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ORIGINAL RESEARCH PAPER

Leratiomyces ceres (Strophariaceae, Basidiomycota), new to Poland

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Leratiomyces ceres, an extra-European species hitherto unknown in Poland, was identified in a public park in Rybnik City (SW Poland). The first Polish collections of the fungus were studied using macroscopic and microscopic features. A brief description and illustration of the species, based on Polish specimens, are presented. The ecology and characteristics distinguishing *L. ceres* from related *Leratiomyces* species are also discussed.

Keywords

Stropholoma aurantiacum; *Stropharia aurantiaca*; *Psilocybe aurantiaca*; alien
invasive species; woodchip fungi; Upper Silesia; Europe

Introduction

The name, *Leratiomyces*, was designated by Bresinsky and Binder [1] as a potentially valid substitute for an older invalid generic name “Le Ratia” that was originally used to represent a small group of secotiaceous fungi from New Caledonia by Patouillard [2]. *Leratiomyces* was then adopted to define a phylogenetically defined clade of agarics and secotiaceous fungi by Bridge et al. [3], who provided an emended diagnosis of the genus. However, for various nomenclatural reasons, the generic name *Leratiomyces*, as proposed by Bresinsky and Binder [1], was not validly published. The nomenclatural problems regarding this name were reviewed in detail and finally resolved by Redhead and McNeill [4]. Consequently, the genus was typified by *Leratiomyces similis* (Sacc. & Trotter) Redhead & McNeill, and the generic name currently in use is *Leratiomyces* Bresinsky & Manfr. Binder ex Bridge, Spooner, Beever & D. C. Park. The genus *Leratiomyces* includes saprotrophic mushrooms found on naked soil, rotten wood, wood debris (including saw-dust and woodchip mulch), and other vegetal debris in woodchip beds, dry grasslands, or sandy-soil habitats [5,6]. It is a small genus which contains around ten agaricoid or hymenogasteroid species distributed worldwide [3–5,7,8], and so far, two of them have been reported in Poland: *Leratiomyces squamosus* (Pers.: Fr.) Bridge & Spooner [syn. *Psilocybe squamosa* (Pers.: Fr.) P. D. Orton, *Psilocybe squamosa* var. *thrausta* (Kalchbr.) Guzmán, *Stropharia squamosa* (Pers.: Fr.) Quél., *Stropharia squamosa* var. *thrausta* (Kalchbr.) Masee] and *Leratiomyces laetissimus* (Hauskn. & Singer) Borov., J. Stríbrný, Noordel., Gryndler & Oborník (syn. *Psilocybe laetissima* Hauskn. & Singer) [9–12].

In 2018, *Leratiomyces ceres* (Cooke & Masee) Spooner & Bridge, the species new to Poland, was found on wood debris and soil within municipal shrubberies mulched with bark in Rybnik (SW Poland). It should be noted that the earlier record of the species from a fertile lowland beech forest in the vicinity of Gdańsk announced in Wojewoda [9] with no information about sources or materials traced, reported as “(?) *Psilocybe aurantiaca* (Cooke) Nordel.”, must remain as doubtful. Today it is believed that *L. ceres* is an alien invasive species from outside Europe [5,13,14]. It was originally described from material collected in Melbourne (South Australia) by the English botanists and

mycologists M. C. Cooke and G. E. Masee under the name of *Agaricus* (*Psilocybe*) *ceres* [15]. Although the species was collected in New Zealand in the 1940s (cf. [16]), it was hardly ever reported under the name, *Psilocybe ceres* (Cooke & Masee) Sacc. [17] – after its original description – until the 1960s when it became better known in Western Europe under the misapplied name, *Stropharia aurantiaca* [18]. It is believed that the first reliable observations of this non-native basidiomycete were made on the continent between 1953 and 1957 [19]. During this period, “*S. aurantiaca*” appeared in disturbed outdoor habitats in the Netherlands (Hengelo), Belgium (Antwerp), and England (Somerset: Bossington; Surrey: Richmond Palace gardens) [18–22]. In 1966, it was recognized in France [19], and in 1968, “*S. aurantiaca*” was discovered in Germany [23–25]. Over the next fifty years, “*S. aurantiaca*” was also found for the first time in other European countries and regions, including Austria, Balearic Islands, Corsica, Italy, Luxembourg, Portugal, Spain, Switzerland, and the Czech Republic [26–34]. It was also recognized in Macaronesia (Madeira) [35], South Africa [36,37], South and North America (Brazil, USA) [38–41], and Tasmania [42]. After decades of being represented by a false name, the history of “*S. aurantiaca*” was reviewed, and with the help of genetic analysis, a new name, *Leratiomyces ceres* was proposed [3]. Currently, the species is considered to be one of the most widespread (and often abundant) and distinctive woodchip mulch fungi [14,43,44]. Our finding in Poland extends the known distribution of *L. ceres* in Europe. The aim of this paper is to give a detailed description and illustration of the Polish collections and to compare them with reports of this species from other regions available in literature.

