

Genus *Chamaemyces* (Agaricaceae) in Israel

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Abstract. The species of the genus *Chamaemyces* present in Israel and their distribution are considered. Detailed data on *Chamaemyces fracidus* var. *pseudocastaneus*, new to Israel's mycobiota, and *Ch. carmelensis* M. Didukh et S. Wasser, sp. nov. are presented.

Key words: *Chamaemyces*, Israel, taxonomy

Introduction

Species diversity and distribution of tribes Leucocoprineae Singer and Lepioteae Fay. in Israel have not been properly studied. While studying the latter tribe, we have revealed a number of taxa previously not known for the country. One of them is the genus *Chamaemyces* Batt. ex Earle (tribe Lepioteae) (Didukh *et al.* 2003).

Although *Agaricus fracidus* had been described by Fries at the beginning of the 19th century, a separate monotypic genus for it was created by European taxonomists about a century later (Horak 1968). *Chamaemyces* is a well-circumscribed genus placed into the tribe Lepioteae along with *Lepiota* (Pers. : Fr.) Gray, *Pseudobaesopora* Singer, *Smithiomyces* Singer, and *Hiatulopsis* Singer et Grinling. In the tribe Lepioteae, *Chamaemyces* seems to be close to the genus *Lepiota* differing from it as well as other genera of the tribe in a number of important traits: spore characteristics (inamyloid, metachromatic endosporium in Cresyl Blue), type of carpophore development, presence of conspicuous pleurocystidia (recorded for few tropical *Lepiota* only), and abundant cheilocystidia.

To date, no generally accepted opinion exists as to the type species of the genus (Donk 1962; Horak 1968; Singer 1986). Fries, not having a specimen of *Agaricus fracidus*, gave its description based on the data in the literature. The description corresponded so closely to *A. mucidus* Schrad. : Fr. sensu Secr., that Donk (1962) considered both descriptions to be of the same species. Konrad & Maublanc (1928) treat

A. mucidus sensu Secr. as conspecific with *Lepiota irrorata* Quél. Consequently, *L. irrorata* is a synonym for *Agaricus fracidus*. Gilbert (1918) created a new subgenus of *Lepiota* s.l., namely *Lepiotella* with the type species *Lepiotella irrorata* Quél. Konrad (1934) designated *Lepiotella* as a valid genus.

Similarly, the question of *Agaricus demisannulus* Fr. and *A. fracidus* remains controversial. Locquin (1954) pointed out differences between *Drosella fracidia* and *D. demisannula*. In particular, the latter was characterized by sparse cystidia, a hardly developed gelatinous layer on the pileus, and the absence of pleurocystidia. There is no consensus status of *D. demisannula*: these two species are considered synonymous by Vellinga (2001); whereas Moser (1978, 1983) treats them as synonyms of *Chamaemyces demisannulus* (Secr. : Fr.) M.M. Moser.

After designation of the genus '*Chamaemyces*' (Donk 1962), the taxonomic debates around this taxon seemed to have finished. However, this issue has recently received further development (Migliozzi & Zecchin 1993a, b). For instance, genus *Lepiotella* (J.E. Gilbert) Konrad with species *Lepiotella irrorata* (Quél.) Konrad is suggested.

Up till now, the genus was considered as monotypic with several debated taxa included. Singer (1986) considers the genus *Chamaemyces* monotypic although he notes that an undescribed species *Mellomyces paraensis* Singer (ined.) from Brazil and *Lepiota rufipes* Morgan could enter the genus as representatives of a special subgenus. The former species was recombined in the genus as *Chamaemyces paraensis* Singer (Singer 1989). The thorough study of *Lepiota rufipes*

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by Vellinga (2001) suggests that this species could not be included in *Chamaemyces*.

