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NEW DATA ON RARE AND DEBATABLE SPECIES OF THE FAMILY *AGARICACEAE* (FR.) COHN

Key words: tribes *Agariceae*, *Lepioteae*, *Agaricales*, distribution, taxonomy

Abstract

Data on four rare and debatable species of the family *Agaricaceae* are presented. Morphology, anatomy, distribution, and taxonomy of two *Agaricus* species — *A. padanus* and *A. kuehnerianus* (tribe *Agariceae*) and two *Leucoagaricus* species — *L. macrorhizus* and *L. cinerascens* (tribe *Leucocoprineae*) are presented. Their position and related taxa are considered.

Introduction

Importance of the family *Agaricaceae* (Fr.) Cohn can hardly be overestimated. The family includes range of species of already established culinary-medicinal value, as well as potential biotechnologically important species [8, 11, 13, 20, 26, 27, 35–37].

The scope of the family is rapidly changing as new taxa are being described. Apart from accumulating data on rare, endemic, and recently described taxa critical studies of known species, analysis and verification of their position in the frame of the group are needed.

While working with fresh and herbarium material from the Ukraine and Israel, four rare and critical taxa have been found: *Agaricus padanus* Lanconelli, *A. kuehnerianus* Heinem., *Leucoagaricus macrorhizus* (Locq.) Horak, and *L. cinerascens* (Quél.) M. Bon et Boiff.

Materials and methods

Specimens suited are preserved in M.G. Kholodny Institute of Botany herbarium, Kyiv, Ukraine (*KW*), Tel Aviv University herbarium, Israel (*TELA*), and the herbarium of the Institute of Evolution, University of Haifa, Israel (*HAI*).

The species concept and definitions of infraspecific taxa are according to Wasser [32, 33] and follow the definitions adopted at the Lausanne symposium in 1976 [9].

Agaricus species are placed in concordance with the system of Wasser [32–34], *Leucoagaricus* — of Singer [25].

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Specimens were examined with standard taxonomic techniques. Microscopic traits were examined in 10 % KOH or in a solution of glycerol:ethanol:water 1 : 1 : 1. For statistical purposes 30 spores per preparation were measured. Three preparations for each specimen were examined.

Quotient Q of spores, namely ratio of length and width ($Q = l/w$) as well as the average quotient (Q_{av}) was calculated as an additional characteristic [4, 6].

Description and discussion of species

Tribe *Agariceae* Pat.

Genus *Agaricus* (L.: Fr.) P. Karst.

Subgenus *Agaricus*

Section *Duploannulatae* S. Wasser

Agaricus padanus Lanconelli, Rivista Micol. 2002, 1: 29–37 p.

Pileus 6–10 cm in diam., truncate-conical in young, hemispheric to convex, with depression in the center, margin involute, white, with pale grey tint, dry, smooth, thin-fleshed in the center and thick-fleshed towards the margin (1–1.3 cm), later on the cuticle remains smooth at the center only and closer to the edge the cuticle disrupts into wide radial fibrillose adpressed scales. Upon aging pileus disrupts revealing flesh. The surface of pileus turns slightly pink on handling. **Pileal covering** cutis, consisting of 9.6–14.4 μm in diam. hyphae cylindrical or somewhat attenuated towards the septae, slightly branching, regularly septated, hyaline, some — with pale-brown pigment in the cell walls (Fig. 1, a). **Gills** adnexed, thin, crowded, wide, with white edge, pink in young, finally pale brown, ventricose. Gill trama irregular. **Basidia** 24.2–31.2 \times 7.2–9.6 (12) μm , clavate, 4-sterigmatae (Fig. 1, c). Sterigmata 2.2–3.0 μm long. **Spores** 5.5–7.7 \times 4.4–5.5 μm , subglobose to broadly ellipsoid, pale brown, with one refractive droplet (Fig. 1, b). **Cheilocystidia** 21–40 \times 11–15 μm , abundant, of various shape, clavate, conical, fusiform, some — septated, consisting of two cells, hyaline (Fig. 1, d). **Stipe** 5.0–10.0 \times 2.0–3.9 cm, central, cylindrical, straight or slightly curved, filled, fleshy, of whitish colour same as pileus, smooth in the upper part, with numerous squames easily destroyed on handling below the ring. **Ring** upper, thin, evanescent, membranous, with striate upper surface, whitish. **Flesh** gains brown tints on bruising. Rather unpleasant not very pronounced odour. Schaeffers's reaction positive on the surfaces of pileus and stipe.

