dimensions, followed by DNA sequencing. However, citizen scientists are rarely involved in genomic biodiversity research projects. Volunteers and amateurs usually photograph and post their observation records to social media platforms without collecting specimens of fungi for genome sequencing or microscopic examination. Most of them are not familiar with the field methods for collecting, preserving and identifying fungal specimens. However, amateur experts, while in the field, may notice and record some characters useful for species identification, if those are defined and communicated.

Some of the visually distinctive characters of *A. microsporus* have been already reported by Fraiture et al. (2008), e.g. compact habit of basidiomes. In *A. microsporus*, the upright branches are tightly clustered from the base right through the top of the basidiome (Fig. 1A), in contrast to those of *A. pyxidatus*, which are loosely arranged and remain well separated from each other towards the top (Fig. 3A). Indeed, basidiomes of *A. microsporus* have the appearance, as if they have been growing in a tightly restricted space. The branches are usually densely packed from the very base of basidiomes. Large basidiomes are often wider at the base than at the top and thus resemble in shape a half rugby ball with a flat base (Fig. 2).

Another distinguishing character is that in *A. microsporus* the branches appear almost not broadened or only slightly broadened towards branching nods and apices (Fig. 1B), unlike those in *A. pyxidatus*, which appear noticeably wider towards the nods and apices (Fig. 3B). This feature of the former species is also notable in less tightly packed basidiomes with more slender branches.

Colour of the basidiomes in both species is rather variable depending on weather conditions and the development stage. However, the colour of coronate branch tips is apparently an important morphological character. The light orange apices of branches have been reported previously as a unique character in *A. microsporus* (Wu, Petersen, 1992), comparatively to pale yellowish apices in *A. pyxidatus* (Wu

Fig. 1. *Artomyces microsporus*. A: basidiome; B: a close-up of its branching pattern (image: E. Singayevskiy)

Fig. 2. Basidiome of *Artomyces microsporus* (image: V. Kavurka)

et al., 1995). With age, the branch tips in *A. microsporus* become orange brown to dark brown (Fraiture et al., 2008). The originally orange coloured tips (Fig. 1B) upon desiccation under dry weather conditions turn dark umber to blackish brown, and then basidiomes of *A. microsporus* may have the superficial appearance as if they were slightly burnt.

In Ukraine, *A. microsporus* was first recorded in 2004 on the outskirts of Kyiv City (Novobilychi neighbourhood), in a pine forest with admixture of oak and other deciduous trees and shrubs (Fraiture et al., 2008). It was repeatedly observed at the same site in the forest to the north-west of the city suburbs for the subsequent years. Most likely, the fungus could still be found there by now. However, at present it may be unsafe to access that forest parcel, as it extends across the area immediately adjacent to severely affected towns of Irpin and Bucha, where Russia's invaders advancing towards Kyiv have been stopped in March 2022.

Nevertheless, a long-term personal observation of the occurrence of *A. microsporus* in the reported locality in the late 2000s–2010s provided additional information on morphology (described above) and ecology of the fungus, in particular about its tree host species/substrate preference and position of host trees (standing tree/fallen trunk). In all observed there records of *A. microsporus*, the host plant was the Scots pine (*Pinus sylvestris* L., also known as the Baltic pine or European red pine). The substrate was dead wood, especially stumps and fallen trunks, but also standing trees. On dead standing trunks, the basidiomes were occasionally found at a height up to one metre above ground. It is also worth noting that the fungus was frequently observed on relatively undecayed wood substrate, i.e. bark-covered fallen trunks and cut stumps at an initial state of decay. This is in contrast to *A. pyxidatus*, which is commonly found on well decayed wood, mostly on barkless fallen logs or stumps at more advanced stages of wood decomposition.

In Europe, *A. microsporus* is apparently a host-dependent species occurring on coniferous (pine) wood. In all known up to now records, including those from Ukraine (Fraiture et al., 2008) and the reliable data on the host substrate accessible in GBIF (GBIF.org, 2024), *A. microsporus* shows a clear preference for *Pinus* spp. as host plants. It was also reported on the bark of *Pinus densiflora* Siebold & Zucc. from Korea (Lee et al., 2014). However, the holotype specimen was collected in Japan on hardwood (Wu, Petersen, 1992) and a recent collection from China was also reported on a dead angiosperm (Liu et al., 2023). On the contrary, *A. pyxidatus* has a wide spectrum of various deciduous hosts, with only occasional records on coniferous wood.