The position of *Chamaemyces* in the framework of the family has been more or less defined since its establishment. Separated from *Lepiota* and yet recognized as its relative, *Chamaemyces* has been assigned to the tribe Lepioteae ever since it was described. Phylogenetic inference using nLSU and ITS as separate and combined datasets have not clarified the position of the genus. The hypothesis that *Chamaemyces* belongs to *Lepiota* either in a restricted (Singer 1986; Candusso & Lanzoni 1990; Bon 1996; Vellinga 2001) or in a wider sense (Friesian concept) is not unambiguously supported, as the two different data sets give different outcomes (Vellinga 2003b). It has been shown that while the position of *Chamaemyces* in Lepioteae can be accepted, its position within the tribe is not settled. Depending on alignment and data sets analyzed, placement of the genus changes from either inclusion into *Lepiota* or exclusion from it as a group basal to the whole family (Vellinga 2003a).

Materials and Methods

The study of the genus *Chamaemyces* in Israel is based on: (1) our investigations during the 1994–2002 growing seasons; (2) study of material at the Tel Aviv University Herbarium (TELA); and (3) review of the literature. *Chamaemyces* collections are kept at the herbarium of the Institute of Evolution, University of Haifa, Israel (HAI).

The species concept and definitions of infraspecific taxa follow the compromise definitions adopted at the Lausanne symposium in 1976 (Cléménçon 1977) and are according to Wasser (1985, 1989, 1993).

Spores and sections were examined in smear mount (mixture of glycerin, water, and ethanol 1:1:1) and in 3% w/v KOH. Thirty spores were measured in each preparation and 3–4 preparations were studied for each collection where possible. Quotient Q of spores, namely, ratio of length and width ($Q = l/w$) was calculated.

Descriptive part

Chamaemyces Batt. ex Earle, Bull. N. Y. Bot. Gard. 5: 446, 1909. — *Lepiota* subgen. *Lepiotella* J.E. Gilbert, Le genre *Amanita* Persoon, p. 159, 1918. — *Lepiotella* (J.E. Gilbert) J.E. Gilbert ex Kühner et Maire, Bull. Soc. Mycol. Fr. 50: 15, 1934. — *Drosella* Maire in Kühner et Maire, Bull. Soc. Mycol. Fr. 50: 15, 1934 (nom. nudum).

Type species: *Chamaemyces fracidus* (Fr.) Donk

General habitus of carpophores is similar to some middle-sized *Lepiota*. Pileus fleshy, with a gelatinous layer of different density or without it. Surface of a pileus might be covered with amber-yellowish drops leaving dark-colored spots on drying. Margin with or without remnants of general veil. Gills free. Gill trama regular, with inamyloid hyphae with clamps. Spore print

pale-ochre. Spores hyaline, inamyloid, cyanophilic, without germ pore, smooth, binucleate. Pleuro- and cheilocystidia are present. Stipe central, eccentric, cylindrical, covered with thin spot-like squamules below the ring. Ring upper, disappears early, can be seen mostly as the ring zone at maturity. Flesh whitish, turning black on autooxidation. Type of development of carpophores monovelangiocarpic and stipitocarpic (Singer 1986). Remnants of universal veil are present as the radiating hyphae at the pileus (Reijnders 1963).

Humus saprotroph, seldom growing on decayed wood, edible. Eurasian.

Chamaemyces fracidus (Fr.) Donk, Beih. Nova Hedwigia 5: 48, 1962. — *Agaricus fracidus* Fr., Epic. Syst. Mycol., p. 25, 1838. — *Lepiota irrorata* Qué., Comptes Rendu Assoc. Franc. Avanc. Sci. 11: 387, 1882. — *Lepiotella irrorata* (Qué.) J.E. Gilbert, Le genre *Amanita* Persoon, p. 159, 1918. — *L. irrorata* (Qué.) Konrad, Schweiz. Z. Pilzk. 12(12): 174, 1934. — *L. irrorata* f. *passerini* Migl. et Zecchin, Micol. Ital. 22(2): 51, 1993.