Material and methods

Field photographs of fresh basidiomata were taken with the aid of a Tamron SP 90 mm F2.8 macro lens mounted on a Pentax K10D camera. Basidiomata were collected and transported to the laboratory where they were dried for further studies. Characteristics that changed over time (color, smell, and texture of the basidiomata) were noted in the field. The macroscopic description is based on both the study of fresh material (three collections comprising thirty basidiomata at different developmental stages) and the analysis of photos. Microcharacters were observed using a Nikon Eclipse E-400 light microscope equipped with a Nikon digital camera (DS-Fi1). All microscopic structures were observed in preparations from dried material. Freehand sections of rehydrated pieces of basidiomata were examined in squash preparations in 5% NH₃·H₂O and Congo red reagent. Image-grabbing and biometric analyses were done using NIS-Elements D 3.1 imaging software. The dimensions of microcharacters are given as follows: (minimum) 10–90 (maximum) percentile values, average ± standard deviation. Randomly selected mature basidiospores were measured without the hilar appendix. Basidia lengths were measured, excluding sterigmata. Statistical computations were carried out using Statistica software (StatSoft). The following abbreviations are used: L = number of lamellae reaching the stipe; l = number of lamellulae between each pair of lamellae, and Q = the length–width ratio of basidiospores (mean value). The morphological terminology follows that used by Vellinga [45] and Vellinga and Noordeloos [46]. The nomenclature of vascular plants was based on The Plant List (<http://www.theplantlist.org/>). The studied collections have been deposited in the Museum of Natural History, University of Wrocław, Wrocław, Poland (WRSL).

Results

Leratiomyces ceres (Cooke & Masee) Spooner & Bridge (Fig. 1–Fig. 3)

Mycotaxon 103: 116. 2008 ≡ *Agaricus ceres* Cooke & Masee, *Grevillea* 16(No. 79): 72. 1888 ≡ *Psilocybe ceres* (Cooke & Masee) Sacc., *Syll. fung.* (Abellini) 9: 140. 1891 = *Naematoloma rubrococcineum* Balletto, *Bull. trimest. Soc. mycol. Fr.* 83: 217 (1967) ≡ *Stropholoma rubrococcineum* (Balletto) Balletto, *Micol. Ital.* 18(1): 36. 1989 (nom.

inval.) \equiv *Hypholoma rubrococcineum* (Balletto) Bellù in Nonis, Riv. Micol. 37(2): 109. 1994 = *Stropharia aurantiaca* sensu auct. (e.g., [19,21,22,24,34,43,47,48]) (misapplied name).

Illustrations. Noordeloos (Phot. 23 [5: p. 473–476]), Fortey (Fig. 1 [18: p. 78]), Booms-luiter (phot. [20: p. 11]), Hagara (phot. [27: p. 992]), Courtecuisse and Duhem (Fig. 1275 [28: p. 357]), Desjardin et al. (phot. [40: p. 332]), Pegler and Legon (phot. [43: p. 180]), Jordan (phot. [49: p. 265]), Phillips (Phot. c [50: p. 248]), Ludwig (Fig. 35.11 [51: p. 58]), Høgsberg (phot. [52: p. 38]), Marren (phot. [53: p. 133]), Davis et al. (phot. [54: p. 218]), Boccardo et al. (Fig. 782 [55: p. 289]), Roux (phot. [56: p. 922]), Gerhardt (phot. [57: p. 331]).

Macroscopic characteristics. Pileus, 15–60 mm, hemispherical at first, expanding with age to convex, with deflexed margin, mostly with low and broad umbo, not hygrophorous



Fig. 1 *Leratiomyces ceres*. (A,B) Fresh (young and mature) basidiomata in the field (MH-2018-1847). This picture is a copyright of Marek Halama.



Fig. 2 *Leratiomyces ceres*. (A,B) Fresh basidiomata in longitudinal section (MH-2018-1847). This picture is a copyright of Marek Halama.