General distribution. *Europe:* Italy. *Asia:* Israel.

Habitat: on sandy soil, under *Pinus halipensis* Mill.

Specimens examined: Israel, Nesher, sandy soil under *Pinus halepensis* Mill., 11.01.2003, leg. S.P. Wasser, det. M. Didukh (*HAI*, № 0312).

Note. This is the second finding reported of *A. padanus*. Described from Italy only in 2002, the species is assigned to the section *Bitorques*, as close to *A. bernardi* (Quél.) Sacc. and *A. bitorquis* (Quél.) Sacc. [17].

Numerous fragile flocci covering stipe below ring, upper ring, group mode of growth, microscopic traits allow for its placement to the section *Duploannulatae* [34]. The robust fruit bodies grew as one group with stipes joined at the base. Several dif-

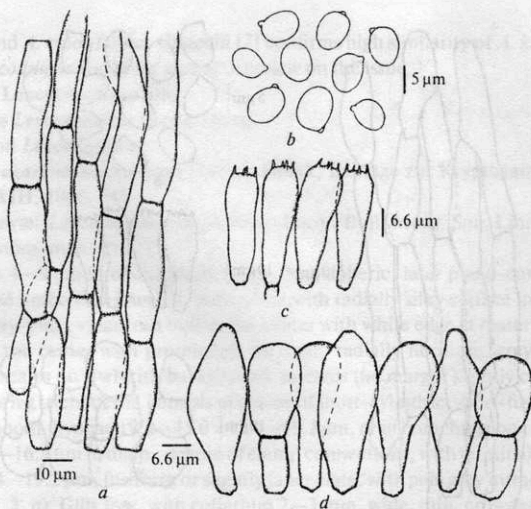


Fig. 1

ferences from the original description of the species were observed: smaller spores, bigger cheilocystidia, and unpleasant not very pronounced odour, whereas *A. padanus* is with a faint odour [17].

Subgenus *Flavoagaricus* S. Wasser

Section *Majores* Fr.

Subsection *Flavescentes* (J. Schaeff. et Moell.) S. Wasser

Agaricus kuehnerianus Heinem. Numero Special Bull. Soc. Linn. Lyopn, 1974, 15 fevrier: 183.

Pileus 45 cm in diam., fleshy, hemispherical in young, later convex, or slightly umbonate, whitish with greyish or yellowish tints (yellow or pale brown on druing), with shiny surface, turning yellow on touch, the surface is covered with more or less concentrically situated scales, cracked in the center or sometimes at the margin as well, cracks sometimes deep, reminiscent of *A. tabularis* Peck, margin thin, wavy, involute (up to 2 cm wide), with remnants of partial veil. **Pileal covering** consists of hyphae 6–12 µm in diam., hyaline, sometimes arranged in bundles (Fig. 2, a). **Gills** free, thin, crowded, pale-grey, later brownish, with pale sterile edge. Gill trama regular in young, irregular later on. **Basidia** 28–37 × 9–12 µm, clavate, hyaline, sometimes with brownish content (Fig. 2, c), 4-sterigmata. **Sterigmata** 4.0–4.5 µm long. **Spores** 7.2–10.0 × 5.0–6.8 µm, dark brown, amygdaliform in side view, ellipsoid in frontal view (Fig. 2, b). **Cheilocystidia** 28.8–38.4 × 12.0–16.8 µm, broadly fusiform, broadly clavate, catenulate (Fig. 2, d), hyaline or with thickened yellowish walls. **Stipe** 10.0 × 2.5–6.0 cm, thick fleshed, subclavate or cylindrical, concolorous with pileus, yellowing on