Pileus 2–7 cm in diam, thick-fleshy in the center, thin-fleshy towards the edge, hemispheric or hemispheric with applanate center, grayish with olive tint or yellowish-brownish, darker in the center, paler towards the margin, almost dry, with or without amber-yellow drops and black-brownish wavy remnants of the universal veil, with or without chestnut colored spots all over the surface. **Pileal covering** – hymeniderm, consists of hyphae 3–6 μ m wide, elongated, thin-walled, cylindrical, frequently septate, with numerous clamps. **Pileocystidia** 32.5–45 \times 12.5–15 μ m, clavate, thin-walled, hyaline or with intracellular pigment, slightly yellowish-brownish in 5% KOH, or may be absent (var. *pseudocastaneus*). If absent, terminal elements 10–13 μ m wide, long, slightly fusiform, thin-walled, hyaline are present. **Gills** free, thin, wide, ventricose, crowded, pale cream with yellow tint, with concolorous, even, sterile edge. **Gill trama** regular, hyphae elongated, cylindrical, 3–7 μ m in diam, often with clamps above septa. **Basidia** 18–26 \times 5–7.5 μ m, 4-sterigmatae, clavate. Sterigmata 2.5–3 μ m long. **Cheilocystidia** (25–) 30–50 \times 7.5–20 μ m, oblong-utriform, rounded-fusiform, abundant. **Pleurocystidia** same as cheilocystidia or 40–55 \times 12.5–15 μ m, shortly clavate, numerous. Spore-print cream. **Spores** 3–6.5 (–7.5) \times 2.5–5 μ m, $Q=1.13$ –1.6, broadly ovoid, roundish-ellipsoid, smooth, hyaline, without germ pore, thin-walled, inamyloid, metachromatic in Cresyl Blue. **Stipe** 3–6 \times 0.7–1.5 cm, central, cylindrical, narrowing towards the base, often curved at the center, solid, above ring-zone whitish, turns brown towards the base, is often beset with dark brown dots (glands). Young and fresh fruit bodies are often exuding small drops at the upper part of the stipe. **Ring** apical, narrow, the outer side is yellowish-brownish at first, becoming black-brownish with time, white-cream from the inner side, pending. **Flesh** white in pileus, whereas in stipe whitish, on exposure at the base becoming black, without any particular smell, taste acrid.

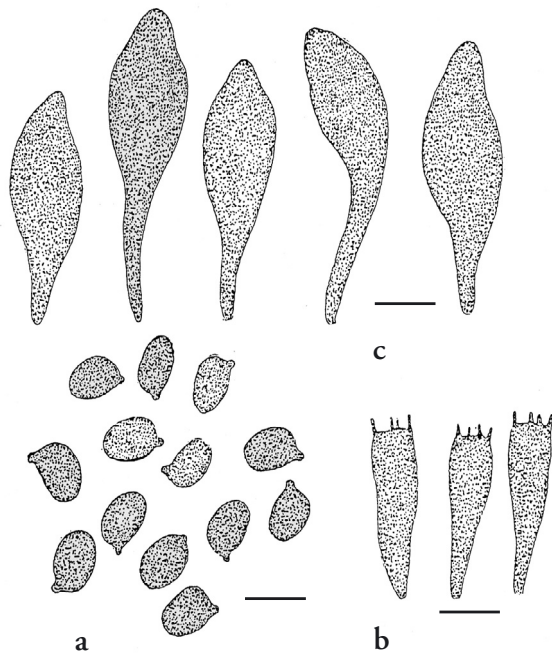


Fig. 1. *Chamaemyces fracidus* (Fr.) Donk var. *fracidus*: a – spores, b – basidia, c – cheilocystidia. Scale bars: a = 5 µm; b, c = 10 µm

var. *fracidus*

Pileus grayish with olive tint, darker in the center, paler towards the margin, almost dry, with or without amber-yellow drops and black-brownish wavy remnants of the universal veil. **Pileal covering** consists of 3–6 µm wide, elongated, thin-walled, cylindrical, frequently septated hyphae with numerous clamps. **Pileocystidia** 32.5–45 × 12.5–15 µm, clavate, thin-walled, hyaline, slightly yellowish-brownish in 5% KOH. **Basidia** 20–26 × 5–6 µm, clavate (Fig. 1b). **Cheilocystidia** 30–50 × 10–20 µm, oblong-utriform, rounded-fusiform, abundant (Fig. 1c). **Pleurocystidia** 40–55 × 12.5–15 µm, shortly clavate. **Spores** 3–5 × 2.5–3 µm (Fig. 1a), $Q=1.13-1.6$.

