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ORIGINAL RESEARCH PAPER

New localities of *Sarcodontia crocea* (Polyporales, Basidiomycota) in Poland

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Abstract
Sarcodontia crocea is a fungus relatively rarely recorded in Central and Northern Europe, where as a parasite it grows mainly on old apple trees. The most recent data on the occurrence of this fungus in Poland are presented in this study. Seven new localities of *S. crocea* are reported, found in the regions of Mazowsze, Podkarpacie, Ziemia Łódzka, and Żuławy Wiślane in the years 2013–2016. The *S. crocea* basidiomes were recorded on 12 apple trees. The fungus occurrence on *Malus pumila* 'Niedzwetzkyana' was documented for the first time. Four beetle species representing four families were found in the studied *S. crocea* basidiomes. Their feeding on *S. crocea* has not been mentioned in the literature so far.

Keywords
apple tooth fungus; wood-decaying fungi; red list of fungi; distribution; *Malus pumila* 'Niedzwetzkyana'; Coleoptera; beetles; mycetobionts

Introduction

Sarcodontia crocea (Schwein.) Kotl. is a wood-inhabiting basidiomycetous fungus relatively infrequently recorded in Poland, like in many other Central and North European countries. It parasitizes deciduous trees causing white rot of wood in stem and branches. Two studies concerning biology, ecology, and distribution of *S. crocea* in Poland were recently published [1,2]. In the cited studies, the description and pictures of basidiomes were included, which are characterized by resupinate shape, built of aculei ca. 17 mm long, first sulfureous, later orange, vine-red to rust-brown color. The basidiomes of *S. crocea* form in summer and fall. The fresh *S. crocea* basidiomes have specific, very intense odor resembling pineapple or grated apples. Two volatile benzaldehyde derivatives: 4-(furan-3-yl)benzaldehyde and 4-(5-oxotetrahydrofuran-3-yl)benzaldehyde are responsible for this characteristic odor [3].

Sarcodontia crocea parasitizes mainly apple trees *Malus* spp. It was recorded less frequently on other trees: pear *Pyrus* spp. (including *P. communis*), plum *Prunus* sp., whitebeam *Sorbus aria* and service tree *S. domestica*, hawthorn *Crategus* sp., Taiwanese photinia *Photinia serrulata*, common ash *Fraxinus excelsior*, beech *Fagus* sp., holm oak *Quercus ilex*, and maple *Acer* sp. [4–14]. In Poland, *Malus domestica* (or in general *Malus* species) and, twice, pear *Pyrus* were reported as host species [1,2,15,16].

Because of its rarity the species was included in the "Red list of macrofungi in Poland", with the R category – rare [17]. Szczepkowski [1] proposed for *S. crocea* the NT (near threatened) category.

The aim of this study was to document a new host taxon for *S. crocea* in Poland, to complete data on its distribution in our country and to present a list of beetles recorded in the basidiomes collected.

Material and methods

The authors searched unsystematically *S. crocea* in Poland in the years 2013–2016. The analysis and distribution map of the *S. crocea* localities were presented based on the data given in papers [1,2,18–21], from the Internet database Register of Protected and Endangered Mushroom Species (GREJ) [22–25], and the localities specified in this study. The names of macro- and mesoregions were given according to Kondracki [26], plant names – Mirek et al. [27], and beetle names – *Catalogue of Palearctic Coleoptera* [28,29]. The dried specimens of *S. crocea* were deposited in fungarium of the Division of Mycology and Forest Phytopathology, Warsaw University of Life Sciences – SGGW (WAML) and private fungarium of Błażej Gierczyk (BGF).

Results

The authors discovered seven new localities of *S. crocea* in the years 2013–2016 (Fig. 1). The localities were found in four provinces: Mazowieckie, Łódzkie, Podkarpackie, and Pomorskie. The basidiomes were recorded on 12 apple trees, four of which were *Malus pumila* 'Niedzwetzkyana' – the fungus host unknown so far. In the basidiomes four mycetobiontic beetle species were recorded.

A list of new localities

1 – Pobrzeże Gdańskie seashore, Żuławy Wiślane fens, Pomorskie Province, Nowodworski County, Kępiny Małe village; woods at the road running on the flood bank of the Nogat River; on wood, in bark cracks and rotted hollow of the alive *Malus domestica* tree, one basidiome; 2013-10-03; leg. et det. G. & K. Neubauer (WAML 934). 2 – Nizina Południowopodlaska lowlands, Wysoczyzna Kałuszyńska low plateau, Mazowieckie Province, Miński County, Dobre village, near the junction of the Gen. J. Skrzynecki Street (the province road No. 637) with the K. Laszczki Street; an old orchard, on branches of the dying *Malus domestica* tree; 2014-09-21; leg. et det. A. Szczepkowski (WAML 715). 3 – Nizina Środkowomazowiecka lowlands, Równina Warszawska plain, Mazowieckie Province, Warszawa City, Praga district, Saska Kępa neighborhood, the Walecznych Street near the intersection with the Międzynarodowa Street; a remnant of an old orchard; on the branch of alive *Malus domestica*, the basidiome grew on wood and the underside of partially unbarked branch at a distance of ca. 1 m; 2015-09-27; leg. et det. A. Szczepkowski (WAML 837). 4 – Nizina Środkowomazowiecka lowlands, Równina Warszawska plain, Mazowieckie Province, Warszawa City, Ursynów district, the Nowoursynowska Street, the Warsaw University of Life Sciences – SGGW campus, near the building of the Faculty of Civil and Environmental Engineering; at the base of a trunk, on the trunks and thick