(rarely slightly hygrophanous with translucently striate margin when moist), orange-red or brown with dark red tint, slightly viscid when wet, initially had white patches of veil on the margin. Lamellae ($L = 25-40$, $l = 3-7$), moderately crowded to fairly distant, adnate, pale grey, yellow-grey with olivaceous tint to pale olivaceous when young, then olive-umber and, olive-purple to purple-brown in old age with white, fimbriate edge. Stipe, $20-100 \times 3-10$ mm, central, cylindrical, slightly broadened towards the base (or rarely narrowed), stuffed then hollow (fistulose), whitish or tinged yellow above, developing reddish-orange stains over the lower half (also when bruised), pruinose (in the upper part), slightly fibrillose-striate below, with patches of annulus (rarely annulate), white tomentose base and sometimes with white to yellow mycelial threads. Veil, thin-membranous, whitish, quickly disappearing or rarely forming a slight, easily-obliterated annulus on the stipe. Context pallid, first cream, then pale ochre to ochre in the central part of stipe and in the cortex of the pileus, then reddish brown at the base of the stipe, sometimes orange-red spotted in pileus. Smell not distinctive, taste not recorded. Spore deposits not obtained. Basidiomata growing in a bundle (fasciculate), in small groups or solitary.

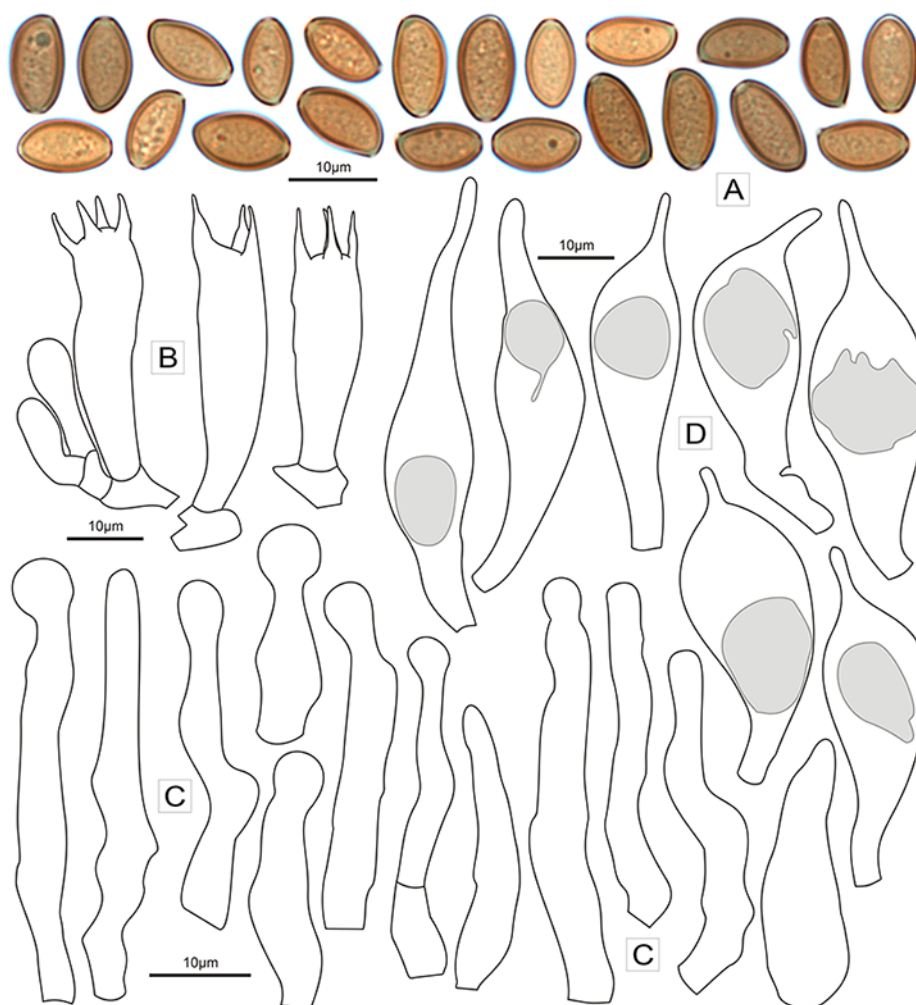


Fig. 3 *Leratiomyces ceres*. (A) Basidiospores (in 5% $\text{NH}_3\cdot\text{H}_2\text{O}$). (B) Basidia. (C) Cheiloleptocystidia. (D) Pleurochrysocystidia (all photographed and traced from MH-2018-1847). This picture is a copyright of Marek Halama.