Specimens examined: ISRAEL: Mt. Carmel National Park, Nahal Neshet, in grass, 6 Dec 1994, leg. et det. S.P. Wasser, rev. M. Didukh (HAI 1001); Mt. Carmel National Park, Haifa University, 8 Dec 1994 (HAI 1002), 20 Dec 1994 (HAI 1003), 12 Jan 2000 (HAI 1004), *ibid.*, leg. et det. S.P. Wasser, rev. M. Didukh; 12 Dec 2001, leg. S.P. Wasser, det. M. Didukh (HAI 1005).

General distribution: Europe (France, the Netherlands, Denmark, Sweden, Switzerland, Italy, Greece, Germany, Austria, Hungary, Czech Republic, Lithuania, Ukraine) and Asia (Israel).

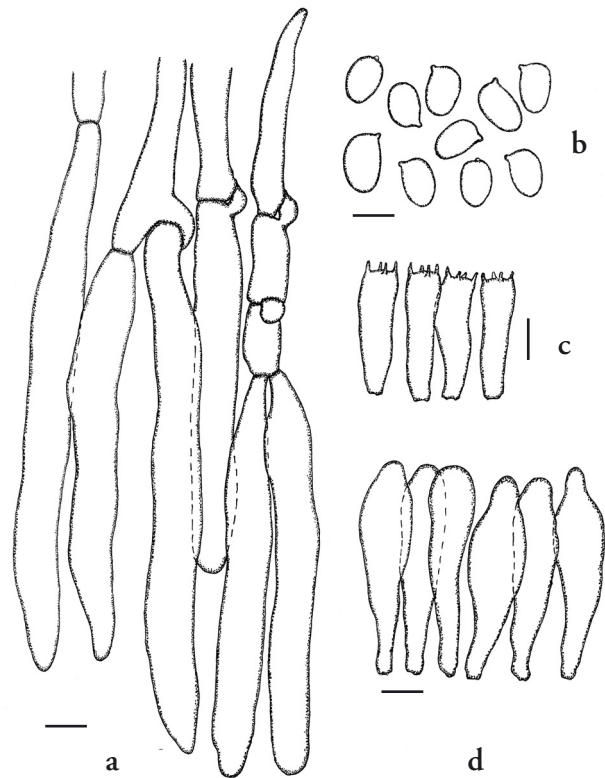


Fig. 2. *Chamaemyces fracidus* (Fr.) Donk var. *pseudocastaneus* Bon et Boiffard: a – elements of pileal covering, b – spores, c – basidia, d – cheilocystidia. Scale bars: a = 10 µm; b = 5 µm; c = 6.6 µm; d = 10 µm

var. *pseudocastaneus* Bon et Boiffard, Bull. Soc. Mycol. Fr. 90: 303, 1974.

Pileus 2.5–5 cm in diam, thick-fleshy in the center, thin-fleshy towards the edge, hemispherical when young, later on plano-convex with applanate center, yellowish-brownish, darker in the center, paler towards the margin, with chestnut colored spots all over the surface, almost dry, devoid of black-brownish wavy remnants of the universal veil. **Pileal covering** (Fig. 2a) with terminal elements 10–13 µm wide, long, slightly fusiform, thin-walled, hyaline. **Pileocystidia** absent. **Basidia** 18–23 × 6–8 µm, 4-sterigmatae, clavate (Fig. 2c). Sterigmata 2.5–3 µm long. **Cheilocystidia** (25–) 30–40 × 7.5–10 µm, oblong-utriform, rounded-fusiform (Fig. 2d), abundant. **Pleurocystidia** same as cheilocystidia. **Spores** 4.5–6.5 (–7.5) × 4–5 µm, $Q=1.13-1.3$, oblong, ellipsoid, more ovoid in frontal view (Fig. 2b), smooth, hyaline, without germ pore, thin-walled, inamyloid, metachromatic in Cresyl Blue.