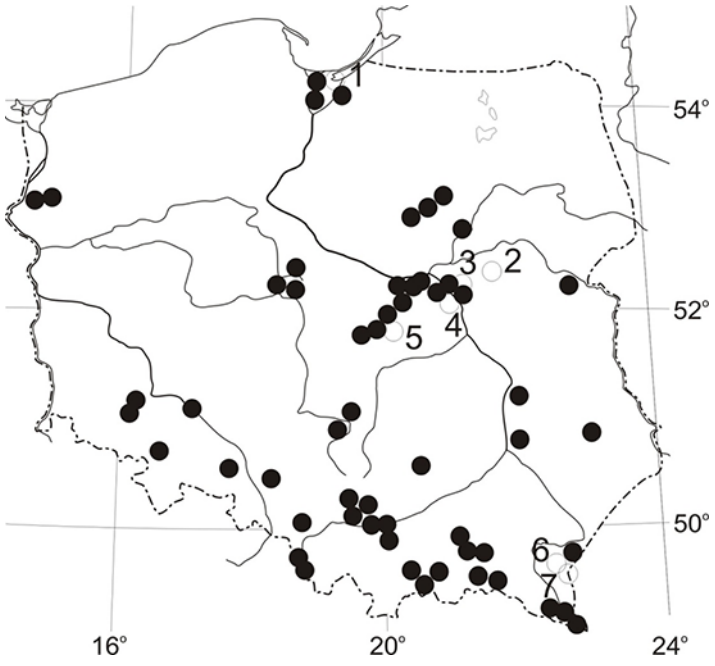

Fig. 1 Distribution of *Sarcodontia crocea* (Schwein.) Kotl. in Poland. White circles – new localities; black circles – localities known from the literature.

Fig. 2 Basidiome of *Sarcodontia crocea* (Schwein.) Kotl. on trunk of apple tree *Malus pumila* 'Niedzwetzkyana', 2016-08-16, Warsaw. Photograph by Andrzej Szczepkowski.

branches of four apple trees, *Malus pumila* 'Niedzwetzkyana', the basidiomes began to appear from early July in the years 2013–2016; leg. et det. A. Szczepkowski (WAML 829, 830, 863, 933) (Fig. 2). 5 – Wzniesienia Południowomazowieckie hills, Wzniesienia Łódzkie hills, Łódzkie Province, Brzeziński County, Popień village; the roadside, in the trunk crevice of the alive *Malus domestica*; 2013-10-18; leg. et det. A. Szczepkowski (WAML 705). 6 – Pogórze Środkowobeskidzkie foothills, Pogórze Przemyskie foothills, Podkarpackie Province, Przemyski County, Paportno-Sopotnik abandoned village; an old orchard, on two specimens of *Malus domestica*; in the trunk crevice and on the branch of the alive tree, between bark and wood, basidiome ca. 1.5 m long; 2016-08-03.; leg. et det. A. Szczepkowski (WAML 864, BGF/BG/160831/0081). 7 – Pogórze Środkowobeskidzkie foothills, Pogórze Przemyskie foothills, Dolina Jamninki valley, Podkarpackie Province, Bieszczadzki County, Jamna Górna abandoned village; the trunk and branches of two declining *Malus domestica* trees; 2016-09-02; leg. et det. A. Szczepkowski, B. Gierczyk (BGF/BG/160902/0055); on the alive tree with the *Phellinus alni* basidiomes, on the branch at 6 m height, the basidiome ca. 60 cm long and ca. 10 cm wide; 2016-09-02; vid. B. Gierczyk and A. Szczepkowski.

A list of beetles recorded in the collected basidiomes

Bitoma crenata (F.) (Zopheridae) – (WAML 864, BGF/BG/160831/0081) – two specimens, leg. A. Szczepkowski, det. J. Borowski; the under-bark species commonly occurring within the whole area of Poland. Biologically associated with under bark mold fungi, however, perfect states are being found in basidiomes of different lignicolous fungi.

Dacne bipustulata (Thunb.) (Erotylidae) – (WAML 715, 863, 933) – a few specimens each time, leg. A. Szczepkowski, det. J. Borowski; the species commonly seen, associated with annual basidiomes of different lignicolous fungi, in which it develops.