Microscopic characteristics. Basidiospores, (10.1) 10.4–12.1 (13), $11.2 \pm 0.7 \times (5.7)$ 6–6.8 (7), $6.4 \pm 0.3 \mu\text{m}$, $Q_w = (1.6)$ 1.7–1.9 (2), 1.8 ± 0.1 ($n = 54$), ellipsoid to ovoid, smooth, thick-walled, with distinct, central or slightly eccentric germ pore (0.8–1.3 μm wide), yellow-brown to brown in 5% $\text{NH}_3\cdot\text{H}_2\text{O}$. Basidia (18.1) 20.9–32.3 (34.7), $25.7 \pm 4.3 \times (6.7)$ 7.8–9.4 (10.2), $8.6 \pm 0.7 \mu\text{m}$ ($n = 36$), mostly four-spored (also two-, three-spored), clavate, clamped. Cheiloleptocystidia (21.5) 23.5–40.5 (50), $31 \pm 6.5 \times (3)$ 4–6.5 (8.5), $5.5 \pm 1 \mu\text{m}$ ($n = 59$), irregularly cylindrical to filamentous, rarely narrowly lageniform, often flexuose, sometimes subcapitate to distinctly capitate, abundant, hyaline in 5% $\text{NH}_3\cdot\text{H}_2\text{O}$. Cheilochrysocystidia, scattered along edge, rarely absent, similar to pleurochrysocystidia. Pleurochrysocystidia, (36.5) 42.5–56.5 (63.5), $48.5 \pm 6.5 \times (10.5)$ 11.5–16 (17), $13.5 \pm 2 \mu\text{m}$ ($n = 25$), broadly clavate, with rounded to pointed or mucronate apex or lageniform, with distinct refractive, yellowish content (in 5% $\text{NH}_3\cdot\text{H}_2\text{O}$), thin-walled, rather abundant. The pileipellis consisted of two layers: suprapellis, a thin ixocutis of narrow, cylindrical hyphae, embedded in a colorless or yellow gelatinous matrix, and subpellis, almost cellular, made up of short, inflated elements (not measured). Pigment reddish-orange to yellow-orange, membranous and incrusting in pileipellis. Caulocystidia (25) 30.5–69 (108), $50 \pm 17 \times (8.5)$ 10–19 (32), $14.5 \pm 4.5 \mu\text{m}$ ($n = 48$), usually septate, with the apical part variable in shape: clavate (usually with pointed to mucronate apex), lageniform, cylindrical to filamentous, some with subcapitate apex, some flexuose, thin-walled, occurring in clusters. Clamp-connections present in all tissues.

Material examined. Poland, Silesian Upland, Rybnik Plateau (Rybnik City), a wooded park area, on small fragments of wood debris (freshly applied wood chips, rests of

bark, fallen twigs), also on soil, surrounded by coniferous and deciduous trees and shrubs (*Abies alba*, *Aesculus hippocastanum*, *Forsythia suspensa*, *Lonicera xylosteoides*, *Quercus rubra*, *Rhododendron* sp., *Symphoricarpos albus*, *Taxus baccata*), alt. 243 m a.s.l., 50°5'29" N, 18°32'40" E, July 20, 2018, leg. M. Halama (WRS: HM-2018-0101, HM-2018-0102, HM-2018-0103); *ibidem*, on small fragments of wood debris (freshly applied wood chips), also on soil, surrounded by coniferous and deciduous trees and shrubs (*Abies alba*, *Aesculus hippocastanum*, *Forsythia suspensa*, *Lonicera xylosteoides*, *Rhododendron* sp., *Symphoricarpos albus*), July 24, 2018, leg. M. Halama (WRS: MH-2018-1847, HM-2018-1848).

Discussion

The practice of applying wood and bark from chipped or shredded trees, to conserve soil moisture and as a natural weed barrier, to vegetable gardens, flower beds and shrubberies has become more popular since the mid-1980s, contributing to the emergence of a unique habitat for many species of wood-decaying fungi [44,58]. Possibly due to the high levels of terpenes and other inhibitory compounds in bark, mulch fungi are generally known to prefer woodchips than bark chippings [58]. Finely chopped woody material can support diverse saprotrophic fungal communities, including alien species [44,53], although these assemblages are generally known to be short-lived. Additionally, it is well-known that many of the species do not produce fruit bodies in subsequent seasons [14,58].

