10.31195/ejejfs.577929

Eurasian Journal of Forest Science

2019 7(3): 237-242

http://dergipark.gov.tr/ejejfs

A new locality record of a rare fungus *Cercopemyces rickenii* (Agaricales: Tricholomataceae) in Ukraine

Maryna M. Sukhomlyn[1], Vasyl P. Heluta[2], Yulia M. Kulsha[3], Ilgaz Akata[4,*] and Vitaliy I. Sapsay[2]

[1]*Educational and Scientific Centre, Institute of Biology and Medicine, Taras Shevchenko Kyiv National University, 64 Volodymyrska Str., Kyiv, 01033, Ukraine*
[2] *M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, 2 Tereshchenkivska Str., Kiev, 01004, Ukraine*
[3] *Kaniv Nature Reserve, 108 Shevchenko Str., Kaniv, 19000, Ukraine*
[4*] *Ankara University, Faculty of Science, Department of Biology, Ankara, 06100, Turkey*
Corresponding author: fungus@hotmail.com.tr

Abstract
Cercopemyces rickenii (Bohus) Dima & L. Nagy (Agaricales: Tricholomataceae) is a rare species red-listed in Ukraine and in a number of other countries. Before now in Ukraine, the fungus was recorded in five localities, only in the steppe zone. All known localities were confined to sandy soil and plantings of *Acer tataricum* L. or *Robinia pseudoacacia* L. It is reported about sixth record of *C. rickenii*, located outside the steppe zone and the most northern in Ukraine. The fungus was found here in plantings formed by *Caprinus betulus* L. and *Acer platanoides* L. on forest soils. Using scanning electron microscopy, it was shown that the spore surface of *C. rickenii* had tuberculate ornamentation. In addition, it was shown that the basidium of the fungus could have more than four sterigmata.
Keywords: new locality, rare species, Tricholomataceae, Ukraine

Introduction

Different authors at different times included *Cercopemyces rickenii* (Bohus) Dima & L. Nagy (Agaricales: Tricholomataceae) into several genera. Therefore, this fungus was previously known as *Armillaria rickenii* Bohus, *Floccularia rickenii* (Bohus) Wasser ex Bon or *Ripartitella rickenii* (Bohus) Singer. However, recently the species was transferred to the genus *Cercopemyces* T.J. Baroni, Kropp & V.S. Evenson (Dima, 2015). Today *C. rickenii* is known from Bulgaria, Czech Republic, France, Hungary, Poland, Russia, Slovakia, Sweden, and Ukraine (Bohus, 1970; Wasser, 1971; Lange, 1995; Prydiuk 1999; Lizon, 2001; Gyosheva et al., 2006; Denchev and Assyov, 2010; Gierczyk et al., 2012; Lessoe, 2014; Rusanov, 2014; Westling, 2015). The fungus is rare in everywhere and red-listed in a number of countries. Therefore, it was proposed to be included in the European Red List (Senn-Irlet, 2011).

In Ukraine, *C. rickenii* (sub *Floccularia rickenii*) is listed in the Red Data Book as a vulnerable rare species with a disjunctive range (Didukh, 2009). Before our research, the fungus was known here only from five localities, exclusively in the steppe zone (Figure 1). However, in 2014 and 2015, this species

was found by us outside of this zone. Consequently, this article supplemented the information about distribution of *C. rickenii* in Ukraine. In addition, we expanded the morphological characteristics of the species by studying the hymenium using scanning electron microscopy.