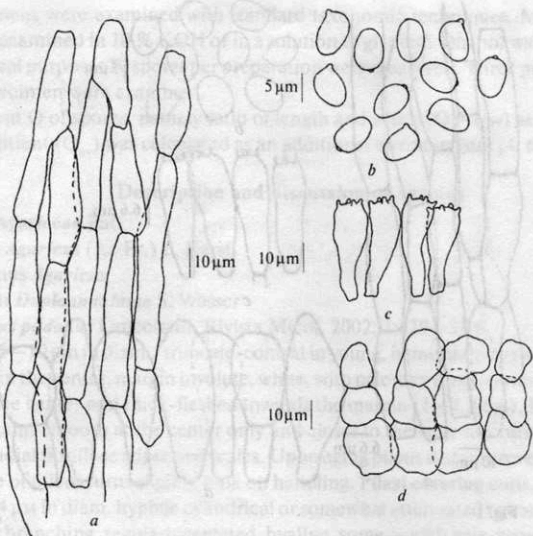


Fig. 2

touch, smooth above the ring, covered with white, later yellowish concentric flake-like flocci easily destroyed on touch. **Ring** upper, simple, wide, thin, with smooth upper surface and lower surface flake-like cover. **Flesh** white, on autooxidation turning pink-rusty in the stipe base mainly. Odour of anise. Shaeffer's reaction positive.

General distribution. *Europe:* France, Ukraine. *Asia:* Israel.

Habitat: in grass, mountain meadows.

Specimens examined. Israel, Mt. Meron, in the open field, 12.02.2003, leg. Y. Ur, det. M. Didukh.

Note. *A. kuehnerianus* was described in 1974 from France [12]. Apart from France and Israel, the species was found in Ukraine [32] and in the Netherlands [22] (as *A. urinascens* (Moeller et Schaeff.) Sing.). The species is known to be rare in Ukraine [31], the Netherlands [22] and has been found in only one locality in Israel. Unlike in previous records [12, 31], the Israel locality is not situated high in the mountains. Specimens collected in Israel were of characteristic campestroid habitus and well-preserved remnants of partial veil at the pileus' surface and margin. However, they differed in smaller spores and bigger cheilocystidia from the Ukrainian material.

Agaricus kuehnerianus forms a complex of close species along with *A. macrosporus* (Moell.) Moell., *A. excellens* (Moell.) Moell., *A. stramineus* (Moell.) Moell., and *A. crocodilinus* Murrill. The species' independent position is not totally accepted. For instance, according to Bon [1], *A. kuehnerianus* would be synonymous with *A. mac-*

rosporus and *A. crocodilinus*. Cappelli [7] confirms high similarity of *A. kuehnerianus* and *A. crocodilinus* and gives a good overview on the issue.

Tribe **Leucocoprineae** Sing.

Genus ***Leucoagaricus*** (Locq.) Sing.

Section ***Leucoagaricus***

Leucoagaricus macrorrhizus (Locq.) Horak, Beiträge zur Kryptogamenflora der Schweiz, XIII, 1968: 344.

Basionym: *Leucocoprinus macrorrhizus* Locq., Bull. Mens. Soc. Linn. Lyon, 12, 1943: 75 (nom. nudum).