Specimen examined: ISRAEL: Mt. Carmel National Park, Nahal Neshet, in grass, 21 Dec 1994, leg. S.P. Wasser, det. S.P. Wasser & M. Didukh (HAI 1006).

General distribution: Europe (France and Italy) and Asia (Israel).

Notes: Both varieties of *Ch. fracidus* are new to Asia. In view of rare occurrence of var. *pseudocastaneus* its complete description is given. Basic differences from var. *fracidus* based

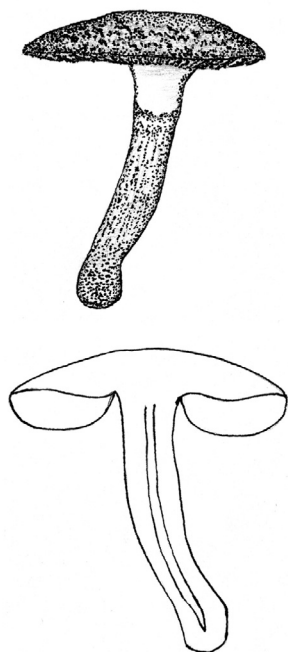


Fig. 3. *Chamaemyces carmelensis* M. Didukh et S. Wasser: fruit bodies

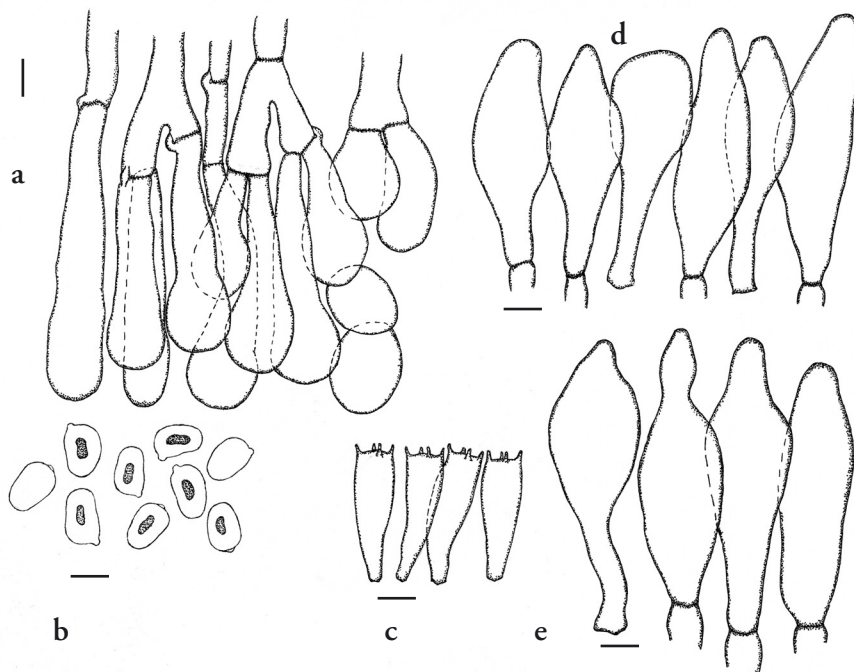


Fig. 4. *Chamaemyces carmelensis* M. Didukh et S. Wasser: a – elements of pileal covering, b – spores, c – basidia, d – cheilocystidia, e – pleurocystidia. Scale bars: a = 5 μm ; b = 3 μm ; c-e = 6.6 μm

on the studied specimen are absence of pileocystidia, bigger spores, smaller cheilocystidia. Besides microscopic differences, var. *pseudocastaneus* is distinguished by more yellow-tinted colors of pileus and chestnut spots at the surface of pileus (probably dry exudate drops) (Candusso & Lanzoni 1990; Collucci & Galli 1995). The variety is treated as a separate species by Contu (1990) – *Chamaemyces pseudocastaneus* (Bon et Boiffard) Contu.

