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Short note

A Second Record of the Species Clathrus ruber P. Micheli ex Pers. in Romania, and Notes on its Distribution in Southeastern Europe

Ciprian Bîrsan[1*], Constantin Mardari[1], Ovidiu Copoț[1], Cătălin Tănase[2]

1 - A. Fătu Botanical Garden, Alexandru Ioan Cuza University of Iaşi,
7-9 Dumbrava Roşie, 700487 Iaşi, ROMANIA
2 - Faculty of Biology, Alexandru Ioan Cuza University of Iaşi,
Carol I 20A, 700505 Iaşi, ROMANIA
[*]Corresponding author: ciprian.birsan@uaic.ro

Abstract. In this short note, the fungal species *Clathrus ruber* is reported for the second time in Romania, 60 years after the first record. It was identified in the northeastern part of the country, in Iaşi region, in a *Lolium* sward from a private garden. Twenty fruitbodies were counted between June and October 2020. It is not known how the species was brought into the garden.

Key words: stinkhorns, rare species, distribution, new occurrence.

Introduction

Clathrus ruber P. Micheli ex Pers. (syn. *C. cancellatus* Tourn. ex Fr.) is one of the two species of the genus *Clathrus* (*Phallaceae*, *Phallales*) that have been identified in Romania (besides *C. archeri* (Berk.) Dring (Bereş, 1996)). The species was first described by the Italian botanist Pier Antonio Micheli in 1729 (Micheli, 1729). Species in the genus *Clathrus* are characterized by fruitbodies with bright colors and bizarre shapes. Etymologically, the name comes from the Greek "*kleithron*" = grid, box, cage and the Latin "*ruber*" = red (Bresson, 1996). The popular French name of "witch heart" comes from the Spanish and Serbian vernacular names (Courtecuisse & Duhem, 2013). According to some authors, *C. ruber* is quite common in the Mediterranean region where it can be found on sandy and calcareous soils, in coniferous forests (Mallorca, Sardinia, Corsica), but also on the French Atlantic coast (Breitenbach & Kränzlin, 1986; Gerhardt, 1999). It is a species with a Mediterranean origin, occurring throughout the year in southern France. Sporadic occurrences have been reported in Central Europe. The species is absent in Northern Europe.

In Romania, *Clathrus ruber* (Fig. 1) was considered a rare macromycete species, with only one reported occurrence in the Black Sea coastal area (Toma et al., 1962). It was regarded as vulnerable and included in Romanian Red List of Macromycetes (Tănase & Pop, 2005). Also, it was included in the Red Lists of other countries, such as Ukraine, Bulgaria, Macedonia, and Slovakia (Didukh et al., 2009; Gyosheva et al., 2006; Karadelev & Rusevska, 2013; Lizoň, 2001).

Fig. 1. Fully developed fruitbody of *Clathrus ruber* in Valea Adânca, Northeastern Romania (Photo: Birsan C.)

In Bulgaria it was identified from the coastal region of the Black Sea and sporadically found in the city of Sofia, and the Vitosha and Rodopi Mountains, which was an extension of its habitat compared to the first discovery in 1936 in the Botanical Garden of Sofia (Hinkova, 1961). It was also identified from the northern slopes of Mount Sakar, in plantations of *Pinus nigra* and mixed forests of *Fraxinus* sp., *Quercus* sp., and *Pinus* sp., on sandy soils (Lacheva, 2015). Recently, in 2016, the species was discovered in three new localities in the southwestern part of Bulgaria on decaying plant material in *Platanus orientalis* and *Castanea sativa* forests. The fungus produced fruitbodies between May and November and was found at altitudes ranging between 10-600 m a.s.l. (Uzunov et al., 2016). The distribution of the species in Bulgaria is related to milder climates and high humidity in regions adjacent to the Black Sea (Assyov et al., 2010).

In the Ukraine, most reports of this species are from the Crimean region, especially from the Nikita Botanical Garden and neighboring areas. The first published report of *Clathrus ruber* from the Ukraine dates from June 12, 1961 (Zerova, 1962). The fungus was identified in deciduous (*Quercus* sp.) and mixed (*Pinus* sp. and *Quercus* sp.) forests, and frequently occurred in old parks and areas with strong anthropogenic influence (e.g. terrains in the Magarach Institute for Grapes and Wines, Yalta cargo port area). The increase in the records of this species on the southern coast of Crimea agrees with the opinion of mycologists regarding favorable habitat conditions for *Clathrus ruber* in regions around the Black Sea. In September 2017, fruitbodies were identified in the Ivano-Frankivsk region (Heluta & Zykova, 2019) from parks, plantations and natural forests, on clay and mostly basic soils with poorly developed or absent herbaceous vegetation. They were found mainly under the canopy of trees that maintained soil moisture, thus favoring their development. The period for producing fruitbodies in this region was from April to October, with the largest number found in August (Dudka, 2015).

In Serbia, *Clathrus ruber* was discovered in October 1983 during a botanical expedition. It is interesting that the substrate of the habitat in which the species occurred was ultra-alkaline; this was the only specimen found in such habitat in the former Yugoslavia regions (Ivancevic & Tatic, 2004).

In Turkey, the species was found in winter (December), in the province of Izmir, in olive tree plantations and during the summer (June-August) in the Sinop region of the Black Sea, in hardwood forests (Afyon et al., 2004; Yilmaz & Solak, 2004).

In Macedonia it is a rare species identified from five localities in Jakupica, Vodno, Pelister Mountains. In the village of Katlanovo at the St. Bogorodica Monastery the species has been identified in a *Querco-Carpinetum orientalis* forest at 200 m a.s.l., at the end of October (Karadelev et al., 2008).