Pileus 4–9 cm in diam., thick fleshy, hemispheric, later plano-convex, with a small broad umbo or without it, pure white with radially silky surface in young, becoming clay-pink, vinaceous buff in the center with white edge at maturity, covered mainly in the center with prominent, multiple, radially fibrillose, greyish, slightly squarrose scales on a whitish background, towards the margin slightly cracked, dry. **Pileal covering** trichoderm, consists of chains of short-cylindric, short-fusiform, thin-walled, smooth, hyphae 19.2–45.0 × 12.0–19.2 μm, or of branching long hyaline segments 9.6–16.8 μm in diam., devoid of clamp connections, with terminal cells 36.0–81.0 × 14.4–19.2 μm, fusiform or slightly lanceolate, with pale grey intracellular pigment (Fig. 3, a). **Gills** free, with collarium 2–3 mm, wide, thin, crowded, with even edge, white then creamy. Gill trama irregular, composed of elongate-cylindric, dichotomously branched, septated smooth hyaline hyphae 3–5 μm in diam. **Basidia** 24.0–30.0 × (6)7.2–8.8 μm, clavate, thin-walled, hyaline (Fig. 3, c), 4-sterigmatae. **Sterigmata** 2.5–3.0 μm long. Spore print whitish, cream-whitish. **Spores** 6.6–7.7(8.8) × 4.0–5.5 μm, Q=1.4–1.65, varying from broadly elliptical to ovate, without germ pore, thin-walled, smooth (Fig. 3, b), colourless, metachromatic, strongly dextrinoid. **Cheilocystidia** 30.0–40.0(45.0) × 14.0–17.6 μm, clavate, fusiform, broadly utriform, pyriform, ellipsoid, or of irregular shape, thin-walled, hyaline, abundant (Fig. 3, d). **Pleurocystidia** absent. **Stipe** 4.0–8.0(12.0) × 1.5–2.0 cm, central, cylindric, narrowing towards the base (the underground part is often larger than the aboveground one), fistulose, cream-whitish, brownish at the base, slightly browning on handling, naked, smooth, silky filamentous. **Ring** simple, upper, 0.4–0.7 cm, infundibuliform, rigid, whitish, above with tiny flakes, below smooth, becoming flaring, with a slightly wavy thickened edge, immobile, preserving well at maturity. **Flesh** white in young, vinaceous buff upon maturity. **Odour** pleasant, taste of an English walnut.

Specimens examined: Israel, Haifa, Carmel Park, in grass, on the sandy soil, 05.11.2002, 13.11.2002, leg. S.P. Wasser, det. M. Didukh (*HAI*, № 0267; № 0269).

General distribution. *Europe:* British Isles, Ukraine, Slovak Republic, France, Italy, Spain. *Asia:* Armenia, Israel. *Africa:* Morocco.

Habitat: solitary or in groups in parks, gardens, among grass on lawns, in fields, pastures and other intensively exploited areas, but also in rocky semideserts at an altitude of 600–1500 m above sea level.

Note: Horak [14] and Singer [25] consider *Leucoagaricus macrorrhizus* to be the type species of the genus *Leucoagaricus*.

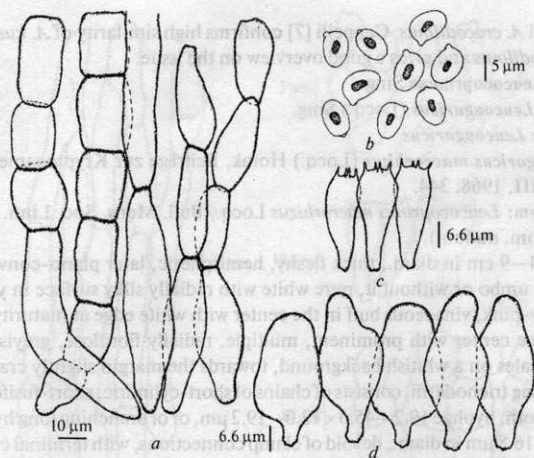


Fig. 3

Leucoagaricus macrorrhizus is a rare, rather interesting thermophilic species. The typical morphological peculiarity of the species is the size of the underground part of the stem which is larger than the part aboveground. According to our observations the underground cord-like appendage develops in a great number of Agaricales s.l. and Gasteromycetes growing in dry arid regions [33].