Leratiomyces ceres is said to be one of the common and most characteristic species of extra-European origin which epitomize the interests of the woodchip communities in West and Central Europe [3,14,44,53]. It is a very distinctive mushroom, considering the striking copper, orange red to dark red coloration of the pileus that often has white veil remnants on the margin and, purplish brown lamellae when mature, in conjunction with its habitat on decaying woodchip mulch, sawdust, and other wood debris in human-influenced sites [48]. It is important to note, however, that while the species in general has a clear preference for woody mulch in parks, gardens, cemeteries, and boulevards (this study and [14,25,44,58]), a few instances of the fungus growing away from human habitation (away from woodchips) have also been reported [18,23,42]. *Leratiomyces ceres* seems to be most frequently found in high abundance on relatively freshly applied mulches [58,59]. Our study also highlights the importance of this kind of substrate on which the species apparently grows best or is favorably disposed towards. However, during field works, we also found a few basidiomata of this mushroom growing directly on rich soil (humus without visible buried wood debris in the immediate vicinity). On the one hand, this supports the suggestions of some authors [14,17,34,39,48,59] that *L. ceres* may be associated with soil, but, on the other hand, it seems to refute the view that the fungus is only able to fructify when some factors associated with woodchip mulch are present [59]. This issue evidently needs further research.

It is difficult to interpret the description of *Agaricus ceres* by Cooke [15]. The original diagnosis is too vague to allow a reliable taxonomic conclusion. Moreover, it is somewhat aberrant regarding the given spore size (14–16 × 6–8 μm). This cannot change the fact that later interpretations of the species in literature (also based on the examination of the holotype) are congruent [3] (also cf. [60]). The Polish material of *L. ceres* agrees well with the account and iconography of the species given, for instance, by Cleland [17], Orton [21], Engel and Engel [23], Watling and Gregory [47], Pegler and Legon [43], and Noordeloos [5,34], except the hygrophany of the pileus. This character is generally not reported [42,43] or considered to be atypical of *L. ceres* [5,34], and only exceptionally, is the hygrophany confirmed for the species [48]. We found *L. ceres* to be at least partially hygrophantous and occasionally translucently striate when very moist. We are inclined, however, to consider these features accidental due to the unique weather conditions (abundant rainfall and very high humidity) preceding and accompanying the observation period. According to literature, *L. ceres*, when fresh, may be similar to a slender *Leratiomyces squamosus* var. *thraustus* (Kalchbr.) Bridge & Spooner [syn. *Stropharia thrausta* (Kalchbr.) Sacc.], but is readily distinguished by its more robust stature, thinner and often incomplete annulus, often disappearing with age, and mostly

due to the presence of chrysocystidia [5,34]. Additionally, the cheiloleptocystidia of *L. squamosus* var. *thraustus* seem to consistently be a little more slender, more frequently filamentous-flexuous, and tapering towards the apex than those found in *L. ceres* [5,34]. Balletto [61] described a new species from France, *Naematoloma rubrococcineum*, which appeared to be like *L. ceres* based on its gross morphology (colors and stature) and microfeatures (spore characteristics and the possession of chrysocystidia). This was first suggested by Mazza [62], who noted the name, *N. rubrococcineum*, as a possible synonym of “*Stropharia aurantiaca*”. Although the identity of this taxon was not checked using type material, the macro- and microfeatures published by Balletto [61], supplemented by colored plates by Mazza [62] and Nonis [63] enabled Bridge et al. [3] to conclude that *N. rubrococcineum* is contaxic with *L. ceres*. Consequently, the name *N. rubrococcineum* is to be considered a synonym of *L. ceres*.

The practical significance, nutritional and biochemical value of *L. ceres* seem to be insufficiently known. In literature, the edibility of the species is often unspecified [28] or reported as “unknown” [39,40,64], or the fungus is generally considered “inedible” [49,55,57,65–67]. We could not find any official report of use of *L. ceres* as a psychoactive mushroom, and we did not have the opportunity to investigate the collected specimens for the presence of indole derivatives. However, the findings of Anastos et al. [68] suggest that *L. ceres* contains psilocybin in relatively large amounts (9,700–9,900 mg/kg dry weight) (cf. [69]).