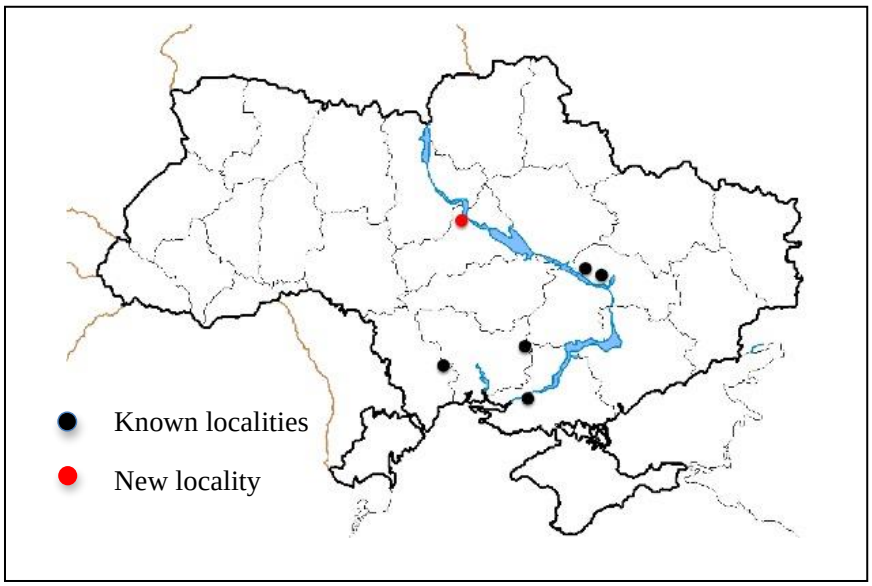

Figure 1. Distribution of *Cercopemyces rickenii* in Ukraine

Material and Methods

The materials for the study were samples of *C. rickenii* collected by us on May 11, 2014 and June 25, 2015 on the territory of the Kaniv Nature Reserve (Cherkasy Region, Ukraine). The specimens were dried at room temperature. The spores and hymenium elements of the fungus were studied and photographed under a light microscope Primo Star (Carl Zeiss, Germany) using the camera Canon A 300 and the software AxioVision 4.7. For scanning electron microscopy (SEM), small pieces of dried hymenial lamellae were placed on a metal stub, then coated with gold and observed under SEM Jeol 6060LA, Japan. Species names of vascular plants are in accordance with the catalogue "Vascular plants of Ukraine. A nomenclatural checklist" (Mosyakin and Fedoronchuk, 1999).

Results and Discussion

Cercopemyces rickenii is a quite easily recognizable species in natural conditions. The fungus has rather large basidiocarps covered with conical or pyramidal scales (Figure 2A). The basidiocarps grow on the ground singly or in groups, sometimes large. *Cercopemyces rickenii* is a thermophilic species, a humus saprotroph that prefers sandy soils (Wasser, 1975, Gierczyk et al., 2012). Most European records of the fungus are associated with *Robinia pseudoacacia* L. (Wasser, 1975; Horak, 2005). However, in Sweden it was found among the bushes of *Crataegus rhipidophylla* Gand. and Rosa sp. (Bohlin and Knutsson, 2001). In Ukraine, C. rickenii was collected both under *Robinia pseudoacaia* and in monocultures of *Acer tataricum* L. (Prydiuk, 1999).

For the first time in Ukraine, *C. rickenii* was found by S.P. Wasser in 1968 on the territory of the Oleshky Forestry (Oleshky District, Kherson Region) (Wasser, 1971). Sometime later, in 1970, the fungus was collected by the same author on sand or sandy soil in other forest areas located in the steppe zone of

Ukraine, namely Berezivske Forestry (Berezivka District, Odesa Region) and Volodymyrske Forestry (Bereznehuvate District, Mykolaiv Region), as well as in the Orel Forest (Petrykivka District,