Current distribution patterns of *Artomyces microsporus*

Hitherto, there is limited published data on the worldwide occurrence of *A. microsporus*, based on the specimens identified using molecular markers. According to the sequence data in GenBank (https://www.ncbi.nlm.nih.gov/), the sequenced up to now vouchers of *A. microsporus* are of Asian and European origin and represent the following countries: Japan (Lickey et al., 2003), Ukraine (Fraiture et al., 2008), Korea (Lee et al., 2014; Min et al., 2021) and China (Zhao et al., 2017; Liu et al., 2023).

Much more extensive information on the distribution of *A. microsporus*, based on macromorphology and host preference of the fungus, is currently accessible on the global biodiversity platforms. The GBIF provides over 70 occurrence records for *A. microsporus* from 11 countries (GBIF.org, 2024); these include automatically uploaded to GBIF the "Research Grade" observations from iNaturalist (https://www.inaturalist.org). Thus, based on the published data and the information on the distribution pattern deposited in GBIF, *A. microsporus* is apparently known from Europe (Austria, Belarus, Czech Republic, Germany, Lithuania, Poland, RF, Ukraine) and Asia (China, Japan, Korea, RF).

Within Ukraine, observations of the occurrences of *A. microsporus* posted by amateurs to the "*Fungi of Ukraine*" Facebook group (https://www.facebook.com/groups/1054204501266549/), have also greatly expanded the distribution pattern for this fungus from previously reported Kyiv Region to much wider areas, mostly in the north and west of the country, including Cherkasy, Chernihiv, Khmelnytskyi, Lviv, Rivne, Volyn and Zhytomyr regions.

Conclusion

Although morphological characteristics of the basidiomes of *A. microsporus* are quite variable, some distinctive characters described above are apparently species-specific and can be useful for the species delimitation. In combination with the host/substrate preference, those characters can help amateurs and citizen scientists to differentiate the observations of *A. microsporus* from those of *A. pyxidatus* in the field and to select those specimens that otherwise need to be collected for DNA sampling.

The advantage of this approach is a minimum extent of necessary collections that should be preserved for further examination and molecular analysis, while the rest of field data on the occurrence of these fungi can be simply photographed and uploaded directly to the biodiversity repositories or social media platforms. This will significantly contribute to clarifying and providing regular updates on the distribution patterns of *A. microsporus* at the local, continental and global scales.

Fig. 3. *Artomyces pyxidatus*. A: basidiome; B: a close-up of its branching pattern (image: V. Siranskyi)

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ETHICS DECLARATION

The author declares no conflict of interest.

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Artomyces microsporus* (*Auriscalpiaceae*) — рідкісний вид, який можна сплутати з *A. pyxidatus

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Реферат. *Artomyces microsporus* уперше в Європі був знайдений в Україні майже два десятиліття тому. Цей ксилотрофний базидієвий гриб є морфологічно подібним до іншого виду цього роду — *A. pyxidatus*, який повсюдно трапляється у помірному поясі Північної півкулі. Це дослідження спрямоване на визначення надійних ознак для розрізнення цих видів у природі, що можна використовувати як додатковий спосіб ідентифікації видів до застосування молекулярних методів. Розглядаються як морфологічні ознаки плодових тіл *A. microsporus*, так і особливості субстратної приналежності. Такі ознаки можуть широко застосовуватись непрофесійними науковцями при проведенні спостережень про трапляння цих видів грибів для світових баз даних з вивчення біорізноманіття і соціальних мереж. Використання надійних ознак для визначення цих видів сприятиме уточненню даних щодо поширення *A. microsporus* на регіональному і світовому рівні.

Ключові слова: *Artomyces*, *Basidiomycota*, *Clavicorona*, громадянська наука, морфологія, поширення, субстратні уподобання