Leucoagaricus macrorrhizus was described by Locquin [18] as *Leucocoprinus macrorrhizus* without Latin diagnosis from France. Later Singer [24] transferred this species to *Leucoagaricus* (*L. macrorrhizus* (Locq.) Singer), and Kühner and Romagnesi [16] transferred it to *Lepiota* (*L. macrorrhiza* (Locq.) Kühn. et Romagn.) without indication of the basionym of their combinations and without the Latin diagnosis. It is strange that Dennis, Orton and Hora [10] did not validate this species though in their famous work «New Check List of British Agarics and Boleti» they gave for many species the lacking Latin diagnosis. What is more, the authors paid attention to the fact that *Lepiota macrorrhiza* and all its synonyms are nomina nuda. Only Horak [14] validated this species by a Latin diagnosis, after a thorough study of the lectotype (№ 19201) obtained from Romagnesi's herbarium.

Since the validation, several varieties have been assigned to the taxon apart from var. *macrorrhizus*:

— var. *pinguipes* (A. Pearson) Alessio, *Micologia Italiana*, 17(2), 1988: 8.

Basionym: *Lepiota pinguipes* A. Person, *Trans. Brit. Mycol. Soc.*, 35(2), 1952: 97. *Leucoagaricus pinguipes* (A. Pearson) M. Bon, *Doc. Mycol.*, 11(43), 1981: 54 [6].

— var. *pseudocinerascens* M. Bon [2].

Basionym: *Leucoagaricus pseudocinerascens* M. Bon ad int. 1977, *Doc. Mycol.*, 77—78: 13.

This variety was described on the base of particularities of pileal surface, structure of epicutis, not radicate stipe, clavate (neither ventricose nor shortly subutriform) cheilocystidia up to $40(50) \times 10(13) \mu\text{m}$. Later on Bon [3] separated the variety as an independent species *L. pseudocinereascens* (M. Bon) M. Bon, with an ad. int. variety *oblongisporus* M. Bon et Courtec. [4].

Thus considered as either one species with three varieties, or as a group of closely related species, the complex has been much debated.

In 1998 Reid, on studying the original account and illustration of *L. pinguipes* with that of lectotype of *L. macrorrhizus* with subsequent accounts of both taxa as well as collections of 1995, came to the conclusion that the two taxa represent one species — *L. pinguipes* according to the principle of priority. This opinion is shared by Vellinga [28, 29]. Having studied the type and co-type of *Lepiota barsii*, annotations on type of *Lepiota pinguipes* and fresh Dutch collections, the author concluded that *Leucoagaricus barsii*, *L. pinguipes* and *L. macrorrhizus* are synonyms.

Type, co-type specimens of *Lepiota barsii* and type of *Lepiota pinguipes* had spores of similar characteristics, cheilocystidia of approximately same size and similar in shape. Besides that, both species were characterized with pleurocystidia: *L. barsii* — with some pleurocystidia only near edge of gills same as cheilocystidia, and *L. pinguipes* — with scarce pleurocystidia difficult to see $38-54 \times 11-16 \mu\text{m}$ [28].

At present, *L. barsii* with *L. pinguipes* and *L. macrorrhizus* as synonyms is characterized with cheilocystidia $20-85 \times 6-25 \mu\text{m}$, varied in shape and size, clavate, cylindrical, broadly utriform, often with thickened colourless walls. Pleurocystidia present near lamellar edge, similar to cheilocystidia [28, 29].

However, in the description of the lectotype of *L. macrorrhizus* by Horak [14] is indicated that pleurocystidia are absent. In other publications on the species, including the one by Reid [23], involving comparison of existing publications with original descriptions of Pearson and Horak, and in his own description of *Leucoagaricus pinguipes*, based on approximately 20 studied fruit bodies, no pleurocystidia are mentioned. Whereas recent collections of *L. pinguipes* from the Netherlands shared macro- and microscopical characters with *L. barsii* from California [27].

Our collections identified as *L. macrorrhizus* were devoid of pleurocystidia, in concordance with Horak's (in our specimens germ pore was lacking) and Reid's descriptions.