Mycetophagus piceus (F.) (Mycetophagidae) – (WAML 863) – one specimen, leg. A. Szczepkowski, det. J. Borowski; the species quite commonly occurring, associated with basidiomes of different lignicolous fungi, in which it develops.

Orthoperus corticalis (Redt.) (Corylophidae) – (BGF/BG/160831/0081, WAML 863, 864, 933) – a few specimens each time, leg. A. Szczepkowski, det. J. Borowski; the species commonly seen, associated with mold fungi growing on wood. Perfect states are sporadically entrapped on the basidiomes of Polyporales.

Discussion

Sarcodontia crocea most often parasitizes trees from the Rosaceae family. It was reported from the representatives of six genera belonging to the Rosaceae family (*Crategus*, *Malus*, *Photinia*, *Prunus*, *Pyrus*, *Sorbus*). Furthermore, it was recorded among four other genera belonging to three families: *Acer* (Aceraceae), *Fraxinus* (Oleaceae) as well as *Fagus* and *Quercus* (Fagaceae). The less reliable data relate to the occurrence of this fungus on tree genera *Castanea* [30] and *Elaeagnus* [31]. Until now, three *Malus*

species have been reported as hosts of *S. crocea*: *M. domestica* (i.a., [1,2]), *M. sylvestris* [9,11,32], and *M. pumila* [33]. To our knowledge, this fungus has up to now never been observed on *Malus pumila* 'Niedzwetzkyana', therefore the data in our work are the first documented record of *S. crocea* on this *Malus* cultivar.

The number of known *S. crocea* localities reported by Szczepkowski [1], Neubauer and Szczepkowski [2] from the area of our country increased from 55 to 72, with five localities listed in recent works [18–21], five included into the GREJ database in the years 2010–2015 [22–25], and seven new ones presented in this work (Fig. 1). In the nineteenth century, six localities were recorded. In the twentieth century, four sites in the years 1900–1950, and as many as 62 after 1950 were recorded, which is most probably a consequence of bigger interest in fungi and reflects our current state of knowledge. In some European countries, e.g., in Estonia [34], *S. crocea* is considered as regionally extinct (RE), or is known only from single or few localities, e.g., in Denmark, Finland, Italy, Latvia, Switzerland, Sweden, and Hungary [11,12,35,36].

Among the localities presented in this work, three are in Mazowieckie, two in Podkarpackie, one in Łódzkie, and in Pomorskie provinces. The *S. crocea* locality in Dobre (WAML 715) is the first record of this species in Wysoczyzna Kałuszyńska low plateau. The locality in the Praga district is the eighth known record in Warsaw, the capital of Poland, and at the same time it is the first one in its right bank of the Vistula River (WAML 837). The locality in Kępiny (WAML 934) is the third contemporary record from the area of Żuławy Wiślane fens. The locality in Popień (WAML 705) is the fifth one in the Łódzkie Province. Two localities from Pogórze Przemyskie foothills raise the number of known localities from this region up to three.

Despite increasing interest in *S. crocea* in Poland during the last years, there are still no reports on its occurrence in two provinces: Podlaskie in northeastern and Lubuskie in western Poland. In three next provinces (Kujawsko-Pomorskie, Świętokrzyskie, Warmińsko-Mazurskie), only single records are known. Two localities were found in the following provinces: Opolskie, Wielkopolskie, Zachodniopomorskie, three in the Pomorskie and Lubelskie, four in Dolnośląskie, and five in Łódzkie and Śląskie. Most of the known localities were in the provinces: Mazowieckie (21), Małopolskie (15), and Podkarpackie (7).

Among seven new localities, two were found in old orchards, two on roadside trees, and one (four trees) in ornamental greenery (the area around a building in the Warsaw University of Life Sciences – SGGW campus). The locality in the SGGW campus on the apple trees *Malus pumila* 'Niedzwetzkyana' is ca. 250 m far away from the locality reported by Szczepkowski [1] on *M. domestica*.

Among four beetle species which were recorded in the basidiomes studied, two (*O. corticalis* and *B. crenata*) belong to common, polyphagous species feeding on mold and are not biologically associated with the *S. crocea* basidiomes. The two remaining species, *D. bipustulata* and *M. piceus*, specialize in decomposing annual basidiomes of lignicolous fungi and *S. crocea* may certainly be included in the developmental stage of these beetle species. To our knowledge, these are the first records of beetles feeding on basidiomes of *S. crocea*.

Based on the current criteria and guidelines of International Union for Conservation of Nature regarding threat status of red-listed organisms, adjusted to assess threat of fungi species [37], we recommend that *S. crocea* in Poland should preserve the NT (near threatened) category, previously proposed by Szczepkowski [1]. This recommendation is based on the D1 criterion that relates to species with very small or geographically very restricted populations (the number of adult individuals <2000).

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