In the opinion of Miglioizzi & Zecchin (1993a, b) *Ch. fracidus* is an erroneous name of *Lepiotella irrorata* (Quél.) J.E. Gilbert (= *L. irrorata* (Quél.) Konrad) presenting a complex of three formae: *irrorata* (= *fracidus*), *pseudocastanea*, and *passerini* Migl. et Zecchin. The latter forma (treated here as a synonym) differs from the type in the smaller size of fruit bodies and especially in darker olive tints of the pileus.

We do not accept combination transforming existing varieties into formae in view of existing microscopic differences between them.

Chamaemyces carmelensis M. Didukh et S. Wasser, **sp. nov.**

Pileus 2.2-7 cm *latus*, *primo plano-convexus*, *postea convexus*, *applanatus*, *cum truncatus minutus umbo*, *argilla*, *murinus*, *cinereus*. *Pileipellis hyphis clavatus* 14.4-29 \times 7.2-12 μm , *subgloboseus* 10-12 \times 8.4-9.6 μm . *Lamellae liberae*, *albidae*, *ventricosum*, *cum collarium distinctum*, *margo concoloris*. *Lamellae trama irregularis*, *ad hyphae* 10-15 μm *latus composita*. *Basidia* 21.5-23 \times 6-7.5 μm , 4 *sterigmatica*, *clavata*. *Acies lamellarum steriles*. *Cheilocystidia* 38-55 \times 14-16 μm , *fusiformis*, *angustus utrififormibus*, *non frequenter clavata*. *Pleurocystidia* 43-55 \times 14.4-16 μm , *latus utrififormibus*, *clavata*

ad apicem attenuatus, *lageniformis*. *Sporae* 4.4-5.5 \times 2.7-3.3 μm , *oblongus*, *leviter phaseoliformis e latere*, *cum apiculus distinctum*, *hyalinae*, *non metachromaticae*. *Stipes* 3.6-5 \times 0.5-1 cm, *centralis*, *ad apicem albidus vel pallidus griseus*, *ad basim umbrinus*, *cum basis attenuatus vel leviter dilatatus*, *angustus fistularis*. *Caro albida*, *immutabilis*. *Odor et sapor nullus*.

Holotypus: Israel, 'Mt. Carmel National Park', sub *Pinus halepensis* Mill., 7.XI.2002, leg. S.P. Wasser, det. M. Didukh et S.P. Wasser. In herbario 'Inst. of Evolution' (HAI 1007) *conservatur est*.

A speciebus differe in Chamaemyces fracidus ab sporae formae, pleurocystidia formae; sporae, cystidia, epicutis pilei cellulae non metachromaticae.

Pileus 2.2-7 cm in diam, plano-convex with inflexed margin in young and convex with straight to reflexed margin in mature (Fig. 3); with a small truncate umbo or without it; cigar-brown in the center, clay or vinaceous buff towards the margin; cuticle is smooth in the center, cracks into tiny concentric squamules towards the margin; thick-fleshed in the center, thin-fleshed towards the margin. **Pileal covering** a hymeniderm made up of tightly packed clavate to broadly clavate, 14.4-29 \times 7.2-12 μm , or subglobose, 10-12 \times 8.4-9.6 μm , elements, joined into small bundles and groups (Fig. 4a). Subcutis composed of frequently septate, sometimes thick-walled hyphae, 4-5 μm in diam with numerous short, small clamps. **Gills** white, ventricose, free with a very distinct wide collarium, wide, thin, crowded, with slightly eroded concolorous edge. **Gill trama** irregular, composed of hyphae 10-15 μm in diam.