Thus, acknowledging great variability of size, shape spores and shape of cheilocystidia we believe the contradictories in data on pleurocystidia in type specimens of *Lepiota barsii*, *L. pinguipes*, *Leucoagaricus macrorrhizus* and recent collections of these species from Europe and America to be too significant to be neglected. In view of this, we retain name *Leucoagaricus macrorrhizus*.

Section *Annulati* (Fr.) Sing.

Leucoagaricus cinerascens (Quél.) M. M. Moser, Die Röhrlinge und Blätterpilze, in Kl. Krypt.-flora, B. II, B/2, Basidiomyceten, 2 Teil, 1978: 38.

Basionym: *Lepiota cinerascens* Quél., C. R. Assoc. Franc. Avan. Sci., 22, 2, 1894: 484.

Pileus 3—10 cm in diam., thick-fleshy, hemispheric, later convex-plane, at the center with a broad umbo, dark to pale grey or ochraceous with grey center, when fresh

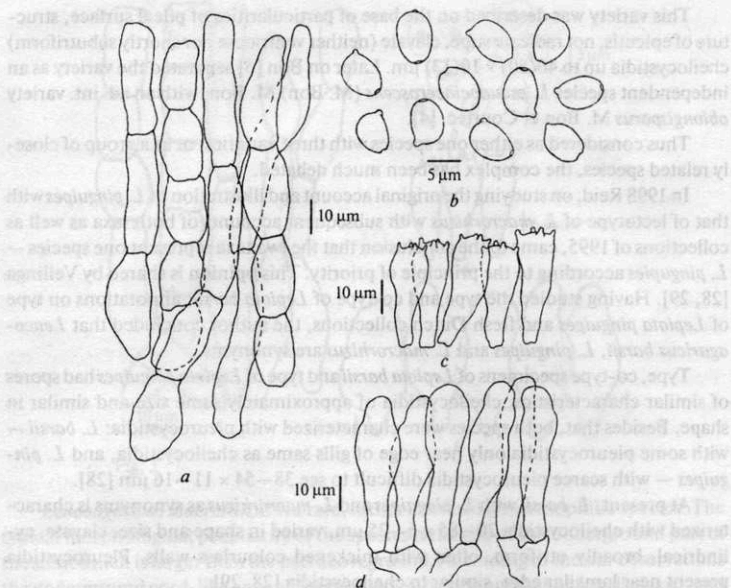


Fig. 4

with violaceous tint, surface mat, granulose, cracking and becoming areolate when old. **Pileal covering** consists of cylindrical or fusiform hyaline hyphae $60\text{--}90 \times 10\text{--}18 \mu\text{m}$, with terminal elements $50\text{--}80 \times 12\text{--}17 \mu\text{m}$, with chains of short subglobose cells with thickened walls (Fig. 4, a), grey in KOH. **Gills** free, with collarium $2\text{--}3 \text{ mm}$, wide, thin, densely compacted, edge fimbriate, white, then whitish; on drying they become slightly grey. Numerous lamellules of different sizes occur. Gill trama irregular, hyphae of trama consisting of cylindrical thin-walled cells, $4\text{--}6 \mu\text{m}$ in diam. **Basidia** $27.0\text{--}35.0 \times 8.0\text{--}10.0 \mu\text{m}$, clavate, thin-walled, hyaline, 4-sterigmatae (Fig. 4, c). **Sterigmata** $2.5\text{--}3.0 \mu\text{m}$ long. Spore print whitish. **Spores** $7.0\text{--}9.5 \times 4.8\text{--}6.0 \mu\text{m}$, broadly ovoid to slightly amygdaliform (Fig. 4, b), with small germ pore, thin-walled, smooth, hyaline, metachromatic, strongly dextrinoid. **Cheilocystidia** $35.0\text{--}50.0 \times 8.0\text{--}12.0 \mu\text{m}$, clavate, fusiform, lageniform, thin-walled, smooth, hyaline (Fig. 4, d). **Stipe** $4.0\text{--}14.0 \times 0.5\text{--}1.5 \text{ cm}$, central, cylindrical, equal, narrowing toward the base, fistulose, whitish above, ochraceous below, white, with gray margin of the ring. Flesh compact, white, on exposure unchanging or slowly becoming yellow. Smell faint, metallic, without special taste.