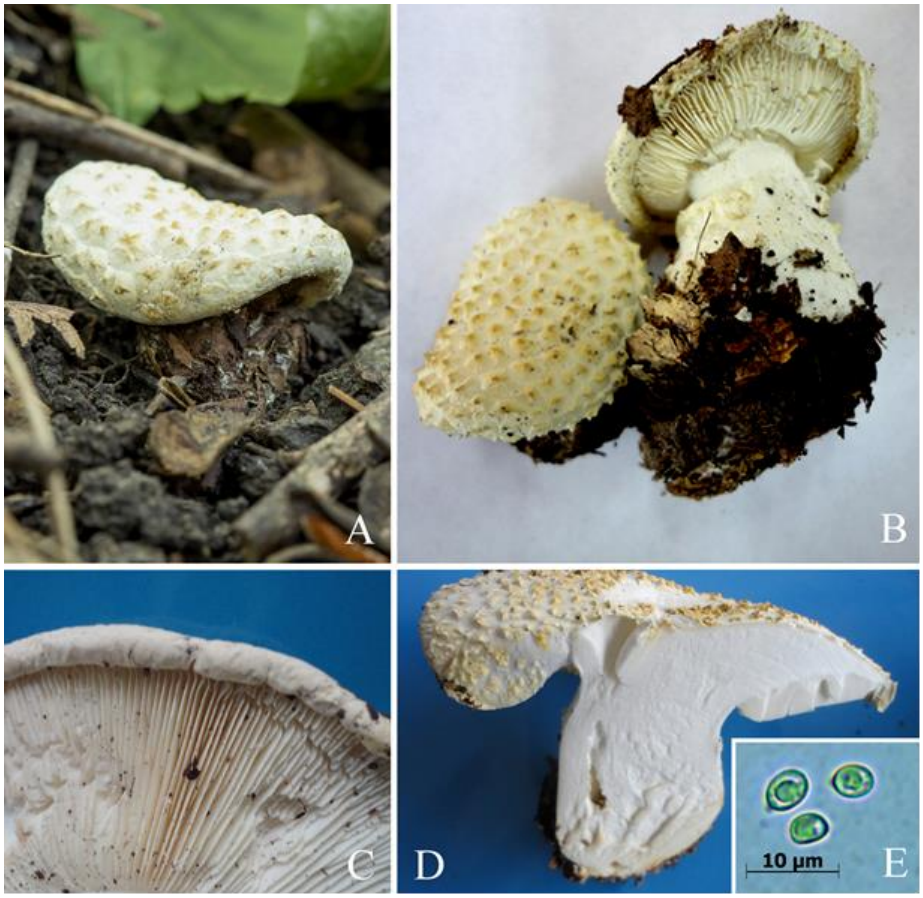

Figure 2. Morphology of the basidiocarp of *Cercopemyces rickenii*. A, B - the surface of the pileus; C - gills; D - the basidiocarp in section; E - spores (light microscope, scale bar =10 µm).

Dnipropetrovsk Region) (Wasser, 1971, 1974, 1976). The author also reported on the localities of this species, gave a description and black-and-white photos of basidiocarps, drawings of the gill trama structure, and spore images of this fungus. Much later, after 30 years, *C. rickenii* was again found in the steppe zone, in the Dniprovsko-Orilsky Nature Reserve (Dnipro and Petrykivka districts, Dnipropetrovsk Region), on the sands in the thickets of *Acer tataricum* and *Robinia pseudoacacia* (Prydiuk, 1999, 2005). After than, until our research, the fungus was no longer found in Ukraine.

As already mentioned above, *C. rickenii* was found by us in 2014 and 2015 on the territory of the Kaniv Nature Reserve located in the forest-steppe zone of Ukraine (Figure 1). Habitats of the fungus were situated in a leveled area of a broad-leaved forest, which bordered on the edge of the forest and passed to the slope of the southern exposure. The tree tier was composed here mainly of *Caprinus betulus* L. and *Acer platanoides* L. Also in this tier there were *Quercus robur* L., *Ulmus scabra* Mill., *Betula pendula* Roth., *Acer negundo* L., *Crataegus pseudokyrtostyla* Klok., and *Fraxinus excelsior* L. The undergrowth was formed by *Caprinus betulus* L., *Acer platanoides* L., *Fraxinus excelsior* L. The grass layer formed mainly by *Stellaria holostea* L. and *Viola hirta* L.; *Asarum europaeum* L., *Galium aparine* L., *Polygonum convolvulus* L., *Alliaria petiolata* (Beib.) Cavara et Grande, *Dentaria bulbifera* L., and *Poa nemoralis* L. was also present.