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References

1. Bresinsky A, Binder M. *Leratiomyces* nom. nov. für eine bislang nicht gültig beschriebene Gattung der Strophariaceae (Agaricales) aus Neukaledonien. *Z Mykol.* 1998;64:79–82.
2. Patouillard NT. Le *Ratia*, nouveau genre de la série des *Cauloglossum*. *Bulletin de la Société Mycologique de France.* 1907;23:50–52.
3. Bridge PD, Spooner BM, Beever RE, Park DC. Taxonomy of the fungus commonly known as *Stropharia aurantiaca*, with new combinations in *Leratiomyces*. *Mycotaxon.* 2008;103:109–121.
4. Redhead S, McNeill J. The generic name *Leratiomyces* (Agaricales) once again. *Mycotaxon.* 2008;105:481–488.
5. Noordeloos ME. *Strophariaceae* s. l. Alassio: Edizioni Candusso; 2011.
6. Ryman S. *Stropharia* (Fr.) Quél. In: Knudsen H, Vesterholt J, editors. *Funga Nordica. Agaricoid, boletoid, clavarioid, cyphelloid and gastroid genera.* Copenhagen: Nordsvamp; 2012. p. 965–970.
7. Redhead SA. Nomenclatural novelties. Index Fungorum No. 142 [Internet]. 2014 [cited 2019 May 10]. Available from: <http://www.indexfungorum.org/Publications/Index%20Fungorum%20no.142.pdf>
8. Crous PW, Wingfield MJ, Burgess TI, Hardy GESJ, Gené J, Guarro J, et al. Fungal Planet description sheets: 716–784. *Persoonia.* 2018;40:239–392. <https://doi.org/10.3767/persoonia.2018.40.10>
9. Wojewoda W. Checklist of Polish larger Basidiomycetes. Kraków: W. Szafer Institute of Botany, Polish Academy of Sciences; 2003. (Biodiversity of Poland; vol 7).
10. Karasiński D, Kujawa A, Gierczyk B, Ślusarczyk T, Szczepkowski A. Grzyby wielkoowocnikowe Kampinoskiego Parku Narodowego. Izabelin: Petit s.k. na zlecenie Kampinoskiego Parku Narodowego; 2015.
11. Kujawa A, Gierczyk B. Rejestr gatunków grzybów chronionych i zagrożonych w Polsce. Część IX. Wykaz gatunków przyjętych do rejestru w roku 2013. *Przegląd Przyrodniczy.* 2016;27:3–55.
12. Kujawa A. Grzyby makroskopijne Polski w literaturze mykologicznej [Internet]. 2019 [cited 2019 May 11]. Available from:

- <http://www.grzyby.pl/grzyby-makroskopijne-Polski-w-literaturze-mikologicznej.htm>
13. List of species alien in Europe and to Europe. In: DAISIE, editor. Handbook of alien species in Europe. Dordrecht: Springer; 2009. p. 133–263. (Invading Nature – Springer Series in Invasion Ecology; vol 3). https://doi.org/10.1007/978-1-4020-8280-1_11
 14. Bridge PD, Prior C. Growth and spread of the woodchip associated fungus *Leratiomyces ceres* in undisturbed garden soils. Fungal Ecol. 2010;3:234–239. <https://doi.org/10.1016/j.funeco.2009.10.007>
 15. Cooke MC. Australian fungi. Grevillea. 1888;16:72–76.
 16. Ridley GS. The scarlet roundhead [Internet]. 2011 [cited 2019 May 10]. Available from: <https://sporesmouldsandfungi.wordpress.com>
 17. Cleland JB. Toadstools and mushrooms and other larger fungi of South Australia. Part I. General introduction and the toadstools and mushrooms. Adelaide: Government Printer; 1934. <https://doi.org/10.5962/bhl.title.112109>
 18. Fortey R. *Psilocybe aurantiaca* and a case of mistaken identity. Field Mycol. 2004;5:77–80. [https://doi.org/10.1016/S1468-1641\(10\)60555-5](https://doi.org/10.1016/S1468-1641(10)60555-5)