For the present Note, we identified the species using macroscopic and microscopic characters described in the following literature: Breitenbach & Kränzlin (1986), Courtecuisse & Duhem (2013), Eyssartier & Roux (2013), Gerhardt (1999) and Tănase et al. (2009). The scientific name follows Index Fungorum database. One voucher specimen

from the examined material was deposited in the Herbarium [I] of the "Alexandru Ioan Cuza" University from Iaşi, Faculty of Biology [voucher I 185665].

The distinctive cage like fruitbody develops rapidly (in a matter of days) and cannot be confused with other stinkhorn species as *Clathrus archeri* (star-shaped fruitbody) or *Aseroe rubra* (presenting a stipe with a radiating ring with 6-10 bifid arms). In the first phase it is globular, white or yellow, in the shape of an egg ca. 2–3 cm long. With maturity it becomes cage-like, in the form of a red-orange network, fragile and spongy, with dimensions ranging from 6–10 (length) × 4–7 cm (diam.) (Fig. 1). At the base it has a soft spongy receptacle with a porous appearance. The fungus emits a cadaveric smell at maturity arising from the olivaceous–black gleba, arranged on the inside of the net. The spore cloud is white. The spores measure 5-6 × 2 µm, are more or less cylindrical to elliptical, without ornamentation (Breitenbach & Kränzlin, 1986; Tănase et al., 2009).

All species in the family *Phallaceae* have a gleba (spore-bearing inner mass) with a foetid odour in order to attract insects to facilitate the dispersal of spores. Spores stick to the body of the insects and others are consumed thus ensuring dissemination the species over possibly quite long distances (Fig. 1). Spores are dispersed by many insect species (e.g. near a specimen of *Clathrus ruber* in the Martinazo forest (Spain) an abundance of dipteran species and three beetles (Román, 2008) was noted).

The new Romanian record was registered from the *Lolium* sward of a private property in Valea Adâncă, a locality close to the city of Iaşi (geographical coordinates: 47.134286 N and 27.548369 E), at an altitude of 109 m a.s.l. The manner of introduction is not known. A total of 20 fruitbodies was identified, the first on 24th June 2020 while the last hatched on 17th October 2020. Taking into consideration that the owner has built a new house, it could be assumed that the species was brought in with construction material. It is the second report from Romania, after the first discovery in July–September 1961, when the species was identified in a private garden in the town of Eforie (Toma et al., 1962). In that report it is interesting that the fruitbodies were recorded from April to July, consisting of 10 specimens. The area where the mushroom was found in 1961 is influenced by the Black Sea, presenting a milder climate, typical for the coast, at an altitude of 20 m a.s.l., in a soil with permanent humidity (Fig. 2).

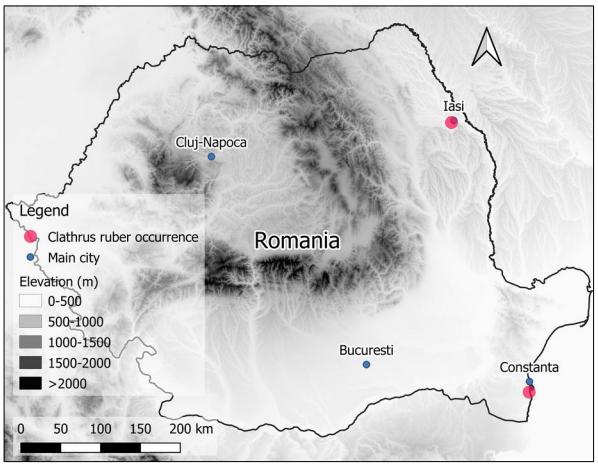

Fig. 2. *Clathrus ruber* occurrences in Romania (map created using the Free and Open Source QGIS, after SRTM digital elevation model).

From a climatic point of view, the new area where the fungus was identified in 2020, near the city of Iaşi, is characterized by an average annual temperature of 9.5 °C, an average annual rainfall of 585.8 mm and prevailing winds from North – Northwest (National Meteorological Agency, 2008). The occurrence of the *Clathrus ruber* species in the Iaşi area could be related to climate change, as both temperature and precipitations-related indices have shown significant modifications in the past decades, such as a decreasing number of days with low and moderate precipitation (Croitoru et al., 2015), and an increasing number of hot and humid days and nights in the area (Croitoru et al., 2012). Also, in the past years, an increase of mean annual temperature has been observed in comparison with the 1961-2009 period,

indicating a temperature positive anomaly (Sfîcă et al., 2017).

The altitudinal range of the localities where *Clathrus ruber* has been found in Romania is from 20 m to 109 m above sea level. *Clathrus ruber* is a thermophilic species, which could potentially be found on the sandy soils of southern Romania (Tănase et al., 2009). In other areas of Europe, it has been identified in deciduous and coniferous forests especially in southern regions of the Continent. It also sporadically occurs in parks, cemeteries, and gardens (Breitenbach & Kränzlin, 1986; Eyssartier & Roux, 2013), especially during the summer.

The free movement of population and merchandise in the European Union can advantage the spread of *Clathrus ruber*. This saprophytic species found mainly in parks and gardens also occurs in forest habitats on decaying plant matter. In the context of global warming, an expansion of the distribution of this species in new territories with favorable climatic and anthropogenic conditions is not unexpected. The intensification of anthropogenic pressure and the changes in land use have led to the decline of macromycete diversity in Europe, especially in developed countries of southern and western Europe (Senn-Irlet et al 2007). Parks and gardens are suitable habitats for introduced fungal species especially for those belonging to the *Phallaceae* that grow on mulch and rotting vegetal matter (Heluta & Zykova, 2019).

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