The basidiocarps we found were 5–8 cm in diameter, had a yellowish-white, yellowish-creamy (with a lemon tinge), a slightly darker to the center, convex, convex-expanded, dry, matte pileus covered by concentrically arranged multi-faceted conical warts (Figure 2A and 2B). The edge of the pileus smooth, slightly bent down, with white remnants of the universal veil. Gills dense, attached, with a straight edge, white, white-cream (Figure 2C). The gill trama regular. The stipe 1.0–1.5 × 3–6 cm, the same color as the cap, central, solid, slightly narrowed upwards and enlarged downwards, at the top smooth, below covered by the remnants of an universal veil in a form of warts forming a rapidly disappearing ring. Flesh dense, firm, white in the pileus and stipe, unchanging on cutting (Figure 2D), sweetish. It was previously reported that young basidiocarps have a pleasant mushroom smell (Wasser, 1971) but our samples were odorless, probably due to the fact that they were quite dry. Spore-print cream. Basidiospores broadly ovoid, 4.6–5.8 × 2.8–3.7 μm, that fully corresponds to already known data (Wasser, 1971; Prydiuk, 1999; Lange 2008; Didukh, 2009; Gierczyk et al., 2012). Under a light microscope and with small magnifications in a SEM, spores appear smooth (Figure 2E and 3A). However, with a large magnification, more than × 12 000, tuberculate ornamentation is visible on the spore surface (Figure 3B and 3C). The tubercles are arranged throughout the spore surface unevenly at a distance of 0.2–5.0 μm. The dimensions and bulge of the tubercles are also variable. Before, it was not known that the surface of the spore of *C. rickenii* was ornamented. However, the same surface is typical for *Cystoderma ponderosum* (A.H. Smith & Singer) T.J. Baroni, Kropp, & V.S. Evenson (Franco-Molano, 1993), which was later also referred to the genus Cercopemyces (Baroni et al., 2014).

In addition, in the SEM image, it can be seen that spores have a nipple-like apiculus (Figure 3C). Basidia are clavate (Figure 3D), mostly having four sterigmata. However, for the first time, basidia with a more number of sterigmata were found for this species (Figure 3E and 3F). The sterigmata are long, up to 3.4 μm, with spherical extensions on the apex. After maturation and separation of basidiospores these thickened apices become flattened to almost hemispherical (Figure 3F).

Thus, as a result of our research a new, sixth and the most northern locality of the rare fungus *C. rickenii* has been recorded in Ukraine. In addition, the fungus was found on forest soil in plantings mainly formed by *Caprinus betulus* and *Acer platanoides*, but not on sandy soils in plantings of *Acer tataricum* or *Robinia pseudoacacia*, as it was previously known. Using scanning electron microscopy, for the first time it was shown that the spore surface of *C. rickenii* has tuberculate ornamentation, and that the basidium of the fungus could have more than four sterigmata.