Basidia 21.5-23 × 6-7.5 µm, 4-sterigmatae, clavate (Fig. 4c). Sterigmata 2.4-3 µm long. **Cheilocystidia** 38-55 × 14-16 µm, fusiform, broadly fusiform, narrowly utriform, seldom clavate (Fig. 4d), abundant. **Pleurocystidia** 43-55 × 14.4-16 µm, broadly utriform, clavate tapering towards the apex, lageniform with a very short neck, frequent (Fig. 4e). **Spores** 4.4-5.5 × 2.7-3.3 µm, Q=1.6, hyaline, oblong, almost cylindrical (Fig. 4b), slightly phaseoliform in side view, with distinct hilar appendage, smooth, hyaline, uniguttulate, inamyloid, not metachromatic. **Stipe** 3.6-5 × 0.5-1 cm, central, whitish or pale gray in the upper part, umber or bay towards the base, straight or slightly curving, smooth, with a tapering or slightly widened base; narrowly fistulose. **Ring** present only as a velar zone with small flakes. **Flesh** is white and unchanging in all parts of the fruit body, devoid of any specific smell or taste.

Etymology: *Ch. carmelensis* is named after Mt. Carmel (Israel), where it was found for the first time.

Holotype: ISRAEL: Mt. Carmel National Park, University of Haifa, under *Pinus halepensis* Mill., 7 Nov 2002, leg. S.P. Wasser, det. M. Didukh et S.P. Wasser (HAI 1007).

Basic differences between varieties of *Ch. fracidus* and *Ch. carmelensis* include particularities of pileal covering

(shape and size of terminal elements, pileocystidia not observed), shape of cheilocystidia, size and shape of spores, absence of metachromacy of spores, cystidia, and elements of pileal covering.

Note: *Ch. carmelensis* macroscopically resembles *Lepiota brunneoincarnata* Chodat et C. Martín or *L. subincarnata* J.E. Lange. However, its microscopic traits and microscopic chemical reactions assign it to the genus *Chamaemyces*.

Apart from the species presented above, possibly one species from North America – *Ch. alphitophyllus* (Berk. et M.A. Curtis) Murrill (= *Oudemansiella canarii* (Jungh.) Höhn.), and one species from Brazil (*Chamaemyces medullaris* (Rick) Raitheh., belong to the genus as well. However, none of these taxa, including *Ch. paraensis*, have yet been encountered in Israel.

Chamaemyces carmelensis and varieties of *Ch. fracidus* are not widespread throughout the country. They occur on the territory of the Mt. Carmel National Park and University of Haifa (Mt. Carmel). The studied specimens have been collected repeatedly from closely situated manmade habitats (lawns). The vegetation period is rather short – end of December-beginning of January. None of the taxa had a gelatinized pileus. The species of the genus present in Israel can be presented in the following key.

Key to the species of the genus *Chamaemyces* present in Israel

- 1 Pileus cigar-brown in the center, clay or vinaceous buff towards the margin, smooth in the center, with concentric squamules towards the margin and pileal covering hymeniderm, made up of tightly packed clavate to broadly clavate, 14.4-29 × 7.2-12 µm, or subglobose, 10-12 × 8.4-9.6 µm, elements, joined into small bundles and groups; spores 4.4-5.5 × 2.7-3.3 µm, oblong, almost cylindrical, slightly phaseoliform in side view, not metachromatic in Cresyl Blue. *Ch. carmelensis*
- 1* Pileus smooth, grayish with olive tint or yellowish-brownish, spores metachromatic in Cresyl Blue. 2
- 2 Pileal covering consists of 3-6 µm wide, elongated, thin-walled, cylindrical, frequently septated hyphae with numerous clamps. Pileocystidia 32.5-45 × 12.5-15 µm, clavate, thin-walled, hyaline, slightly yellowish-brownish in 5% KOH are present. Spores 3-5 × 2.5-3 µm, broadly ovoid, roundish-ellipsoid. *Ch. fracidus* var. *fracidus*
- 2* Pileal covering without pileocystidia, with terminal elements 10-13 µm wide, long, slightly fusiform, thin-walled, hyaline; spores 4.5-6.5 (-7.5) × 4-5 µm, oblong, ellipsoid, more ovoid in frontal view, smooth, hyaline, thin-walled. *Ch. fracidus* var. *pseudocastaneus*

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