 19. Daams J. *Stropharia aurantiaca* in Opmars. Coolia. 1991;34:37–44.
 20. Boomsluiters M. Orangerode stropharia, een fraaie aanwinst voor onze natuur? Kijk op Exoten. 2015;4:5.
 21. Orton PD. New check list of British agarics and boleti. Part III. Notes on genera and species in the list. Transactions of the British Mycological Society. 1960;43:159–384. [https://doi.org/10.1016/S0007-1536\(60\)80065-4](https://doi.org/10.1016/S0007-1536(60)80065-4)
 22. Reid DA. Coloured icones of rare and interesting fungi. Part 1. Nova Hedwigia (Supplement). 1966;11:1–32.
 23. Engel H, Engel M. *Stropharia aurantiaca* (Cooke) Orton erstmalig in Westdeutschland gefunden. Westfälische Pilzbriefe. 1970;8:7–23.
 24. Runge A. Zur Chronologie, Chorologie und Ökologie der bisherigen Funde des Orangeroten Träuschlings, *Stropharia (Hypholoma) aurantiaca* in der Bundesrepublik Deutschland. Beiträge zur Kenntnis der Pilze Mitteleuropas. 1991;7:33–38.
 25. Kajan E. Pilzportrait Nr. 3, *Stropharia aurantiaca (Hypholoma aurantiacum)*. Mitteilungsblatt der Arbeitsgemeinschaft Pilzkunde Niederrhein. 1984;2:9–12.
 26. Gminder A. Strophariaceae Singer & Smith. In: Krieglsteiner GJ, editor. Die Großpilze Baden-Württembergs. 4. Ständerpilze: Blätterpilze. II. Stuttgart: Verlag Eugen Ulmer GmbH & Co.; 2003. p. 346–426.
 27. Hagara L. Ottova encyklopédia húb. Praha: Ottovo Nakladateľství; 2014.
 28. Courtecuisse R, Duhem B. Guide des champignons de France et d'Europe. Paris: Delachaux et Niestlé; 2007.
 29. Garnier-Delcourt M, Marson G, Reckinger C, Schultheis B, Tholl MT, Turk J. Notes mycologiques luxembourgeoises. IV. Bull Soc Nat Luxemb. 2010;111:61–79.
 30. Illescas T, Morente C. Dos localizaciones de *Leratiomyces ceres* en Andalucía. Boletín Informativo, Sociedad Micológica Extremeña. 2016;16:23–30.
 31. Hausknecht A, Klofac W, Jaklitsch W, Dämon W, Krisai-Greilhuber I. Ergebnisse des Mykologischen Arbeitstreffens in Gamlitz (Südsteiermark) im September 1996. Osterr Z Pilzkd. 1999;8:169–199.
 32. Krieglsteiner GJ. Neues zum Areal und zur- Taxonomie des “Orangeroten Träuschlings”. Mitteilungsblatt der Arbeitsgemeinschaft Pilzkunde Niederrhein. 1984;2:13–15.
 33. Merino Alcántara D. Aportaciones micológicas 25. Micobotánica-Jaén. 2016;11:80–124.
 34. Noordeloos ME. Family Strophariaceae. In: Bas C, Kuyper TW, Noordeloos ME, Vellinga EC, editors. Flora Agaricina Neerlandica. Critical monographs on families of agarics and boleti occurring in the Netherlands. Vol. 4. Rotterdam: A. A. Balkema Publishers; 1999. p. 27–107.
 35. Calonge FD, Menezes de Sequeira M. Contribution to the catalogue of the fungi of Madeira (Portugal). Bol Soc Micol Madr. 2003;27:277–308.
 36. Reid DA, Eicker A. South African fungi 10: new species, new records and some new observations. Mycotaxon. 1999;73:169–197.
 37. Gryzenhout M. Mushrooms of Southern Africa. Cape Town: Struik Nature; 2010.
 38. Silva PS, Cortez VG, Silveira RMB. Synopsis of the Strophariaceae (Basidiomycota, Agaricales) from Floresta Nacional de São Francisco de Paula, Rio Grande do Sul State,