Specimens examined: Israel, Haifa, Mt. Carmel National Park, on the lawn, 06.01.2001, leg. S.P. Wasser, det. M. Didukh (HAI, № 0115).

General distribution. *Europe:* Norway, Denmark, Austria, Slovak Republic, France, Italy, Russia. *Asia:* Israel.

Note. Several species concepts of *L. cinerascens* are known. Apart from minor differences (yellowing or browning of the flesh on manipulating; stipe tapering or widening at the base; the degree the pileal cuticle is cracked), discrepancies in data on cheilocystidia and pileal covering are reported [3, 6, 15, 19, 21, 25, 33]. Our data based on Israeli specimens on cheilocystidia and pileal covering are in concordance with concept of Bon [3]. In contrast to data of Migliozi, no pileocystidia were observed. Analysis of data on *L. cinerascens* from Ukraine show that Ukrainian specimens differ in less pronounced differentiation of catenulate elements of the pileal covering and less diverse shape of cheilocystidia. Apart from this minor differences, specimens present *L. cinerascens*. However, these differences indicate high variability of the taxon.

Leucoagaricus cinerascens belongs to the complex of closely related species: *L. holosericeus* (Fr.) M.M. Moser, *L. cretaceus* (Bull.: Fr.) M.M. Moser, *L. subcretaceus* M. Bon, *L. leucothites* (Vitt.) S. Wasser, *L. carneifolius* (Gill.) S. Wasser, *L. subpudicus* M. Bon, *L. olgae* (Velenov.) M.M. Moser, and *L. densifolius* (Gill.) Babos. Understanding relationships within the complex is complicated by high variability of taxa and absence of clear delimiting criteria. Besides, several concepts exist for nearly each of the aforementioned species. Critical study involving types of the species is needed in order to clear up existing contradictions. For the time being, we accept the concept of Bon [3] as the only correct concept of *L. cinerascens*.

Leucoagaricus cinerascens var. *riparius* [5] differs from var. *cinerascens* in pale pink-ochraceous tint of spore print, slightly yellowish flesh, cuticula in older specimens excoriate, and pileal covering not paliform.

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НОВІ ДАНІ ПРО РІДКІСНІ ТА ДИСКУСІЙНІ ВИДИ РОДИНИ AGARICACEAE (FR.) CONN

Розглянуто чотири рідкісні та дискусійні види родини *Agaricaceae*. Наводяться дані з морфології, анатомії, поширення і таксономії двох видів роду *Agaricus* — *A. padanus* Lanconelli та *A. kuehnerianus* Heinek. (триба *Agariceae*) та двох видів роду *Leucoagaricus* — *L. macrorhizus* (Locq.) Horak та *L. cinerascens* (Quél.) M. Bon et Boiff. (триба *Leucocoprineae*). Дискутується їх положення, а також видів, близьких до них.

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НОВЫЕ ДАННЫЕ О РЕДКИХ И ДИСКУССИОННЫХ ВИДАХ СЕМЕЙСТВА AGARICACEAE (FR.) CONN

Рассмотрены четыре редкие и дискуссионные вида семейства *Agaricaceae*. Представлены данные по морфологии, анатомии, распространению и таксономии двух видов рода *Agaricus* — *A. padanus* Lanconelli и *A. kuehnerianus* Heinek. (триба *Agariceae*) и двух видов рода *Leucoagaricus* — *L. macrorhizus* (Locq.) Horak и *L. cinerascens* (Quél.) M. Bon et Boiff. (триба *Leucocoprineae*). Дискутируется их положение, а также видов, близких к ним.