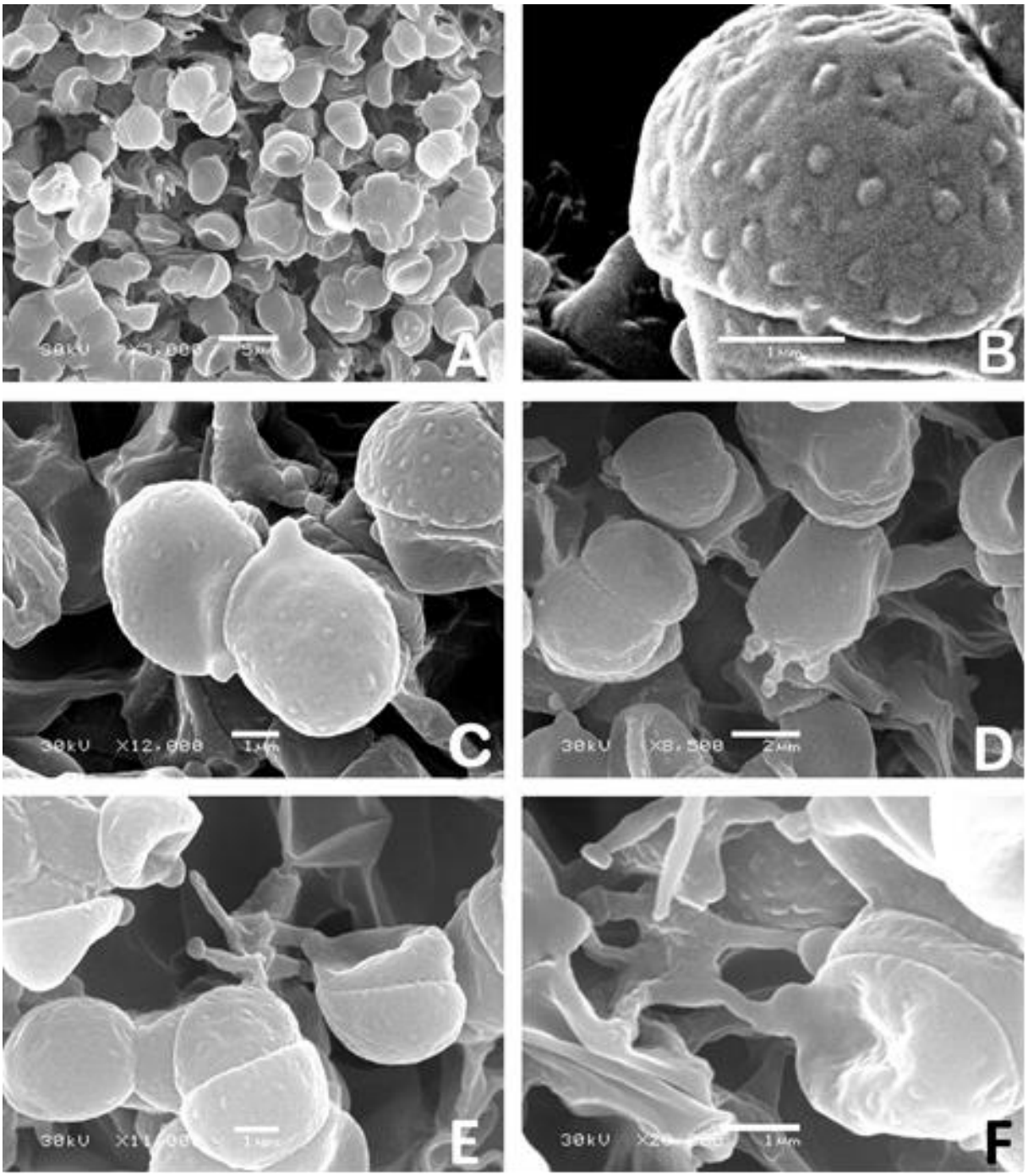

Figure 2. Morphology of basidia and basidiospores of *Cercopemyces rickenii*. SEM. A - basidiospore mass on the surface of the gill; B - basidiospore at high magnification; on the surface is clearly visible tuberculate ornamentation; C - basidiospores with apiculi; D - young basidium (in the central part of the image); E - sterigmata (in the center) with spherical extensions on the apex; F - basidium with more than four sterigmata. Scale bar for A = 5 μm, for B, C = 1 μm, for D = 2 μm, for E, F = 1 μm

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Submitted: 14-06-2019 Accepted: 06-10-2019