- Brazil. *Hoehnea*. 2012;39:479–487. <https://doi.org/10.1590/S2236-89062012000300008>
39. Arora D. *Mushrooms demystified*. 2 ed. Berkeley, CA: Ten Speed Press; 1986.
 40. Desjardin DE, Wood MG, Stevens FA. *California mushrooms: the comprehensive identification guide*. Portland, OR: Timber Press; 2014.
 41. Moreno G, Albertó E. *Agaricales sensu lato de Argentina*. I. *Cryptogam Mycol*. 1996;17:61–84.
 42. Chang YS. *Taxonomic studies of Strophariaceae (Agaricales) in south-east Tasmania [PhD thesis]*. Hobart: University of Tasmania; 1992.
 43. Pegler DN, Legon NW. Profiles of Fungi: 97. *Stropharia aurantiaca* (Cooke) Imai. *Mycologist*. 1998;12:180. [https://doi.org/10.1016/S0269-915X\(98\)80078-5](https://doi.org/10.1016/S0269-915X(98)80078-5)
 44. Shaw PJA, Kibby G. Aliens in the flowerbeds. The fungal biodiversity of ornamental woodchips. *Field Mycol*. 2001;2:6–11. [https://doi.org/10.1016/S1468-1641\(10\)60081-3](https://doi.org/10.1016/S1468-1641(10)60081-3)
 45. Vellinga EC. Glossary. In: Bas C, Kuyper TW, Noordeloos ME, Vellinga EC, editors. *Flora Agaricina Neerlandica. Critical monographs on families of agarics and boleti occurring in the Netherlands*. Vol. 1. Rotterdam: A. A. Balkema Publishers; 1988. p. 54–64.
 46. Vellinga EC, Noordeloos ME. Glossary. In: Bas C, Kuyper TW, Noordeloos ME, Vellinga EC, editors. *Flora Agaricina Neerlandica. Critical monographs on families of agarics and boleti occurring in the Netherlands*. Vol. 4. Rotterdam: A. A. Balkema Publishers; 1999. p. 6–12.
 47. Watling R, Gregory NM, editors. *Strophariaceae & Coprinaceae pp.: Hypholoma, Melanotus, Psilocybe, Stropharia, Lacrymaria & Panaeolus*. Edinburgh: Royal Botanic Garden; 1987. (British Fungus Flora Agarics and Boleti).
 48. Ludwig E. *Pilzkompendium. Band 1: Beschreibungen. Die kleineren Gattungen der Makromyzeten mit lamelligem Hymenophor aus den Ordnungen Agaricales, Boletales und Polyporales*. Eching: IHW-Verlag; 2001.
 49. Jordan M. *The encyclopedia of fungi of Britain and Europe*. London: Frances Lincoln; 2004.
 50. Phillips R. *Mushrooms: a comprehensive guide with over 1250 detailed photographs of mushrooms and other fungi*. London: Macmillan; 2006.
 51. Ludwig E. *Pilzkompendium. Band 1: Abbildungen. Die kleineren Gattungen der Makromyzeten mit lamelligem Hymenophor aus den Ordnungen Agaricales, Boletales und Polyporales*. Eching: IHW-Verlag; 2000.
 52. Høgsberg P. Orange Bredblad – en ny træflisvoksende Bredblad-art i Danmark. *Svampe*. 2000;41:39–40.
 53. Marren P. *Mushrooms: the natural and human world of British fungi*. Gillingham: British Wildlife Publishing Ltd; 2012.
 54. Davis RM, Sommer R, Menge JA. *Field guide to mushrooms of western North America*. London: University of California Press, Ltd; 2012.
 55. Boccardo F, Traverso M, Vizzini A, Zotti M. *Funghi d'Italia*. Bologna: Zanichelli editore S.p.A.; 2008.
 56. Roux P. *Mille et un champignons*. Sainte-Sigolène: Édition Roux; 2006.
 57. Gerhardt E. *Grzyby. Wielki ilustrowany przewodnik*. Warszawa: KDC; 2006.
 58. Shaw PJA, Butlin J, Kibby G. Fungi of ornamental woodchips in Surrey. *Mycologist*. 2004;18:12–15. [https://doi.org/10.1017/S0269-915X\(04\)00103-X](https://doi.org/10.1017/S0269-915X(04)00103-X)
 59. Bridge PD, Prior C. Introduction or stimulation? The association of *Stropharia aurantiaca* with bark and wood-chip mulches. *Eur J Soil Biol*. 2007;43:101–108. <https://doi.org/10.1016/j.ejsobi.2006.10.006>
 60. Pegler DN. Studies on Australian Agaricales. *Aust J Bot*. 1965;13:323–356. <https://doi.org/10.1071/BT9650323>
 61. Balletto C. Une nouvelle espèce du genre *Naematoloma* sensu H. Romagnesi: *Naematoloma rubrococcineum* nov. sp. *Bull Soc Mycol France*. 1967;83:215–217.
 62. Mazza R. *I funghi. Guida al riconoscimento*. Milano: Manuali Sonzogno; 1994.
 63. Nonis U. Note micologica su reperti osservati in esplorazioni personali nel commune de Morsano al Tagliamento (PN). *Riv Micol*. 1994;37:99–112.
 64. Trudell S, Ammirati J. *Mushrooms of the Pacific Northwest*. Portland, OR: Timber Press; 2009.

65. Læssøe T. Mushrooms. London: Dorling Kindersley Publishing; 2000.
66. George-Nascimento GMF. Fungi Austral: Guía de campo de los hongos más vistosos de Chile. Santiago de Chile: Corporación Chilena de la Madera; 2007.
67. Soothill E, Fairhurst A. The new field guide to fungi. London: Michael Joseph Ltd; 1978.
68. Anastos N, Lewis SW, Barnett NW, Sims DN. The determination of psilocin and psilocybin in hallucinogenic mushrooms by HPLC utilizing a dual reagent acidic potassium permanganate and Tris(2,20-bipyridyl)ruthenium(II) chemiluminescence detection system. *J Forensic Sci.* 2006;51:45–51. <https://doi.org/10.1111/j.1556-4029.2005.00033.x>
69. Andersson C, Kristinsson J, Gry J. Occurrence and use of hallucinogenic mushrooms containing psilocybin alkaloids. Copenhagen: Nordic Council of Ministers; 2008. (TemaNord; vol 606). <https://doi.org/10.6027/TN2008-606>